Physical infrastructure

This lesson covers the following topics:

- Physical infrastructure overview
- Physical infrastructure components
  - Compute
  - Network
  - Storage

IT-infrastructure

Orr, Anthony T. *Introduction to the ITIL service lifecycle*. The Stationery Office, 2011.

https://www.tsoshop.co.uk/Business-and-Management/AXELOS-Global-Best-Practice/ITIL-4/

ISO/IEC 20000

ISO Specification and Code of Practice for IT Service Management. ISO/IEC 20000 is aligned with ITIL Best Practice.

ISO/IEC 27001

(Service Design) (Continual Service Improvement) ISO Specification for Information Security Management. The corresponding Code of Practice is ISO/IEC 17799. *See also* Standard.

IT Directorate

(Continual Service Improvement) Senior Management within a Service Provider, charged with developing and delivering IT services. Most commonly used in UK Government departments.

IT Infrastructure

All of the hardware, software, networks, facilities, etc. that are required to develop, Test, deliver, Monitor, Control or support IT Services. The term IT Infrastructure includes all of the Information Technology but not the associated people, Processes and documentation.

IT Operations

(Service Operation) Activities carried out by IT Operations Control, including Console Management, Job Scheduling, Backup and Restore, and Print and Output Management. IT Operations is also used as a synonym for Service Operation.

IT Operations Control

(Service Operation) The Function responsible for Monitoring and Control of the IT Services and IT Infrastructure. *See also* Operations Bridge.

IT Operations Management

(Service Operation) The Function within an IT Service Provider that performs the daily Activities needed to manage IT Services and the supporting IT Infrastructure. IT Operations Management includes IT Operations Control and Facilities Management.

IT Service

A Service provided to one or more Customers by an IT Service Provider. An IT Service is based on the use of Information Technology and supports the Customer's Business Processes. An IT Service is made up from a combination of people, Processes and technology and should be defined in a Service Level Agreement.

IT Service Continuity Management

(Service Design) The Process responsible for managing Risks that could seriously affect IT Services. ITSCM ensures that the IT Service Provider can always provide minimum agreed Service Levels, by reducing the Risk to an acceptable level and Planning for the Recovery of IT Services. ITSCM should be designed to support Business Continuity Management.

IT Service Continuity Plan

(Service Design) A Plan defining the steps required to Recover one or more IT Services. The Plan will also identify the triggers for Invocation, people to be involved, communications etc. The IT Service Continuity Plan should be part of a Business Continuity Plan.

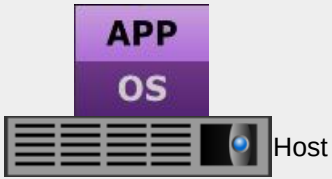
IT Service Management

The implementation and management of Quality IT Services that meet the needs of the Business. IT Service Management is performed by IT Service Providers through an appropriate mix of people, Process and Information Technology. *See also* Service Management.

Physical infrastructure

Compute System

- A computing platform (hardware and system software) that runs applications



Compute System

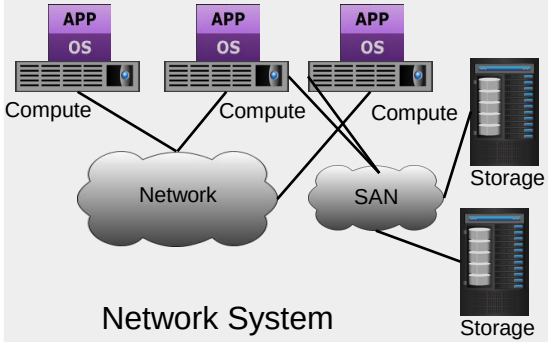
Storage System

- A repository for saving and retrieving data

Storage System

Network System

- Communication path established between connected devices in an IT infrastructure

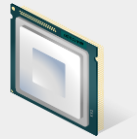


Network System

Compute system components

Components

Processor	• Integrated circuit • Executes software programs
Random Access Memory (RAM)	• Volatile data storage • Stores frequently used software instructions
Read Only Memory (ROM)	• Semiconductor memory • Contains boot and other device-specific firmware
Motherboard	• Printed circuit board • Holds major components like processor and memory
Operating System	• Software program that manages systems resources • Controls the application execution

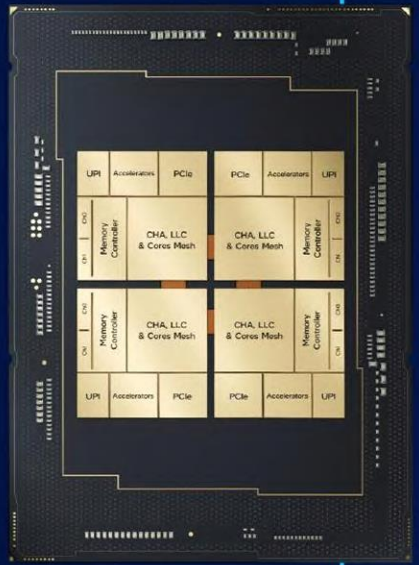


https://www.techtarget.com/whatis/definition/NUMA-non-uniform-memory-access

5th Gen Intel® Xeon® Processors

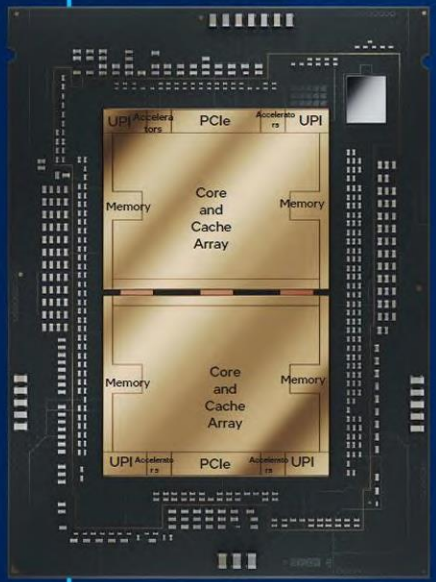
Platform enhancements delivering significant gains at the same power envelope[1]

4th Gen Xeon



- **Drop-in compatible** with 4th Gen Xeon processors
- Up to **64** cores per CPU
- Up to **5600** MT/s memory speed
- Up to **3x** shared Last Level Cache (up to **320 MB** total)
- Up to **20** GT/s UPI 2.0 Speed
- **Type 3** memory support with Compute Express® Link 1.1*
- Intel® Trust Domain Extension **broad support**

5th Gen Xeon



* Type 3 CXL targeted deployment

Significant Performance Leaps

5th Gen Intel® Xeon® CPUs provides generational improvements on CPU and platform upgrades

CPU upgrade

4th Gen Intel® Xeon® CPU
vs. 5th Gen Intel Xeon CPU

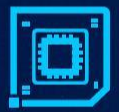
1.21x average performance gain

Up to **1.42x** higher inference

Up to **1.4x** higher HPC performance gain

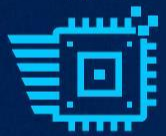
Up to **1.7x** higher throughput[4]

General purpose compute



AI

HPC



Networking and storage

Server platform upgrade

3rd Gen Intel® Xeon® CPU
vs. 5th Gen Intel Xeon CPU

1.84x average performance gain

Up to **14x** higher inference and training performance

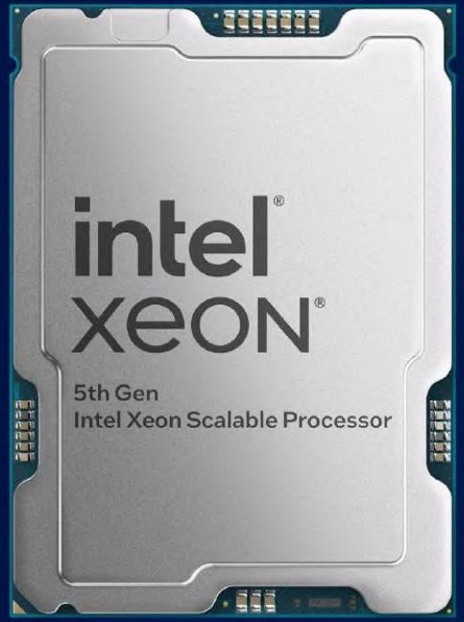
Up to **2.1x** average performance gain

Up to **3.6x** higher throughput

See [G1, A17, H7, H1, N6, N13] at intel.com/processorclaims: 5th Gen Intel Xeon Scalable processors. Results may vary. 10

Intel® Xeon® - The Processor Designed for AI

Architected for general AI and Large Language Models (LLMs)



Up to 64 cores per CPU

Intel® Advanced Matrix Extensions (Intel® AMX)
Better AMX Frequencies, with new licensing levels

Increased Memory BW
Up to 5600 MT/s

CXL Memory BW expansion

Large Last Level Cache (LLC)
Up to 3x

Compared to 4th Gen Intel® Xeon® processors

Intel® AI Software

Optimizations up-streamed
300+ DL Models
50+ optimized ML and Graph Models
Intel® AI Developer Tools

PyTorch containers
https://hub.docker.com/r/intel/intel-optimized-pytorch

TensorFlow containers
https://hub.docker.com/r/intel/intel-optimized-tensorflow

Compute system types

Tower

- Upright cabinet that stands alone
- Works simultaneously to perform different tasks and processes

Rack-Mounted

- Hardware placed in a downright horizontal rack
- Rack contains multiple mounting slots called as bays
- Each bay holds a hardware unit in a rack

Blade

- Electronic circuit board
- Contains core processing components
- Each blade server is dedicated to a single application

Modular, software-defined infrastructure.
PowerEdge MX740c Compute Sled

https://www.dell.com/en-us/shop/servers/sc/servers?~ck=bt

Storage device types

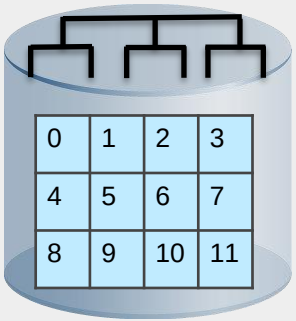
Storage Devices

Magnetic Tape Drive	• Uses magnetic tape to store data • Thin, long strip of plastic film, coated with magnetizable material	
Magnetic Disk Drive	• Uses magnetization process to write, read, and access data • Stores data in form of tracks and sectors	
Solid-State (Flash) Drive	• Stores data on a semiconductor-based memory • Very low-power requirements, and high throughput	
Optical Disk Drive	• Uses optical storage techniques to read and write data • Stores data digitally by using laser beams	

Storage system options

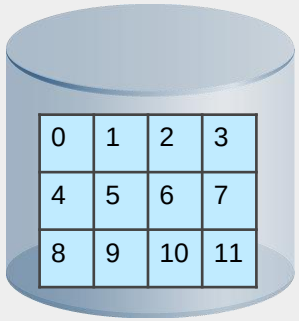
File-based Storage

- A dedicated, high-performance file server with storage
- Also called as Network Attached Storage (NAS)



