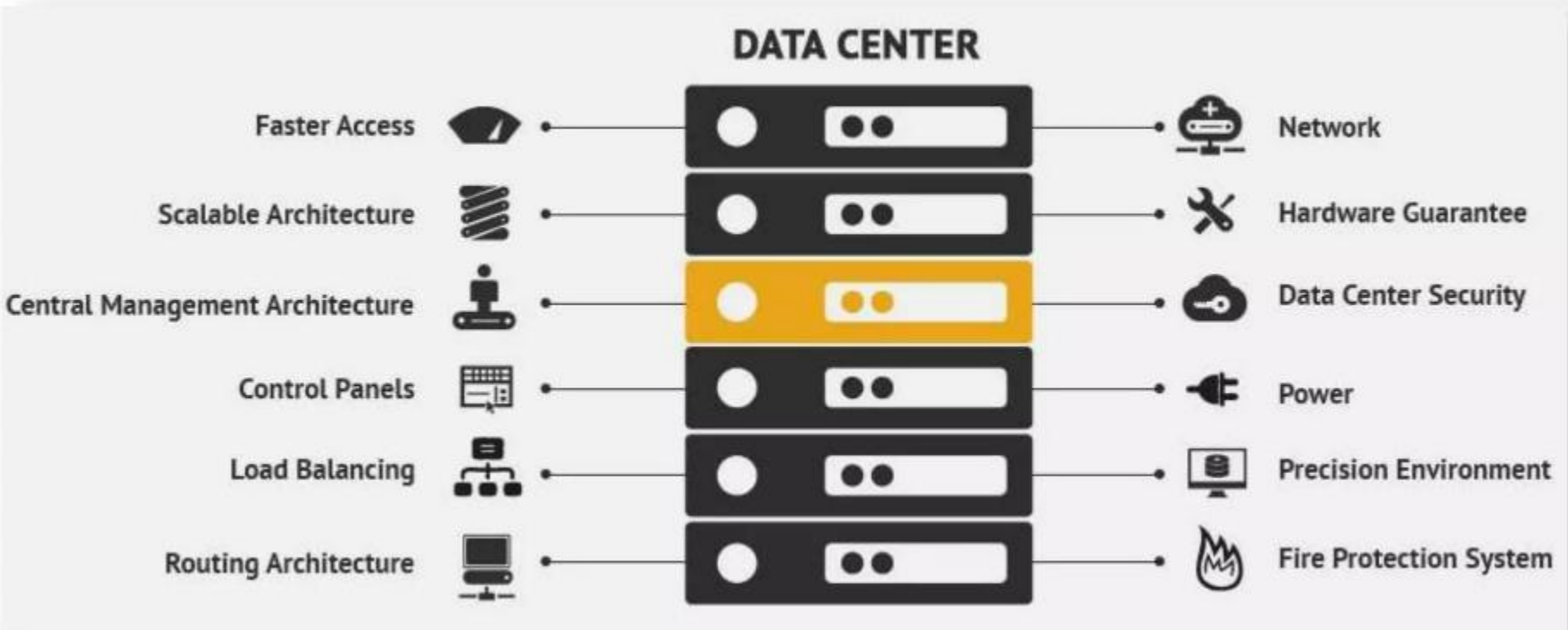
DATA CENTER

Mochammad Zen Samsono Hadi, ST. MSc. Ph.D

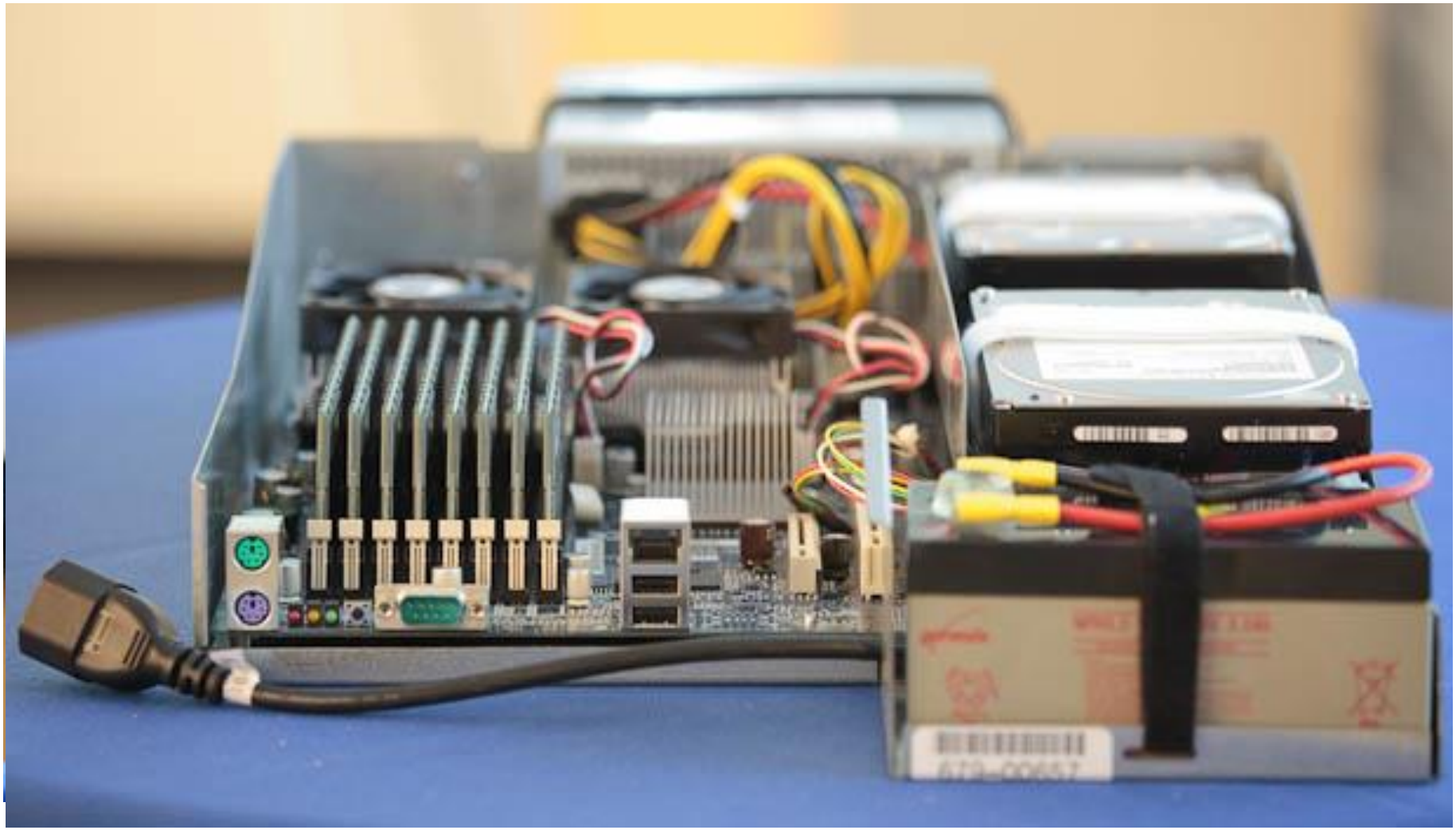
Data Center

- ***Data center*** atau lebih dikenal dengan pusat data merupakan ruangan yang dirancang khusus untuk tempat penyimpanan file, mengelola, melakukan backup, informasi bisnis, hingga server komputer dari perusahaan yang biasanya terhubung dengan jaringan internet.
- Meski sering disebut sebagai benda tunggal, data center pada kenyataannya melibatkan banyak elemen, mulai dari **router, saklar, switch, server, perangkat keamanan**, dan masih banyak lagi.
- Elemen-elemen tersebut memiliki kaitan satu sama lain sehingga bisa bekerja membentuk jaringan penghimpun informasi.

