DATA CENTERS

A holistic view of the data center and the opportunities to enhance its infrastructure to meet current and future demands

COMMSCOPE®

Chapter 3
Data center topologies and architectures

# Data center topologies and architectures

Creating a blueprint for better data center performance

A data center networking architecture—the layout of the cabling infrastructure and the way servers are connected to switches—must strike a balance between reliability, performance, agility, scalability and cost. It must also support both current and future applications and speeds.

Key factors in selecting a data center architecture include:
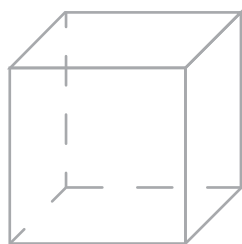
The size of the
current data center
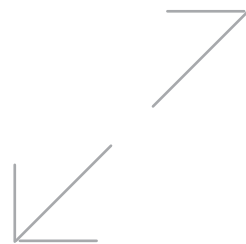
Anticipated growth of
the data center

Whether it's a new
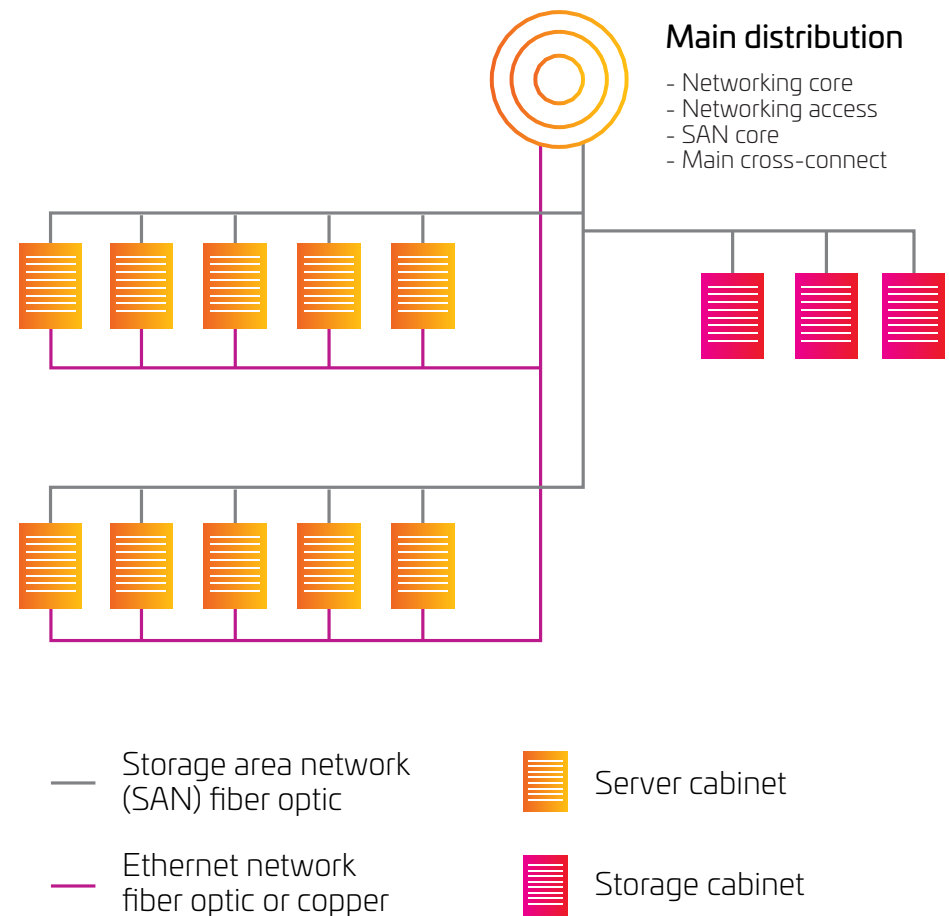installation or an upgrade
of a legacy system

TOPOLOGIES

There are three main data center topologies in use today—and each has its advantages and trade-offs. In fact, some larger data centers will often deploy two or even all three of these topologies in the same facility.

