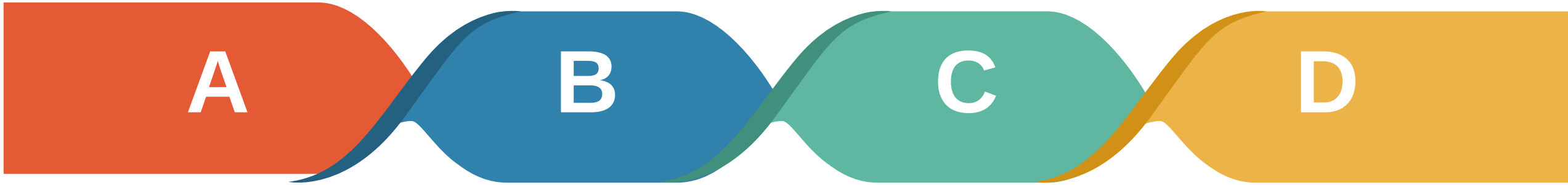
The features, hardware, and architectures of data center networks: A survey

Reporter: Liu Yu Jie

2019-05-28

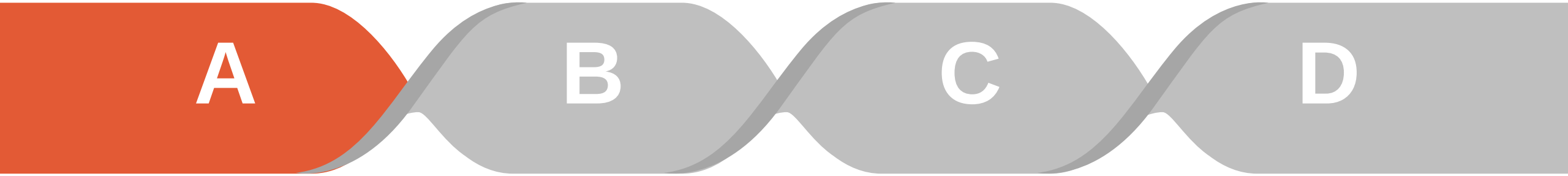


An overview of production data centers

Hardware of data center networks

Architectures of data center networks

Summary



A. An overview of production data centers

B. Hardware of data center networks

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D. Summary

Representative data center image

(a)

(b)

(c)

The size of data centers.

Size	Covering area (ft2)	Examples
Huge	More than 100,000	Microsoft Quincy
Large	20,000 to 100,000	Oracle Austria
Medium	5000 to 20,000	Sinopec group
Small	2000 to 5000	SJTU

Modular data centers

(a)

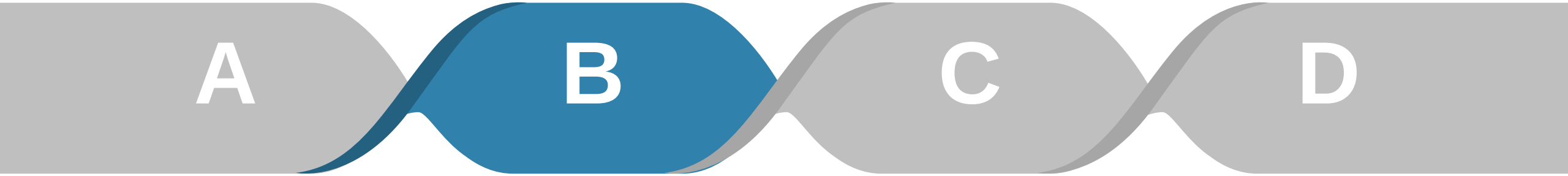
(b)

(c)

Green data centers

A green DC is an energy efficiency DC, which employs energysaving technologies (e.g. modular design, advanced power unit), green management, and renewable resources.

名称	PUE
HP EcoPOD数据中心	1.05
Facebook Prineville数据中心	1.07
雅虎纽约数据中心	1.08
Capgemini Merlin模块化数据中心	1.08
Google Saint-Ghislain数据中心	1.16
Microsoft Dublin数据中心	1.25



An overview of production data centers

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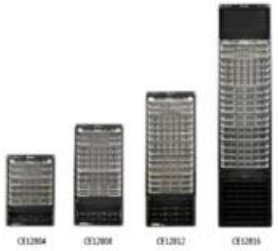
Architectures of data center networks

Summary

Switch

(a) Cisco Nexus 7000 series data center switches.



