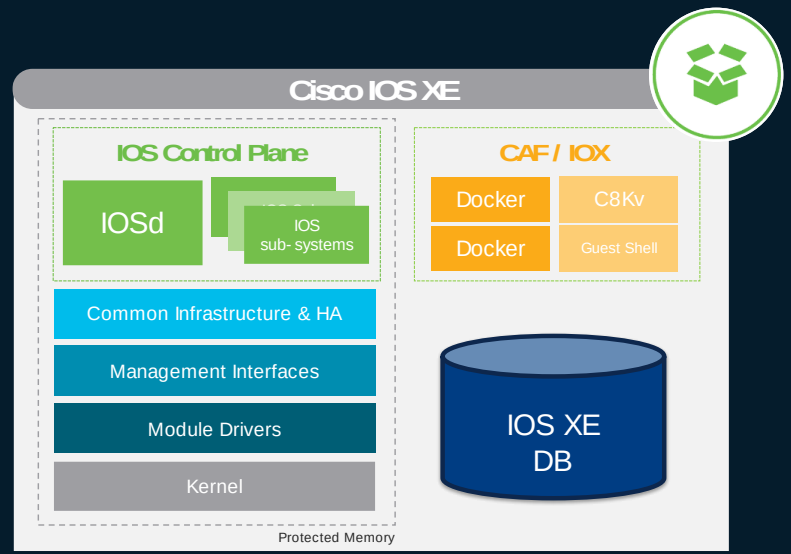
The bridge to possible

Cisco IOS XE Software Architecture & Innovations

Catalyst 9000 Series



Minhaj Uddin – Leader, Technical Marketing
@Minhaj_U

BRKARC-2090

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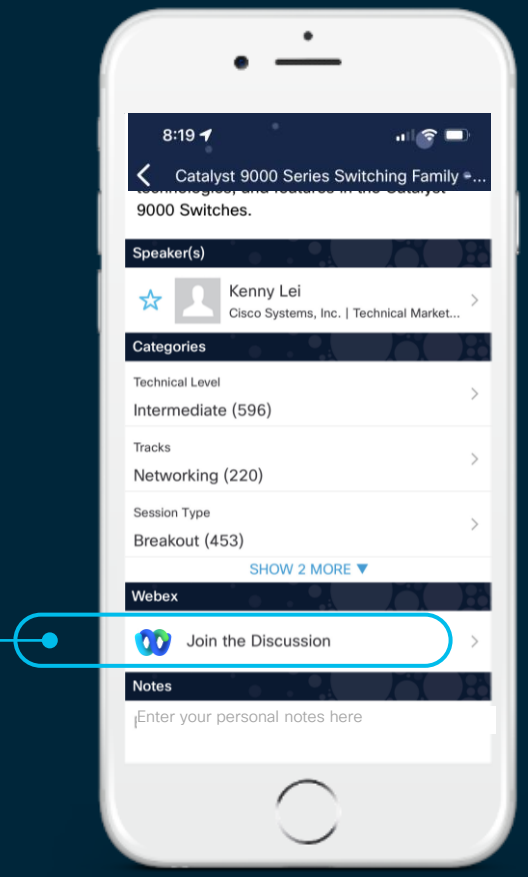

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Webex spaces will be moderated by the speaker until June 17, 2022.

Session Abstract

You've used the CLI commands. You've tried the Programmable API's.
You've seen the GUI screens.... but what's **REALLY** happening inside **IOS XE**?

- How is Cisco IOS XE similar or different from other Cisco OS architectures?
- Do you wish you could look –inside- the different software layers, and understand how they all work together (or when they don't, for troubleshooting)?

This session will focus on the **software components** (processes) within IOS XE on the Catalyst 9000 series:

