Technology Innovations in Broadcast and Post-production

Thomas Burns
CTO, Media & Entertainment

DELL Technologies

Enterprise IT Transformation

Digital Transformation

IT Transformation

Workforce Transformation

Security Transformation

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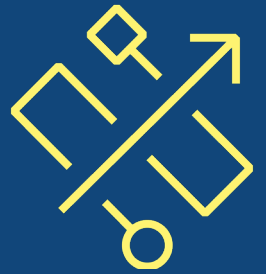
Digital Transformation



Broadcast → Network Fabric

- “One-to-Many” becomes “Service Mesh Architecture”
- IP, ATSC3.0, 5G network evolution
- Edge compute & 5G networks = “Internet of Things”

Decentralized Content Fabrics re-defining Core vs. Edge

- Intelligent network routing using machine learning
- Just in time rendering of content increases edge efficiency

IT Transformation

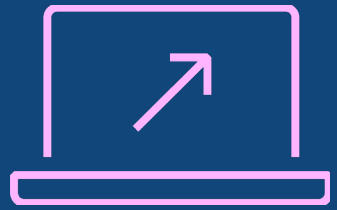
Virtualization of Server & Network applications

- Hyper-converged Infrastructure
- Software-defined storage & networking

Workflow Orchestration

- Enterprise Service Bus (~2003)
- Service Oriented Architecture (~2008)
- API layers replacing individual hardware drivers (~now)

Workforce Transformation



Migrating project-based creative talent = most time and cost

- Virtualizing creative applications next step
- PCoIP protocol for remote workstations
- Hypervisor for fully virtualized environments

Multi-cloud for global collaboration

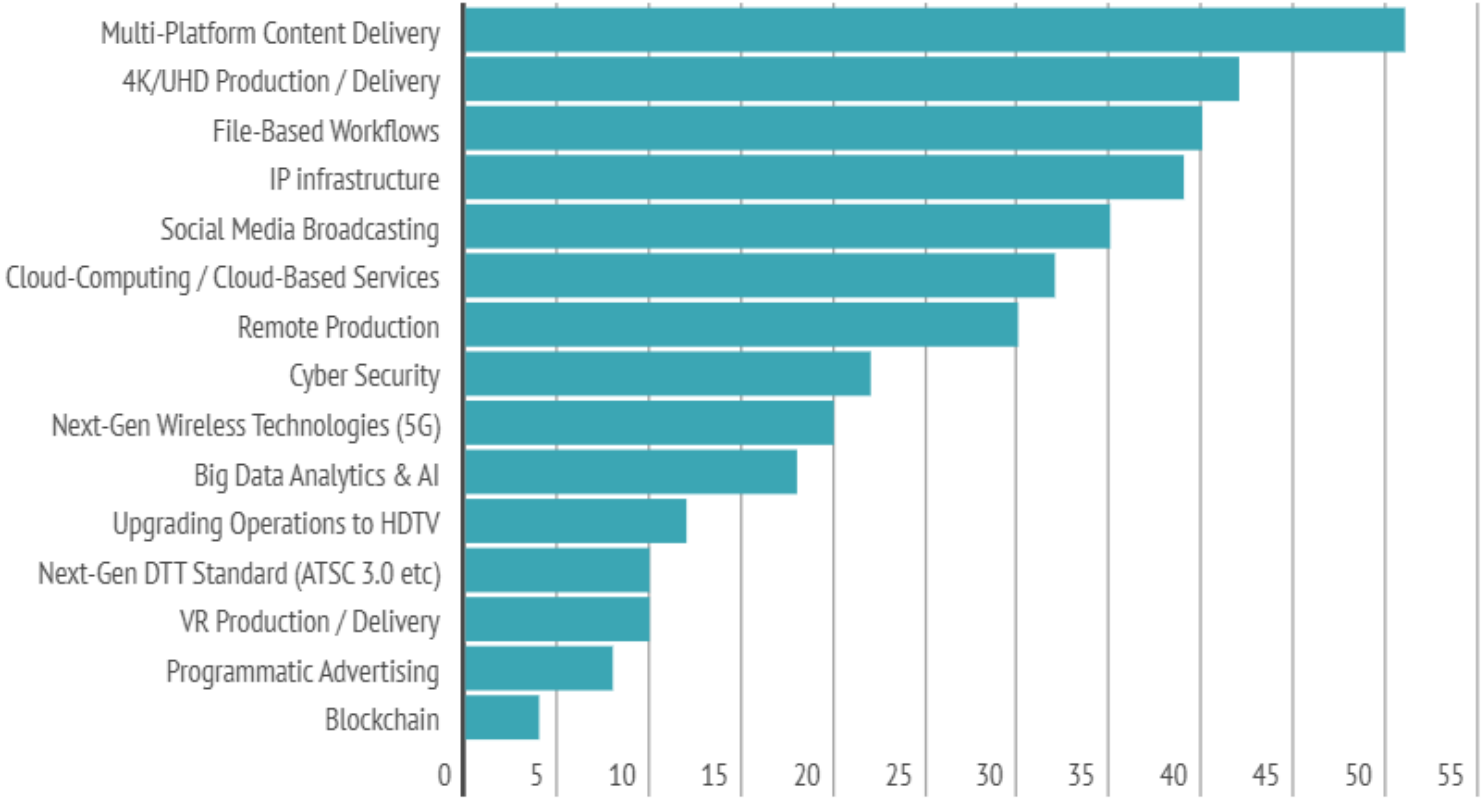
- On-premise file for high-throughput, low-latency workflows
- Object store becomes globally accessible asset library
- Hybrid Private/Public cloud with workload mobility

Security Transformation

Trusted Partner Network Webinar (courtesy MESA)

- https://vimeo.com/268679740

Media Technology Priorities - 2019



Source: IABM / Devoncroft

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JT-NM “Dematerialized Facilities” in 2017

- “A broadcast facility operating on generic IT equipment either contained locally, or a remote facility operated by others”
- Runs on virtual machines
- Uses “Non-Media specific” COTS hardware to rapidly scale up or down
- Open architecture using self-describing APIs

Media Function Virtualisation Journey

Hardware
Dedicated hardware & devices
SDI Video & Audio

Software
Generic HW + Application SW

SMPTE ST 2110

Transition to IP
Efficiency, agility & scale

Virtualisation
Media Functions on Virtual Infrastructure in private cloud

Multi-Cloud
Media Functions running in a fabric of multiple cloud service providers

AIMS Roadmap – July 2019

SDI over IP Baseline	Audio over IP	Standardized Transport of Audio, Video, & ANC Elements	System Environment & Device Behaviors
SMPTE ST 2022-6 SDI Over IP	**AES67** Audio Over IP	**SMPTE ST 2110-10** Timing & Definitions **SMPTE ST 2110-20** Uncompressed Video **SMPTE ST 2110-21** Packet Pacing **SMPTE ST 2110-30** AES67 Audio **SMPTE ST 2110-31** AES3 Compressed Audio **SMPTE ST 2110-40** Ancillary Data	**PTP, DHCP, LLDP, DNS-SD** Network Environment **AMWA NMOS IS-04** Discovery & Registration **AMWA NMOS IS-05** Connection Management **System Resource** Critical System Parameters
SMPTE ST 2022-6	**AES67**	**SMPTE ST 2110**	**JT-NM TR-1001-1**