Fungsi Data Center



Google Server Internals

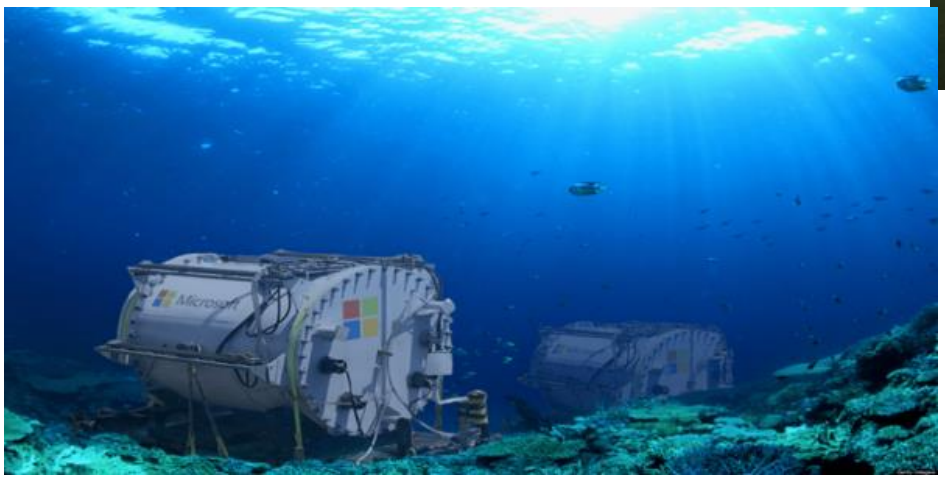


Arsitektur Data Center

- Arsitektur data center biasanya dibuat pada tahap perancangan dan pembangunan data center.
- Arsitektur data center menentukan di mana dan bagaimana server, jaringan penyimpanan, rak, dan sumber daya pusat data lainnya akan ditempatkan secara fisik.
- Selain itu juga membahas bagaimana sumber daya/perangkat ini akan saling terhubung dan bagaimana alur kerja keamanan fisik dan logis diatur.

Infrastruktur Data Center

Contoh Data Center



Infrastruktur Data Center

Sesuai dengan arsitektur data center dan layanan yang diberikan, terdapat 3 infrastruktur data center:

- Traditional Data Center
- Modular Data Center
- Cloud Data Center

Traditional Data Center

Modular Data Center

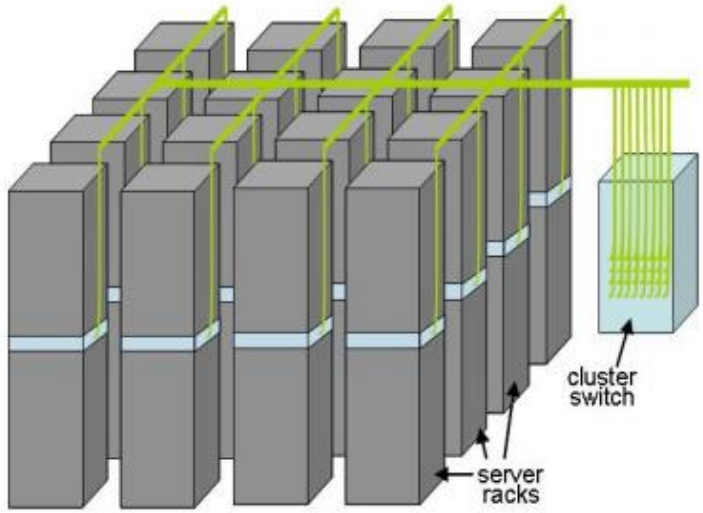
Cloud Data Center

Arsitektur Traditional Data Center

Servers mounted on
19'' rack cabinets

Servers
- CPUs
- DRAM
- Disks

Racks
- 40-80 servers
- Ethernet switch



Clusters

Racks are placed in single rows forming corridors between them.

- Src: the datacenter as a computer – an introduction to the design of warehouse-scale machines

Microsoft's Chicago Modular Datacenter

STRUCTURE: A 24,000-square-meter facility houses 400 containers. Delivered by trucks, the containers attach to a spine infrastructure that feeds network connectivity, power, and water. The data center has no conventional raised floors.

POWER: Two power substations feed a total of 300 megawatts to the data center, with 200 MW used for computing equipment and 100 MW for cooling and electrical losses. Batteries and generators provide backup power.

Power and water distribution

Water-based cooling system

CONTAINER: Each 67.5-cubic-meter container houses 2,500 servers, about 10 times as many as a conventional data center packs in the same space. Each container integrates computing, networking, power, and cooling systems.

Racks of servers

Power supply

Truck carrying container

Len Rogers Collection

The Million-Server Data Center

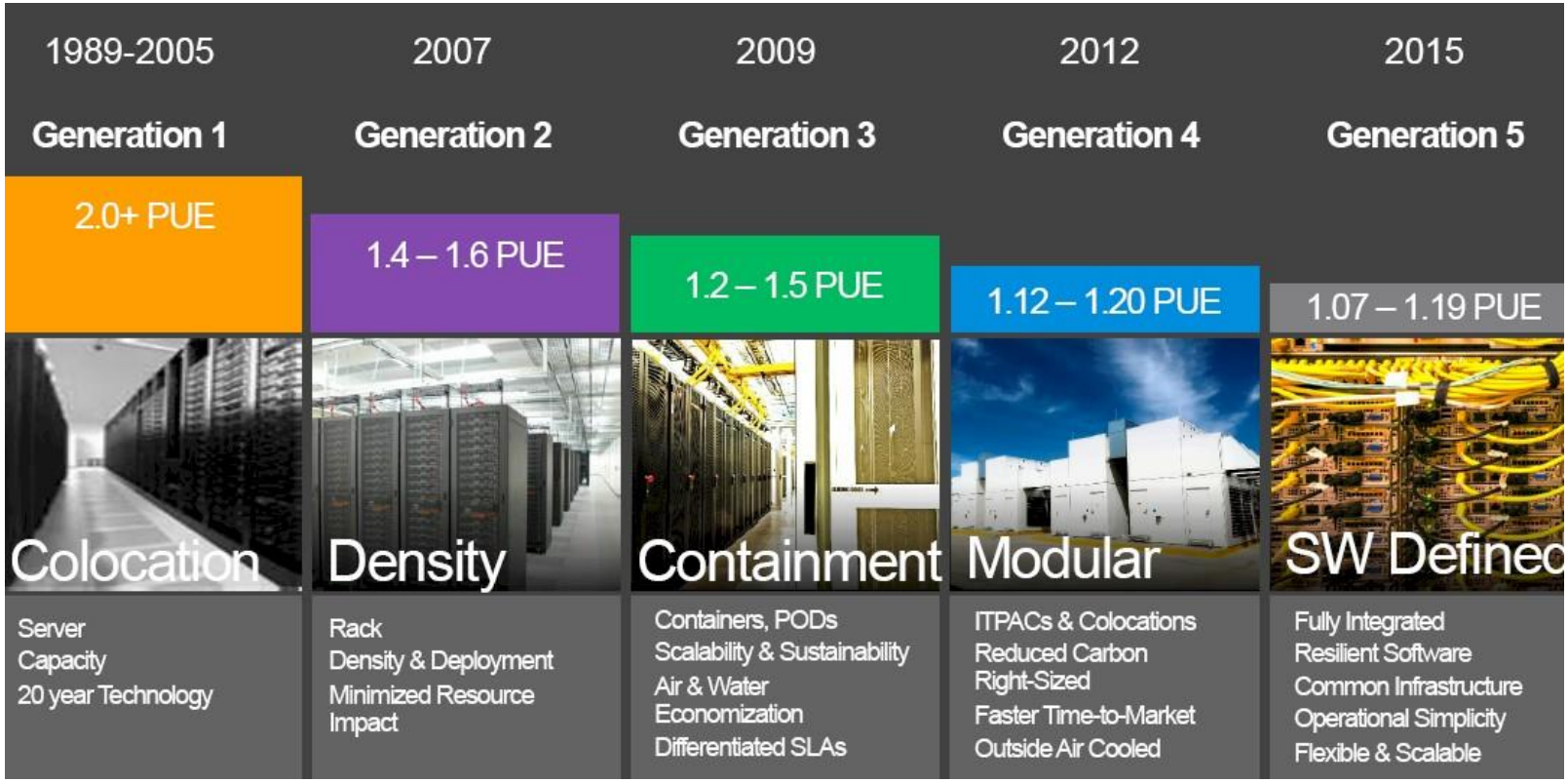
Today's most advanced data centers house tens of thousands of servers. What would it take to house 1 million?