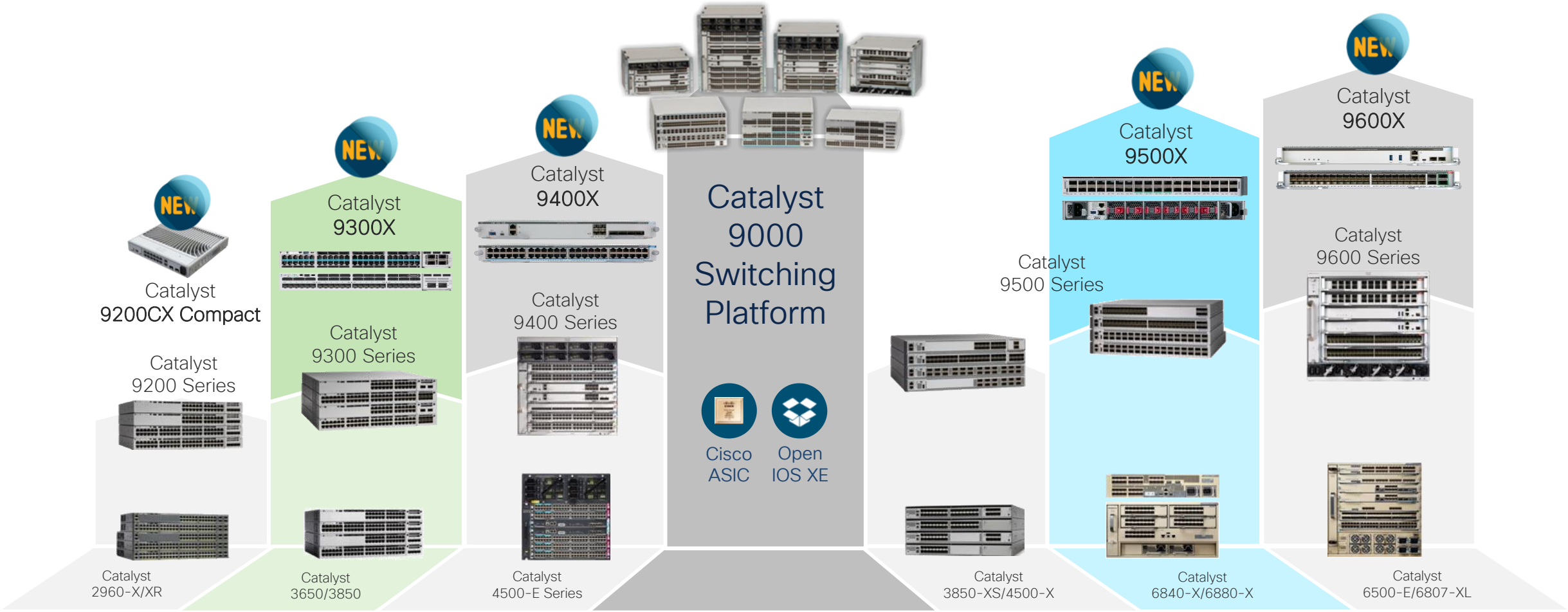
1. Recap of the **basic principles and history** of IOS
2. Summary of **basic components** of Catalyst 9000 IOS XE
3. Summary of **key technologies** enabled by IOS XE
4. Catalyst 9000 IOS XE architecture **up to 17.6.1 release**
5. Catalyst 9000 IOS XE architecture **after 17.7.1 release**

Agenda

1. Brief History of IOS XE
2. Basic IOS XE Components
3. IOS XE Technologies
4. C9K IOS XE upto 17.6.1
5. C9K IOS XE after 17.7.1
6. Summary & References