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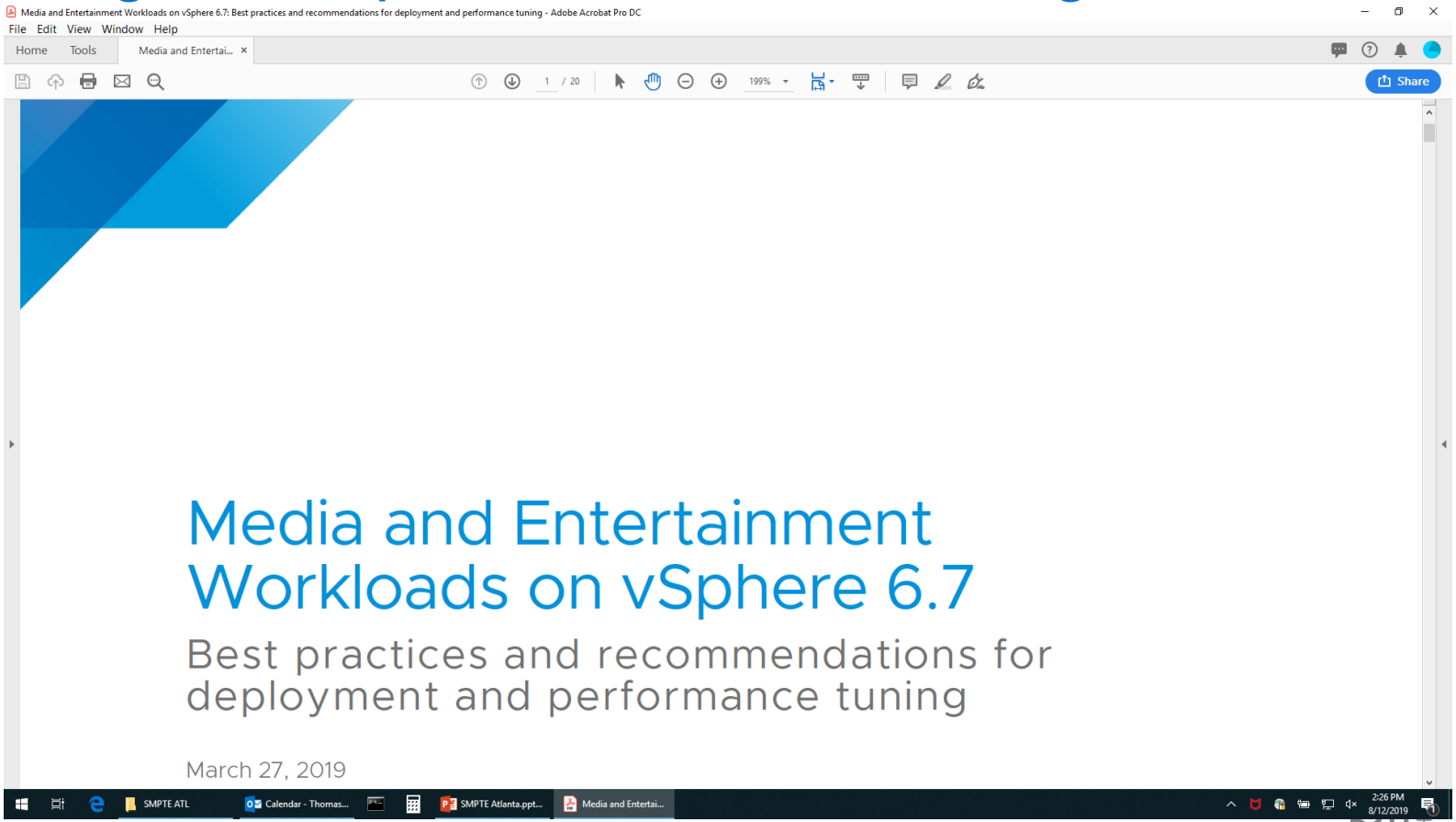
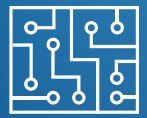
Pushing uncompressed IP flows through vNICs



Key areas of innovation



Accelerated compute

Compute & analytics at the edge

High-performance storage & data protection

Multi-cloud operating models

Software-defined infrastructure

Data mobility

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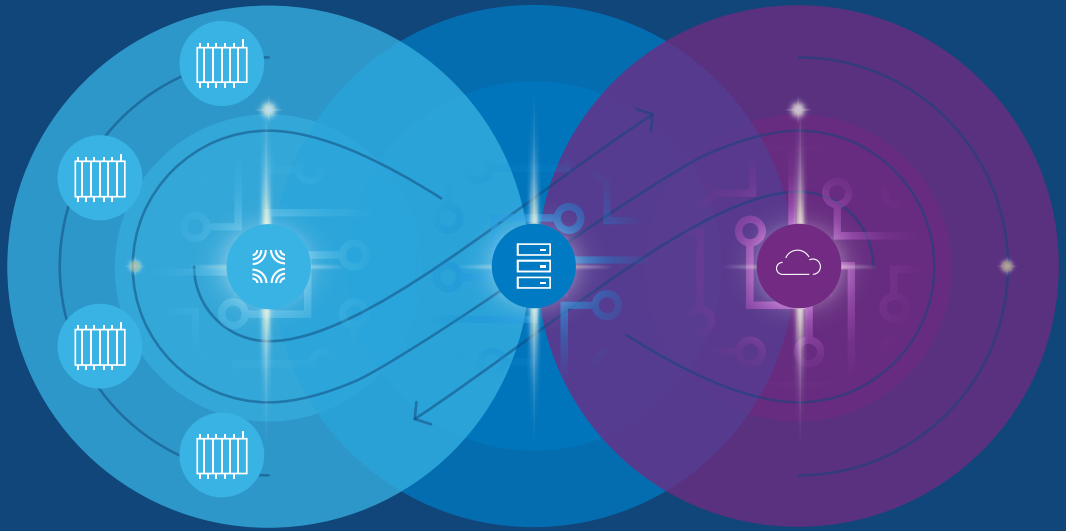
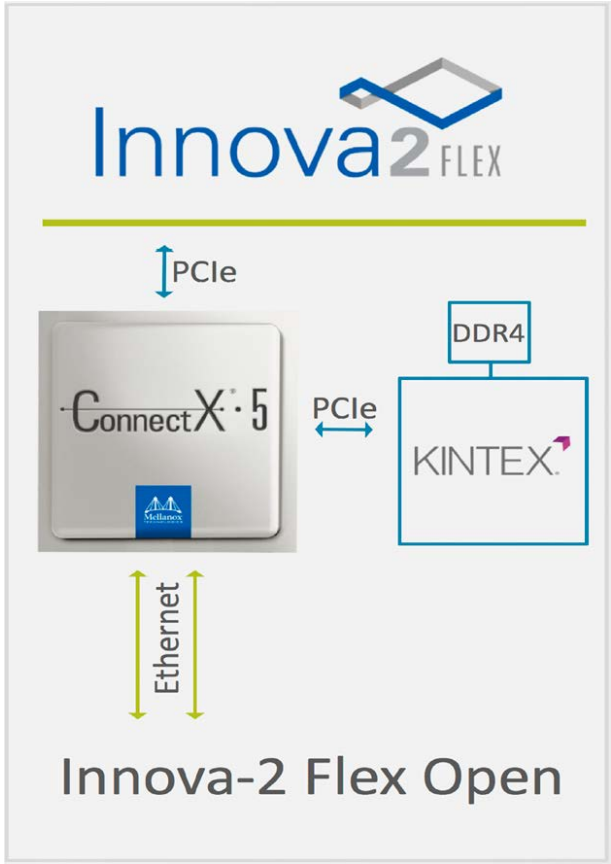
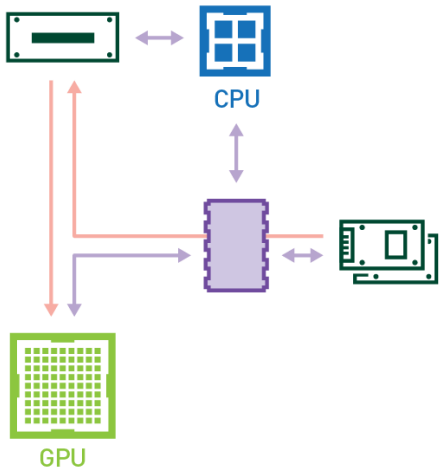