Jenis Data Center

- **Enterprise Data Centers**: Data center milik individu atau organisasi untuk memenuhi kebutuhan internal. Server dapat berlokasi di gedung yang sama dengan kantor atau kampus.
- **Managed Service Data Centers**: Infrastruktur data center yang dibangun oleh sebuah perusahaan, kemudian disewakan ke perusahaan lainnya. Contohnya seperti Gedung Cyber yang berlokasi di Jakarta Selatan.
- **Colocation Data Centers**: Mirip dengan managed data center, hanya saja perusahaan penyewa memegang kendali penuh atas infrastruktur yang mereka sewa.
- **Cloud Data Centers**: Data center yang paling canggih dengan sistem cloud sebagai tempat penyimpanan data.

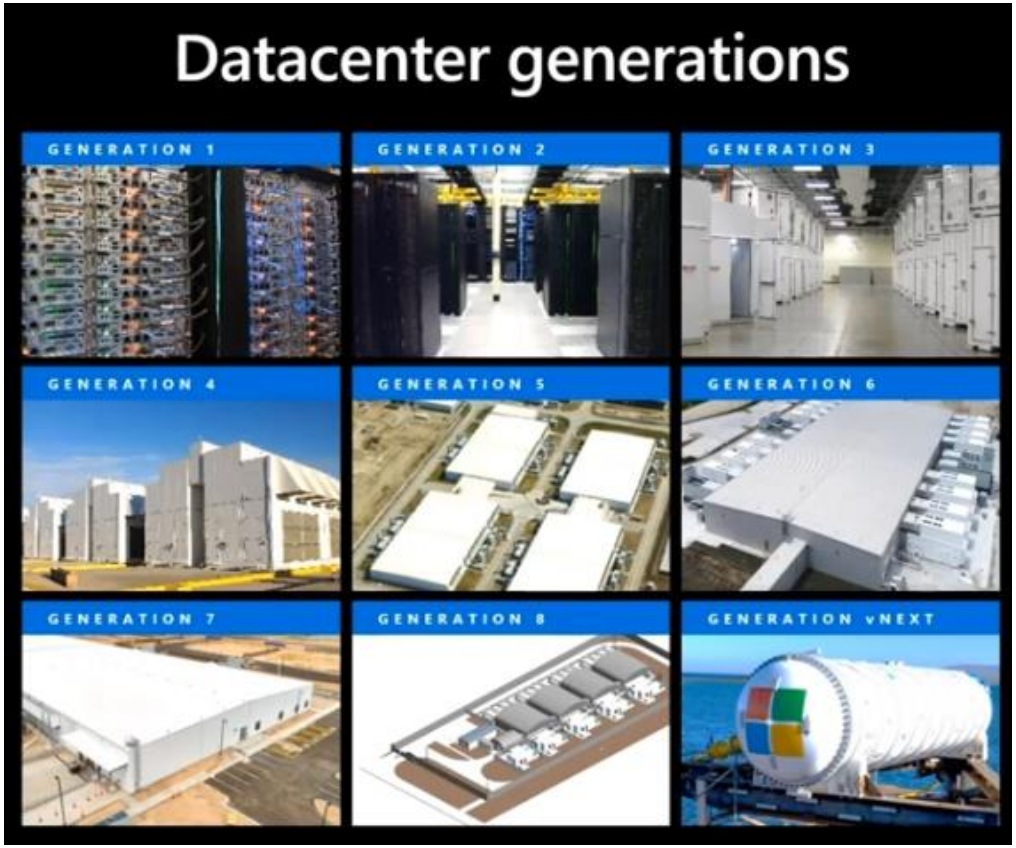
Evolution of data center design

- Case study: Microsoft



https://www.nextplatform.com/2016/09/26/rare-tour-microsofts-hyperscale-datacenters/

Evolution of datacenter design



Src: Inside Azure Datacenter Architecture with Mark Russinovich

- **Gen 6: scalable form factor (2017)**
  - Reduced infrastructure, scale to demand
  - 1.17-1.19 PUE
- **Gen 7: Ballard (2018)**
  - Design execution efficiency
  - Flex capacity enabled
  - 1.15-1.18 PUE
- **Gen 8: Rapid deploy datacenter (2020)**
  - Modular construction and delivery
  - Equipment skidding and preassembly
  - Faster speed to market
- **Project Natick (future) – 1.07 PUE or less**