Cisco Catalyst 9000 Switching Portfolio

Adding the “X factor” to the industry’s leading switching family



Catalyst 9000 Series – Common Building Blocks

Programmable x86 Multi-Core CPU

Application Hosting
Secure Containers

Open IOS XE® Polaris

Model-Driven APIs
Modular Patching

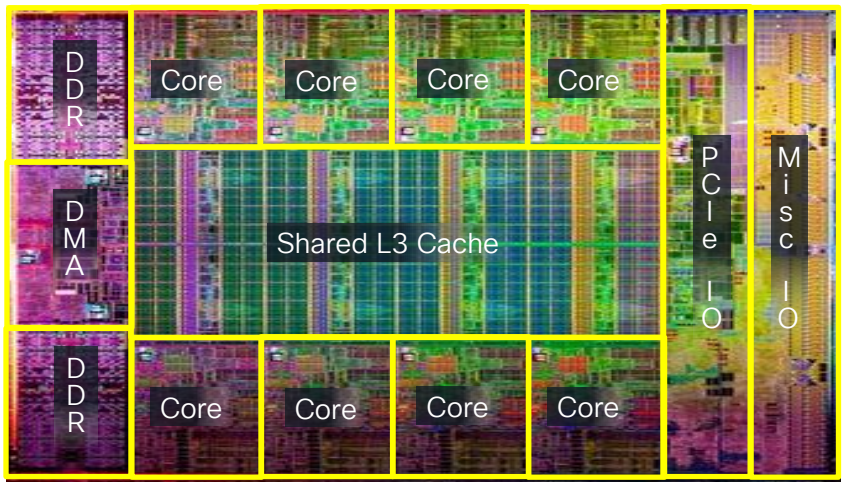
Cisco UADP & Silicon One™

Programmable Pipeline
Flexible Tables

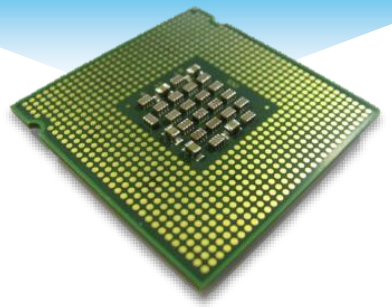
Same IOS XE image for both **UADP*** and **Silicon One** C9K platforms

