Data Center Evolution and Network Convergence

SNIA™ WEBCAST

Ossama El Samadoni
SNIA Europe Middle East Committee
(Dell)
Author: Joseph L White, Dell

HOSTED BY
SNIA EUROPE

Webcast Presenter

Ossama El Samadoni, SNIA Middle East Committee Vice Chair (Dell)

Ossama El Samadoni is currently the Director of Storage Solutions in Dell for the Emerging Markets EMEA

Ossama started his career as a systems engineer in IBM; then diversified his work on technical; sales and channel management in Oracle, HP, Dell, NetApp and IBM.

Ossama has a diverse multi faceted industry knowledge ranging from Health care, Security and Defense, Oil and Gas, Banking and Government.

SNIA

Education

Data Center Evolution and Network Convergence

Joseph L White, Juniper Networks

Author: Joseph L White, Juniper Networks

SNIA Legal Notice

- The material contained in this tutorial is copyrighted by the SNIA unless otherwise noted.
- Member companies and individual members may use this material in presentations and literature under the following conditions:
  - Any slide or slides used must be reproduced in their entirety without modification
  - The SNIA must be acknowledged as the source of any material used in the body of any document containing material from these presentations.
- This presentation is a project of the SNIA Education Committee.
- Neither the author nor the presenter is an attorney and nothing in this presentation is intended to be, or should be construed as legal advice or an opinion of counsel. If you need legal advice or a legal opinion please contact your attorney.
- The information presented herein represents the author's personal opinion and current understanding of the relevant issues involved. The author, the presenter, and the SNIA do not assume any responsibility or liability for damages arising out of any reliance on or use of this information.
  NO WARRANTIES, EXPRESS OR IMPLIED. USE AT YOUR OWN RISK.

Abstract

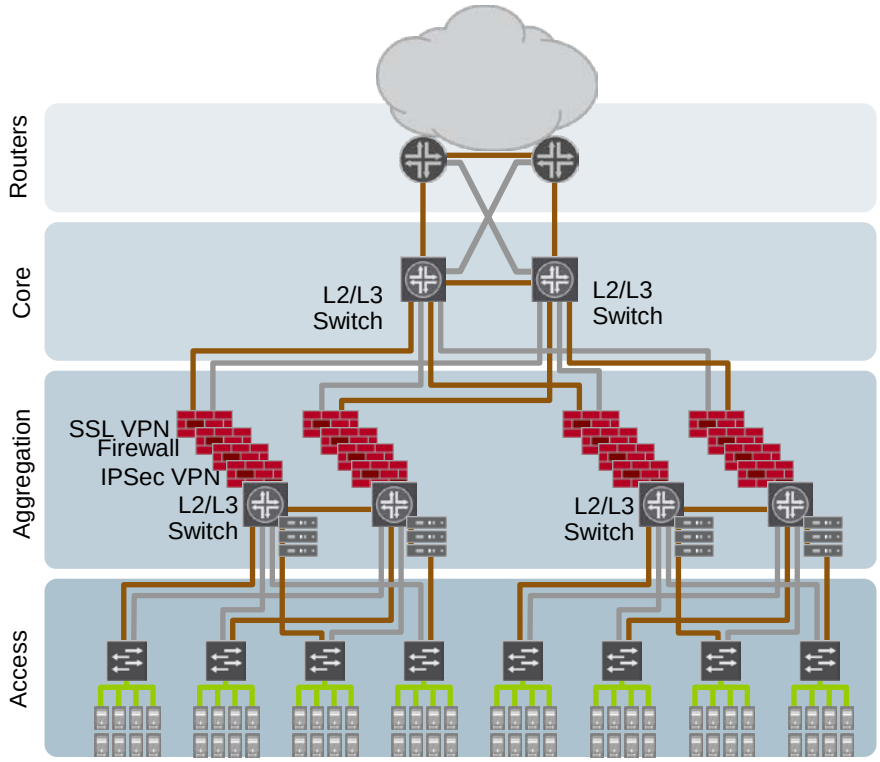
Data Center Evolution and Network Convergence

- FC, FCoE, NAS, iSCSI, DCB, traditional LAN, internet/WAN, HPC, clusters, clouds, server virtualization, storage virtualization, network virtualization, and more are all colliding in your data center. Redundancy, resiliency, security, I/O consolidation, network convergence, dynamic application distribution, and thin provisioning with high levels of service are desired at all layers and all data center sizes across a broad spectrum of use cases. You worry about operational separation, buying decisions, investment protection, cost and energy savings, and evolving standards while maintaining very high levels of service and security. Is the technology evolving to a dream come true or a nightmare? If that doesn't keep you up at night nothing will.
- This tutorial will untangle, define, and illustrate the main ideas and concepts behind Data Center Evolution and Network Convergence to give context and a solid foundation for discussions with your vendors as well as for your further reading and investigation. The point of view taken for this presentation is that of the network and transport characteristics in the face of the changes taking place.