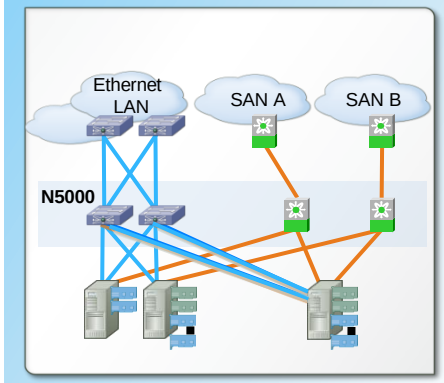
PUE: Power Usage Effectiveness

An Innovative Platform To Simplify Data Center Transformation

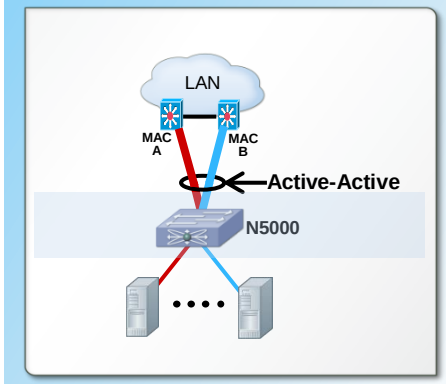
Standards

IETF IEEE ANSI

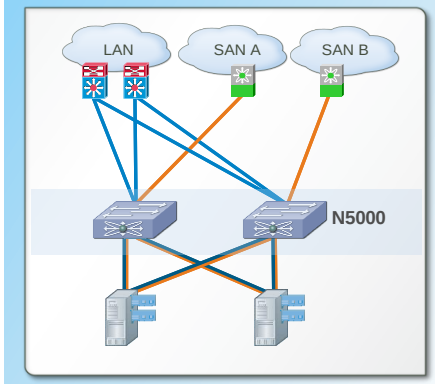
Wire Speed 10GbE Switching
Capacity



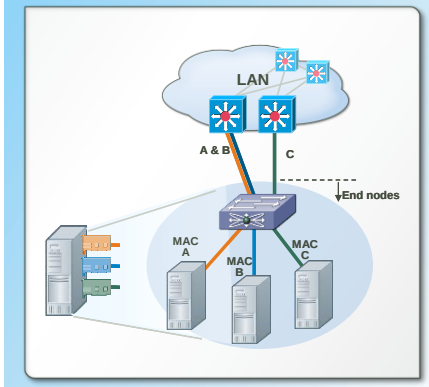
Data Center Ethernet
Scalability



Fibre Channel over Ethernet
Consolidation



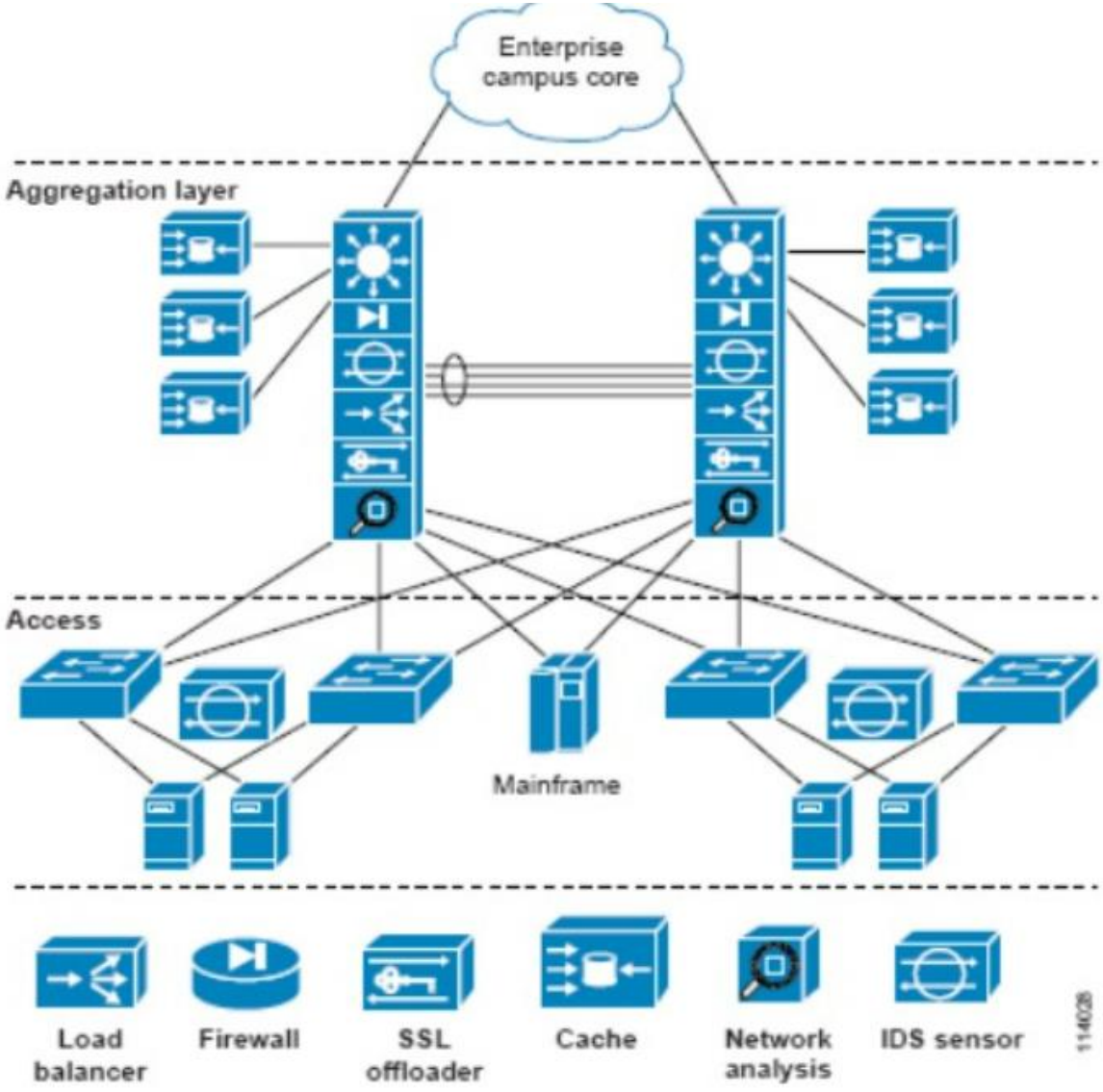
VM Optimized Networking
Virtualization



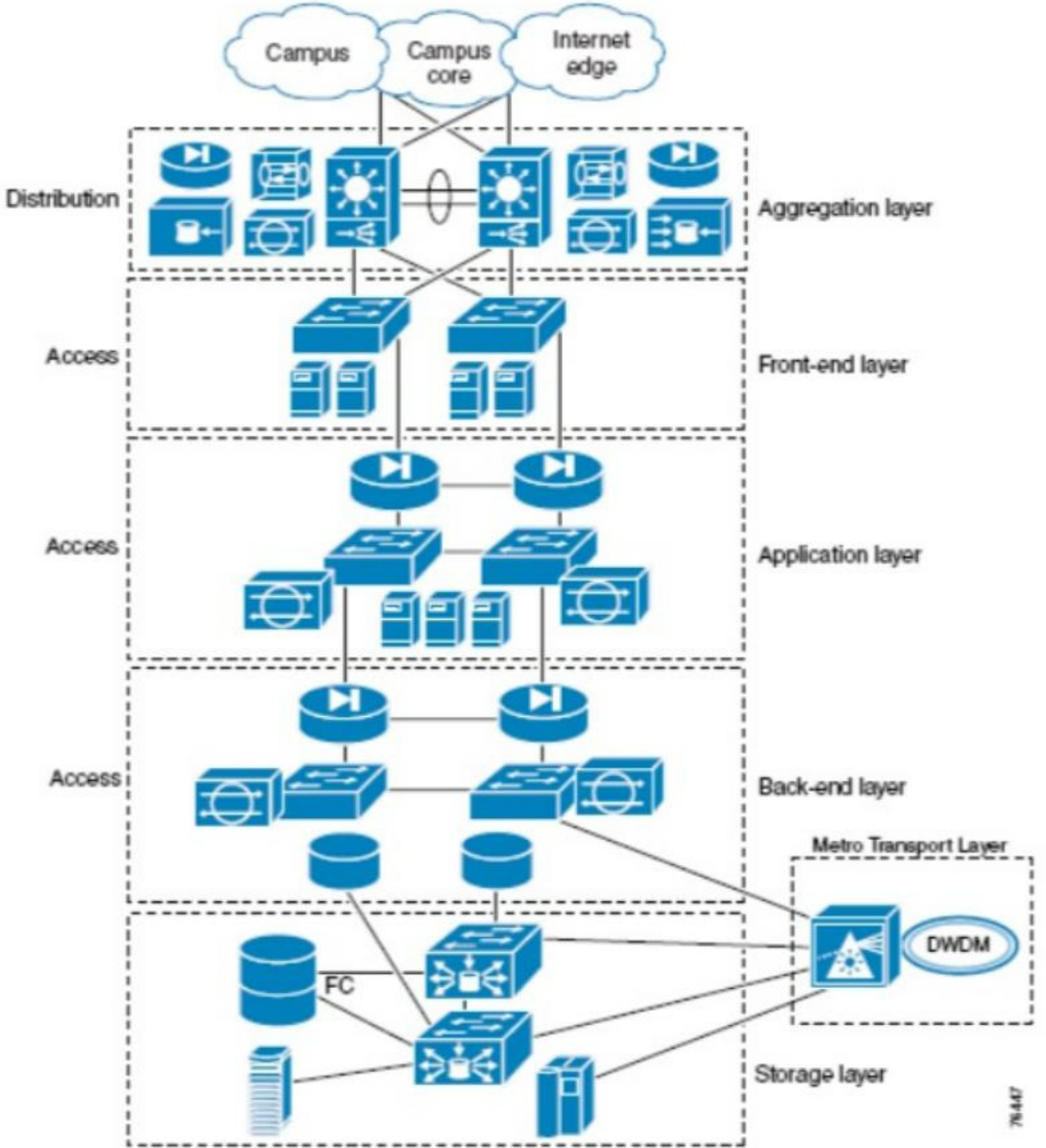
