Proving a Realistic Use Case for Edge Virtualization

BROCADE FORTINET intel IXIA OVERTURE SPIRENT SUPERMICRO

Consortium of key industry players collaborate to provide independent NFV performance and service chain validation on low-cost COTS hardware

Brocade, Fortinet, Intel, Ixia, Overture, Spirent and Supermicro are all companies that are heavily involved in the software-defined networking (SDN) and Network Functions Virtualization (NFV) movement. Under the sponsorship of the Intel Network Builders program, these companies collaborated to provide the industry with a set of performance data that proves the business case for deploying virtualization at the network edge. EANTC was retained to execute a series of tests using a realistic traffic profile that passed through several Virtual Network Functions (VNFs).

The customer group for the defined use case was small & medium enterprises (SMEs). Like other customers, SMEs try to mitigate cost when investment decisions have to be made.

Use Case

Together with the vendors, EANTC identified a specific use case that included a service chain of typical network functions, such as switch, router and a firewall.

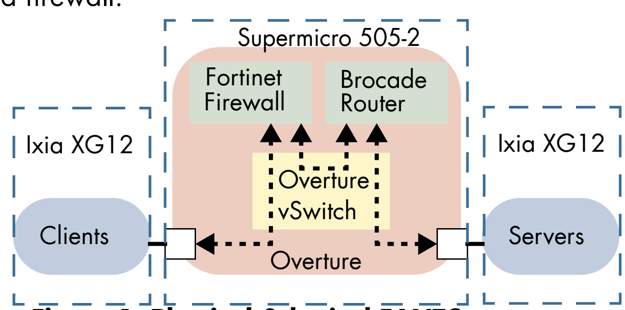


Figure 1: Physical & logical EANTC test setup

We expected the service chain to provide basic functionality and suitable performance that a company would require, as well as an easy-to-set-up drop-in replacement for an infrastructure of an access router and a firewall. The flexibility to add functions and adjust performance was also required.

Test Highlights

- → **100% Line Rate vSwitch Throughput Performance On 1 CPU Core Only**
- → **1 GBit Throughput with Multiple VNFs Running On COTS Hardware**
- → **Tested With Advanced Firewall Features And Realistic Rule Set**
- → **Built-in Performance Testing**

Test Scenario

The test scenarios were based on the assumption that a small company network would serve up to 200 active users, and would have an Internet connection capacity in the range of 100 megabits per second (Mbit/s) and 1 gigabit per second (Gbit/s). We also defined a Layer 7 traffic profile, which reflected typical Internet usage, containing 60% HTTP (small objects), 35% HTTP video (large objects), 4% FTP and 1% DNS traffic.

Although our use case involved a router instance, the routing was not complex. We wanted to simulate a single local network, where the service chain served as a gateway to the Internet provider. In order to add some complexity for the router, we enabled NAT masquerading, a feature that might be realistically required in our use case.

For the firewall configuration, we defined rules to deny access to certain IP ranges; and to only allow access to the Internet for a number of ports, while blocking any connection attempts from the outside. For a realistically complex test scenario we defined a set of 100 rules for the firewall.

Test Goals

Utilizing both Ixia and Spirent products in various scenarios, we validated the following:

- Throughput performance of each separate VNFs (vSwitch, vRouter, vFirewall).
- Throughput and latency of the full service chain with a realistic traffic mix.
- Long-term stability under high load.

Tested Components

The following components were tested:

Hardware: The hardware platform used in the test was a Supermicro 505-2 server, equipped with an eight-core Intel® Atom™ processor. Measuring 1 rack unit, the platform is compact, energy-efficient and affordable, and it is suitable for network virtualization.

vSwitch: The Overture Ensemble Carrier Ethernet (ECE) VNF is based on a KVM+QEMU hypervisor enhanced with Dataplane Development Kit (DPDK) technology. ECE provides accelerated virtual switching capabilities in addition to full CE 2.0 functionality. ECE itself utilizes two cores of the Intel Atom processor: one for the hypervisor and management, and the other one for the vSwitch, leaving six cores for the VNFs.

vRouter: The Brocade vRouter is a complete VNF implementation of a router. The Brocade vRouter uses vPlane technology and DPDK to provide routing, NAT and VPN functions. For the duration of the testing the Brocade vRouter was allocated two CPU cores

vFirewall: The Fortinet FortiGate-VM is a fully functional firewall set up as a VNF, enabling widespread security functionality in virtual and physical environments. All testing scenarios were performed with the FortiGate-VM utilizing two CPU cores.

vTesthead: The Spirent Avalanche Virtual is a virtual test solution that is capable of emulating client and server traffic in various scenarios to simulate real-life traffic for testing purposes.

Test Equipment

For our performance tests of the Overture ECE, Brocade vRouter, and FortiGate-VM, we used the Ixia XG12 tester and IxLoad software to simulate and analyze a realistic Layer 7 traffic mix. For the testing of the service chain that included a virtual test head, we used a Spirent Avalanche Virtual running as a VNF on the Device Under Test (DUT) and a Spirent Avalanche 3100 tester.

