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DAY ONE GREEN: OPTIMIZE YOUR LAB WITH ENERGY SAVINGS VIA VIRTUALIZATION

By virtualizing your lab, or parts of it, you can save money, energy, and a reduction in your carbon footprint while being more agile.

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Day One Green

Optimize Your Lab with Energy Savings Via Virtualization

Energy grids, environment crisis, global warming – you've read these headlines at least a hundred times. Can you make a difference? The fact is that you can save resources and energy consumption in your lab setup by using the most powerful feature that every IT system has to offer: virtualization! By virtualizing your lab, or parts of it, you can save money, energy, and a reduction in your carbon footprint while being more flexible and agile. Most importantly you can help to slow climate change down a bit. Your lab savings may not be enough to save the planet, but climate scientists tell us that every reduction helps, every thousandth of a percent lower can have a global impact.

In the Lab

My fellow network engineers all know this: when testing new protocols, new features, new designs, you need a lab. A Proof of Concept (PoC) is great but its only inside a lab that you will know if the technologies being tested will really work in your environment. You must test every bit to verify the desired impact and confirm nothing results in a disaster.

In the past you had to purchase multiple routers, switches, and firewalls similar to your production boxes to achieve this goal, resulting in an enormous amount of heat (which you need to cool down by using more devices), a huge electricity bill, and a *lot* of rack space. And that wasn't even the worst part. Lab changes were mostly done manually and required a technician to travel to the site to patch in new lines and if you forgot a cable, you had to travel all over again, resulting in a lot of CO2 when traveling. Each of these lab devices consumes electrical energy and needs cooling. Wouldn't it be awesome if just one

device that already consumes the energy and that already produces the heat would be able to run multiple devices or even a complete lab, site, or data center? Guess what? This dream *is* possible, and it's called virtualization (See Figure 1). Virtualization is the ability to run multiple *hardware* appliances on shared hardware by separating the hardware from the OS. It's what Juniper did with the RE and PFE separation so that the *brain* can run independently from the hardware.

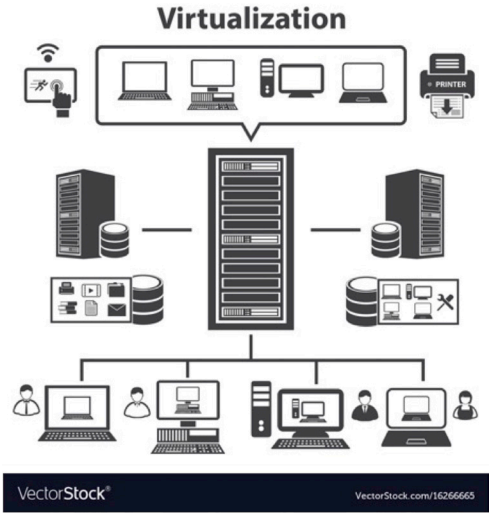

Figure 1 *The Virtualization Concept*

vLab Solutions

Let's have a look at some numbers and begin proving the point that vLabs can conserve energy better than a lab full of racks. Before we begin, note that the focus is on a general calculation since every lab, like every network, is different. Also note that each vDevice has a use case consumption of its own that is not covered nor calculated into our basic assumptions.

Each networking device has a unique power consumption number that you can find within the Juniper datasheets. This consumption times 3.41 results in the heat emitting from the device in terms of BTU/h. The rack space needed can also be found in the datasheet. Our next few examples will look at the following devices as they are very close to the performance numbers that a vDevice can run on:

- The vSRX compared to SRX345
- The vMX compared to MX150
- The vQFX (technically a QFX10k) compared to QFX5120-48Y

The server running our sample vDevices is an HP DL360G8 with 1HE rack space (see Figure 2). If you use a 2HE, or a 4HE server, with four or six possible CPU slots, the savings can be way bigger as you get more slots that share the same power footprint. Carefully check your use cases and size your vLab accordingly. You want to have neither too few but also not too many resources.

Figure 2 *The HP DL360G8 Server*

NOTE Obviously there can be certain use cases that cannot be use a vLab. In this case you need the real hardware. But even here, look for ways that you can at least partially virtualize. Remember, every percentage counts.

