

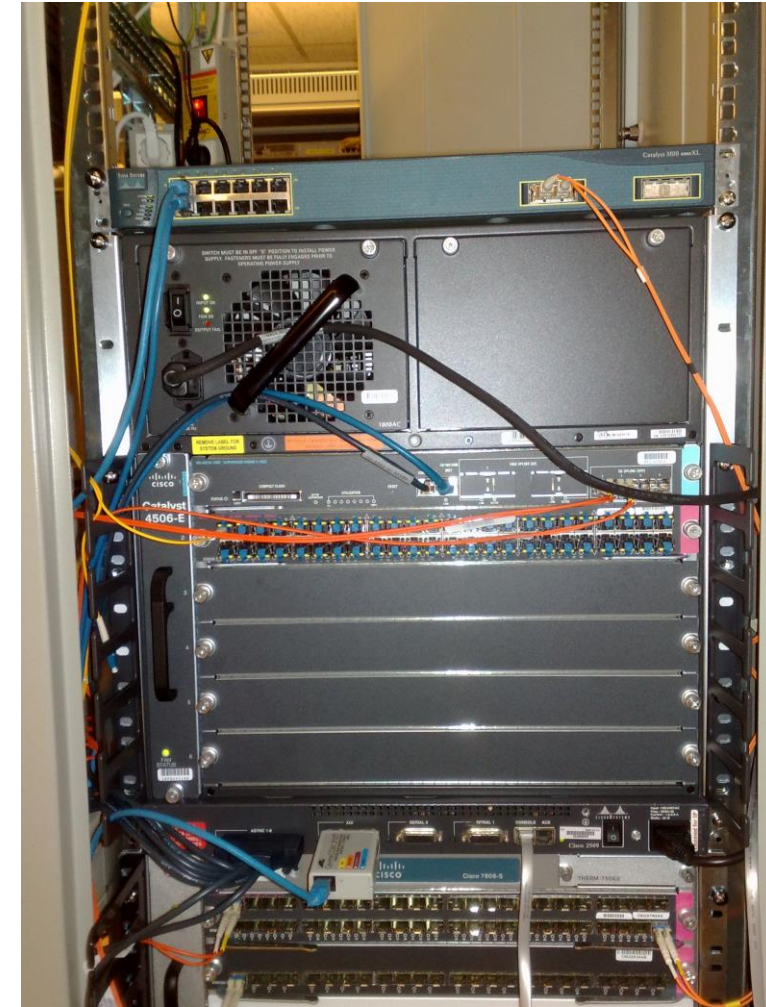


# NLNOG: THE POWER OF LABS

Rinse Kloek  
June 2023

# TOPICS IN THIS PRESENTATION

- Physical labs vs Virtual labs
- Traffic generators
- Theory and practice
- Production as lab
- Bugs you will never find in the lab



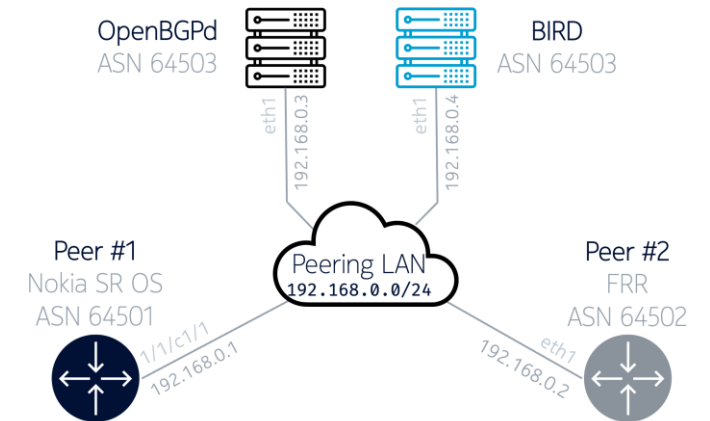
# HOW TO START WITH A PHYSICAL LAB

- Use spare hardware as lab equipment
- During the RFP proces there is always room to negotiate about extra lab equipment or licenses
- Ask your favourite refurbished dealer for EOL hardware (Or ask our NLNOG friends 😊 )
- Hypervisor with Proxmox/ESXI to easily spin up VM's + favourite open source tools.