Agenda

- **What is Network Convergence?**
  - **Definitions**
- Why would Data Centers Evolve in this direction?
  - Trends & Pressures
  - Advantages
- How do Deployments and Infrastructure change
  - Deployment models
  - Supporting Protocols

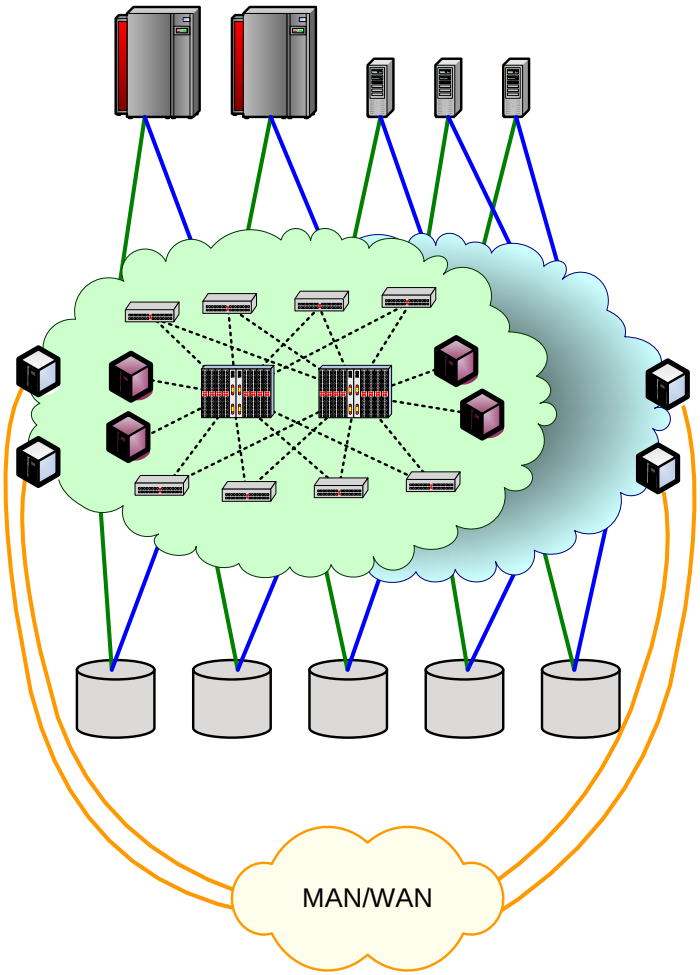
Data Center LAN (today)



built from Multi-Tier Trees

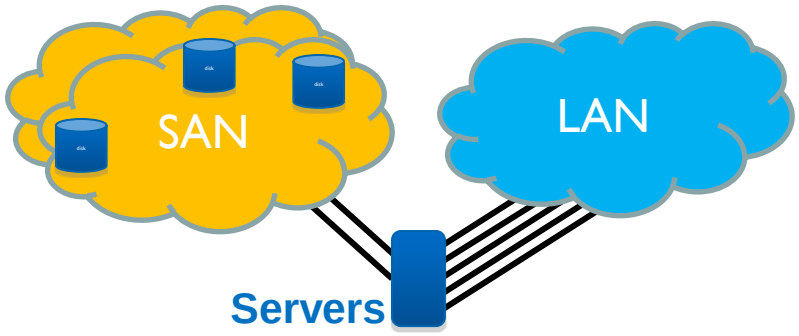
- Servers → Servers, NAS, Campus/MAN/WAN across switched network
- Multi-Tier
- 100's to many1000's of ports
- multi-link redundancy
- 100s of meters max diameter
  - oversubscribed
  - East-West Latency can be a problem
- Ethernet carrying predominantly IP traffic
- Firewalls and security in aggregation layer
  - have to be distribute in the data path due to efficiency forced by oversubscription

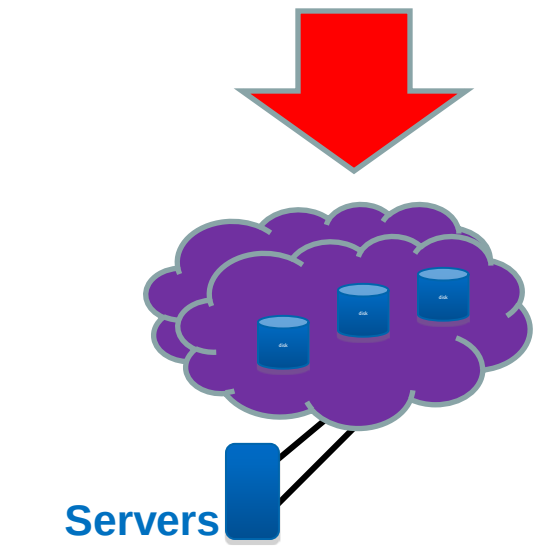
Data Center FC SAN (today)



- Servers → Storage across switched network
- Core – Edge or Edge – Core – Edge
  - in effect one level of tier collapse is done
- 10's to 1000's of ports
- Full Dual Rail Redundancy
- 100s of meters max diameter
  - High Bandwidth, Low Latency
  - Lossless Links
- Fabric Services provide Discovery, Access Control, and Change Notification
- Gateways and specialized extension devices provide remote access for BC/DR
- Attached Appliances provide data services
  - Encryption, Block Virtualization

Network Convergence





- Running disparate network traffic types across common physical infrastructure
- Disparate network traffic
  - Block Storage (FC, FCoE, iSCSI)
  - Networked file systems (NFS, CIFS/SMB, CAS)
  - Server LAN access
  - High speed clustering and transactions
- Common Physical Infrastructure
  - Ethernet with multi-protocol switches
  - Fabric based distributed switches
  - Infiniband

