White Box: GRNET Data Centre Use Case

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GÉANT Infoshare: White Boxing for NREN use cases
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Agenda

- Project objectives
- White Box switches overview
- Data Centre topology overview
- Validation tests and results
- Conclusions

Objectives

- Build a new small-scale Data Centre (DC) to host cloud resources for our customers as well as for GRNET internal resource needs.
- Reduce cost.
- Improve independence from vendors.
- Get acquainted with White Box switch concept in general.

White Box switches

Traditionally, the Data Centre network is a combination of hardware and software components provided by the same vendor.

The White Box switch introduces the concept of **decoupling software and hardware components**. As a result, a customer can choose their own combination from a variety of Network Operating Systems (NOSs) and commodity hardware solutions.

White box switches have significant advantages such as:

- Freedom of choice (vendor independence)
- Flexibility –option to replace either the NOS without changing the Hardware and vice versa;
- Cost savings
- Being able to use open-source solutions

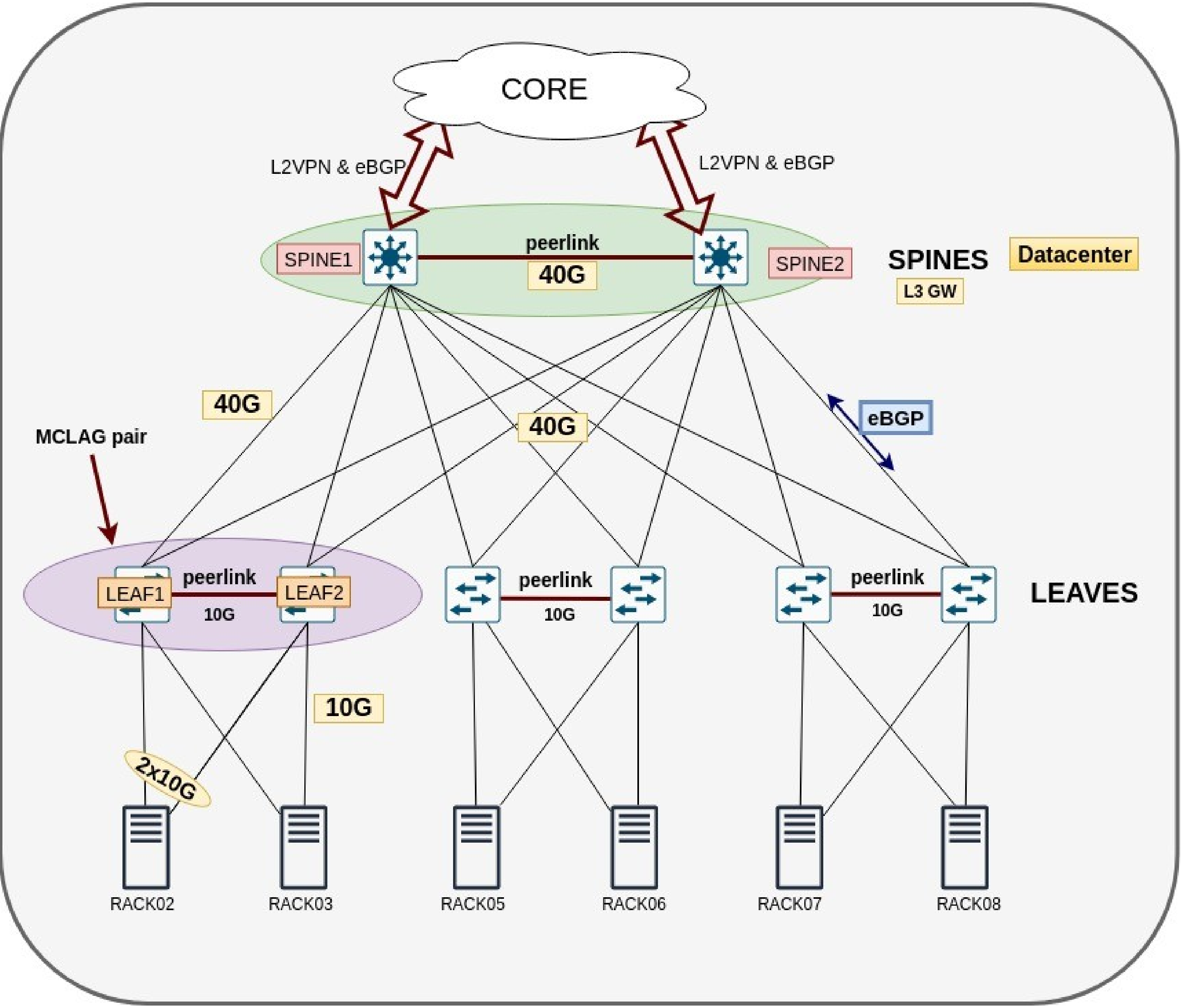
Datacenter use-case design decisions

GRNET is already operating three medium-to-large scale DCs in three different Points of Presence (PoPs) based on:

- IP Clos topology (Spine-Leaf architecture)
- EVPN/VxLAN protocol
- Ansible for configuration management.

Decided to use the same architecture principles but based on White Box switches and non-hardware vendor NOS to provide L2/L3 connectivity to the cloud resources.

Topology



‘**All active links and switches**’ setup for redundancy.

Each server is dual-homed to a pair of leaves with an LACP bond of 2x10Gbps interfaces.

Pair of leaves create **MCLAG peering** through a connection between them (peerlink).

MCLAG feature provides redundancy and load-balancing on hosts.

Each leaf is connected to a couple of spines using 40G physical links.

L3 termination on Spines with virtual gateway redundancy

Underlay (packet forwarding): **eBGP unnumbered (RFC5549).**
Spine-Leaf neighbourship with IPv6 link local addresses.
No need to setup IPv4 point-to-point addresses.

Overlay control plane:
EVPN is used for MAC/IP advertisement of hosts across the DC.

Overlay dataplane: **VxLAN**
Leaves perform VxLAN tunnel encapsulation/decapsulation.

External communication of DC:
Double physical links,L2VPN and double eBGP peerings from each spine towards Border Routers.

NOS acquisition

NOS: Cumulus Linux (version 4.3)

- Widely used in Data Centre solutions
- Native Linux distribution based on Debian-Buster
- NOS that runs on switches from multiple vendors
- Acquired by NVIDIA (March 2019)

