Huawei 1T Line Processing Unit

Performance, Scale, Power Efficiency and Functionality Test Report

Introduction

In October 2013, we released a report investigating Huawei's LPUF-400 line cards – a 4 ports 100GigabitEthernet (GbE) line card which was hosted in Huawei's core router – The NE5000E. Not 4 month later, Huawei approached us again and asked to up the ante with a new test focusing on their new 1T Line Processing Unit (LPU).

As the name indicates the new interface is aiming to provide 1Tbit per second in a single Huawei NE5000E slot. The goal is indeed impressive and is likely to be a welcome upgrade to service providers especially those that already have the NE5000E installed in their network, but are running out of capacity. In theory, one could pull out the existing line cards, replace them with the new line cards and achieve higher capacity in the same form factor – no forklift upgrade needed.

Background

At EANTC we spend a large portion of our time executing service provider Proof of Concept (PoC) tests. In these tests service providers always try to determine which solution will best fit their needs as they evolve their network. The needs are specified in Request for Proposal (RfP) documents which tends to look similar between different service providers.

We used the same approach in this engagement asking ourselves what would a service provider look for before deciding to install a new line card in the network. Since the control plane, which we tested in October 2013, sitting in the same router, did not change, we really tried to focus the tests on line-card specific functions such as forwarding performance and forwarding information base (FIB) scale as well as the power consumption. To be sure that the router still functions as we have seen in the previous tests we also ran through a serious of functional tests to check that the traditional service provider-oriented services were working just fine.

	Test Results Highlights
Throughput	→ LPUI-1T 8x 100GbE: 800 Gbit/s Per Slot Capacity For All Frame Sizes Tested → LPUI-1T 24x 40GbE: 960 Gbit/s Slot Capacity For All Frame Sizes Tested
Scale	→ 3.6 Million IPv4 and IPv6 Routes in FIB
Power Efficiency	→ 667 Watt Modular Power Consumption for LPUI-1T 8x 100GbE at Full Load
Resiliency	→ eBGP Average Convergence Time For Dual Stack 4.4 s With 500,000 Routes → IS-IS Average Convergence Time For Dual Stack 301 ms With 20,000 IS-IS Routes

Tested Devices and Equipment

The same NetEngine 5000E that was used in the previous engagement with Huawei was used in this test again. The difference now was that it was equipped with two 8-port 100GbE LPUI-1T line cards. Two of the 4-port 100GbE LPUF-400, which we tested in October, were also installed in the router and enabled us to test various aggregation scenarios. In one additional test case we used two of Huawei's 24x 40GbE line cards to measure slot performance. The router was running Huawei Versatile Routing Platform VRP (R) software version 8.80 in all test cases.

Ixia supported the tests with an XG12 chassis installed with Xcellon-Lava 40/100-Gigabit Ethernet test module. In the performance test cases we connected the Huawei NE5000E directly to the tester while in the functionality test cases we build complete network topologies and emulated customer edge routers.

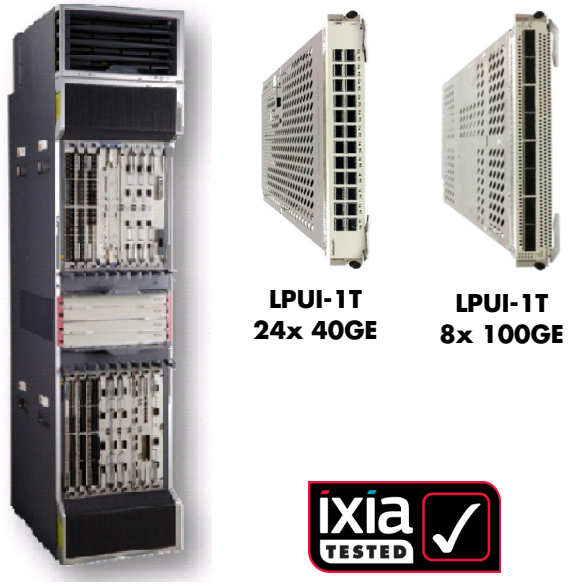

Figure 1: Huawei NE5000E and LPUI-1T Cards

Test Results: Performance

The main focus of the tests was the performance of the new line cards. Two variants of the LPUI-1T were available for the tests: the 8x 100GbE and the 24x 40GbE. We tested each of the line cards by itself using the same methodology. Each setup included two line cards of the same type sending traffic from ingress ports on one line card to the other line card.

