Pluribus NETWORKS

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Transforming Lab Automation with Layer-1 switching fabrics based on SDN and whitebox switches

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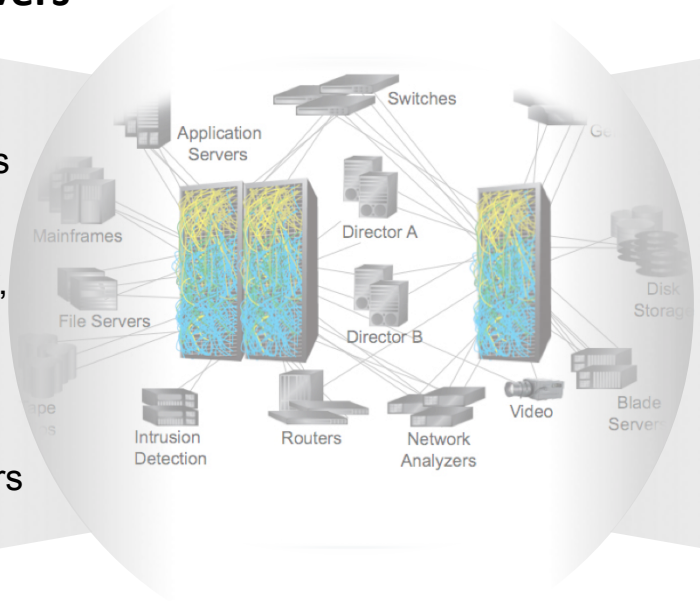
Challenges of the Modern Test Lab

Automation – Business Drivers

Accelerate service onboarding, testing of updates and patches, developing and testing new services – **Accelerate time-to-revenue**

Eliminate manual, error-prone, slow, topology moves, adds – **Reduce OPEX**

Maximize utilization and sharing of expensive tools like traffic generators across groups/projects – **Reduce CAPEX**



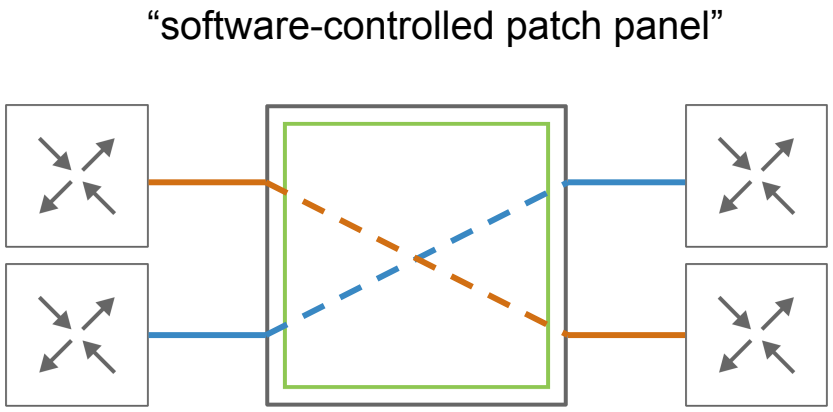
Traditional Labs Realities

Time consuming, error prone reconfigurations of topologies

Expensive equipment is often located in silos around the company, simultaneously underutilized and inaccessible to many

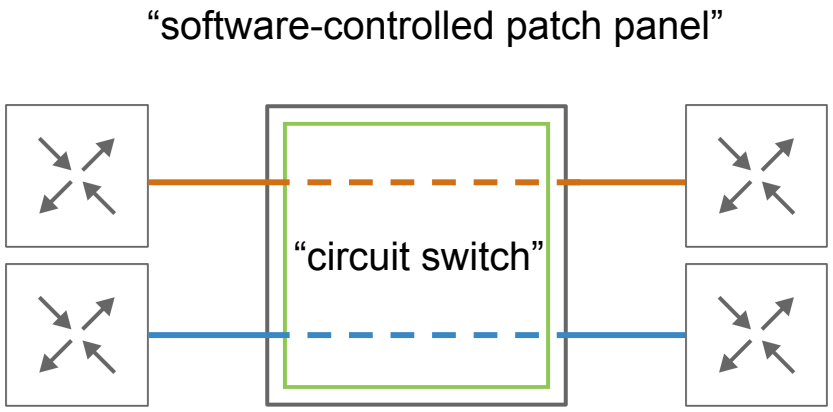
Increase test velocity while reducing capital equipment costs and cutting overall operational expense

L1 Switching Concept



- Once an internal connection is made within the layer 1 switch, the now-paired routers ‘appear’ to be directly connected to each other.
- The name layer-1 switch comes from the fact that they’re trying ’emulate’ the behavior of a physical cable between the two devices.

