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[Networking - Software]

Software Defined Fabric for OCP-based Leaf & Spine Switches

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Problems with Data Center Networking

- **Lacks automation:** Too labor-intensive and error-prone
- **Lacks programmability:** Prevents developers from driving innovation and customers from adding new services and features themselves
- **Not scalable** to sustain emerging applications and evolving infrastructures
- **Too expensive** and doesn't leverage white boxes
- **Lacks openness:** Tightly integrated HW and SW, proprietary APIs
- High end-to-end **latency**
- Unable to guarantee isolated virtual **networking slices**
- Lacks proper support for **IPv6**
- **Resource-inefficient:** power, compute, networking resources, engineering personnel

Open Networking

Standards-based

NETWORKING

Standard Linux-based

- No kernel patches
- Updates in tandem with compute and storage
- Interfaces towards widely deployed orchestration systems and **SDN controllers**
- Plugins for OpenStack, Kubernetes, and OpenDaylight

Open APIs

- NETCONF API based on YANG models

Open-source friendly

- Contributing improvements upstream to Linux and Kubernetes

Open networking support

- No vendor lock-in
- White box friendly
  - Certified with switches from multiple ODMs

Open Networking HW

NETWORKING

- **Disaggregate** the appliance model
  - Separate SW from HW
- Challenges are **standardization** to drive adoption
  - OCP is becoming the leading standard for DC networking
  - $2.5 billion market today (excluding FB and MS), and will grow to $10 billion in three years
- **Commoditizes the networking HW** to drive down cost
  - Commoditizes the networking chipsets, white boxes and PODs

Open Hardware Example

Wedge100BF-32Q/65X Switch Bare Metal Switch from EdgeCore

- OCP Accepted, cost-effective, bare-metal switch infrastructure for data center fabric
- Designed with programmable Tofino switch silicon from Barefoot Networks and XEON-D host processor
- Deploys as Leaf or Spine switch supporting 10GbE, 25 GbE, 50GbE,or 100GbE ports
- Layer 2 or Layer 3 forwarding of 3.2/6.4 Tbps (full duplex)
- Hot-swappable, load-sharing, redundant AC or 48V DC PSUs
- 5/10 redundant, hot-swappable fan modules