Cumulus Linux Architecture

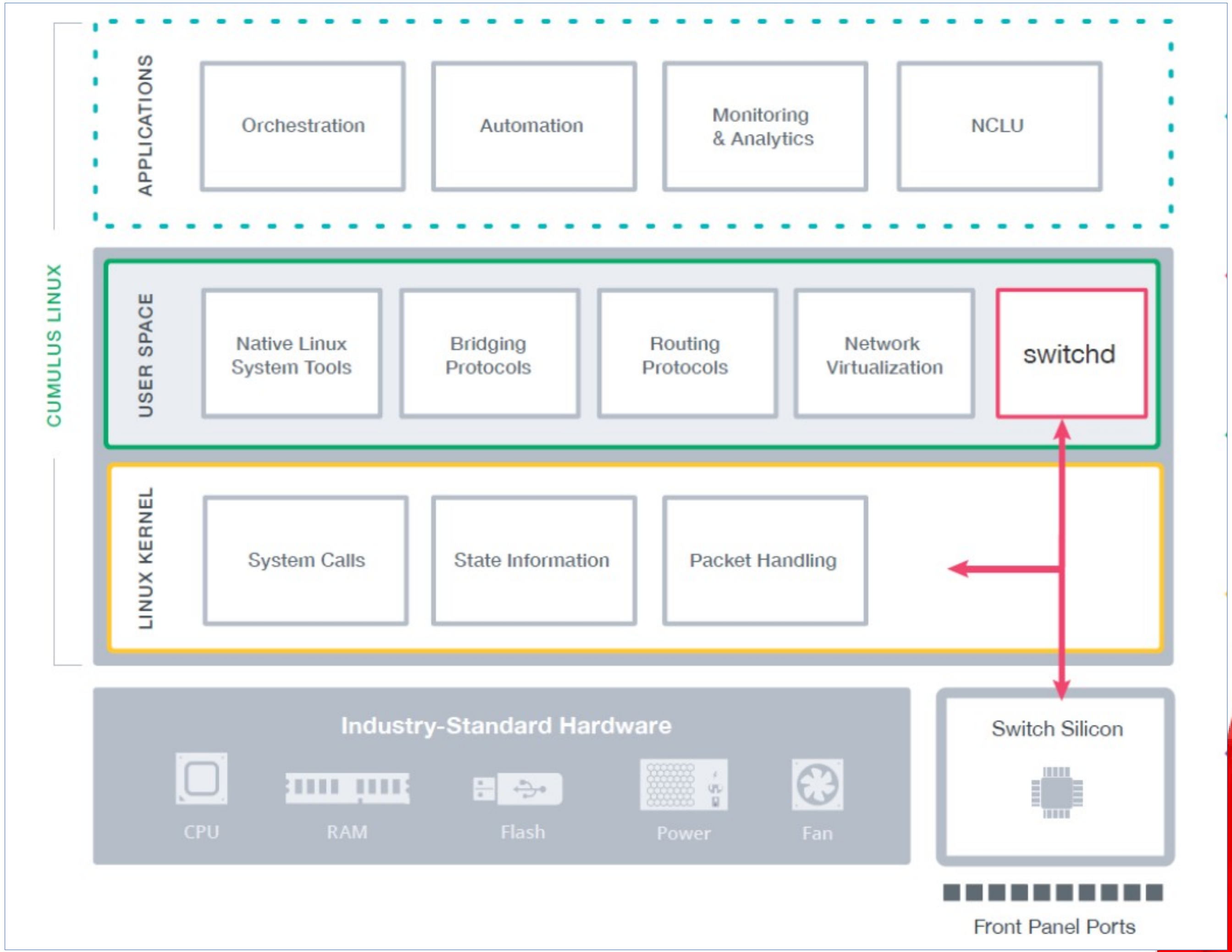
- Process called ‘**switchd**’ peers with the kernel and directly with network ASICs and normalizes the networking model

- Uses **FRRouting** protocol suite for all routing functions

- Cumulus authored **NCLU tool**: A command line interface that simplifies the networking configuration process for all users.

- Almost any Linux tool can be used for configuration and management

- Linux commands and configuration files are always available.



HW Equipment acquisition

Spine: Edgecore AS7712-32X

- 32-Port 100G QSFP28
- **ASIC Broadcom Tomahawk 3.2Tbps**
- Intel Atom® C2538 CPU
- ONIE software installer
- dual 110-230VAC 650W PSUs
- 6 Type C Fan Modules with power-to-port airflow

HW Equipment acquisition

Leaf: Edgecore AS5812-54T

- 48-Port 10GBASE-T with 6x40G QSFP+ uplinks
- **ASIC Broadcom Trident II+ 720Gbps**
- Intel Atom® C2538 CPU
- ONIE software installer
- dual 110-230VAC 400W PSUs
- 5 Type D Fan Modules with power-to-port airflow

Equipment acquisition- Cost

- The solution should not exceed the cost of the budget required for the previous network data centre implementations of GRNET using traditional vendors.

- The cost assessment was made thanks to the TCO calculator [TCO] previously published by the GN4-3 WP6 T1 white box team.

- The cost of the Spine Edgecore AS-7712 with the Juniper QFX-10k-36Q were compared.

- White Box solution was about 10% cheaper.