(b) Cloud Engine 12 800 series high-performance switches.

(c) RG-N18000 series data center switches.

(d) Arista 7500E series data center switches.

(e) Cisco Nexus 3064 series switches.

(f) Arista 7050QX series data center switches.

The performance parameters of switches.

Name	Switching capacity (Tbps)	Forwarding performance	Number of line-speed ports
Cisco Nexus 7000 Series	17.6[a]	1.44–11.5 bpps[b]	32 100 GbE[c], 192 40 GbE or 768 10 GbE
Huawei CloudEngine 12 800 Series	16–64	4.8–19.2 bpps	96 100 GbE, 288 40 GbE or 1152 10 GbE
Ruijie RG-N28000 Series	32–96	11.5–17.3 bpps	96 100 GbE, 288 40 GbE or 1152 10 GbE
Arista 7500E Series	Over 30	up to 14.4 bpps	96 100 GbE, 288 40 GbE or 1152 10 GbE
Cisco Nexus 3064 Series	1.28	950 mpps	48 10 GbE or 4 40 GbE
Arista 7050QX Series	2.56	1.44 bpps	96 10 GbE or 8 40 GbE

[a] Tbps = Terabits per second.
[b] bpps = billion packets per second.
[c] GbE = Gigabit Ethernet.

Server

Tower servers : first used in DC’s, of which the shape and performance are larger and several times higher than those of a PC

Rack servers : the mainstream servers used in modern DCN’s. A rack server is a standard space-saving and maintainable host placed in a rack

Blade servers: e blade-like, low-cost High Availability, High Density servers designed for applications in communication, military, medical, and so on

Storage

NAS : a file-oriented storage systems

SAN :a high-speed storage network

The performance parameters of storage systems.

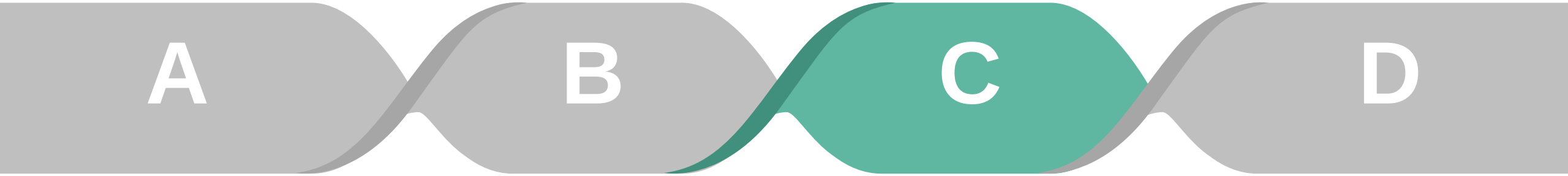
Name	Storage type	Storage capacity (PB)	Cache capacity
EMC VMAX 40 K	SAN	4	2 TB
HP StoreServ	SAN	3.2	768 GB
Huawei OceanStore	NAS	15	192 GB
NetApp FAS6200	SAN or NAS	4	1 TB
IBM System Storage	SAN or NAS	5	192 GB

