Network device validation

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White Box in NREN context

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Agenda

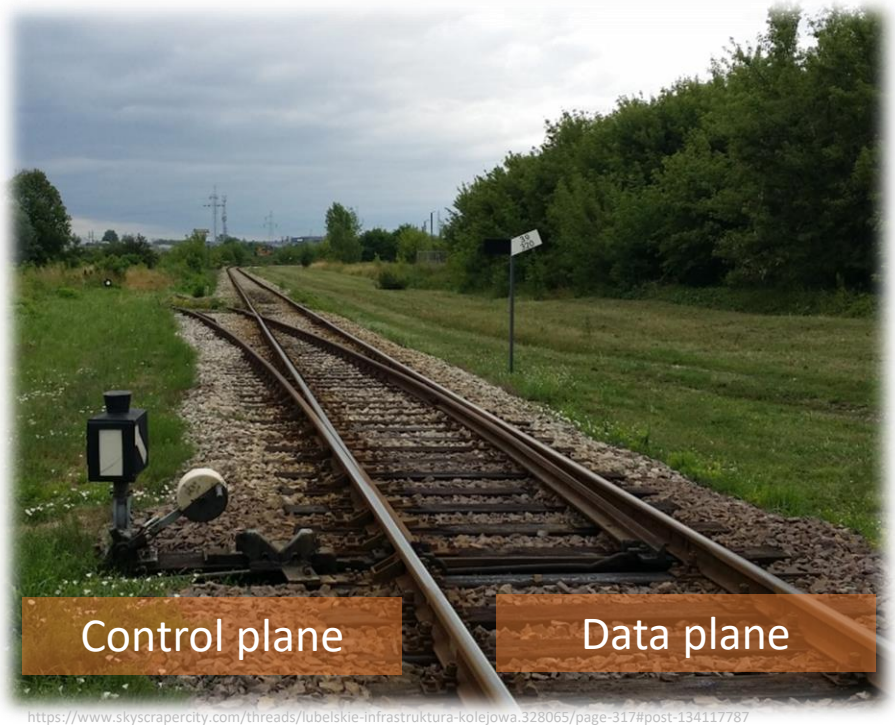
- White box or rather still black box?
- A look inside the black box
  - Control plane
  - Data plane
  - Use case
- Tools for opening the black box
- What we found inside

White box or rather still black box?

- Device Under Test (DUT)
  - Hardware properties
    - Network processor / chipset
    - TCAM / FIB
    - Number of match/action stages in the pipeline
    - Buffers
    - Switching matrix
  - Software/NOS functionalities
    - Signaling protocols
    - Services
    - Drivers

White box or rather still black box?

- What is Device Under Test
  - Legacy vendor
    - Hardware + Software
  - Whitebox
    - Hardware
    - NOS (Software)



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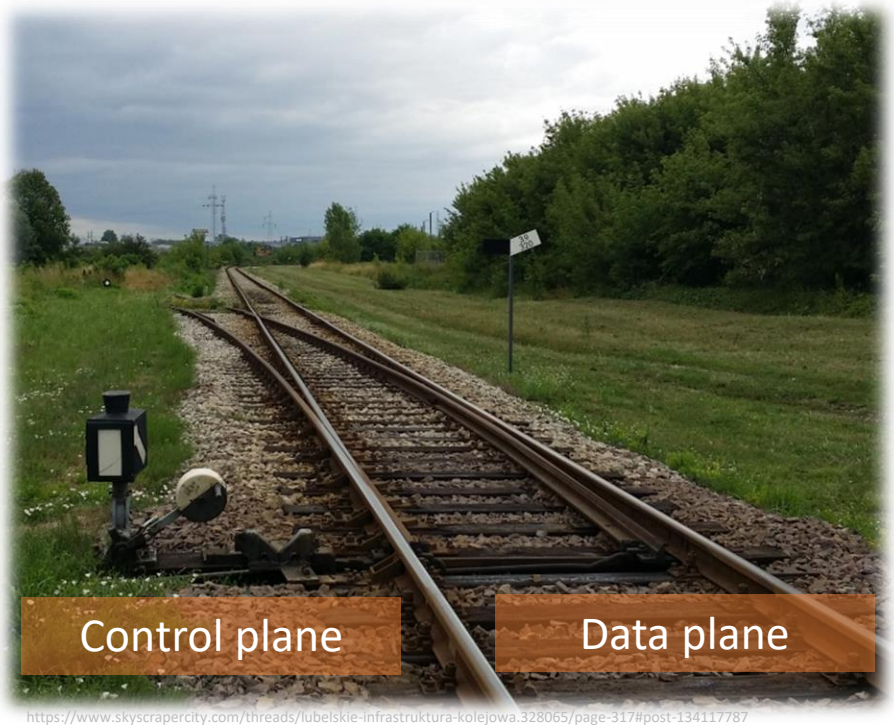
A look inside the black box