MCLAG vs EVPN Multihoming

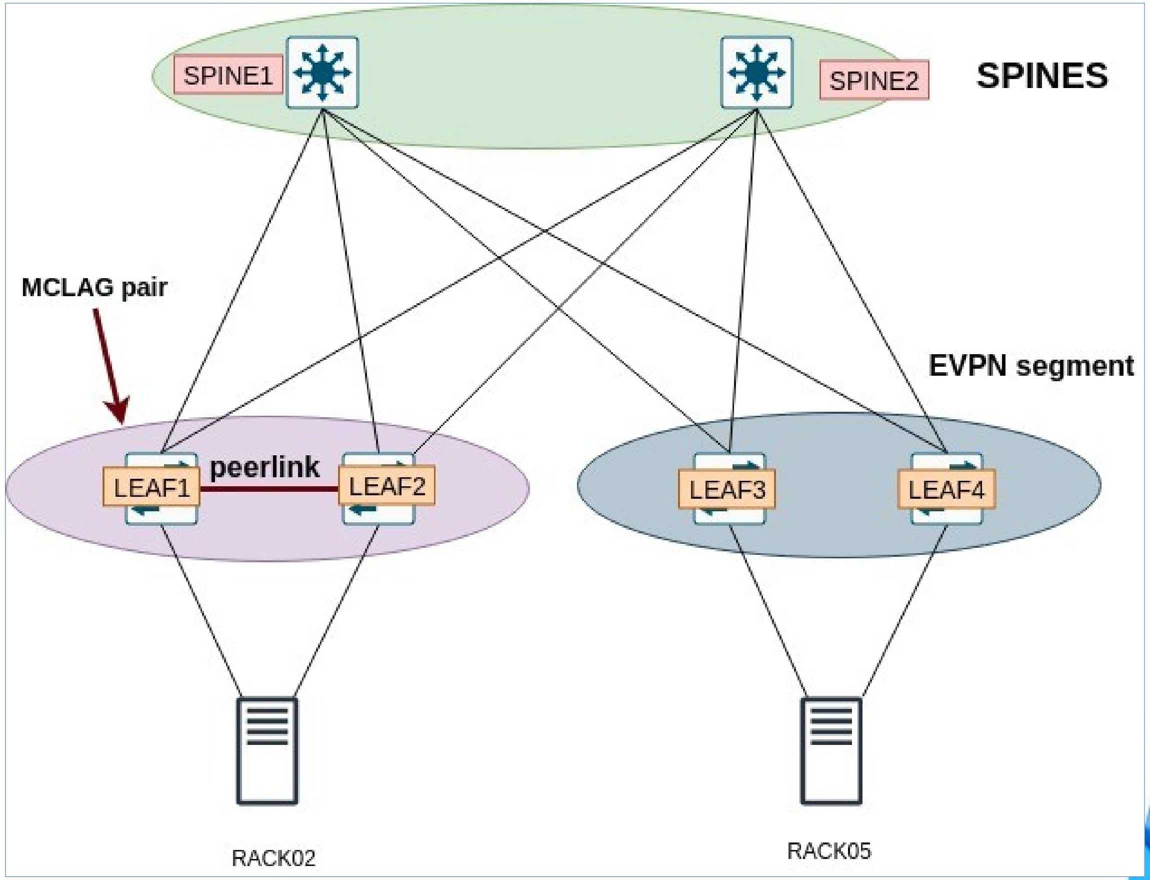
MCLAG: uses peer link between switches to determine host sharing and primary-secondary negotiation.

EVPN-MH: uses the same ESI value (Ethernet Segment Identifier) through EVPN to determine dual-homed hosts.

EVPN has advantages against MCLAG:

- Eliminates the need for peer links or inter-switch links between the top of rack switches.
- Peer link capacity must increase proportionally to the traffic served to underlying servers.
- Allows multi-vendor interoperability

GRNET uses EVPN-MH to production DCs



Cumulus release 4.2 does not support EVPN-MH for Broadcom Chipset. Used MCLAG to overcome the problem.

Testing

Configuration and management

- NCLU
- Ansible
- Support Documents

Protocol features and failure scenarios

- eBGP unnumbered, eBGP towards core routers
- ECMP and load balancing across data centre links
- EVPN MAC/IP advertisements
- DHCP relay
- L3 GW redundancy
- MCLAG failure scenarios
- ACLs

- **Performance measurements (iperf3)**
- TCP/UDP traffic (Up to 20Gbps = LAG capacity)
- Latency

