TOMORROW
starts here.
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# NX-OS, IOS, IOS-XR, Unique and Similar at the Same Time

BRKCRT-2001

Joseph J Rinehart, MBA, CCIE #14256

Senior Education Specialist, Cisco Systems

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# Agenda

- Introduction
- IOS Origins
- Cisco OS Architectures
- IOS & NX-OS: Comparison/Contrast
- IOS & IOS-XR: Comparison/Contrast
- Conclusion/Q&A

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# Introduction

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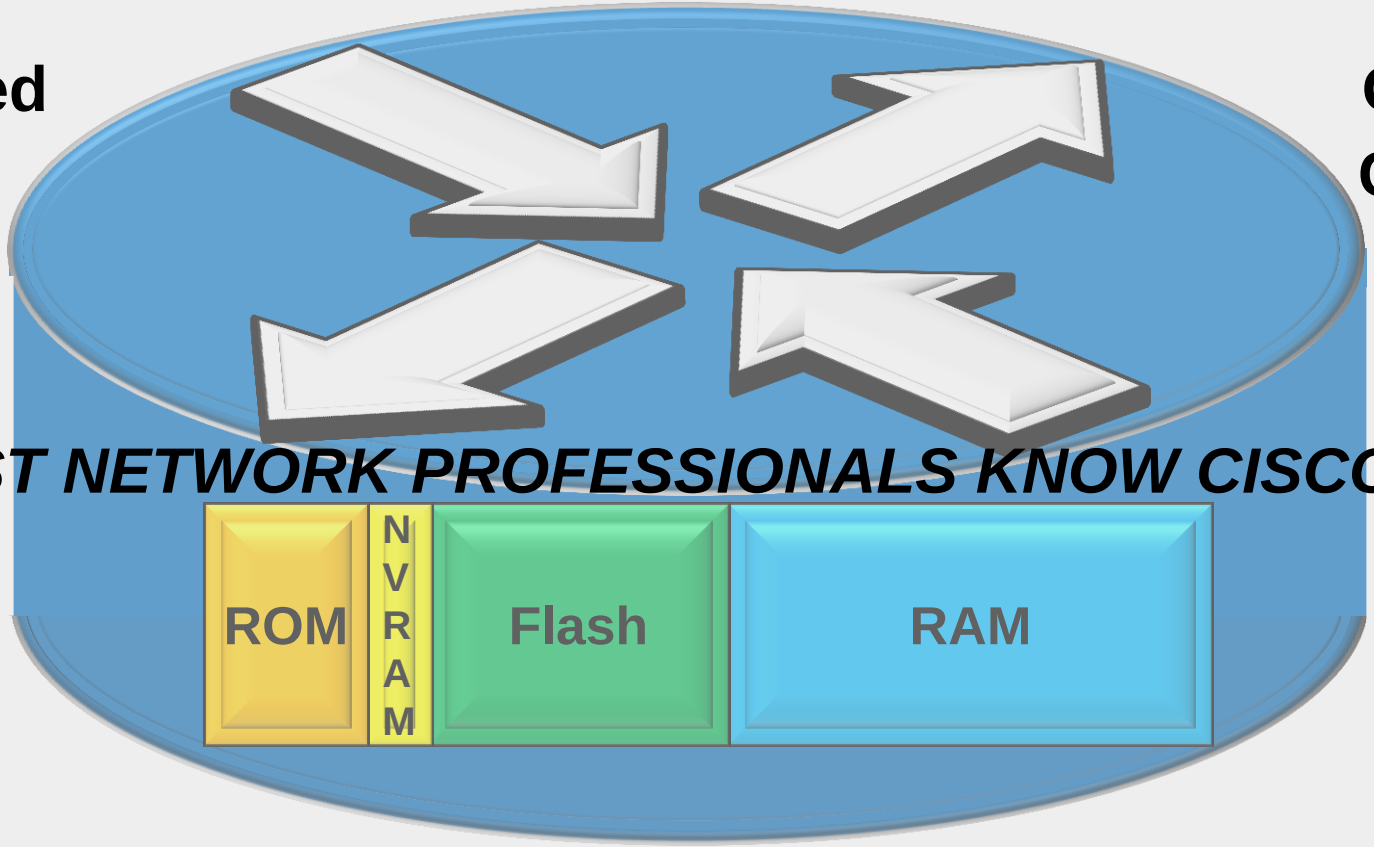
# In the Beginning…was IOS

**Released Circa 1984**




**Over 2M Certified People**

***MOST NETWORK PROFESSIONALS KNOW CISCO IOS***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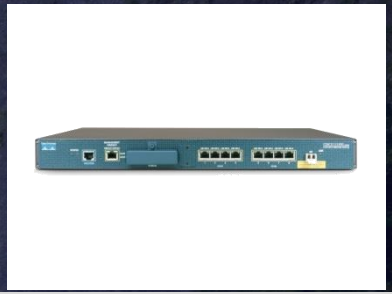
# Discontinued/Obsolete Cisco OS's

**FastHub OS**

**C1900 OS**



**CSS11501 OS**

**Catalyst OS**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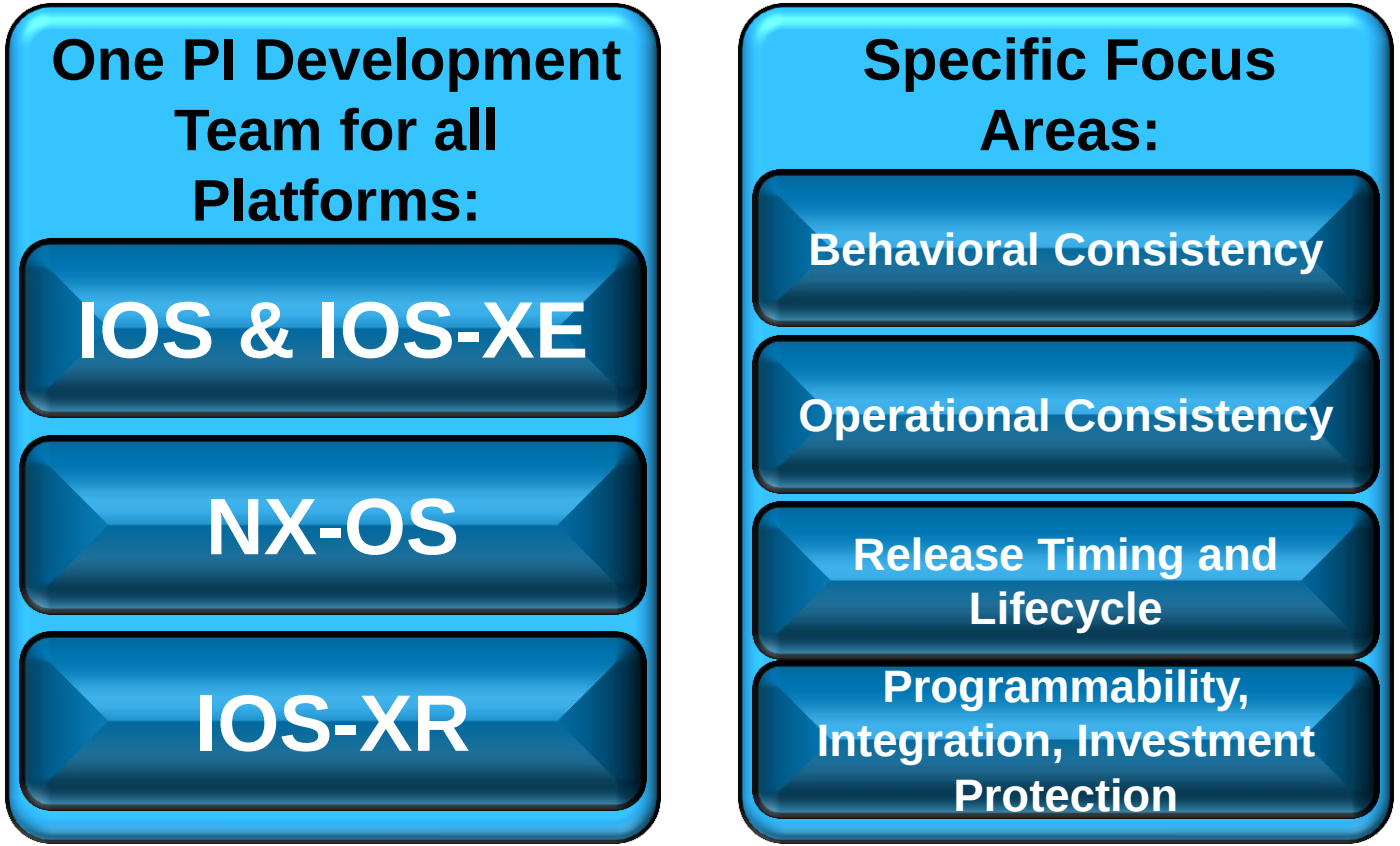
# Centralized OS Development

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# Cisco IOS Family

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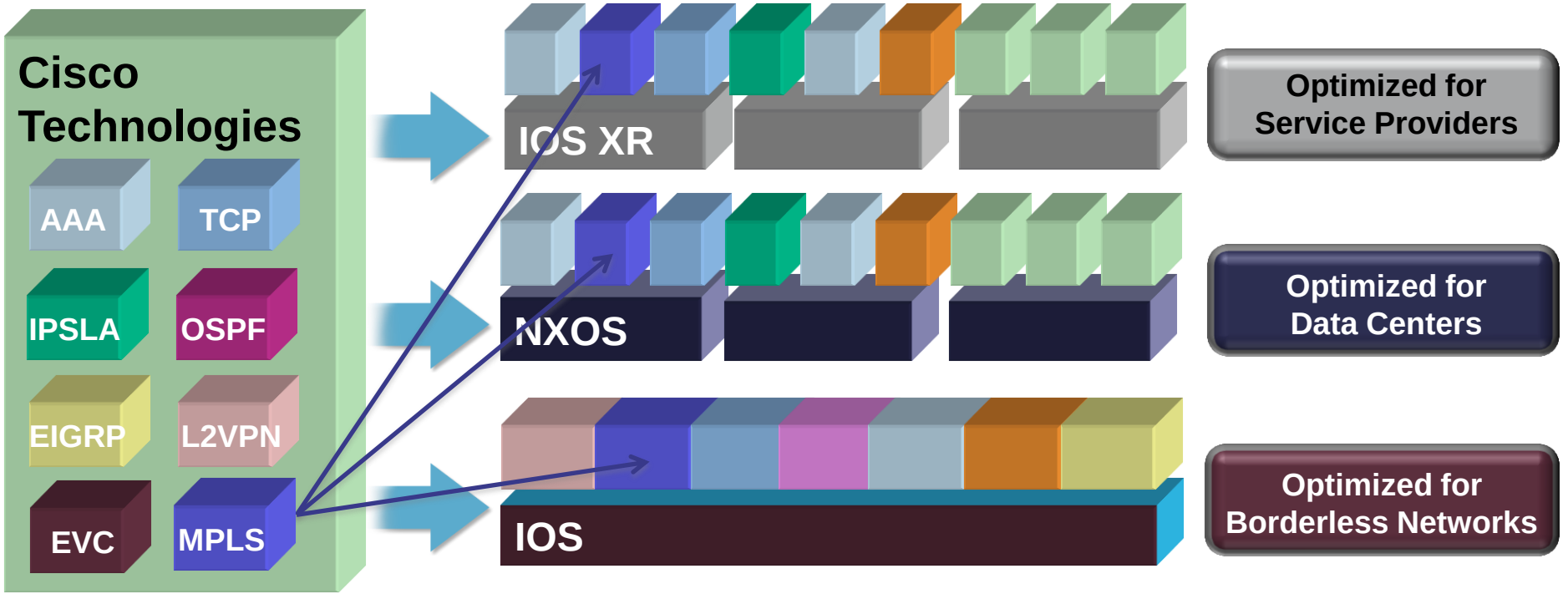
# Cisco IOS Family





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# Cisco IOS Family

**What about….**

**…IOS XE?**


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IOS-XE is the
*FUTURE* of IOS

# IOS Origins

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# IOS Trivia Questions

**The original software program that became Cisco IOS was written by:**

- Leonard Bosack
- Kirk Lougheed
- William Yeager
- Greg Satz


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# IOS Trivia Questions

**IOS itself was created in what Assembler?**

- C
- Java
- Linux
- Unix


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# IOS Trivia Questions

**Why did IOS jump from version 12.4 to 15.0? What happened to 13 & 14?**

- **Trademark Issues**
- **Unlucky Numbers**
- **Testing Versions**
- **Failed Software**


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# Early Versions of Cisco Hardware

**Early Prototype at Rutgers University**


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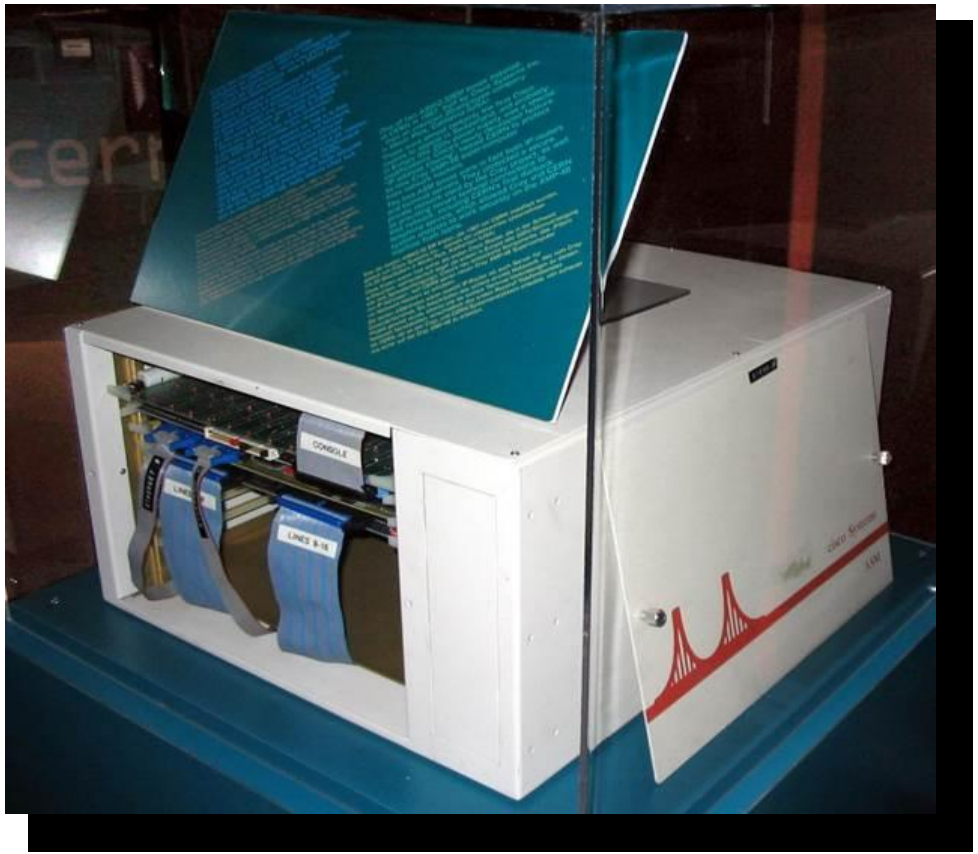
# Early Versions of “Cisco OS” (forerunner to IOS)





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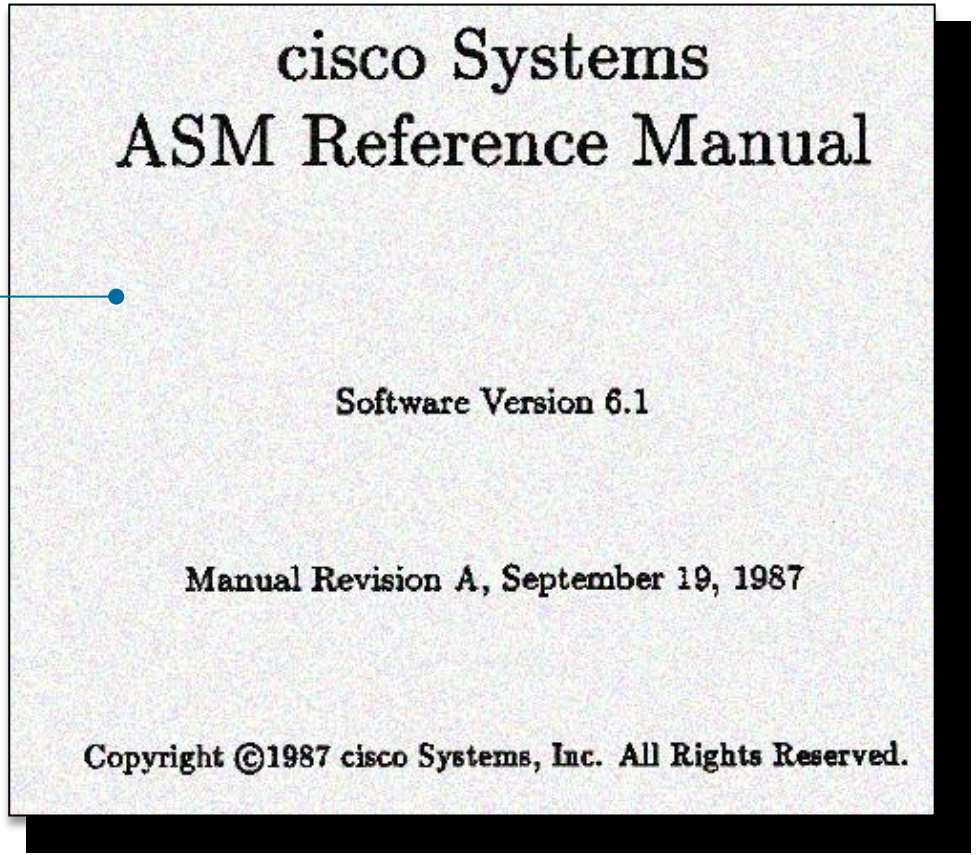
# Early Versions of “Cisco OS” (forerunner to IOS)

System Software Manual

One of the earliest officially available examples of hardware and software





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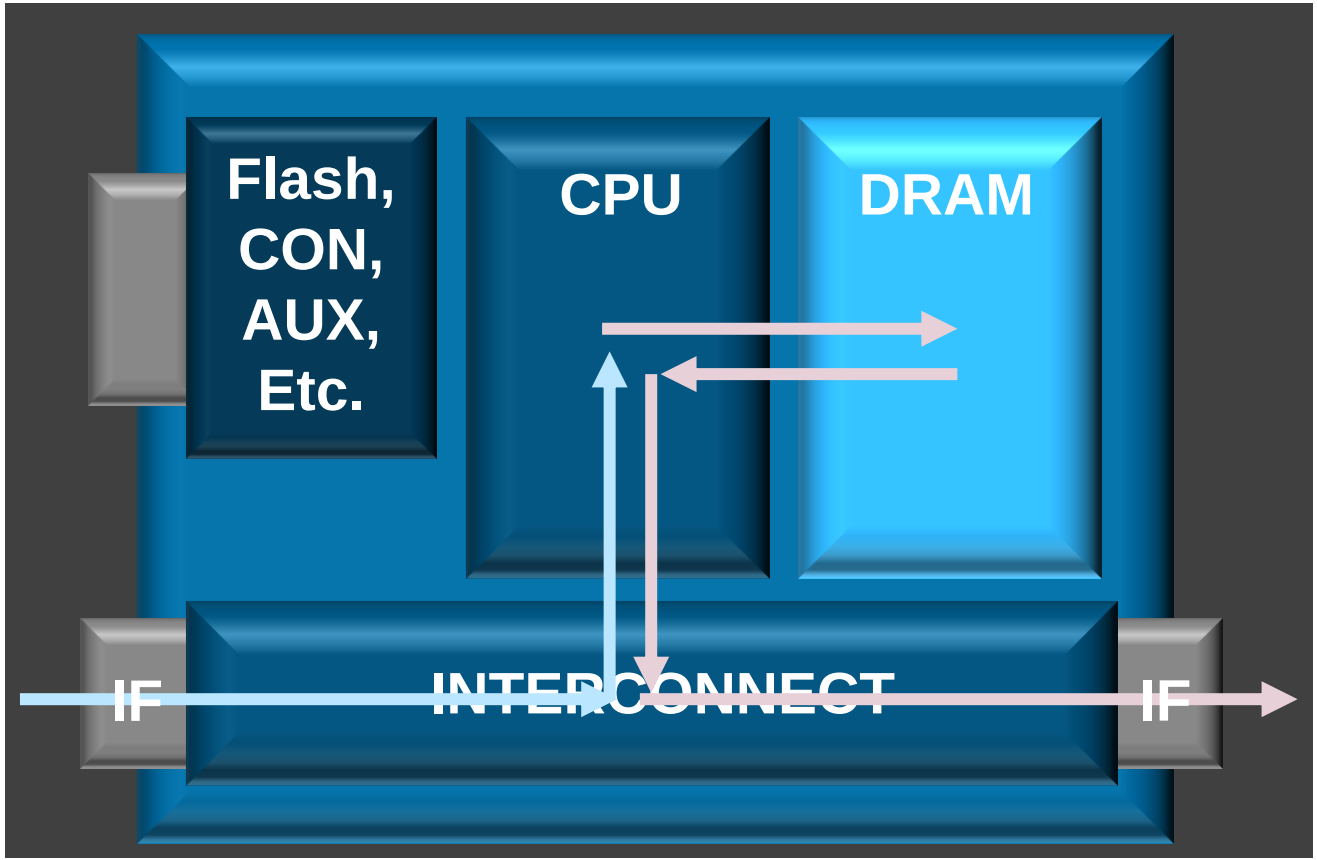
# Cisco Router Architecture