New trend: The distributed storage systems & SDS

Rack & Cable

Rack : support server, switch, and storage devices for easy management

Cable: interconnect the other components and transport electricity



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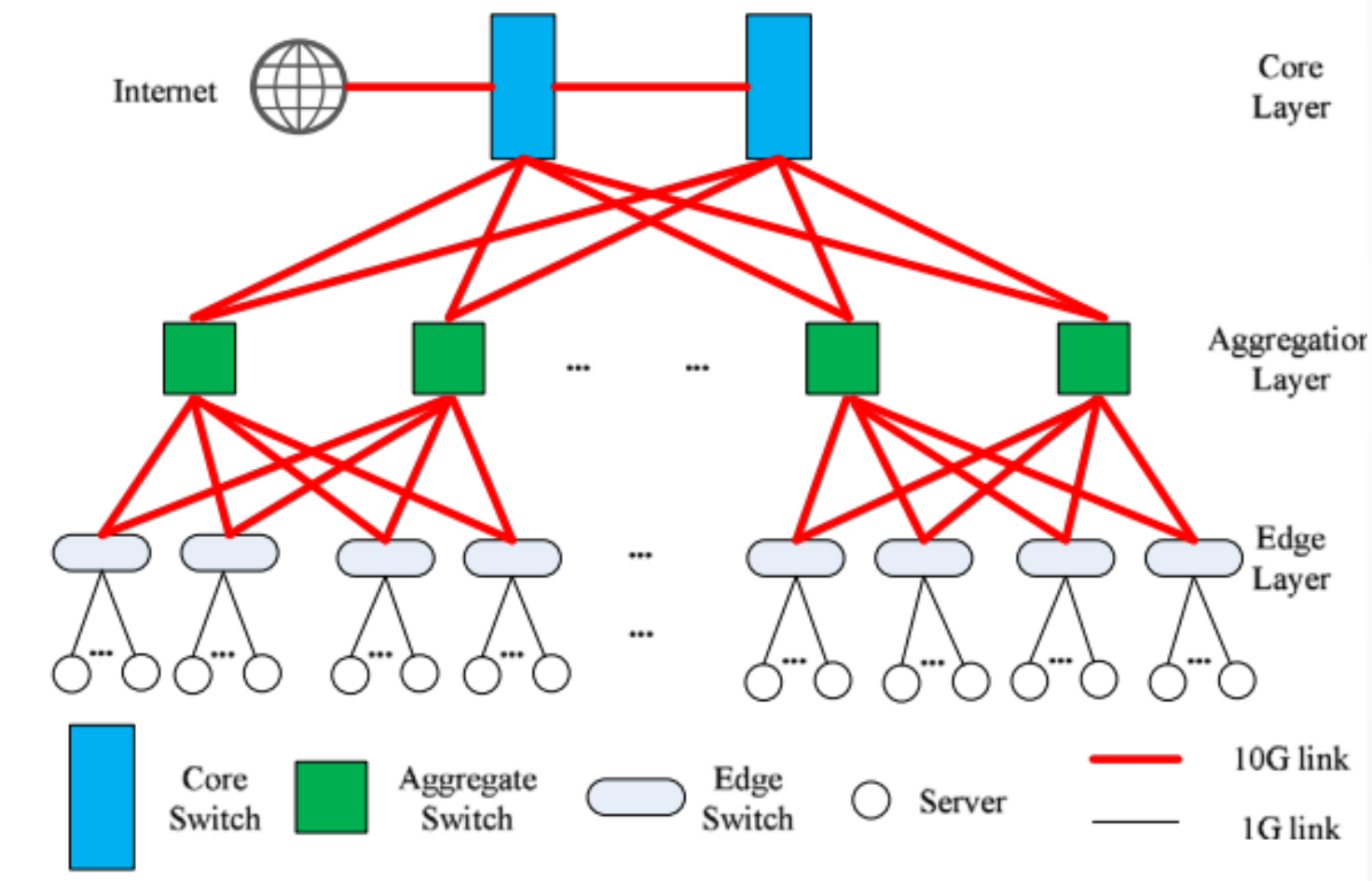
traditional DCN



Disadvantage:

- Limited bandwidth
- Poor flexibility
- Low utilization
- Complex cabling

The modern DCN

Switch-centric architectures

- Tree-like switch-centric architectures
- Flat switch-centric architecture

Server-centric architectures

- Server-centric architectures for mega DC’s
- Server-centric architectures for modular DC's