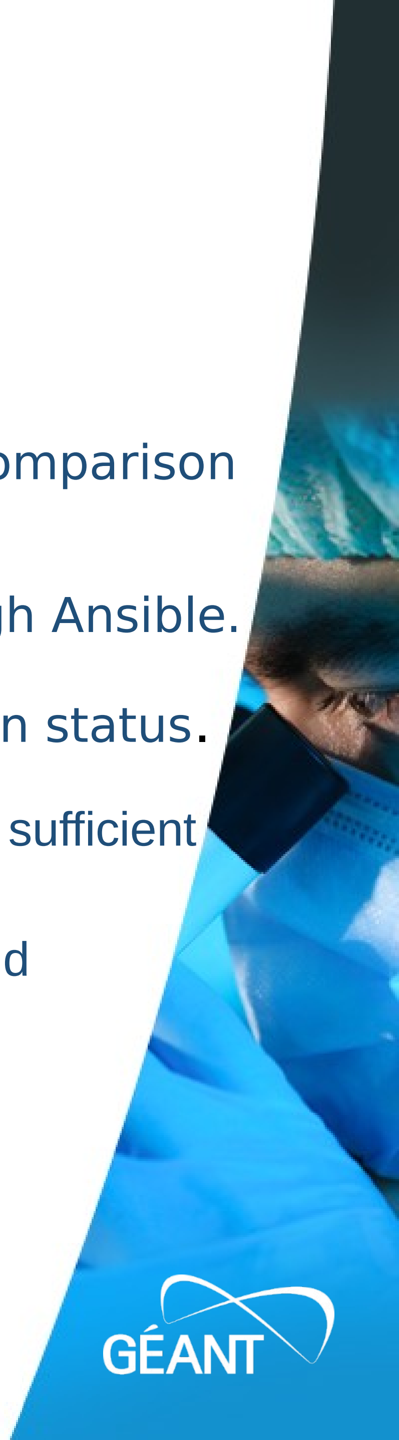
Special feature validation

- MAC mobility

Results and validation

Configuration and Management

- NCLU ‘net show’ commands sometimes give irrelevant and misleading output in comparison with configuration files.
- More reliable to directly change the **configuration files** either manually or through Ansible.
- The native Linux commands are available and always display the real configuration status.
- Documentation for Cumulus NOS has a lot of configuration scenarios and examples but is not sufficient enough for troubleshoot.
- Very active community (via a Slack channel) that can be of significant help on configuration and troubleshooting.



Results and validation

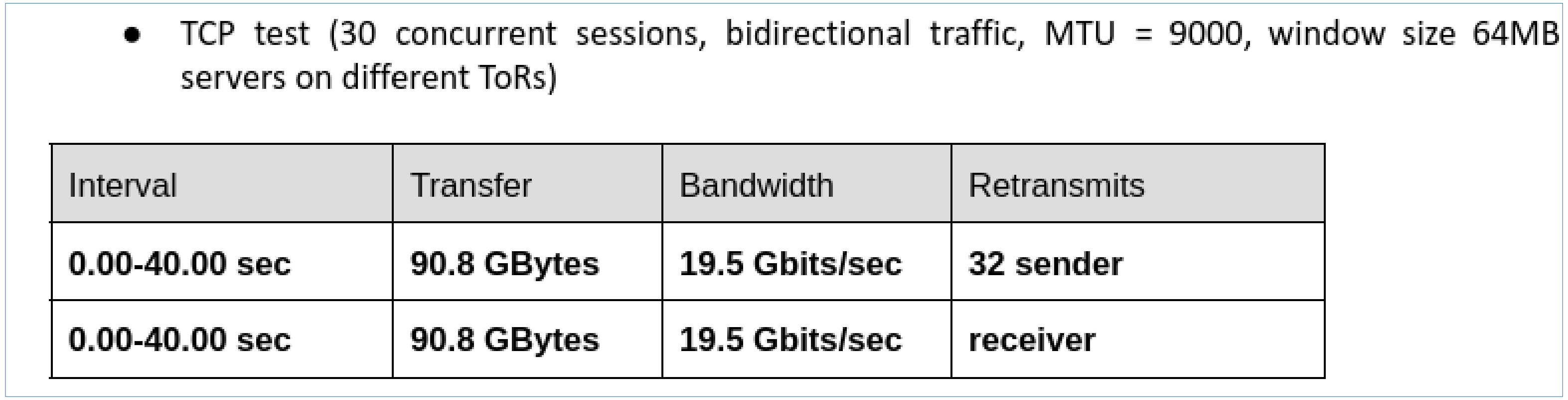
Protocol features and failure scenarios

- All fundamental protocol features were successfully tested.
- Despite the disadvantages against EVPN-MH, MCLAG feature tests, performance tests and failure scenarios proved that **MCLAG functions properly**.