## Early Software-Based Devices





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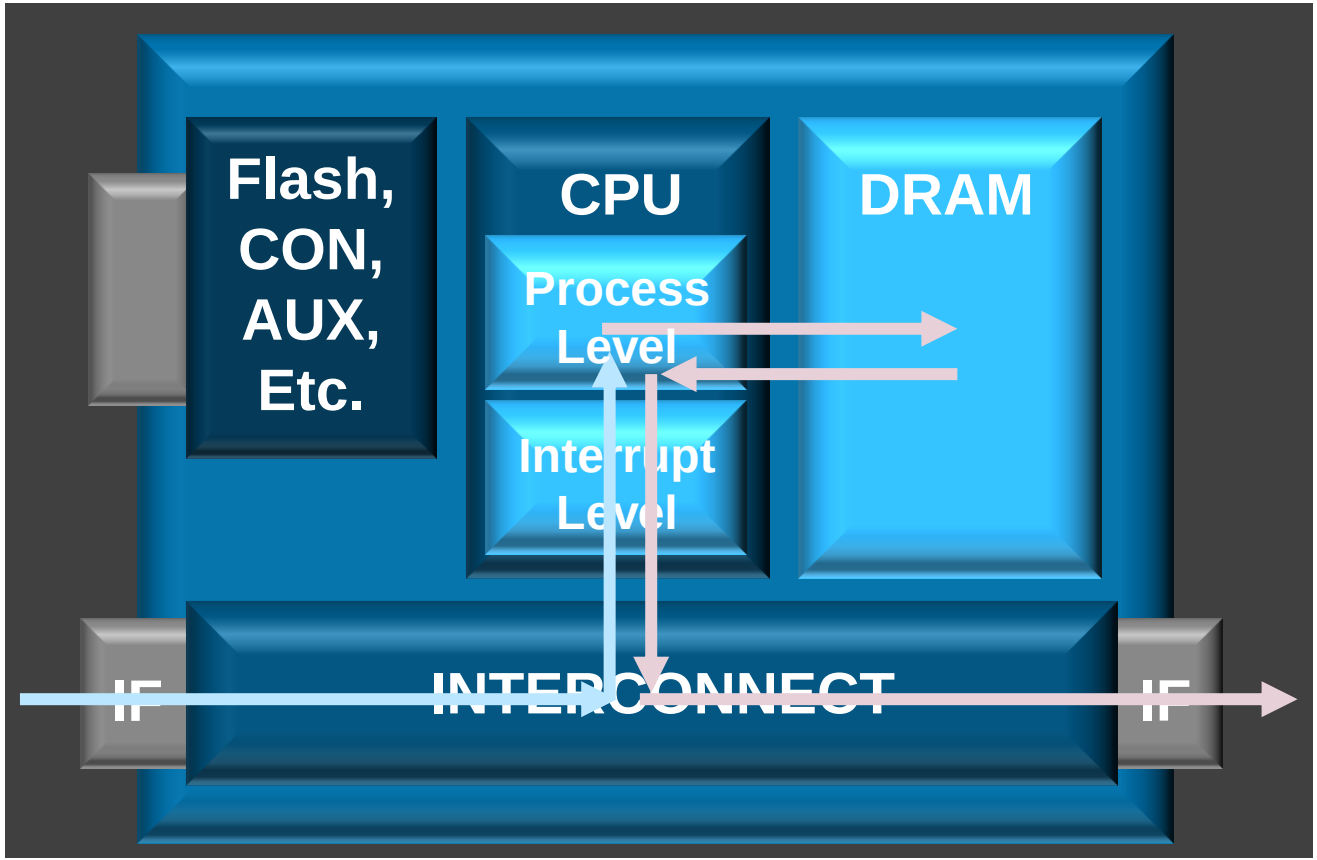
*** Adapted From, BRKSPG-2772,** Anatomy of Internet Routers, 2013

# Cisco Router Architecture

## Process Switched Devices





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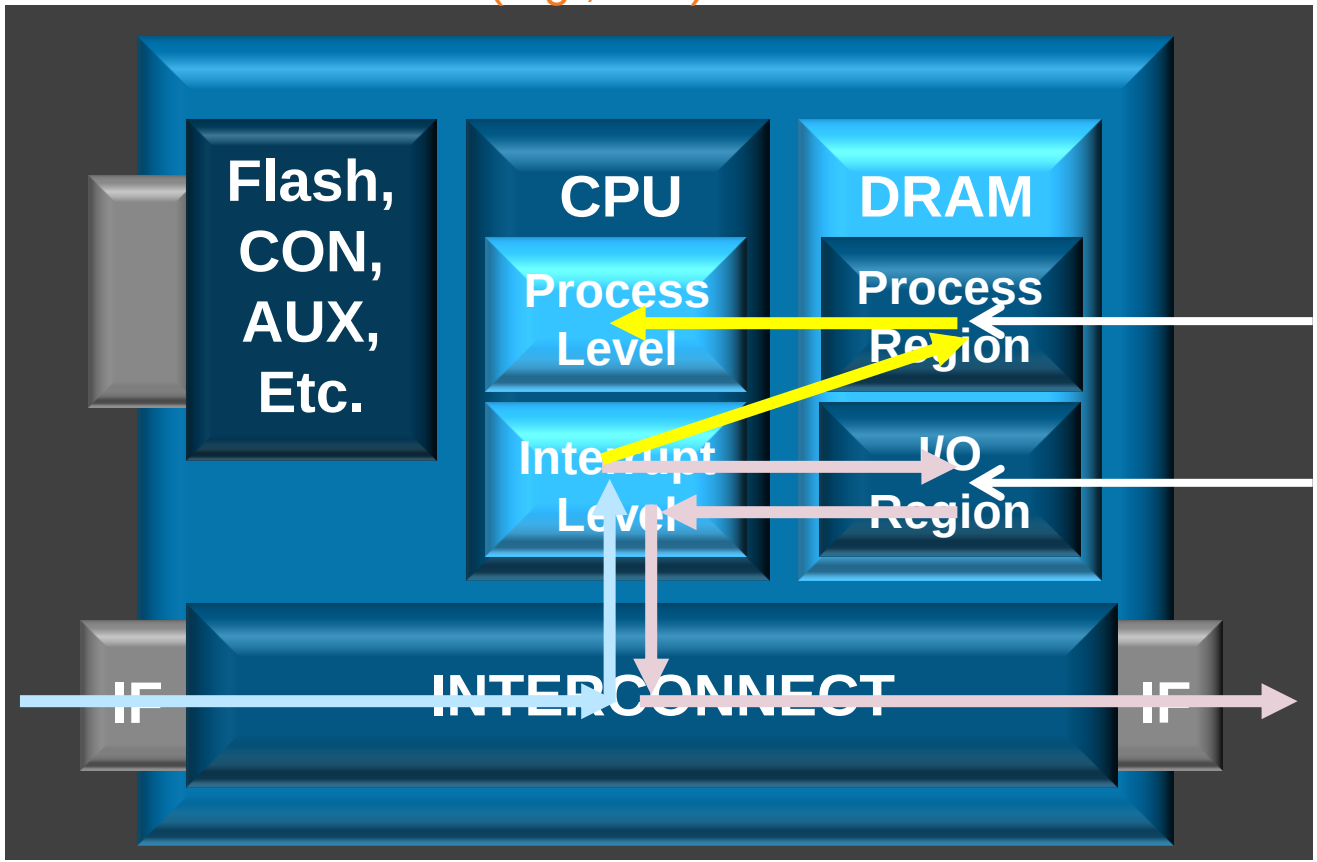
*** Adapted From, BRKSPG-2772,** Anatomy of Internet Routers, 2013

# Cisco Router Architecture

## Software Based Modern Routers (e.g., ISR)





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*** Adapted From, BRKSPG-2772,** Anatomy of Internet Routers, 2013

# Cisco IOS Facts

**Early IOS Versions Had NO CLI**

**IOS 9.2 Introduced Line Editing Features**

**Originally Only Used on Routing Products**

**Introduced on Catalyst Switches in 11.2(8) SA**

**Version Numbering Based on TOPS20 OS**


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# Cisco IOS Facts

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IOS 9.2 Intro ng Features

Originally Or ing Products

Introduced on s in 11.2(8) SA

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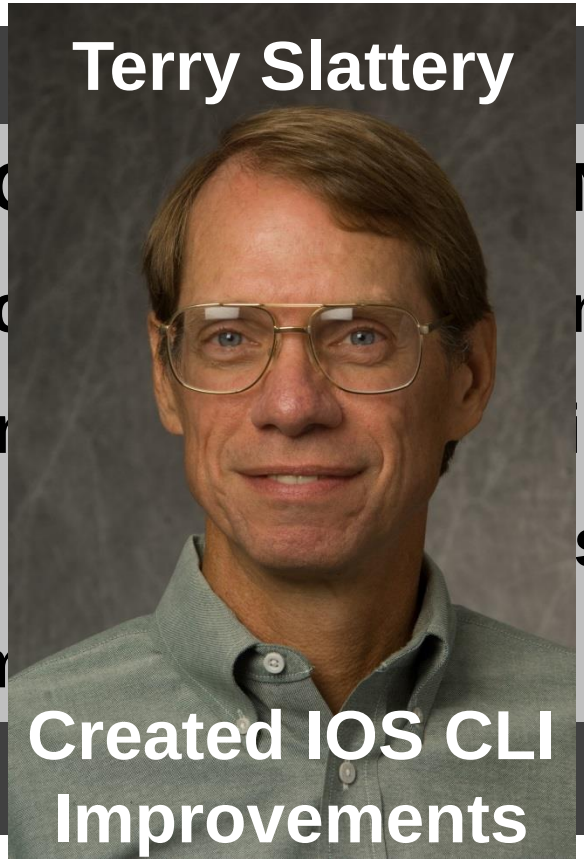



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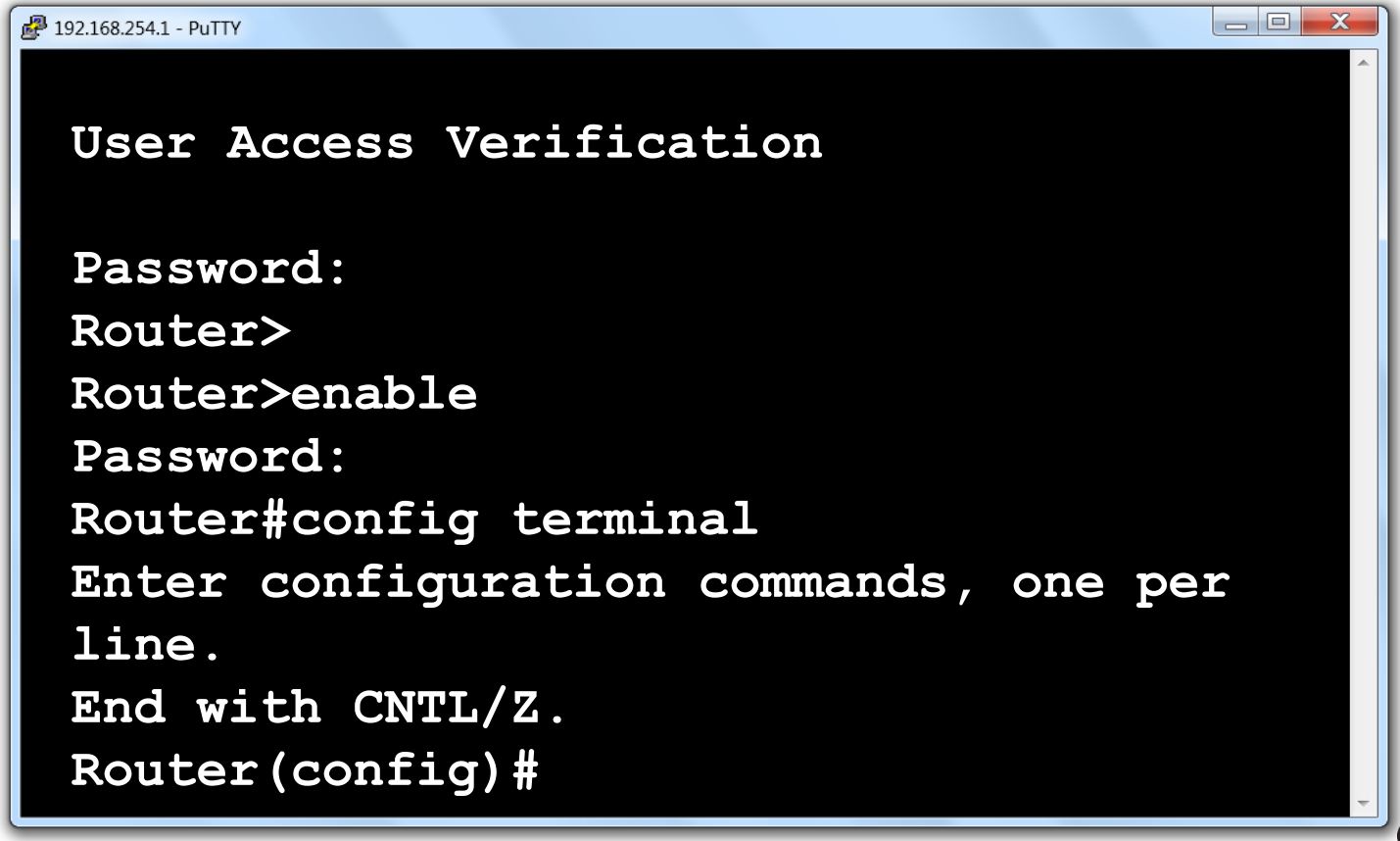
# The IOS CLI





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# Cisco OS Architectures

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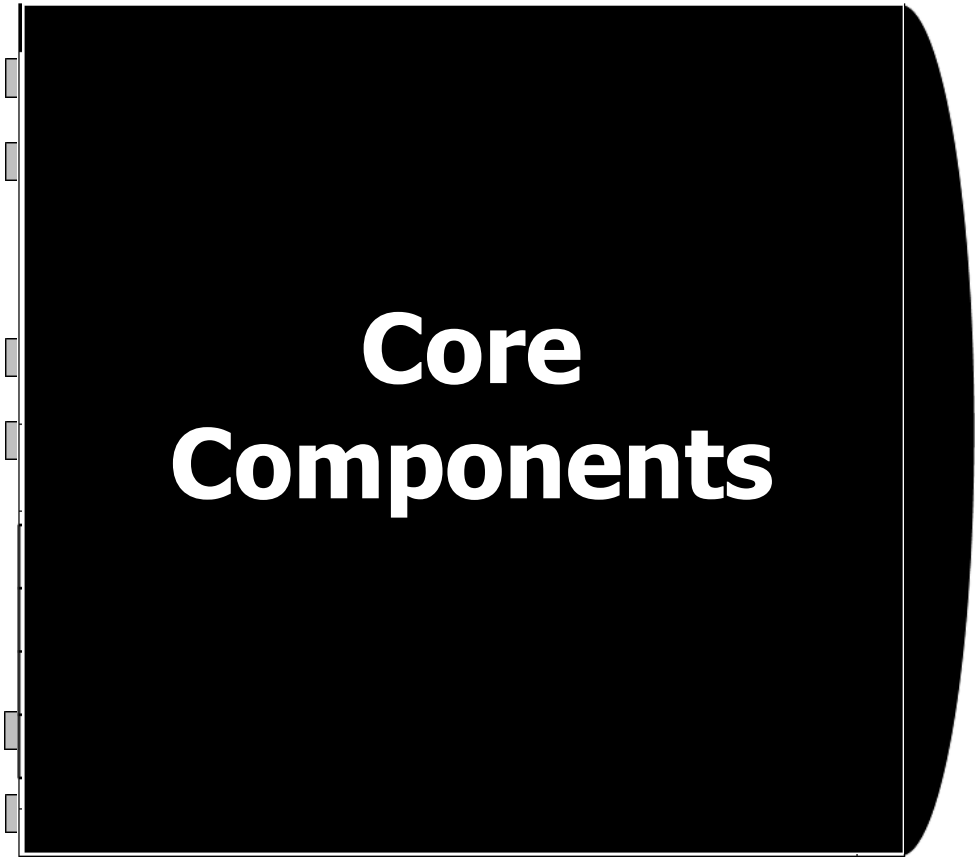
# OS Fundamentals: Computer Architecture





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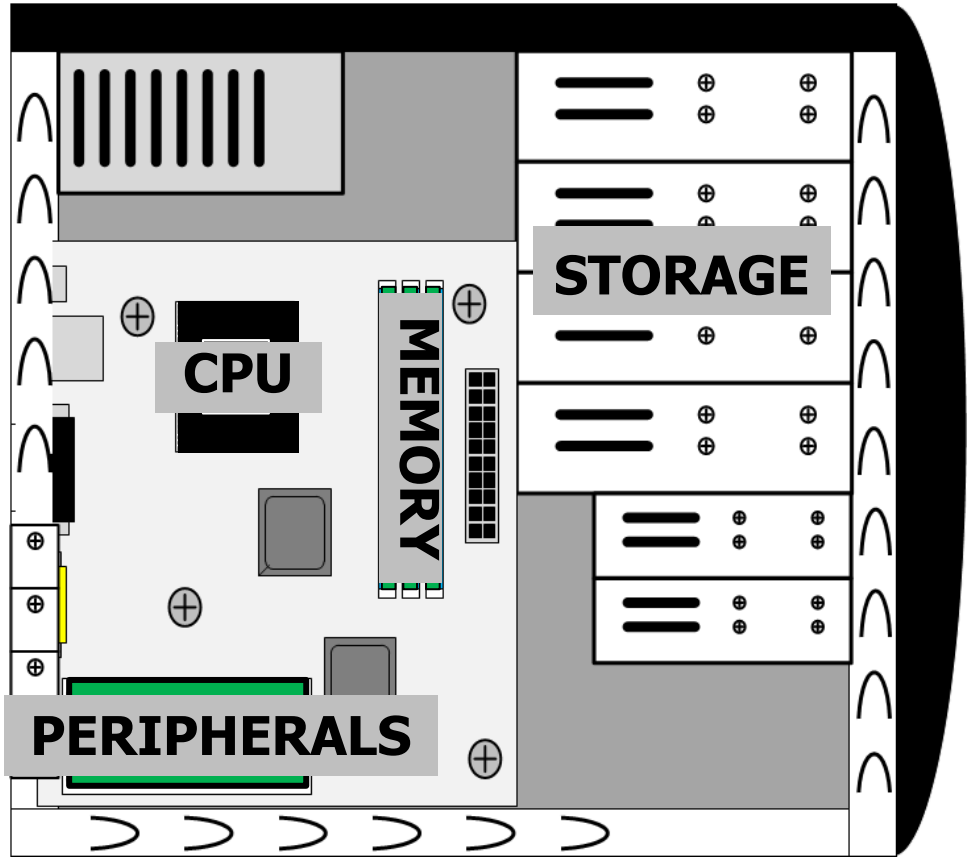
# OS Fundamentals: Computer Architecture





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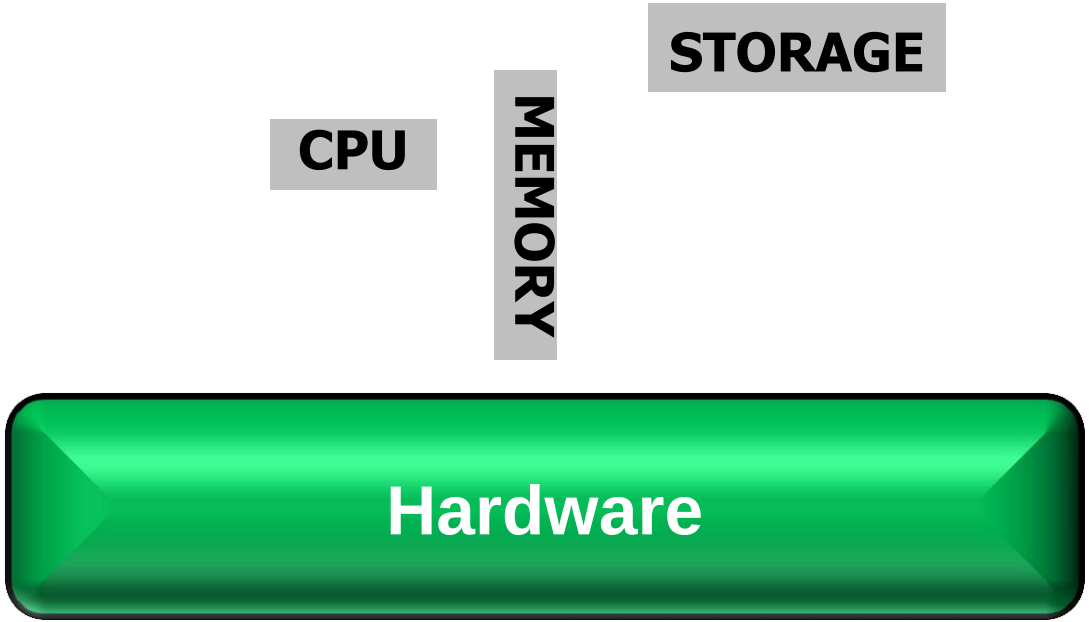
# OS Fundamentals: OS Architecture





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*** Adapted From, Haldar,** Operating Systems, 2010

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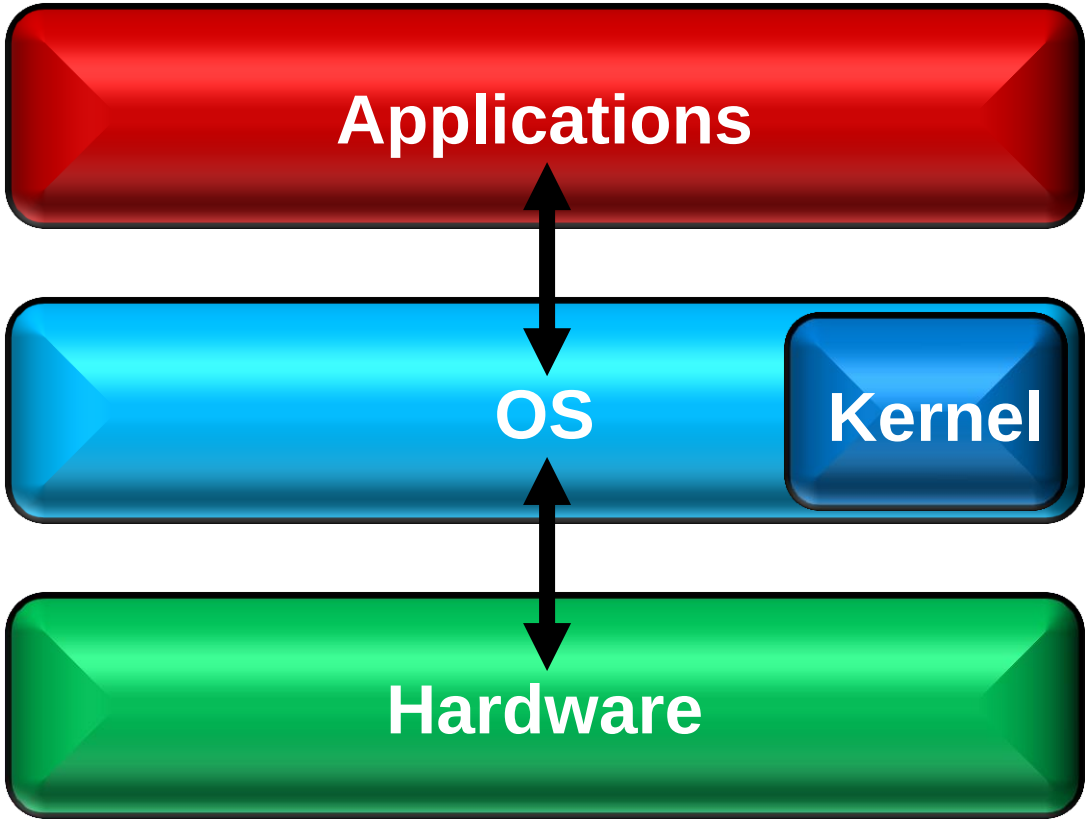
# OS Fundamentals: OS Architecture