FPGA integrated with Network interface

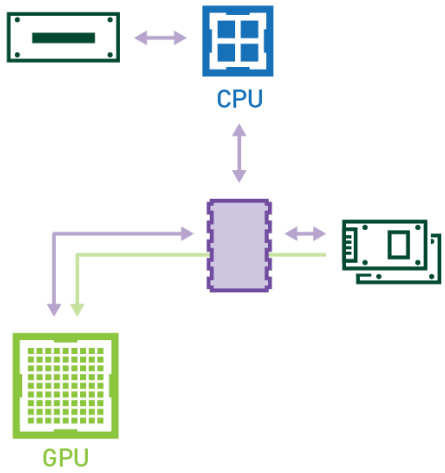
- Traffic shaping, natively offloaded and further customized via FPGA logic
- Video down-sampling for multi-viewer applications
- Hitless switching for video redundancy



Moving data from Storage to GPU



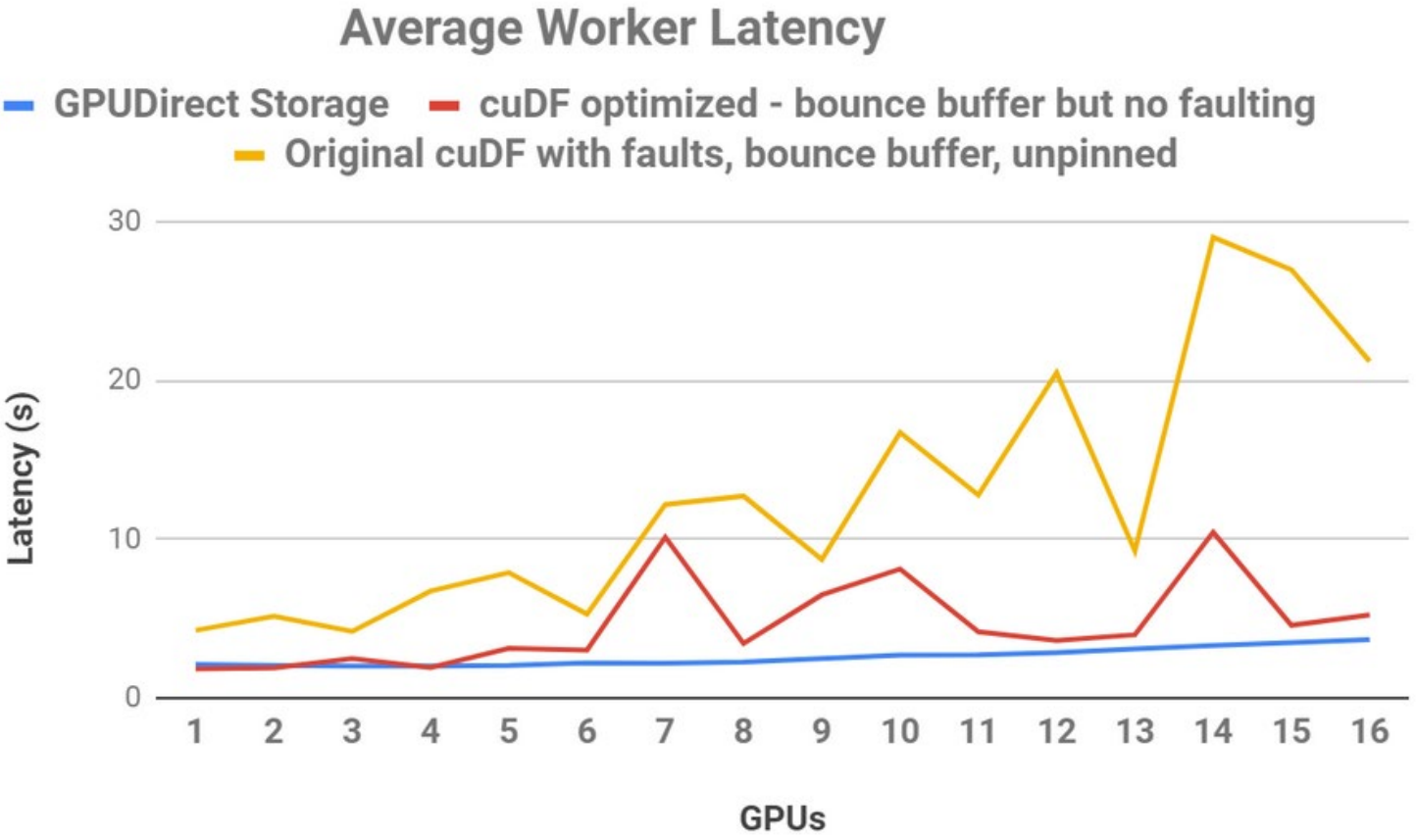
Without GPUDirect Storage



With GPUDirect Storage

System Memory NVMe PCIe Switch GPUDirect Storage Bounce buffer PCIe

Latency improvements with GPU Direct access



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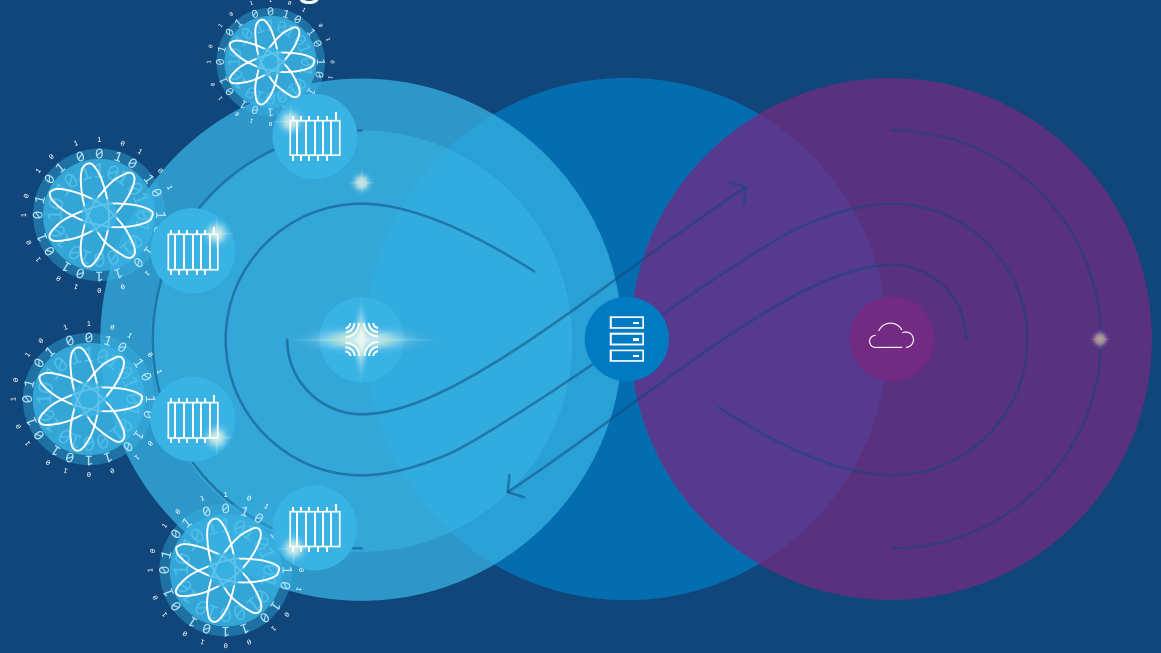