Results and validation

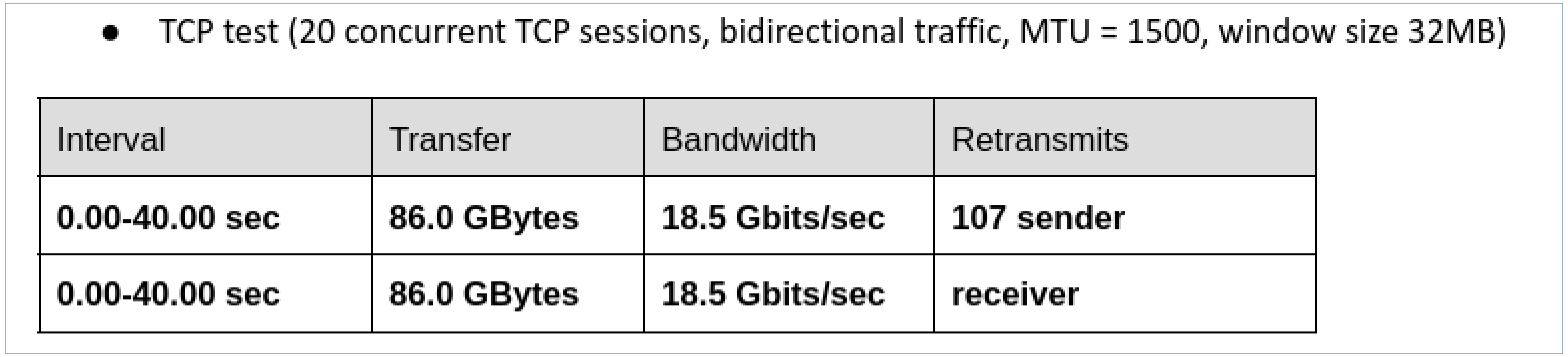
Performance measurements

- Sufficient for regular operation and many failure scenarios.



- TCP test (30 concurrent sessions, bidirectional traffic, MTU = 9000, window size 64MB servers on different ToRs)

Interval	Transfer	Bandwidth	Retransmits
0.00-40.00 sec	**90.8 GBytes**	**19.5 Gbits/sec**	**32 sender**
0.00-40.00 sec	**90.8 GBytes**	**19.5 Gbits/sec**	**receiver**