The testers were connected to the DUT's physical interfaces using 1 Gigabit Ethernet links, or in the case of the virtualized testing solution, connected internally to the vSwitch.

Performance of the VNFs

In order to verify the performance of the individual VNFs, we conducted tests for each VNF, offering a 1 Gbit/s load of the defined Layer 7 test traffic mix.

First we tested the ECE VNF alone, then ECE in combination with FortiGate-VM, ECE with the Brocade vRouter and finally ECE with FortiGate-VM and Brocade vRouter as presented in the diagrams below.

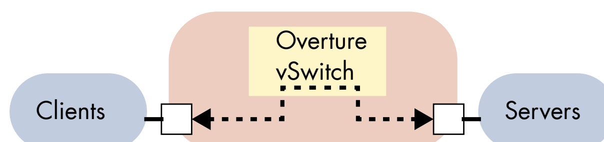


Figure 2: Barebone vSwitch Performance Test

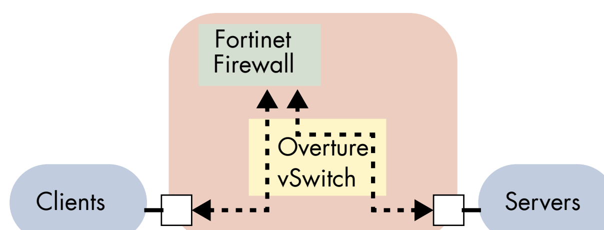


Figure 3: vSwitch + Firewall Performance Test

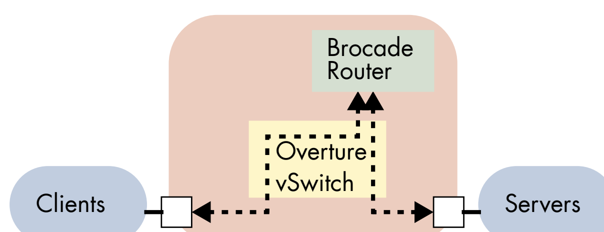


Figure 4: vSwitch + Router Performance Test

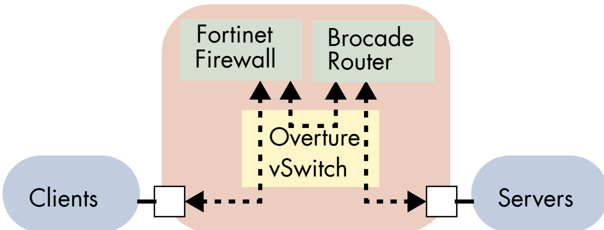


Figure 5: Full Service Chain Setup

In the ECE-only mode, the traffic was simply Firewall-Firewall bridged between two physical ports of the Supermicro box. In the other scenarios it was forwarded through the vSwitch.

In all four scenarios, we achieved stable throughput at line rate.

The values in the table below correspond to the average traffic rate at Layer 7, i.e. the data transported within TCP connections. The physical bit rate is calculated by taking the protocol headers into account corresponded to 1 GBit/s in all tests.

Scenario	L7 Throughput [Mbit/s]	L1 Line rate [%][a]	Avg. TTFB[b]
ECE	939	100.0	16ms
ECE, Firewall	929	100.0	17ms
ECE, Router	939	100.0	16ms
ECE, Firewall, Router	929	100.0	17ms

a. Rounded values
b. Time To First Byte - time needed for the first data byte of a server response to reach the client

Performance of the Full Service Chain

For the next test, we set up a full service chain that included ECE, Brocade vRouter and FortiGate-VM and tested it using the same traffic mix. The goal of this test was to show that Intel Atom processor cores were sufficient to run virtual switching, routing and firewall, leaving two cores for other functions or a performance extension.

We observed full line rate throughput performance in this case as well.

IPv4 versus IPv6

As the next step, we examined the capability of the DUT to handle IPv6 traffic. In order to increase the stress on the FortiGate-VM, we also added a small amount of "illegal" traffic to the mix — traffic that would be blocked, according to the firewall's rule set.We conducted a comparison test using the same application traffic mix with IPv4 addresses first, then with IPv6 addresses. Our measurements showed that the DUT performed equally well at the line-rate speeds.

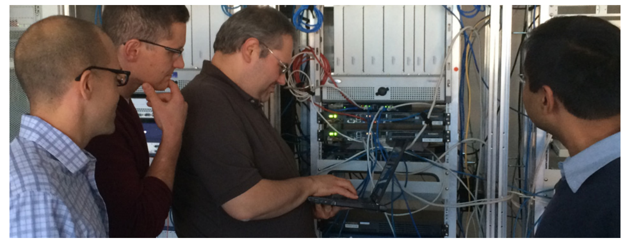


Figure 6: Testing Team at EANTC's Lab

Advanced firewall setup

Finally, we activated some of the advanced protection options on the FortiGate-VM - the Intrusion Prevention System mode (IPS) and the Application Control (AC) feature to simulate a more real-world deployment. The IPS and Application Control features enable FortiGate-VM to block security holes in higher layer protocols and categorize applications to enable fine-grained security controls beyond simple TCP stateful inspection.