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OCP Accepted Switch example

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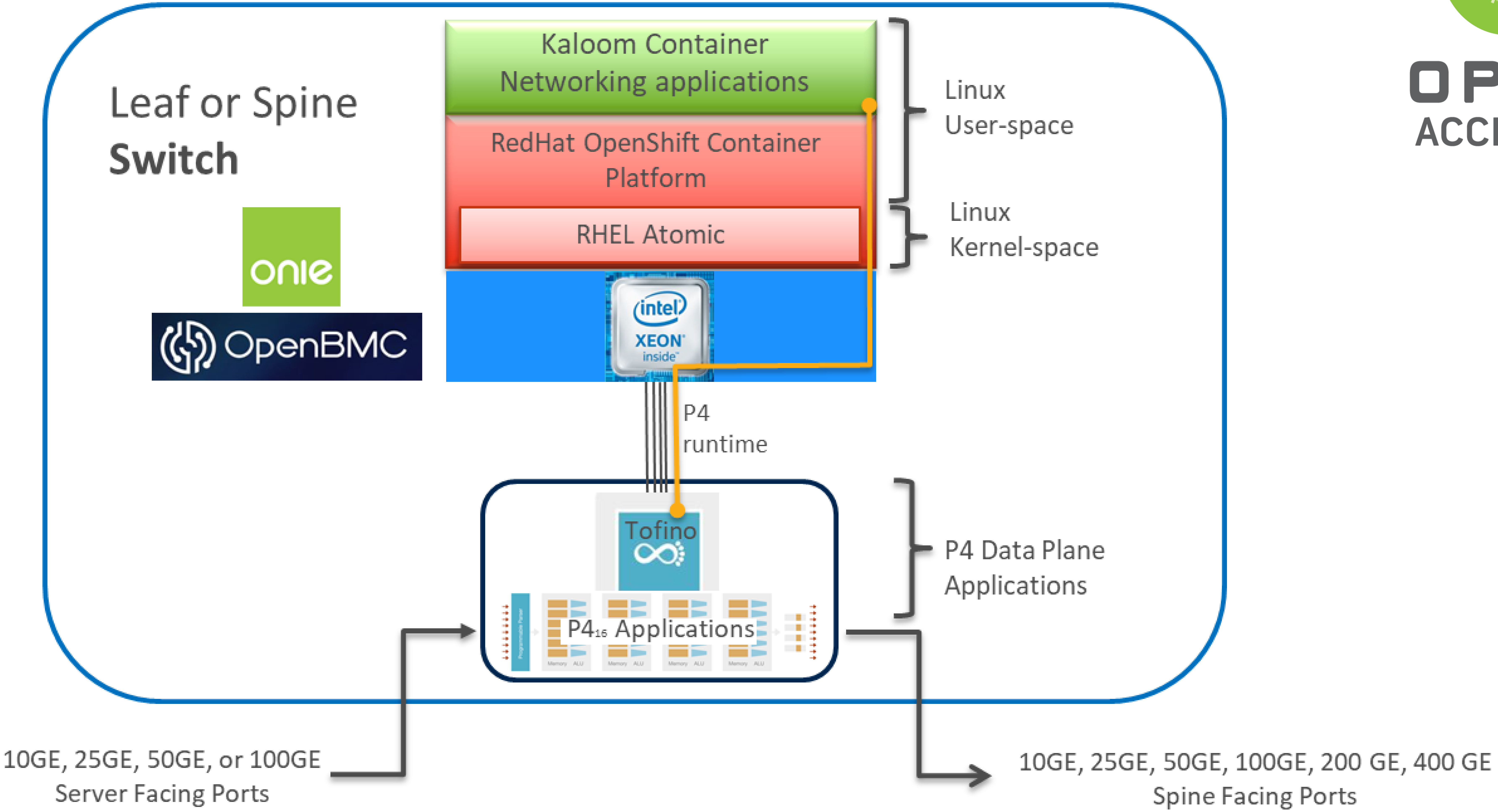


Leaf or Spine
Switch
onie
OpenBMC
Kaloom Container Networking applications
RedHat OpenShift Container Platform
RHEL Atomic
intel XEON inside
P4 runtime
Tofino
P4₁₆ Applications
Linux User-space
Linux Kernel-space
P4 Data Plane Applications
10GE, 25GE, 50GE, or 100GE Server Facing Ports
10GE, 25GE, 50GE, 100GE, 200 GE, 400 GE Spine Facing Ports

One System Management Approach

Server like Management

	Application Servers	Storage Servers	Leaf Switches	Spine Switches	Fabric Controllers
Remote System Management	OpenBMC DMTF Redfish	OpenBMC DMTF Redfish	OpenBMC DMTF Redfish	OpenBMC DMTF Redfish	OpenBMC DMTF Redfish
Network Install	iPXE	iPXE	onie iPXE	onie iPXE	iPXE
Operating System	redhat Enterprise Linux CoreOS	redhat Enterprise Linux CoreOS	redhat Enterprise Linux CoreOS	redhat Enterprise Linux CoreOS	redhat Enterprise Linux CoreOS