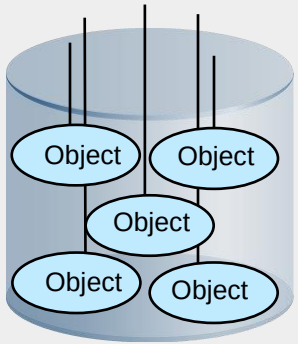
Block-based Storage

- Provides compute system with block-based access to storage



Object-based Storage

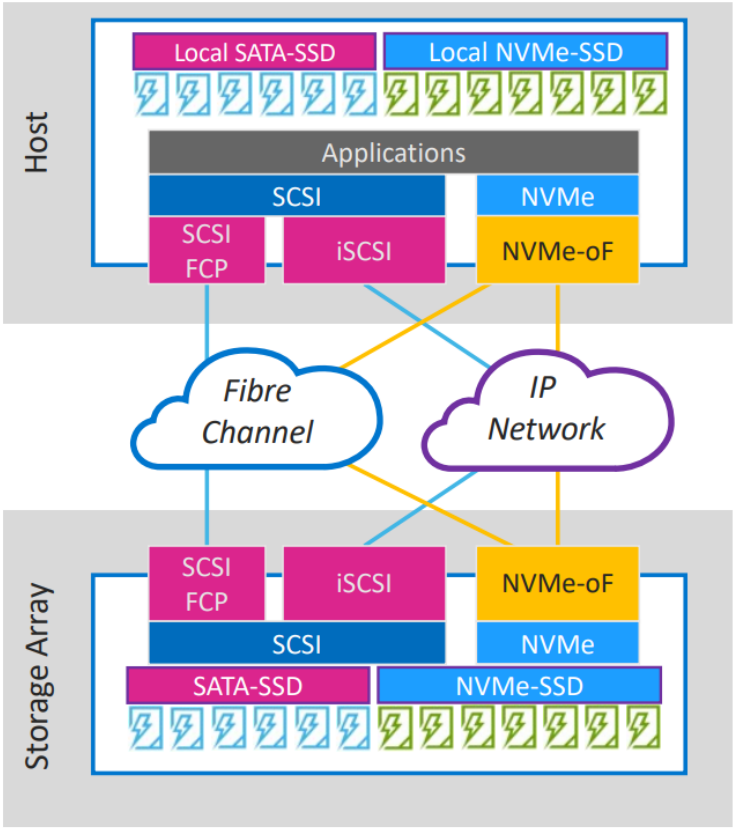
- Stores data in the form of objects on flat address space based on its content and attributes rather than the name and location



SAN Evolution

From SCSI to NVMe

- Applications running on a host that are accessing external array-based storage via either FC or iSCSI.
- NVMe Drives were first introduced on the host in 2015 and were used mainly for caching and boot drives
- NVMe-SSDs improve storage array performance locally but using the SCSI protocol can add significant latency.
- NVMe-oF™ can run over either Fibre Channel or Ethernet.



зберігання

Object storage with openstack swift: Demo

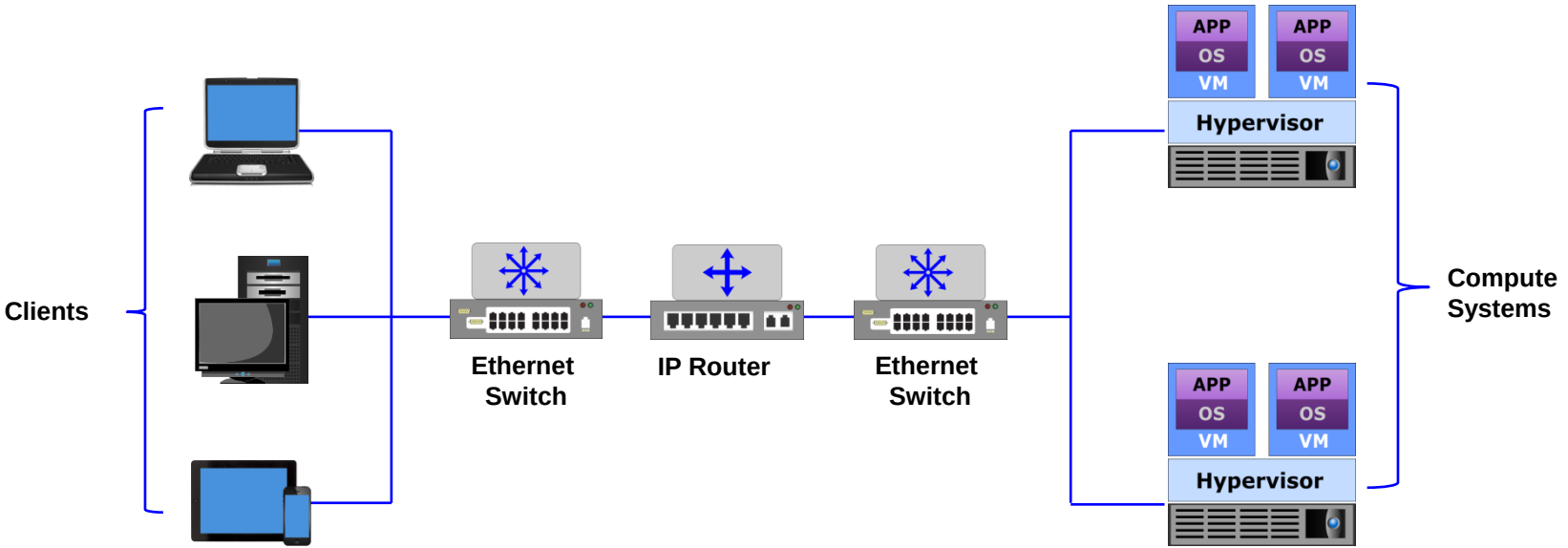
To access the video, please click the below link

https://edutube.emc.com/Player.aspx?vno=OGJIbngugXskqtyJLcqcFA==&autoplay=true&t=0h0m0s

Network communication types

Compute-to-compute network

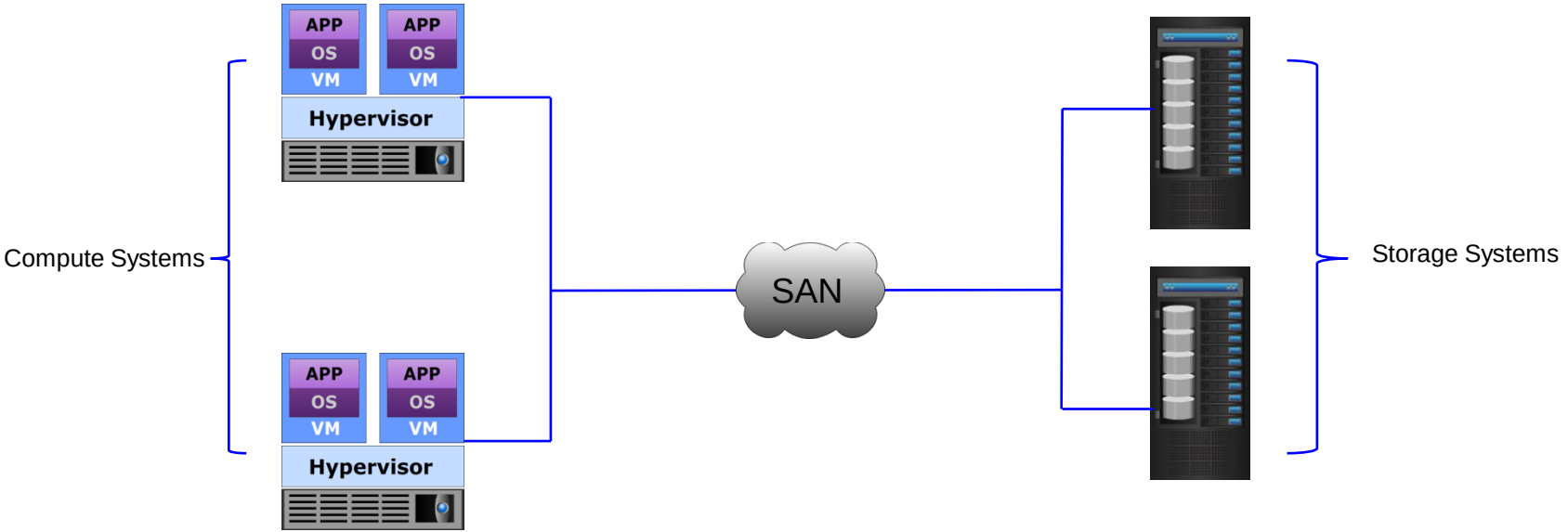
Typically uses protocols based on the Internet Protocol (IP). Each physical compute system is connected to a network through one or more host interface devices.



Network communication types (Cont'd)

Compute-to-storage network

Storage may be connected directly to a compute system or over a Storage Area Network-SAN. A SAN enables the compute systems to access and share storage systems.



Virtual infrastructure

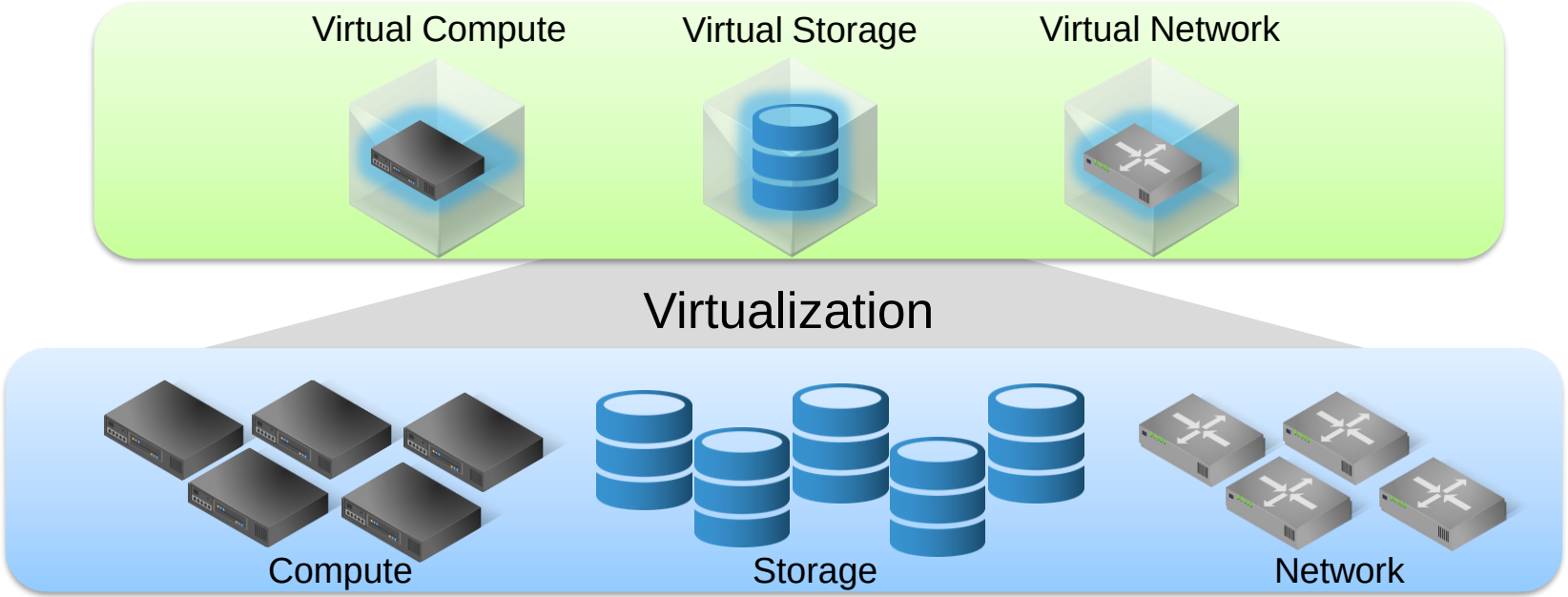
This lesson covers the following topics:

- Virtualization overview
- Virtualization benefits
- Types of Virtualization
- Resource pooling

Virtual infrastructure

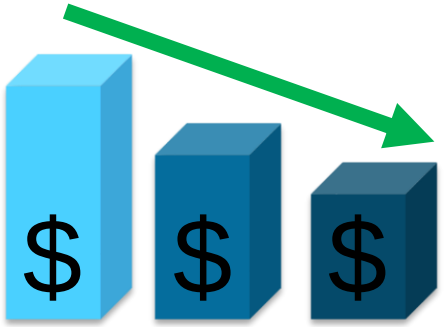
Virtualization

The process of abstracting physical resources such as compute, storage, and network, and making them appear as logical resources.