Here's the basic numbers in our simple math comparison:

SRX345 apc (average power consumption): 122W
SRX345 ahd (average heat dissipation): 420BTU/h
SRX345 rack space: 1HE

MX150 apc: 140W
MX150 ahd: 480BTU/h
MX150 rack space: 1HE

QFX5120-48Y apc: 550W
QFX5120-48Y ahd: 1880BTU/h
QFX5120-48Y rack space: 1HE

DL360G8 apc: 520W
DL360G8 ahd: 1773BTU/h
DL360G8 rack space: 1HE

The server described here has a dual Xeon CPU (six cores each, so twelve cores when using HT) and the max possible RAM (768GB). HT, or *hyper-threading*, is a technology which enables you to double your CPU cores. This topic is obviously *way* more complex than intended. If you want to maximize your vLab capability, then learn more about the vConcept and there are a ton of resources on Google.

The aforementioned DL360G8 can use a virtualization solution like EVE-NG, GNS3, or similar. They enable you to run the vendors' software on your server in parallel. So instead of powering up multiple QFX or MX devices, you can simply power up your EVE-NG Server and run multiple devices on it – immediately resulting in less rack space. Let's have a look at how many devices can run (not mixed) per server. The numbers for the CPUs and RAM that you are about to see are taken from the official datasheets and reflect the corresponding settings that the real device would use for the same performance.

The vSRX on a DL360G8: 2vCPUs per device, server has 24 logical cores so that makes 12 devices (not looking at technologies to further improve the number of devices):

12 SRX345s:	1464W	5040BTU/h
DL360G8:	520W	1773BTU/h
Savings	*944W*	*3267BTU/h*

The vMX on DL360G8: 4vCPUs per device, server has 24 logical cores so this makes six devices (not looking at technologies to further improve the number of devices):

6 MX150s:	840W	2880BTU/h
DL360G8:	520W	1773BTU/h
Savings	*320W*	*1107BTU/h*

The vQFX on DL360G8: 4vCPUs per device, server has 24 logical cores so this makes 6 devices (not looking at technologies to further improve the number of devices). Let's also looks at some costs associated (in Euros, my lab currency) .

DL360G8	520W	1773BTU/h,	5,62€/day,	2051,3€/yr
6 QFX5120-48Ys	3300W,	11280BTU/h,	35,64€/day,	13008,6€/yr
Savings	*2780W,*	*9507BTU/h,*	*30,02€/day,*	*10957,3€/yr*

NOTE These savings ignore the needed devices to cool down your lab – the savings are purely the electrical power costs assuming the devices run at the specified wattage 24/7.

NOTE2 And now imagine running the topologies on Juniper's vLabs – you have zero, yes, zero costs! Juniper will deal with the power consumption and cooling for you. And they provide this for free – this is not a typo. Nice of them, isn't in? Check out the various topologies here: https://jlabs.juniper.net/vlabs/.

As you can see, the savings from using a vLab are quite significant. And we just covered the *pure* approach by not mixing the vDevices. Normally in a lab this is exactly what would happen. And the more powerful your server is, the more rack space, power, and cooling you can save. I've seen real life scenarios where customers could save up to two racks worth of equipment and instead use a 2HE Server to achieve the very same – including more agile setups and quicker redesigns.

Example Topology: OSPF - Multi-area

vLab Sandbox: OSPF - Multi-area

Here is some more information about the OSPF - Multi-area sandbox.

Description

- Devices: 6 vMXs running Junos OS 21.1R3.11
- Configured Interfaces:
  - ge interfaces for in-band traffic
  - lo0 as loopback interface
- Configured protocols: OSPF, three areas (0, 1, 2)
- IP addressing: all addresses are in the range 10.100.x.x/24

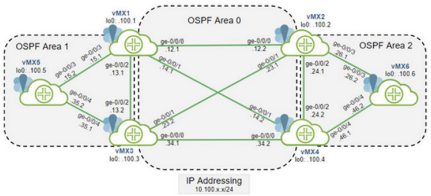

Figure 3 OSPF Topology

Let's assume you are a new engineer and need to learn about OSPF. Or maybe you are an OSPF veteran and want to verify a certain behavior that you rarely deal with. This topology runs six vMXs – remember that the MX is *the* router that powers the Internet! It's also heavily optimized to get the most throughput per watt out of these ports – that alone could potentially fill a book (and if you want to learn more on the MX and vMX see this highly recommended book: https://www.juniper.net/documentation/en_US/day-one-books/DayOne_vMX.pdf).