1. CENTRALIZED

The centralized model is an appropriate topologies for smaller data centers (under 5,000 square feet). As shown, there are separate local area network (LAN)/ storage area network (SAN) environments and each one has home run cabling that goes to each of the server cabinets and zones. Each server is effectively cabled back to the core switches, which are centralized in the main distribution area.
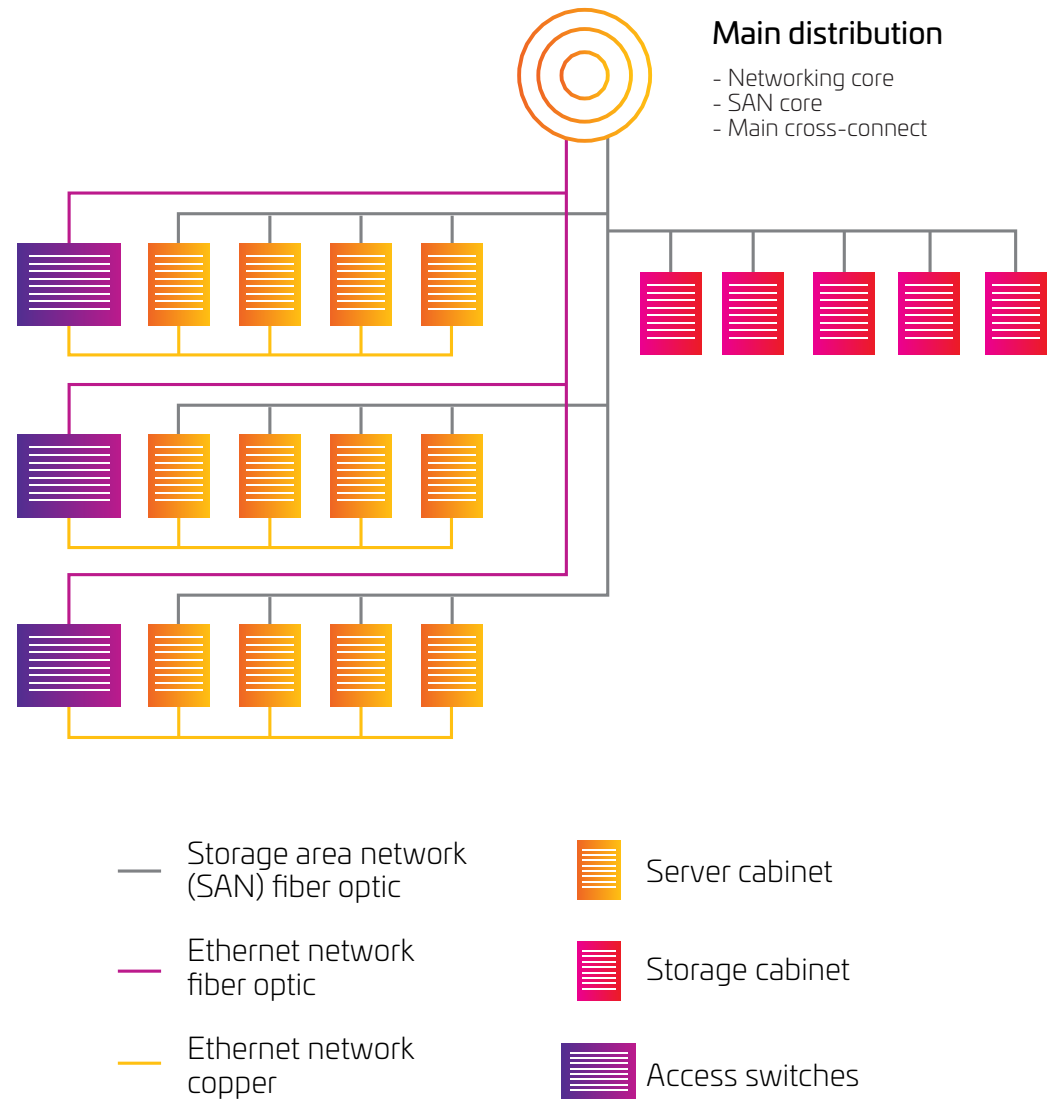
This provides very efficient utilization of port switches and makes it easier to manage and add components. The centralized topology works well for smaller data centers but does not scale up well, which makes it difficult to support expansions. In larger data centers, the high number of extended-length cable runs required causes congestion in the cable pathways and cabinets, and increases cost. While some larger data centers use zoned or top-of-rack topologies for LAN traffic, they may also utilize a centralized architecture for the SAN environments. This is especially true where the cost of SAN switch ports is high and port utilization is important.