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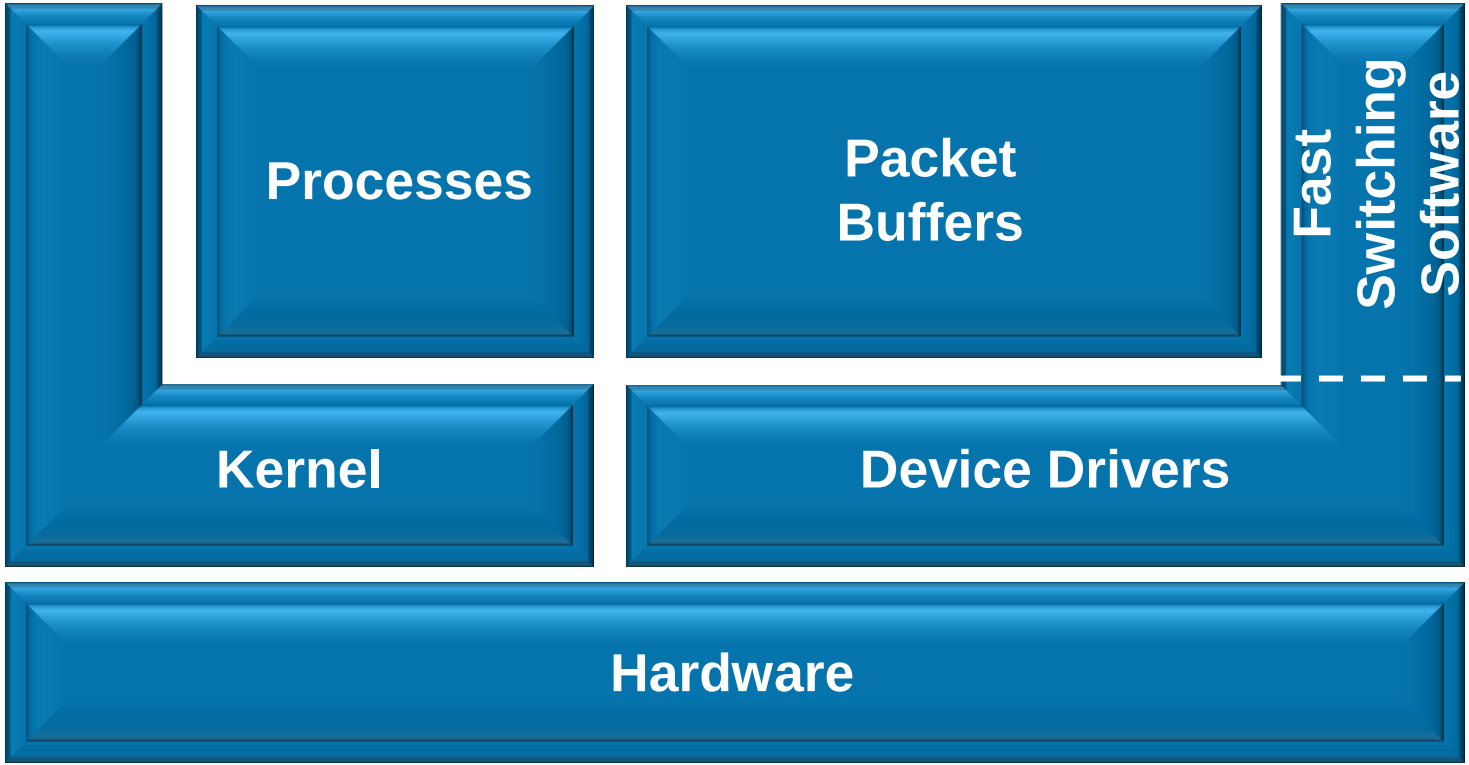
# Original IOS Architecture





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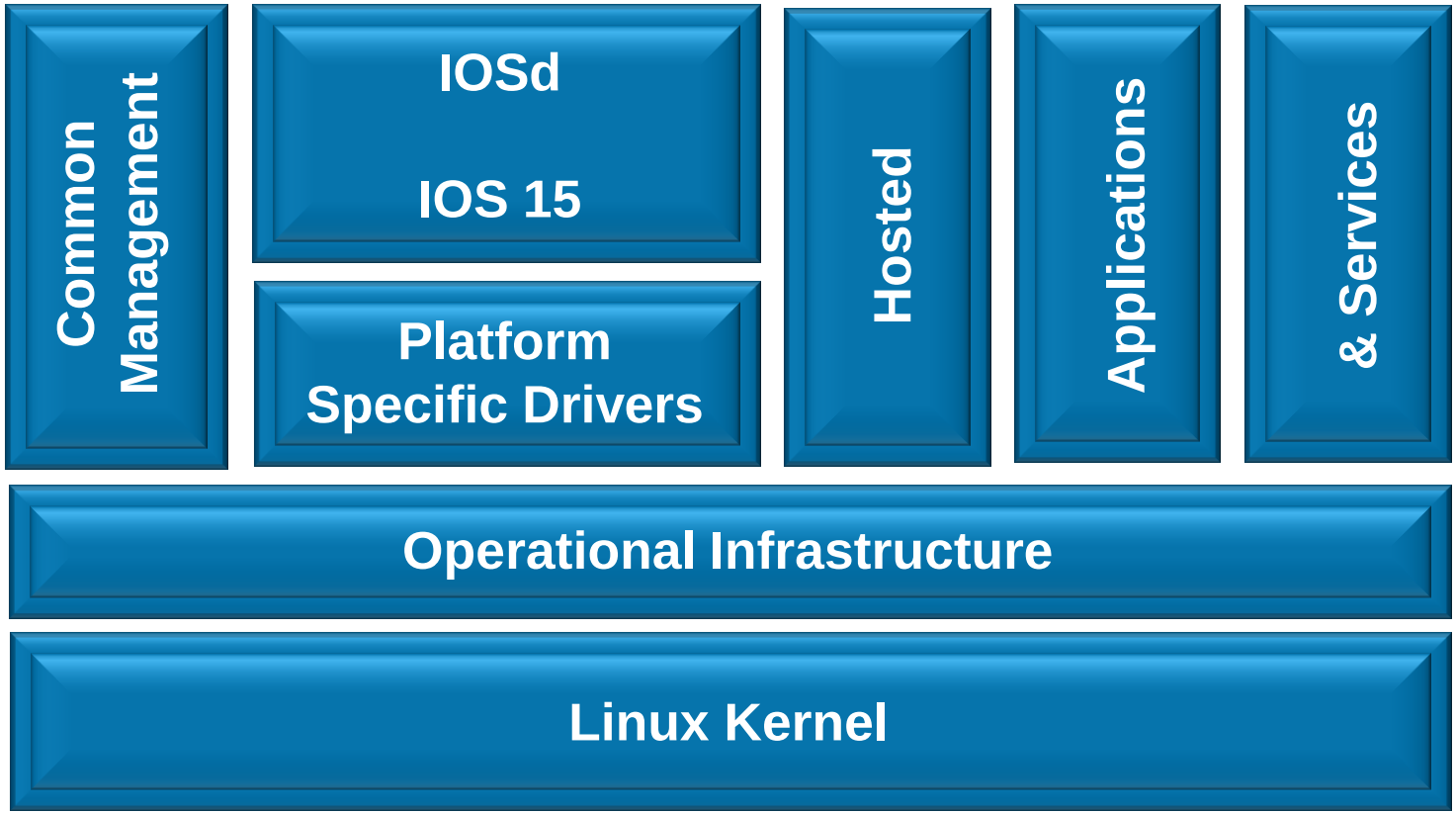
*** Adapted From, Bollapragada,** Inside Cisco IOS Software Architecture, 2000

# IOS-XE Architecture





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*** Adapted From, BRKARC-2007 IOS Strategy and Evolution, multiple years**

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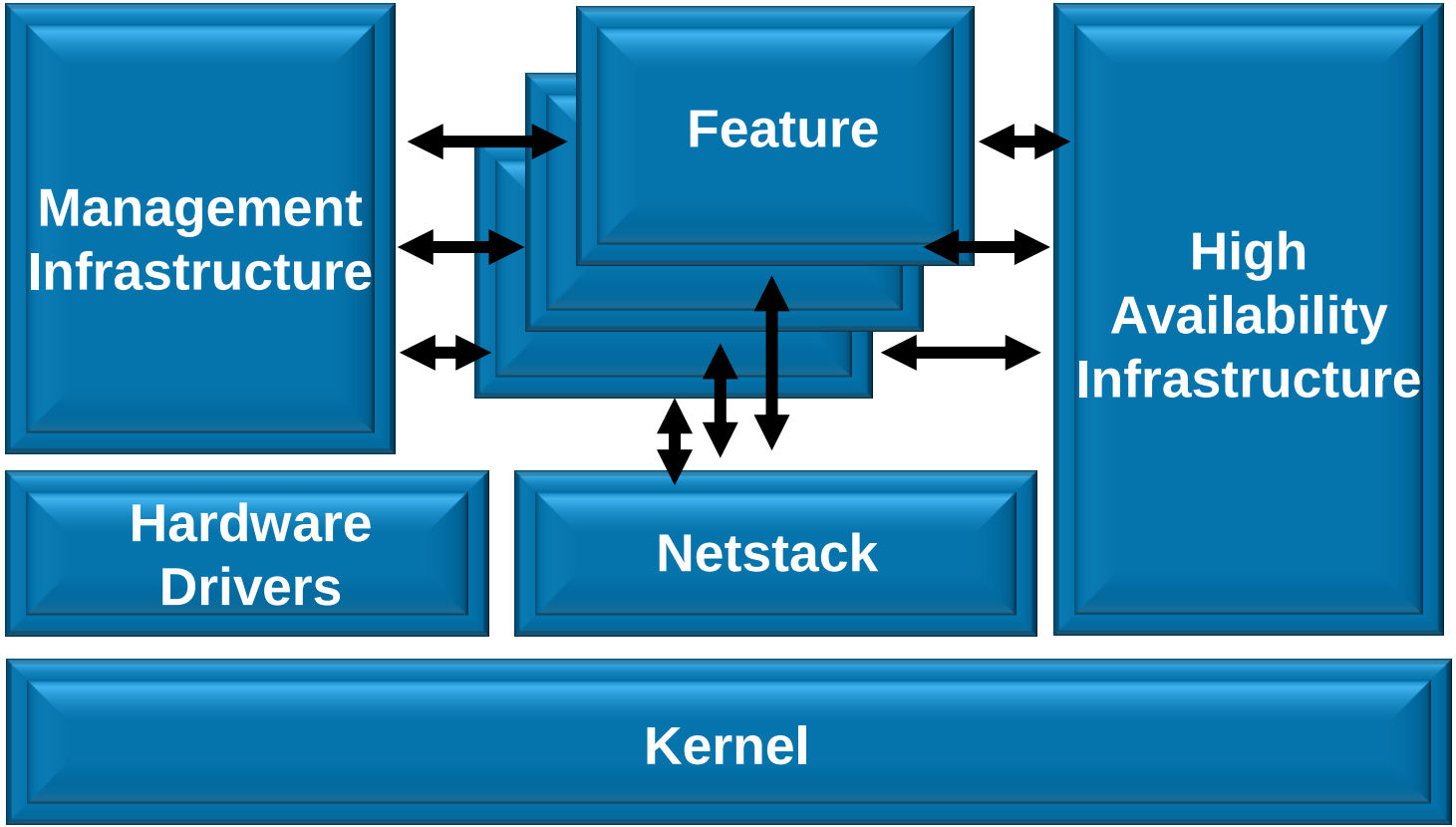
# NX-OS Architecture





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*** Adapted From, BRKARC-3471, Cisco NX-OS Software Architecture, multiple years**

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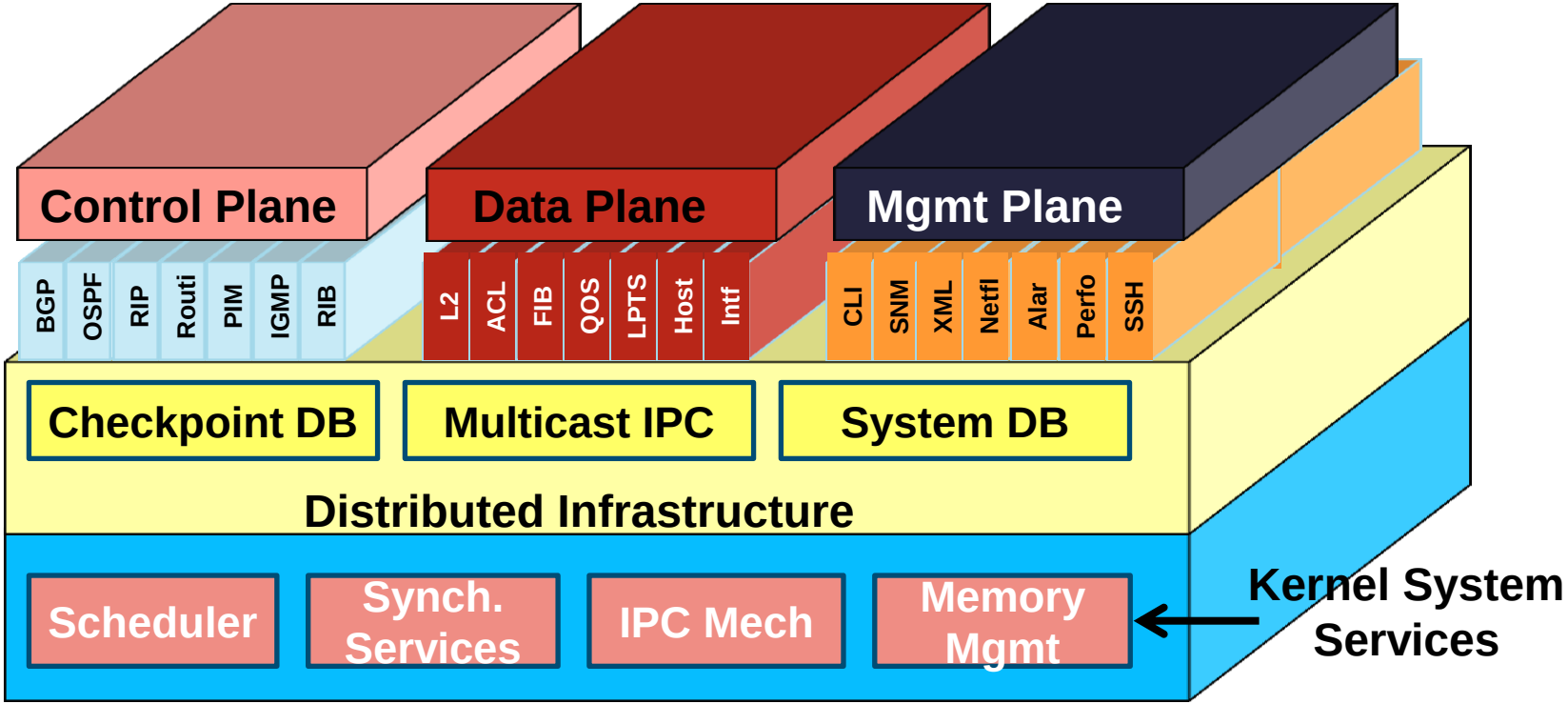
# IOS-XR Architecture





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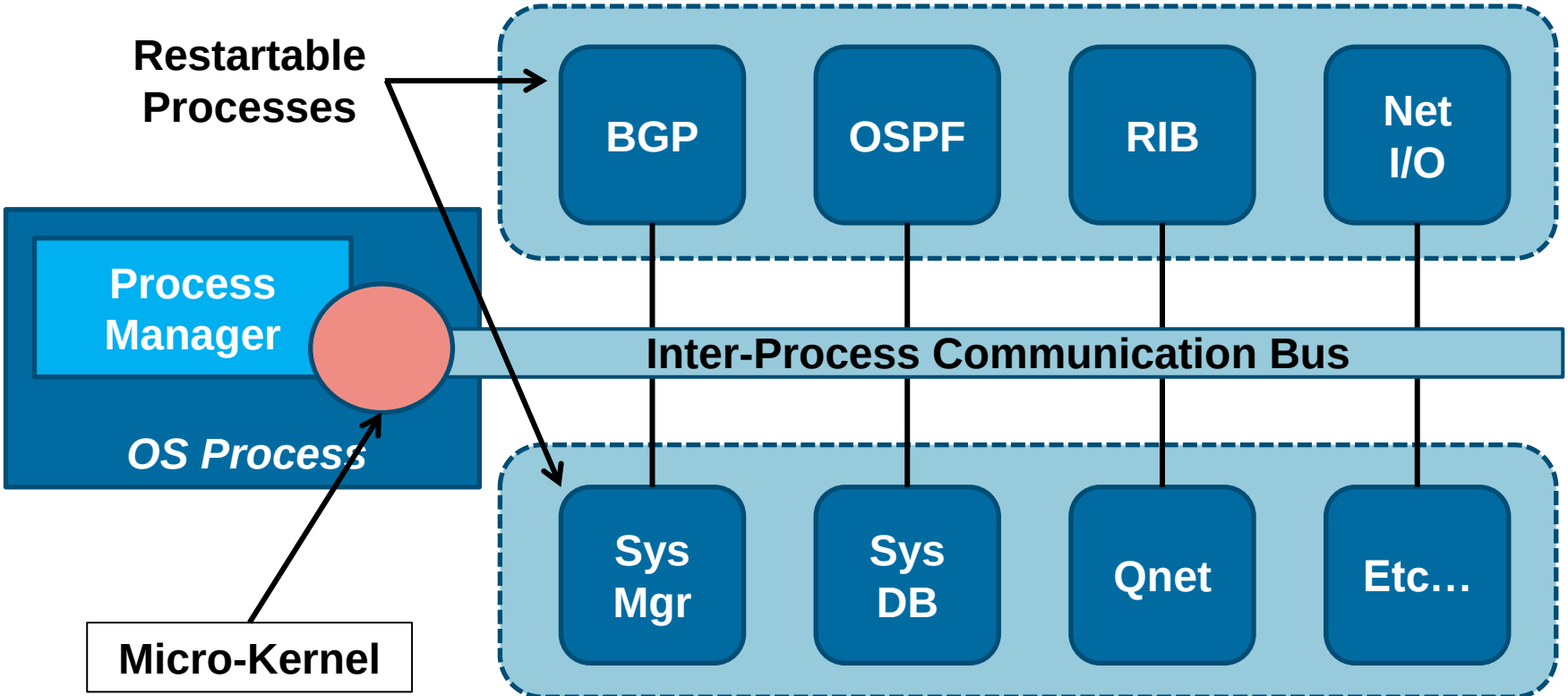
# IOS-XR Architecture (2)





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# IOS & NX-OS: Comparison/Contrast

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# IOS/NX-OS Similarities

**The Relationship of IOS and NX-OS…**

**…Can be likened to that of brothers**


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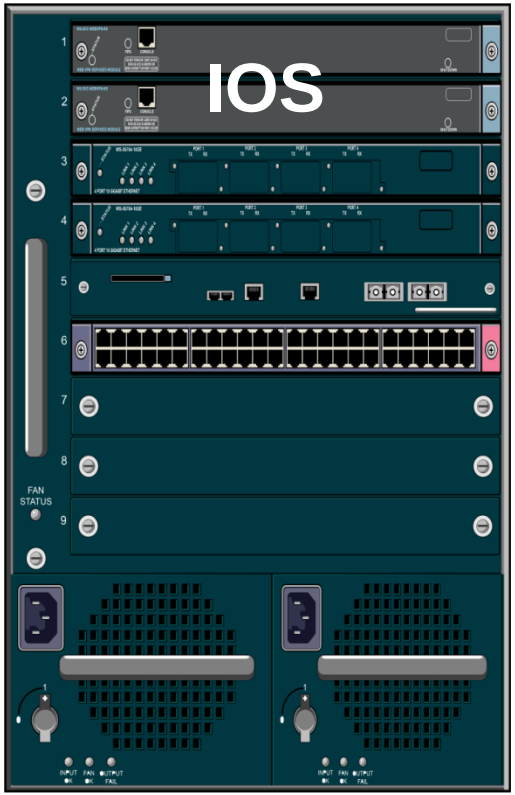
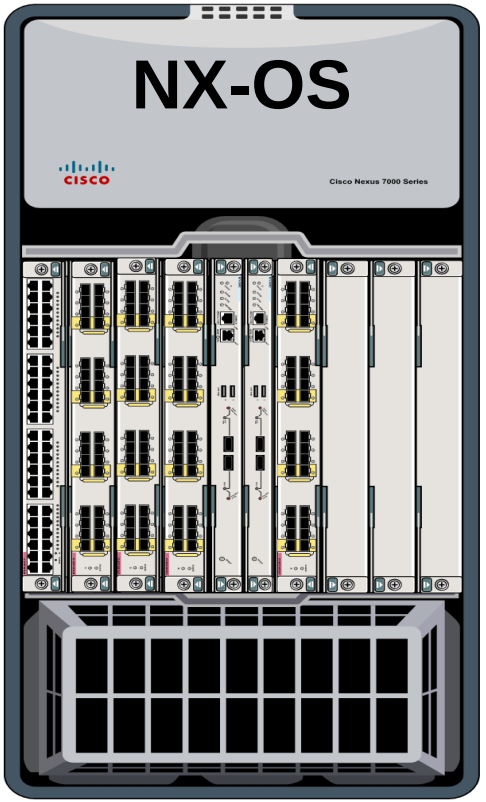
# IOS/NX-OS Similarities




- Hostname & Prompts
- CLI Format/EXEC Modes
- CLI Shortcuts
- Startup/Running Config
- Many Config/Show Commands





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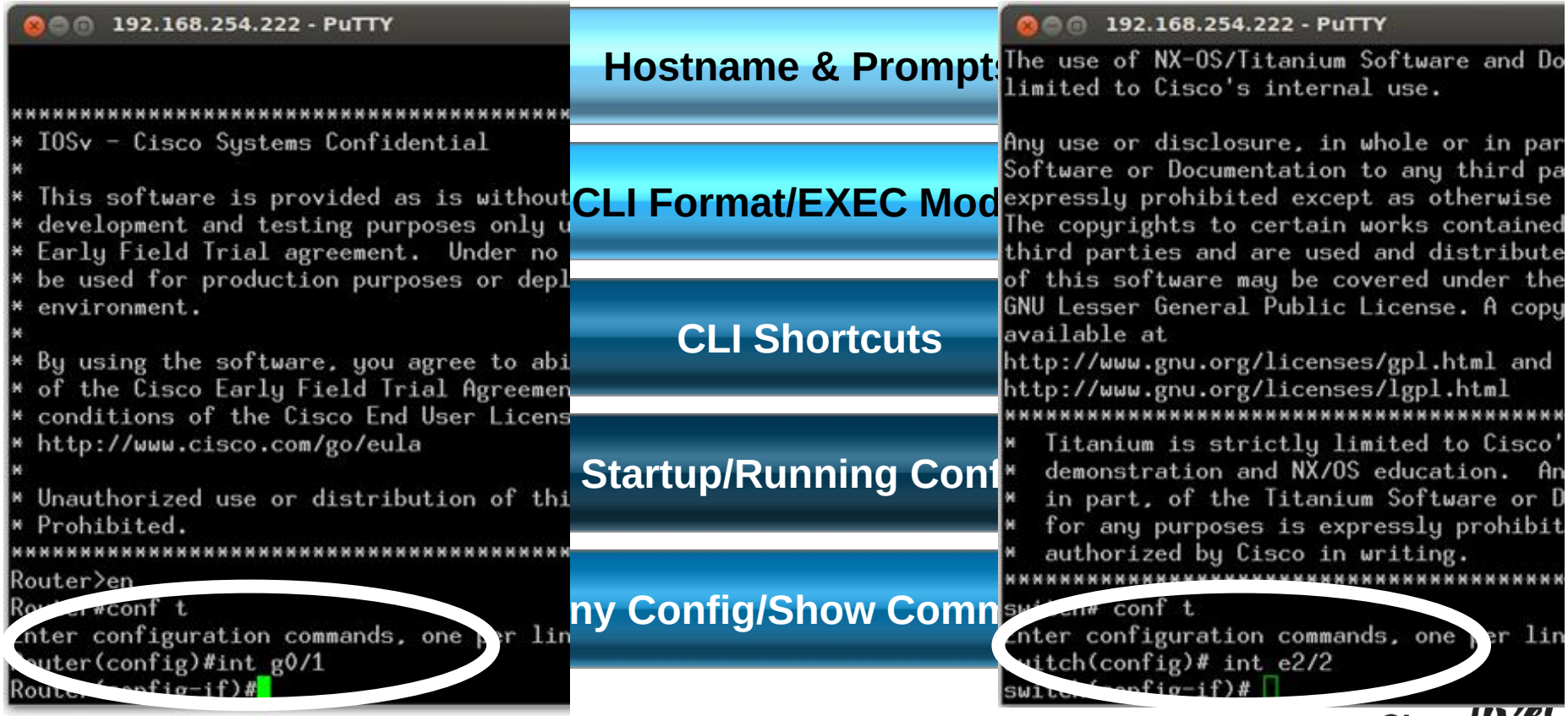
# IOS/NX-OS Similarities