Enhanced architectures

- Optical architectures
- Wireless architectures

Switch-centric architectures

Tree-like switch-centric architectures

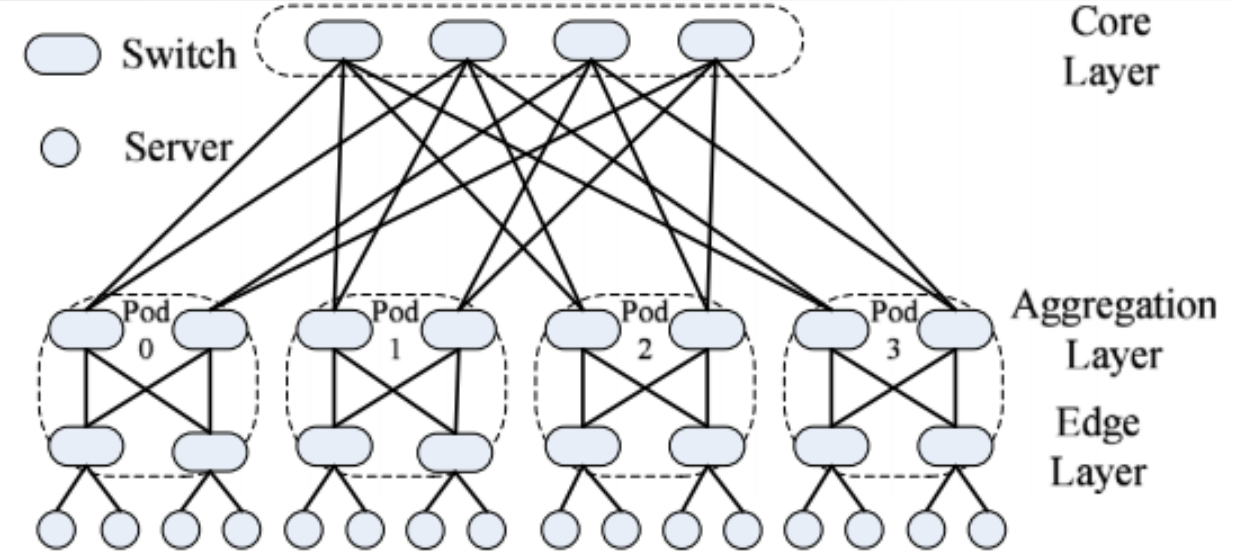


Fig. 13. A fat-tree architecture ($k = 4$).