Main distribution

- Networking core
- Networking access
- SAN core
- Main cross-connect

— Storage area network (SAN) fiber optic

— Ethernet network fiber optic or copper

Server cabinet

Storage cabinet

2. ZONED

Zoned topology consists of distributed switching resources. As shown below, the switches can be distributed among end-of-row (EoR) or middle-of-row (MoR) locations, with chassis-based switches typically used to support multiple server cabinets. This solution is recommended by the ANS/TIA-942 Data Center Standards and is very scalable, repeatable, and predictable. Zoned architecture is usually the most cost-effective design, providing the highest level of switch and port utilization while minimizing cabling costs.
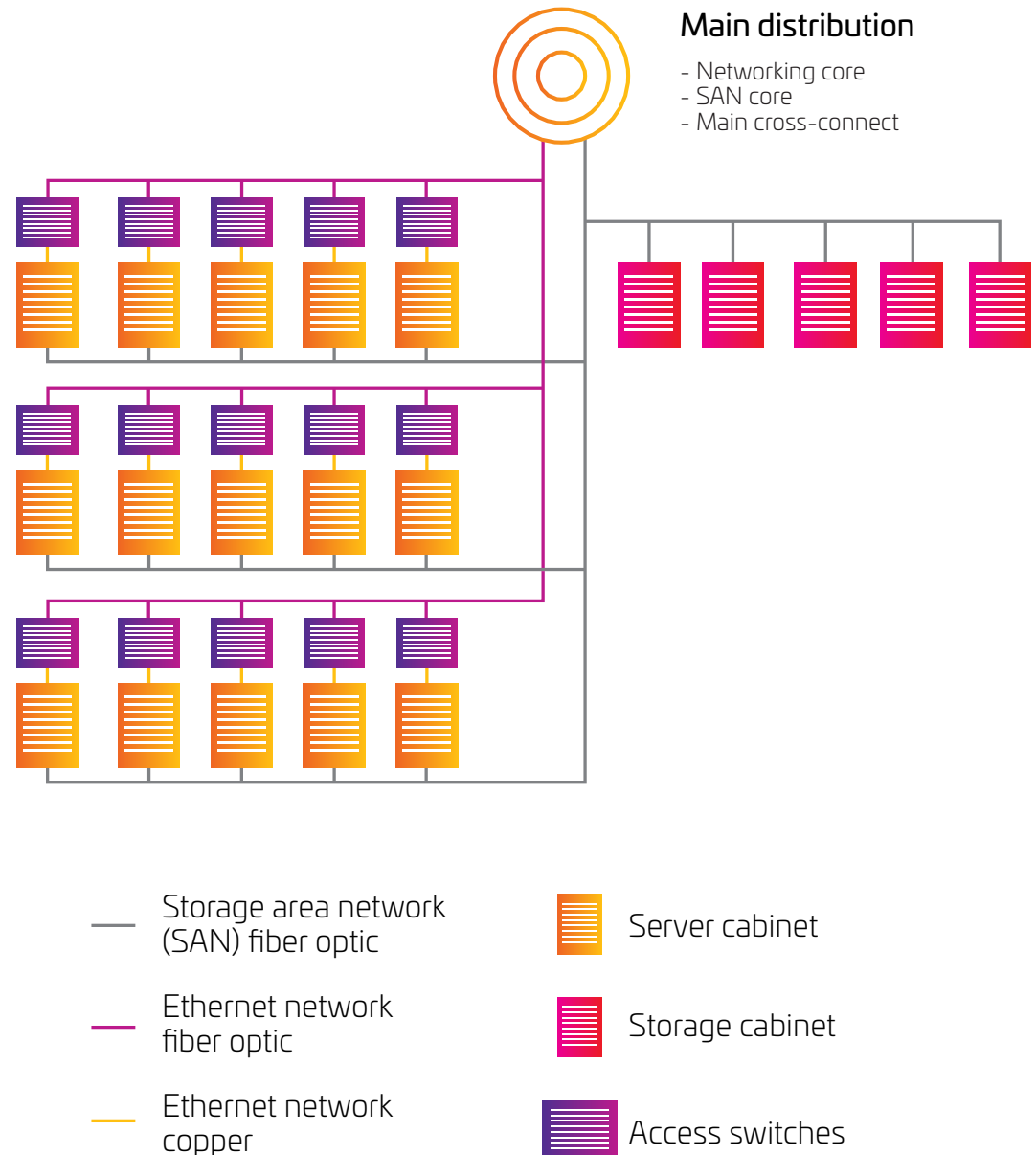
In certain scenarios, end-of-row switching provides performance advantages. For example, the local area network (LAN) ports of two servers (that exchange large volumes of information) can be placed on the same end-of-row switch, for low-latency port-to-port switching. A potential disadvantage of end-of-row switching is the need to run cable back to the end-of-row switch. Assuming every server is connected to redundant switches, this cabling can exceed what is required in top-of-rack architecture.