Let's assume that we run this topology in hardware, then on your EVE-NG Server and lastly on the vLabs (where this topology is actually from). Let's also assume that our lab runs eight hours a day.

Hardware

6 MX150s (140W each) = 840W
Total = 840W
8h running = 6,7kWh
Price per Day (assuming 0.29€/kWh) = 1,95€

Virtualization

1 DL360G8 (520W) = 520W
Total = 520W
8h running = 4,2kWh
Price per Day (assuming 0.29€/kWh) = 1,21€
Power Savings per Day = 0,74€

vLabs

Power Savings per Day = 1,95€

While you might think "*c'mon Christian, it's not that much*" the MX listed here needs optics. Depending on the speed of said optics this adds additional power requirements and you also might need to have a license for the hardware depending on the scenario. And again – we just looked at the power consumption costs – the costs for the 6HE rack space and cooling are in addition and not calculated. That makes this little number a bit more scary – and that's just one topology. Consider the world over and the number gets very large, very quickly.

Example Topology: NAT on vSRX

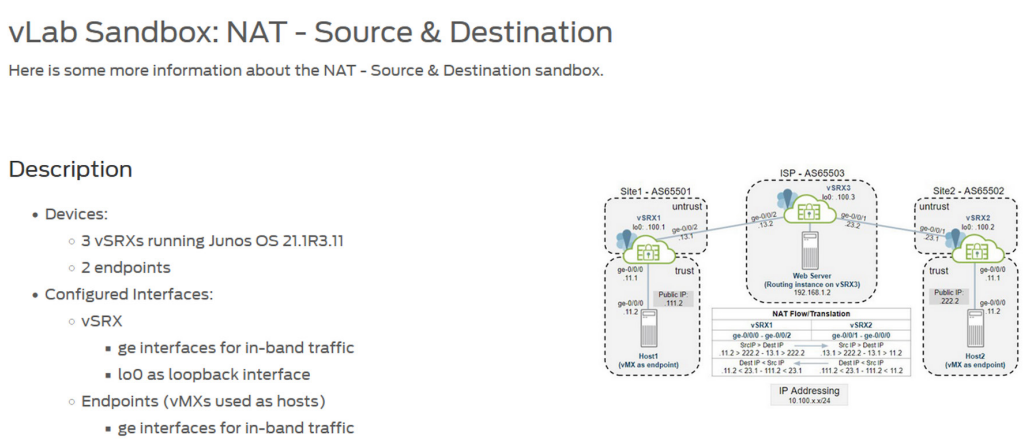

Figure 4 *NAT Topology*

Security is my favorite part because there can't be enough of it in every topology, and it becomes more important each and every day. In this example, we assume that you want to implement NAT (hideous I know – just deploy IPv6 and be happy). But let's say your ISP does (sadly) not yet support IPv6 and we have to lab up some NAT. We use three vSRXs for this (in hardware that's three SRX345s). We also need two servers.

Let's assume that we run this topology in hardware, then on your EVE-NG server and lastly on the vLabs (where this topology is actually from). Let's also assume that our lab runs eight hours a day.