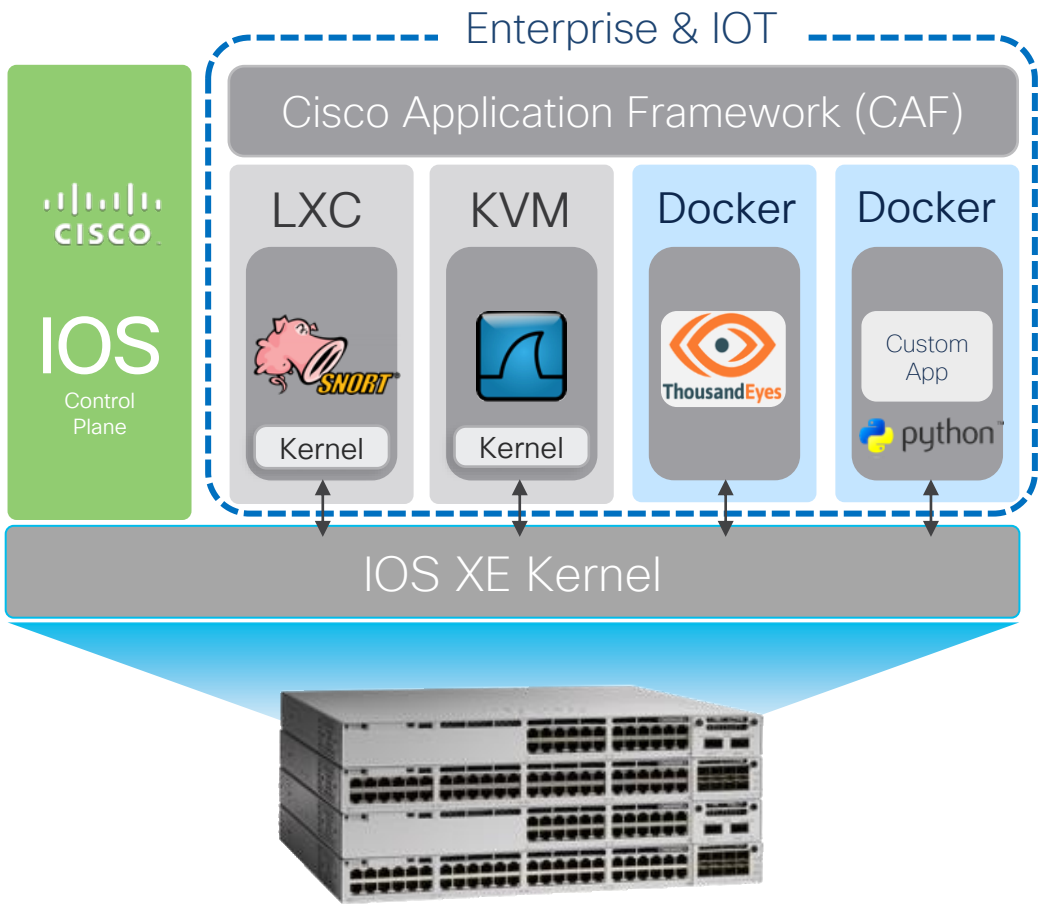
* Catalyst 9200 Series uses IOS XE Lite

Multi-Core CPU – Built for App Hosting



x86 CPU

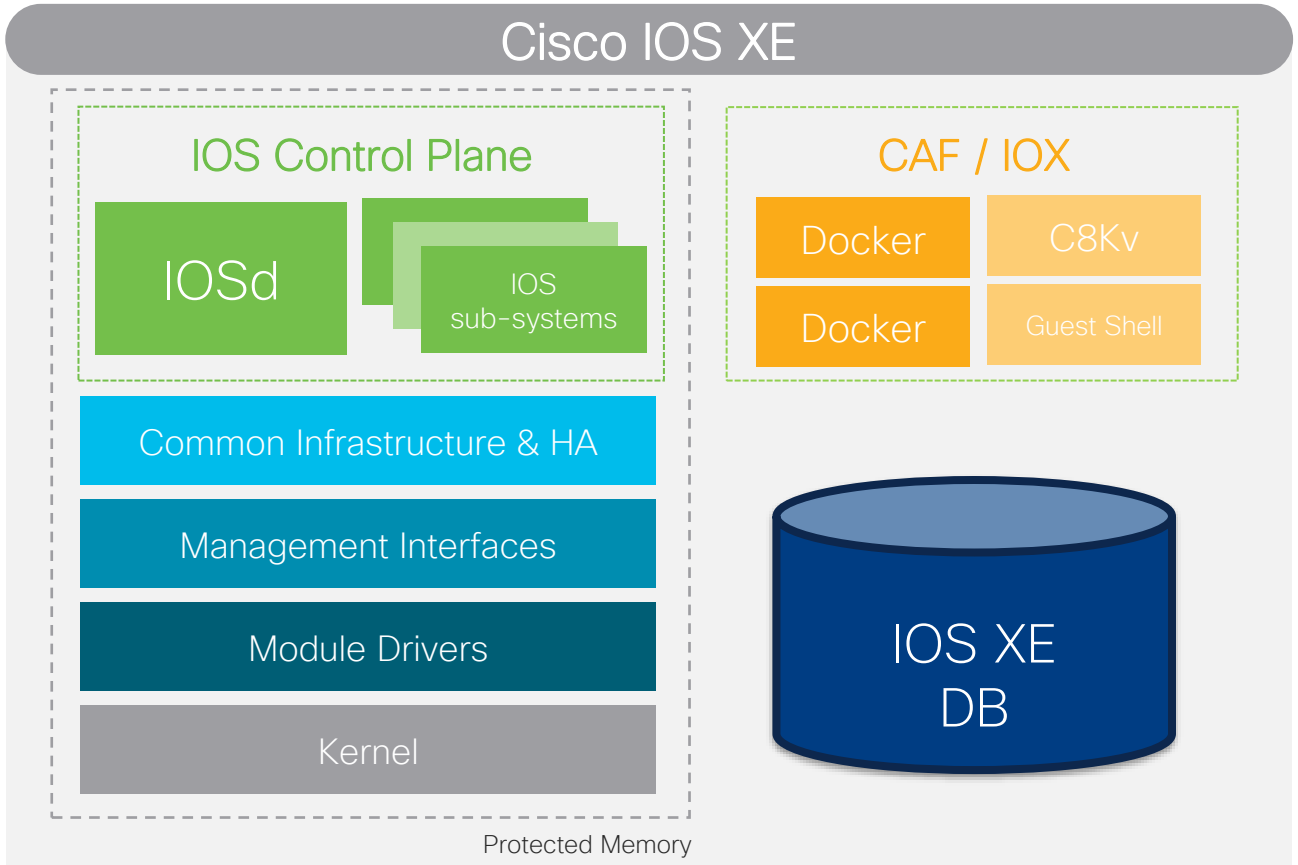




x86 CPU enables hosting NFV devices, Containers and 3rd-party Apps

* Catalyst 9200 Series uses an embedded ARMv8 CPU

Cisco IOS XE – A Modern Operating System



Cisco IOS subsystems
Resiliency and High Availability

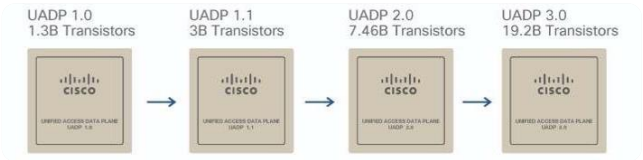
Cisco IOS XE database
Programmability and Open models

IOX + Docker containers
Cisco and 3rd-party App hosting

Open, Model Driven & Secure Operating System

Custom ASICs – Programmable Silicon

Cisco **Unified Access Data-Plane** (UADP®)