Main distribution

- Networking core
- SAN core
- Main cross-connect

___ Storage area network (SAN) fiber optic

___ Ethernet network fiber optic

___ Ethernet network copper

Server cabinet

Storage cabinet

Access switches

3. TOP OF RACK

Top-of-rack (ToR) switching typically consists of two or more switches placed at the top of the rack in each server cabinet, as shown below. This topology can be a good choice for dense one rack-unit (1RU) server environments. All servers in the rack are cabled to both switches for redundancy. The top-of-rack switches have uplinks to the next layer of switching. Top of rack significantly simplifies cable management and minimizes cable containment requirements. This approach also provides fast port-to-port switching for servers within the rack and predictable oversubscription of the uplink.
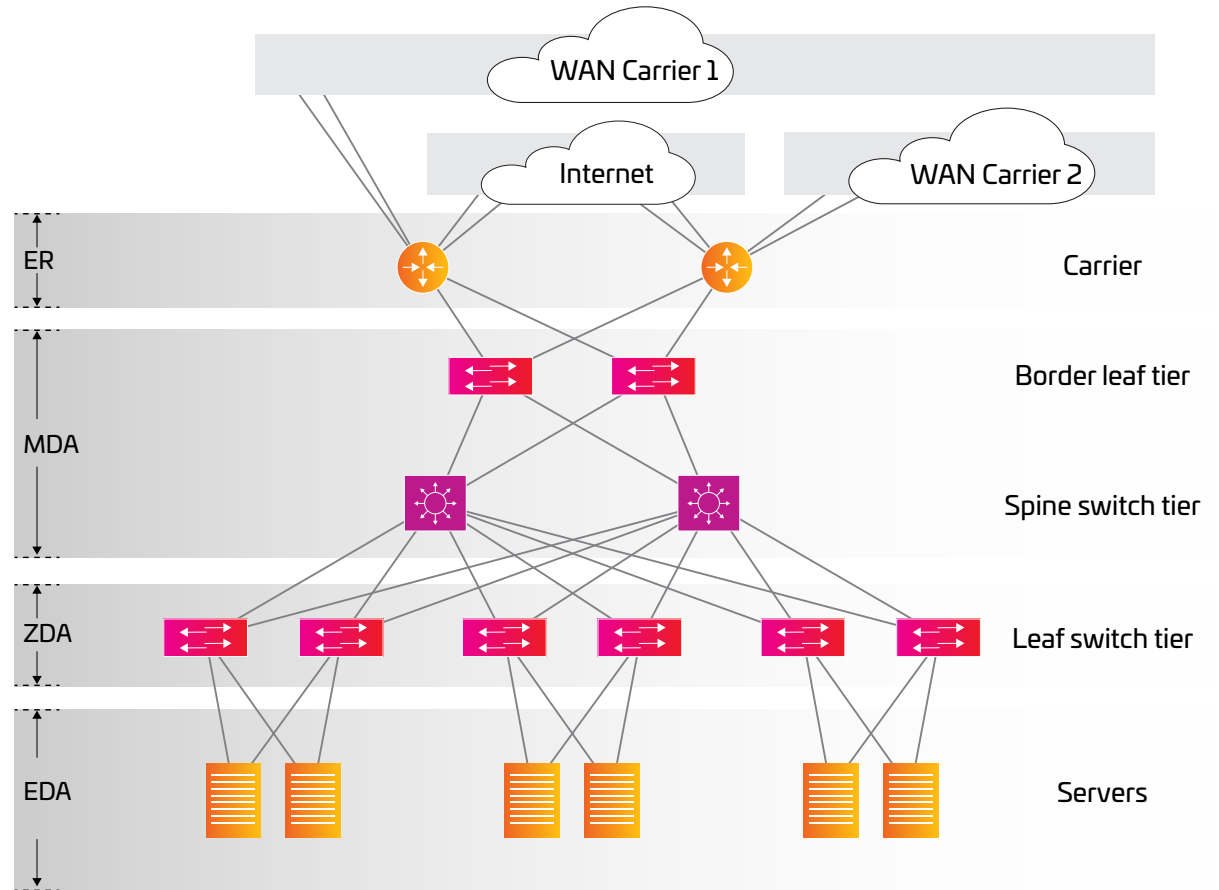
A top-of-rack design utilizes cabling more efficiently. The tradeoffs are often an increase in the cost of switches and the high cost for under-utilization of ports. Top-of-rack switching may be difficult to manage in large deployments, and there is also the potential for overheating of local area network (LAN) switch gear in server racks. As a result, some data centers deploy top-of-rack switches in a middle-of-row or end-of-row architecture to better utilize switch ports and reduce the overall number of switches used.