- Control plane tests
  - Signaling protocols
  - Management and maintenance
  - Hardware parameters setup
- Data plane tests
  - Switching performance
  - FIB size
  - Congestion management
- Use case testing
  - Meet user expectations
  - Performance limit of given solution
  - Verify if the DUT has sufficient capacity for the targeted use case



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Control plane tests

- A number of control plane tests can be performer in virtual environment
  - Signaling protocols
    - Operation
    - Scalability
    - Interoperability
  - Device management and configuration
  - Network convergence time

- Interoperability with hardware
  - FIB programming and maintenance
  - Service parameters setup
    - Header elements pop/push/swap
    - Next-hop selection

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Data plane tests

- Switching performance
  - Frame/packet size
    - Min/Max
    - IMIX
  - Benchmarks (RFC 2544/2889/3918)
    - Fully meshed throughput, frame loss and forwarding rates
    - Partially meshed
    - Maximum Forwarding Rate
    - Address caching capacity
    - Address learning rate
    - Errored frames filtering
    - Broadcast/Multicast frame Forwarding and Latency
- Congestion management
  - Traffic buffering
  - Bursts handling

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Use case testing

- Test parameters and configuration adjusted to user needs
  - DUT configuration
  - Topology emulation
  - Traffic generation/analysis
  - Services deployment

- Validate device operation with multiple predefined parameters
  - Control plane and data plane test at the same time
  - Does the DUT meet the „datasheet” parameters?

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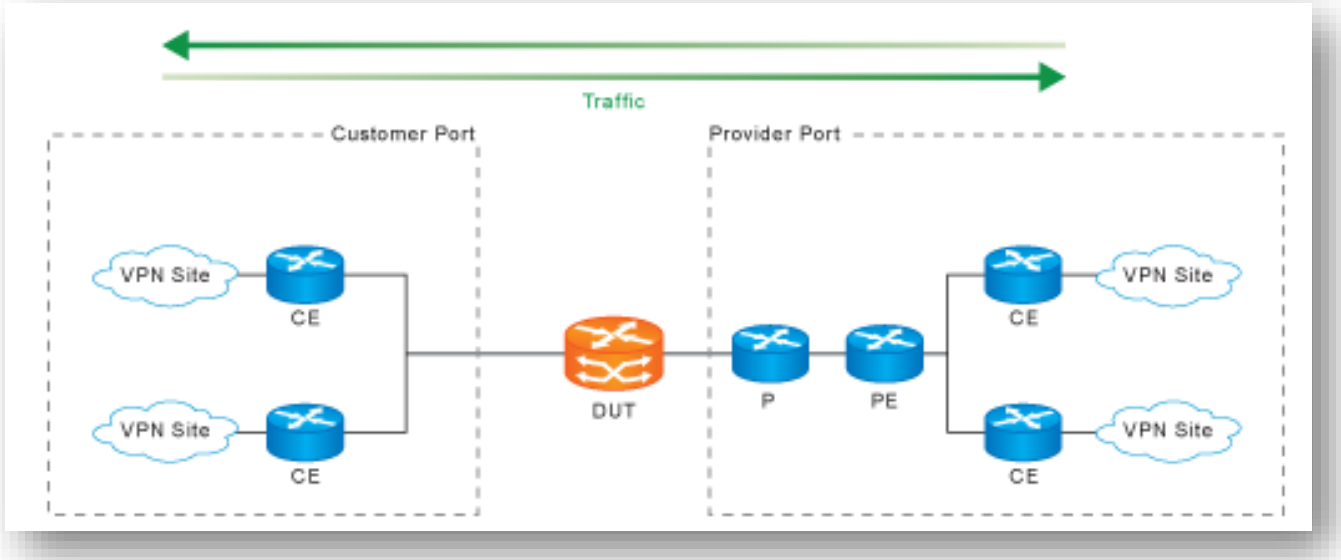
Tools for opening the black box