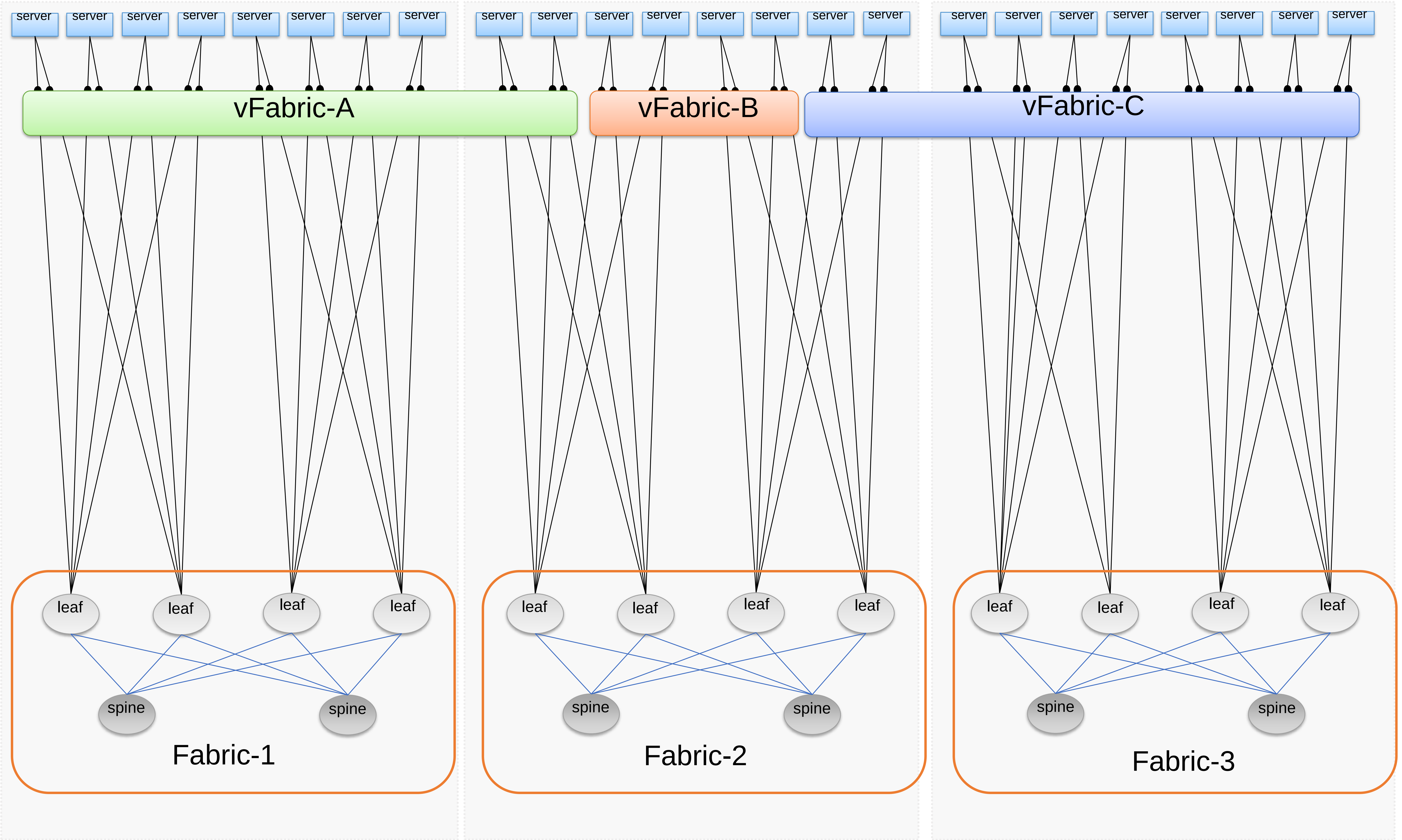
No need for a specialized Linux distribution for switches

Feature	Traditional Networking OS	RHEL CoreOS
Un-modified Linux Kernel capable of supporting Secure-boot	NO	YES
Install via ONIE	YES	YES
Minimum Linux Footprint	NO (> 4GB DDR)	YES (>1GB DDR - lightweight)
Automatic SW Upgrade with Rollback	NO	YES (RPM_OSTREE)
Based on SE-Linux	No… for most of them	YES (Secure)
Optimized for containers	NO	YES
DevOps env	NO	YES

Fabrics (physical DC) vs vFabrics (virtual DC)

Elastic Network Virtualization and slicing

- A vFabric is **a fully elastic isolated network** domain
  - Provisioned in software
  - Collection of termination points towards WAN and servers
- A vFabric is a **logical switch**
  - Delivers integrated NW services
  - Can be part of a virtual data center (vDC)
- A vDC operator offers **cloud services**
  - Can host millions of cloud service users (e.g. tenants)



Why a programmable data plane?