Main distribution

- Networking core
- SAN core
- Main cross-connect

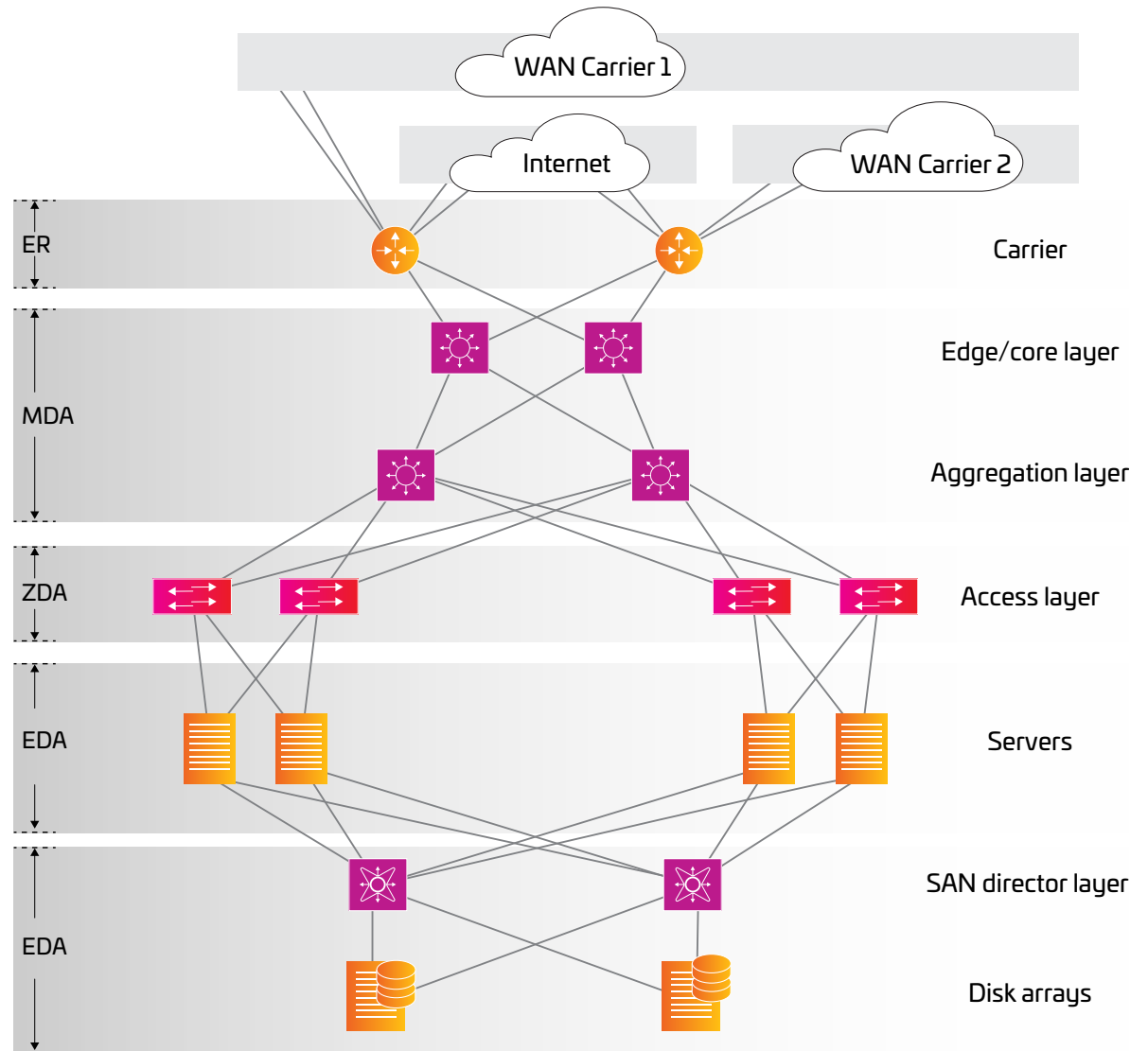|	Storage area network (SAN) fiber optic		Server cabinet
	Ethernet network fiber optic		Storage cabinet
	Ethernet network copper		Access switches