Virtualization benefits

Improves Resource Utilization



Reduces Cost

Increases Management Efficiency

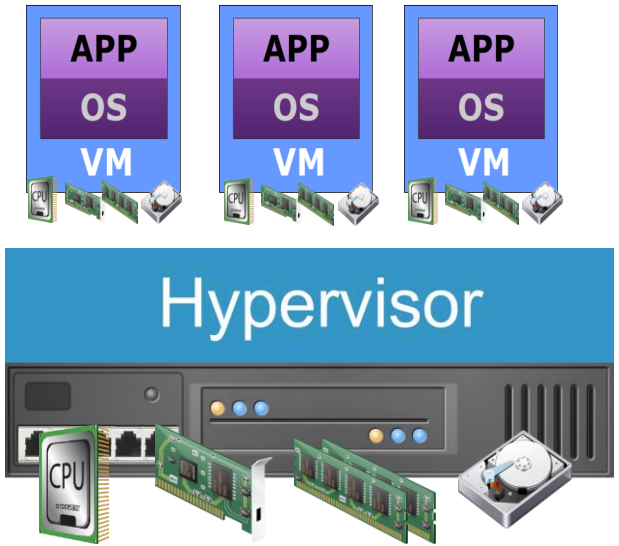
Improves Resource Provisioning

Increase Flexibility

Compute virtualization

Compute Virtualization

The technique of abstracting the physical compute hardware from the operating system and applications enabling multiple operating systems to run concurrently on a single or clustered physical compute systems.

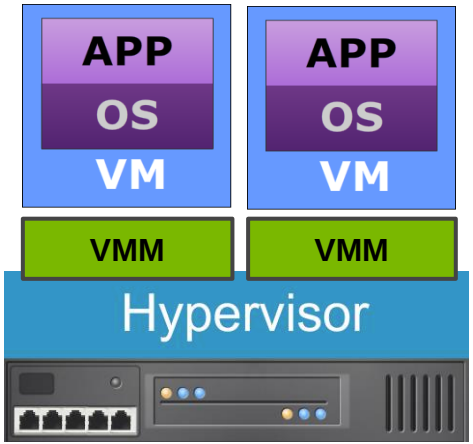


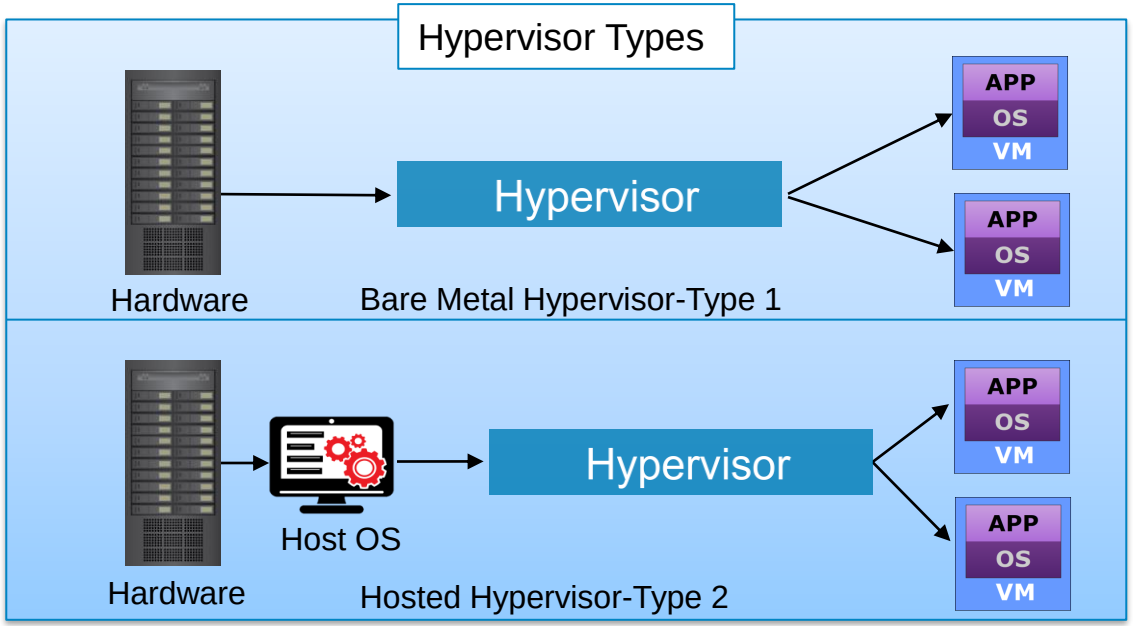
Physical Compute Components

Compute virtualization components: Hypervisor

Hypervisor

Software that provides a virtualization layer for abstracting compute system hardware, and enables the creation of multiple virtual machines.





Compute virtualization components: Virtual machine

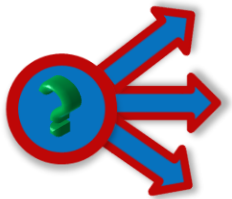
Virtual Machine (VM)

A logical compute system with virtual hardware on which a supported guest OS and its applications run.

- Hypervisor creates a VM
- Comprises virtual hardware, such as virtual processor, memory, storage, and network resources
  - Appears as a physical compute system to the guest OS
  - Hypervisor maps the virtual hardware to the physical hardware
- Provider provisions VMs to consumers for deploying applications
  - VMs on the same compute system or cluster run in isolation

Compute virtualization: Case study

An educational institution deploys the VMware Horizon desktop virtualization.



Challenges

- Infrastructure bottlenecks prevented students and faculty from launching and using applications.
- IT team lost productivity dealing with complaints about system performance.

Solution

- Implementation of the VMware Horizon desktop virtualization.

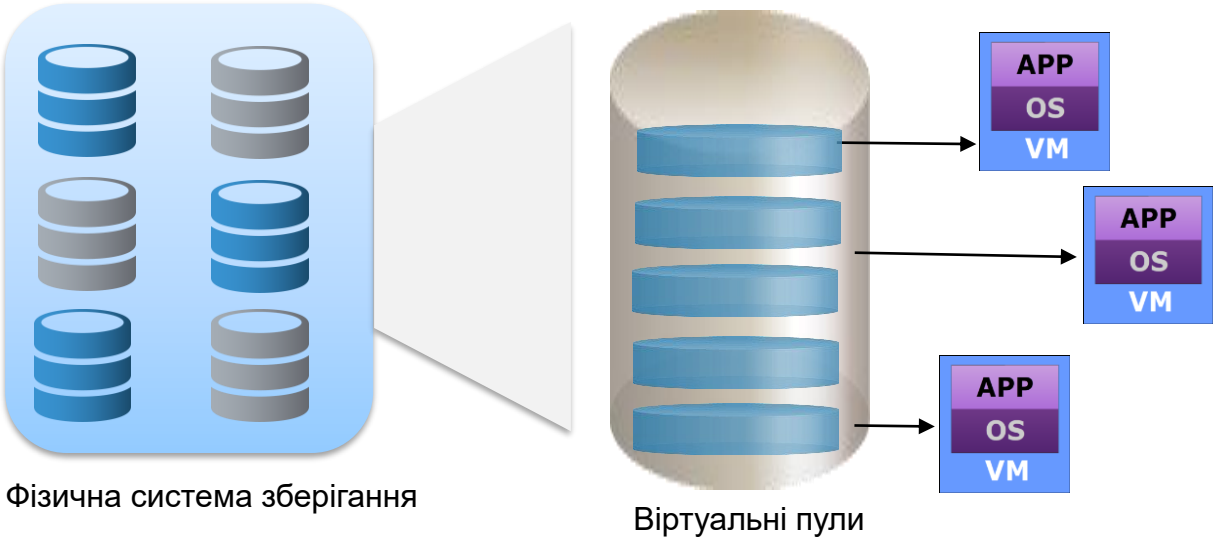
Business Benefits

- Improved productivity and satisfaction for students, staffs, and IT manager.
- Instantaneous access to desktop applications.
- Reduces capital expenditure and operational costs.
- Provides flexibly to add new applications to support coursework.

Storage virtualization

Storage virtualization

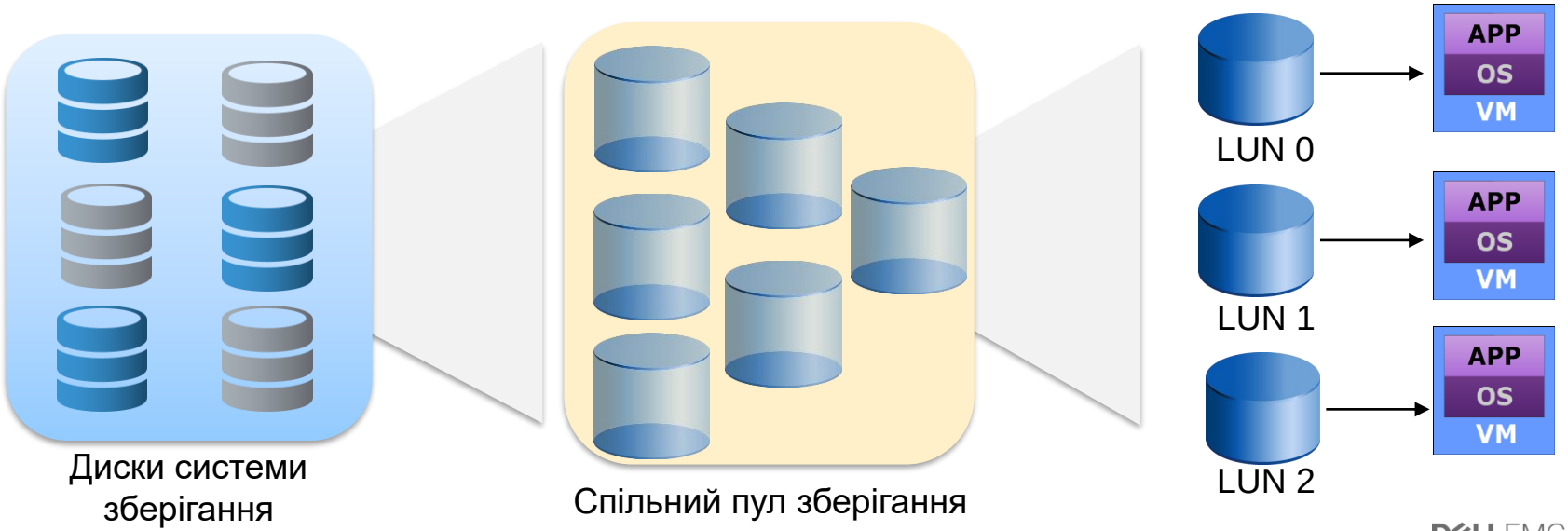
The technique of abstracting physical storage resources to create virtual storage resources.



Logical unit number (LUN)

Logical unit number (LUN)

Abstracts the identity and internal functions of storage systems and appear as physical storage to the compute system.



Network virtualization

Network virtualization

The technique of abstracting physical network resources to create virtual network resources.