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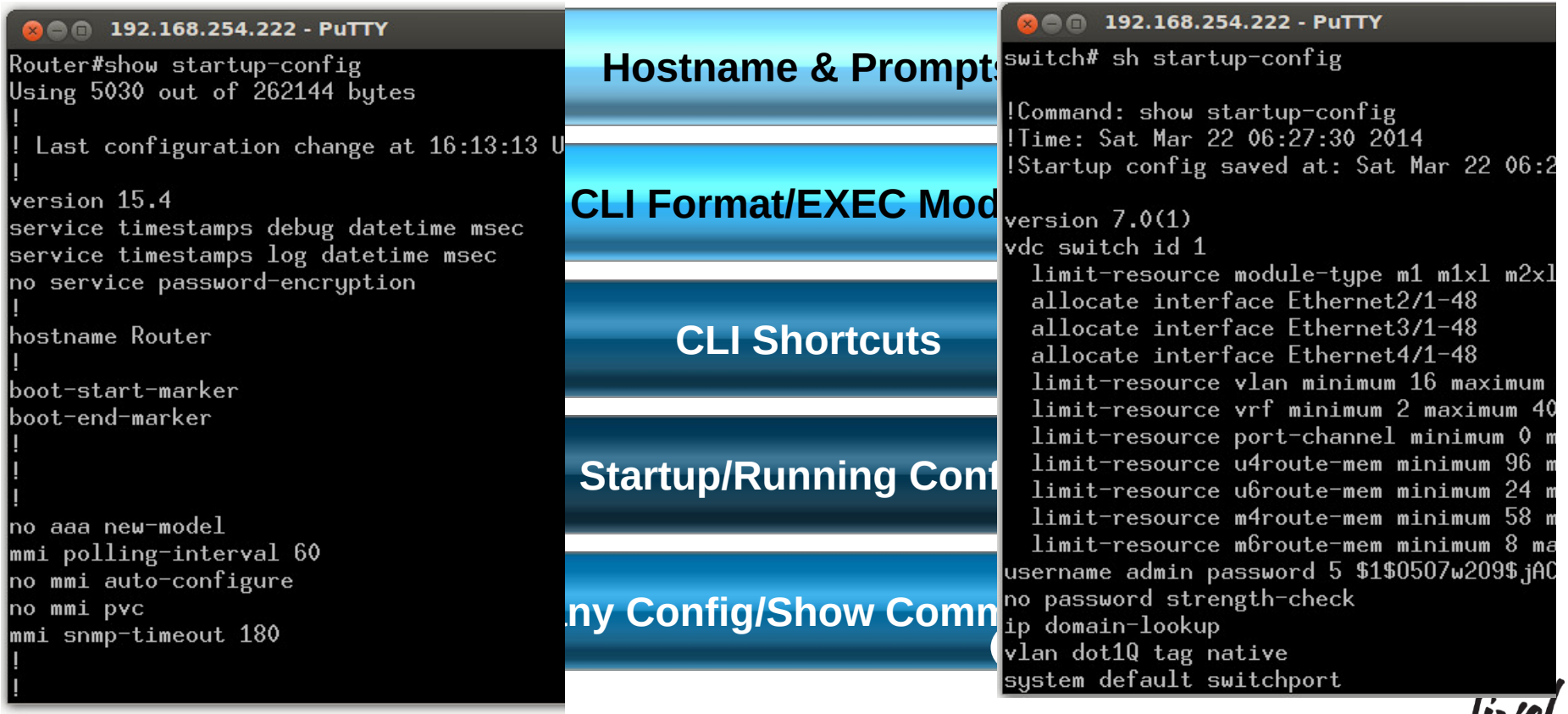
# IOS/NX-OS Similarities





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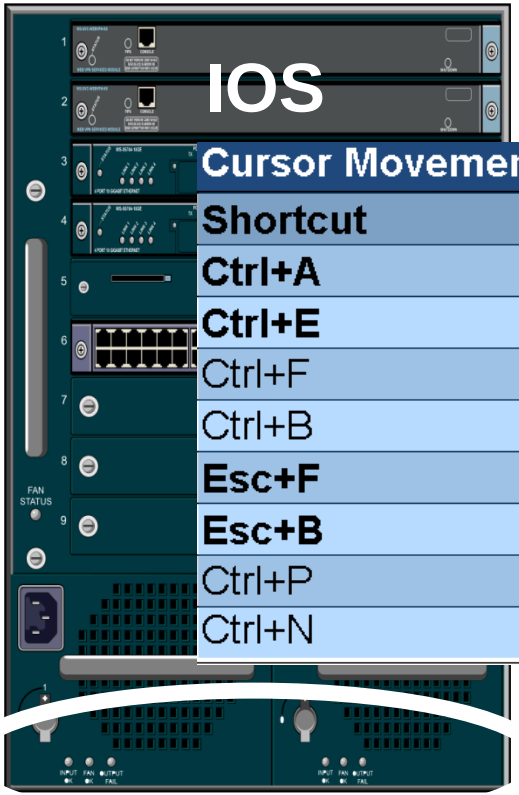
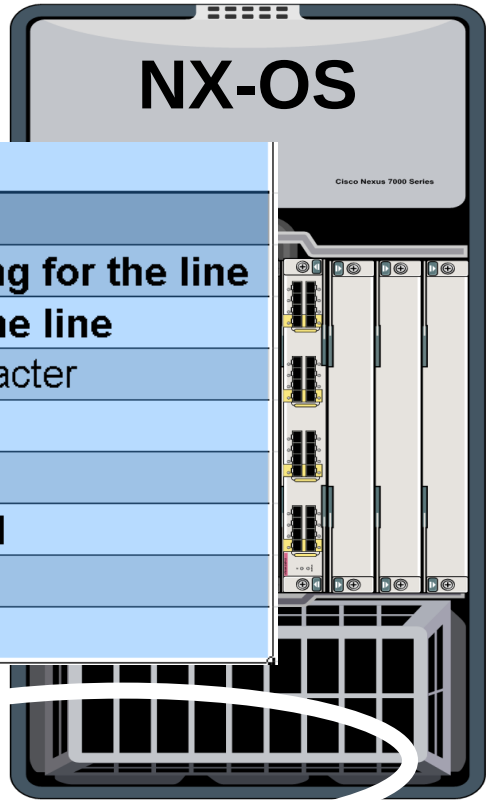
# IOS/NX-OS Similarities




Hostname & Prompts

| Cursor Movement Shortcuts | |
|---|---|
| **Shortcut** | **Description** |
| **Ctrl+A** | **Move cursor to the beginning for the line** |
| **Ctrl+E** | **Move cursor to the end of the line** |
| Ctrl+F | Move cursor forward one character |
| Ctrl+B | Move cursor backward |
| **Esc+F** | **Moves forward one word** |
| **Esc+B** | **Moves backwards one word** |
| Ctrl+P | Previous command |
| Ctrl+N | Next command |

Many Config/Show Commands





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# IOS/NX-OS Similarities

192.168.254.222 - PuTTY

```
Router#show startup-config
Using 5030 out of 262144 bytes
!
! Last configuration change at 16:13:13 U
!
version 15.4
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname Router
!
boot-start-marker
boot-end-marker
!
!
!
no aaa new-model
mmi polling-interval 60
no mmi auto-configure
no mmi pvc
mmi snmp-timeout 180
!
!
```

**Hostname & Prompt**

**CLI Format/EXEC Mod**

**CLI Shortcuts**

**Startup/Running Conf**

**ny Config/Show Comm**

192.168.254.222 - PuTTY

```
switch# sh startup-config

!Command: show startup-config
!Time: Sat Mar 22 06:27:30 2014
!Startup config saved at: Sat Mar 22 06:2

version 7.0(1)
vdc switch id 1
  limit-resource module-type m1 m1xl m2xl
  allocate interface Ethernet2/1-48
  allocate interface Ethernet3/1-48
  allocate interface Ethernet4/1-48
  limit-resource vlan minimum 16 maximum
  limit-resource vrf minimum 2 maximum 40
  limit-resource port-channel minimum 0 m
  limit-resource u4route-mem minimum 96 m
  limit-resource u6route-mem minimum 24 m
  limit-resource m4route-mem minimum 58 m
  limit-resource m6route-mem minimum 8 ma
username admin password 5 $1$0507w209$jAC
no password strength-check
ip domain-lookup
vlan dot1Q tag native
system default switchport
```


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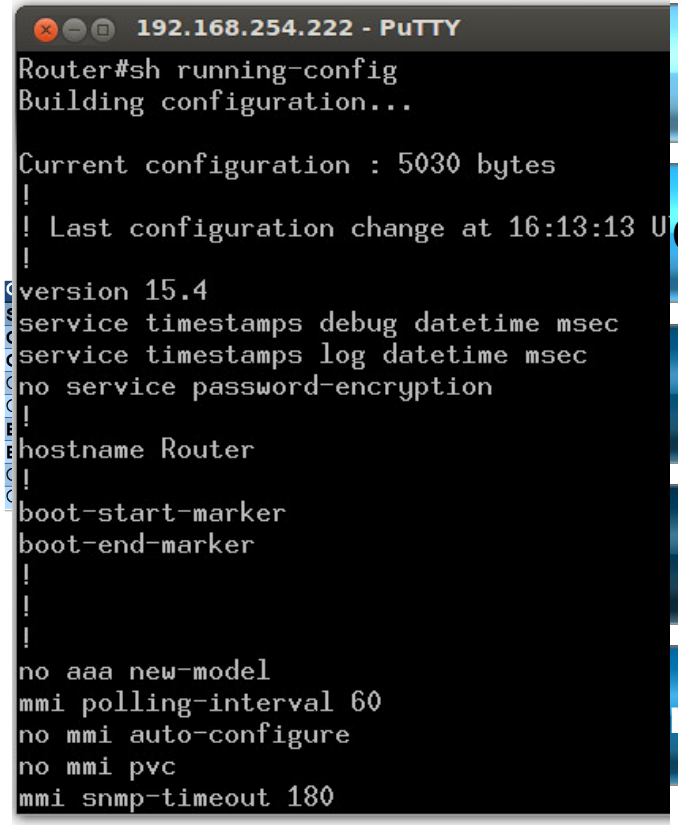
# IOS/NX-OS Similarities




Hostname & Prompt

CLI Format/EXEC Mod

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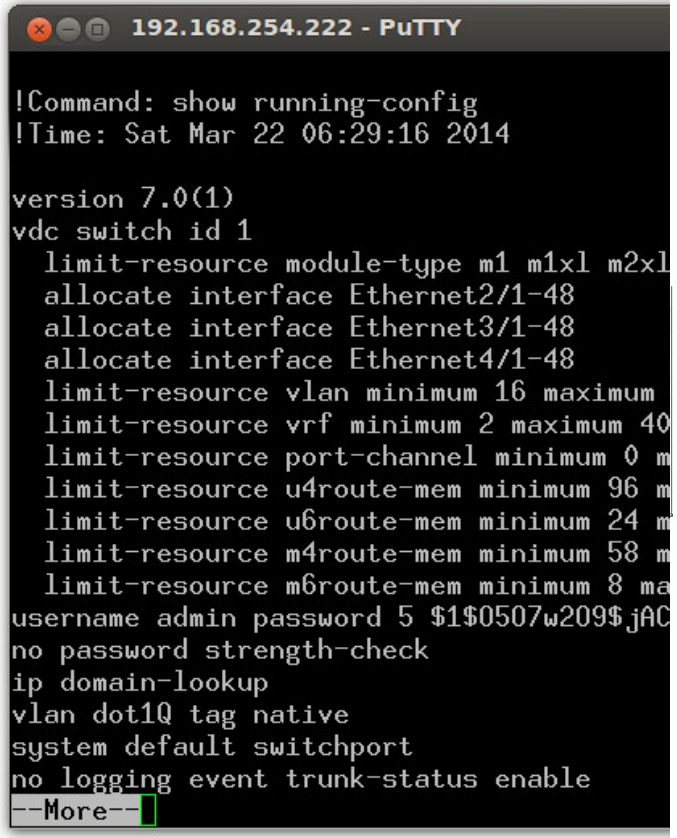



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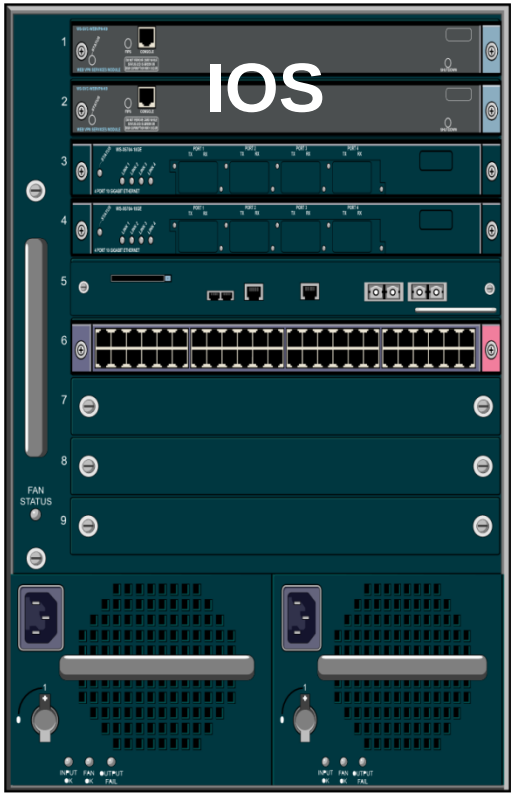
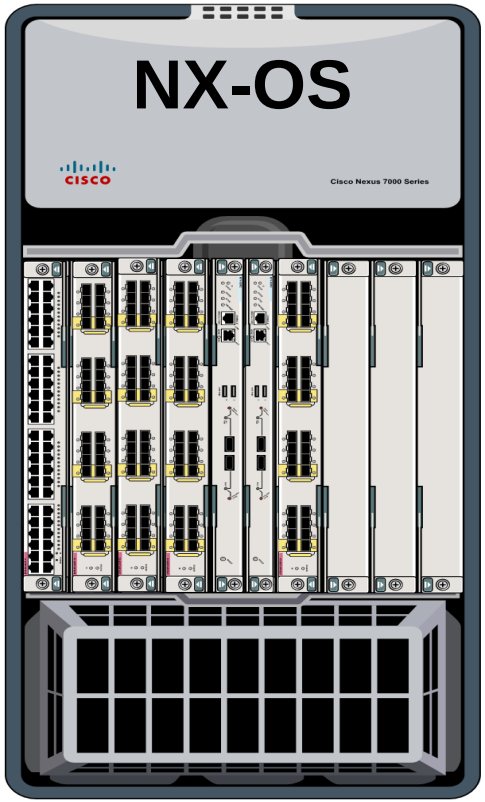
# IOS/NX-OS Feature Parity




## IP Routing

- IPv4/IPv6
- Static
- RIP
- OSPF
- EIGRP
- ISIS
- BGP
- PBR
- Route Maps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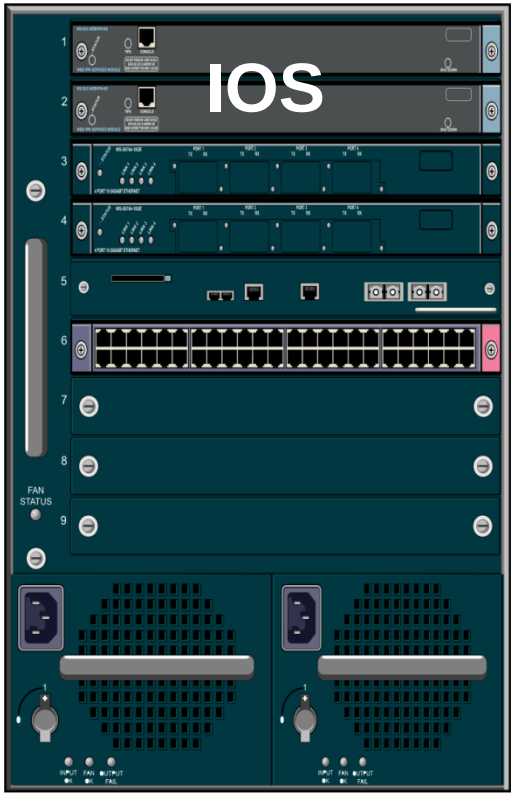
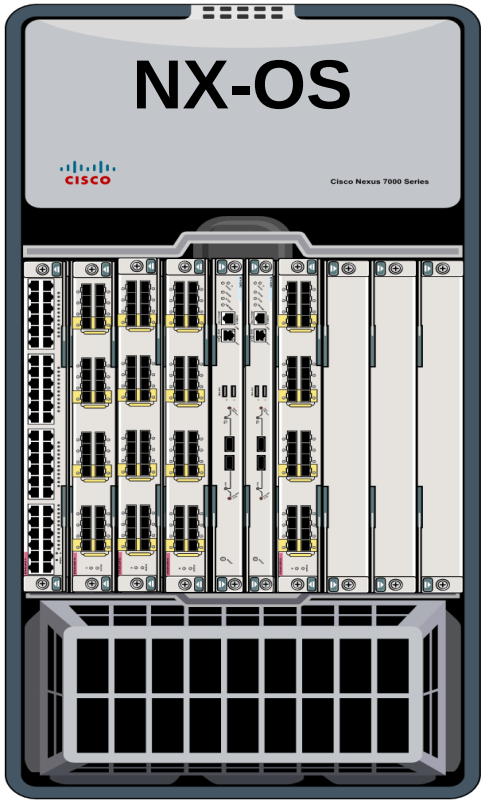
# IOS/NX-OS Feature Parity




## Multicast

- IGMP
- PIM
- MSDP
- IGMP Snooping
- SSM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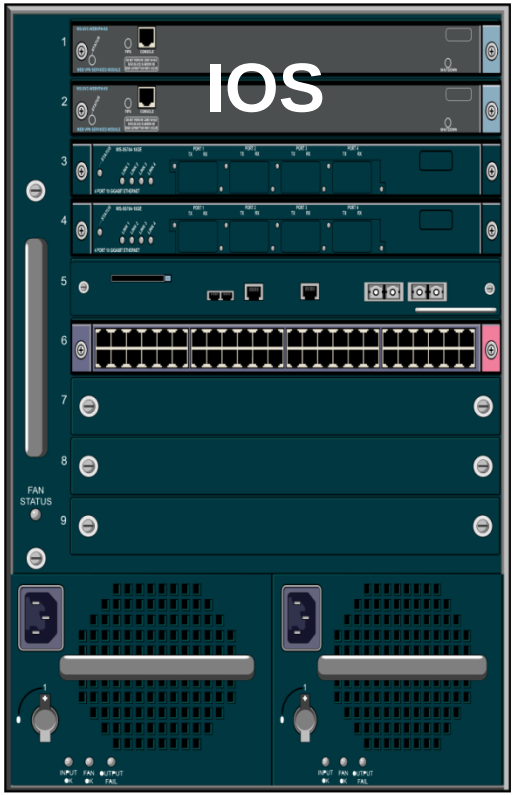
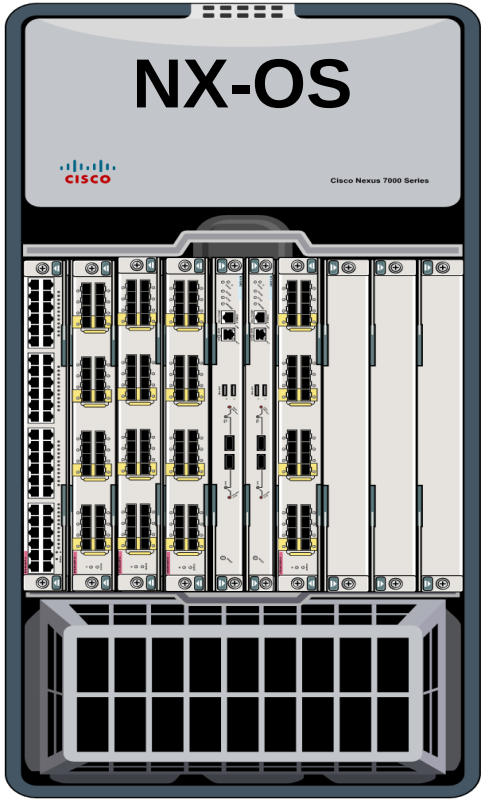
# IOS/NX-OS Feature Parity




## High Availability

- HSRP
- VRRP
- GLBP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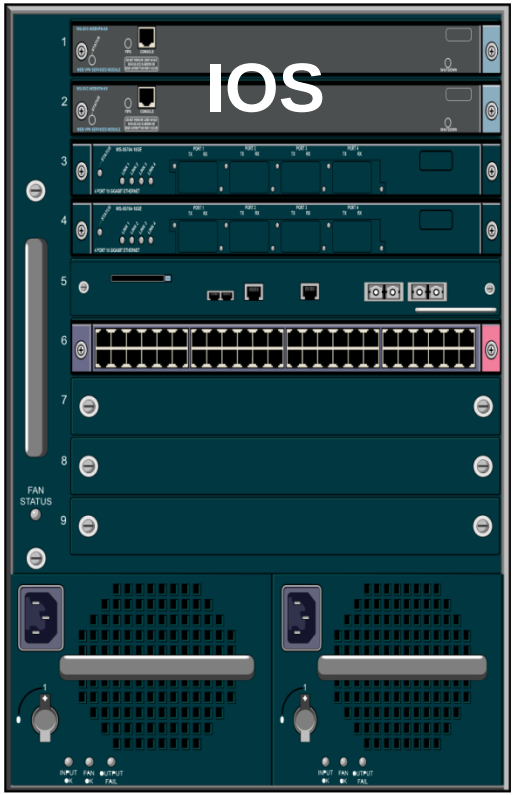
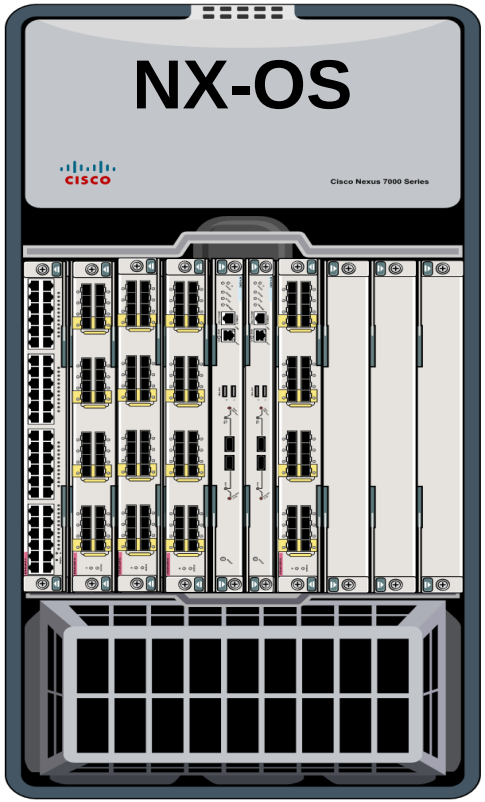
# IOS/NX-OS Feature Parity