ARCHITECTURES

1. MESH NETWORK

The mesh network architecture, often referred to as a "network fabric," or leaf-spine, consists of meshed connections between leaf-and-spine switches. The mesh of network links enables any-to-any connectivity, with predictable capacity and lower latency—making this architecture well suited for supporting universal "cloud services." With multiple switching resources spread across the data center, the mesh network is inherently redundant for better application availability. These distributed network designs can be much more cost-effective to deploy and scale when compared to very large, traditional centralized switching platforms.

WAN Carrier 1

Internet   WAN Carrier 2

ER   Carrier

MDA   Border leaf tier

Spine switch tier

ZDA   Leaf switch tier

EDA   Servers

2. THREE-TIER OR MULTI-TIER MODEL

The multi-tier architecture has been the most commonly deployed model used in the enterprise data center. This design consists primarily of web, application and database server tiers running on various platforms, including blade servers, 1RU servers and mainframes.

WAN Carrier 1

Internet   WAN Carrier 2

ER   Carrier

Edge/core layer

MDA   Aggregation layer

ZDA   Access layer

EDA   Servers

SAN director layer

EDA   Disk arrays
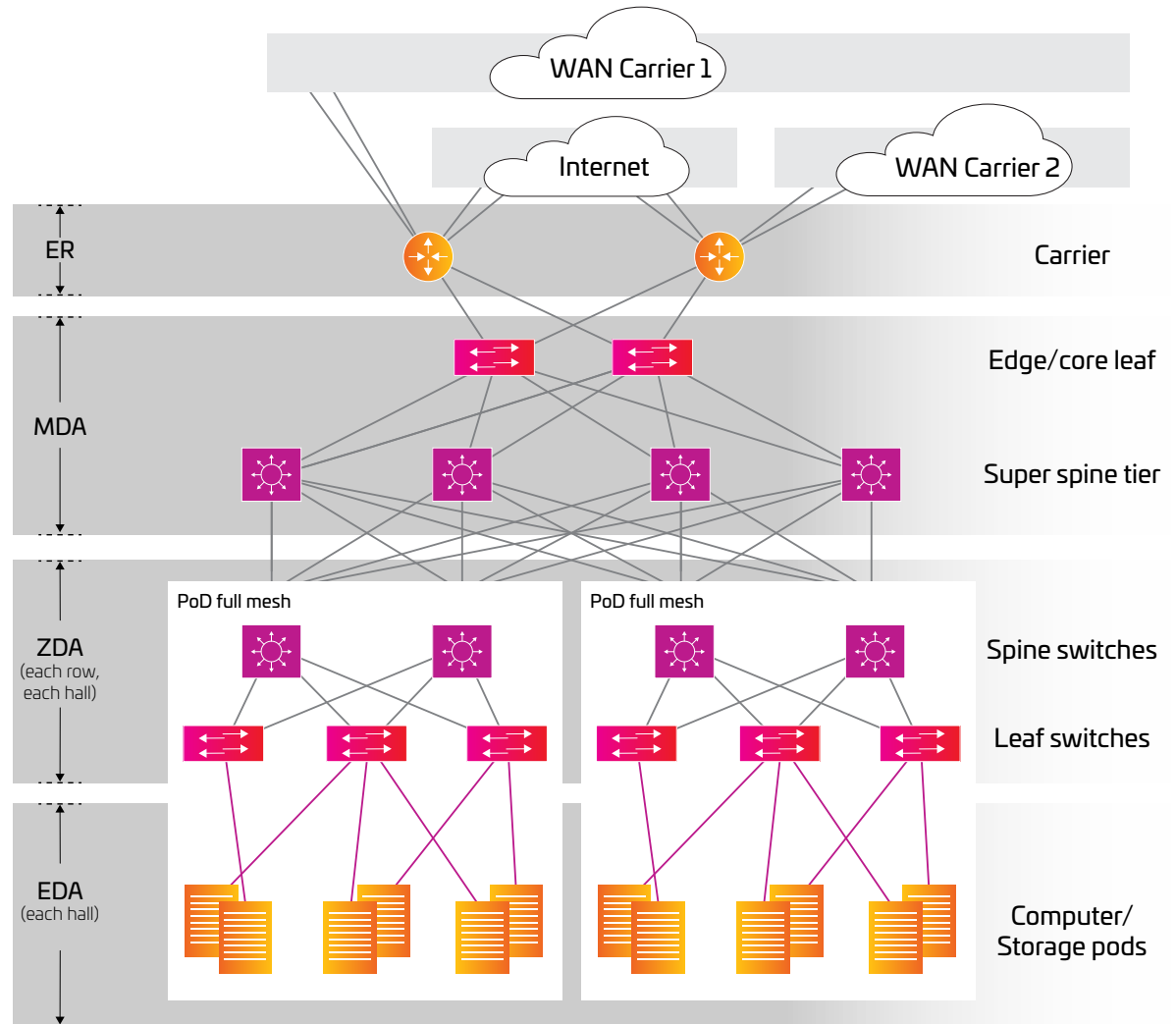
3. MESH POINT OF DELIVERY (PoD)