L1 Switching Concept



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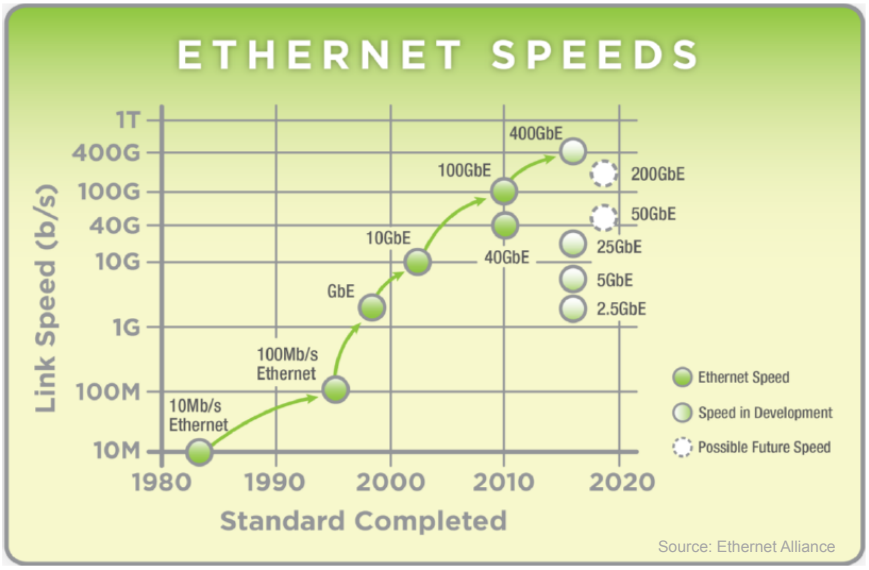
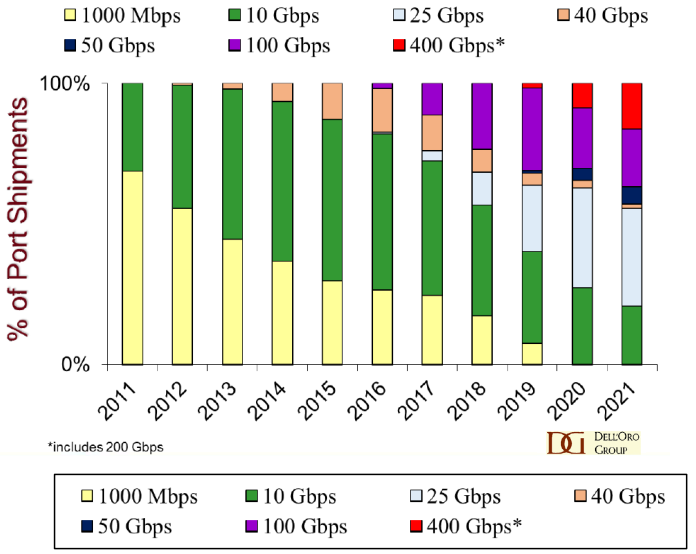
Traditional Solutions For L1 Fabrics

	Packet Brokers	Optical Cross-connects	Media Cross Connect (Optical-Electrical)
Typical System Configuration	Modular Chassis / leaf-spine	Modular Chassis	Modular Chassis
Flexible Media types	✔	✖	✔
Cost	$$$$	$$$	$$$
Speed/Media conversion	✔ not always	✖	✖
L2-4 Packet handling	✔	✖	✖
Automatic Path Discovery with guaranteed connectivity	✖	✖	✖
Path Resiliency and Dynamic Failover	✖	✖	✖
DUT Circuit Sharing	✖	✖	✖
Extends L1 Across Labs	✖	✖	✖

Traditional L1 Do Not Keep Up With Ethernet Speeds And The Multitude of Ethernet PMDs