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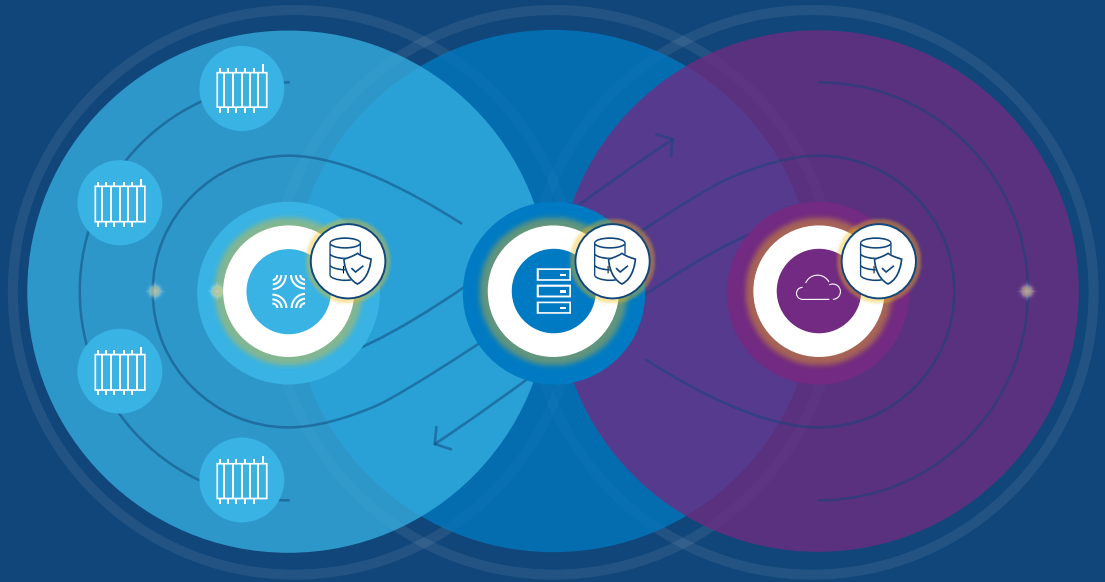

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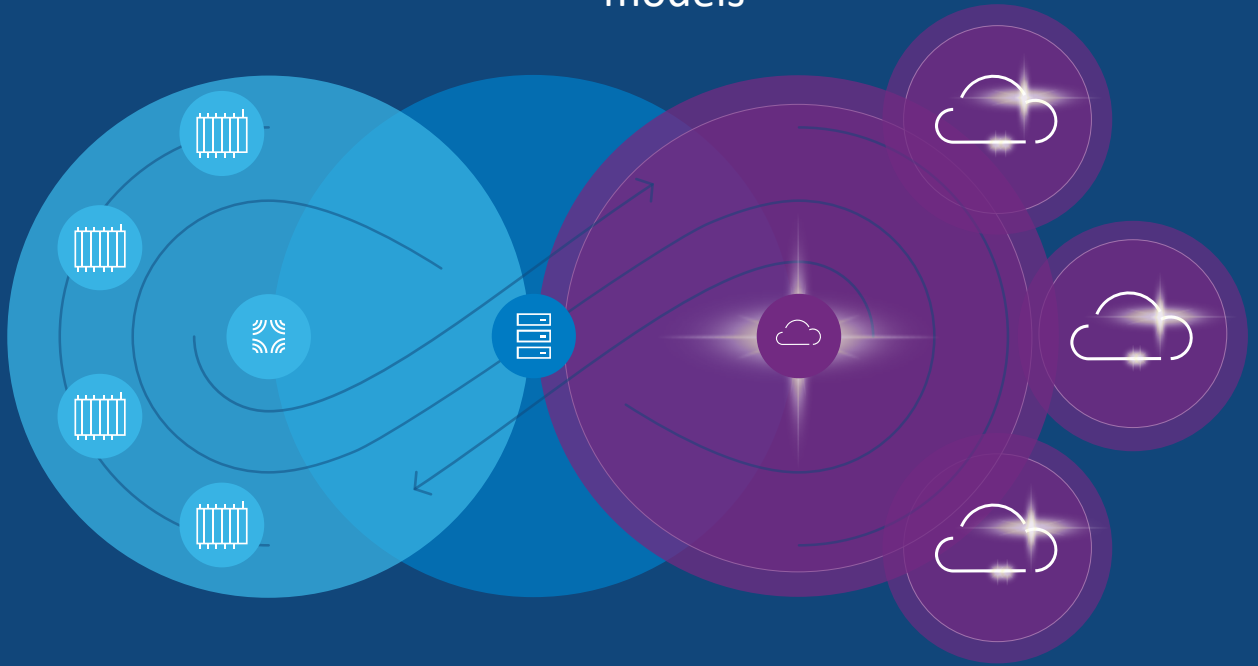
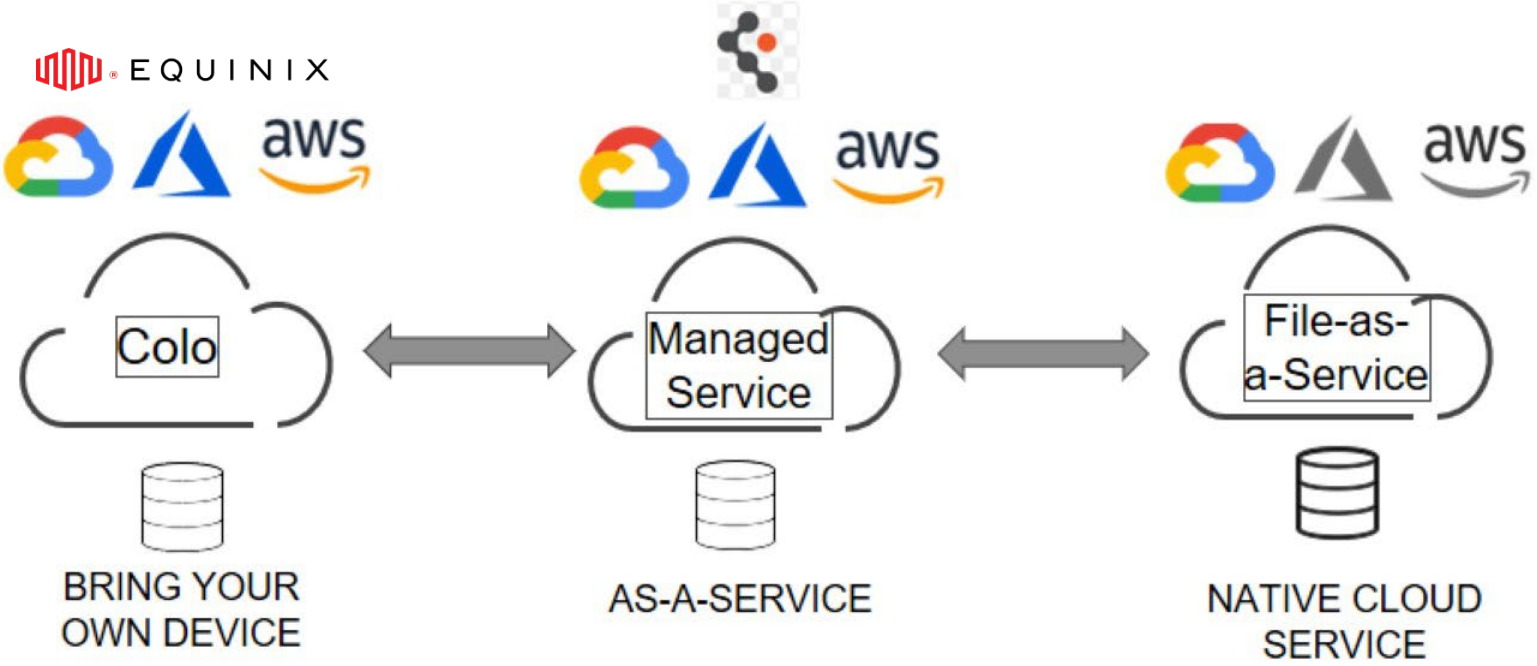