- It takes too long for the introduction of new functions on traditional fixed functions Ethernet ASICs

- Because there are too many needed functions not supported on current fixed functions Ethernet ASICs
  - Virtual datacenters (e.g. vFabric): Complete isolated broadcast domain
  - In-band Network Telemetry
  - Segment Routing IPv6
  - Geneve (e.g. 24 bits and 32 bits ID)
  - GPRS Tunneling Protocol user-plane for 4G and 5G
  - Etc...

- Because data center operators don’t want to replace hardware to introduce new network capabilities
  - Needs network versioning using slicing

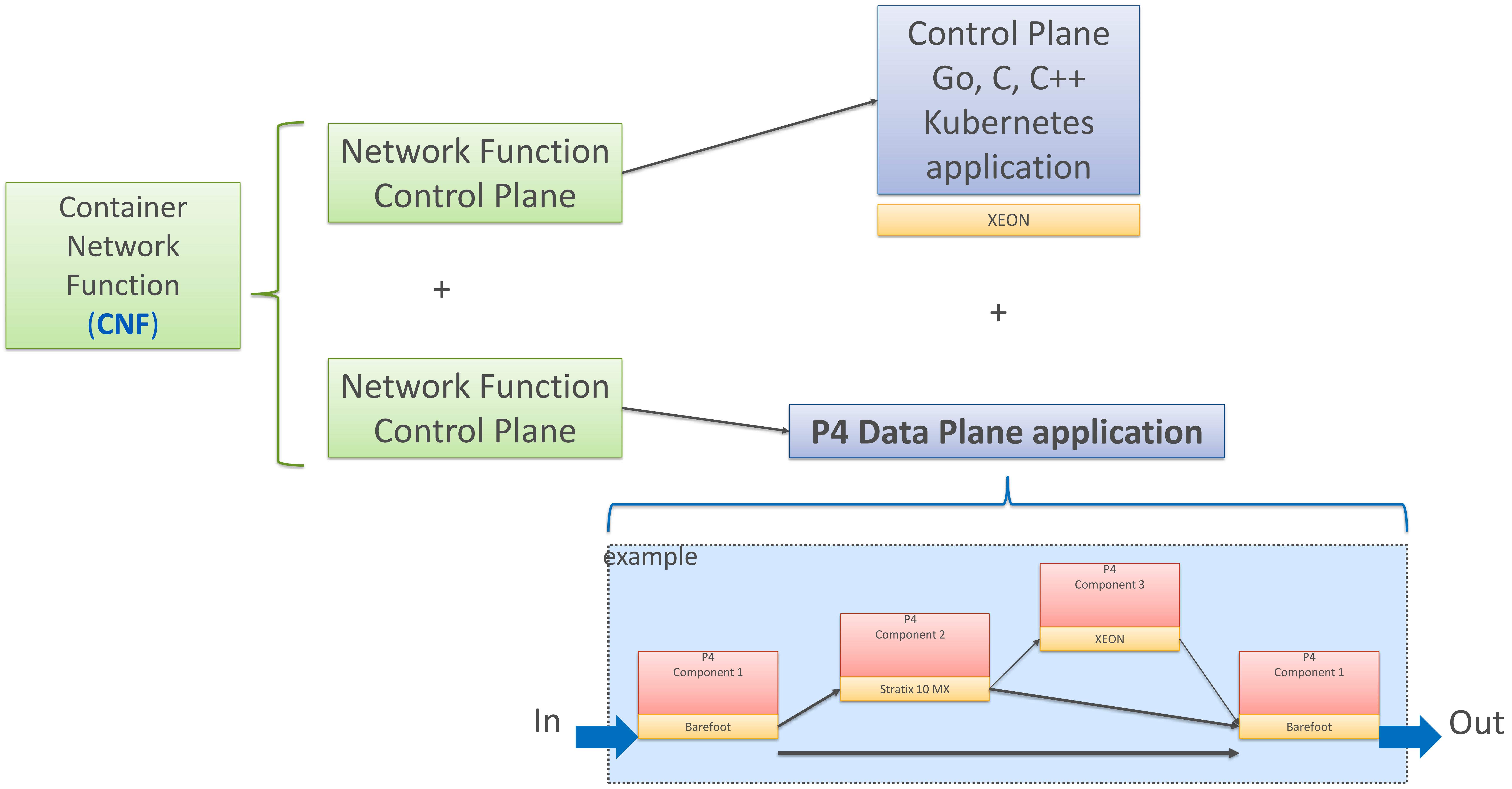
What is P4 and why it matters?