The mesh point of delivery (PoD) architecture features multiple leaf switches interconnected within in the PoDs, with spine switches typically aggregated in a central main distribution area (MDA). Among other advantages, this architecture enables multiple PoDs to connect efficiently to a super-spine tier. Data center managers can easily add new infrastructure to their existing three-tier topology to support the low-latency east-west data flow of new cloud applications. Mesh PoD networks can provide a pool of low-latency compute and storage for these applications that can be added without disrupting the existing environment
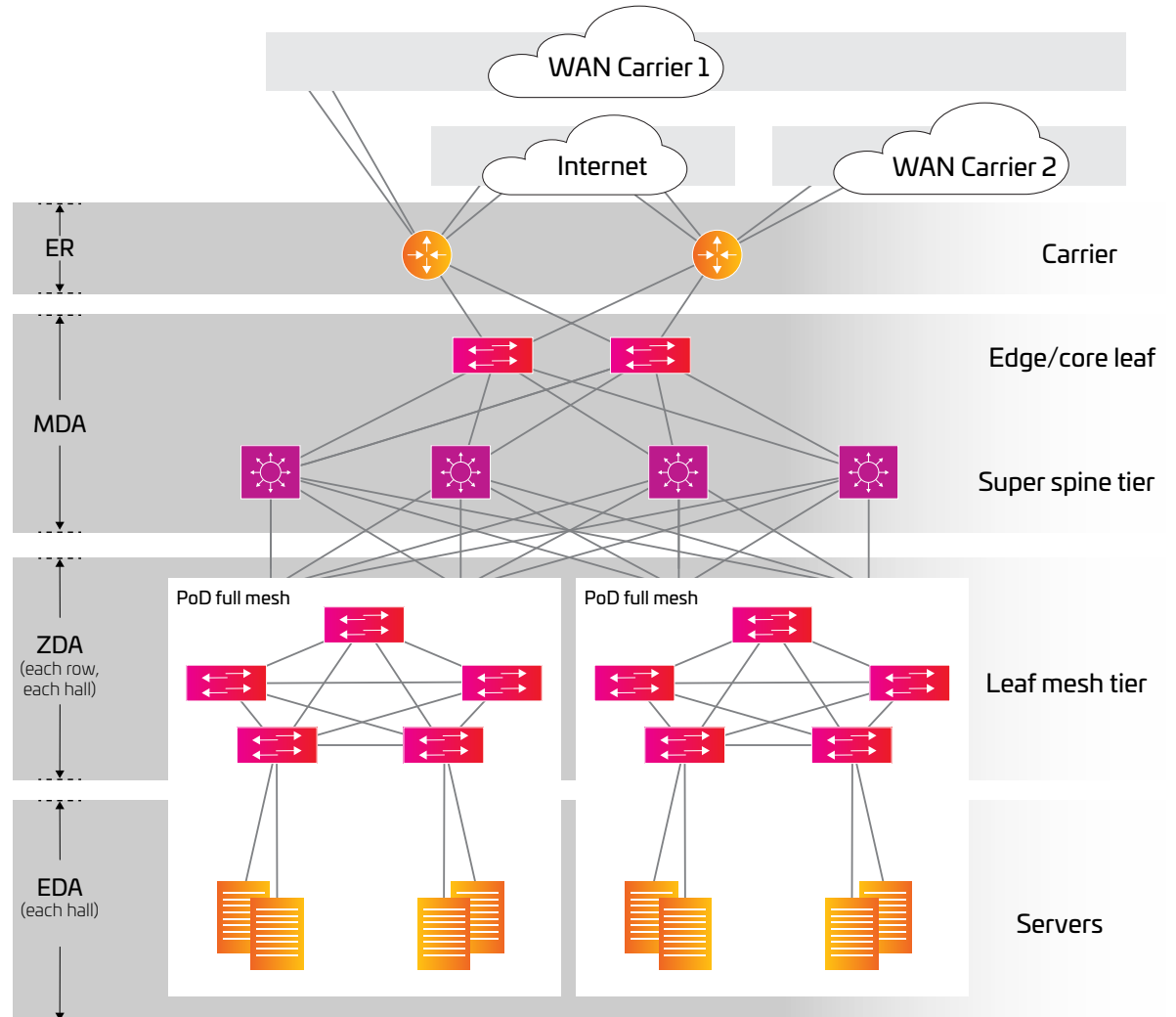
4. SUPER SPINE MESH