As expected, these functions placed a significantly higher performance demand on the FortiGate-VM. However, the performance was stable, even in this overload situation. The achieved throughput well exceeded the target value of most service provider offerings.

Setup Service Chain (vSwitch, Firewall, Router)	Throughput [Mbit/s]	L1 line Rate [%][a]	Avg. TTFB[b]
IPv4	928	100.0	16ms
IPv6	922	99.8	14ms
IPv4 (IPS+AC)	527	56.6	61ms
IPv6 (IPS+AC)	506	55.2	56ms

a. Rounded values
b. Weighted average time to first byte

The results of this rigorous test cycle proved that high performance is achievable in edge virtualization even under advanced setup conditions. This configuration is viable to serve the given use case.

Overnight test

We verified the long-term stability of the solution by running an over-night burn-in test using our use case

ECE and FortiGate configuration with an IPv4 traffic load. Bad traffic was included for realism and was denied by the firewall. The service chain showed no performance degradation.

Adding Service Testing

In cooperation with Spirent Communications, we were able to demonstrate a novel concept of virtualized deployment testing. We installed Spirent Avalanche Virtual tester solution as an additional VNF directly integrated into our service chain, replacing the IXIA hardware used previously.

The idea behind this scenario was to provide customers with a flexible NFV-based solution to test the performance and functionality of their virtualized service offering. As VNF running on the same virtualization platform, Avalanche Virtual can be easily connected to the service chain without the need for a traditional analyzer.

In our scenario, with Overture ECE, Brocade vRouter and Fortigate-VM, the virtualized tester played the role of 200 simulated clients located in the local network. As the server counterpart we used an external Avalanche 3100 analyzer simulating the 10 servers. For this test, we assigned the remaining two cores of the Intel Atom processor to the Avalanche Virtual VNF.

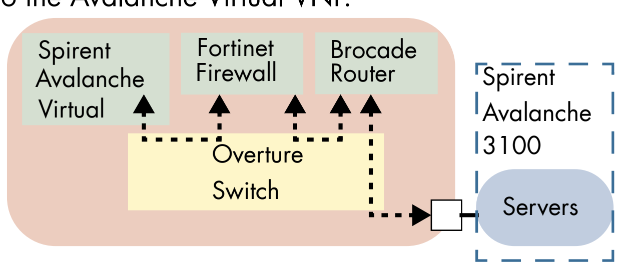


Figure 7: Virtual Tester Setup

With this setup, we were able to achieve a stable throughput of approximately 600 MBit/s through the entire service chain.

Summary

We validated all metrics established in the test plan. Using a real-world traffic model, the solution leveraging VNFs from Brocade, Fortinet, Overture and Spirent running on a Supermicro server showed solid line-rate performance in all test scenarios. Even with the advanced firewall features enabled we were able to demonstrate virtualized throughput performance that is viable for deployment in almost any customer's network environment.

An important achievement of this test series was the feasibility demonstration of a built-in virtualized testing solution from Spirent, that can be easily integrated into a service chain to provide service testing helpful for successful deployment on-site.

During our testing we were able to demonstrate high performance and flexibility of the solution as expected according to our test plan.

Hardware and Software used

Base system

Two Supermicro servers 5018A, 8-core Intel Atom processor C2758 @ 2.40 GHz, 16 GB RAM

OS: CentOS Linux Rel. 7.0.1406 (Core)

Virtualization Platform: QEMU 1.6.2

Virtual network functions

Overture Ensemble Carrier Ethernet (ECE): 15.1.1.32-1

Brocade vRouter 5600: 3.5R5

Fortinet FortiGate-VM: VM64-KVM v5.2.4, build0688, 150722 (GA)

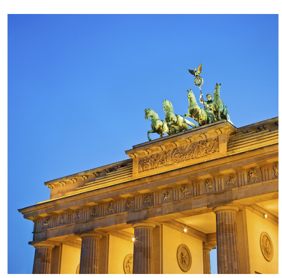
Spirent Avalanche Virtual 4.54

Test equipment

Ixia XG12, IxLoad rev. 6.70.0.287

Spirent Avalanche 3100, software rev. 4.54

About EANTC



EANTC (European Advanced Networking Test Center) is internationally recognized as one of the world's leading independent test centers for telecommunication technologies. Based in Berlin, Germany, the company offers vendor-neutral consultancy and realistic, reproducible high-quality testing services since 1991. Customers include leading network equipment manufacturers, tier-1 service providers, large enterprises and governments worldwide. EANTC's proof of concept, acceptance tests and network audits cover established and next-generation fixed and mobile network technologies. http://www.eantc.com

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