## Security

- (R)ACLs
- MAC ACLs
- PACLs
- Port Security
- DHCP Snooping
- DAI
- PVLAN
- MPLS
- 802.1X/AAA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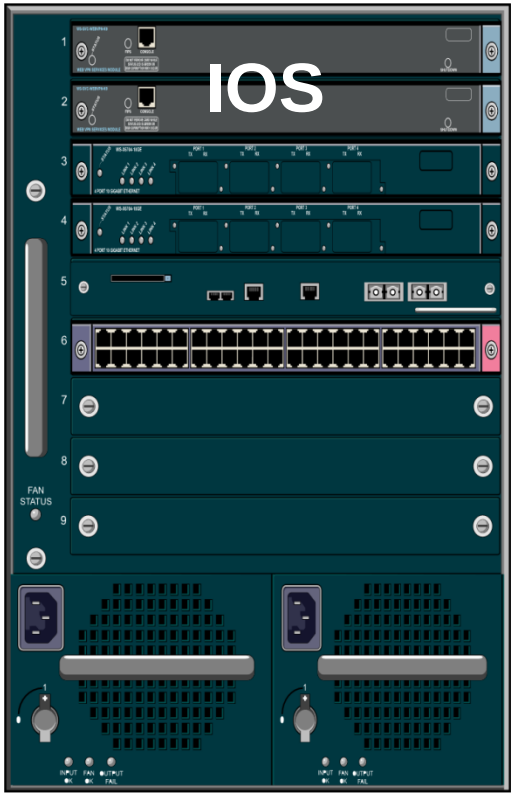
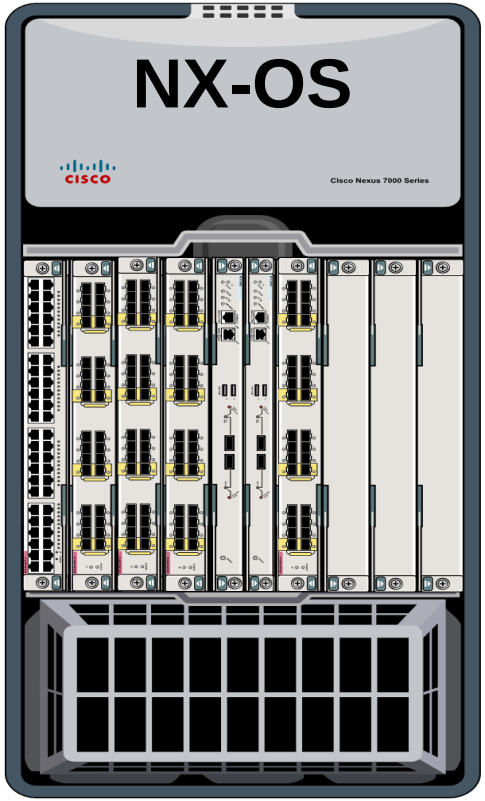
# IOS/NX-OS Feature Parity




## Other Features

- CDP
- LLDP
- Netflow
- VTP
- SNMP
- Port-Channels
- 802.1Q Trunks
- NTP
- Many More!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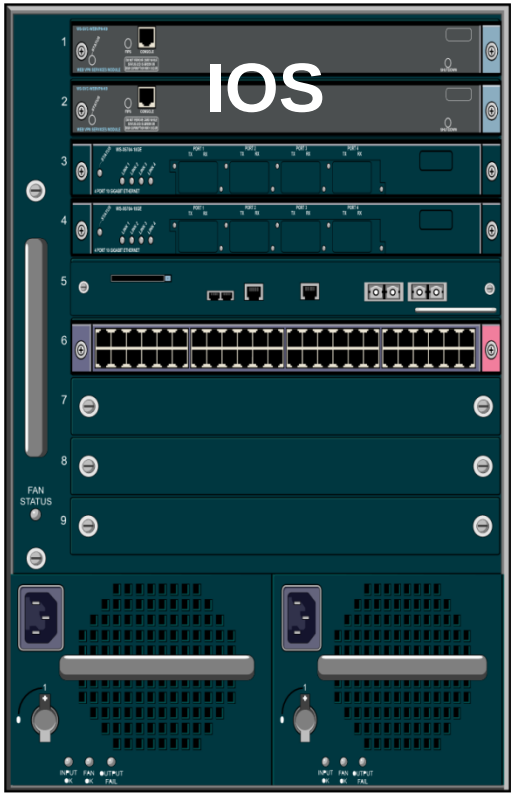
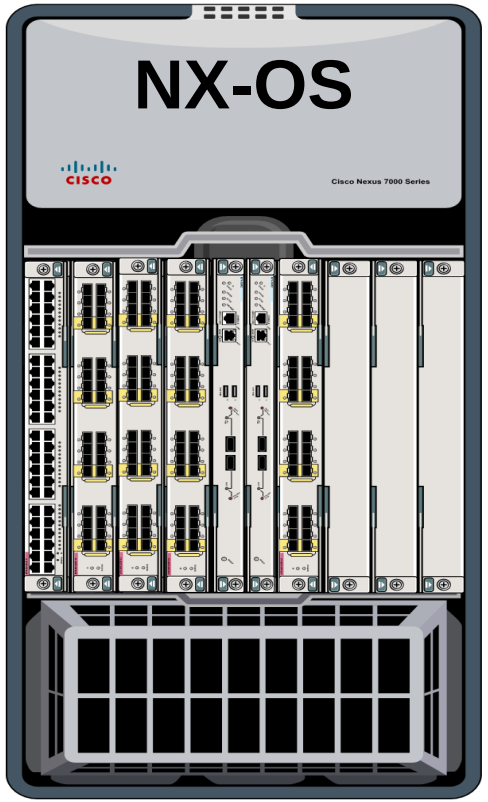
# IOS/NX-OS Differences




## System Access

- Admin User
- Setup Utility
- SSH enabled
- Default Prompt & Mode
- License installs
- RBAC





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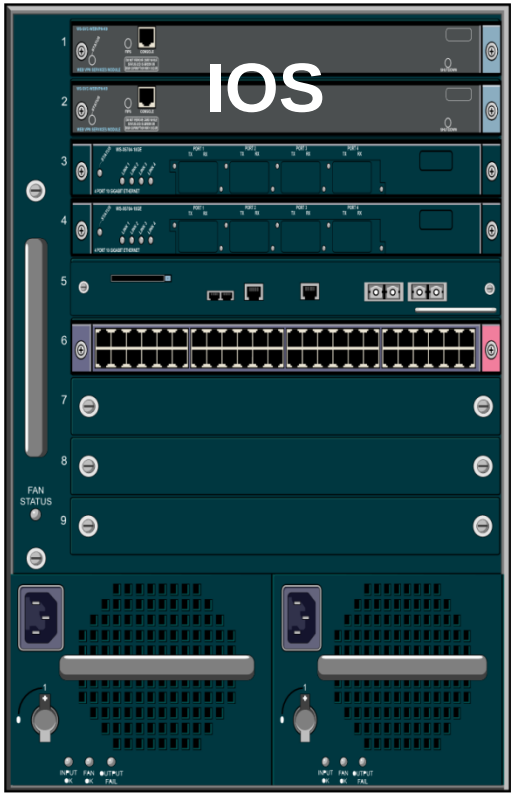
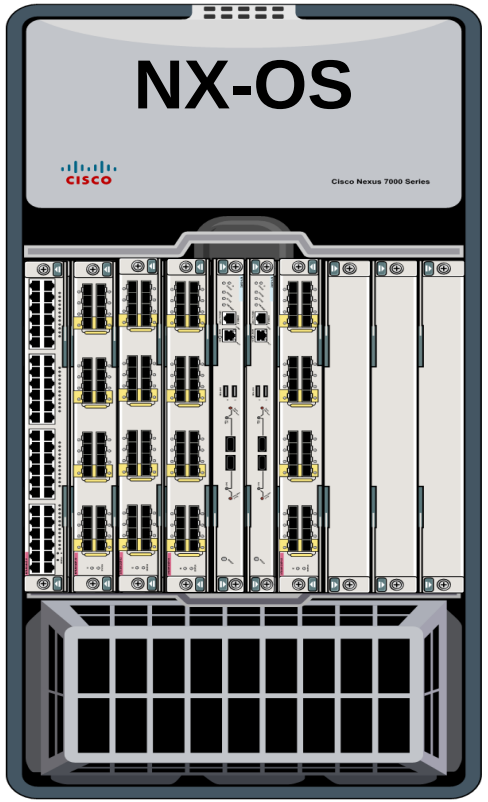
# IOS/NX-OS Differences




## System Operation

- Two OS images
- No write mem!
- VDCs
- Explicit Feature Enablement
- Configuration Rollback
- Different defaults
- No do command





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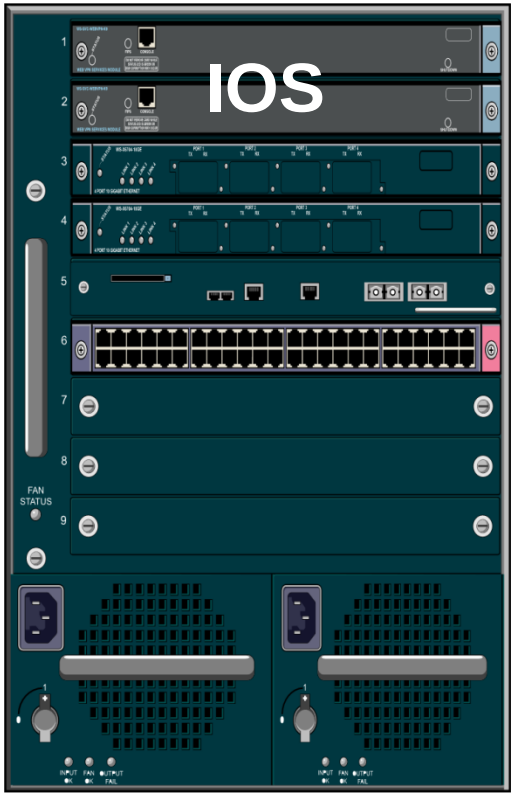
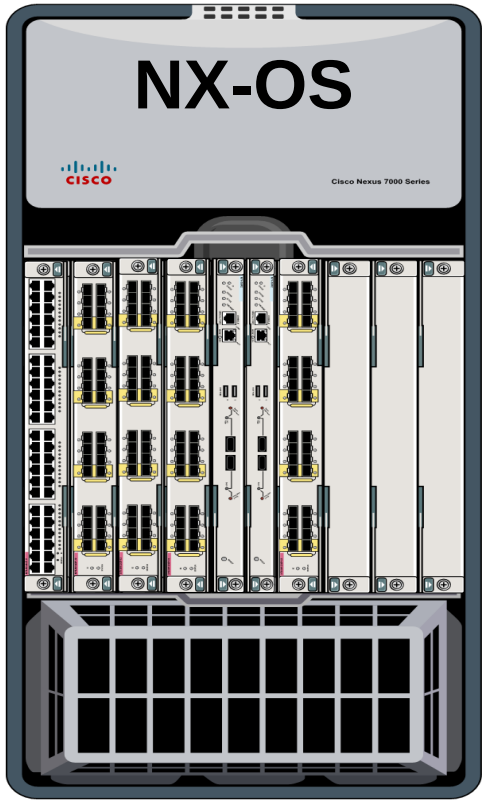
# IOS/NX-OS Differences




## Interfaces

- Ethernet (no speed reference)
- No traditional WAN interfaces
- OOB Management
- Port profiles
- No PoE support
- FC Interfaces
- FEX-Link





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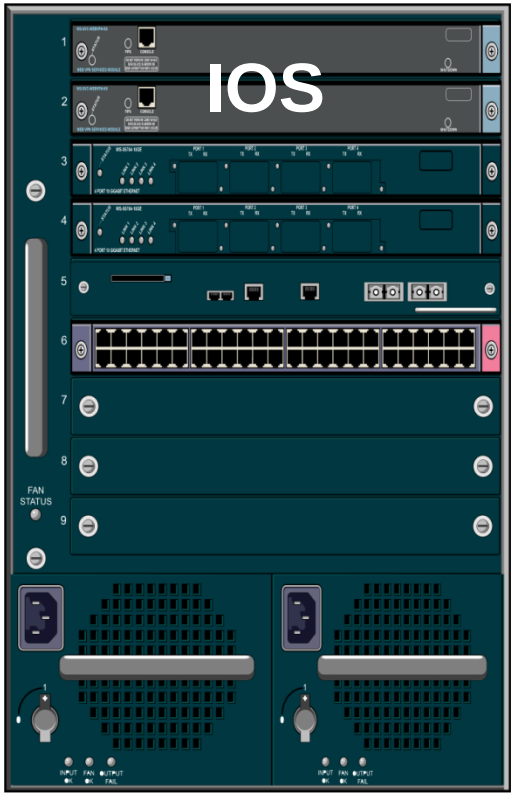
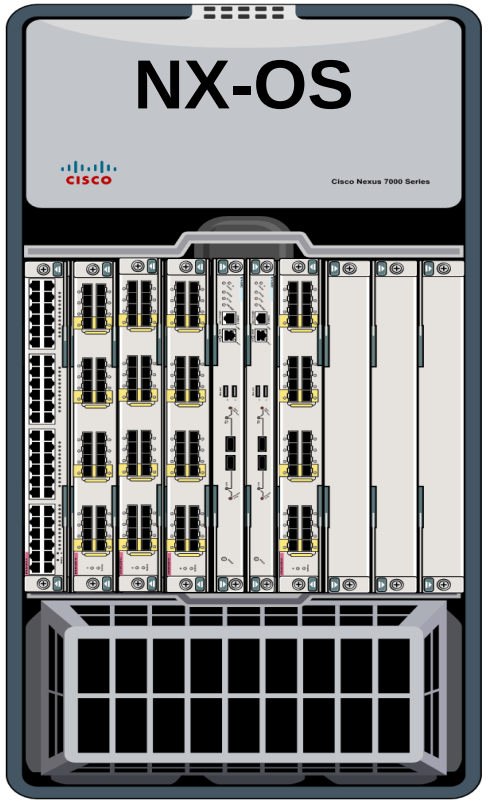
# IOS/NX-OS Differences




**IP Routing**

- **Redistribution behavior**
- **No network commands**
- **Syntax differences**
- **Other varied differences**





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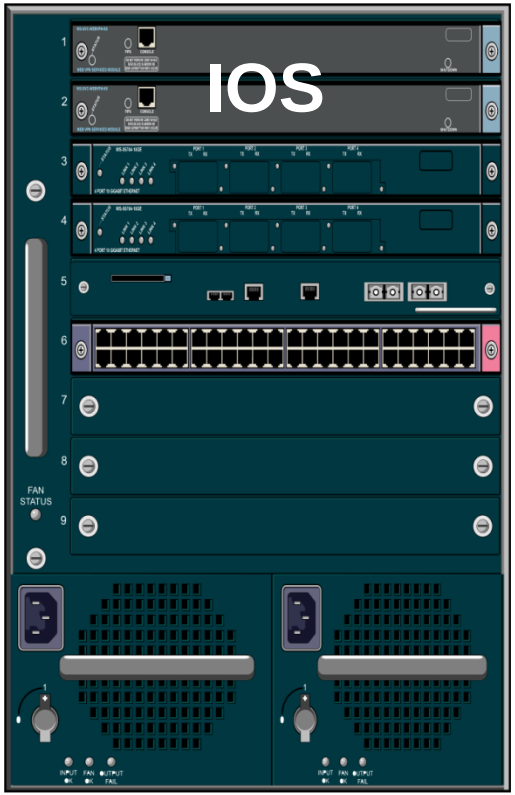
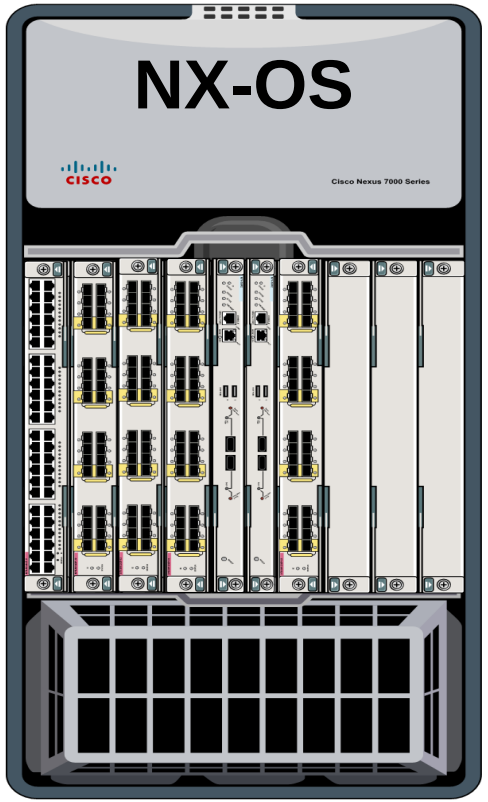
# IOS/NX-OS Differences




**Other**

- No voice support
- No NAT
- Many data-center only features
- No service modules
- Additional variations (see handouts)





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# IOS vs. NX-OS CLI DEMO

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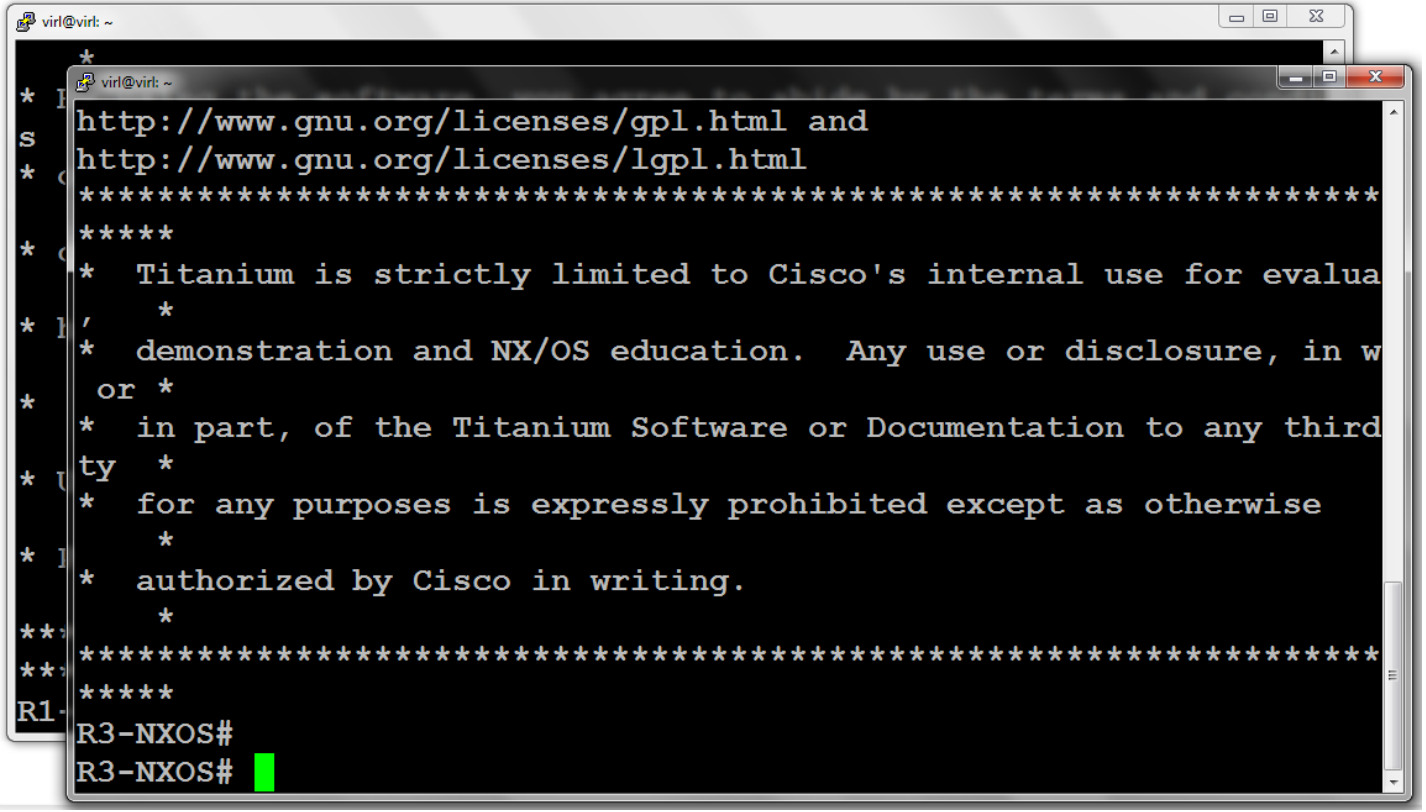
# IOS/NX-OS Lab Demo





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# IOS & IOS-XR: Comparison/Contrast

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# IOS/IOS-XR Similarities

**The Relationship of IOS and IOS-XR…**

**…Can be likened to that of cousins**


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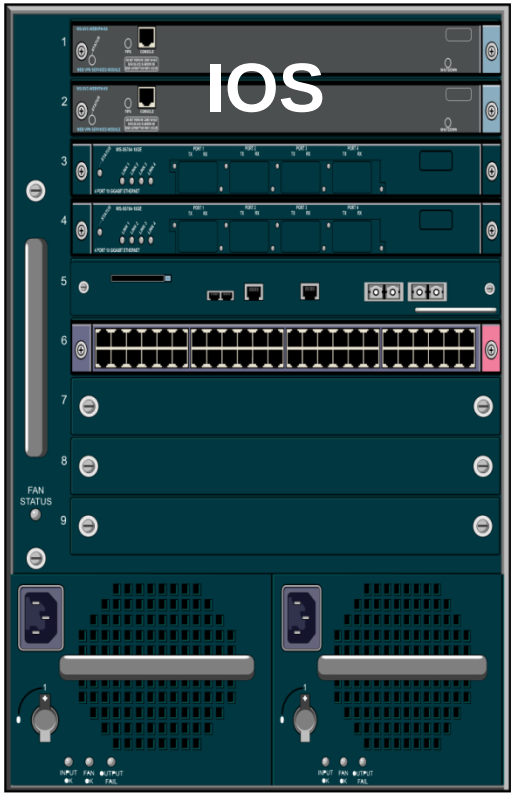
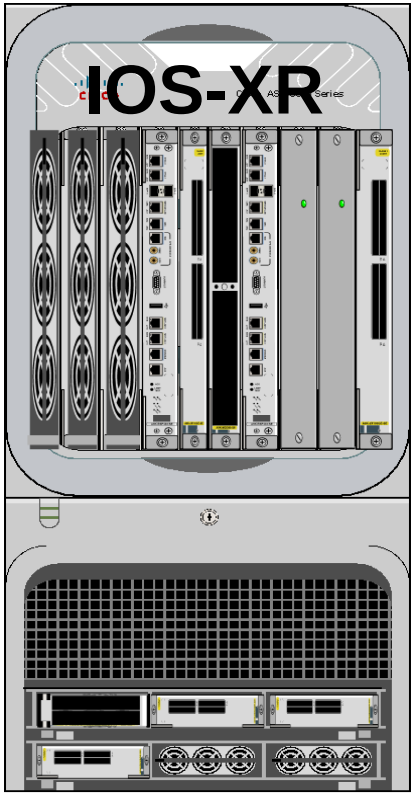
# IOS/IOS-XR Similarities