Super spine architecture is commonly deployed by hyperscale organizations deploying large-scale data center infrastructures or campus-style data centers.

This type of architecture services huge amounts of data passing east to west across data halls.


ER		Carrier
MDA		Edge/core leaf
		Super spine tier

WAN Carrier 1
Internet
WAN Carrier 2

ZDA
(each row,
each hall)

EDA
(each hall)

PoD full mesh   PoD full mesh

Spine switches

Leaf switches

Computer/
Storage pods

— Ethernet link   — Ethernet / FCoE link

Data center equipment connection methods

There are two methods typically used to connect data center electronics via structured cabling: cross-connect and interconnect.
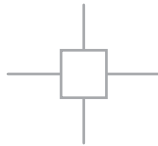
Cross-connect

A cross-connect uses patch cords or jumpers to connect cabling runs, subsystems and equipment to connecting hardware at each end. It enables connections to be made without disturbing the electronic ports or backbone cabling. A cross-connect provides excellent cable management and design flexibility to support future growth. Designed for "any-to-any" connectivity, this model enables any piece of equipment in the data center to connect to any other regardless of location. A cross-connect also offers operational advantages, as all connections for moves, add and changes are managed from one location. The major disadvantage is higher implementation costs due to increased cabling requirements.
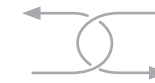
Interconnect

An interconnect uses patch cords to connect equipment ports directly to the backbone cabling. This solution requires fewer components and is, therefore, less expensive. However, it reduces flexibility and introduces additional risk, as users must directly access the electronics ports in order to make the connection. Therefore, CommScope generally recommends utilizing cross-connects for maximum flexibility and operational efficiency in the data center.
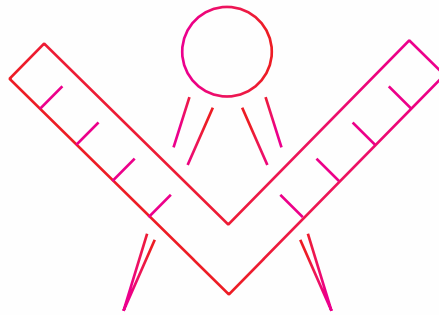
Architecture for a higher-speed future

With newer technologies—25/50/100GbE, 32G and 128G Fibre Channel—
limitations on bandwidth, distance and connections are more stringent than with lower-speed legacy systems.
In planning the data center's local area network (LAN)/storage area network (SAN) environment, designers must
understand the limitations of each application being deployed and select an architecture that will not only support current
applications but also have the ability to migrate to higher-speed future applications.

COMMSCOPE®

Data Center Best Practices
A holistic view of the data center and its infrastructure challenges

Authored by CommScope's data center experts, this eBook is intended to advise those responsible with building an enterprise data center on how to best evaluate important data center decisions, with an in-depth emphasis on choices related to the physical layer infrastructure. Since all the upper layers in the OSI model ("stack")—from the network to the applications themselves—rely on the physical layer, it is essential that it is designed to meet the needs of the data center both now and in the future.

Explore the chapters below to find out tips, answers and insights to demystify the technology, untangle the com plexity and accelerate time to market so you can identify the challenges —and opportunities—in your own data center.

For more information on enhancing your data center, reach out to one of our experts now.

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We collaborate with our customers and partners to design, create and build the world's most advanced networks. It is our passion and commitment to identify the next opportunity and realize a better tomorrow.
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