To access the video, please click the below link

https://edutube.emc.com/Player.aspx?vno=Cpuvwfhz7SxPC4Qj+2vtiw==&autoplay=true&t=0h0m0s

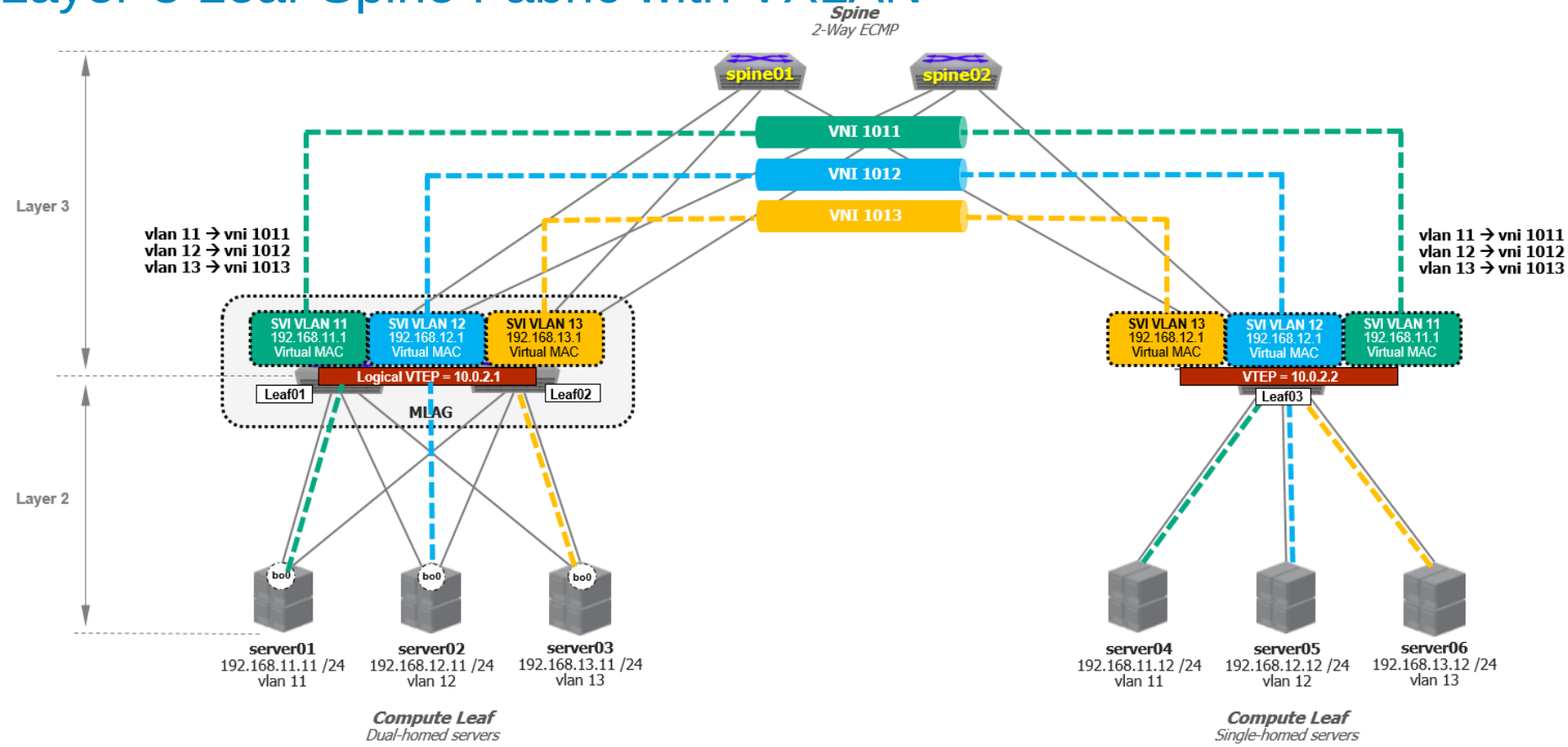
Source: Network Virtualization and Security Platform – NSX - VMware

Virtual network types

Virtual LAN (VLAN)	• Consists of virtual and/or physical switches, which divide a LAN into smaller logical segments
Private VLAN (PVLAN)	• Extension of VLAN standard • Segregates nodes within a VLAN into secondary VLANs
Virtual Extensible LAN (VXLAN)	• OSI Layer 2 overlay network built on an OSI Layer 3 network • Overlay network is a virtual network that is built on top of existing network
Stretched VLAN	• Extends a VLAN across sites • Enables nodes in two different sites to communicate over a WAN
Virtual SAN (VSAN)	• Enables communication between a group of nodes with a common set of requirements

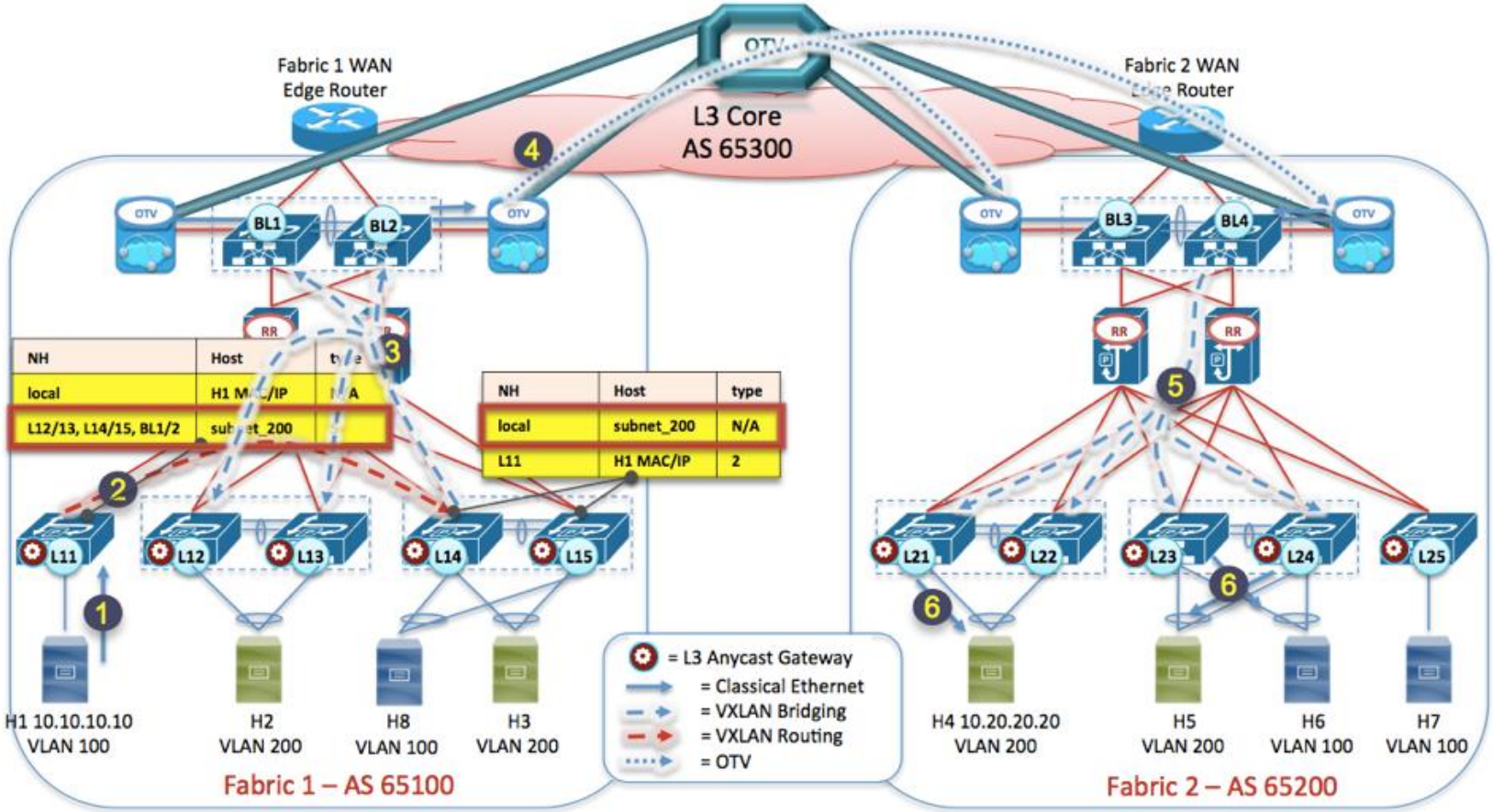
https://datatracker.ietf.org/doc/html/rfc7348

Layer-3 Leaf-Spine Fabric with VXLAN



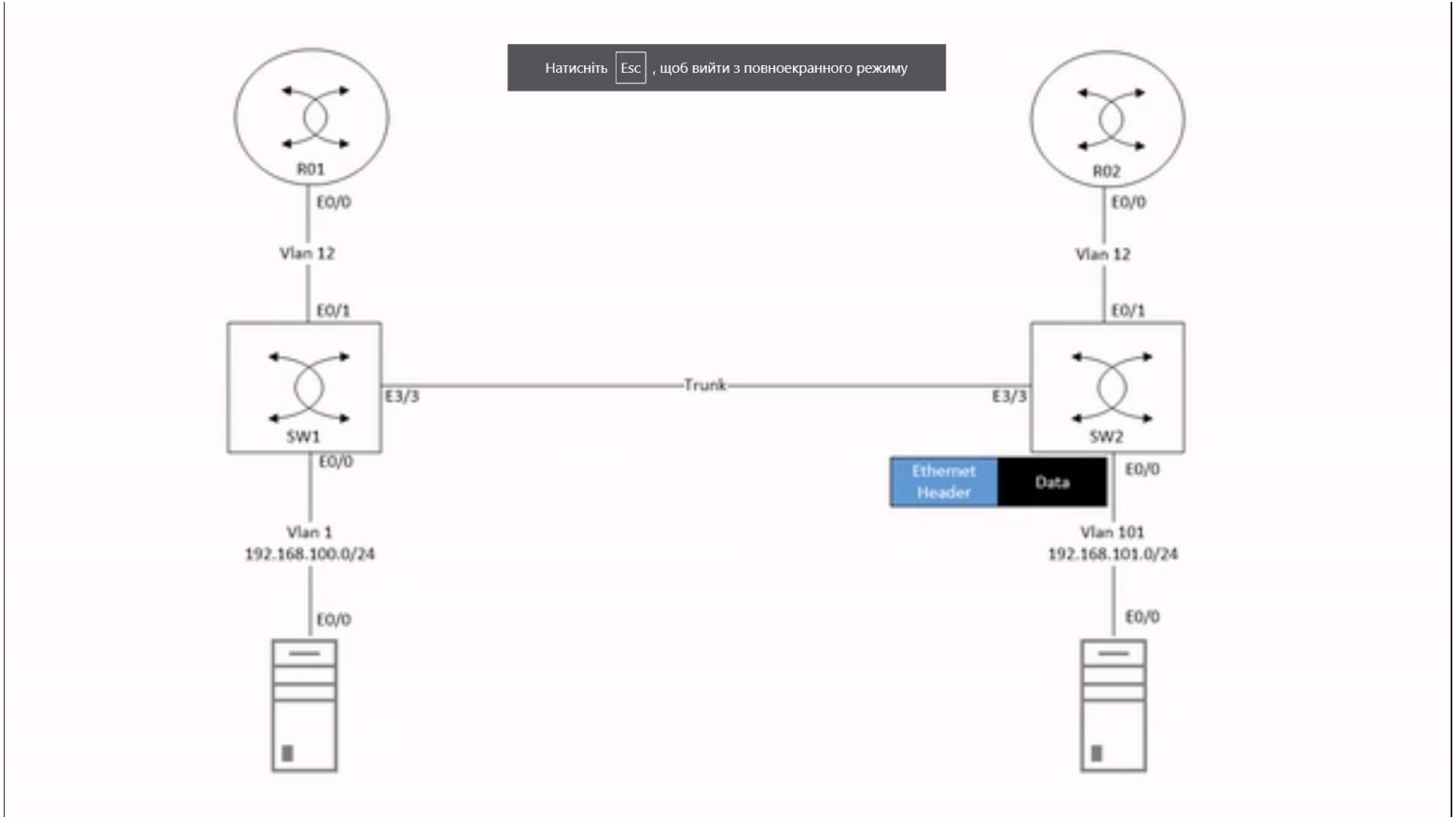
https://thebitmask.files.wordpress.com/2017/08/vxlan-overlay-networks.png

VXLAN EVPN Multi-Fabric Data Plane – inter-subnet communication



http://yves-louis.com/DCI/wp-content/uploads/2017/02/Figure-15-VXLAN-EVPN-Multi-Fabric-Data-Plane-inter-subnet-communication-.png