We followed the methodology specified in RFC 2544 for throughput measurements with a few slight modifications: the smallest frame size used, at Huawei's recommendation, was 128 bytes and the largest 9000 bytes. We also ran a test in which a mix of packets was used, with frame sizes spread across the spectrum from 64-byte to 9000 bytes, with emphasis on the smaller frame sizes.

Throughput of LPUI-1T 8x100GbE

The results of the first test showed that the performance of the LPUI-1T line card matched its port capacity. In all frame sizes and all test runs we measured line rate forwarding of 800Gbit/s per slot. The latency followed the frame sizes, as expected, and was spread between maximum of 22 microseconds for frame size 128 bytes and 21 microseconds for 9000 bytes.

We repeated the same test for a mix of 80% IPv4 and 20% IPv6 traffic. Adding IPv6 to the mix did not decrease the performance of the router nor did we record higher latency.

Since this test campaign was based on the previous set of tests that used Huawei's LPUF-400 we asked Huawei to supply us with two such line cards so we could measure the throughput between the new line card and two of the previously-tested line cards. We wanted to confirm that service providers increasing their network capacity slowly will continue enjoying healthy operations. We executed the test with IPv4 traffic only and measured the same performance as in the previous test setup with comparable latency.

Throughput of LPUI-1T 24x40GbE

The results of the 24 ports 40 GbE tests (using QSFP+) allowed us to get closer to the suggested performance of the line card. Since we had 24 ports of 40GigabitEthernet, we could expect to achieve 960Gbit/s per slot. And indeed, this was the performance we measured.

Since so many ports were required for the test, we used the so-called "snake" configuration in which only two tester ports are needed: an ingress port sending to the first device under test port and an egress port receiving the traffic. The QSFP+ ports on the line cards we tested were configured in such a way that each was cabled to the next port. Using logical connections in the router, traffic was forced to leave each port to the next port on that connection.

While the tester could only measure 40Gbit/s, in order to measure said value the whole test bed had to support the aggregation of the 40Gbit/ multiplied by the number of ports which is why we could safely report that the Huawei 24x40GbE line cards supported 960 Gbit/s per slot.

We followed the same system and configuration in this test and measured also the performance for a mix of IPv4 and IPv6 traffic. The results showed that mixing IPv4 and IPv6 traffic, at the 80%/20% ratio we used, did not adversely influence the forwarding performance of the solution.

We also measured latency in both 24x40GbE test cases, however, the use of the "snake" configuration meant that by the time the test packet left the router, the latency was multiplied 24 times. This meant that the results could not be used but in general, after dividing them by 24, matches the performance of the 8x100GbE line cards.

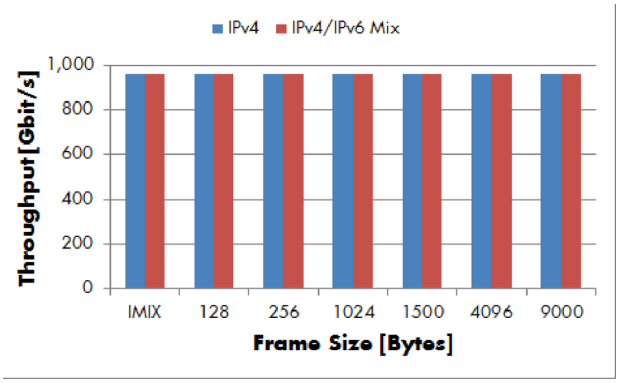

Figure 2: 960Gbit/s Per Line Card Test Results

The table below shows the results of the forwarding performance tests:

Test Focus	Test Parameters	Results
Two 8x 100GbE (All across the backplane)	Frame Sizes 128-9000 Bytes and IMIX IPv4 and IPv6 traffic mix	800Gbit/s per slot
One 8x 100GbE to 2x4x100GbE	Frame Sizes 128-9000 Bytes and IMIX IPv4 only	800Gbit/s per slot
Two 24x40GbE (All across the backplane)	Frame Sizes 128-9000 Bytes and IMIX IPv4 and IPv6 traffic mix	960Gbit/s per slot

Test Results: Power Efficiency

The current pressure that service providers are experiencing in keeping their networks profitable translates to an intense focus on the operational cost (OPEX). Huawei was keen on demonstrating that the new LPUI-1T is actually more power efficient than the previous module we tested. Once again, we followed the test methodology defined in ATIS-0600015.03.2013 specification, performing two test runs. All tests used Huawei's basic (default) mode.