Eco-System

EMULEX NETXEN APC by Schneider Electric QLOGIC intel PANDUIT vmware

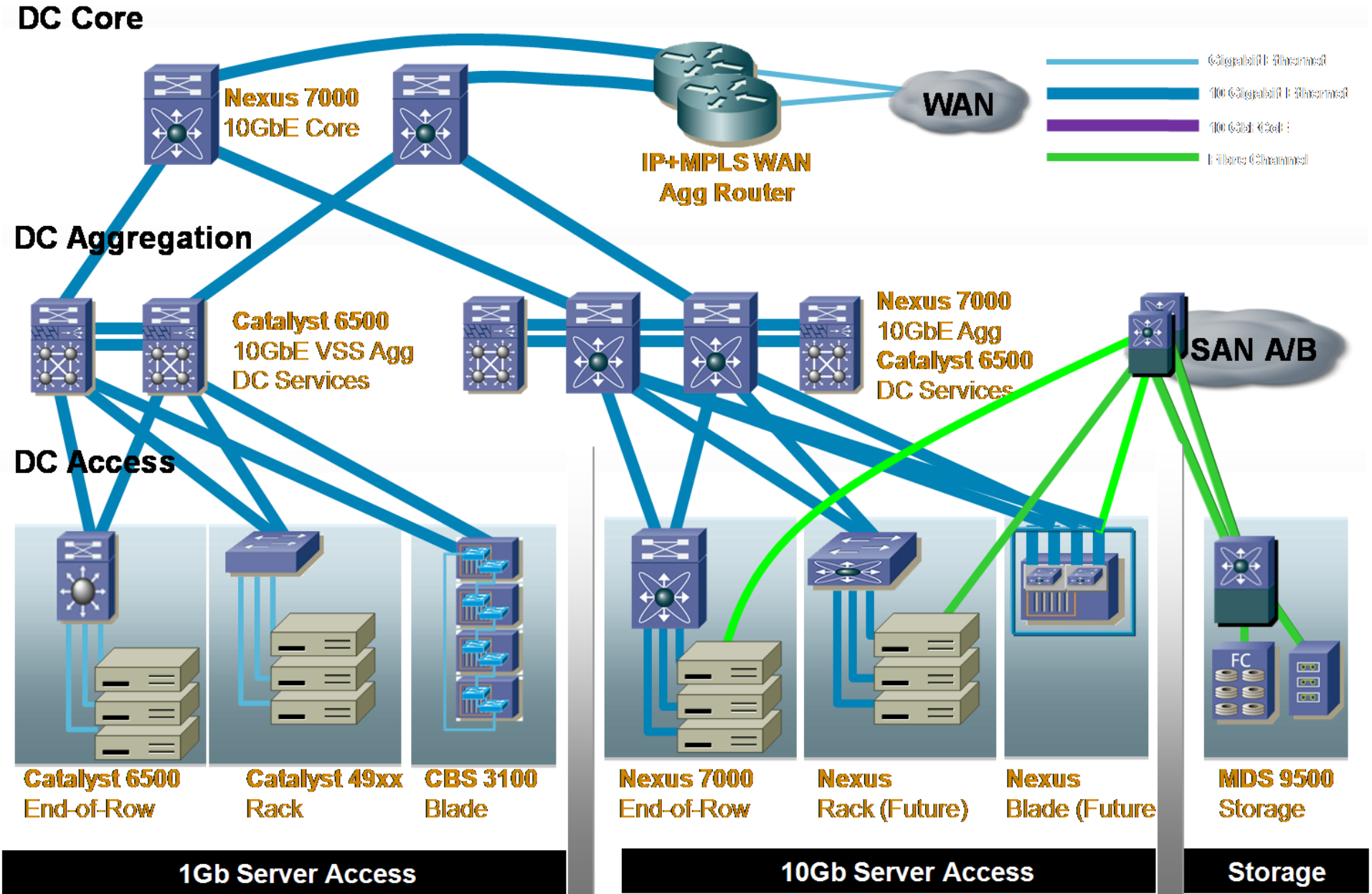
Arsitektur Data Center



Arsitektur Data Center



Data Center 3.0 Infrastructure Portfolio: Cisco



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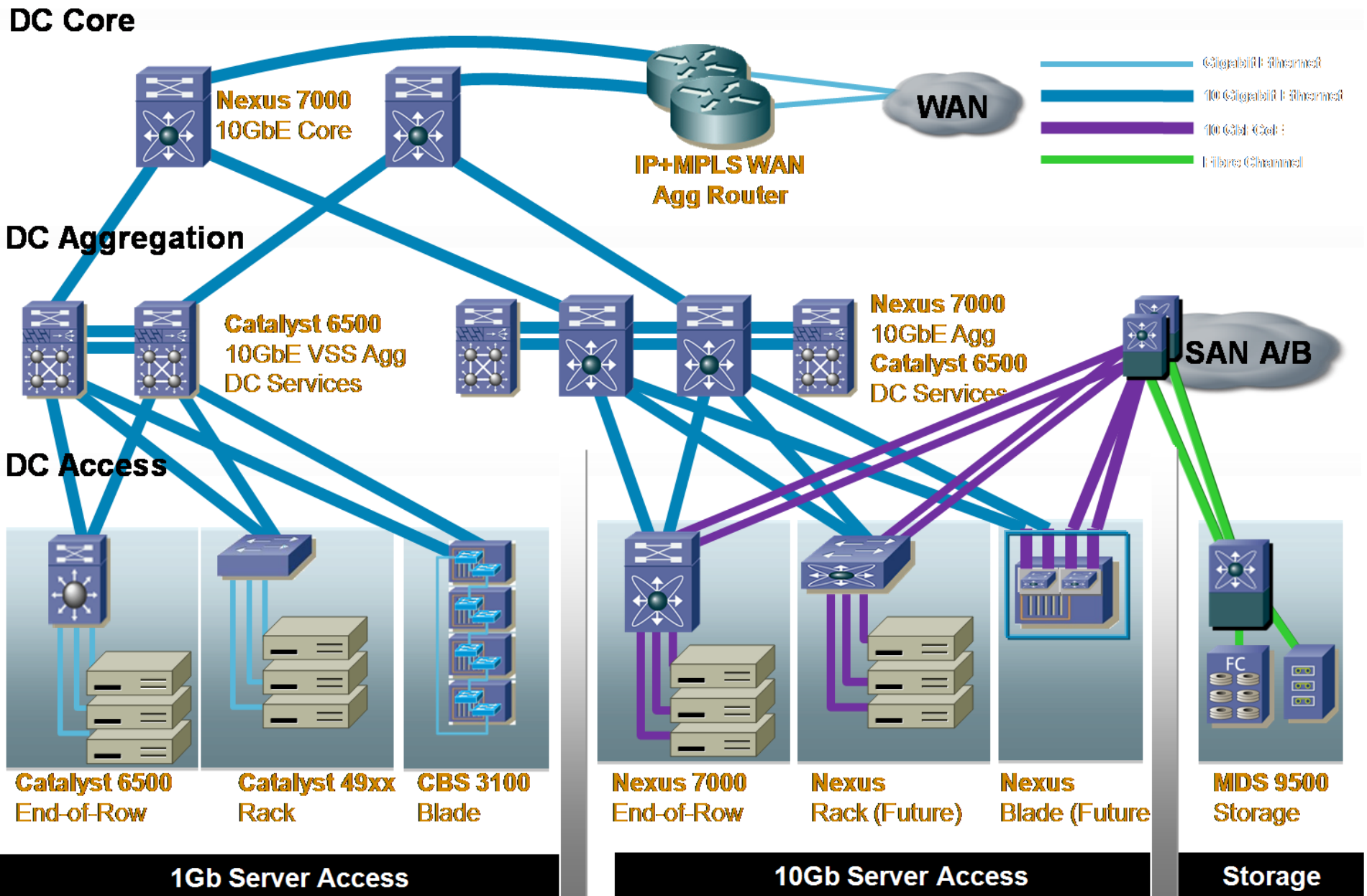


Cisco Nexus 7000 Series

Data Center Class Switches

Operational Continuity

- Zero Service Disruption design
- Graceful systems operations
- Integrated lights-out management

Transport Flexibility