Cisco **Silicon One**™

Flexible Pipelines
Investment Protection

Adaptable Tables
Universal Deployment

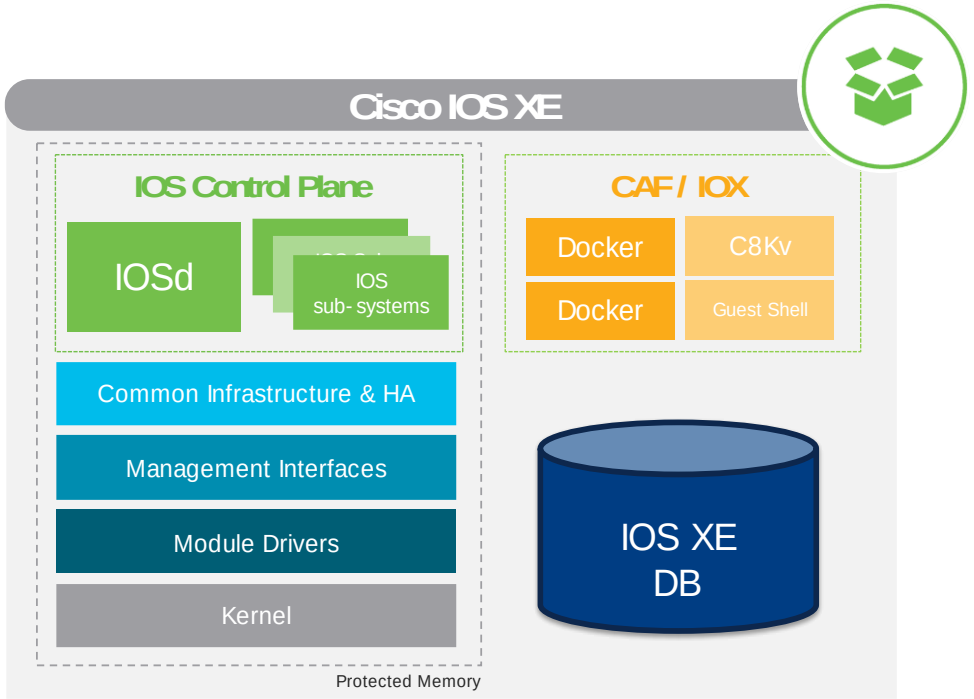
Scalable Resources
Enhanced Scale and Buffering

Flexible & Programmable ASICs – Adapt to New Technologies

Cisco Catalyst 9000 Series IOS XE Software

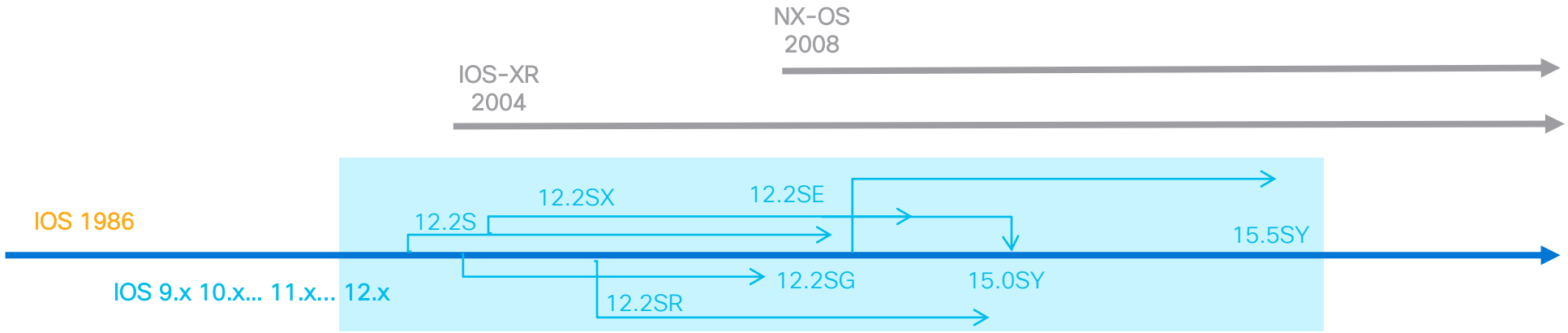
History of IOS XE

- **History of Cisco IOS®**
- **IOS evolves into IOS XE**
- **Nova IOS XE** (Catalyst 3K)
- **Polaris IOS XE** (Catalyst 9K)