Ethernet Port Transition

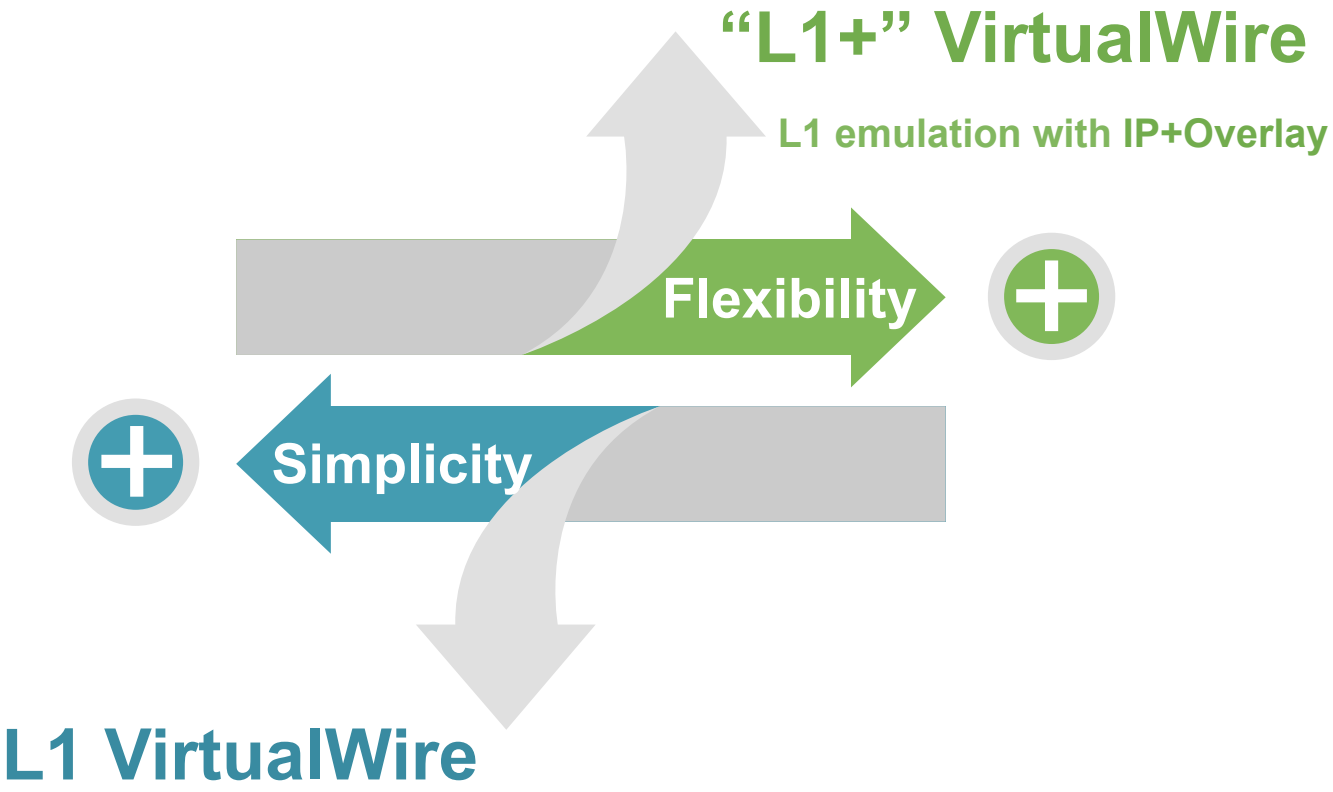


Advantages of Whitebox Ethernet Switching Hardware

Open Network Switches

- Unmatched interface flexibility and density
  → 1, 10, 25, 40, 50, 100, 200, 400G
- SMF | MMF | Optical and Copper speed and media conversion
- Scale-out, pay-as-you-grow with leaf-spine topologies based on 1U commodity switches
- L1 fabric capacity 20X of legacy solutions
- Significantly lower Capex and Opex than any traditional L1 solution