Multi-Cloud Operating models



- Enterprise Scale Out NAS in Cloud with on-prem connections
- Reduced egress charges
- Enhanced Colo Performance
- Multi Cloud Independence

- Enterprise Scale Out NAS in Cloud
- Reduced egress charges
- Managed Service offering
- Multi Cloud Capabilities

- Enterprise Scale Out NAS in Cloud as a native service
- Cloud Portal Integrated
- No egress charges

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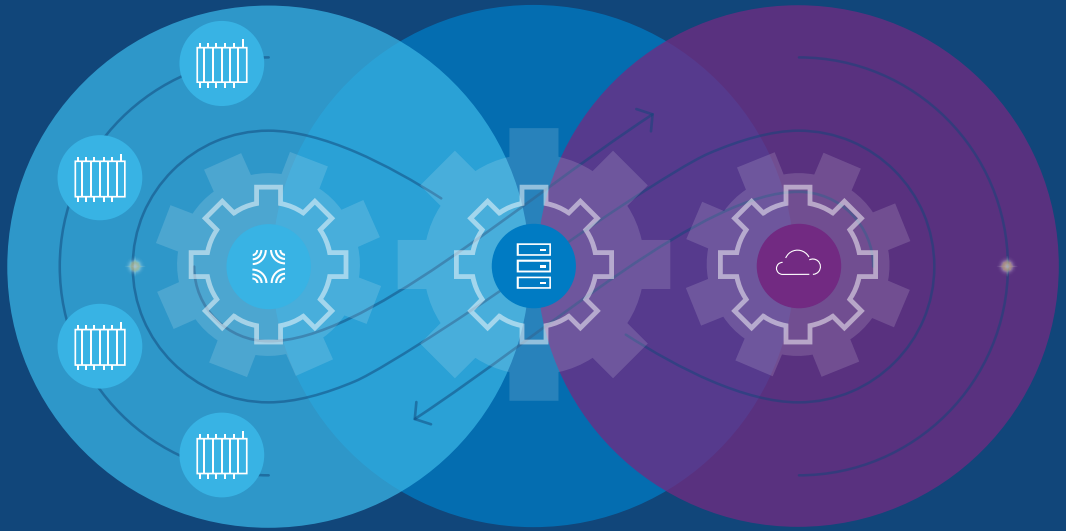

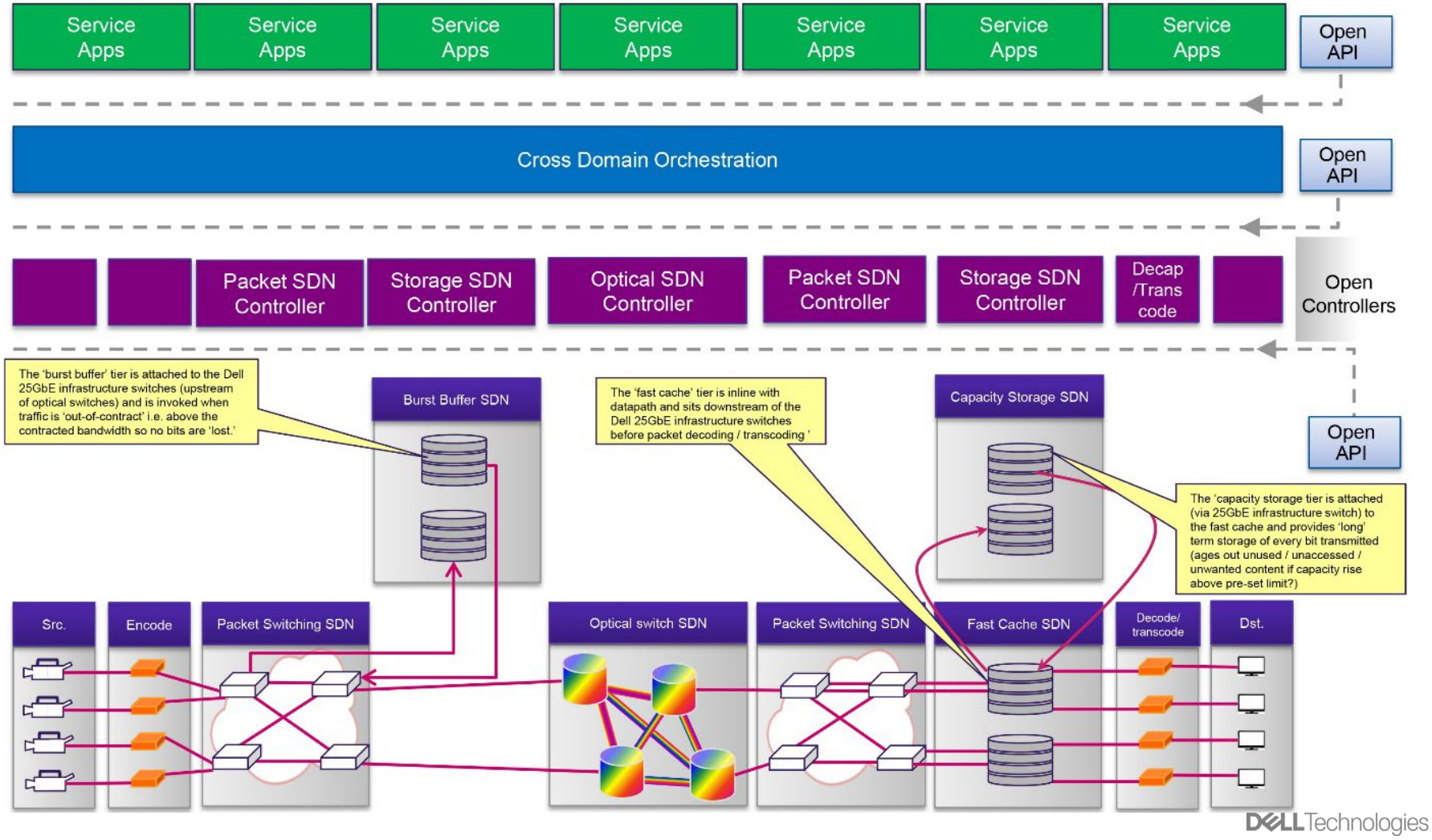
Service Apps
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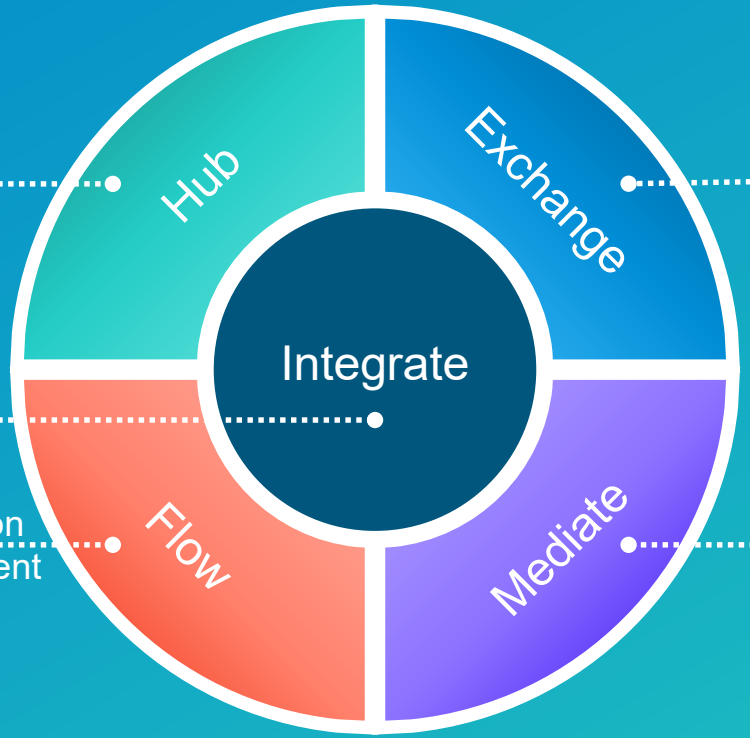
Open API
Cross Domain Orchestration
Open API
Packet SDN Controller
Storage SDN Controller
Optical SDN Controller
Packet SDN Controller
Storage SDN Controller
Decap /Trans code
Open Controllers
Open API
The 'burst buffer' tier is attached to the Dell 25GbE infrastructure switches (upstream of optical switches) and is invoked when traffic is 'out-of-contract' i.e. above the contracted bandwidth so no bits are 'lost.'
Burst Buffer SDN
The 'fast cache' tier is inline with datapath and sits downstream of the Dell 25GbE infrastructure switches before packet decoding / transcoding '
Capacity Storage SDN
The 'capacity storage tier is attached (via 25GbE infrastructure switch) to the fast cache and provides 'long' term storage of every bit transmitted (ages out unused / unaccessed / unwanted content if capacity rise above pre-set limit?)
Src.
Encode
Packet Switching SDN
Optical switch SDN
Packet Switching SDN
Fast Cache SDN
Decode/ transcode
Dst.