- Network testing equipment and software
  - Traffic generators and analyzers
    - Handheld or rack mounted
    - Hardware time stamps in the packet/frames
    - Network topology emulation with traffic validation
    - Stateful of stateless stream generation
    - Virtual test ports
  - Software tools
    - Iperf
    - Scapy
    - TRex

Network testing equipment and software

- Control Plane and Data Plane binding
  - **Bind traffic streams to emulated topology components**
    - IP src/dst to BGP generated prefixes
    - MPLS label to LDP/RSVP signaling
    - MAC src/dst to ARP resolver
  - Analyze received packets
    - total number
    - **header/payload content**
      - stream id
      - sequence



What we found inside

- Use case testing
  - We know what we are looking for
  - We know how to find it

- Example test results
  - MPLS core LSR use case
  - Buffer size

Use case testing

- MPLS LSR for NRENs use case
  - NOS **with** MPLS support in control plane
    - IP Infusion OcNOS
  - Hardware **compatible** with the NOS
    - Edgecore AS5912-54X-O-AC-F
    - Dell EMC S4248FBL-ON

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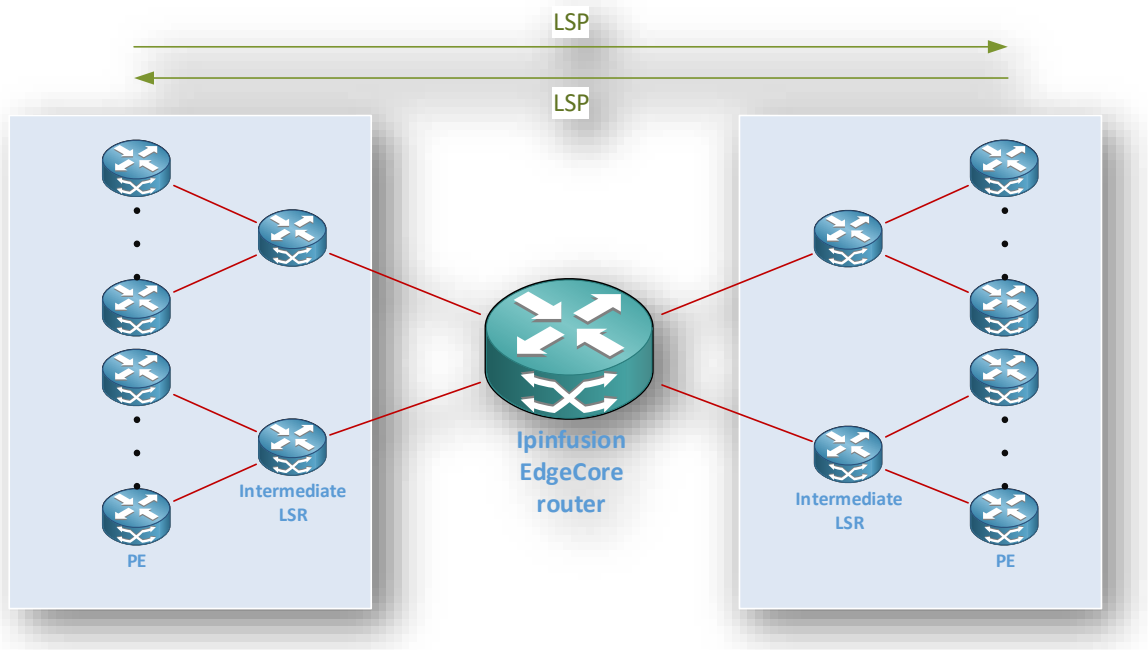
Example tests – MPLS core