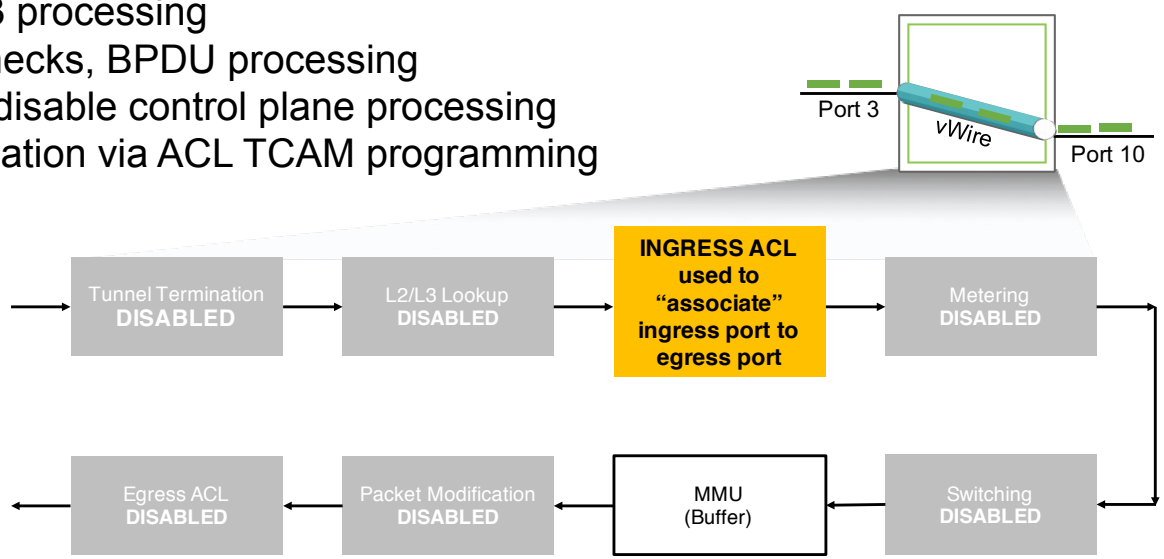
Two Architectural Approaches To Emulate L1 Technology



L1 Ethernet VirtualWire Concept

Merchant Silicon Ethernet Switch Hardware:

1. Network OS must disable MAC learning
2. Disable Routing/L3 processing
3. Disable stp/vlan checks, BPDU processing
4. Network OS must disable control plane processing
5. Circuit switch emulation via ACL TCAM programming

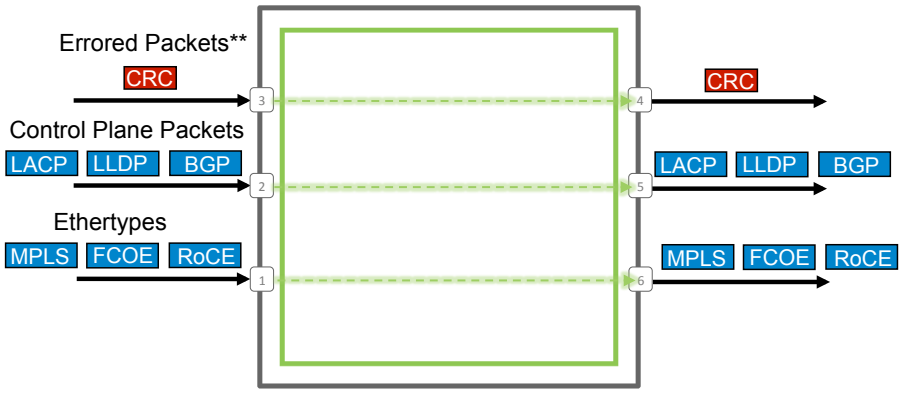


6. It is possible to configure the switch chip* to pass through transparently errored frames (e.g. CRC, runt…)
7. Implement logic to propagate link-up/down events between two mapped ports

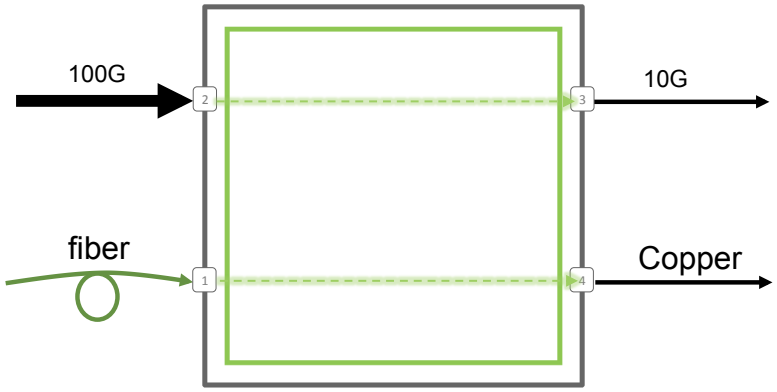
* Verified with at least one merchant silicon chip family

