European Advanced Networking Test Center

Competitive Test Report

Force10 TeraScale E-Series
versus
Cisco Catalyst 6500

EANTC AG

September 2005

European Advanced Networking Test Center

Force10 TeraScale E-Series — Cisco Catalyst 6500 Competitive Test

Introduction

In June 2005, Cisco Systems commissioned the European Advanced Networking Test Center (EANTC) to independently validate the performance, scalability, and availability of Cisco Catalyst 6500 versus Force10 TeraScale E-Series switches. Force10 promotes network designs where large numbers of ports, normally spread across multiple switches in a redundant network configuration are instead "collapsed" into a single high port-density solution comprising a single switch with up to 1,260 Gigabit Ethernet ports. Clearly this is a major departure from current industry accepted network design best practices and one that raises significant questions with regard to service scalability and availability.

To answer these and many other questions raised by the Force10 TeraScale architecture, we conducted a number of tests to investigate just how well the Force10 switches compare to the Cisco Catalyst 6500.

EANTC extensively tested the following categories:

- **Force10's Performance claims made in the Tolly Group Test Reports**
- **Force10's High Availability Claims**
- **Routing Protocol Scalability, Stability, & Resilience**
- **IP Multicast Scalability, Stability, & Resilience**

Our tests are divided into the following broad categories:

- **Investigate Force10 claims made in the Tolly Group reports:** We compare the performance, availability, and scalability claims made by Force10 as validated by the Tolly Group with our own findings. Force10's tests can be found at http://www.tolly.com/Search.aspx?VendorID=27 and are contained in Test Reports 204147 and 204148.

- **Test Force10's High Availability Claims:** We specifically tested the high availability claims made by Force10 as this is such an important part of Force10's proposed network designs. We used the claims made in the Tolly Group test reports and Force10's whitepapers entitled "High Availability in the Force10 Networks E-Series" (Version 1.3) and "Guaranteed Access to System Management even During Processor Overload" as our guide.

- **Routing Protocol Scalability, Stability, & Resilience:** In this section of tests, we focused on the scalability, stability, and resilience of the control plane, the brains of the switch. If the control plane is not capable of scaling to support the high port density of the Force10 switches, then the higher port density offered by the E-Series is of questionable value. For instance, can the routing protocols support the same number of neighbors as there are ports on the switch? How long does it take to learn routes from such a large number of neighbor routers? What about convergence times? A very powerful control plane matching the very large number of interfaces is required to ensure the switch remains stable.

- **IP Multicast Scalability, Stability, & Resilience:** IP multicast traffic is becoming an increasingly important capability of many networks, applications range from remote learning, distribution of market data feeds in trading rooms to the data streams used in education for remote learning applications etc. How does the high availability claims for the Force10 switches apply to mission critical multicast traffic? What multicast scalability can I expect? How effective are Force10's multicast resilience features?

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Aktiengesellschaft

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September 23, 2005

Feedback to Tolly/F10 BGP Scalability Test
Request for Clarification

Dear Kevin, Adolfo,
Dear Andy,

Again, thank you for your cooperation with regards to our request to provide the configurations of some of the Force10 E1200 tests you published.

We have completed our reruns of the "6-million BGP path", "1-million ACL" and IPv6 test cases. Unfortunately we were unable to recreate the behavior documented in the Tolly Group test report.

6-Million BGP Path Test

The test configurations you forwarded showed that 25 equal-cost paths and 260,000 unique BGP routes were used.

In the production release software we used (6.2.1.3), the FToS software only allowed us to create a maximum of 16 equal-cost paths, reducing the maximum number of BGP paths substantially.

It appears that Force10 may have used specially crafted software in your tests to achieve these results, and that subsequently this ability to configure 25 equal-cost paths has never been made available in production software.

When we tried to reach 6 million paths with 16 equal-cost paths used 375,000 unique BGP routes, the E1200 supported the 6 million BGP paths at the software level, but this caused a CAM overload and general instability of the switch in our test.