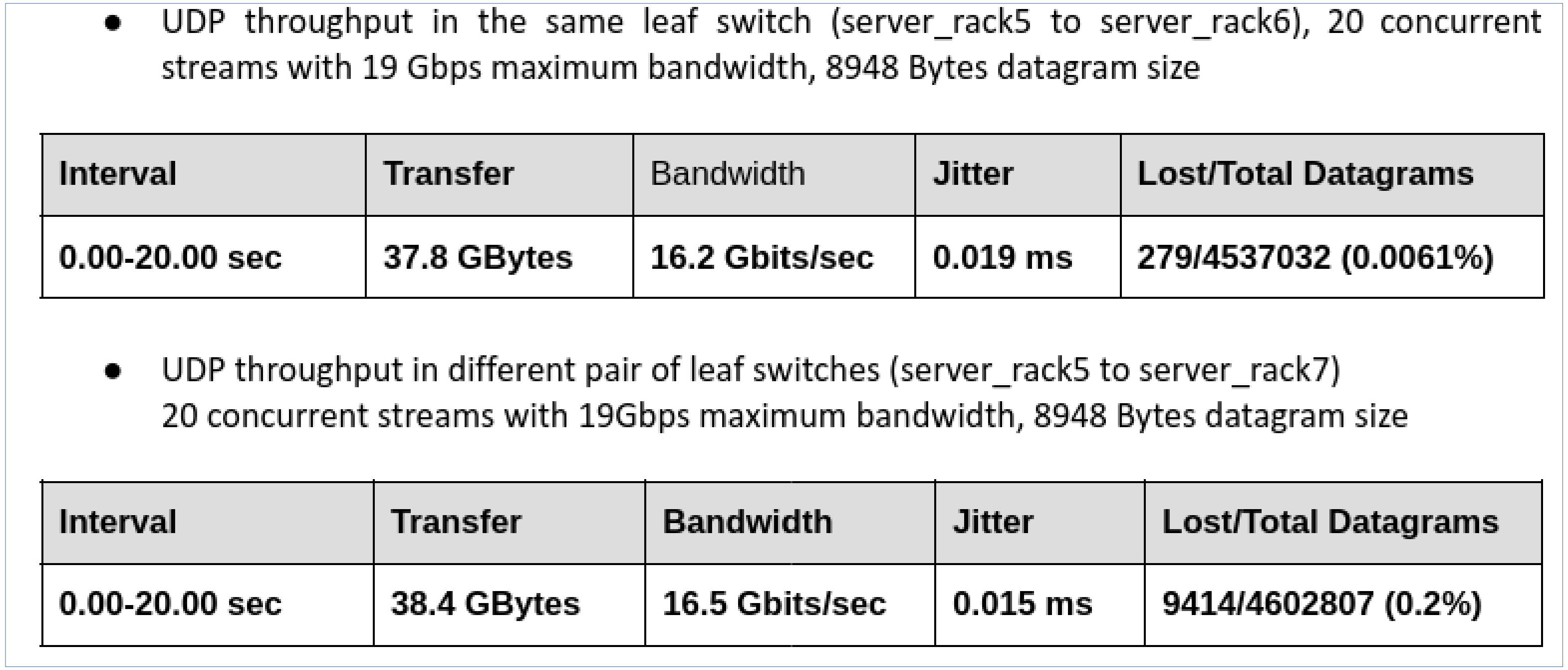


- TCP test (20 concurrent TCP sessions, bidirectional traffic, MTU = 1500, window size 32MB)

Interval	Transfer	Bandwidth	Retransmits
0.00-40.00 sec	**86.0 GBytes**	**18.5 Gbits/sec**	**107 sender**
0.00-40.00 sec	**86.0 GBytes**	**18.5 Gbits/sec**	**receiver**