- A high-level programming language intended for packet processors
- Packet processors include Programmable ASICs such as Barefoot Tofino, FPGAs, and CPUs such as Intel XEON
- Keeps the programming language independent of the hardware
  - Contributes to the portability of data plane applications
- P4 is meant to describe/specify the behavior of the data plane application but not how the data plane is actually implemented

Main issues with data plane application

- CPUs introduce **too much latency** for incoming 5G Networks
- CPUs provide **too low throughput** for packet processing applications executing on XEON processors simultaneously serving large number of connected 4G and 5G devices
  - Operators requirement: Over 500K devices/sessions per dual sockets servers
  - Reality: Good performance until there is a maximum of 40K connected devices or active sessions per XEON Scalable
  - Beyond such numbers, CPU is running out-of-cache with a radical drop in packet-rate
- The cost per connected 5G device resulting from a CPU-based Networking Function is **too expensive** for numerous incoming 5G applications
- **Hardware accelerators can provide a significant cost/performance advantage** over CPUs for running data plane applications…at-scale

Emerging Container Network Functions



Container Network Function **(CNF)**

Network Function Control Plane

+

Network Function Control Plane

Control Plane
Go, C, C++
Kubernetes
application

XEON

+

P4 Data Plane application

example

In

P4 Component 1

Barefoot

P4 Component 2

Stratix 10 MX

P4 Component 3

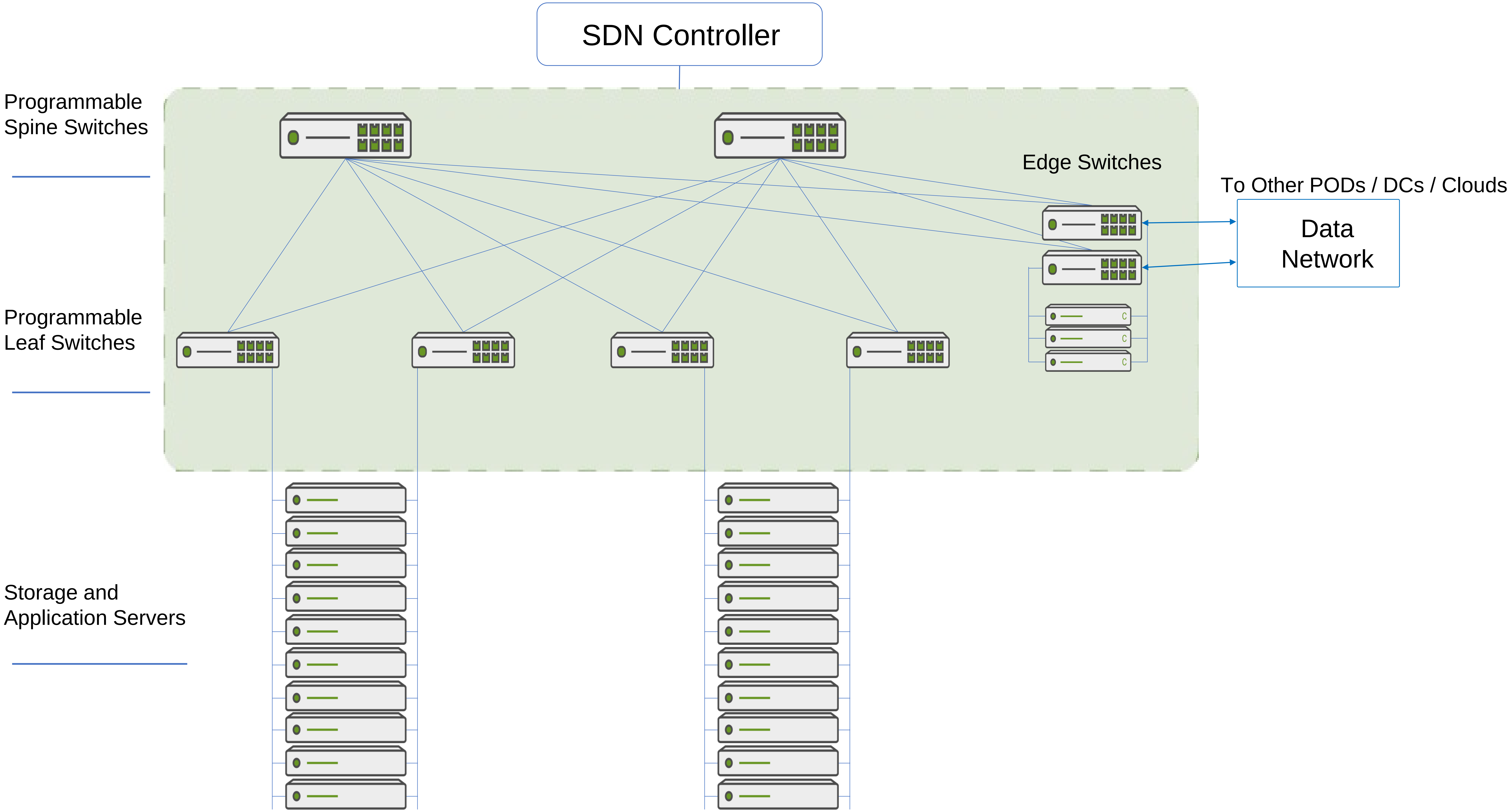
XEON

P4 Component 1

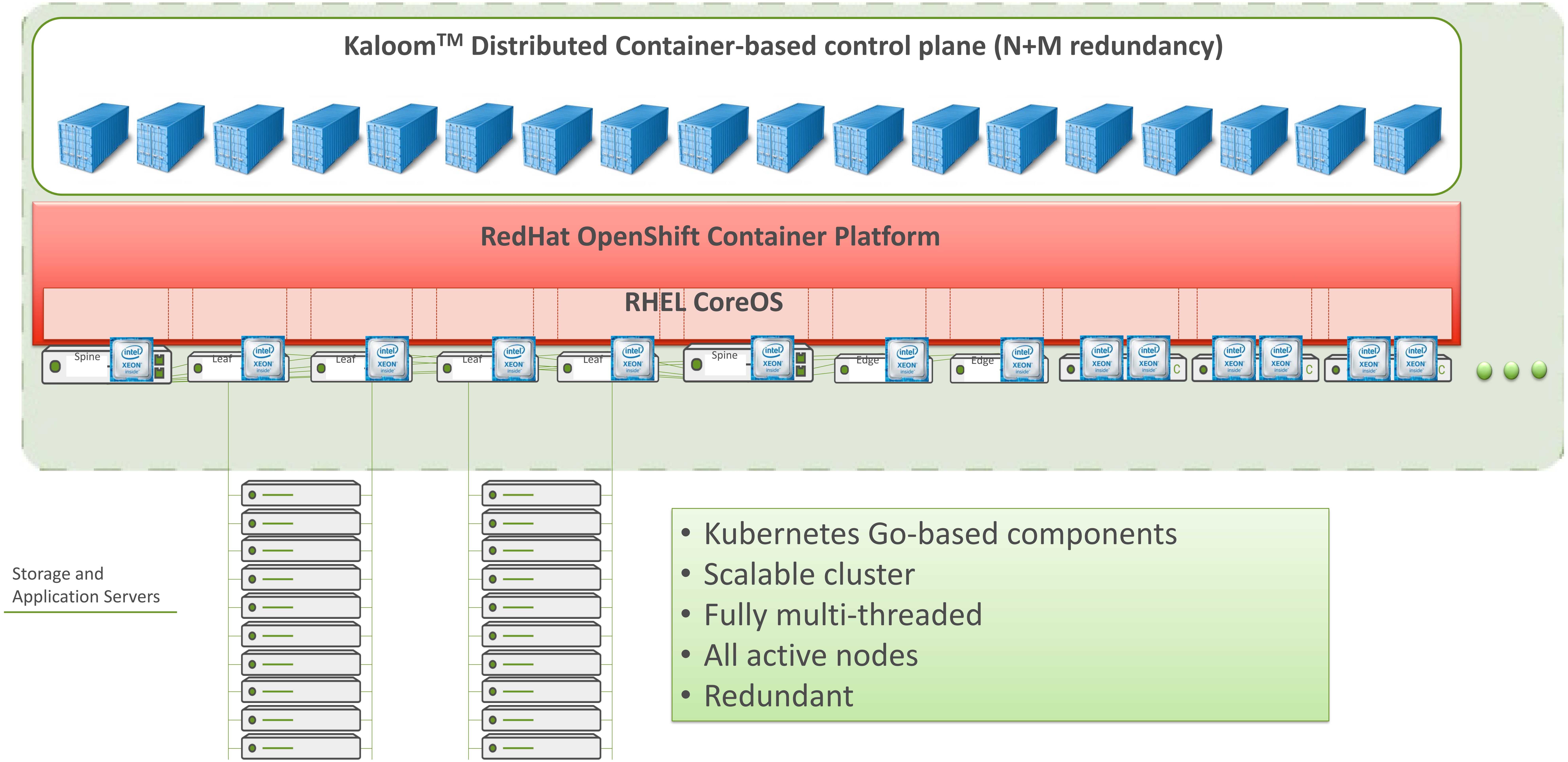
Barefoot

Out

DC Fabric Configuration


SDN Controller
Programmable Spine Switches
Edge Switches
To Other PODs / DCs / Clouds
Data Network
Programmable Leaf Switches
Storage and Application Servers

Distributed Fabric Control Plane



Kaloom™ Distributed Container-based control plane (N+M redundancy)