We believe that the test configuration you used was artificially designed to reach 6 million BGP paths. We do not see any real-world applications for 25 equal-cost BGP paths, and we believe that the fact that only BGP path scalability as opposed to route scalability was reported is misleading.

1-Million ACL Test

Thank you for providing the Force10 configuration used in this test. We cut and pasted your original 20,933 line ACL (not 1 million) to the Force10 E1200, and tried to apply it to an interface as an

ingress ACL.

The switch failed to load anything beyond 12,000 ACL entries per port-pipe.

Once again, this raises the question how was the test run at your labs? Was there any special hardware or software used?

IPv6 Test

Thank you for the Ixia configuration you provided in response to our request. From this configuration, we were able to derive how the test was run and attempted to recreate it.

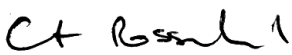
We were unable to configure IPv6 interfaces in the FTOS 6.2.1.3 production release, 12 months after the Tolly report was published.

In the report, you stated that the beta release would be released as version 6.1.1.0. Did you ever repeat the test with FTOS production releases to confirm your statement?

It would be great if you could comment on our findings in writing before COB Thursday, September 29th. Any comments received until then will be viewed as your final statements. Please be aware we reserve the right to make your responses public.

Thank you very much for your cooperation!

Best regards,



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September 28, 2005

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Dear Carsten,

Thank you for giving us the chance to respond to the questions you raised in your letter to Andrew Feldman, vice president of marketing at Force10 Networks, and Kevin Tolly, president and CEO of The Tolly Group, dated September 23.

The Force10 E-Series is a sophisticated, high capacity platform that can be modified to meet many different customer requirements. The E-Series anchors some of the world's largest and most complex networks, including the data centers of top search engine companies and many of the largest supercomputers in the world.

The Force10 E-Series architecture enables a scalability that is unmatched by competitive products. To meet the extraordinarily specialized requirements of its leading customers, Force10 leverages a dynamic CAM configuration. These are specialized CAM profiles for cutting edge companies that have unique networking requirements. As is common practice in our industry, we do not include each of these CAM profiles in our general purpose builds.

We can assure you that the test results are irrefutable and can be easily demonstrated.

Below are answers to each of the questions you raised.

1. Six Million BGP Path Test
   ==========

   This test is done using two IXIA ports connected to DUT. The IP addresses assigned to the E1200 ports are 192.1.1.1 and 192.2.1.1. The E1200 is configured with two BGP peer groups and 25 peers per peer group. Each IXIA port is configured with 25 peers. Each peer on port one advertises the same 130,000 prefixes starting from 1.0.0.0/24 while each peer on port two advertises the same 130,000 prefixes starting from 3.0.0.0/24. This constitutes a total of 260,000 unique prefixes and 6.5 million BGP paths. Data streams are set up such that port two of IXIA generates traffic for all routes advertised by port one and vice versa.

   Once all peers have come up and BGP has converged completely, we forward traffic for all advertised prefixes to ensure traffic flows with zero packet loss.

In the general release build, we download data for the first 16 ECMP paths in the forwarding table. This way, if there is a back-hoe issue that takes fiber down, we can quickly populate the routes from the remaining good fiber. We have several service provider customers who have asked for 32 ECMPs, and our system is flexible enough to accommodate that request (even in hardware, using a different CAM profile). In fact, we are currently deployed in several service

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provider networks that extend beyond this, leveraging the density, reliability and resiliency of the E-Series to aggregate multiple devices using a combination of LAG and ECMP.

In your September 23rd email, you indicated that the E1200 was able to handle the 6.5 million paths. EATNC seems not to see any application for 25 ECMPs. We can only suggest that our customer base differs significantly from that of the company that paid you to test the E-Series.

2. One Million ACL Test
==========

We tested the one million ACLs by using a CAM profile that gave more space to Layer 3 ACLs and less to Layer 2, a scenario that is in production at several of the largest national laboratories. These customers use an intrusion detection system to pump large numbers of ACLs at exceptional speeds. They use our system as a Layer 3 router and do not need Layer 2 entries. To help protect their infrastructure and meet their networking needs, we developed a CAM profile that doubles the standard 12,000 entries to 24,000.