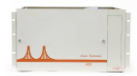
Brief History of Cisco IOS

NOTE: Timeline is just an approximation



1984 — Cisco was born

1986 — Operating System 6.0 — Cisco's Shipped First AGS Router



1993 — IOS 9.x – 12.x — LAN Switching, Remote Access, WAN Switching

2007 — IOS XE BinOS 3.x — ASR1000

2009 — IOS 15.x M&T Release

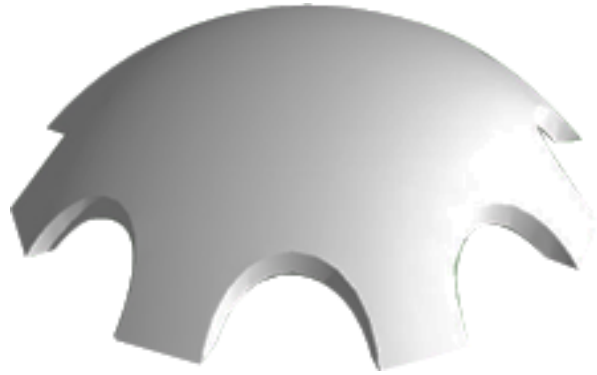
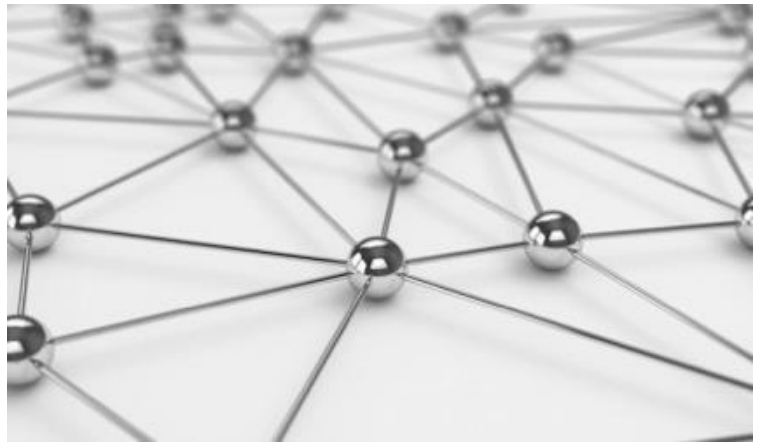
2010 — IOS XE NOVA 3.x — Cat4500, Cat3850