Native Vlan GIF



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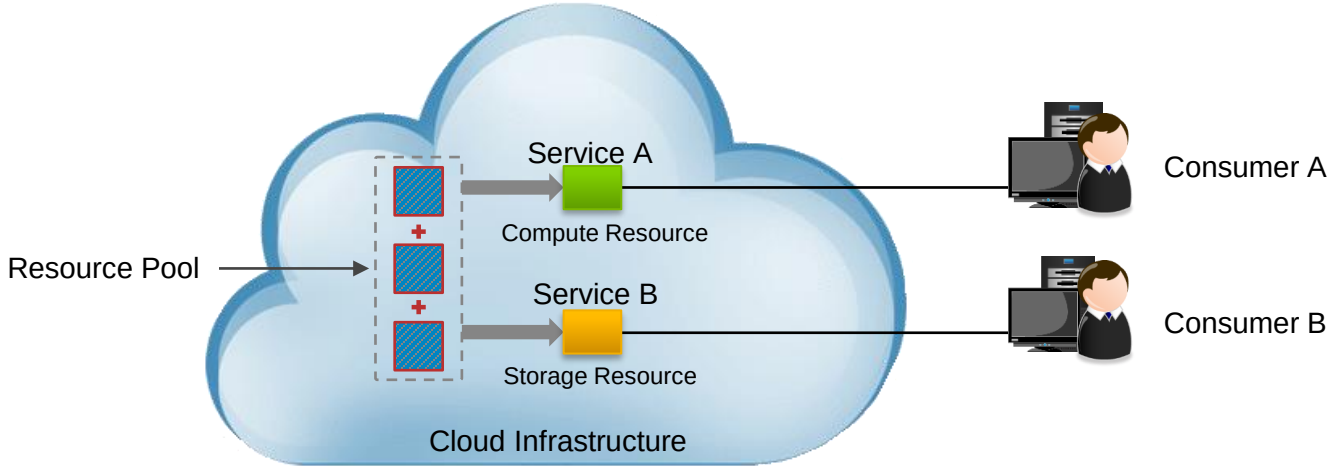
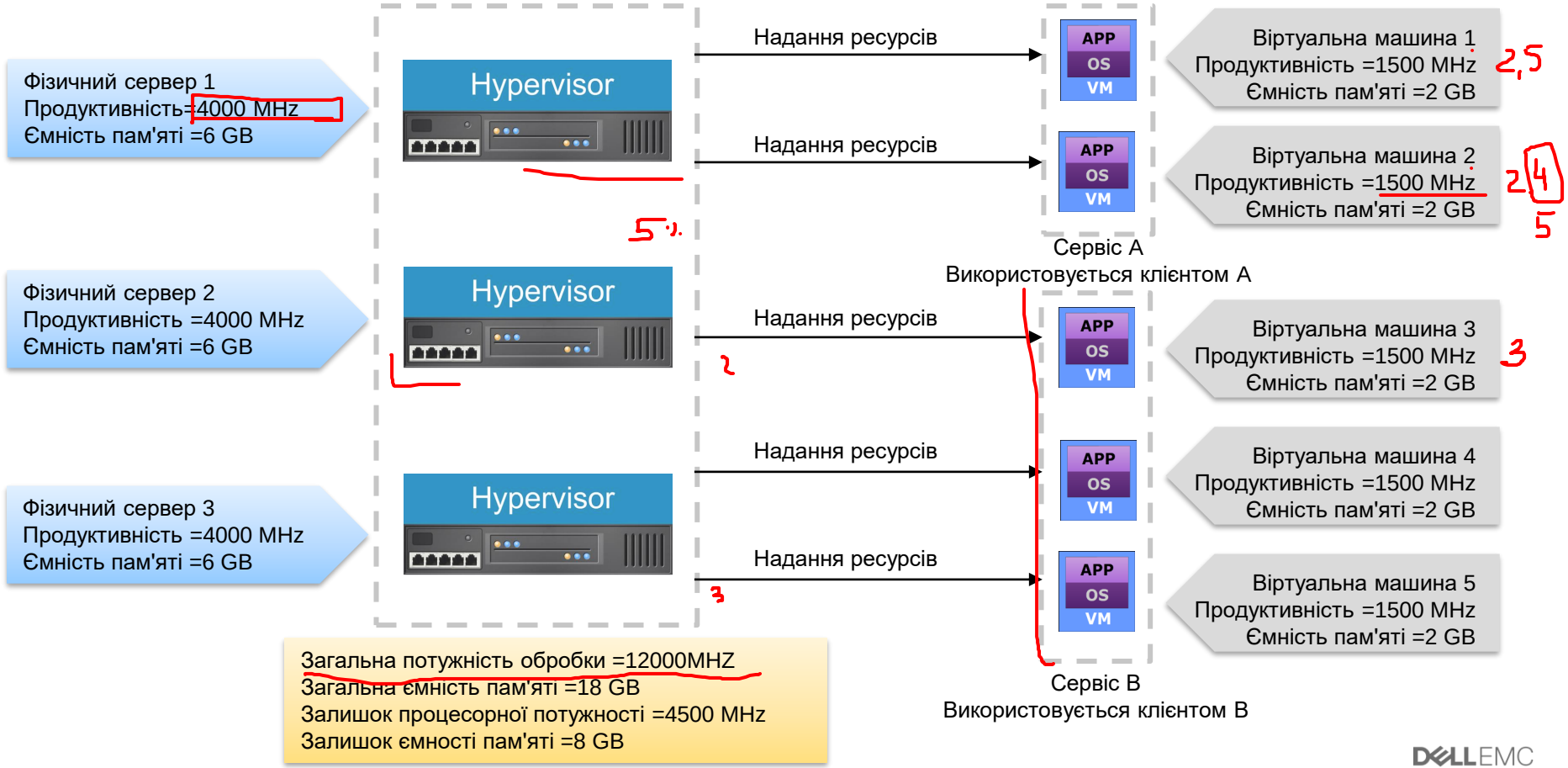
Resource pooling

Resource Pooling

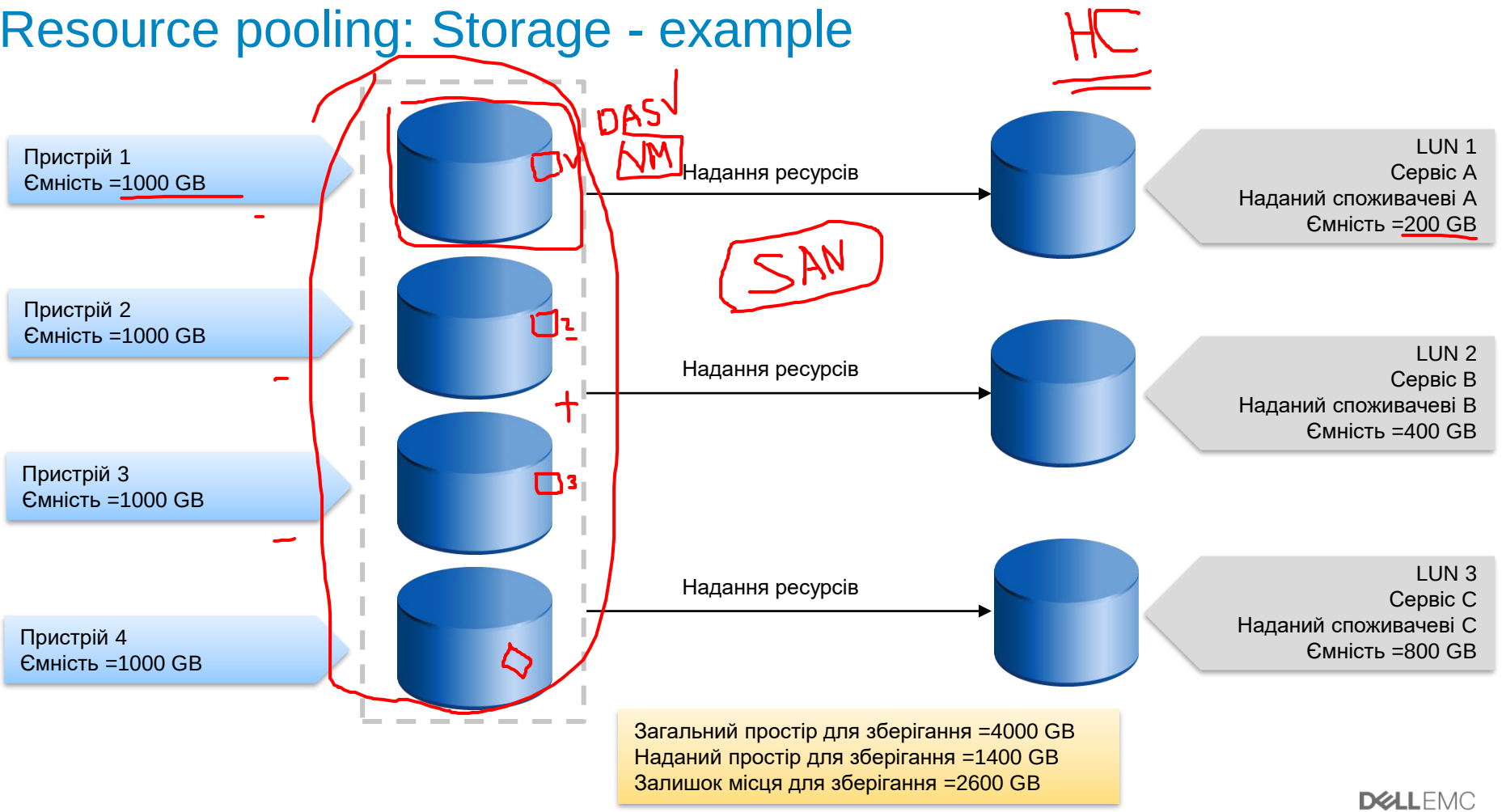
The provider's computing resources are pooled to serve multiple consumers using a multitenant model.



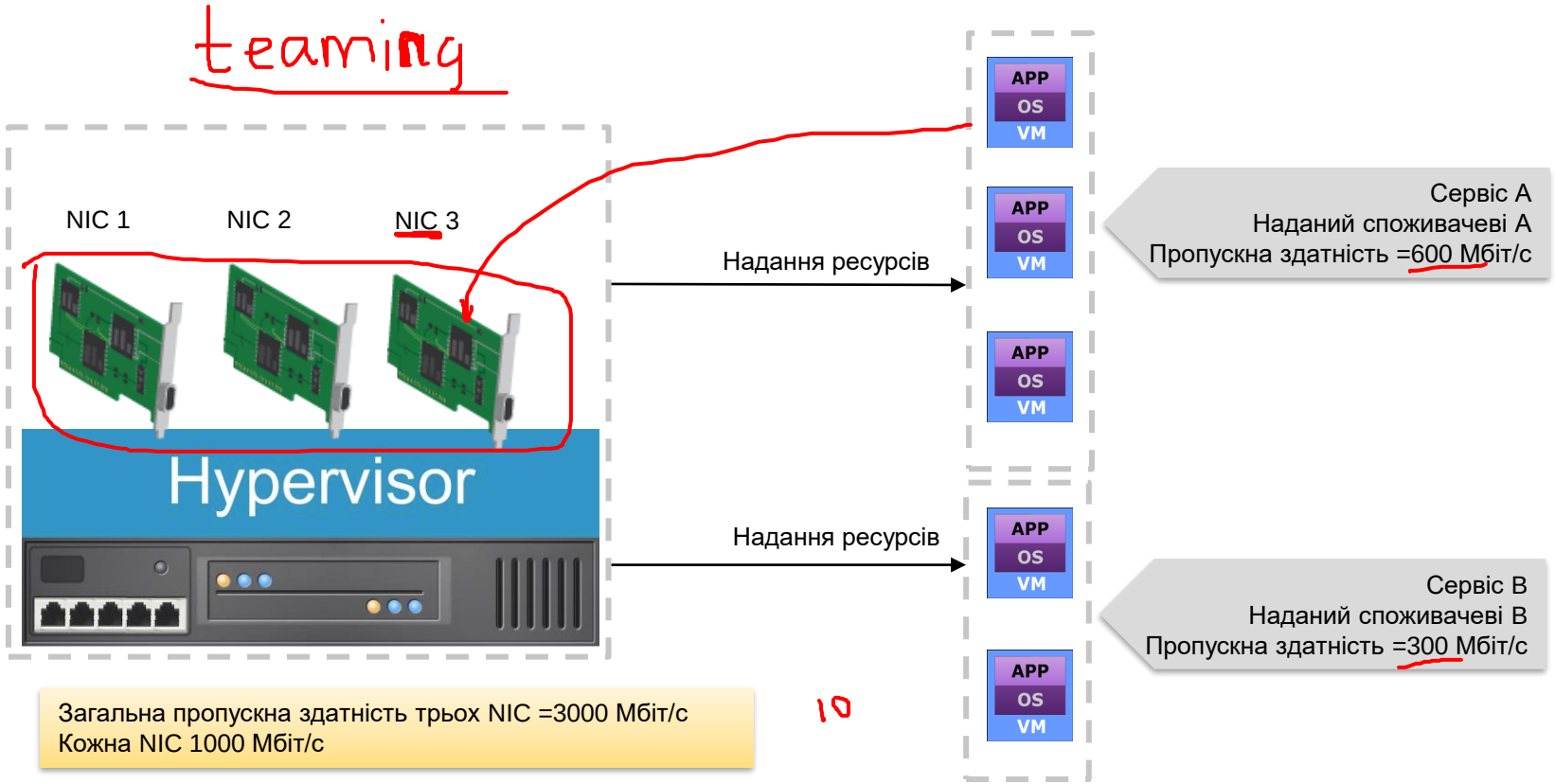
Resource pooling: Compute - example



Resource pooling: Storage - example



Resource pooling: Network - example



Software-defined infrastructure

This lesson covers the following topics:

- Software-defined infrastructure overview
- Software-defined infrastructure benefits
- Software-defined infrastructure attributes
- Software-defined infrastructure components

Why software-defined infrastructure?

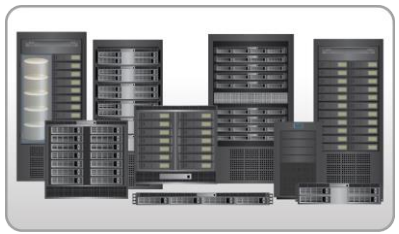
Big Data

Cloud

Social

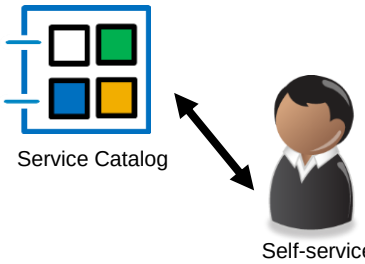
Mobile

Third Platform Application



IT Infrastructure

IT Budget

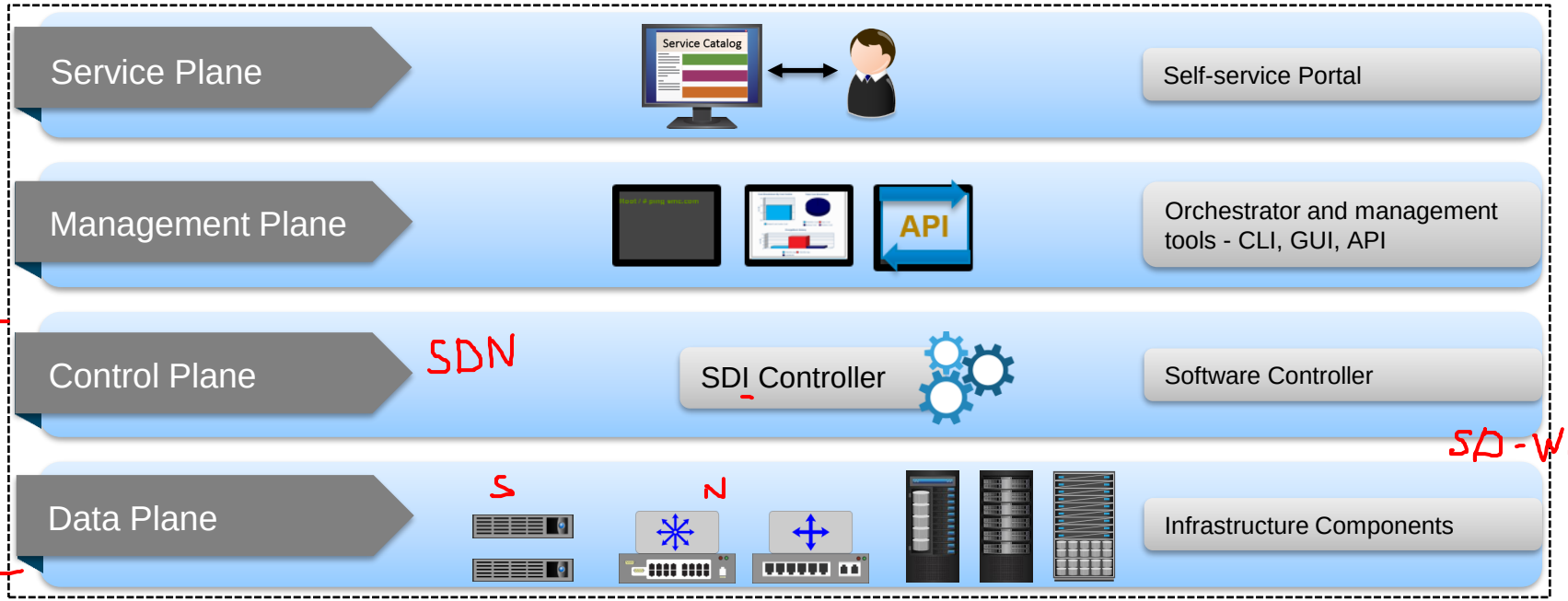


Deliver IT as a Service

Software-defined infrastructure

Software-defined infrastructure (SDI)

All IT infrastructure resources are virtualized, abstracted, and delivered as a service. Automated software controls the entire infrastructure.



Software-defined infrastructure benefits

To access the video, please click the below link

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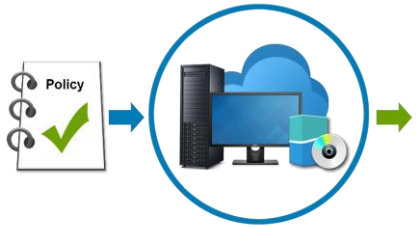
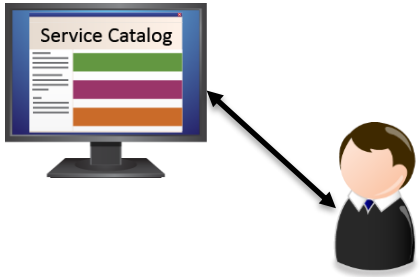
Software-defined infrastructure attributes

Abstraction and Pooling



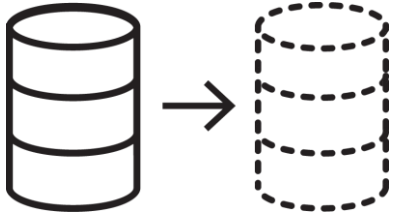
Automates and Policy-Driven Provisioning

Unified Management



Self-Service

Metering

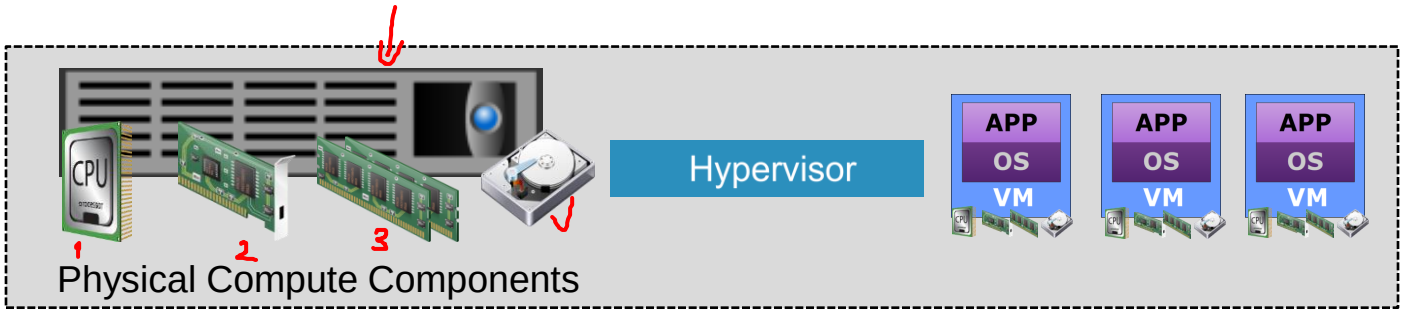


Open and Extensible

Software-defined compute

Software-defined compute (SDC)

SDC is an approach to provision compute resources using compute virtualization technology enabled by the hypervisor.

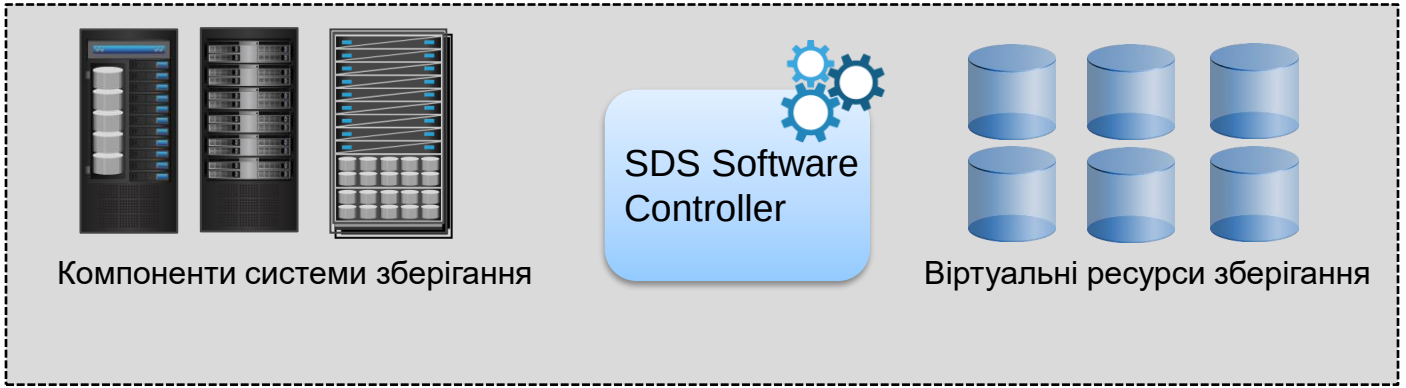


- Hypervisor decouples the application and the OS from the hardware and encapsulates them in an isolated virtual container called a virtual machine (VM).
- Hypervisor controls the allocation of hardware resources to the VMs based on policies, which means the hardware configuration of a VM is maintained using the software.

Software-defined storage

Software-defined storage (SDS)

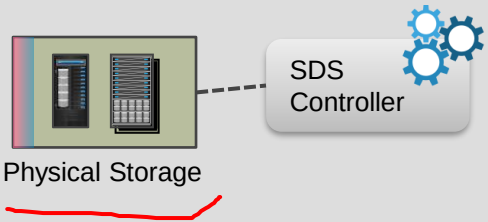
SDS is an approach to provision storage resources in which a software (SDS controller) controls storage-related operations independent of the underlying physical storage infrastructure.



- SDS controller abstracts the physical details of storage and delivers virtual storage resources.
- SDS controller controls the allocation of storage capacity based on policies.

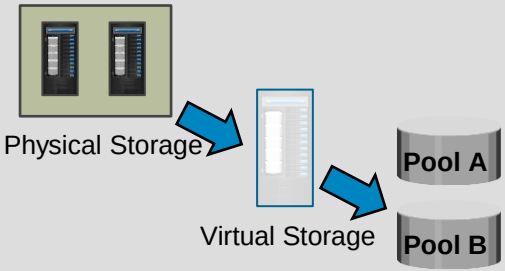
Software-defined storage controller functions

Виявлення сховища



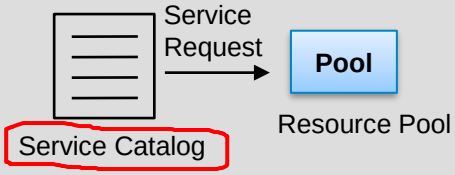
SDS controller discovers physical storage systems to gather data and bring them under its control and management.