# BUILDING VIRTUAL LABS

- Mostly used for creating proof of concepts and functional testing.
- Not very suitable for performance testing
- Easy to build and automate large test scenarios
- Eve-NG / Containerlabs / Cisco VRL / GNS3



# BEST PRACTICES BUILDING LAB

- Keep lab strictly separated from production
- Install monitoring system to monitor during tests
  - LibreNMS to check system load / memory usage / health during test.
- Backup your Lab configs / version control!
  - It's always nice to have a rollback option or check the config before we hit that bug.
- Make it easy to do packet captures. Store them.
- Keeping your lab consistent and stable can be very hard
  - Treat lab like production (make clear rules about changes)
  - Basic rules
  - Everybody his own lab ?



# THE PRO'S AND CON'S OF VIRTUAL VS PHYSICAL

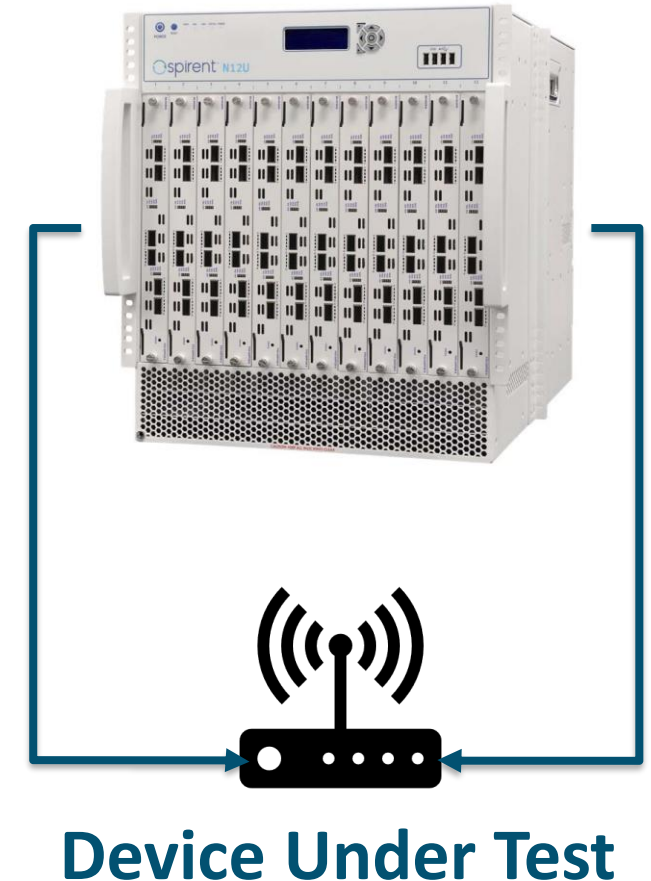
Comparision virtual vs physical lab	PHYSICAL	VIRTUAL
Cost	− −	+ +
Rack space	+ −	+ +
Flexibility / speed	+ −	+ +
Test automation	+ −	+ +
Proof of concept testing	+ −	+ +
Conformance testing	+ +	+ −
Performance testing	+ +	− −

Virtual labs can be very powerful, even with a small budget. Very suitable for education.

Getting as close as possible to the real production situation

# TRAFFIC GENERATORS/ANALYZERS – SWISS ARMY KNIFE

- Traffic generators like Spirent / IXIA / Byteblower are 😊 😊
  - For line rate traffic generation from 1G to 800G per port
- Some test scenario's:
  - Generating 1000's of DHCP/PPPoE sessions to stress test your BNG
  - Sending traffic with different COS / DSCP bits and look QOS works as designed
  - Increasing load in little steps to network to see when traffic starts to drop.
- If budget is low look for rent or refurbished
- Free open source alternative like Cisco Trex (cisco&free!)
  - Statefull (L7/L4) or stateless(L2/L3) traffic generation using DPDK.
  - Check out ipng.ch articles how Pim (<https://ipng.ch>) uses Trex,