The test we did is fully documented with ACL counters for all entries.

For additional information on how Lawrence Berkeley National Laboratory is using this application, please visit http://www.force10networks.com/applications/profiles-LBLids.asp.

3. IPv6 Test
=========

Force10's decision to delay the release of the IPv6 software features was a business decision dictated by the demands of its rapidly growing customer base. In listening to our customer base, which has increased by 350 percent over the last year, we prioritized other features ahead of IPv6. This decision is validated by the fact that Force10's revenue will increase more than 100 percent in fiscal year 2005, faster than every other competitor in the market.

I hope we have answered all your questions. If any remain, we are happy to demonstrate our performance results to you anytime.

Sincerely,

Stephen Garrison
Vice President, Corporate Marketing
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PERMISSION IS GRANTED ONLY TO QUOTE THIS LETTER IN ITS ENTIRETY

Tolly Group Test of Force10 E1200

27 September 2005

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Managing Director, EANTC AG

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Dear Mr. Rossenhövel,

In August 2004, The Tolly Group conducted tests of the Force10 E1200 running a beta release of their software. The results were summarized in two public documents, 204147 & 204148. In those documents, the system software tested is clearly listed as beta.

You noted that you had difficulty reproducing some of the results with the version of software that you tested which was, as you note, different from the version we tested. I have been informed that, separately, Force 10 networks will provide you with a document that explains the results that you saw.

Please note that you apparently misunderstood the configuration information that we sent to you for the 1-million ACL test. We provided a file containing 20,933 access list entries. This was the configuration for a single port. In our test, we applied this configuration to each of 56 ports for a total of 1,172,248 ACLs. Given that we sent this information to you over two and a half months ago, we are surprised that you never questioned us about it in the interim or why your team could not understand that what was sent was the configuration for a single port. You simply chose, in reporting your findings to us, to tell us after the fact that we had sent you a “20,933 line ACL (not 1 million)” file. We would have been happy to clarify this point for your engineers as we did with other questions that you had over the course of your project.

Sincerely yours,

Kevin W. Tolly

Pres. & CEO

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About EANTC

EANTC (European Advanced Networking Test Center) is an internationally recognized test lab based in Berlin, Germany. We offer vendor neutral network test facilities for manufacturers, service providers and enterprise customers. Our business areas include:

➜ Test and Certification Services for Network Equipment Manufacturers

EANTC provides external quality assurance by testing conformance, performance and robustness of single systems as well as the interoperability of multiple components. More than 14 years of testing experience, the use of state of the art analysis equipment and active participation in industry forums enable us to conduct tests even for the most advanced customer requirements.

EANTC tests cover the full range of Carrier Ethernet, IP, and MPLS networks, IP services including firewalls and VPN gateways, ATM, and voice over packet networks.

➜ Test Services for Service Providers and Enterprises

EANTC supports network operators during all stages of the infrastructure life cycle: From network design and RfP creation through prototype testing during the tender process and acceptance testing up to trouble-shooting and future capacity planning. Our tests ensure network performance, availability and resilience. They reduce the risk of network failure and cost of operation.

➜ Philosophy

In all our activities — whether we conduct tests, provide consultancy or training — only the highest quality serves our purpose. EANTC invests much in research, education and development of new test methods to meet the demands of our customers. Our active participation in industry forums is a must to stay up to date.

We often find ourselves mediating between network operators, vendors and systems integrators in a cross-cultural environment. EANTC test services result in neutral, unbiased facts. Our detailed test reports provide the basis for rational decisions and actions. We ensure confidentiality in any required way.

➜ History

In 1991, EANTC was founded at the Technical University of Berlin. EANTC soon started to test and certify network components for high speed network technologies, and continued the close cooperation with the university after its spin-off in 1999.