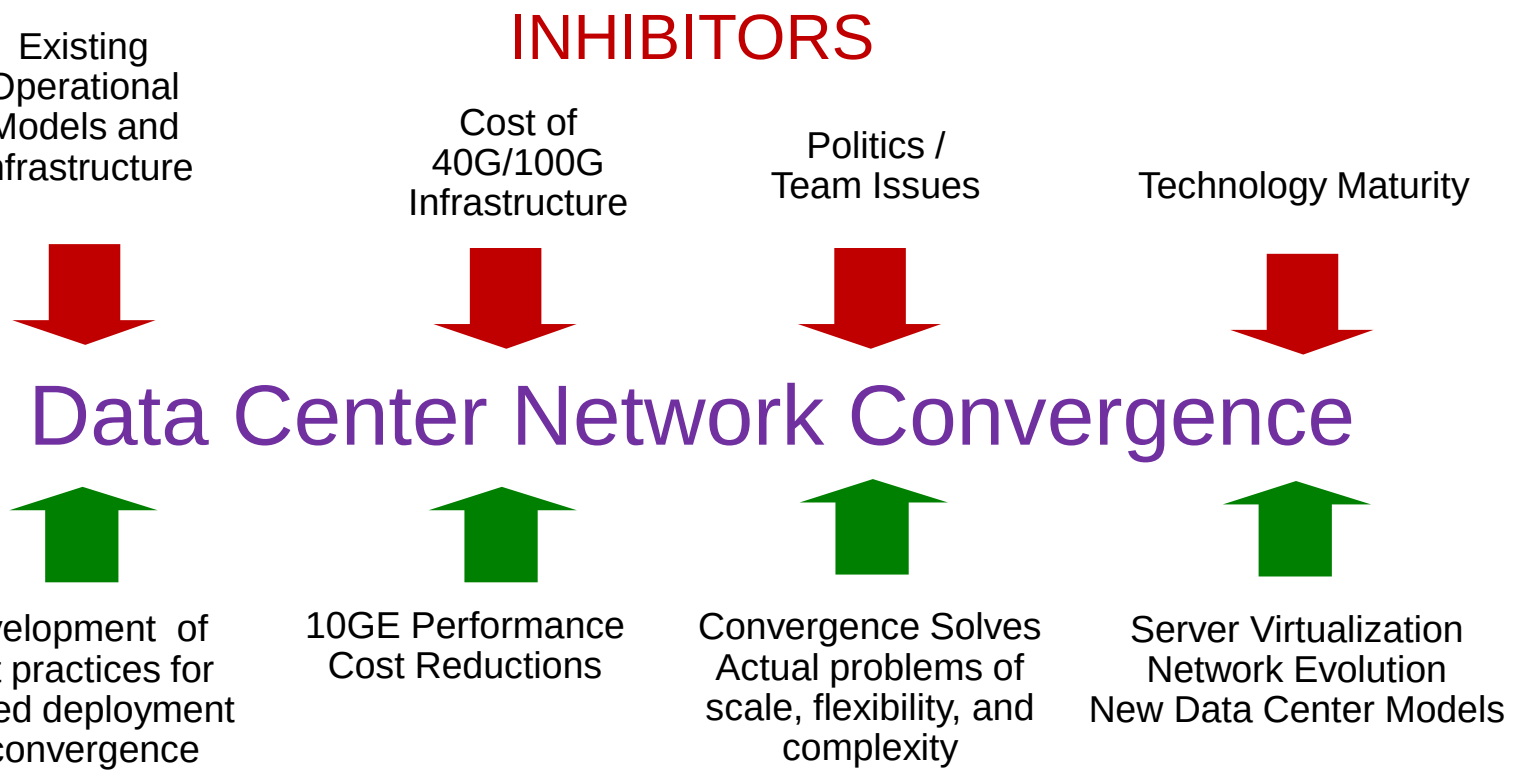
Agenda

- What is Network Convergence?
  - Definitions
- **Why would Data Centers Evolve in this direction?**
  - **Trends & Pressures**
  - Advantages
- How do Deployments and Infrastructure change
  - Deployment models
  - Supporting Protocols

How do the pressures balance?

Convergence is in progress,

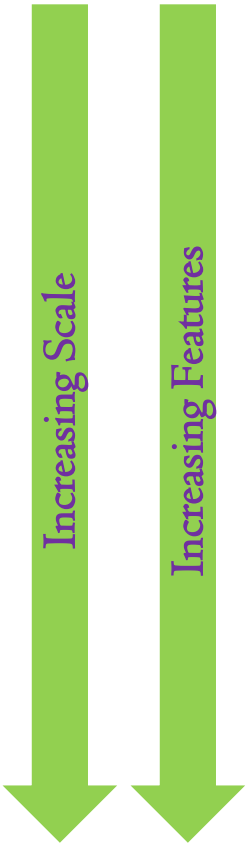
but there is a balance between various factors influencing the adoption rate



On the whole the Accelerators are outpacing the Inhibitors

Overall Trends…

- First Model
  - isolated systems
  - direct attach storage
- Second Model
  - limited networking
  - direct attach storage
- Third Model
  - Networking Explosion
  - direct attach storage + local cluster server-server storage
- Third and a half Model
  - Flexible storage via NAS and network file systems
- Fourth Model
  - SANs for block storage attach plus fully entrenched NAS
- Fifth Model ('current one')
  - Server Virtualization drives first hop I/O consolidation, increased SAN attach
  - "Cloud" (pooled resources of all kinds with uniform distributed access)
- Evolving Model
  - Network Convergence
    - Protocols for SAN and LAN on same infrastructure
    - Network Scaling via virtualization and simplification (tier collapsing, distributed control planes)