# TRAFFIC GENERATORS – EXAMPLE 1: QOS

## Example of a QOS test scenario:

- Sending > 8 Gbps Internet + 220 Kbps voip and 5 Mbit IPTV stream (up and down)
- We expect that Internet traffic will be dropped (QOS gives IPTV + VOIP higher prio)

Streams > Stream Block Results | Change Result View | 1 of 1 | Show: All Ports | Change Counter Mode | Forwarding Perform

Basic Counters | Errors | Basic Sequencing | Advanced Sequencing | Histograms

Tx Port Name	Stream Block	Rx Port Names	Tx Count (Frames)	Rx Count (Frames)	Tx Rate (fps)	Rx Rate (fps)	Tx Rate (Mbps)	Rx Rate (Mbps)	Rx Sig Count (Frames)	Avg Inter-arrival Time (us)
Port //1/2	VOIP UDP Traffic Upstream	Port //1/5	9.005	8.998	215	216	0.22	0.22	8.998	4.649.97
Port //1/2	IPTV Upstream UDP traffic A	Port //1/5	9.005	8.998	215	216	0.22	0.22	8.998	4.650.02
Port //1/2	Internet IMIX BE traffic upstream A	Port //1/5	53.832.634	47.630.907	1.285.554	1.142.844	9.652	8.573.5	47.630.907	0.88
Port //1/5	IPTV Downstream UDP traffic A	Port //1/2	216.057	217.844	5.116	5.118	5.24	5.24	217.844	0
Port //1/5	VOIP UDP Traffic Downstream	Port //1/2	216.057	217.833	5.117	5.118	5.24	5.24	217.833	0
Port //1/5	Internet IMIX BE traffic downstream A	Port //1/2	54.446.184	42.039.543	1.289.293	988.252	9.679.12	8.763.81	42.039.543	0





# TRAFFIC GENERATORS – QOS: VOIP AND IPTV LATENCY

- Overload a connection and check the latency of VOIP and IPTV traffic

Streams > Detailed Stream Results | Change Result View | 1 of 1 | Select Tx Ports: All Ports | Select Rx Ports: All Ports

Basic Counters | Errors | Basic Sequencing | Advanced Sequencing | Histograms

Name/ID	Rx Rate (Mbps)	Tx Count (bits)	Rx Count (Mbits)	Tx L1 Count (bits)	Rx L1 Count (Mbits)	Tx L1 Rate (Mbps)	Rx L1 Rate (Mbps)	Avg Latency (ms)	Min Latency (ms)	Max Latency (ms)
Internet IMIX BE traffic downstream A/58...	49.3	9,000,619,200	862.01	9,192,451,840	880.28	500.44	50.35	84.05	0.02	84.63
Internet IMIX BE traffic downstream B/65...	49.72	8,996,464,720	852.62	9,188,204,720	870.84	500.46	50.78	84.39	35.59	84.64
Internet IMIX BE traffic upstream A/524289	49.58	8,852,118,832	865.69	9,040,754,192	884.13	500.51	50.64	45.63	0.29	55.29
Internet IMIX BE traffic upstream B/524291	49.47	8,850,085,664	845.54	9,038,720,864	863.56	500.98	50.53	45.64	0.3	55.3
IPTV Downstream UDP traffic A/589824	0.22	3,966,976	3.74	4,586,816	4.33	0.25	0.25	0.04	0.02	0.15
IPTV Downstream UDP traffic B/655360	0.22	3,964,928	3.73	4,584,448	4.32	0.25	0.25	0.04	0.02	0.15
IPTV Upstream UDP traffic A/524288	0.22	3,901,440	3.78	4,511,040	4.37	0.25	0.25	1.53	1.03	2.03
IPTV Upstream UDP traffic B/524290	0.22	3,901,440	3.69	4,511,040	4.27	0.25	0.25	2.52	2.02	3.02
VOIP UDP Traffic Downstream/589826	0.09	1,580,032	1.49	1,826,912	1.72	0.1	0.1	0.04	0.02	0.15
VOIP UDP Traffic Downstream/655362	0.09	1,579,008	1.49	1,825,728	1.72	0.1	0.1	0.04	0.02	0.15
VOIP UDP Traffic Upstream/524292	0.09	1,553,408	1.5	1,796,128	1.74	0.1	0.1	5.53	5.03	6.06
VOIP UDP Traffic Upstream/524293	0.09	1,553,408	1.47	1,796,128	1.7	0.1	0.1	10.53	10.03	11.66

- Latency and jitter is within acceptable range.