Whitebox Switch VirtualWire Properties

Transparency to any Ethernet packet

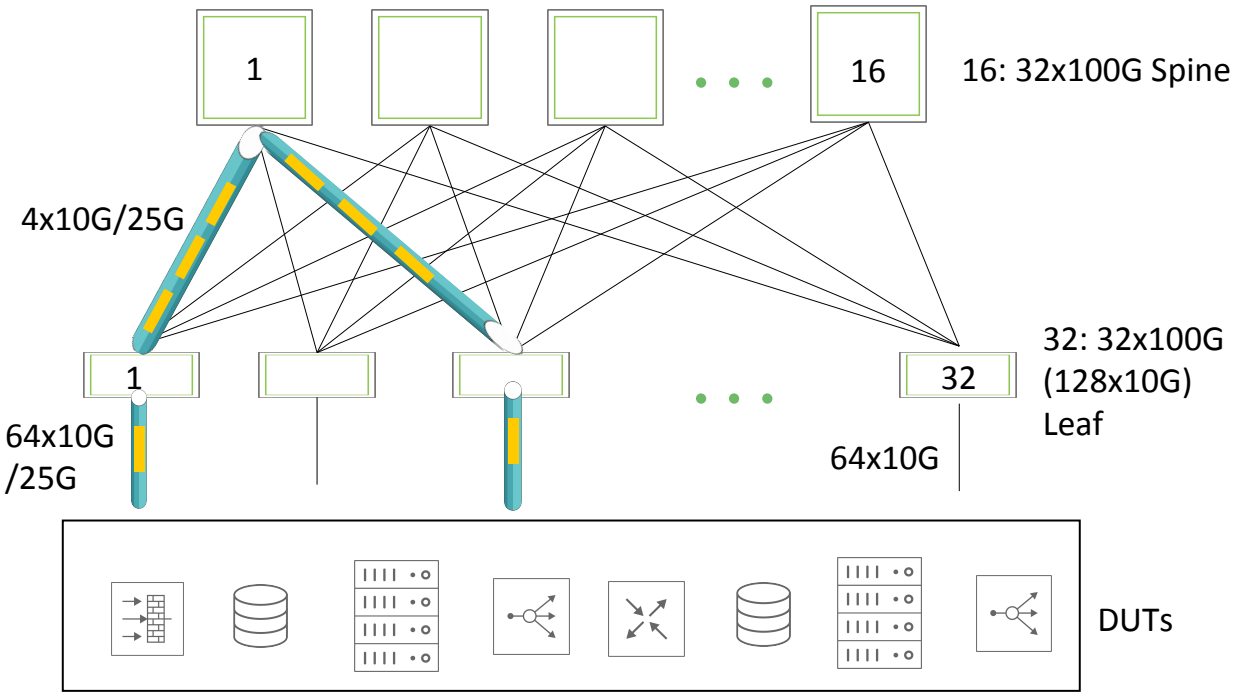


Speed and Media Conversion



L1 VirtualWire Fabric Scalability Example

2,048 10G/25G DUTs Non-blocking fabric



32 x 10G/25G per leaf to DUTs

Spine 64 ports → **32** leaf

Total 10G DUTs: 32x64=2,048

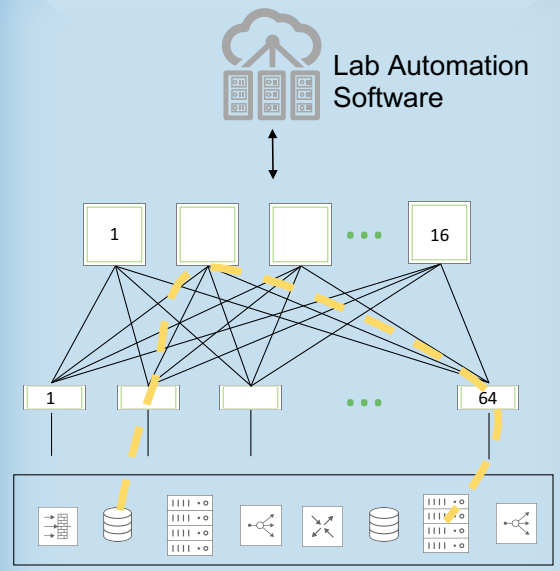
Whitebox L1 VirtualWire Capabilities

Transparent to ALL kinds of Ethernet traffic and encapsulations and frame errors

Flexible interfaces from 1G to 100+G copper and fiber

Any speed, any media conversion

OS must implement Link status Tracking logic to emulate a true L1 switch

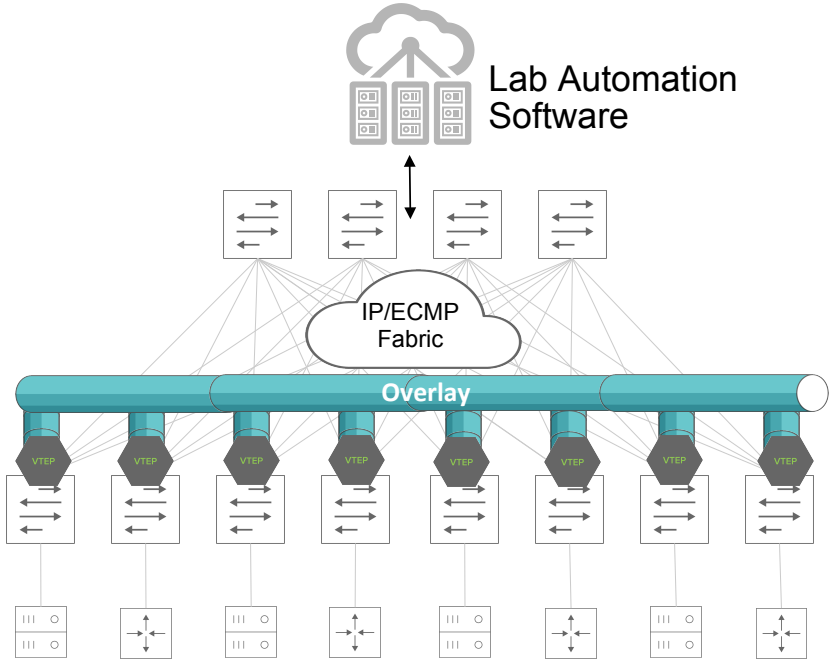


Programmability of Modern Whitebox OSes: RESTful API, CLI, Ansible

End-to-end automatic discovery of available paths via external Lab automation controller

Modular, scale-out, pay-as -you grow design