…reflected in the Data Center

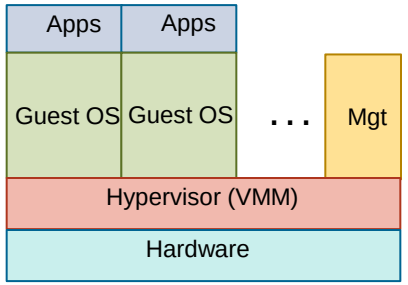
Consolidation

- Mega DCs; 400K sq ft
- 4K racks, 200K servers

DC Scale

Server Trends

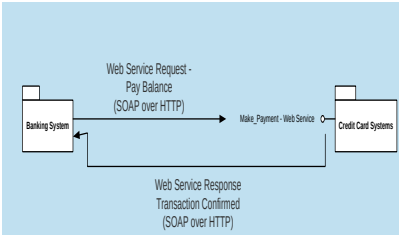
- Multi-core (8->16 >32,….128,…)
- Virtualization and VMs



Want Low Oversubscription

Application Trends

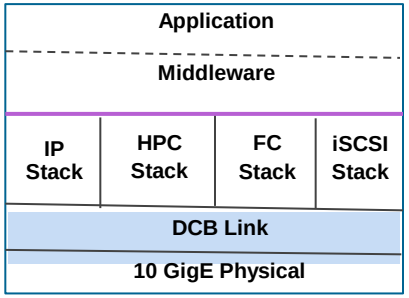
- SOA, Web 2.0
- MapReduce, Hadoop, Grids



Increased East-West traffic

Interconnect Trends

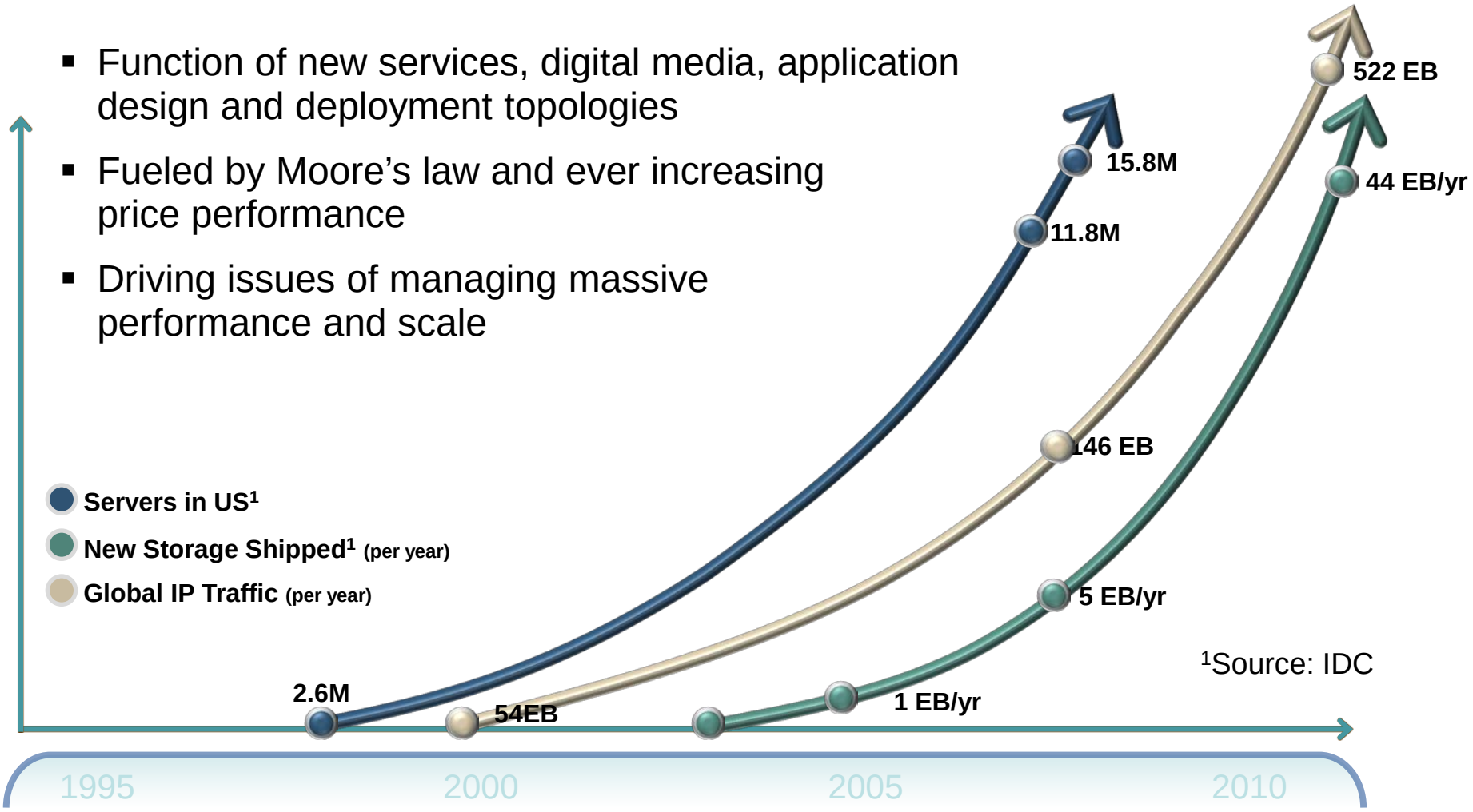
- Convergence to 10 GE
- Enhancements to Ethernet



Large speed increases 10/40/100 GE

Leading to Infrastructure Explosion

- Function of new services, digital media, application design and deployment topologies
- Fueled by Moore's law and ever increasing price performance
- Driving issues of managing massive performance and scale