# TRAFFIC GENERATORS – SHUT / NO SHUT PORT

## Test what the impact is of link flap

- Triple play traffic 100 MBIT up/down
- Shut one port of the LAG
- Measure outage (~10-20ms)
- Unshut one port of the LAG
- Measure packet loss
- No packet loss



Shut no shut != pulling the cable

Tripley\_play\_qos-100mbit:Results 1

Port Traffic and Counters > Basic Traffic Results | Change Result View

Port Name	Tags	Dropped Count (Frames)	In-order Count (Frames)	Total Tx Rate (fps)	Total Rx Rate (fps)
ONT 10G /...	Click to ad...	276	28.524.637	26.500	28.359
Port //1/2	Click to ad...	264	12.209.274	13.357	13.144
Port //1/3	Click to ad...	262	12.229.777	13.357	13.355
Σ		802	52.963.688		

Tripley\_play\_qos-100mbit:Results 1

Port Traffic and Counters > Basic Traffic Results | Change Result View

Port Name	Tags	Dropped Count (Frames)	In-order Count (Frames)	Total Tx Rate (fps)	Total Rx Rate (fps)
ONT 10G /...	Click to ad...	0	881.468	26.502	28.399
Port //1/2	Click to ad...	0	440.288	13.356	13.145
Port //1/3	Click to ad...	0	444.705	13.357	13.356
Σ		0	1.766.461		

# TRAFFIC GENERATORS – SHUT / NO SHUT PORT

- Generate frames of all possible ethertypes, only ARP/IPv4/IPv6 are allowed

General Sources and Destinations Frame Groups Rx Port Preview

Preview: EthernetII  Show All Fields  Allow Invalid Packets

Name	Value
Frame	
EthernetII	
Preamble (hex)	fb555555555555d5
Destination MAC	<auto> 00:10:94:55:00:23
Source MAC	<auto> 00:10:94:01:00:21
Vlans	
Vlan	
Type (hex)	8100
Priority (bits)	000
CFI (bit)	0
ID (int)	<auto> 100
EtherType (hex)	88B5
RangeModifier 9	Count=99999;Step=0001

Summary Counters

	Down	Up
Forwarded	7 frames	307 frames
Discarded	0 frames	10152137 frames
Broadcast	Not Supported	Not Supported
Unicast	Not Supported	Not Supported

We always have .pcap to validate the tests and received traffic:

Destination	Protocol	Length	Priority	Protocol	Ethertype	Ethernet	Info
Broadcast	ARP	64	Best Eff...	ARP	✓	✓	Who has 83.128.3.252? Tell 83.128.3.129
Broadcast	ARP	64	Best Eff...	ARP	✓	✓	Who has 83.128.3.252? Tell 83.128.3.129
ff02::1	ICMPv6	86	Best Eff...	IPv6	✓	✓	Router Advertisement from a2:de:48:00:01:00
ff02::1	ICMPv6	86	Best Eff...	IPv6	✓	✓	Router Advertisement from a2:de:48:00:01:00
Broadcast	ARP	64	Best Eff...	ARP	✓	✓	Who has 83.128.3.252? Tell 83.128.3.129
Broadcast	ARP	64	Best Eff...	ARP	✓	✓	Who has 83.128.3.252? Tell 83.128.3.129
Broadcast	ARP	64	Best Eff...	ARP	✓	✓	Who has 83.128.3.252? Tell 83.128.3.129
255.255.255.255	DHCP	350	Best Eff...	UDP	IPv4	✓	DHCP Discover - Transaction ID 0x9944524a



# THE THEORY AND PRACTICE

- (POC) Lab Testing can
  - Help you validate **your** design.
  - Find bugs in software of **vendor**
  - Validate software updates/ changes in design / config