- CLI Format/EXEC Modes
- Naming
- CLI Prompts/Shortcuts
- Running Config
- Some Config/Show Commands





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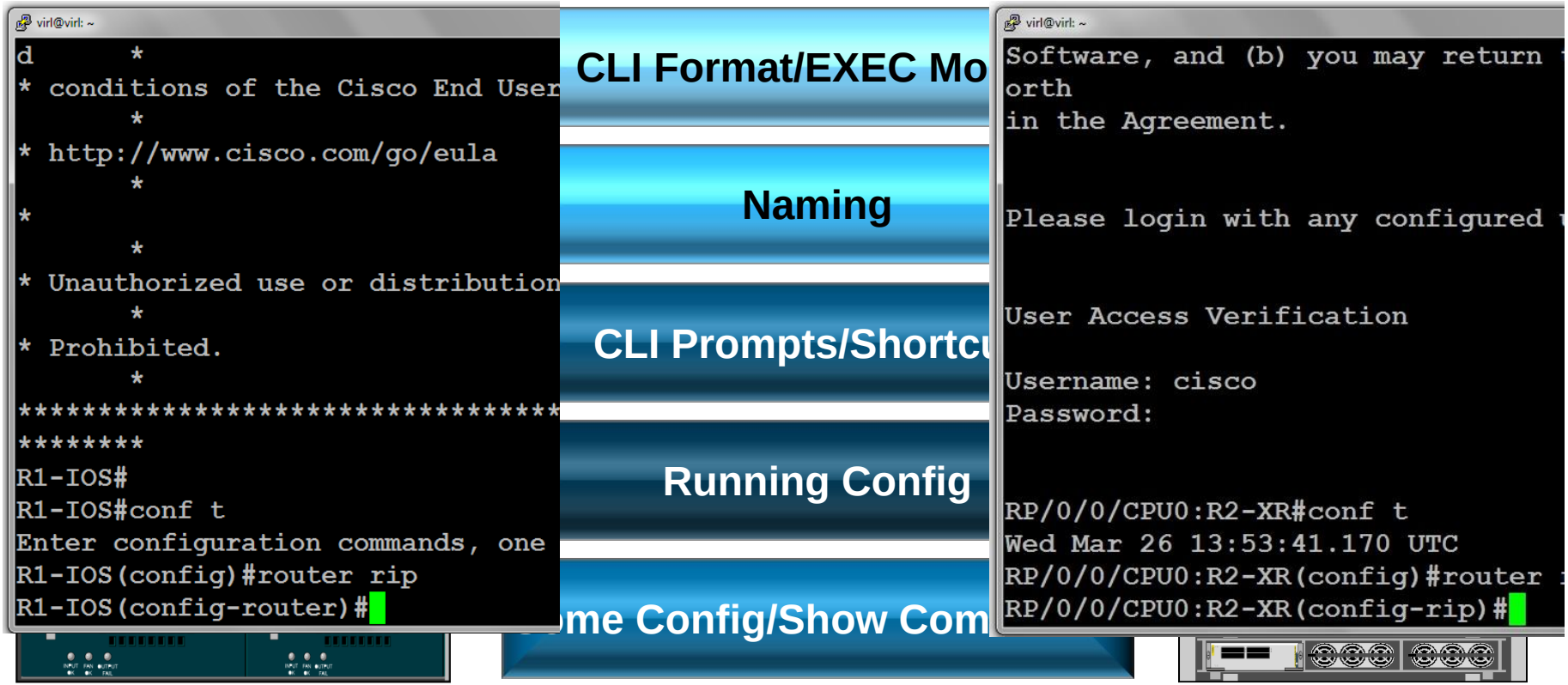
# IOS/IOS-XR Similarities





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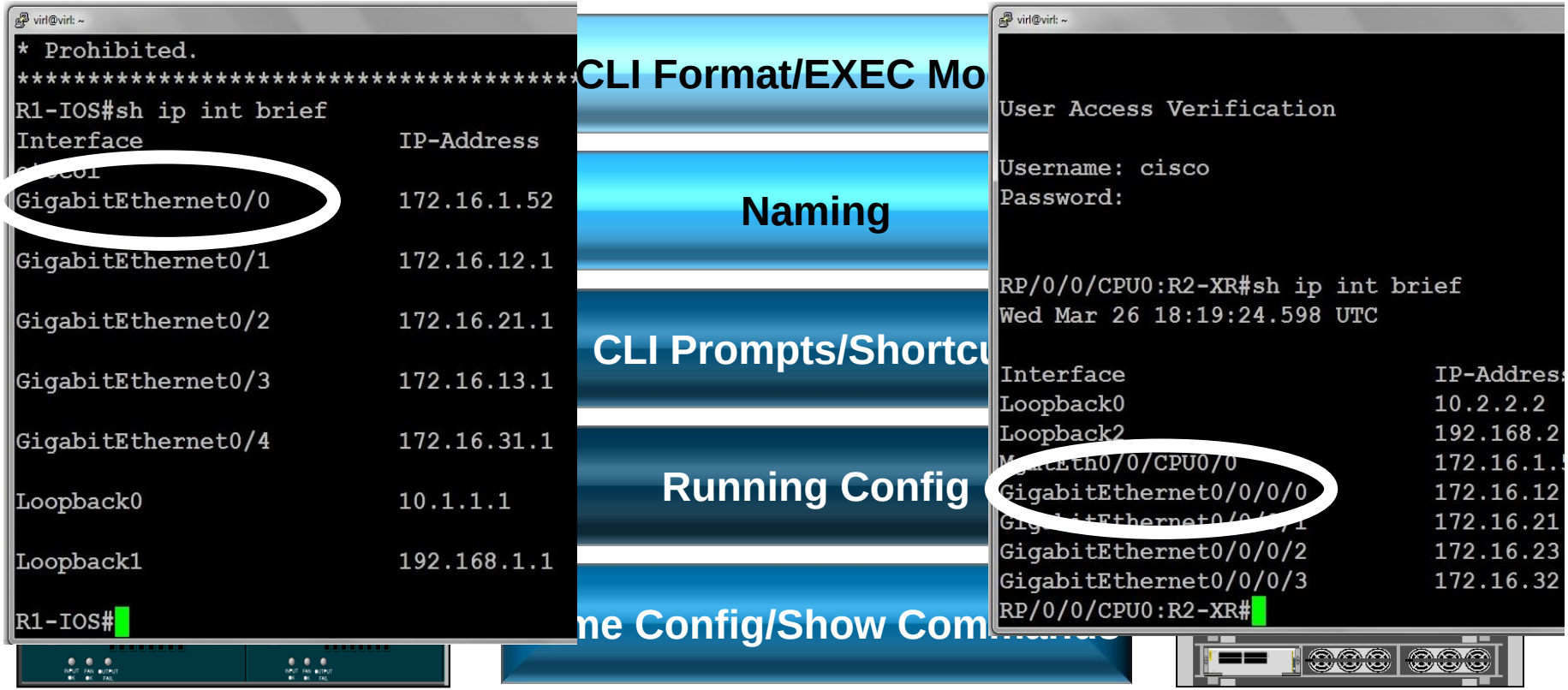
# IOS/IOS-XR Similarities





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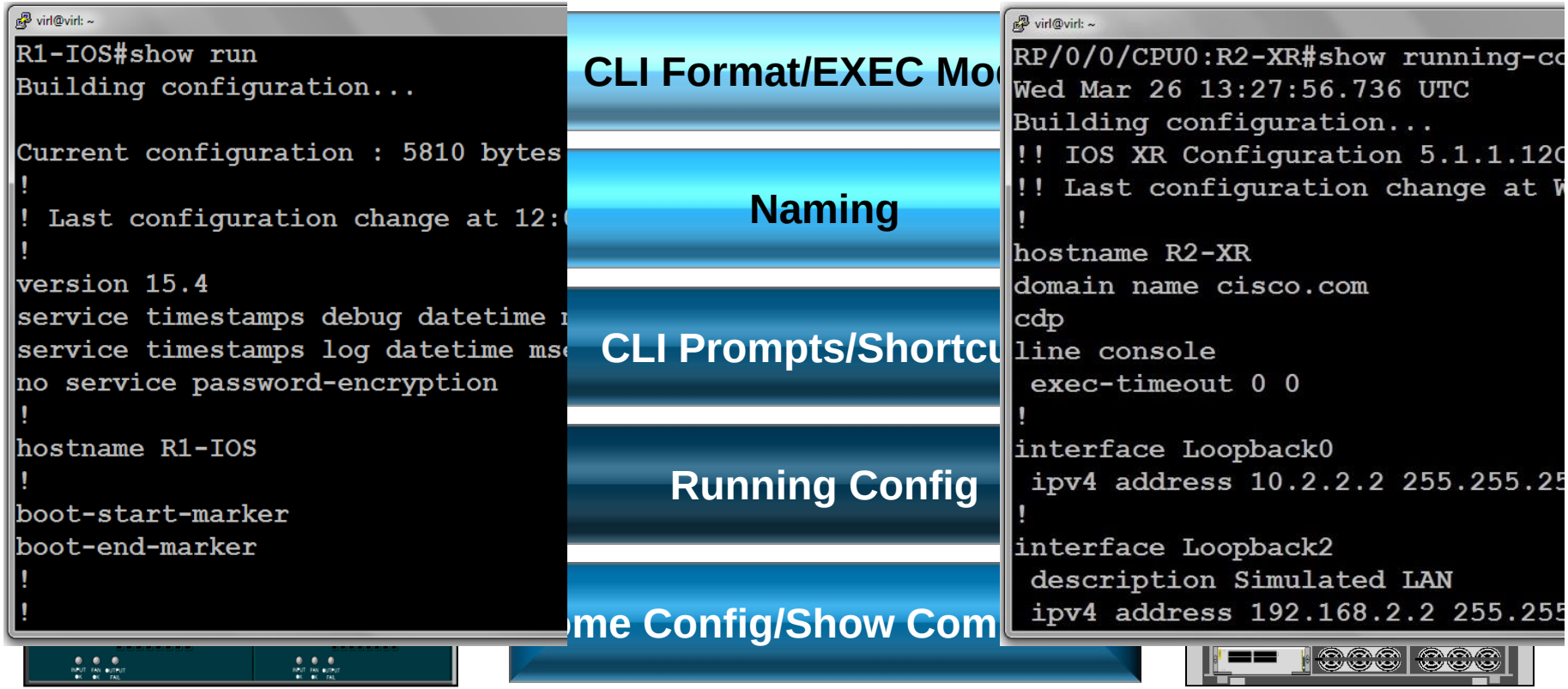



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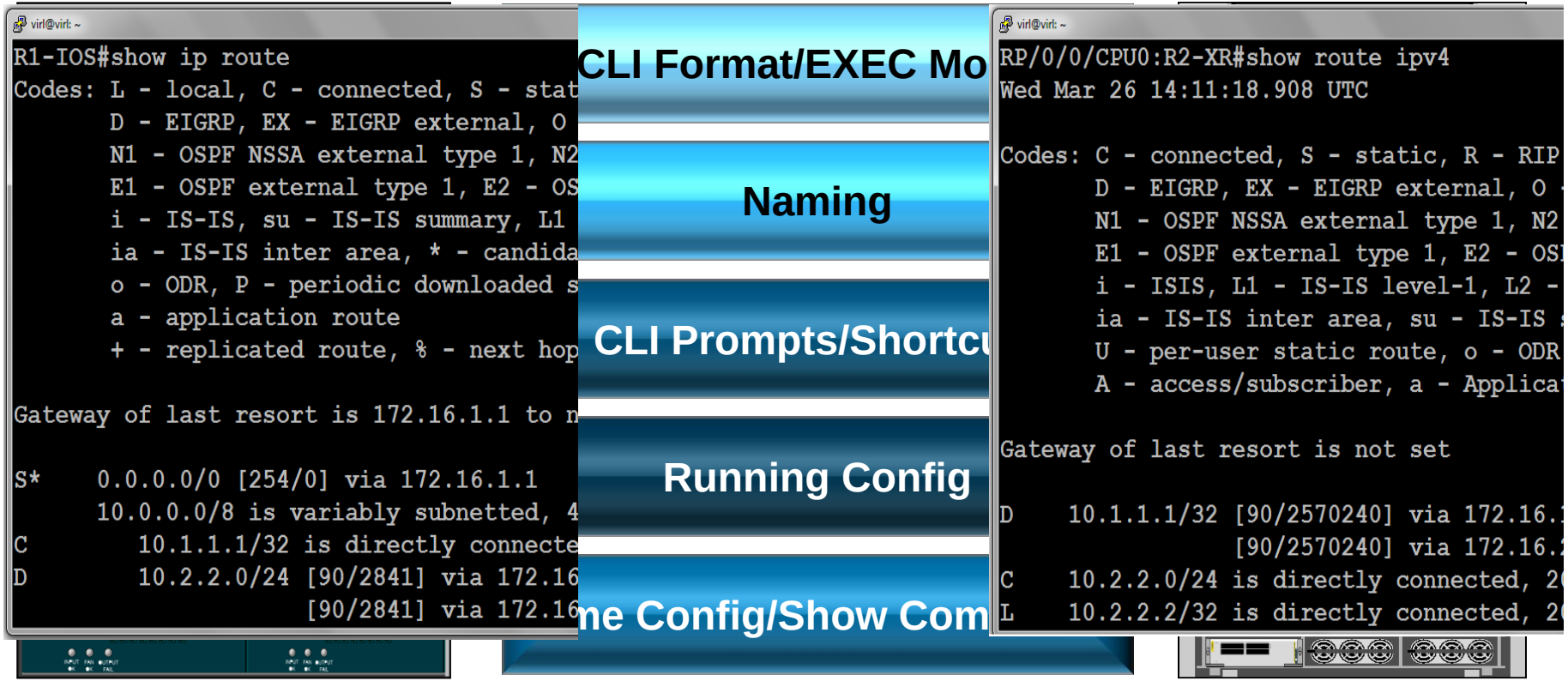
# IOS/IOS-XR Similarities





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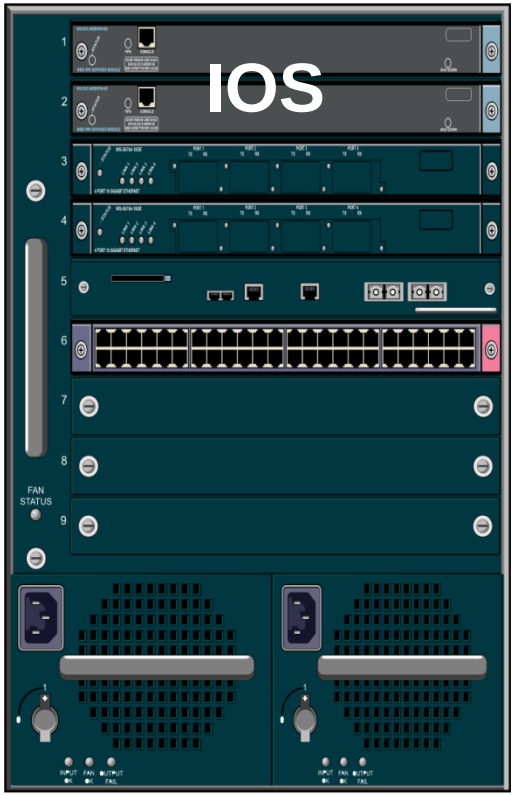
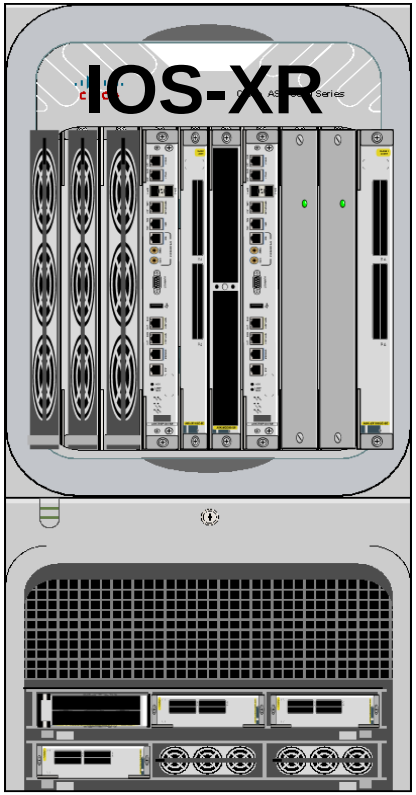
# IOS/IOS-XR Feature Parity




## IP Routing

- IPv4/IPv6
- Static
- RIP
- OSPF
- EIGRP
- ISIS
- VRF Support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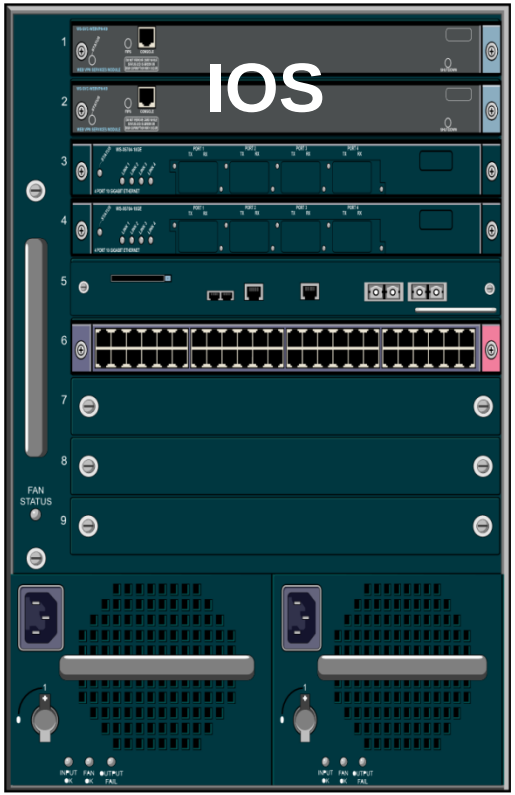
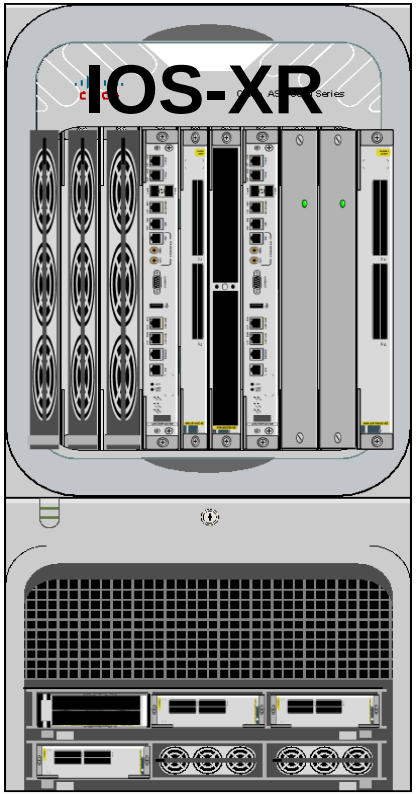
# IOS/IOS-XR Feature Parity




## Multicast

- IPv6/IPv6
- IGMP
- PIM
- MSDP
- SSM
- Auto-RP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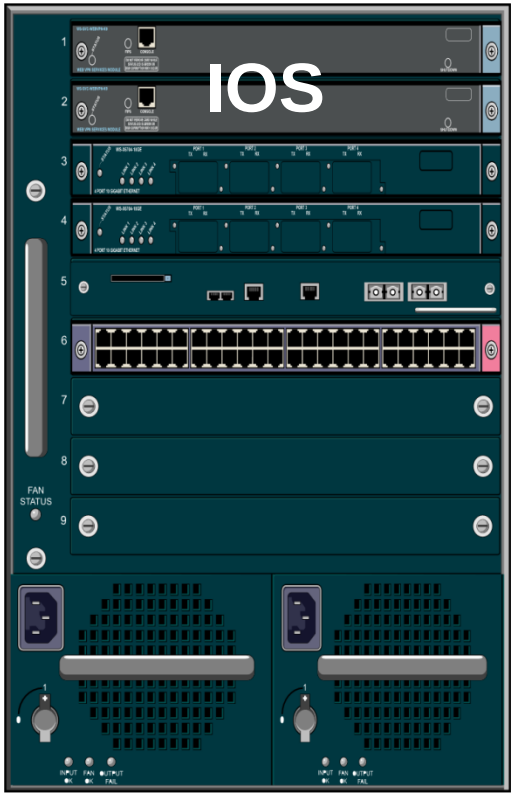
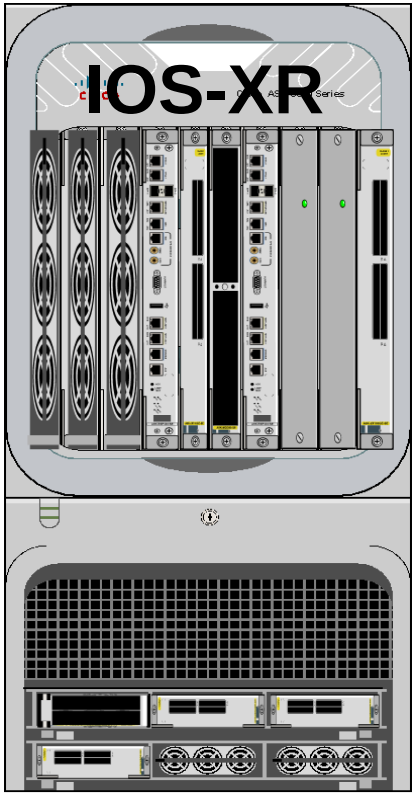
# IOS/IOS-XR Feature Parity