2015 — IOS XE Polaris 16.1 — Cat3850, ASR1K, ISR

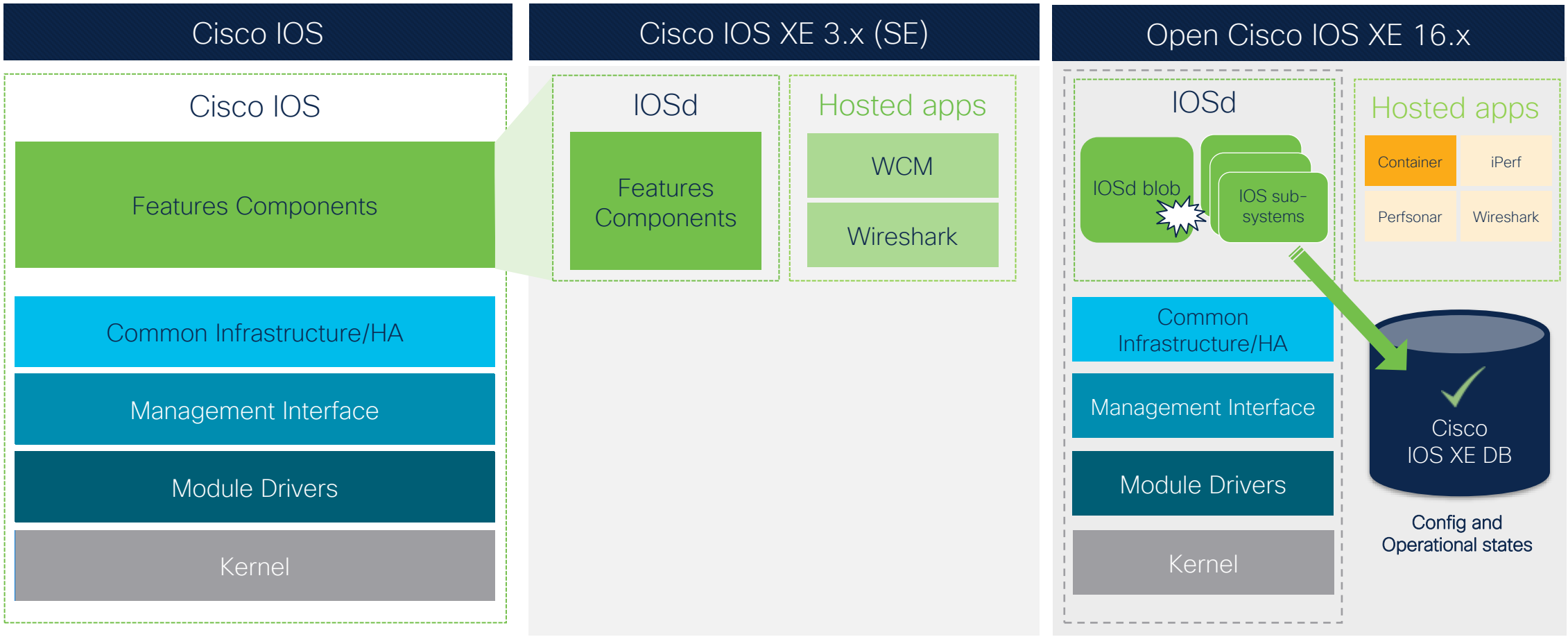
2017 — Open IOS XE 16.5.1 — Catalyst 9K

Cisco IOS XE – Architecture Evolution

Same look and feel – more powerful architecture

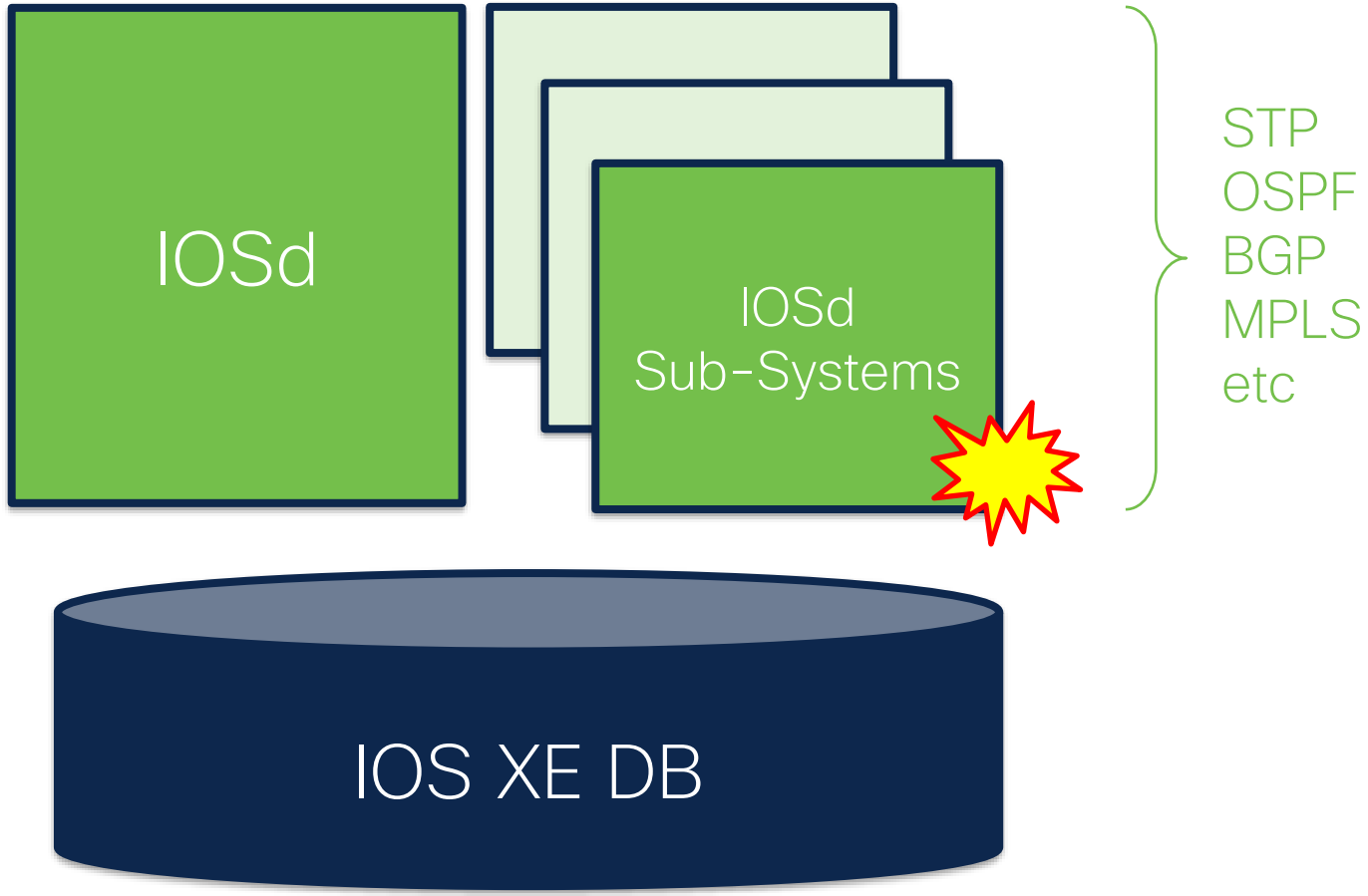
Cisco IOS	Cisco IOS XE 3.7.x(SE)	Cisco IOS XE 16.x
		