API-driven Workflow Orchestration



Master Data Hub

Application and Data Integration

Workflow Automation and App Development

B2B/EDI Management

API Design and Management

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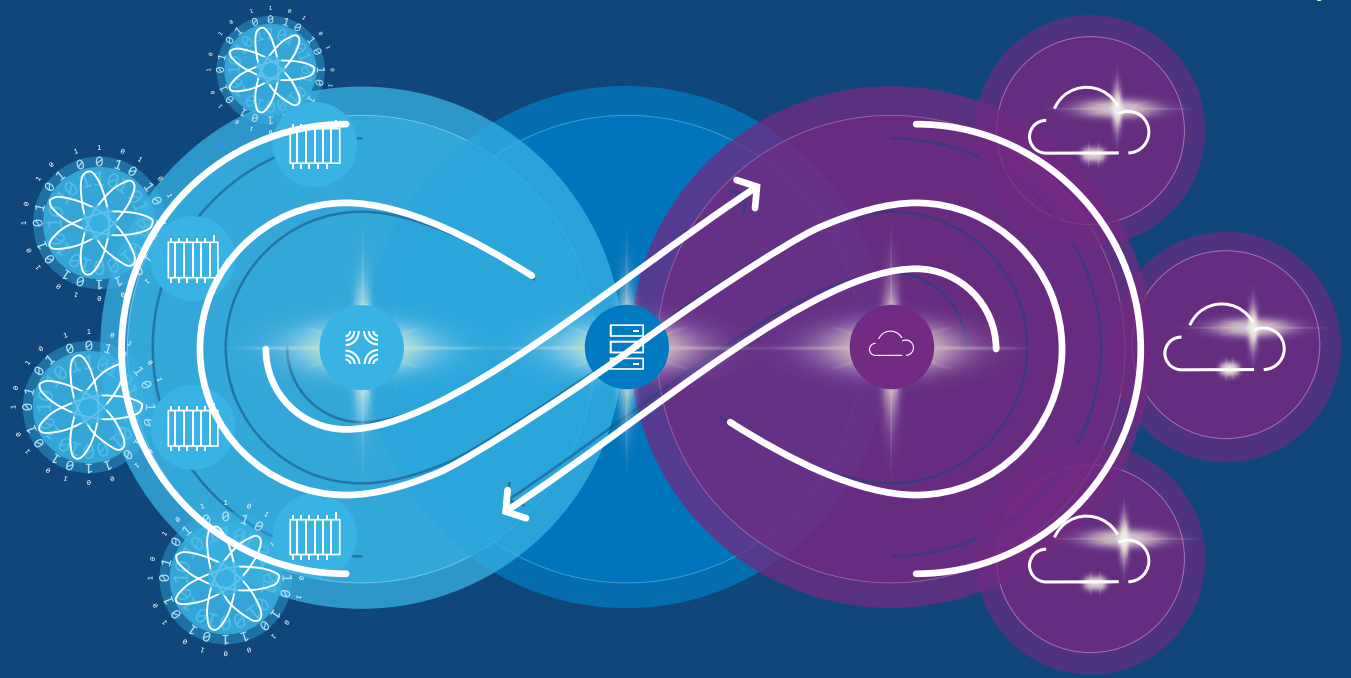

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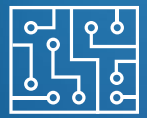