Advantage:

balanced traffic loads
robust fault-tolerance
multi-routing capabilities

Disadvantage:

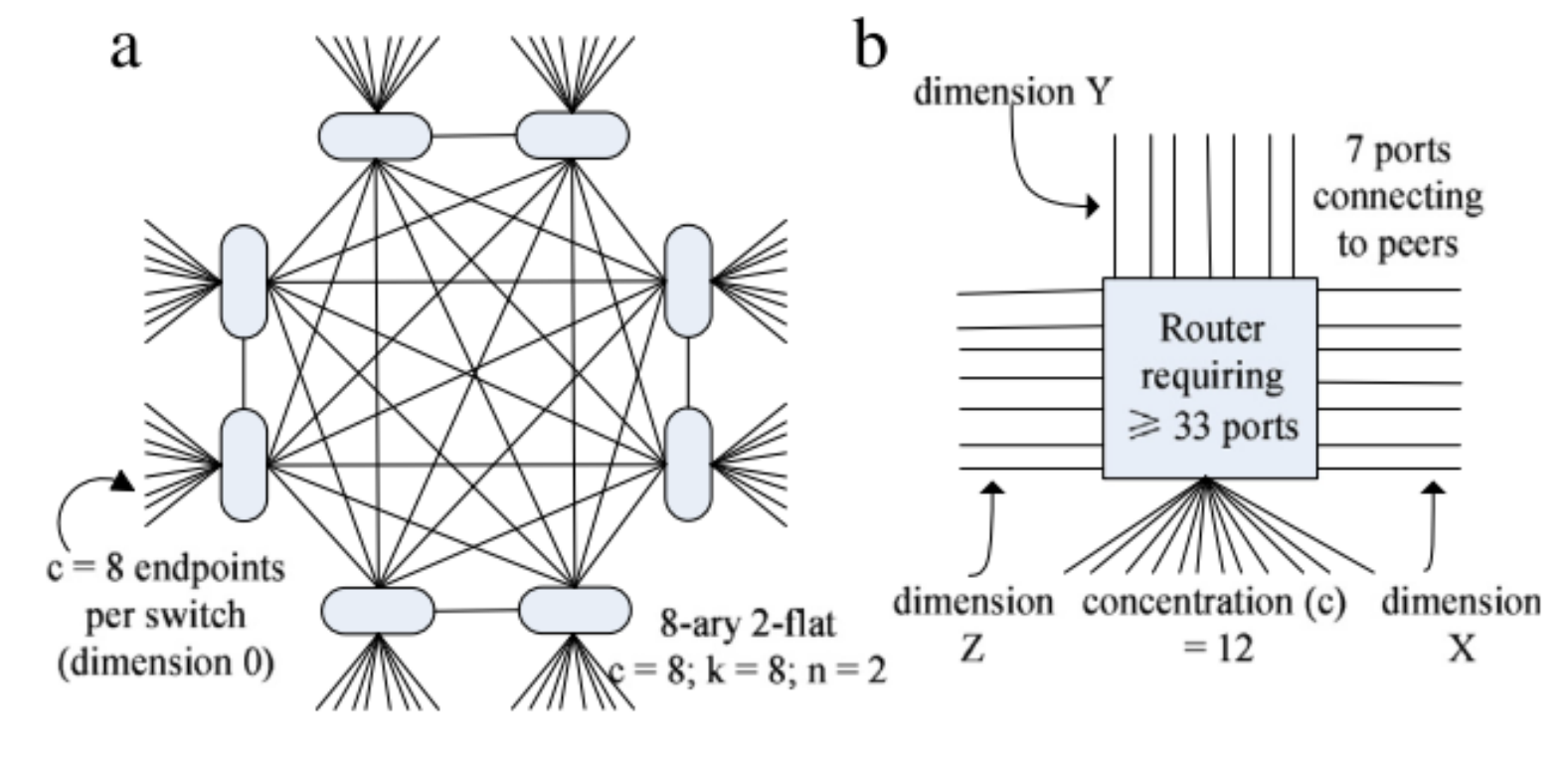
cabling complexity and constrain the network scalability.