Hardware

3x SRX345 (122W each) = 366W
2x DL360G8 (520W each) = 1040W
Total = 1406W
8h running = 11,2kWh
Price per Day (assuming 0.29€/kWh) = 3,26€

Virtualization

1x DL360G8 (520W) = 520W
Total = 520W
8h running = 4,2kWh
Price per Day (assuming 0.29€/kWh) = 1,21€
Power Savings per Day = 2,05€

vLabs

Power Savings per Day = 3,26€

Savings of just 3,26€ for power does not sound scary – but do you get your kWh for 0.29€? In some parts it goes to 0.90€ and higher – and that's just for the power consumption. As you can see, the vLabs can really save here. The next example is an even scarier number…

Example Topology: EVPN-VXLAN + Apstra on vQFX

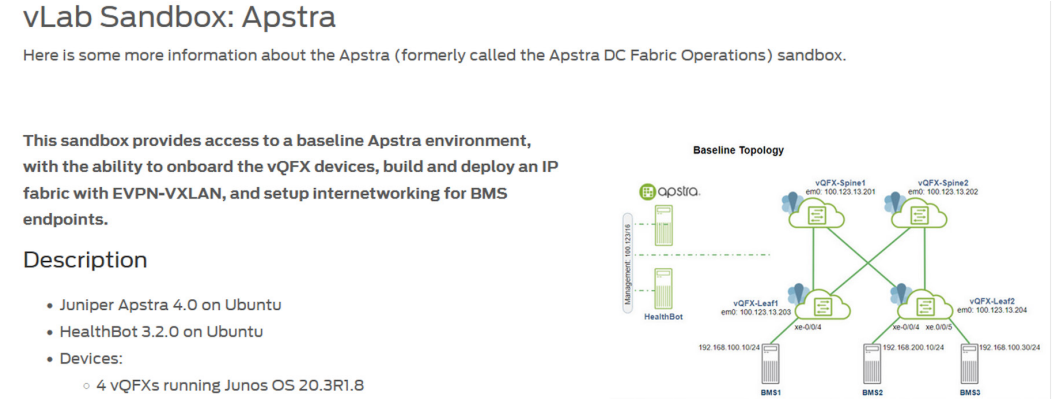

Figure 5 Apstra Topology

Let's have a look at a EVPN-VXLAN spine leaf architecture and add an Apstra Management as a "cherry" on top. This topology runs four vQFX devices (each running the RE and the PFE image) and of course we need an Apstra Server. Apstra can be deployed as a VM or bare metal (since it's basically like EVE-NG just a Ubuntu OS with additional packages). Let's assume that we run this topology in hardware, then on your EVE-NG server and lastly on the vLabs (where this topology is actually from). Let's also assume that our lab runs eight hours a day.

Hardware

4x QFX5120-48Ys (550W each) = 2200W
1x DL360G8 (520W) = 520W
Total = 2720W
8h running = 21,8kWh
Price per Day (assuming 0.29€/kWh) = 6,31€

Virtualization

1x DL360G8 (520W) = 520W
Total = 520W
8h running = 4,2kWh
Price per Day (assuming 0.29€/kWh) = 1,21€
Power Savings per Day = 5,10€

vLabs

Power Savings per Day = 6,31€

So, for running your test fabric for eight hours a day you can save 5,10€ by switching from hardware to a server that runs the devices as vQFX and Apstra-VM, or save even more, the full 6,31€/day, by switching to vLabs. This might sound like a low number but remember, that's each day and it adds up. Wanna know the price per year? 2303,15€ - doesn't sound that cheap anymore, right? And that's just this topology, usually you are running multiple topologies in a lab with way more devices. And in addition, prices are skyrocketing while and you are emitting more carbon than you need to.

Summary Thoughts

Obviously, a lab is not just about power consumption. It's also the space needed, the power needed to cool the emitting heat, and even the noise pollution. While the devices usually run in a separate environment it's still pollution, resulting in a *dirty* environment.

We should take into account that test labs should not run 24/7 all the time. You can leverage powerful Junos features to automatically power off the devices via API when no longer needed. With a CI/CD Pipeline and EVE-NG it's even possible to create, spin up, test, and later tear down the vLab all the while sending you a test report to confirm that your config worked.

Another point to be made is that in the world of carbon targeting, where corporate owners are paying to become carbon neutral, when you save power OpEx you not only save on the initial energy costs but you also save on "buying" extra carbon credits to offset your usage. That means double savings! Energy you didn't use in your labs and carbon credits you don't have to buy because your usage is lower.

The possibilities are compounding. We are still at the very beginning of a series of best practices for the IT industry and its tens of thousands of labs, to save and reduce energy and advance climate resources. Remember, every incremental percentage counts.

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