## High Availability

- **HSRP**
- **VRRP**
- **Multiple Route Processors**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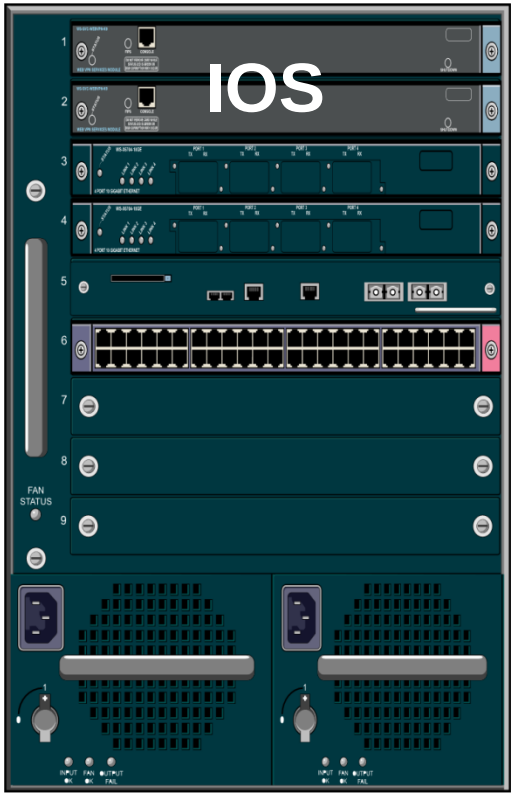
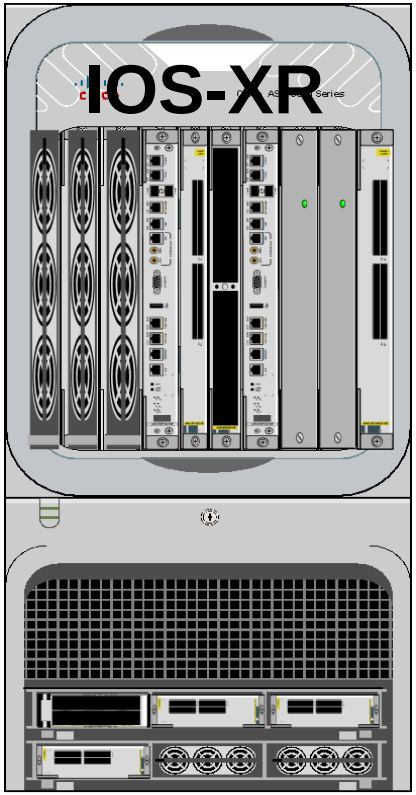
# IOS/IOS-XR Feature Parity




## Security

- AAA (RADIUS & TACACS+)
- ACLs
- uRPF
- MPP
- MPLS/VPN
- IPsec VPN
- DAI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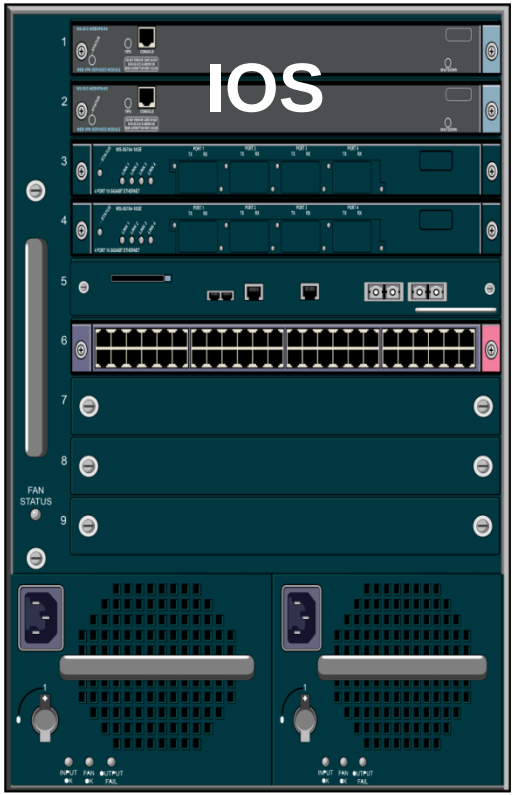
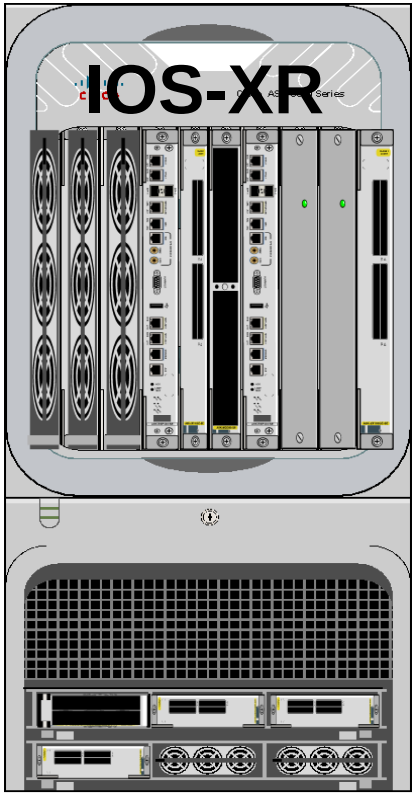
# IOS/IOS-XR Feature Parity




## Other Features

- CDP
- LLDP
- VTP
- SNMP
- 802.1Q VLANs
- NTP
- IP-SLA
- QoS (CBWFQ)
- IRB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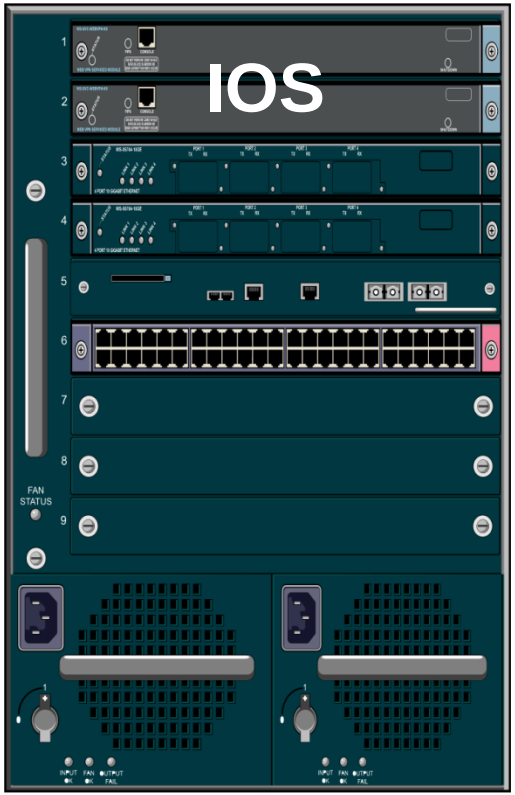
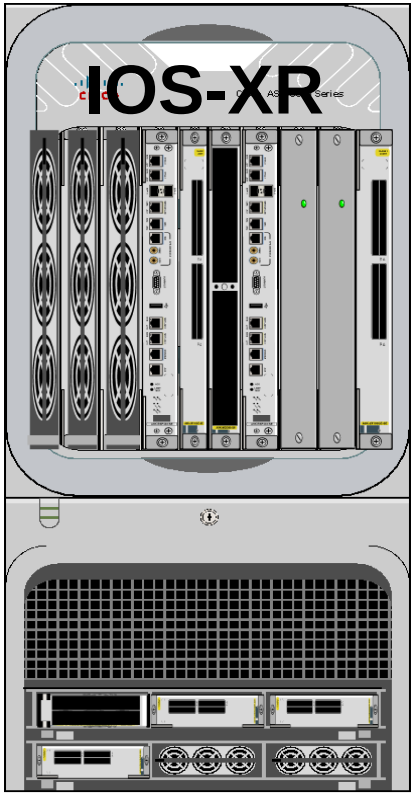
# IOS/IOS-XR Differences




## System Access

- User login
- Default Prompt & Mode
- Hostname
- Line configs
- Admin mode
- License installs
- RBAC





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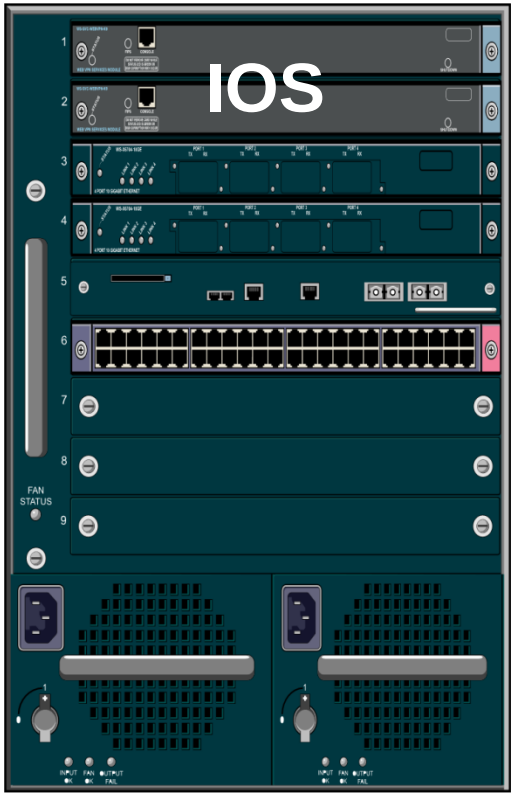
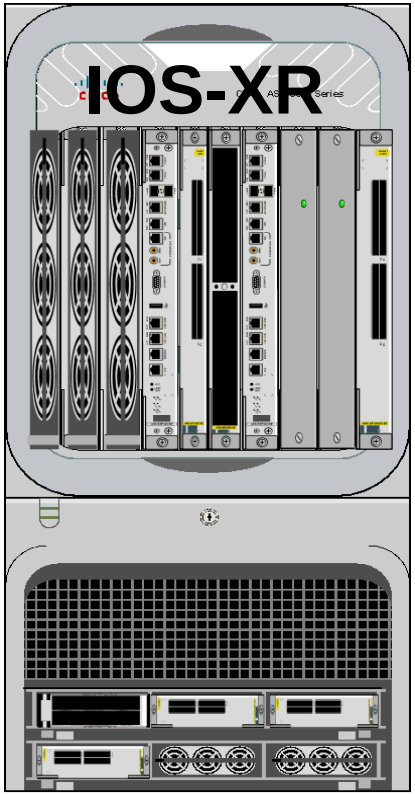
# IOS/IOS-XR Differences




## System Operation

- PIE images
- SDRs
- Two-stage config
- No write mem!
- Configuration Rollback
- Management interface
- Boot options





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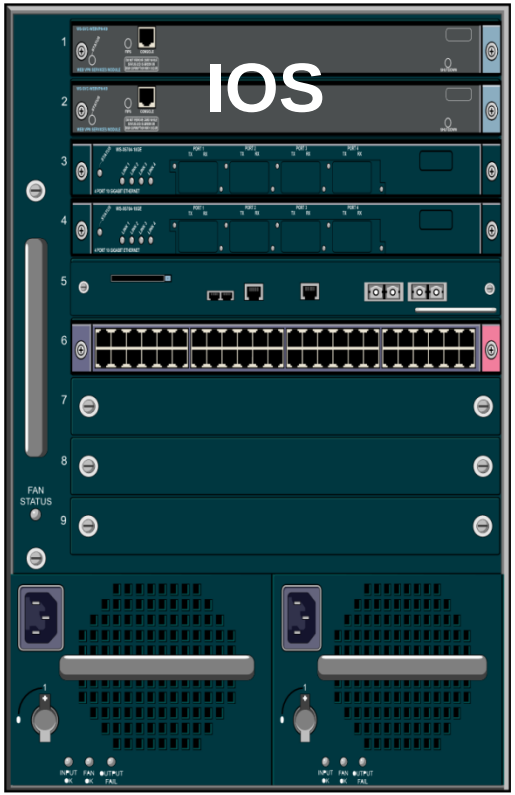
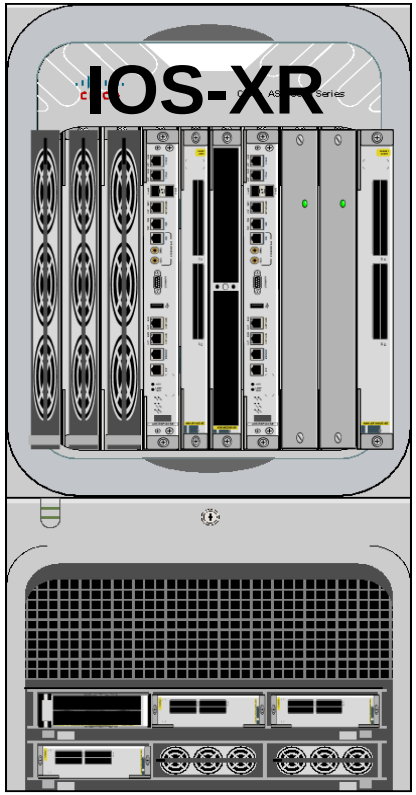
# IOS/IOS-XR Differences




## Interfaces

- DWDM/Optical
- Carrier Ethernet
- SIP/SPA*
- Packet over SONET
- 100 GB Ethernet
- No PoE support
- No voice ports
- Link bundling




*** Model/platform dependent**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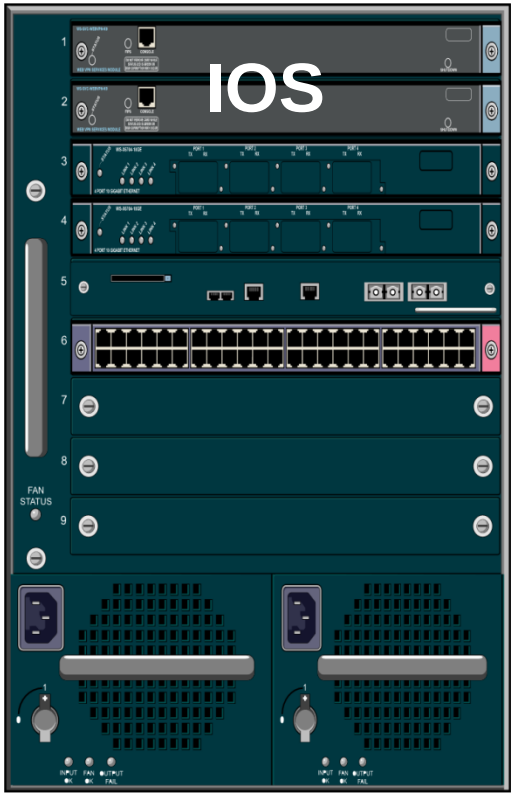
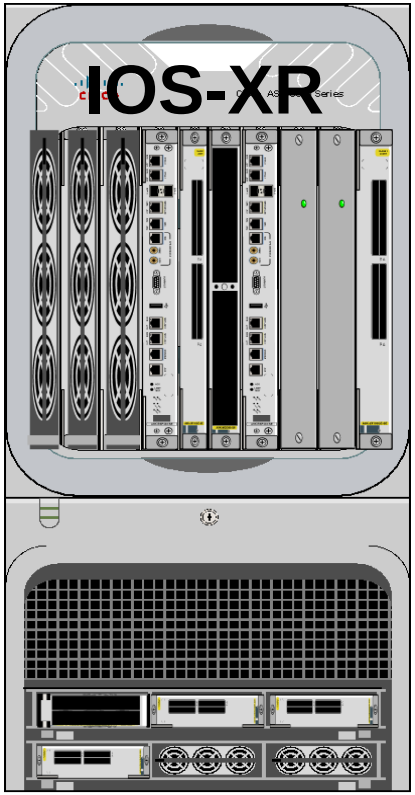
# IOS/IOS-XR Differences




## IP Routing

- Must specify IPv4/IPv6 address
- Address-family
- Route Policy Language (RPL)
- No network statements
- Unique router config commands





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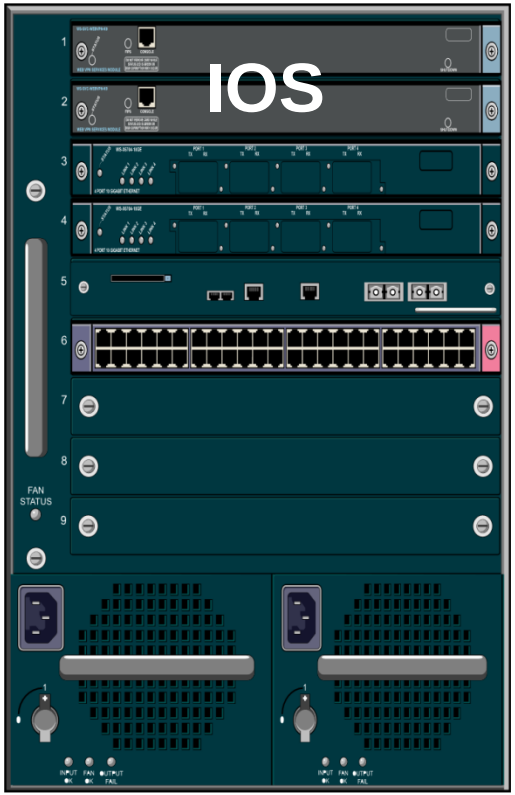
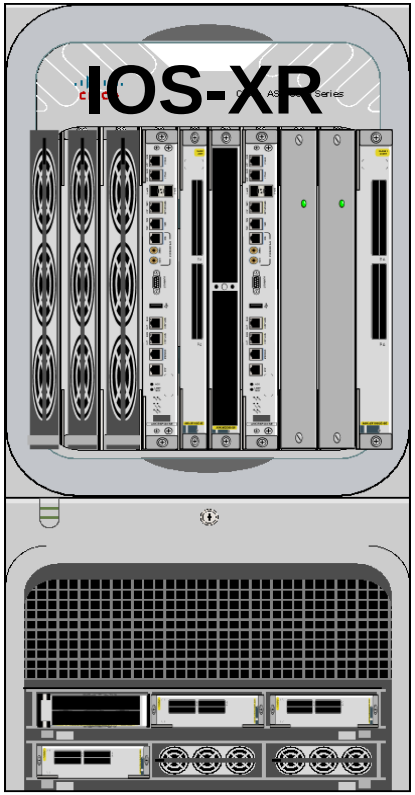
# IOS/IOS-XR Differences




**Other**

- No voice support
- Carrier grade NAT
- Many carrier only features
- LPTS
- SFTP support
- CLI Utilities
- Numerous others





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# IOS vs. IOS-XR CLI DEMO

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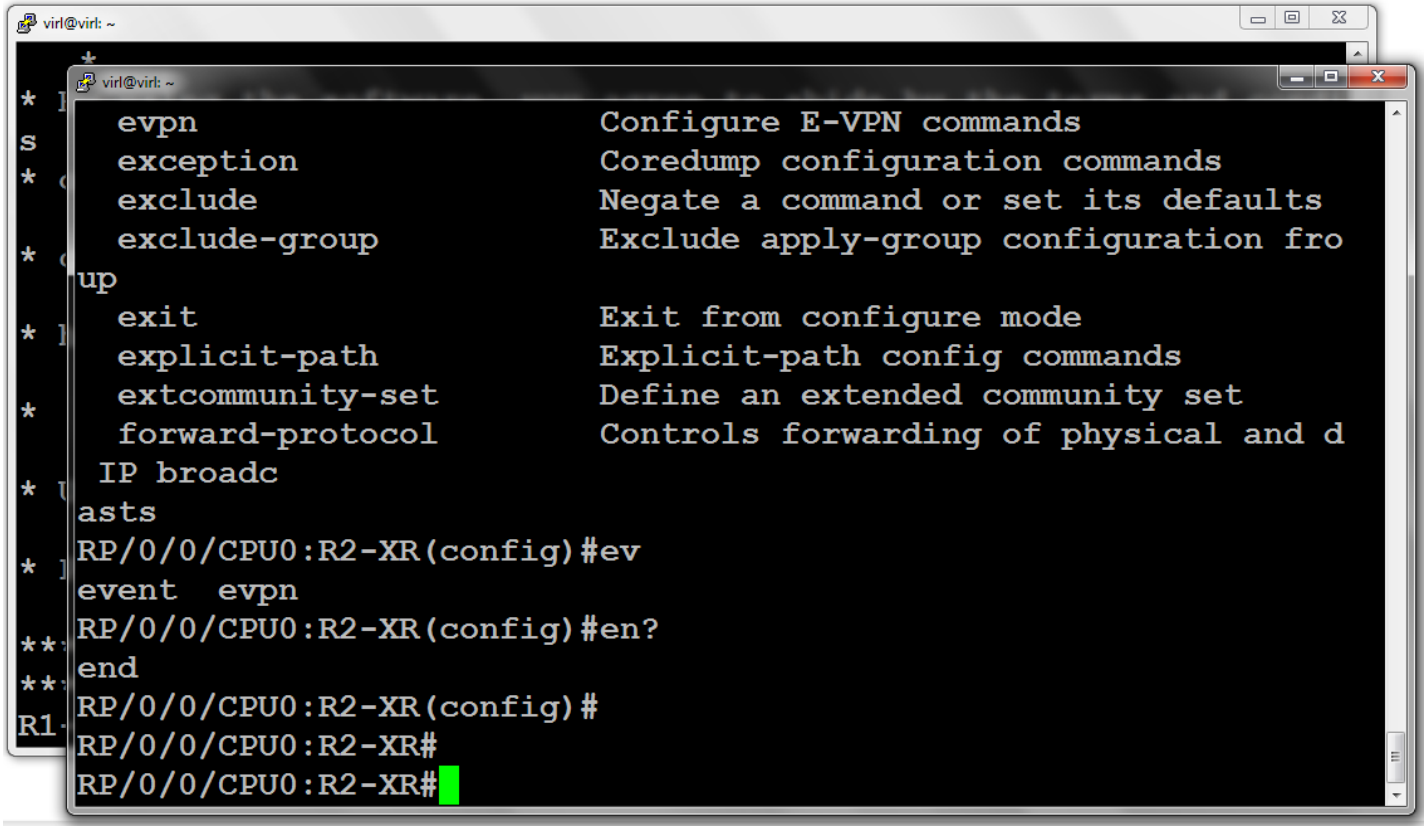
# IOS/IOS-XR Lab Demo





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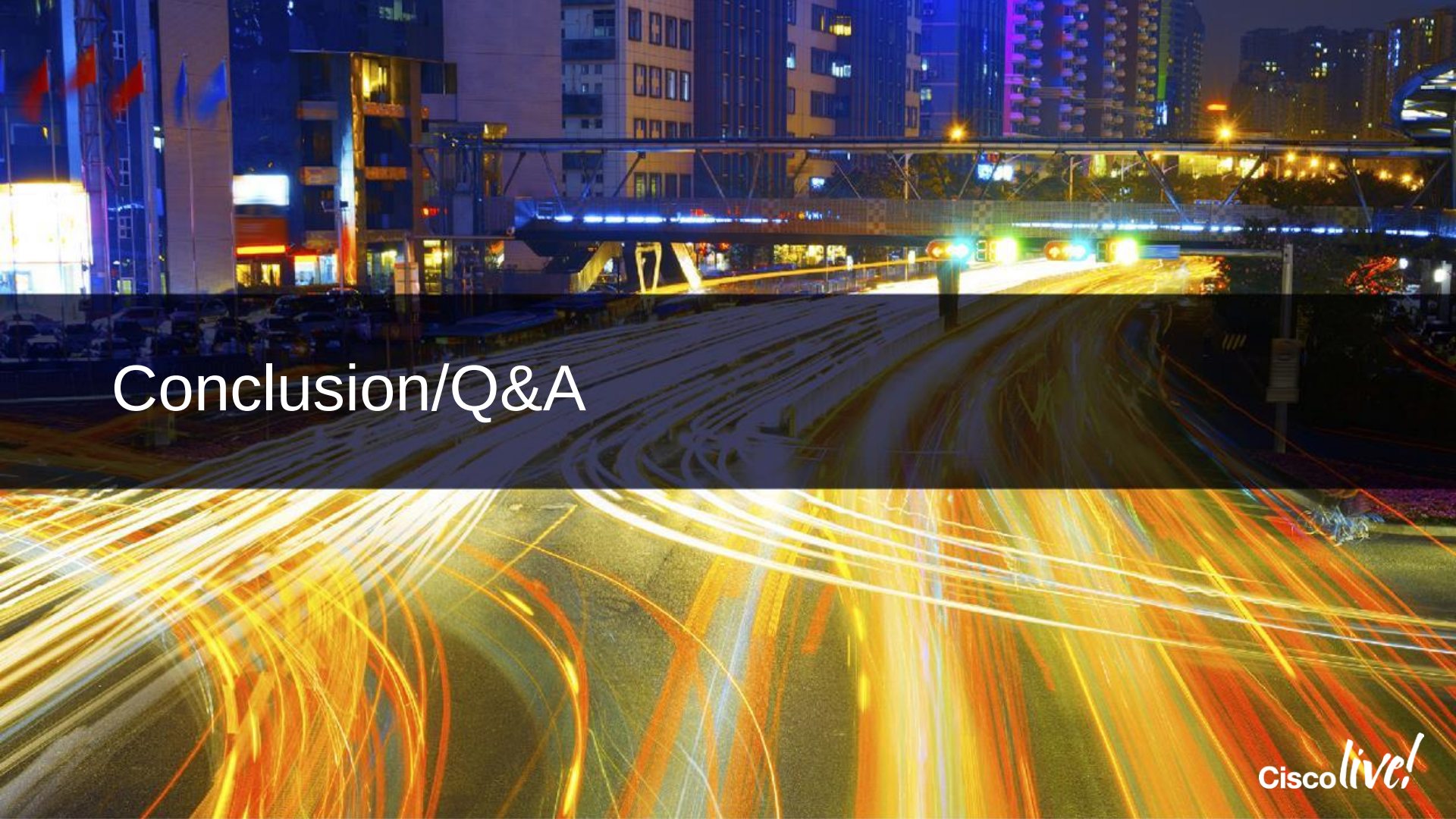