the security and fault tolerance of commodity switches are poor

Switch-centric architectures

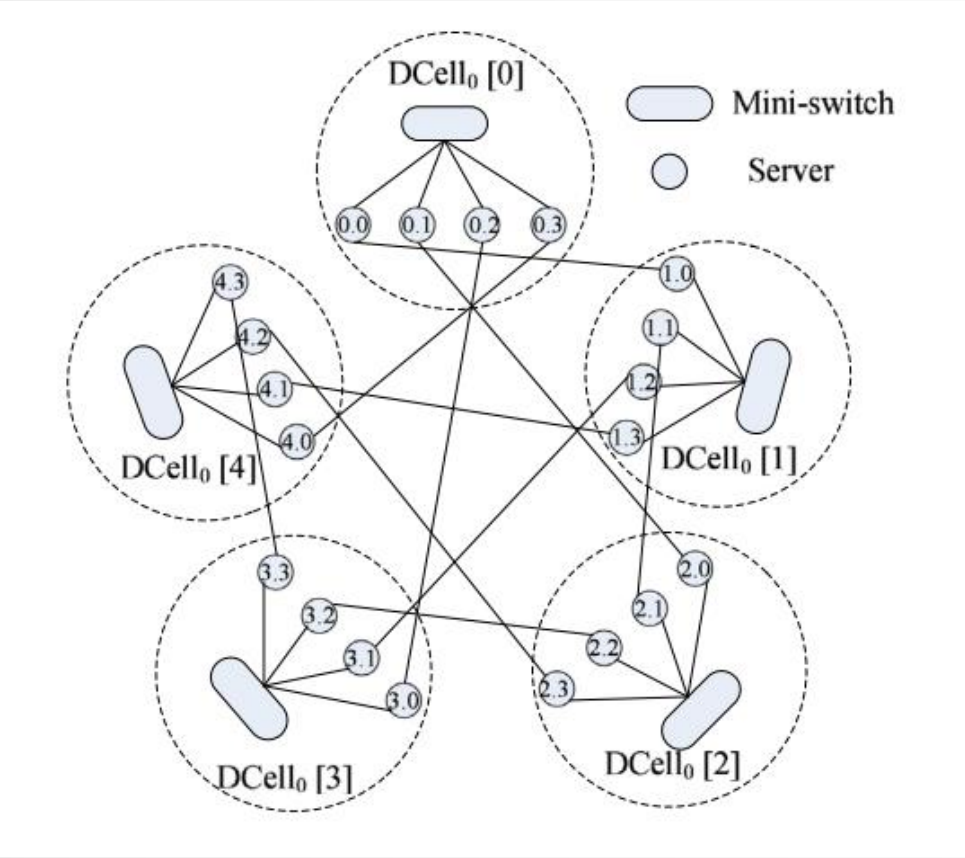
Flat switch-centric architecture

FBFLY:



Server-centric architectures

Server-centric architectures for mega DC's



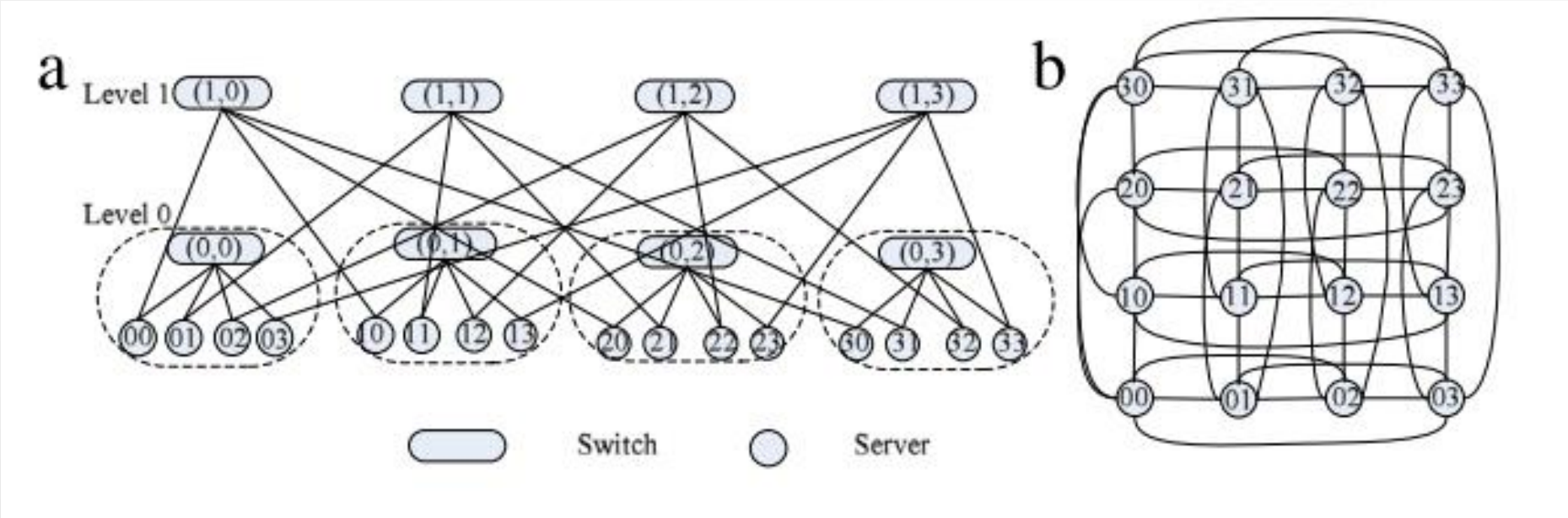
significantly handle a shape increase in servers

the cabling complexity would beextremely high as the level increases.