Results and validation

Performance measurements



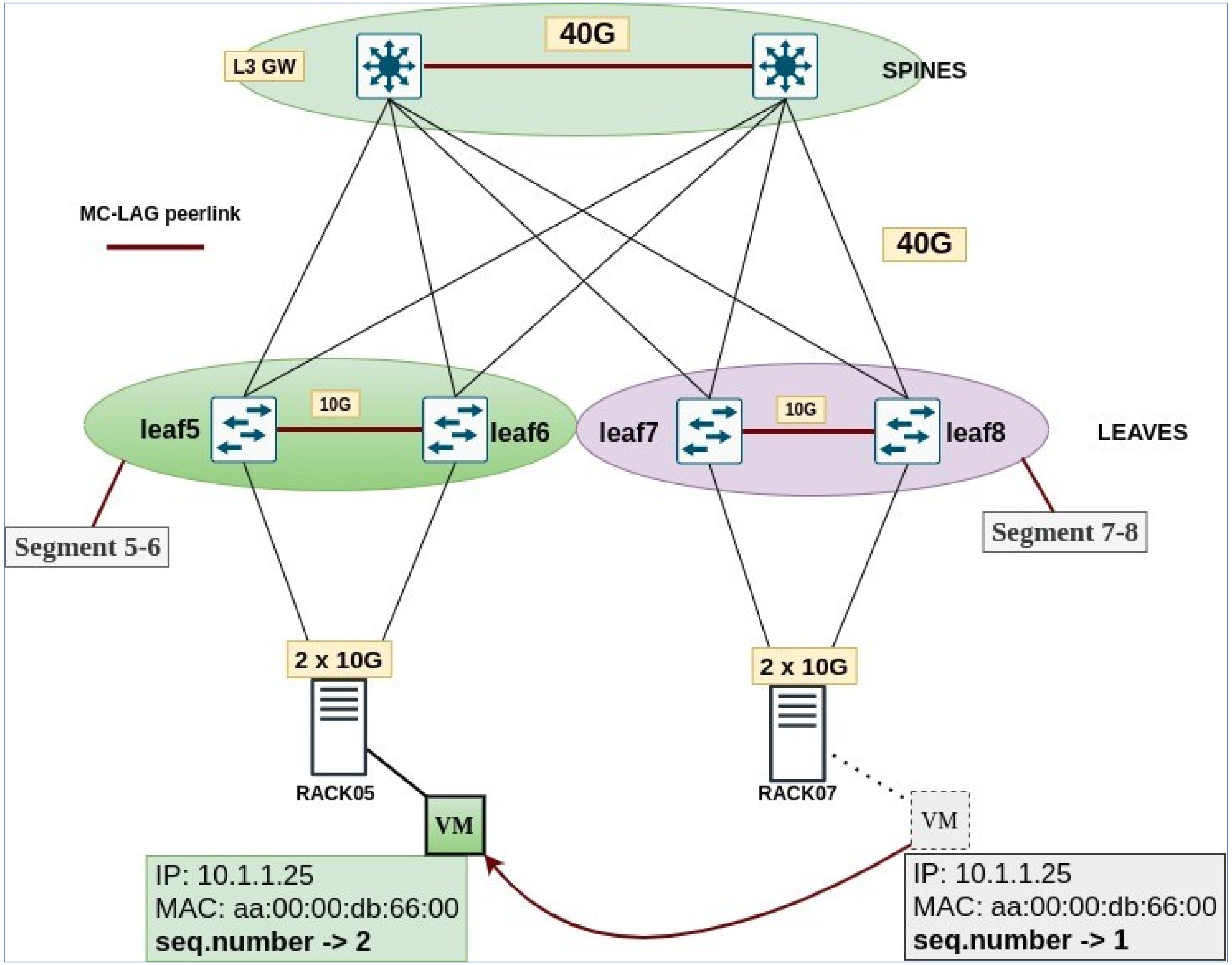
- UDP throughput in the same leaf switch (server_rack5 to server_rack6), 20 concurrent streams with 19 Gbps maximum bandwidth, 8948 Bytes datagram size

Interval	Transfer	Bandwidth	Jitter	Lost/Total Datagrams
0.00-20.00 sec	37.8 GBytes	16.2 Gbits/sec	0.019 ms	279/4537032 (0.0061%)

- UDP throughput in different pair of leaf switches (server_rack5 to server_rack7)
  20 concurrent streams with 19Gbps maximum bandwidth, 8948 Bytes datagram size

Interval	Transfer	Bandwidth	Jitter	Lost/Total Datagrams
0.00-20.00 sec	38.4 GBytes	16.5 Gbits/sec	0.015 ms	9414/4602807 (0.2%)

Special Feature Validation:
MAC Mobility



IP: 10.1.1.25
MAC: aa:00:00:db:66:00
seq.number -> 2

IP: 10.1.1.25
MAC: aa:00:00:db:66:00
seq.number -> 1

- Quite often in Data Centres there is a need to move a host/VM from one HW node to another.
- EVPN takes care of the movement with MAC mobility feature(RFC_7432).
- MAC Mobility extended community attribute.

Testing:

- VM movement through Ganeti cluster management tool from Rack07 to Rack05.
- MAC mobility convergence time was **5.8 ms**.

Market changes

- Cumulus NOS initially supported several types of **Spectrum and Broadcom ASICs**

- **March 2019**: NVIDIA acquired Mellanox

- **June 2020**: GRNET acquired Edgecore switches with **Broadcom Chipset**

- **June 2020**: NVIDIA acquired Cumulus

- **July 2020**: Cumulus 4.2 release - EVPN MH deployment only on Mellanox switches with Spectrum ASIC.
  solution: MCLAG

- **July 2021**: Cumulus release 4.4 supports only Mellanox switches.
  Cumulus 4.3 is the last release that supports Broadcom chipset.

- **December 2025**: Cumulus release 4.3 - End of Support.

- GRNET – 4 remaining years of support.

- Either keep Cumulus NOS and try Mellanox switches or keep Edgecore switches and try another NOS.

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Thank you

Any questions?

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