L1+ VirtualWire Based On IP+Overlay



Can be implemented with a Point-to-point Virtual Private Wire Service (VPWS) using VXLAN Transport:

- Option of EVPN control plane (https://tools.ietf.org/html/draft-ietf-bess-evpn-vpws-14)
- No MAC lookup
- No learning
- Transparency to L2/L3 protocols
- Transparent to different Ethertypes
- Failure propagation
- Few implementations exist today

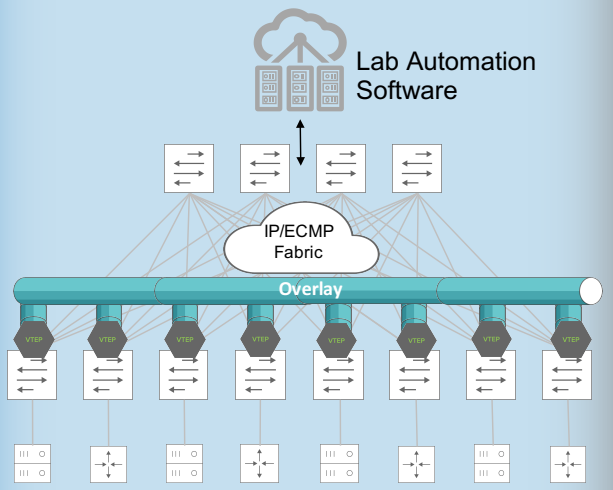
L1+ VirtualWire *Additional* Capabilities

On Top Of The Basic L1 Whitebox VirtualWire

Automated path discovery with guaranteed connectivity

Dynamic bandwidth utilization with DUT path sharing

Path resiliency and automatic failover…upon link and node failures



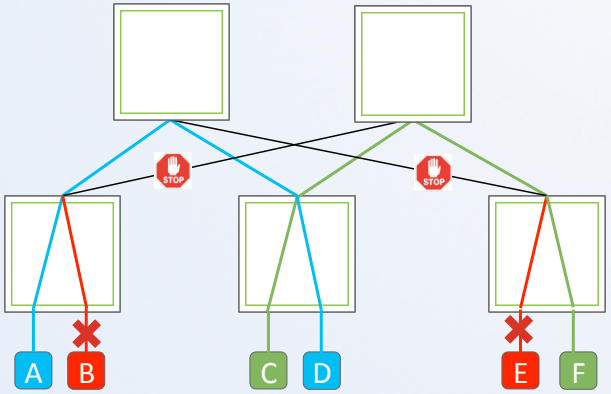
Extend VirtualWires across geographically distributed Labs (MTU adjustments might be necessary to accommodate for the VXLAN encap)