Абстрагування та об'єднання ресурсів



SDS controller abstracts physical storage systems into virtual storage systems and virtual storage pools as per policies.

Розгортання сервісу та надання послуг

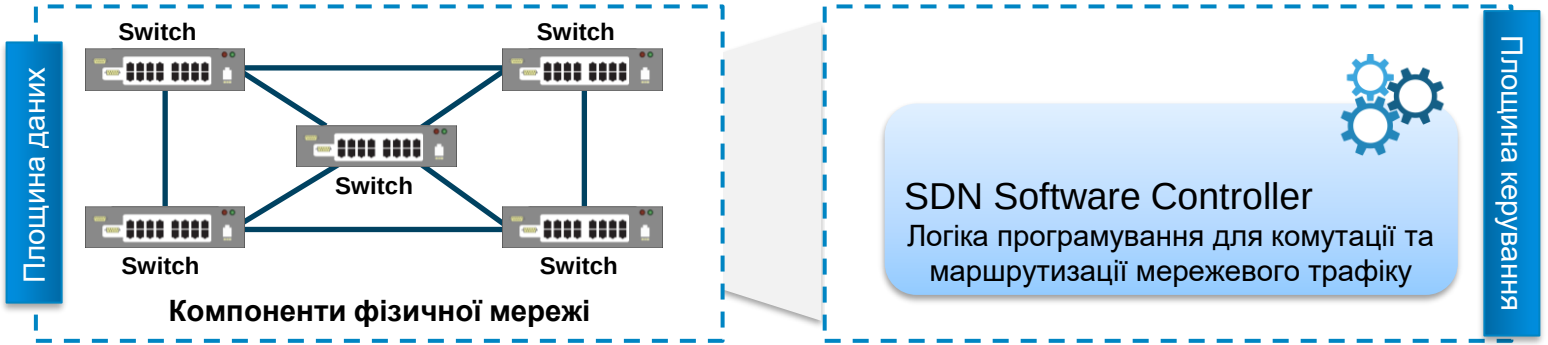


SDS controller automates the storage provisioning tasks and delivers virtual storage resources based on the service request issued through a service catalog.

Software-defined network

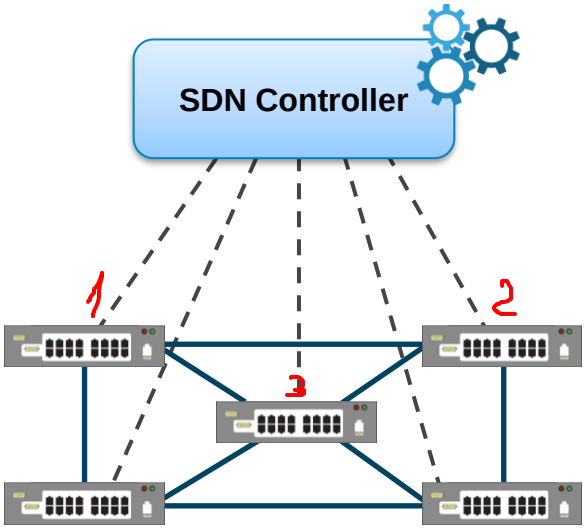
Software-defined network (SDN)

It is a networking approach that enables an SDN controller to control the switching and routing of the network traffic independent of the underlying network.



- SDN controller abstracts the physical details of the network components and separates the control plane functions from the data plane functions.
- SDN controller provides instructions for data plane to handle network traffic based on policies.

Software-defined network controller functions



Компоненти фізичної мережі

Q25

Network Discovery

SDN controller interacts with network components to discover information on their configuration, topology, capacity, utilization, and performance.

Network Component Management

SDN controller configures network components to maintain interconnections among the components and isolate network traffic through virtual networks.

Network Flow Management

SDN controller controls the network traffic flow between the components and chooses the optimal path for network traffic.

SDI customer success story: Dell EMC ViPR Controller

To access the video, please click the below link

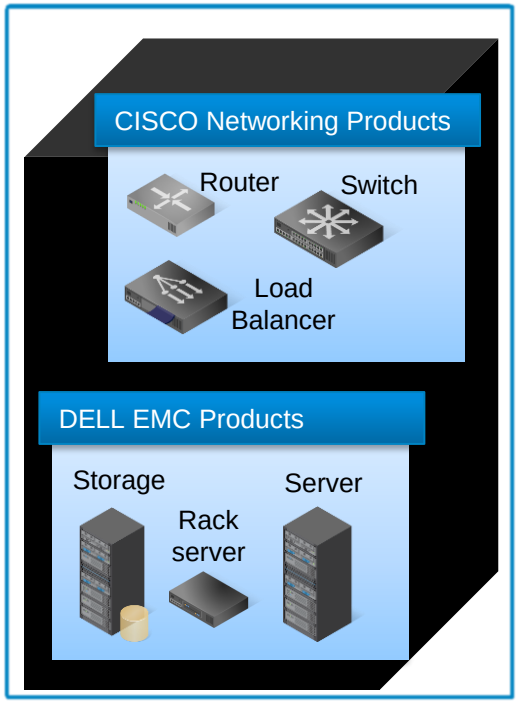
https://edutube.emc.com/Player.aspx?vno=PMRAk+Wt5imIfj8ViampgA==&autoplay=true&t=0h0m0s

Infrastructure deployment options

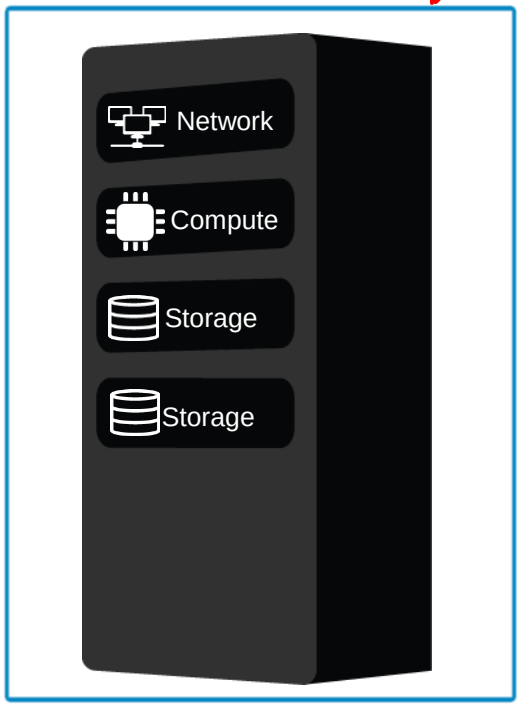
This lesson covers the following topics:

- Best-of-breed infrastructure
- Converged infrastructure
- Hyper-Converged infrastructure

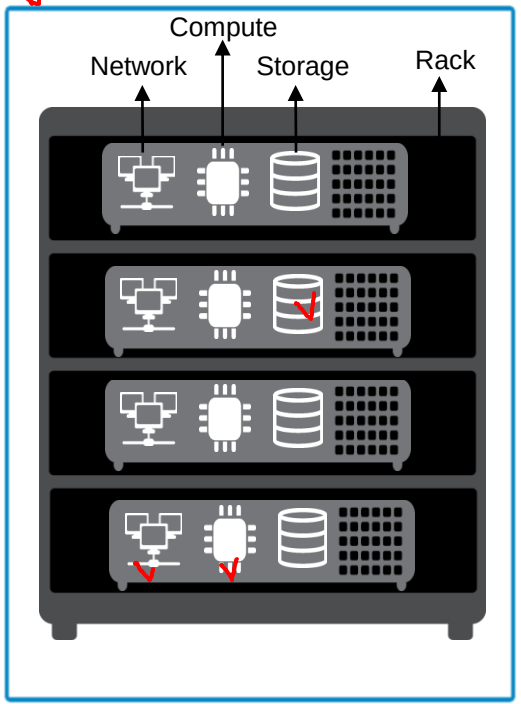
Deployment options



Best-of-breed Infrastructure



Converged Infrastructure



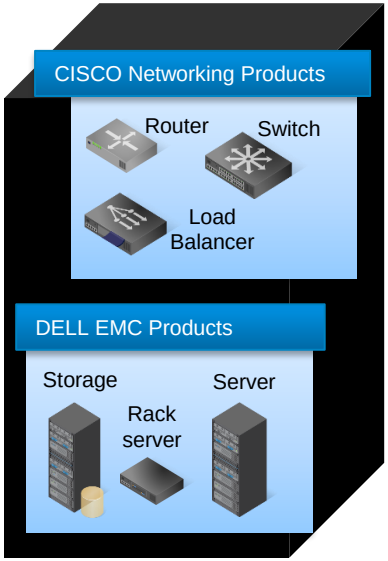
Hyper-Converged Infrastructure

Best-of-breed infrastructure

Best-of-breed

Integrates different hardware and software components from different vendors to built a cloud infrastructure.

- Brownfield deployment option
- Enables repurposing the existing infrastructure components
- Enables organizations to choose and switch vendors easily
- Requires organization to spend significant amount of IT staff time



Best-of-breed Infrastructure

Converged infrastructure

Converged infrastructure

All the infrastructure elements such as compute, storage, network, virtualization, and management are bundled together.

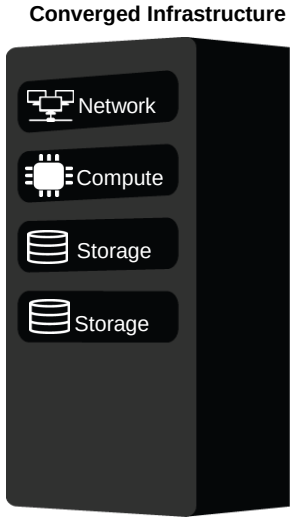
30%
Increase in IT operational efficiency