- MPLS core LSR use case
  - Emulated IS-IS network connected to
  - Transit LSPs established
  - Traffic between emualted LSP endpoints



Example tests – MPLS core

- Spirent Test Center CP emulation

)4 | DS-Lite | BFD | RSVP | ISIS

Device Name	Tags	Device Count	)isable IP	IP Version	Level	Network Type	Router Priority	System ID	Host Name
Intermediate Router 1	Router	1	☐	IPv4	L2	Broadcast	0	00:10:94:00:00:09	Spirent-1
Intermediate Router 2	Router	1	☐	IPv4	L2	Broadcast	0	00:10:94:00:00:0A	Spirent-1
Intermediate Router 3	Router	1	☐	IPv4	L2	Broadcast	0	00:10:94:00:00:0B	Spirent-1
Intermediate Router 4	Router	1	☐	IPv4	L2	Broadcast	0	00:10:94:00:00:0C	Spirent-1

IGP protocol

Port Name	Device Name	Router State	LSP Up	LSP Down	LSP Connecting	Egress LSP Up	Tx Hello	Rx Hello	Tx PATH	Rx PATH	Tx RESV	Rx RESV
Port //6/1	Intermediate Router 1	RSVP_STATE_UP	900	0	0	900	0	0	4 574	3 600	1 800	1 800
Port //6/2	Intermediate Router 2	RSVP_STATE_UP	900	0	0	900	0	0	4 940	3 600	1 800	1 800

RSVP

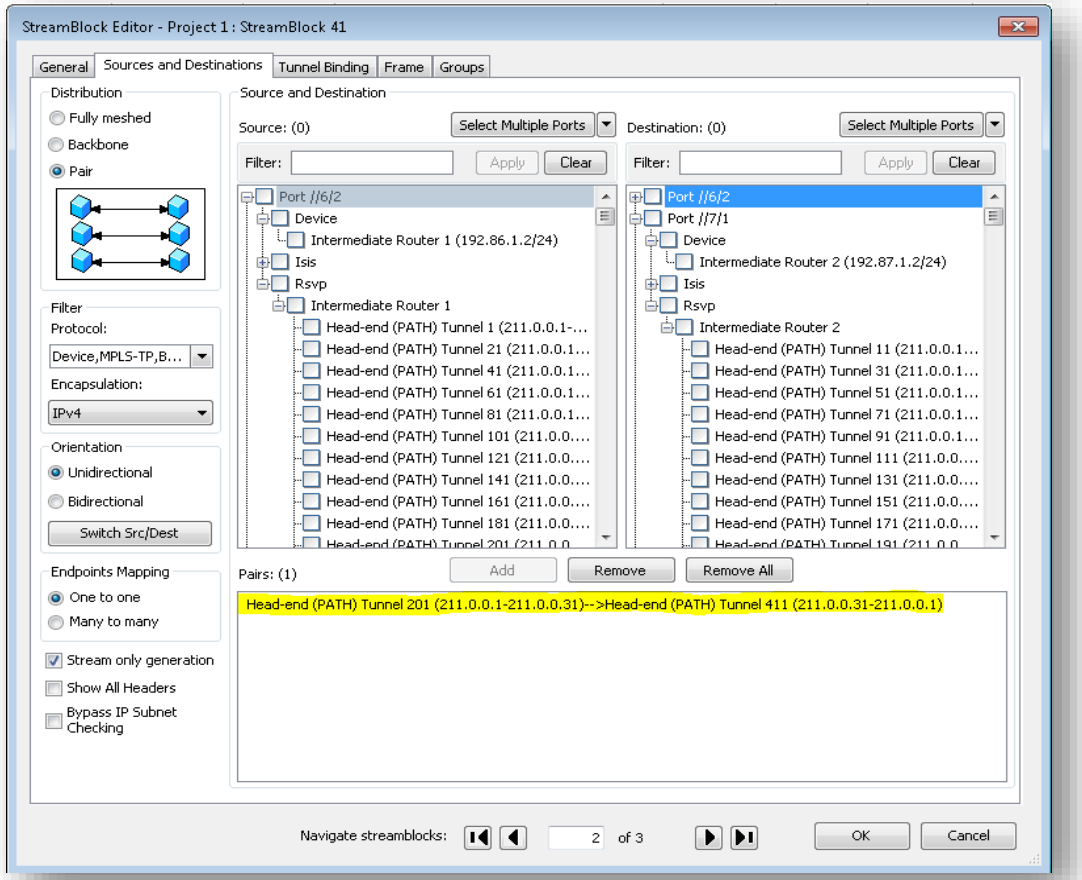
Routing and MPLS > LSP Results > RSVP LSP Results | Change Result View | 1 of 6