Remember: Complexity increases exponentially with scale

Virtualization OF EVERYTHING

- Aggregate up and Virtualize down
  - many examples such as storage arrays, servers, ...
  - avoid Accidental partitioning
  - embrace Deliberate partitioning
- Aggregation
  - Physical and Software
  - Bring together and pool capacity with flexible connectivity
- Virtualization
  - logical partitions of the aggregated systems to match actual need
  - flexibility → fungible resources everywhere
  - Utility Infrastructure with just in time & thin provisioning

THIS IS HAPPENING TO NETWORKS AS WELL

Virtualization Drives Storage Connectivity

Education SNIA

... because Data Centers are always in flux

Application life cycle

services introduced, updated, retired

Load on servers and networks constantly changing

can be unpredictable

Resource management challenge

- Minimize the need for excess capacity
  - Reconfigure
  - Reclaim/Reuse
- Adding resources is last resort

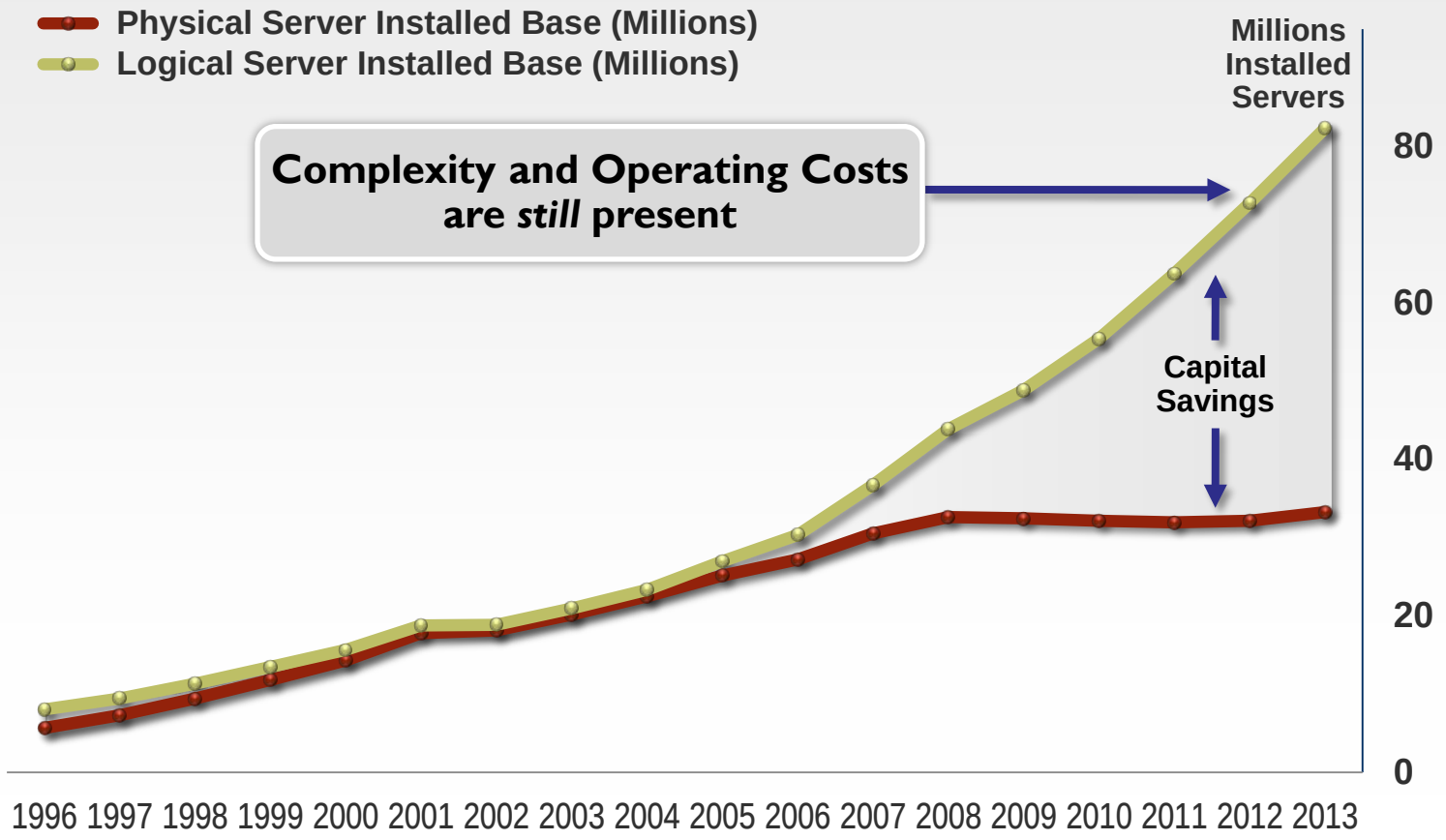
Dynamic shared resource pools address these issues

Enabled by Virtualization + Full Connectivity Networks

Any servers potentially needs access to any storage
Drives SAN attach from 20% to near 100%

If you don't converge you will end up connecting everything to everything anyway but across additional parallel networks.

Virtual to Physical Server Trend



Source: IDC

Agenda

- What is Network Convergence?
  - Definitions
- **Why would Data Centers Evolve in this direction?**
  - Trends & Pressures
  - **Advantages**
- How do Deployments and Infrastructure change
  - Deployment models
  - Supporting Protocols

Hasn't Convergence already happened?