- Lossless fabric architecture
- Dense 40GbE/100GbE ready
- Unified fabric

Infrastructure Scalability

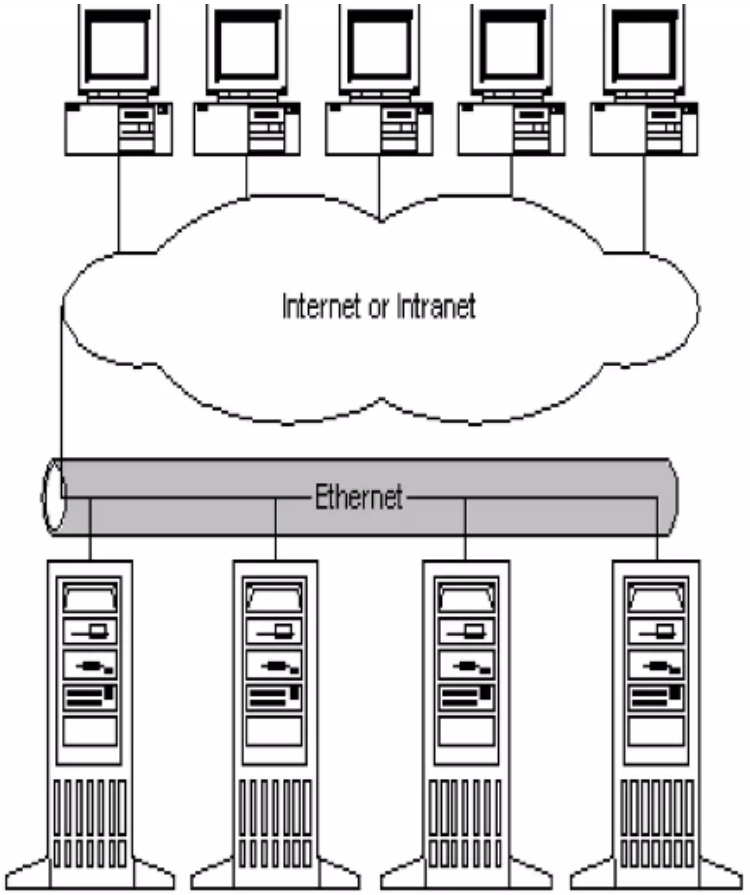
- Virtualized control and data plane
- 15Tb+ switching capacity
- Efficient physical and power design

Data Center Clustering

4 jenis clustering:

- **High Performance computing**
  - Super computing / supercluster
- **Component Load Balancing**
- **Network Load Balancing**
  - Sampai 32 node
  - Layer 2 dan 3 OSI
- **Server Clustering**
  - File share
  - SQL Server