Device Name	Tunnel State	Direction	Source IP Address	Destination IP Address	Tunnel ID	LSP ID	Extended Tunnel ID	Label	Upstream Label
Intermediate ...	No State	Ingress	211.0.0.1	211.0.0.25	81	81	211.0.0.1	0	0
Intermediate ...	No State	Ingress	211.0.0.1	211.0.0.26	101	101	211.0.0.1	0	0
Intermediate ...	No State	Ingress	211.0.0.1	211.0.0.28	141	141	211.0.0.1	0	0
Intermediate ...	No State	Ingress	211.0.0.1	211.0.0.29	161	161	211.0.0.1	0	0
Intermediate ...	No State	Ingress	211.0.0.1	211.0.0.30	181	181	211.0.0.1	0	0
Intermediate ...	No State	Ingress	211.0.0.1	211.0.0.31	201	201	211.0.0.1	24 541	0
Intermediate ...	No State	Ingress	211.0.0.1	211.0.0.32	221	221	211.0.0.1	24 341	0
Intermediate ...	No State	Ingress	211.0.0.1	211.0.0.33	241	241	211.0.0.1	24 460	0
Intermediate ...	No State	Ingress	211.0.0.1	211.0.0.34	261	261	211.0.0.1	24 363	0
Intermediate ...	No State	Ingress	211.0.0.1	211.0.0.35	281	281	211.0.0.1	24 407	0
Intermediate	No State	Ingress	211.0.0.1	211.0.0.36	301	301	211.0.0.1	24 487	0