Server-centric architectures

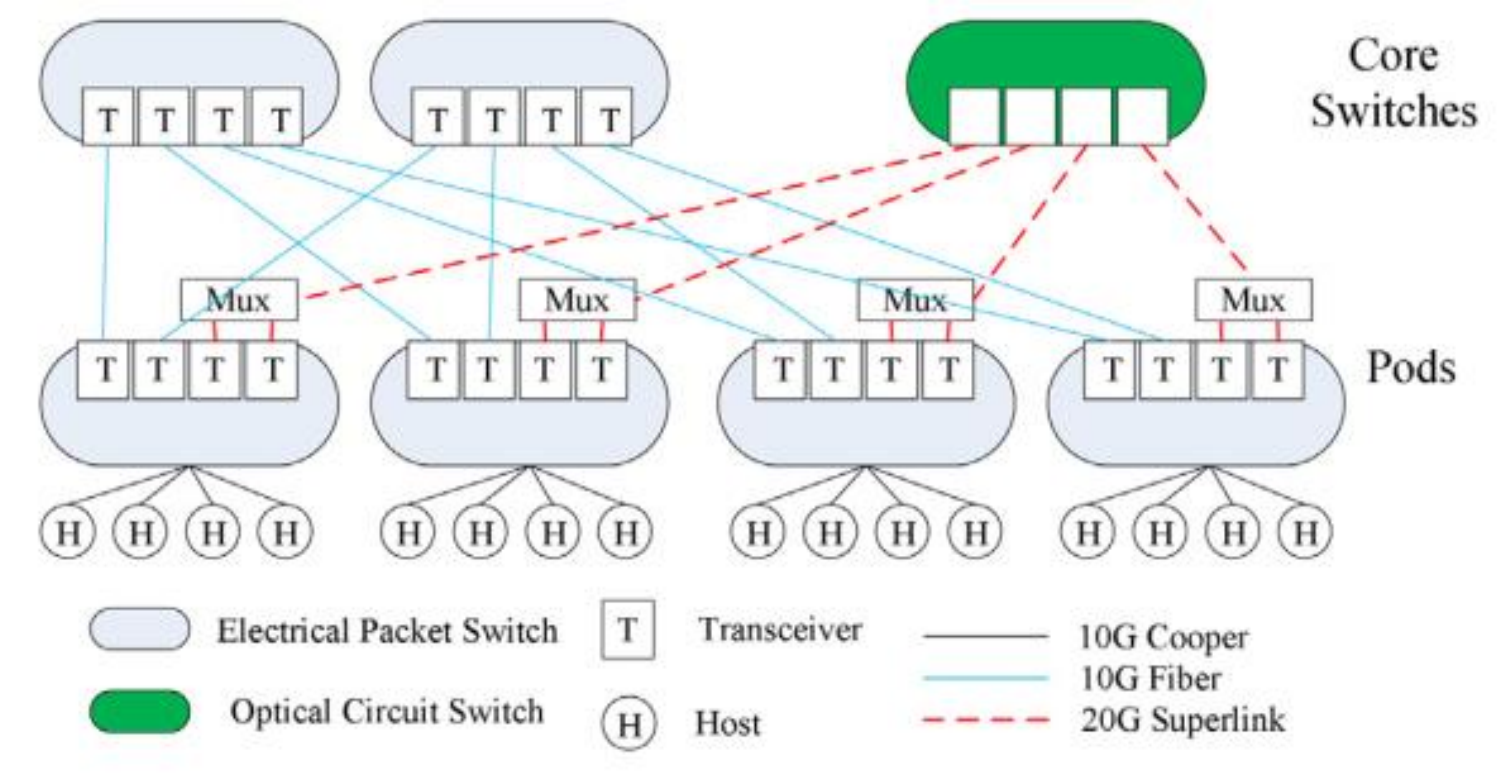
Server-centric architectures for modular DC's