- For some aspects of Convergence: YES
  - NAS Allows access to file based storage across the network
  - iSCSI Allows access to block based storage across the network
  - SANs have been bridged across metro and wide area networks for 10 years (FCIP, iFCP, & proprietary)
  - FCoE provides an accepted protocol for FC across an Ethernet
- These are good but ***not sufficient***
  - Data center LANs have issues at scale
  - WAN IP SAN connections do not solve the Local Data Center problem
  - Operational Characteristics of FC based SANs desirable and entrenched for many applications

Network Convergence Benefits

- results in logical overlays for forwarding on single, shared HW infrastructure

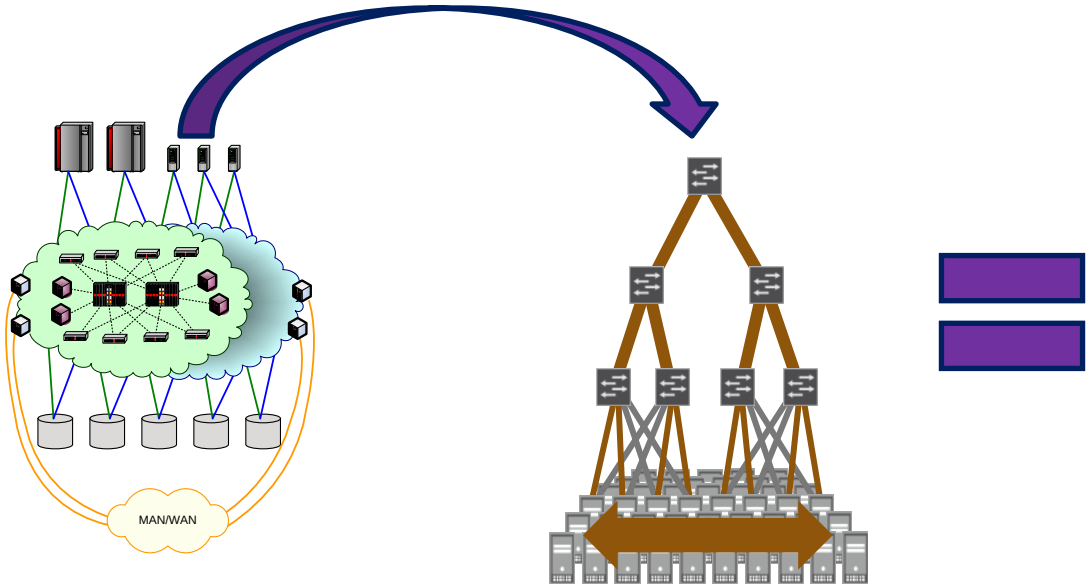
- Benefits
  - stocking of spare FRUs
  - combined operations
  - fewer stranded resources
  - better utilization
  - lower latency
  - better flexibility

Agenda

- What is Network Convergence?
  - Definitions
- Why would Data Centers Evolve in this direction?
  - Trends & Pressures
  - Advantages
- **How do Deployments and Infrastructure change**
  - **Deployment models**
  - **Supporting Protocols**

Network Convergence Deployments

- What does the network look like when you overlay
  the SAN picture .... onto the LAN picture



- You can have converged infrastructure at several places in the network.

Convergence Considerations

- Protocols for storage access
  - Block Storage (FC, FCoE, iSCSI)
  - Networked file systems (NFS, CIFS/SMB, CAS)
- Physical Infrastructure
  - Ethernet with multi-protocol switches
  - Fabric based distributed switches
  - Infiniband
- End to End performance
  - bandwidth & latency & frame processing rate
  - congestion handling
  - logical overlays onto physical infrastructure
- MAN and WAN extension for storage
  - Under convergence the local network is Ethernet. The devices that make up the local Ethernet are not typically suited to directly support lossless distance extension.

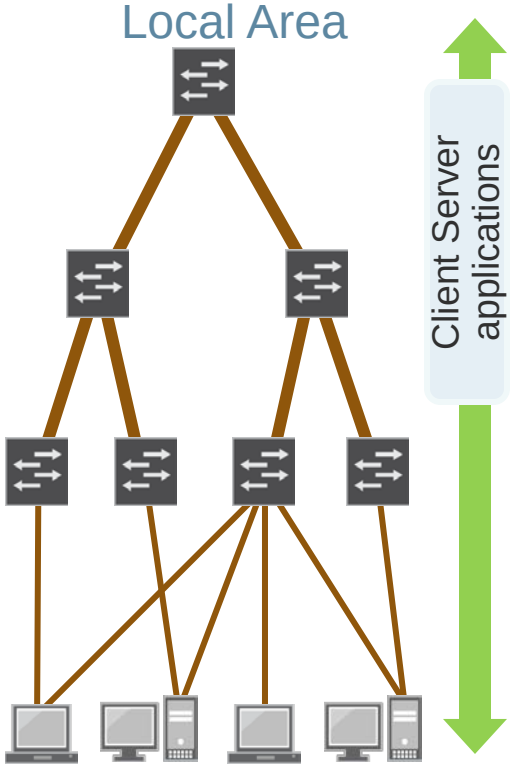
Constructing the DC LAN: Protocols

- In all DC LAN cases the IEEE DCB (Data Center Bridging) and some IETF protocols are required for a properly functioning infrastructure
  - PFC (Priority Flow Control) provides lossless operation
    - Required for FCoE and any high speed SAN traffic where congestion is possible
  - ETS (Enhanced Transmission Selection) – Allows configuration of endpoint bandwidth
  - DCBX – Allows capabilities information to be exchanged
  - CN (Congestion Notification) – Allows the DC LAN to react to congestion by notifying endpoints to slow down
  - L2 multi-path – Allows all physical paths to be utilized
    - Not as important with fabric based infrastructure
  - Non-DCB protocols still important to the DC LAN
    - VLAN – Allows logical organization and overlay onto a physical infrastructure
    - Link Aggregation - Allows multiple physical links between bridges to act as though they were a single link.
    - QoS/CoS – Allows network to manage and prioritize traffic
    - STP (Spanning Tree Protocol)