# Conclusion/Q&A

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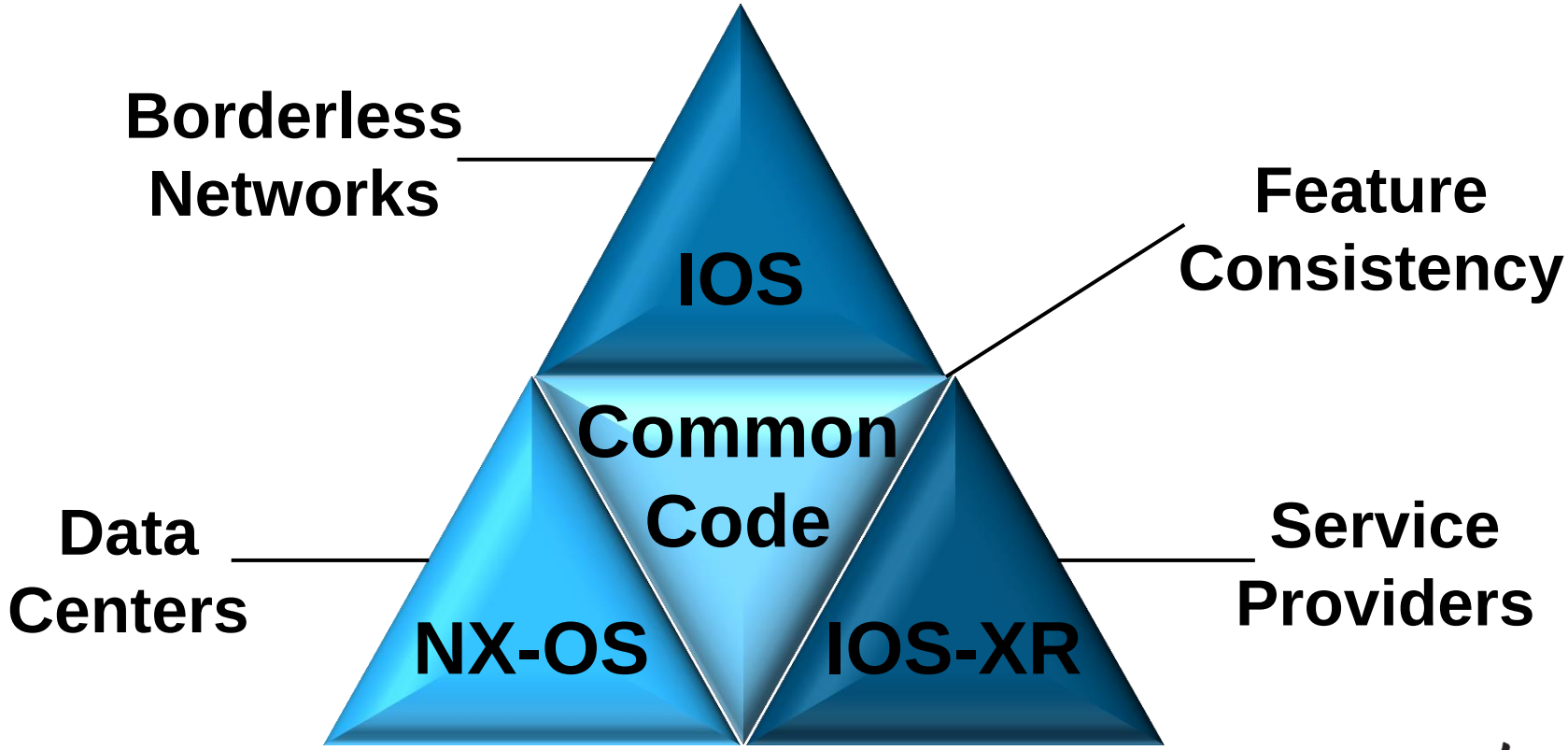
# Tying It All Together





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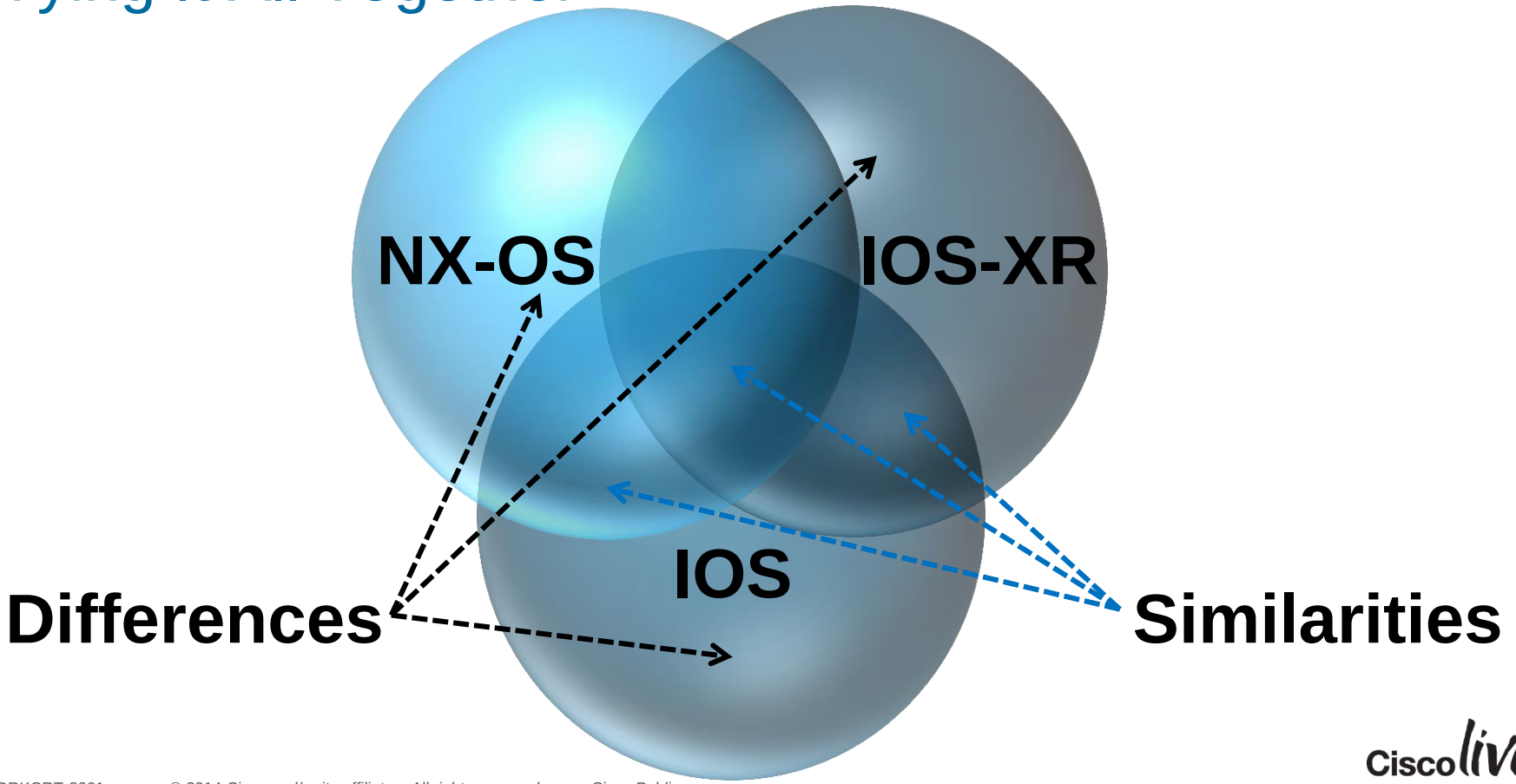
# Tying It All Together





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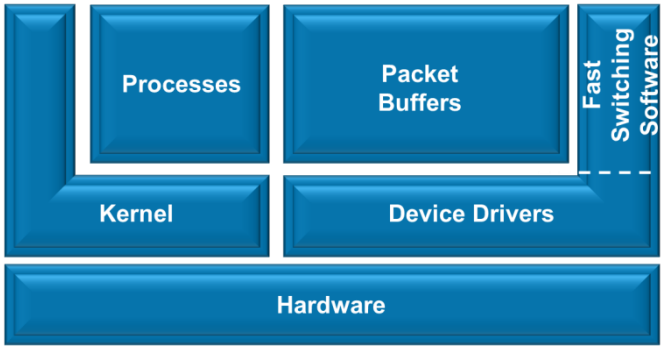
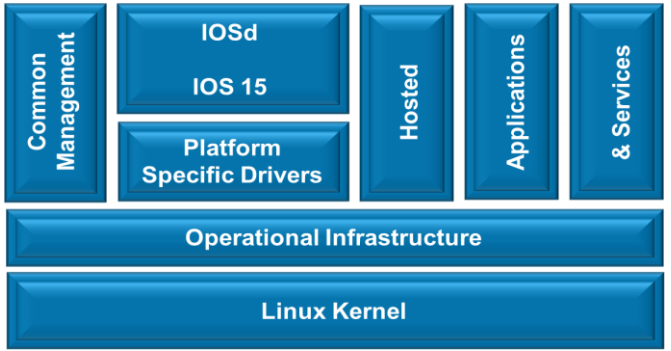
# Things to Remember

## About IOS/IOS-XE

- **User experience (CLI/UI) virtually identical**
- **Very different architectures**
- **IOS daemon running in Linux**
- **IOS traditionally monolithic, XE is highly modular**
- **Platforms supporting XE are increasing in number**





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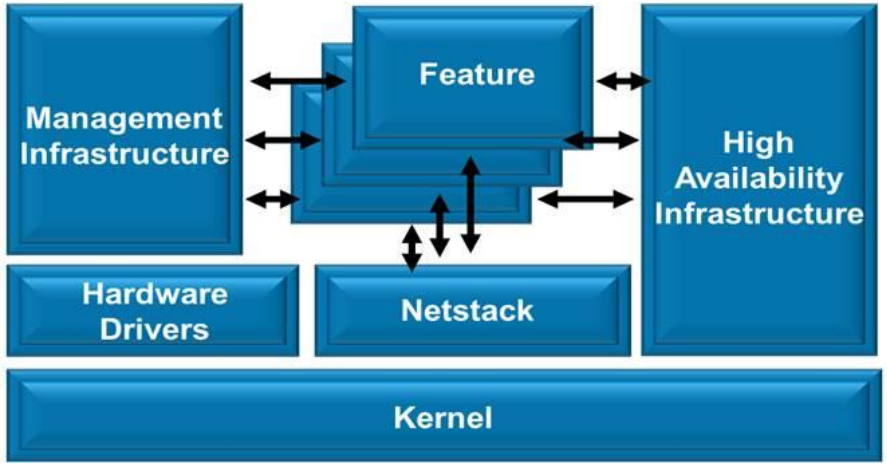
# Things to Remember

## About NX-OS

- **Explicit feature enablement**
- **Same running/startup config setup as IOS**
- **No interface speed references (ethernet)**
- **CIDR addressing format**
- **No Do command needed for exec commands in config**
- **No wr mem command (must create alias)**



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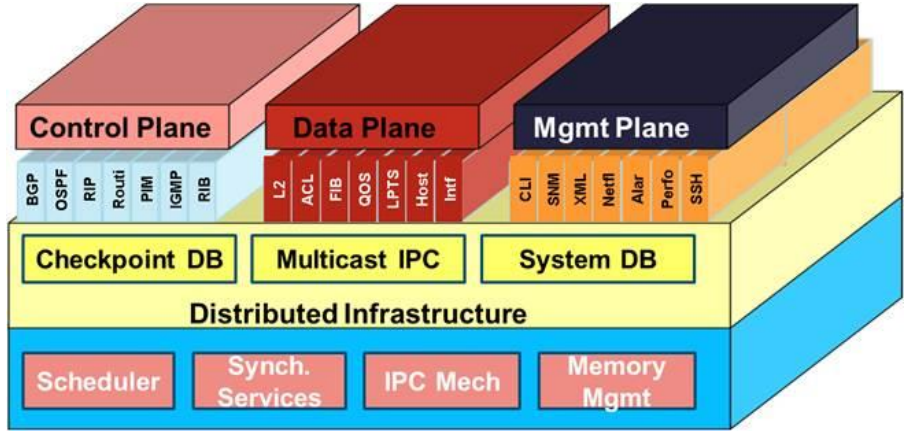
# Things to Remember

## About IOS-XR

- **Two-stage config commit**
- **CIDR addressing format**
- **Secure Domain Router**
- **Admin CLI mode**
- **Vastly different CLI syntax**
- **Route Policy Language (RPL)**
- **System access and prompts**
- **Software installation and updates (e.g., PIE)**
- **Configuration rollback**



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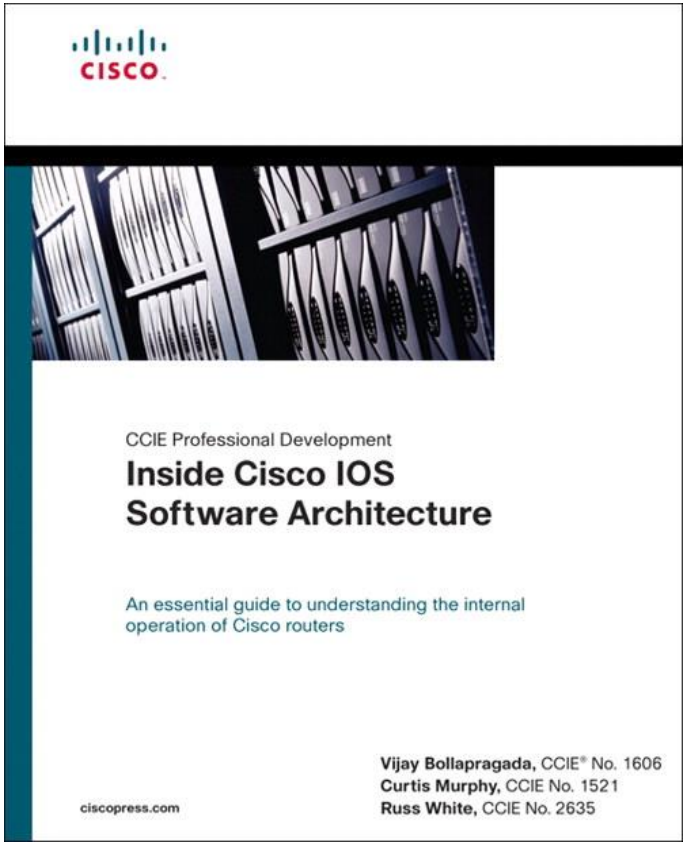
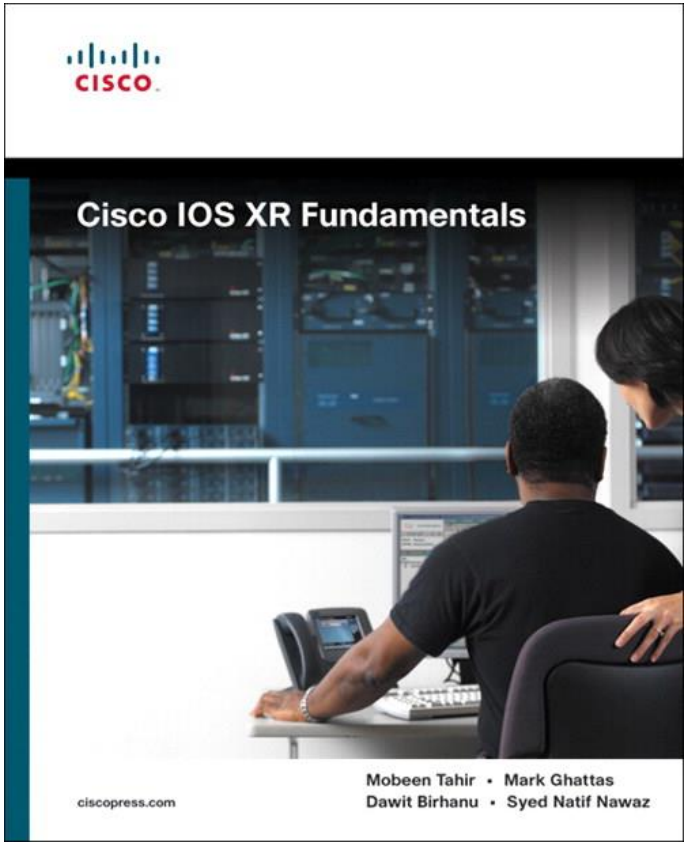
# Additional Resources





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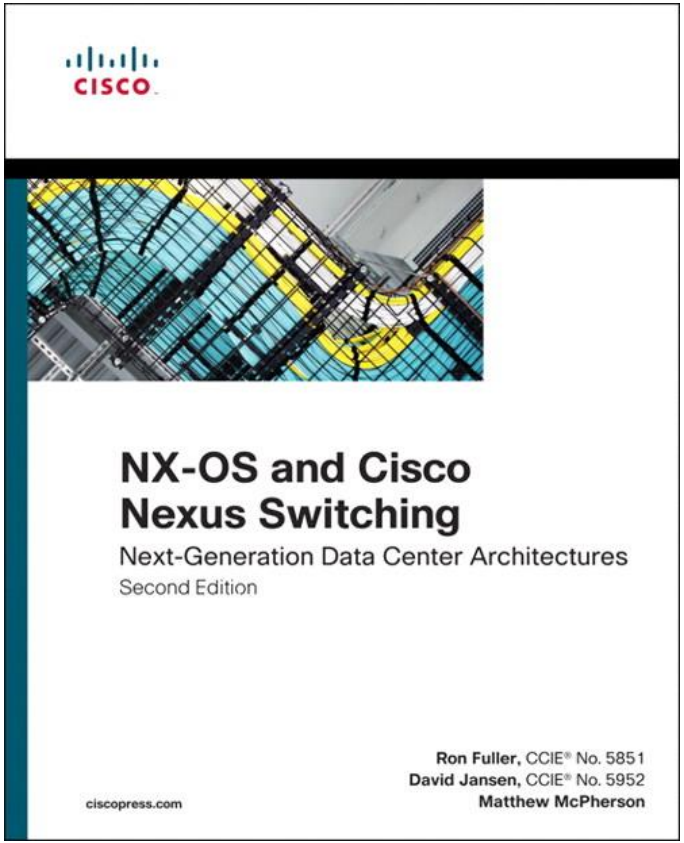
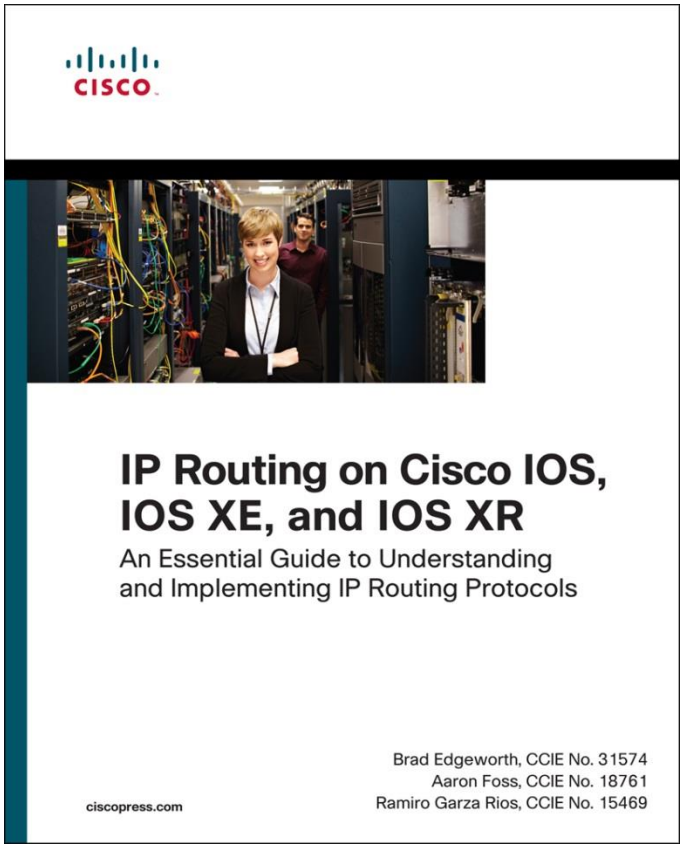
# Additional Resources





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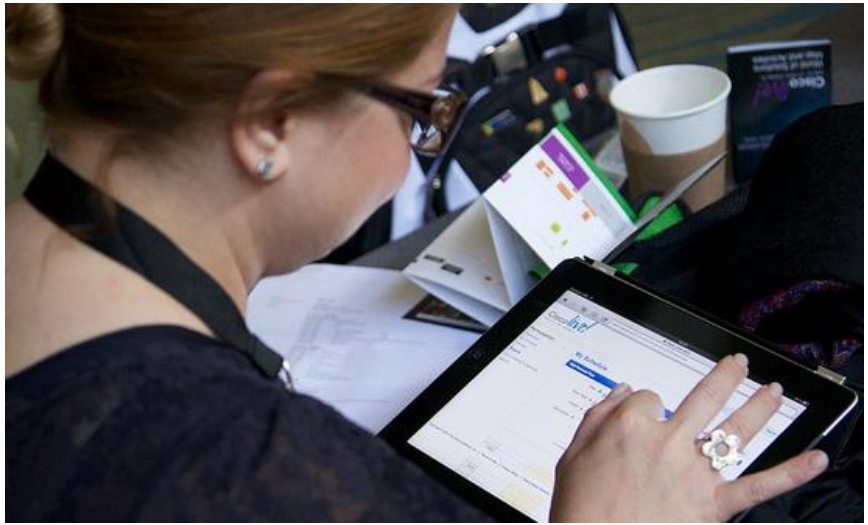

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