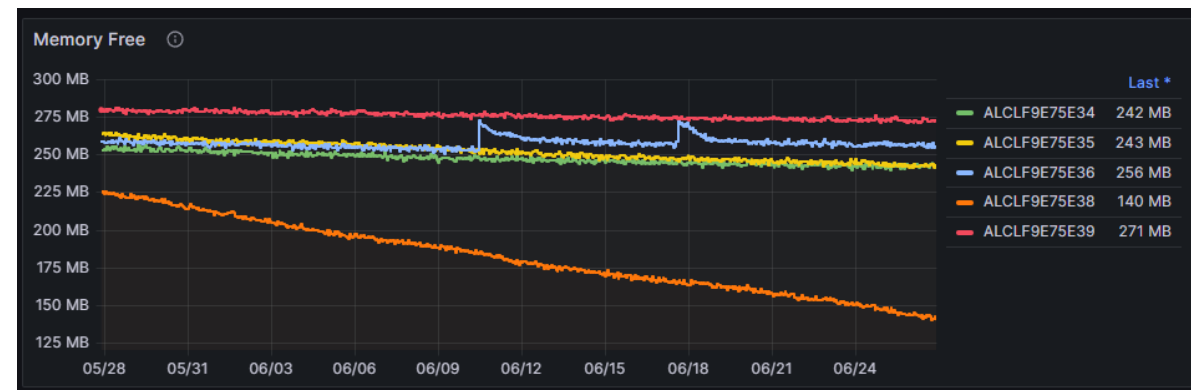
..... decent part of bugs will be found in production

- Pareto principle, 80% of the result come from 20% of the work
  - Finding the last 20% of the issues can be very hard.
  - Sometime business requires to go live before all tests are done.



# PRODUCTION AS LAB => (VERY) FRIENDLY USERS

- Friendly user testing is as important as lab testing
  - Pick one router/switch as “PRE production”
  - Select customers as Friendly users and rollout new software/features for them
  - Give friendly users some extra discount or free testing equipment.
  - Start monitoring from day one
  - Know what to measure!
  - Ask feedback from your friendly users



# BUGS YOU WILL REMEMBER TILL YOU RETIRE:

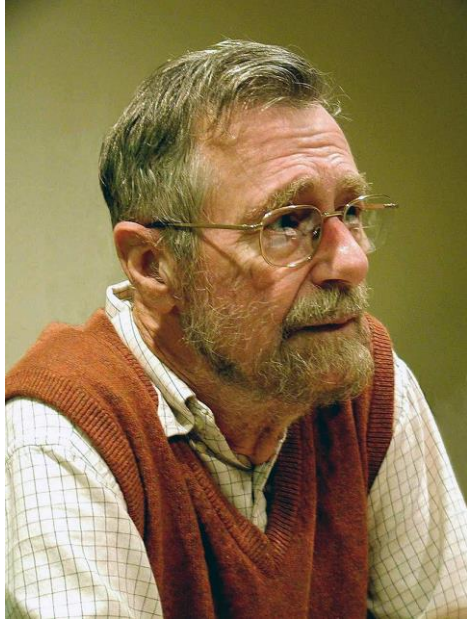
- Customers complaining about IPTV freezes
  - Issue caused by switch from 1-> 3 NTP servers in the DHCP server options

```
> Option: (3) Router
> Option: (6) Domain Name Server
> Option: (15) Domain Name
▼ Option: (42) Network Time Protocol Servers
  Length: 12
  Network Time Protocol Server: 212.45.35.66
  Network Time Protocol Server: 83.247.2.80
  Network Time Protocol Server: 212.45.32.250
> Option: (43) Vendor-Specific Information
> Option: (121) Classless Static Route
> Option: (82) Agent Information Option
> Option: (255) End
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```

- Word .doc attachments disappear while sent via e-mail
  - Issue turned to be a clocking issue in a chip in the CPE
  - Hardware replacement needed to resolve the issue

# QUESTIONS ?



**“Testing can be used to show the presence of bugs, but never to show their absence!”**

Edgar Dijkstra