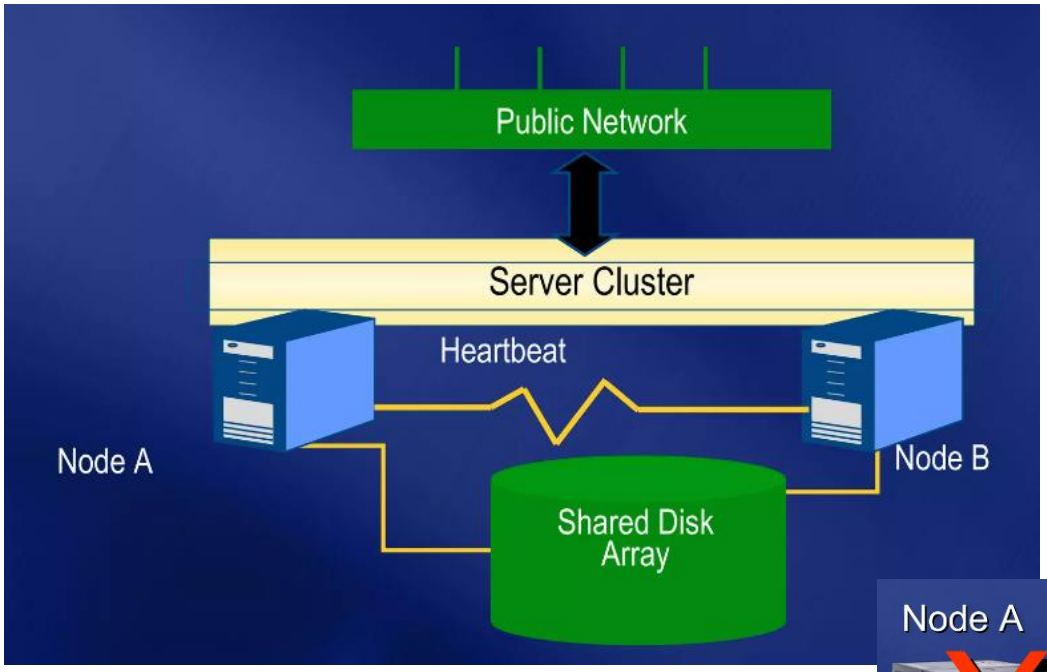
Network Load Balancing

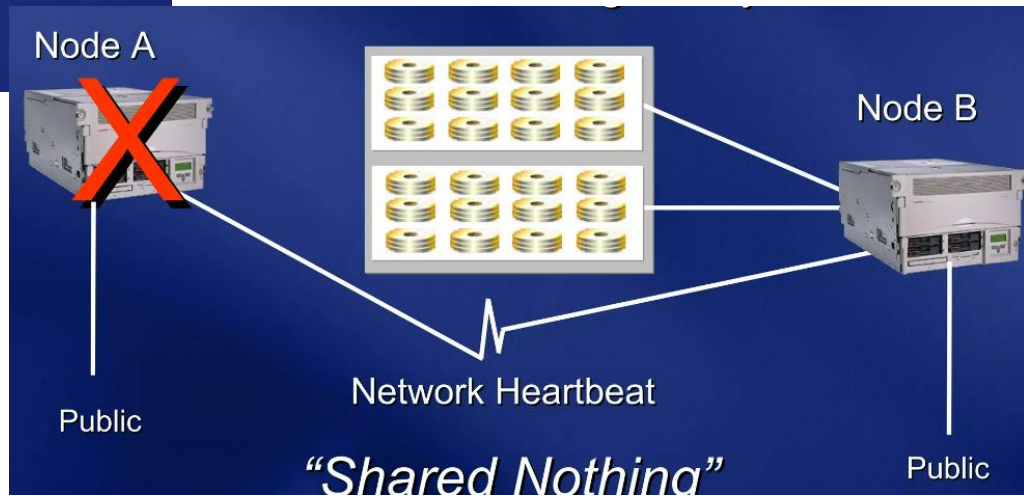


Server Cluster

- **Quorum** = Clustering
  - Clients diharuskan untuk meminta dan memperoleh ijin dari banyak server sebelum reading atau writing dari atau ke item data tereplikasi
- **Protokol berbasis quorum**
  - Perhatikan suatu sistem file terdistribusi dan anggap bahwa suatu file direplikasikan pada N server
  - Aturan write/read:
    - Suatu client pertama harus menghubungi N/2 + 1 servers (suatu majority) sebelum mengupdate sebuah file atau file yang akan dibaca
    - Sekali suara mayoritas diperoleh, file tersebut diupdate dan nomor versinya dinaikkan

Konfigurasi Network Cluster



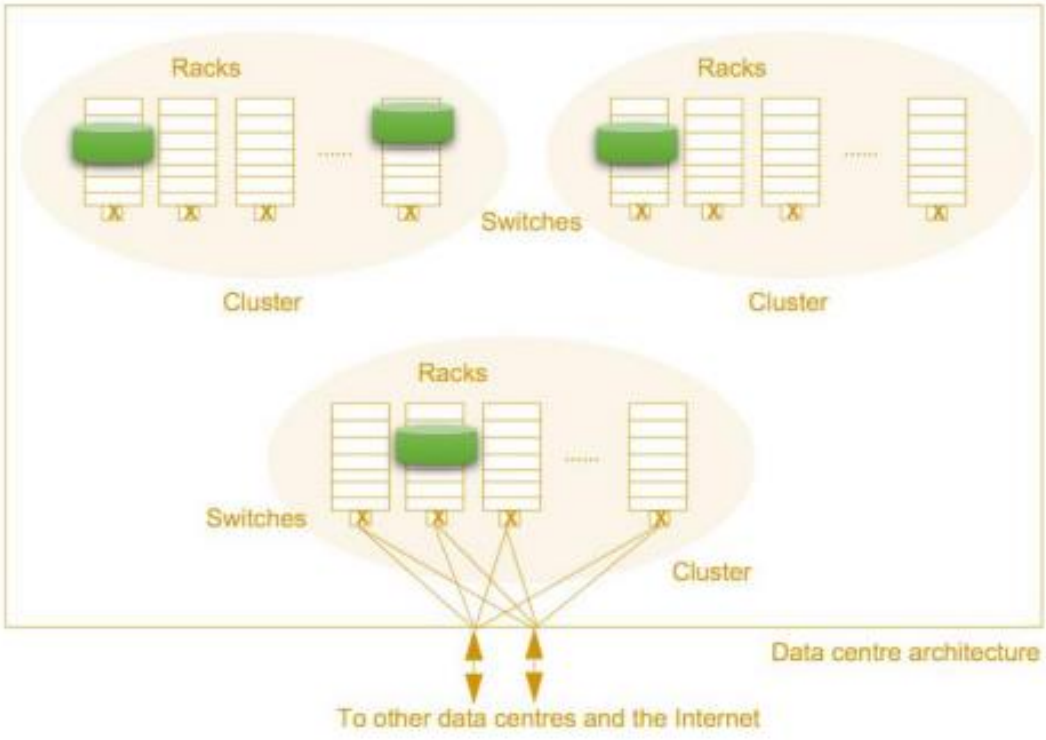


Shared cluster disk array:

- Quorum disk
- Data disks

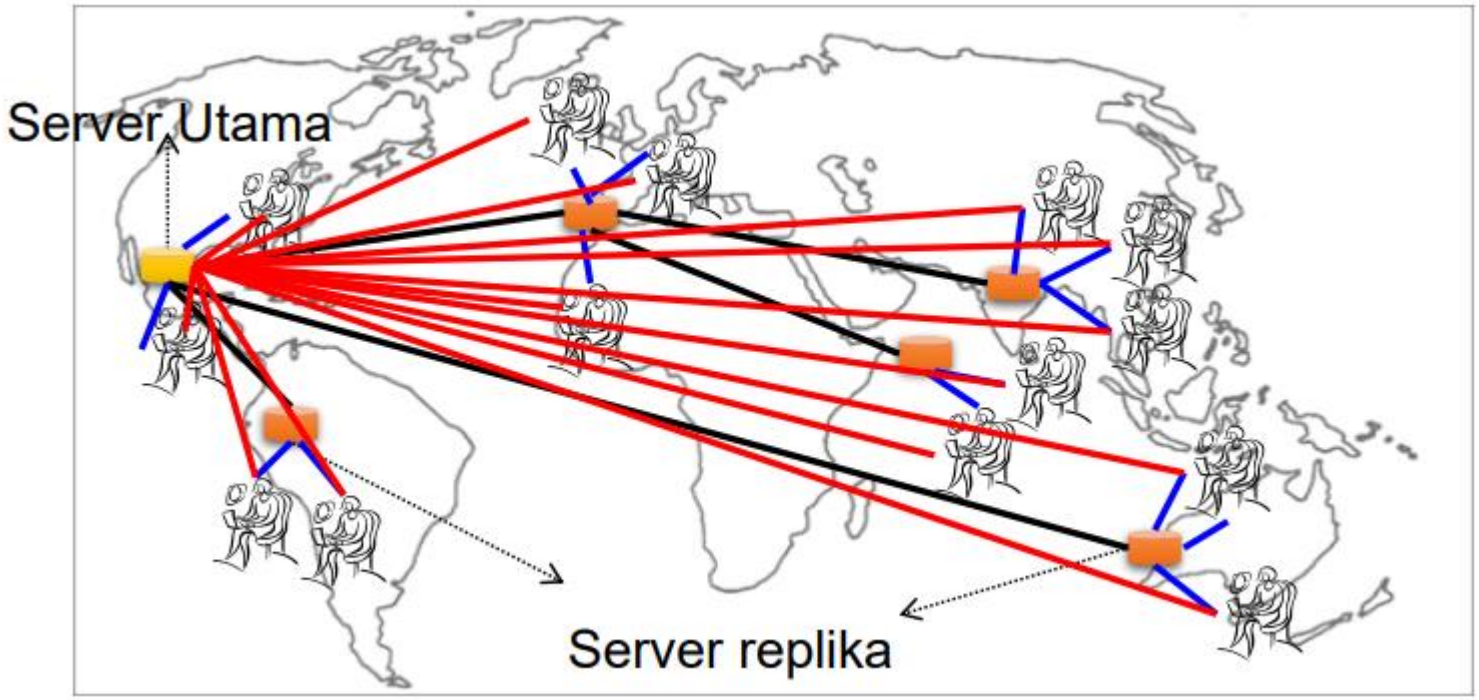
Contoh Cluster: Replikasi untuk High-Availability

- Google File-System mereplikasi blok-blok data pada komputer lintas rack, cluster dan data center
- Jika satu komputer, rack atau cluster mengalami crash, block-block data masih dapat diakses dari sumber lainnya.



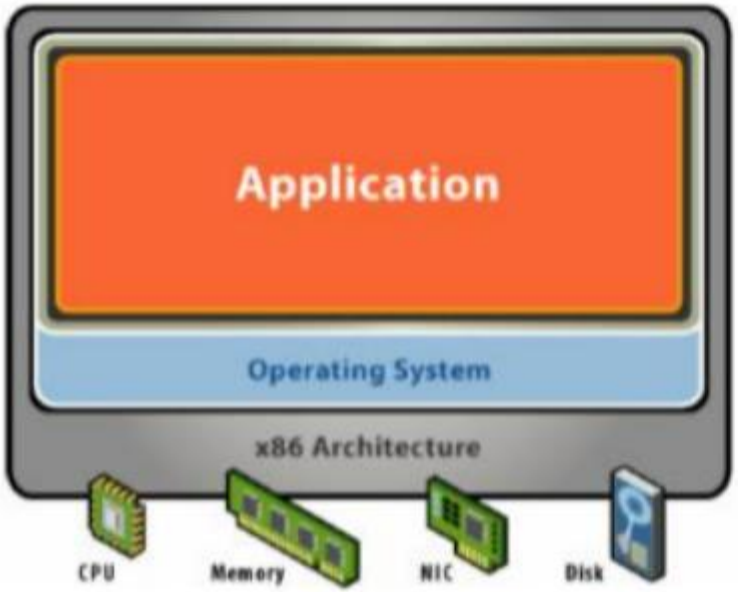
Cluster Replikasi: Skalabilitas

- Mendistribusikan data lintas server replika membantu menjaga server utama dari menjadi suatu performance bottleneck
- Contoh: Content Delivery Networks dapat menurunkan beban pada server-server utama (primer)



Data Center Virtualization

Physical Machine



Physical Hardware

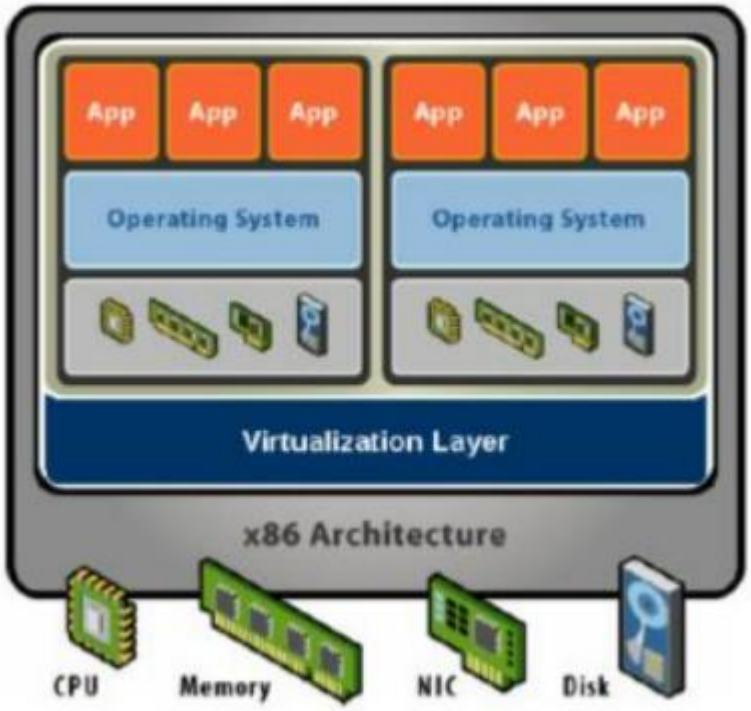
- Processors, memory, chipset, I/O bus and devices, etc.
- Physical resources often underutilized

Software

- Tightly coupled to hardware
- Single active OS image
- OS controls hardware

Data Center Virtualization

Virtual Machine



Hardware-Level Abstraction

- Virtual hardware: processors, memory, chipset, I/O devices, etc.
- Encapsulates all OS and application state

Virtualization Software

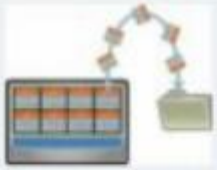
- Extra level of indirection decouples hardware and OS
- Multiplexes physical hardware across multiple "guest" VMs
- Strong isolation between VMs
- Manages physical resources, improves utilization

Data Center Virtualization

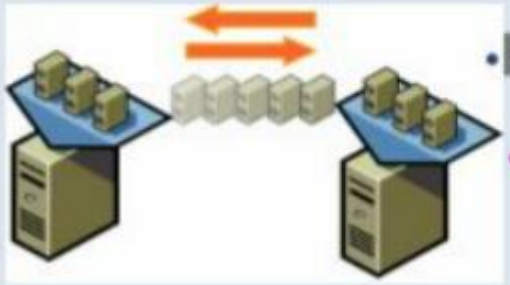
Karakteristik

- Partitioning
  - Run multiple operating systems on one physical machine
  - Divide system resources between virtual machines

- Isolation
  - Fault and security isolation at the hardware level
  - Advanced resource controls preserve performance



- Encapsulation
  - Entire state of the virtual machine can be saved to files
  - Move and copy virtual machines as easily as moving and copying files



- **Hardware-Independence/Compatibility**
  - Provision or migrate any virtual machine to any similar or different physical server