LSPs

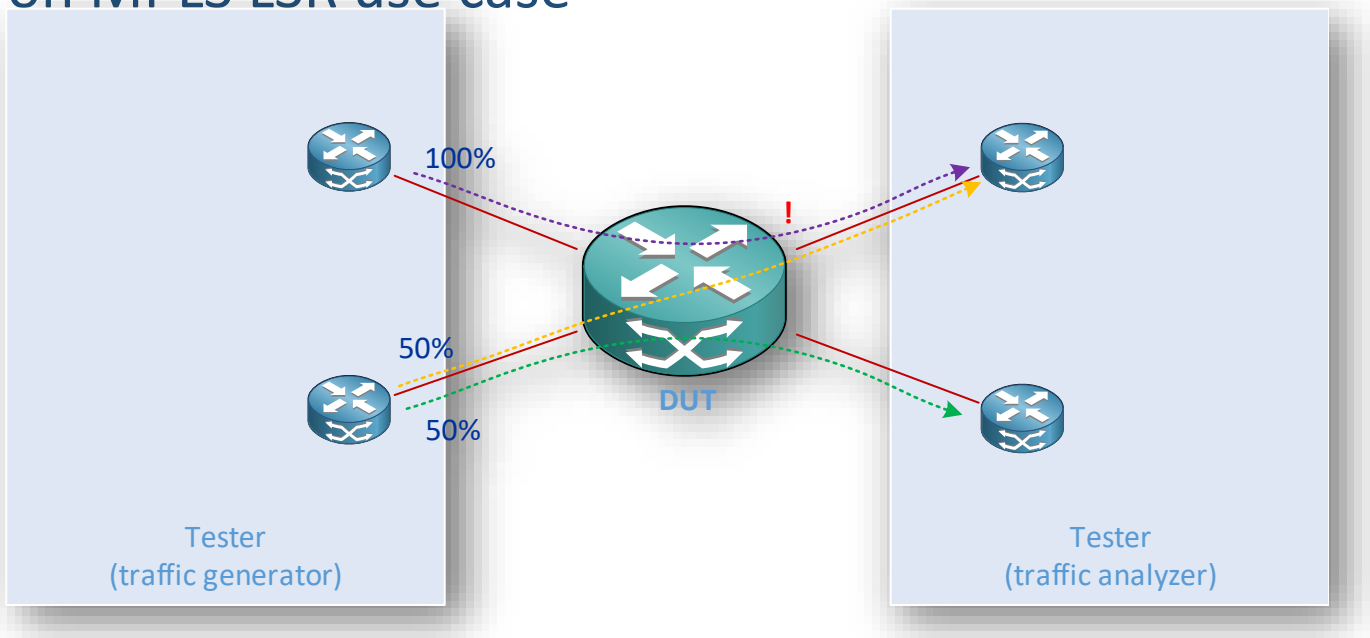
Example tests – MPLS core

- Spirent Test Center DP traffic



Example tests – buffer size

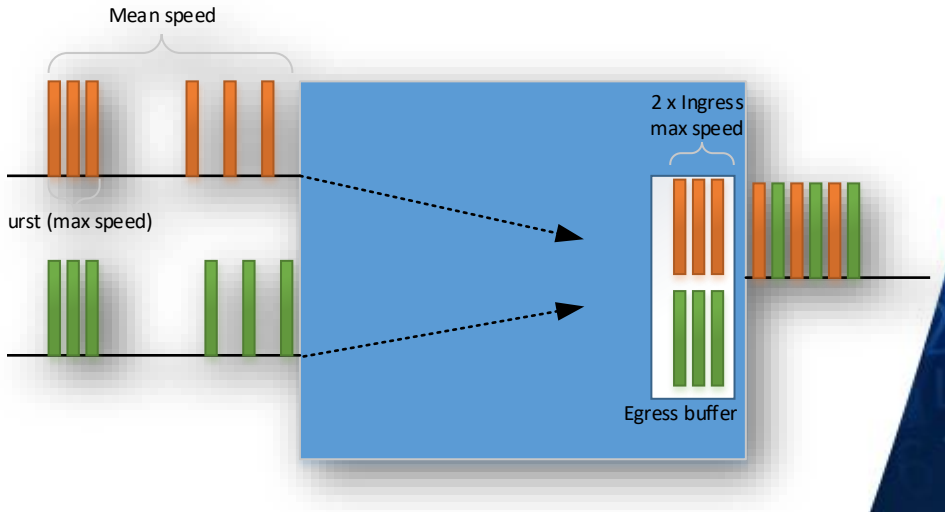
- The WP6 team designed a test setup allowing the buffer size of the given switch to be determined
  - overloading of the egress interface
  - two packet streams from two ingress interfaces to a single egress interface
  - based on MPLS LSR use case



Example tests – buffer size

- Buffering capacity example results
  - ~720 000 IMIX packets

iMIX	Duration (seconds)	Load (%)	Burst size (packets)	Tx Frames	Rx Frames	Frame Loss
Default	10	25	300000	164094616	164094615	1
Default	10	25	310000	164101282	164101280	2
Default	10	25	320000	164101642	164101642	0
Default	10	25	330000	164101095	164101094	1
Default	10	25	340000	164198274	164198274	0
Default	10	25	350000	164199178	164199178	0
Default	10	25	360 000	164100548	164100548	0
Default	10	25	370 000	164150470	164121767	28703
Default	10	25	380000	164199155	164119437	79718
Default	10	25	390000	164250366	164119897	130469
Default	10	25	400000	164195943	164015144	180799



Detailed results available in “White box performance testing and evaluation” WP6 document

Summary

- A NOS is often evaluated by a network provider from the functionality perspective
- The overall solution performance will always depend on the combination of the **hardware platform** and the **NOS** used
- Establish maximum performance values for the platform
- Verify the device operation under given network conditions

- Reference
  - https://www.geant.org/Resources/Documents/GN4-3_White-Paper_White-Box-Testing-and-Evaluation.pdf

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Thank you

Any questions?

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