Data Center LAN: Multi-Tier Trees

Education SNIA

Local Area



20 years ago the Ethernet switch was introduced to solve the LAN problem

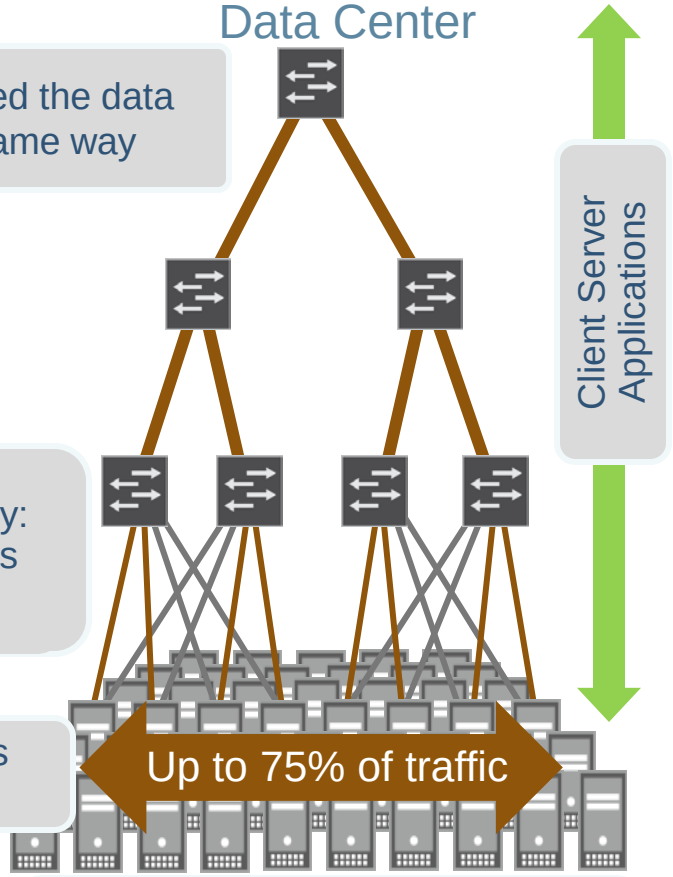
And it became the basic building block of the network

Data Center

And so we wired the data center the same way

Need more redundancy: STP and disabled links OR lots of VLANs

SOA Applications etc

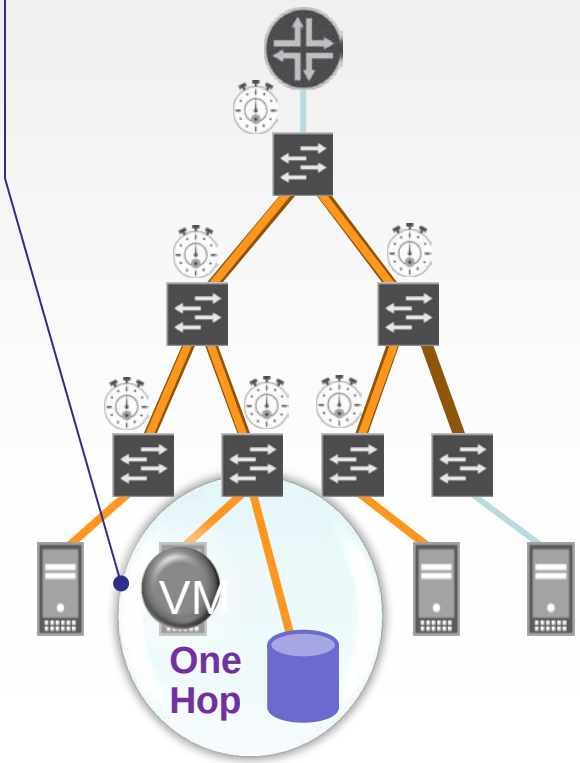


Adding in the complexity of storage networking as well, these pressures force the Ethernet network to change.

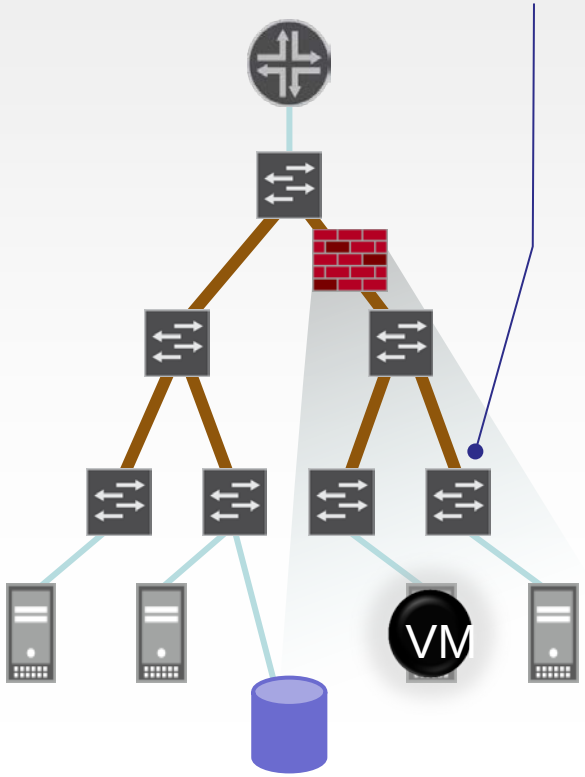
Why not Multi-Tier Trees?