IP control plane is more complex than traditional L1 switching

L1+ Path Auto-discovery With Guaranteed Connectivity

L1 Technology

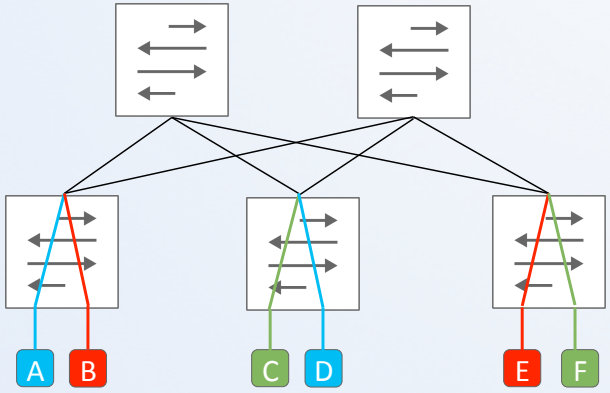
DUTs cannot find a path even if the bandwidth is not oversubscribed



Leads to overprovisioning of the fabric interconnections to prevent path conflicts → $$ and complexity

L1+ Virtual Wire

Path auto-discovery with guaranteed connectivity even with oversubscription

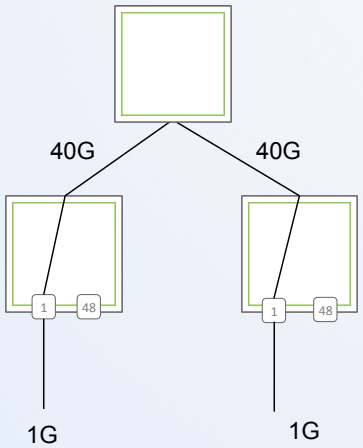


Simpler provisioning and more cost effective with fewer links to manage

L1+ Dynamic Bandwidth Utilization With DUT Path Sharing

VirtualWire and Any L1 Technology

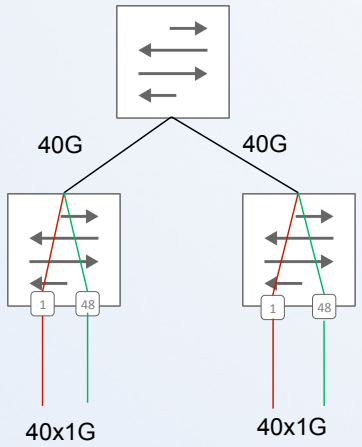
Static provisioning of path bandwidth through the fabric



Leads to poor bandwidth utilization when low speed DUT traverse the high-speed fabric links

L1+ Virtual Wire

Dynamic sharing of fabric bandwidth across many DUT ports

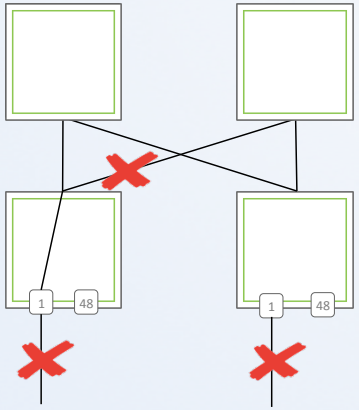


More efficient link utilization, more cost effective and with fewer links to manage

L1+ Path Resiliency And Automatic Failover

VirtualWire and Any L1 Technology

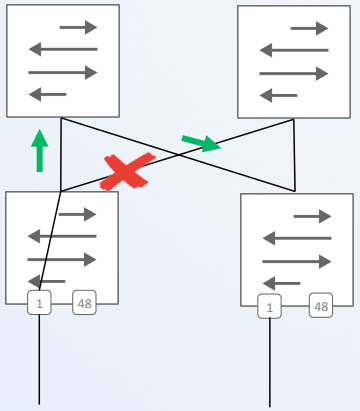
No ability to failover is any of the path links fail