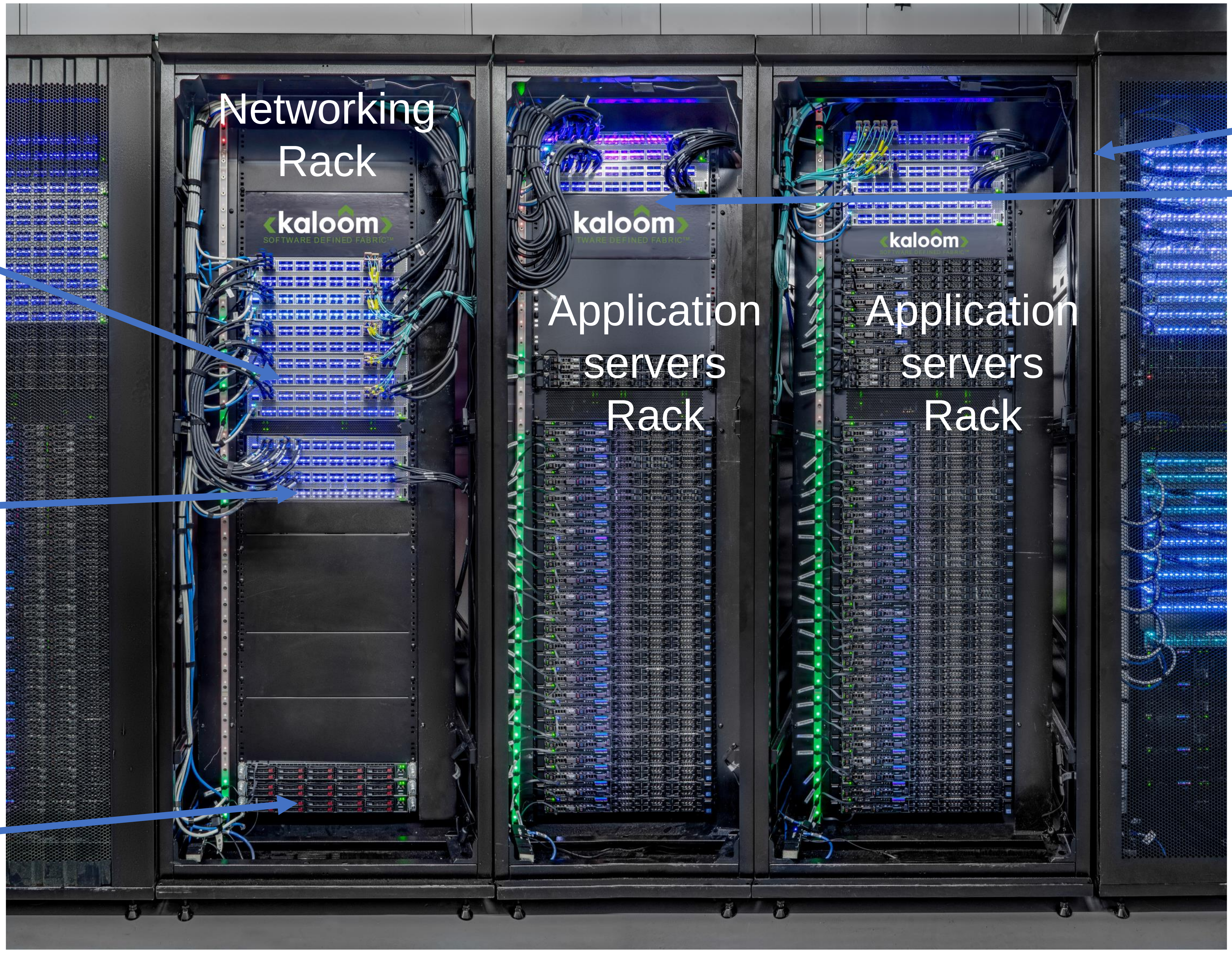
RedHat OpenShift Container Platform

RHEL CoreOS

Storage and Application Servers

- Kubernetes Go-based components
- Scalable cluster
- Fully multi-threaded
- All active nodes
- Redundant

A typical Physical Data Center Fabric Configuration



Spine Switches

Edge Switches

Fabric Controllers

Leaf Switches

Kaloom Software Defined Fabric™ Highlights

1 **Autonomous**
Self-Discovering/
Self-Forming

2 **Fully virtualizable**
Fabric Slicing (vFabric)

3 **Fully Programmable**
Future-proof networking

4 **Dataplane Acceleration**
vSwitch Offload

5 Integrated **vRouter**

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6 **White box** support from
multiple vendors, OCP

Upstream contributions in k8s/Linux

- Please join Kaloom^{TM} to work collaboratively in open networking
- Kubernetes and CNI networking improvements in CNF
- KVS and networking improvements in Linux

https://github.com/kaloom/kubernetes-podagent

https://github.com/kaloom/kubernetes-kactus-cni-plugin

Summary of future DC networking requirements

- Open Networking
- OCP based HW
- Programmable
- Fully Automated
- Standard Linux
- Server Style Mgt of networking
- Containerized

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