Power Consumption of a Representative Chassis Configuration

The first test run involved a fully populated chassis with heterogeneous line cards. Huawei provided two LPUI-1T 8x100GbE line cards along side two 4x100GbE and 12 10x10GbE line cards. With this, all line card slots in the chassis were filled. We calculated the weighted energy consumption to be 7,186, while the power consumption at 100% load was 7,683 watts.

This value was needed in order to allow us to calculate the power consumption of a single LPUI-1T 8x 100GbE which was the real interesting value that Huawei wanted us to measure. This measurement is different than the one we executed in the October, 2013 report. Huawei explained that the focus on a single line card power consumption would allow service providers to understand and calculate the power needed to support the systems as they migrate towards the new LPUI-1T. We complied with Huawei's suggestions and performed an additional test to measure just the 8x100GbE line card based on the ATIS standard.

Modular Power Consumption of LPUI-1T 8x 100GbE

In the baseline test we measured the power consumption of a representative NE5000E configuration. In this test we repeated the measurement with one significant change: the LPUI-1T 8x100GbE module was removed before the tests started. This allowed us to follow the ATIS methodology in calculating the power required to drive the line card – by a process of eliminating.

We measured that the system's weighted energy consumption was 6,603 Watts which meant that, by subtracting this value from the full chassis weighted energy consumption value we arrived at our goal of identifying how much energy will be needed to power a single Huawei LPUI-1T 8x 100GbE line card: 583 Watts. The calculated energy efficiency rating for the line card, which describes how much energy is needed to pass a Gigabit/second through the system, was 0.83 at full load. For reference, the system's power consumption at 100% load, without the LPUI-1T 8x100GbE cards was 7,016 watts.

Test Results: Resiliency

To round up the tests we performed two routing-oriented test cases that were meant to measure the convergence time the Huawei NE5000E requires to switch to new path once routes are withdrawn. We used a three-router topology to enable a bypass route in the network and repeated the tests three times to make sure that we do not have any outliers in the results. We present both test results below.

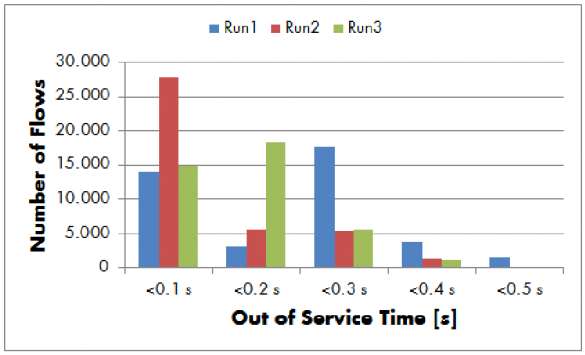

Figure 3: ISIS Out of Service Time Distribution

Figure 4: eBGP Out of Service Time Distribution

Test Results: Router Functionality and Scale

Along side the forwarding performance of the new line cards, we also measured the forwarding information base (FIB) capacity of the line card and verified that some essential core functionality was working adequately in the NE5000E.

The FIB scalability test was relatively straight forward. We advertised 3,200,000 unique IPv4 routes as well as 400,000 IPv6 routes and sent traffic to each of these advertised prefixes. We verified that all 3.6 routes were indeed learned and installed in the line card's FIB.

We then increased the number of routes advertised by 10% to verified that if a sudden spike to routes occurs, the router will not suffer a catastrophic failure. Indeed, increase the number of routes caused no such catastrophe and the router remained stable.

We also ran through the gamut of possible use cases under which the router will be used. We support for Virtual Private LAN Services (VPLS), IP/MPLS Layer 3 VPNs (L3VPNs), as well as 6PE – a method service providers could use to support IPv6 connectivity over an IPv4 core. We also verified multicast functionality with PIM Sparse Mode for both IPv4 and IPv6 streams. All services we tested functioned as expected.

Summary

The tests real focused on the new service-provider focused LPUI-1T line card. We verified that the line card performance was as Huawei claimed and was able to forward full line rate of traffic for all frame sizes tested. The new line card also seemed to contain the power consumption well. Here we were helped by the results we obtained in a previous test and could compare between the power required to move one Gigabit per second.

All core-routing functionality we tested functioned as expected and as Huawei advertised. The NE5000E, equipped with the new LPUI-1T is indeed a powerful core-backbone workhorse with ample selection of line cards and impressive port density.

About EANTC

The European Advanced Networking Test Center (EANTC) offers vendor-neutral network test services for manufacturers, service providers and enterprise customers. Primary business areas include interoperability, conformance and performance testing for IP, MPLS, Mobile Backhaul, VoIP, Carrier Ethernet, Triple Play, and IP applications.

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