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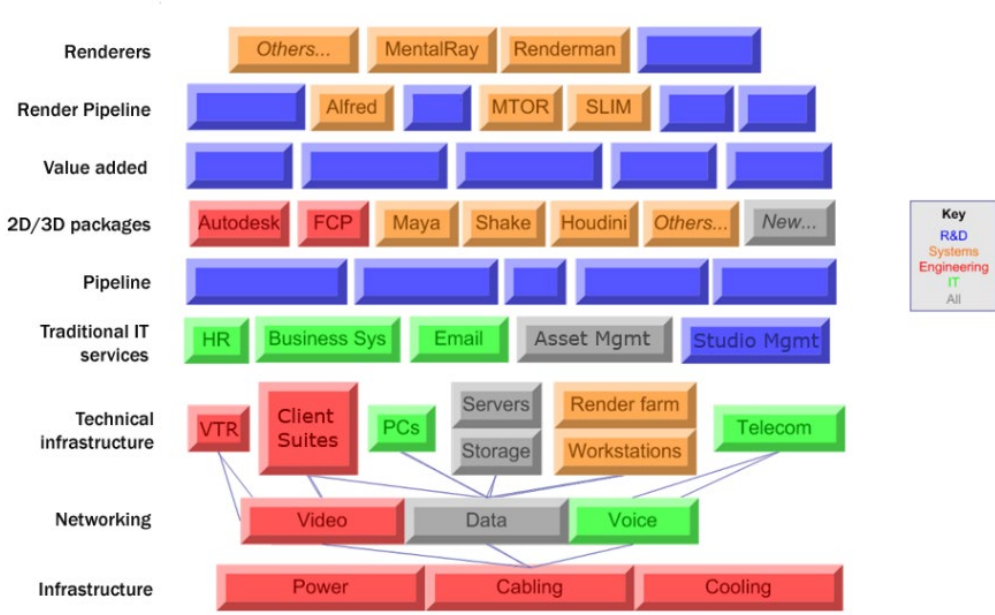
Hyper-converged Infrastructure

- Broadcast ISVs getting out of hardware business
- Virtualized Application, Network and Storage stacks
- Infrastructure upgrades must treat the entire technology stack like connective tissue
- You can't isolate one layer, you must advance them all together



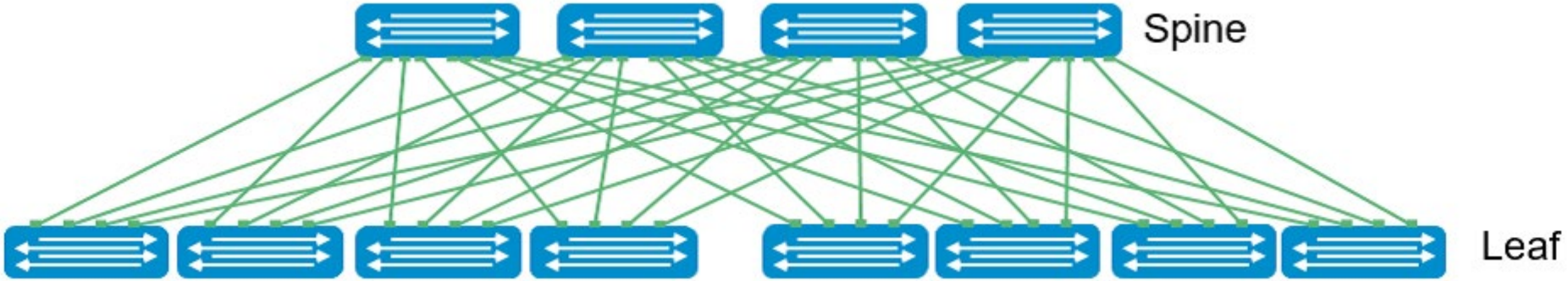
Software-defined Networking (aka Ethernet Fabrics)

- **Benefits**
  - Scales to a higher amount of nodes (250), could go higher in future
  - Removes requirement for large Carrier Grade Switches
  - Switches used are 1U Multirate non-blocking (10, 25, 40, 50, 100 Gb/s)
- **Notes**
  - Same switches supported for both leaf and spine
  - Full bandwidth throughput, non-blocking, 22x 100Gb/s connections down, max of 10 up
  - Switches are in leaf or spine mode, all auto negotiated
  - LBFO daemon will monitor paths between nodes
  - isi_dump_fabric int-a – to show fabric map.