BECAUSE Location matters in a tree architecture

Bubbles of Optimal Performance

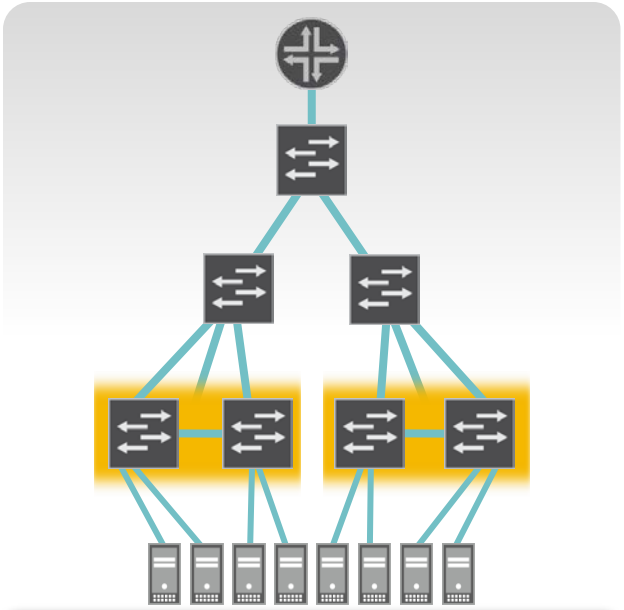


Appliances and VLANs create Shadows of Accessibility



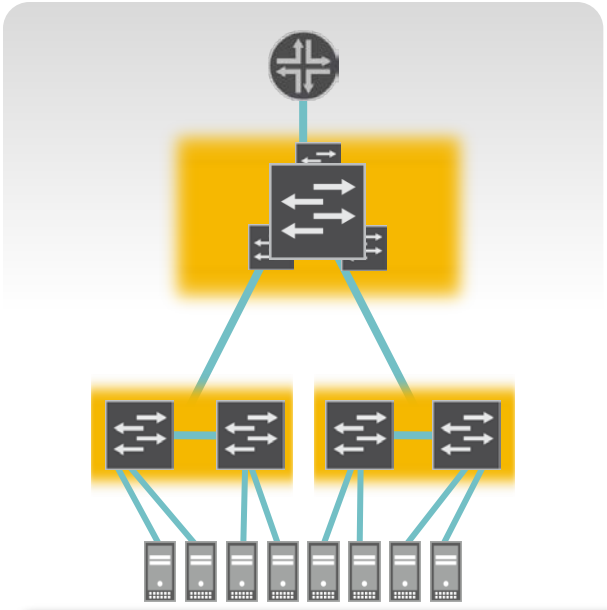
Instead use Fabric Infrastructure

Simplify the Data Center LAN by aggregation and consolidation



Aggregate Switches

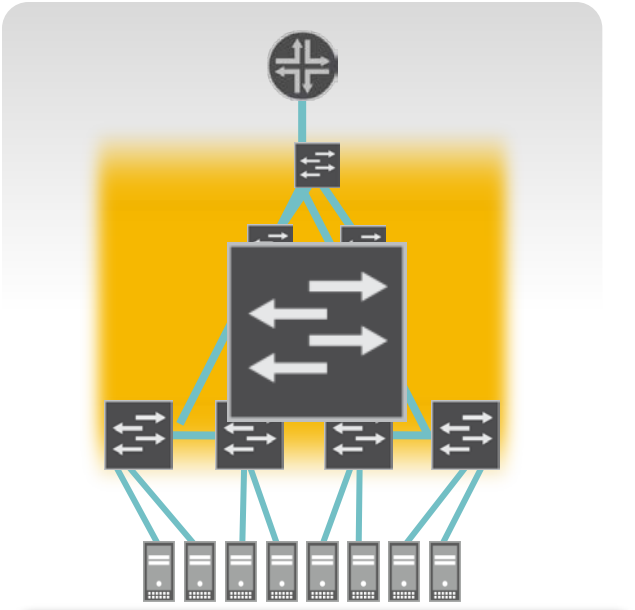
Multiple physical switches that operate as a single logical device for both management and traffic forwarding



Collapse Tiers

Use an aggregated switch to do the work of multiple tiers of switches

Allows aggregated access to services



Create A Fabric

Use both techniques at the same time to build a fabric based infrastructure

This gives another way to scale for Network Convergence

Last Words

- Convergence happening along multiple lines
  - I/O Consolidation
    - Well established now and of direct benefit to server
  - SAN-LAN Fabric Convergence
    - Common Equipment, Shared Infrastructure
    - Multiple Protocols Possible
  - Tier Collapse
    - Local networks replaced by high capacity distributed fabrics
    - Flatter, fewer Tiers, higher utilization
- Network Virtualization underway
  - Large benefits derived from scaled and converged components
- Cloud Deployments benefit from Convergence
  - Cloud does not change the fact that there are very large centralized data centers that need scale,
  - one of the levers to achieve scale is network convergence

Q&A / Feedback

- Please send any questions or comments on this presentation to SNIA: tracktutorials@snia.org

Many thanks to the following individuals for their contributions to this tutorial.

- SNIA Education Committee

Joseph L White
Simon Gordon
Gunes Aybay
Charles Waters
Andy Ingram