More complex to manage, manual recovery, longer outages

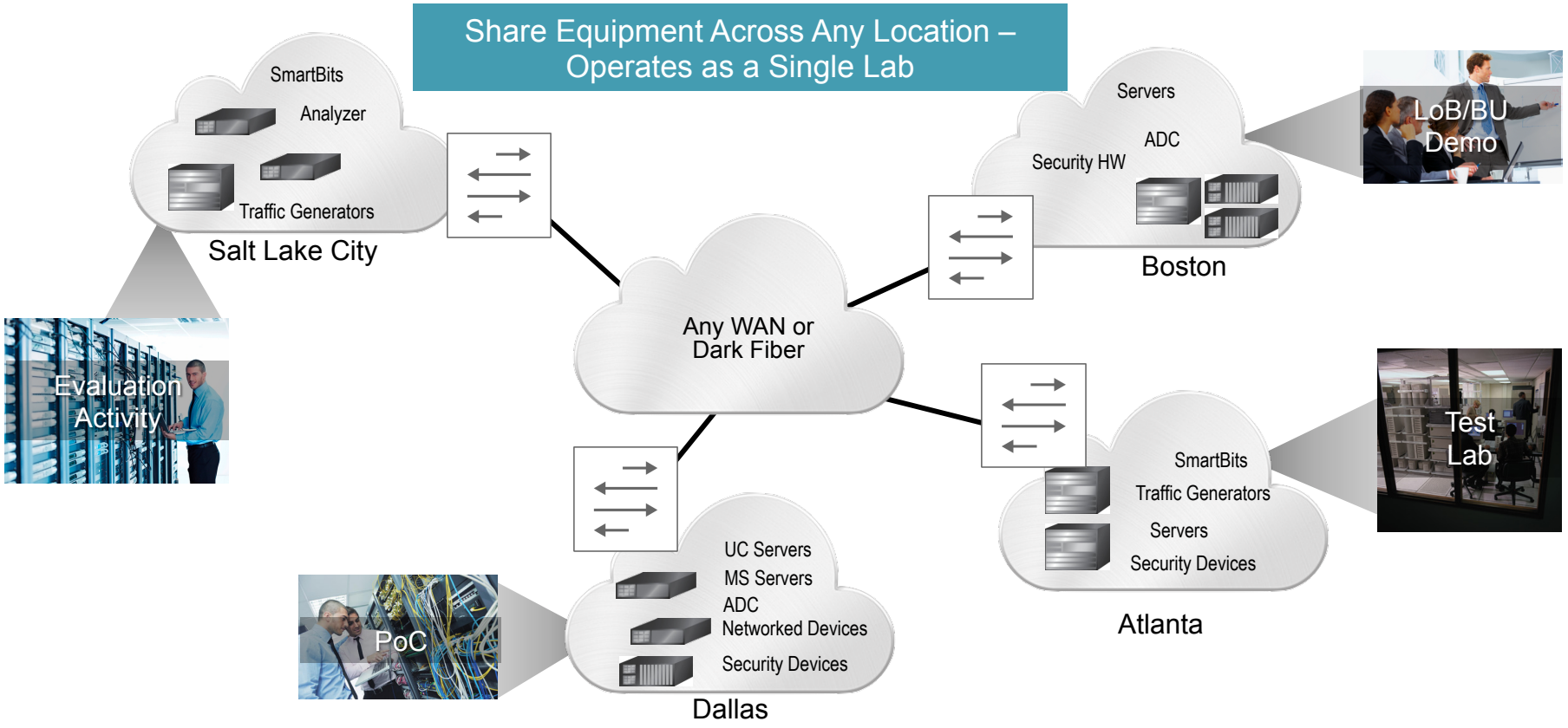
L1+ Virtual Wire

Dynamic sub-second Failover



Resilient to multiple link or node failures. Transparent failover to the DUTs.

L1+ Multi-Lab Fabric Extension



Transforming Lab automation With Commodity Whiteboxes and SDN Fabrics

	Traditional L1 Switches PB, Optical & Media x-connects	L1 VirtualWire	L1+ VirtualWire IP+Overlay
Scalability	✗ Scale up – chassis backplane limited	✓ Scale-out – modular leaf-spine	✓ Scale-out – modular leaf-spine
Cost	✗ $$$$	✓ $	✓ $
Any Media/Speed conversion	✗	✓	✓
Automated path discovery with guaranteed connectivity	✗	✗	✓
Path Resiliency and Automatic Failover	✗	✗	✓
Dynamic bandwidth utilization with DUT path sharing	✗ Static (link size increments)	✗ Static (link size increments)	✓
Extend VirtualWires across geographically distributed Labs	✗	✗	✓
Errored Frames Transparency	✓	✓	✗ Limited
Wirespeed – no overhead	✓	✓	✗ 50 bytes VXLAN hdr overhead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