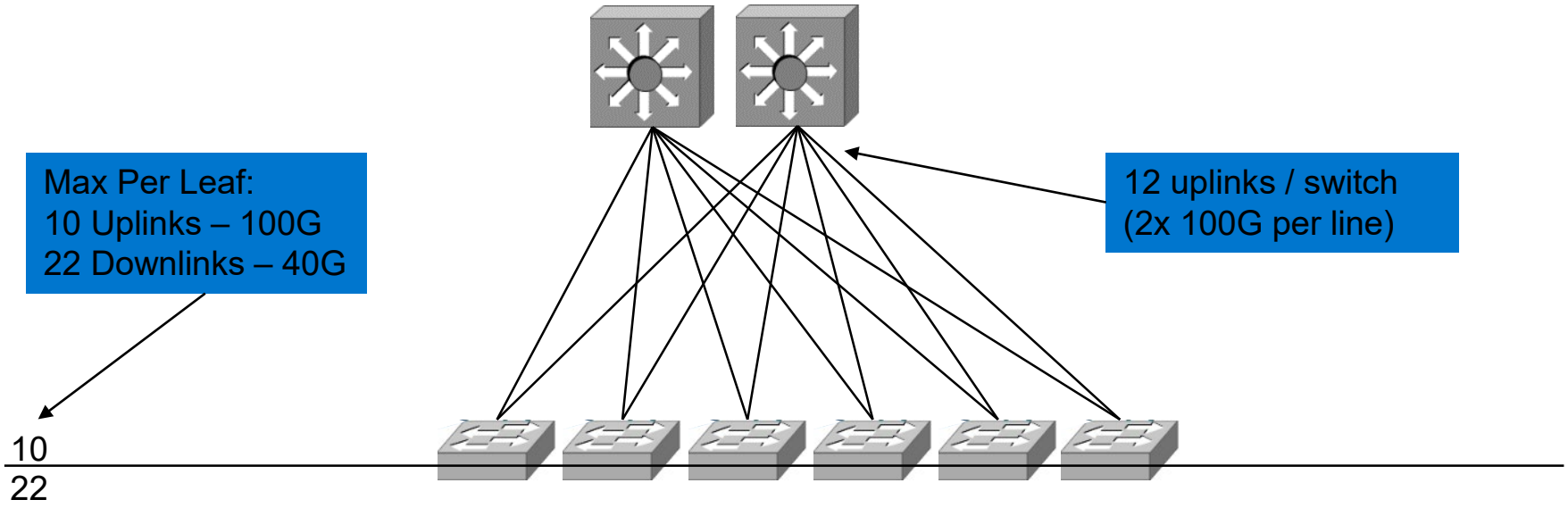
Software-defined Networking

- Spine – Leaf architecture
- Service Meshes
- Distributed CDNs

- 5G Networks
- Multi-access Edge Computing
- High bandwidth, low-latency

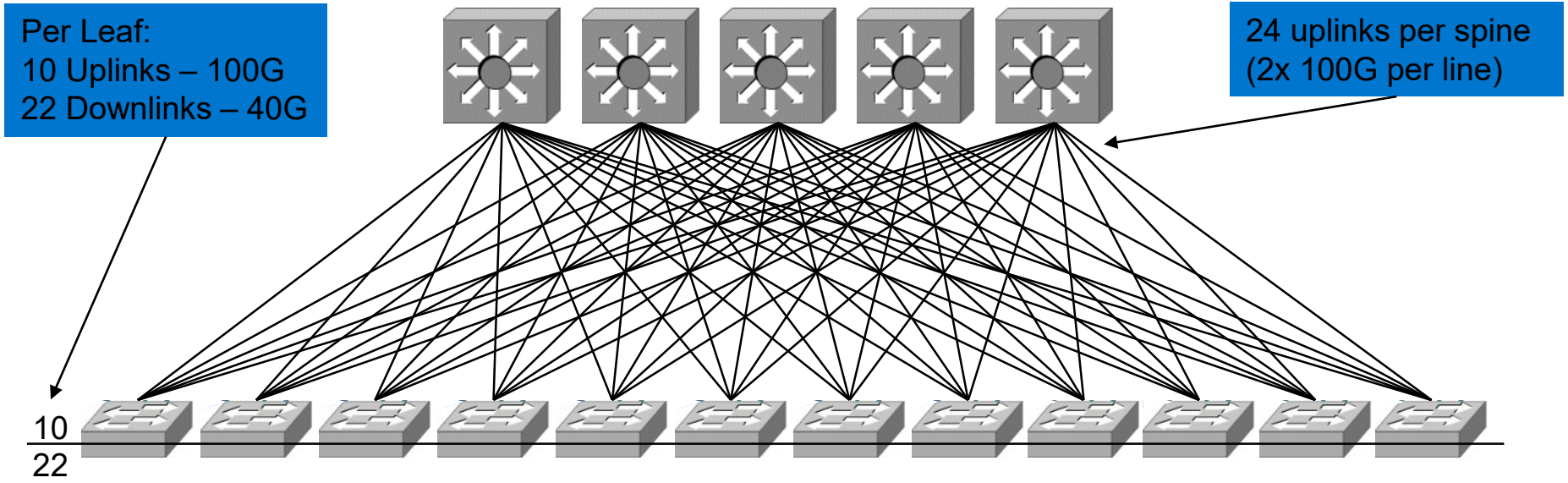


132 Node Leaf-Spine Example



132 nodes requires 2 Spine and 6 Leaf switches per side

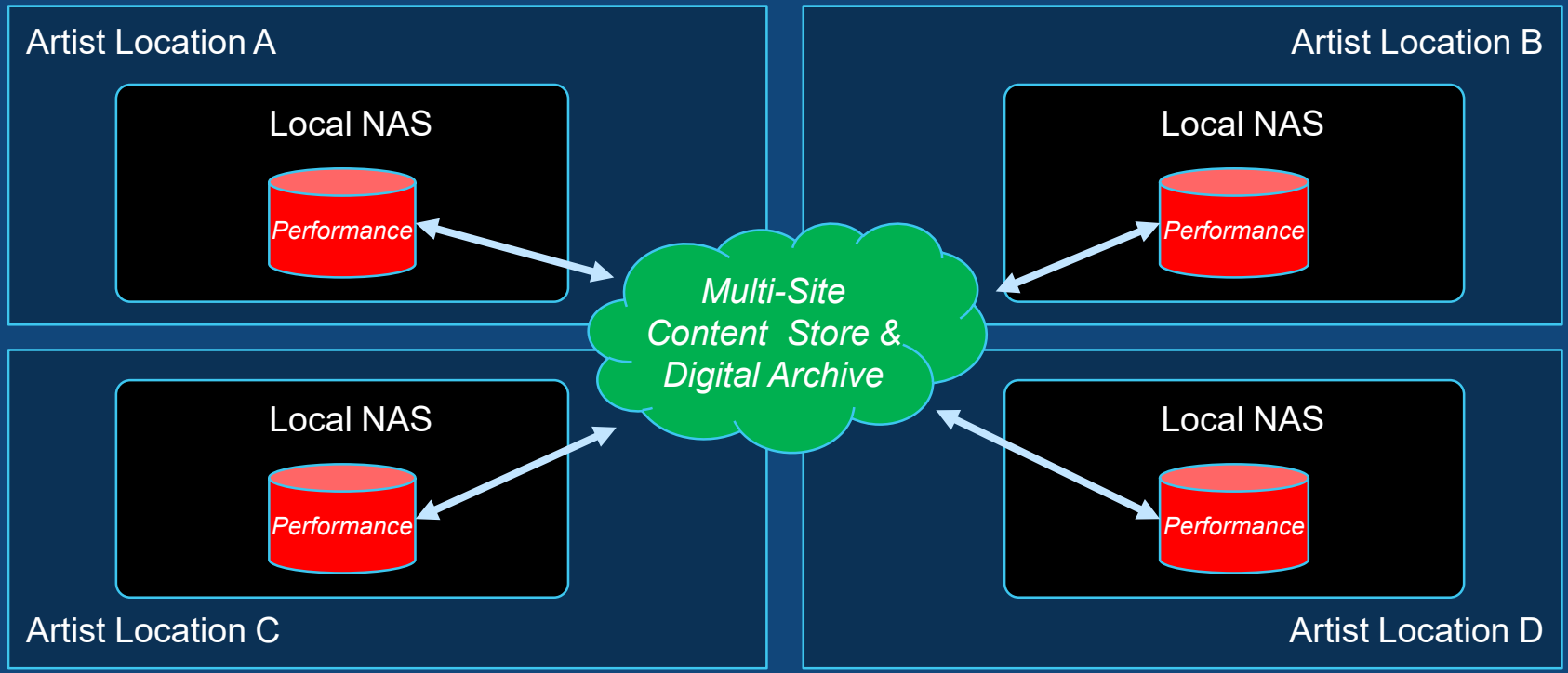
250 Node Leaf-Spine Example



250 nodes requires 5 Spines and 12 Leafs per side

Today's M&E Multi-site Architecture

Architecture for Collaboration



Artificial Intelligence in Media & Entertainment
Broadcast Archives
Advertising analytics
Film Restoration
Wide-area network routing optimization
Render farm optimization
DELL Technologies

LTO tape library migration

- Rights holders need to migrate LTO versions regardless
  - Disk-based active archive more responsive
  - Too much content to manually tag
  - AI techniques yield extended metadata
    - Speech-to-text
    - Actor / player recognition
    - Object recognition
    - Sentiment analysis
    - Searchable video
- Decision support for Asset Library monetization
  - Is this title worth cleaning up and re-mastering for new forms of distribution?
- Need to extract existing proprietary metadata
  - Oracle DIVA
  - MASSTech
  - Interplay
  - Quantum File Manager
  - Other MAM
- Multi-year process for large asset libraries
  - Labor-intensive
  - Offsite copies of LTO media
  - Ongoing operations during migration

Advertising analytics

- Trained human logger is 25% efficient
  - 2 hours of material tagged in 8-hour shift
  - Spotting sponsor logos and car numbers
- PoC with large telco == 67% efficient
  - ID’d car numbers when partially obscured
  - Better at wraparound sponsor logos
  - Increased advertiser CPMs

Restoration Optimization

- Pix2Pix
  - Generative Adversarial Network
  - Runs under TensorFlow
- https://hackernoon.com/remastering-classic-films-in-tensorflow-with-pix2pix-f4d551fa0503

- Remastering workflow for Netflix
  - AI-based EDL matching faster than editor

Genetic GANs: creating people who don’t exist

Decentralized Content Fabric replacing CDNs

Intelligent Network Routing using Machine Learning

- Web-scale, “nothing-shared” distributed store of media and metadata
- Integrated blockchain ledger
  - mediating content versioning; access control,
  - programming business workflow logic in "smart contracts“
  - validation, rights management, sponsorship and monetization
- New machine learning algorithms
  - clients have consistent high bandwidth streaming with minimal latency
- Fully utilize system compute and bandwidth resources
  - minimize core transit bandwidth
- Just-in-time media rendering capability
  - dynamic bitcode execution within the fabric
- Content encrypted end-to-end
  - 'trustless' relationship with the fabric
- Economic incentives for trusted participation
  - some operations must occur on unencrypted content

Thank You!

DELL Technologies