25%
Increase in application developer productivity

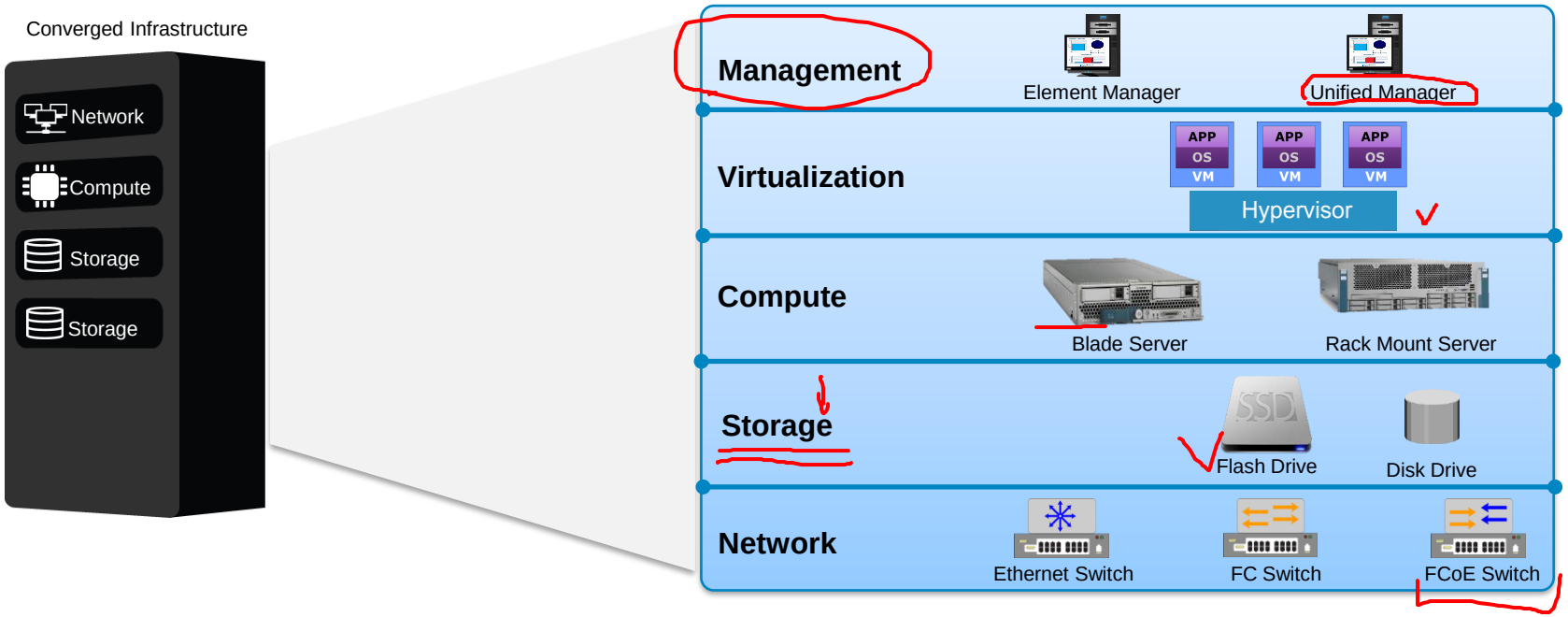
Set up new systems
4.6x
Faster

20 minutes
To deploy a full virtualized environment

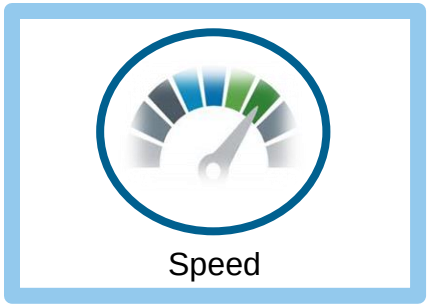
30%
Lowers TCO



Architecture of converged infrastructure



Converged infrastructure benefits



Best-of-breed infrastructure vs converged infrastructure

Best-of-Breed Infrastructure	Converged Infrastructure
Provides flexibility to choose components from leading vendors	Provides limited flexibility although some vendors give options to choose vendors
Prevents vendor lock-in	Imposes vendor lock-in
Incurs significant cost and time to deploy an infrastructure	Reduces the time to deploy an infrastructure and improves time-to-market
Takes long time to scale	Enables rapid scalability
Provides siloed, decentralized management with multiple tools	Provides a single management software and end-to-end management
Has higher power and space requirement	Has lower power and space requirement

Hyper-converged infrastructure

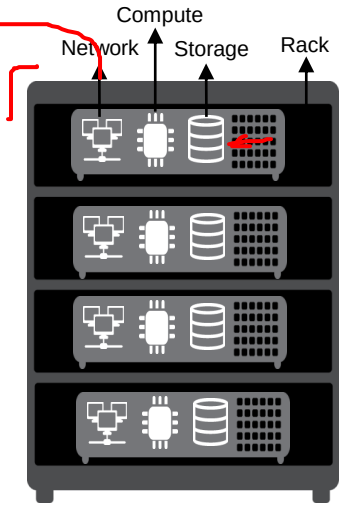
Hyper-converged infrastructure

All the components that are present in converged infrastructure are integrated in a scalable rack or appliance.

Set up new systems
4.6x faster

Scale in 5 minutes
Lowers TCO by
30%

Deploy a fully virtualized environment in 20 minutes



Hyper-Converged Infrastructure

Hyper-converged infrastructure - right solution

To access the video, please click the below link

https://edutube.emc.com/Player.aspx?vno=eErbVUxzXHXQgbCnuwce/A==&autoplay=true&t=0h0m0s

Source: VMware: Hyper-Converged Infrastructure 101 by VMware- What You Need to Know

Why is hyper-converged infrastructure blasting off?

Over 60% of companies have deployed or deploys HCI within two years.

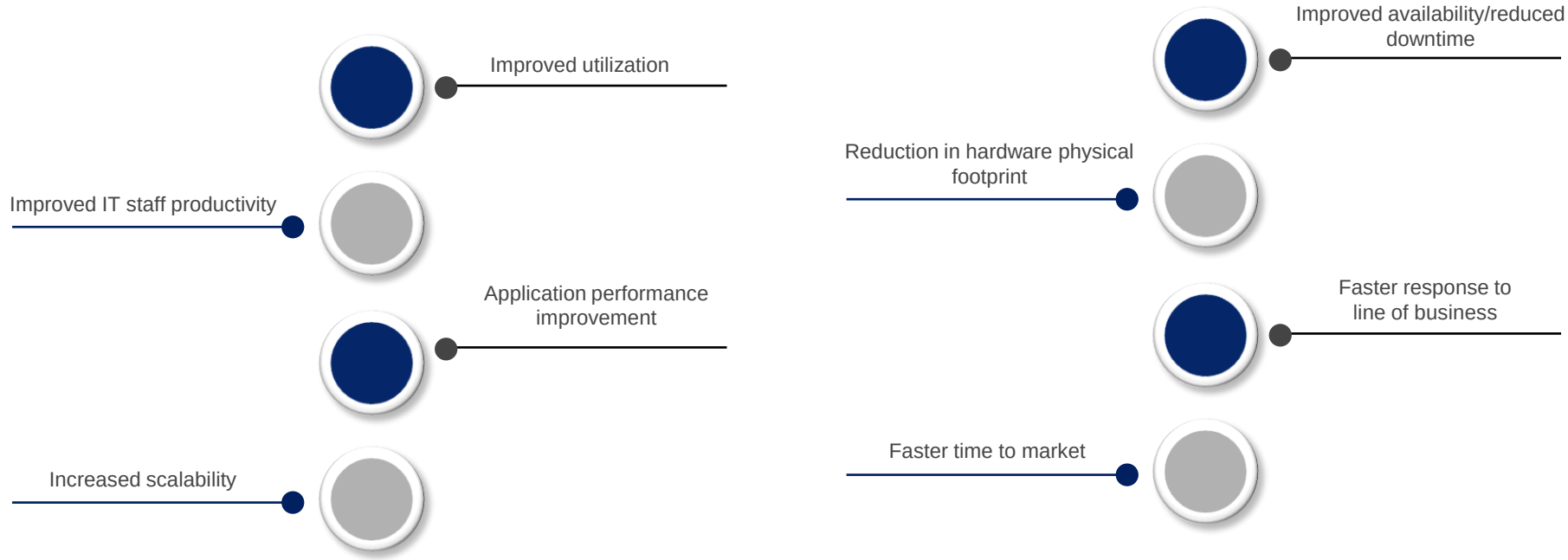
For some simple reasons

Up to 30% lower total cost of ownership versus traditional SAN

87% say that HCI has made them more agile

Up to 400% more expensive to use on-demand AWS versus VxRail HCI

Benefits of deploying converged and hyper-converged infrastructure



Build vs buy: Use case

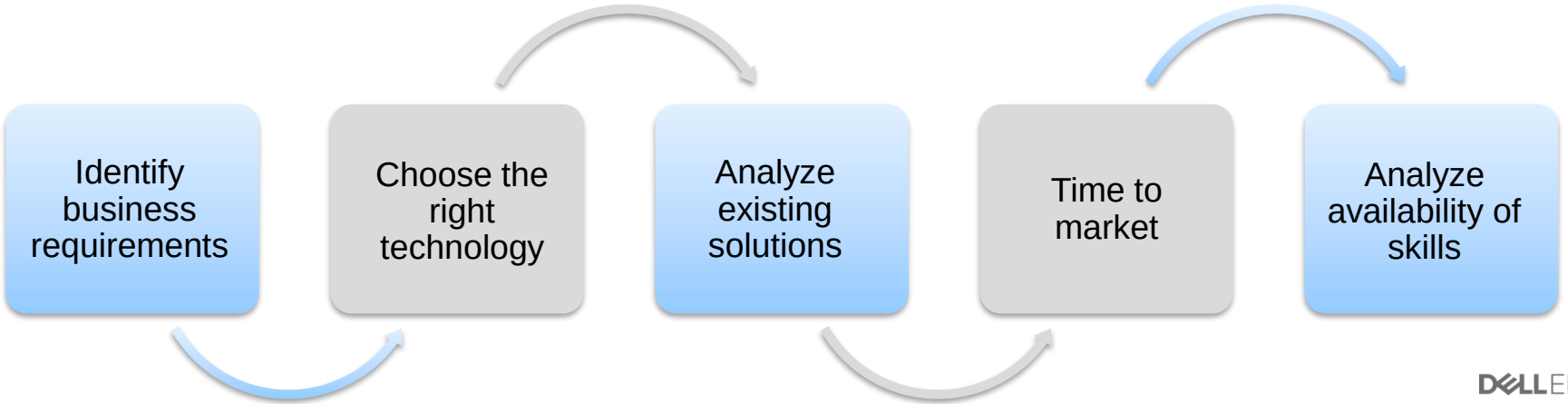
BUILD

Creating and developing a product that meets their organizations need.

BUY

Buying a complete developed product from a vendor, that meets the organizations need.

Considerations to choose the right option: whether to build or to buy



Build vs buy: Use case

Types	 BUILD	BUY 
Advantages	• Controls the deployment and the complete products functionalities • Uses the software that is specific to the organizations requirements	• Readily available in the market • Support systems are available to the customers • Continuous development to meet the changing business requirement • Cost effective • Preconfigured and tested to reduce risks
Disadvantages	• Consumes lot of time to identify the requirements, to build the code, and so on • Requires to maintain the same phase with technology development • Requires a testing environment to check before the usage of the product	• Developers retain the rights of the source code • Product functionalities may not satisfy the requirements completely • Dependent on vendor's support to resolve issues

Concepts in practice

- Dell EMC CloudArray
- Dell EMC VxBlock System
- Dell EMC VxRail Appliance
- Dell EMC XC Series Appliance
- Dell EMC ScaleIO Software
- Dell EMC Elastic Cloud Storage (ECS)
- Dell EMC PowerEdge Server

Concepts in practice (Contd.)

CloudArray

- Cloud-integrated storage and software-defined storage
- High-performance storage arrays with cost effective cloud capacity
- Simplifies storage management for inactive data and offsite protection

CloudArray

VxBlock System

- Converged infrastructure that simplifies all aspects of IT operations
- Integrates with compute, network, storage, and virtualization technologies
- Supports large-scale consolidation, peak performance, and high availability for traditional and cloud-based workloads

VxBlock Systems

Concepts in practice (Contd.)

VxRail Appliance

- Fastest growing hyper-converged system
- Transforms VMware infrastructures by simplifying IT operations
- Accelerates transformation
- Drives operational efficiency
- Lowers capital and operational costs

VxRail Appliance

XC Series Appliance

- Hyper-converged appliance
- Integrates with the Dell EMC PowerEdge server and the Nutanix software
- Managed without any specialized IT resources
- Uses HTML5-based management interface

XC Series Appliance

Concepts in practice (Contd.)

ScaleIO Software

- Deploys software-defined block storage
- Easier storage management and provisioning
- Deploys as all-flash/or hybrid software-defined block storage
- Enables storage tiering

ScaleIO Software

Elastic Cloud Storage (ECS)

- Deploys software-defined object storage
- Supports rapid data growth by providing apt platform
- Flexible to deploy as an appliance or software or as cloud

Elastic Cloud Storage (ECS)

Concepts in practice (Contd.)

PowerEdge Server

- The 13th generation of Dell EMC PowerEdge servers delivers operational efficiency and top performance at any scale.
- Benefits are:
  - Scalable business architecture
  - Intelligent automation
  - Integrated security

PowerEdge Server

Summary

Key points covered in this module:

- Physical infrastructure
- Virtual infrastructure
- Software-defined infrastructure
- Infrastructure deployment options