*Bcube:*a low latency, full bandwidth architecture specifically for MDC's



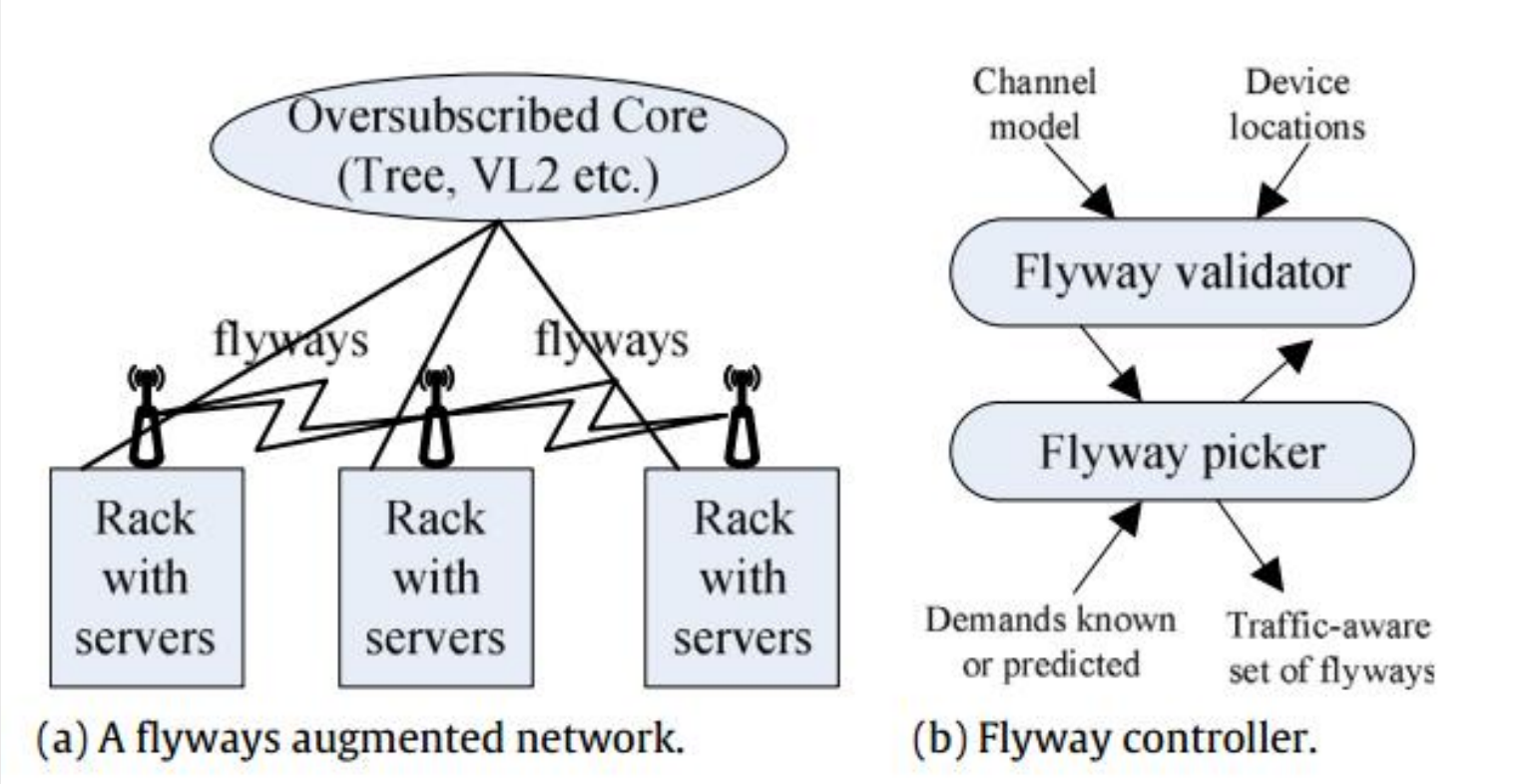
Enhanced architectures

Optical architectures



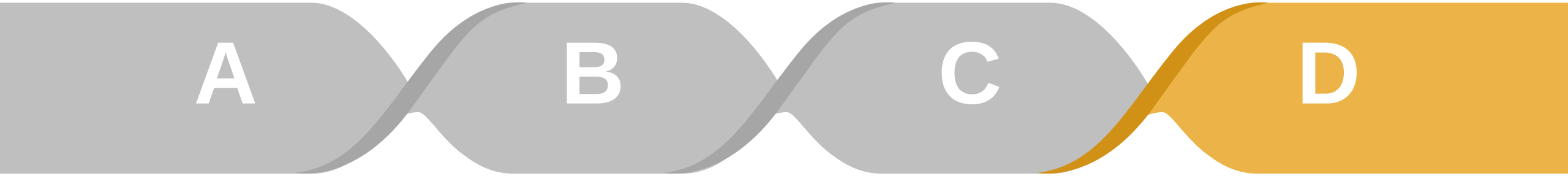
Enhanced architectures

Wireless architectures



(a) A flyways augmented network.

(b) Flyway controller.



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