• **Monolithic OS** • Compact • High performance	• **Monolithic IOSd**: Control-plane • Sub-packages for data plane • Linux daemons hosting capability • Message parsing capability	• **IOSd**: Component assemblies • **Modularized features**: Sub-packages • **Distributed Operating System** • **IOS XE (Crimson) Database** • Radioactive tracing and events

What is “Open” Cisco IOS XE?



Modern Software Architecture – with the same look and feel

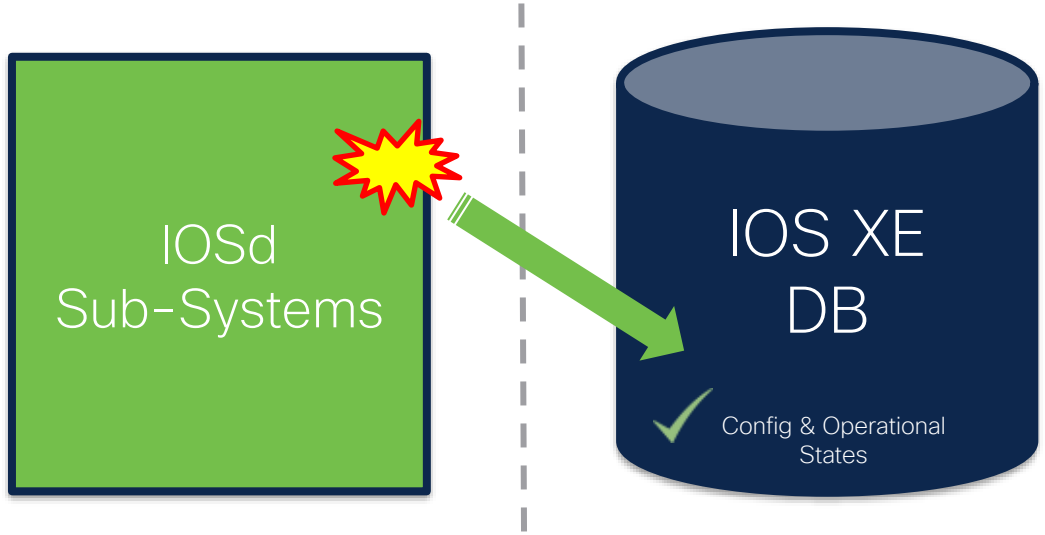
Open IOS XE – IOS Sub Systems



Failure of one IOS XE Sub-System(s) – keeps rest of the system intact

IOSd Sub-Systems enhance IOS Resiliency

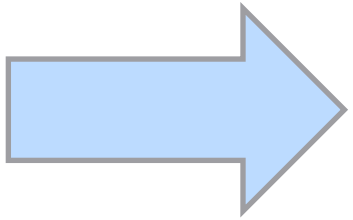
Open IOS XE – Hardware DB



Decoupling Code & Data
protects the Configuration
& Operational States

- Higher Application UP Time
- Quicker Recovery
- Better Convergence

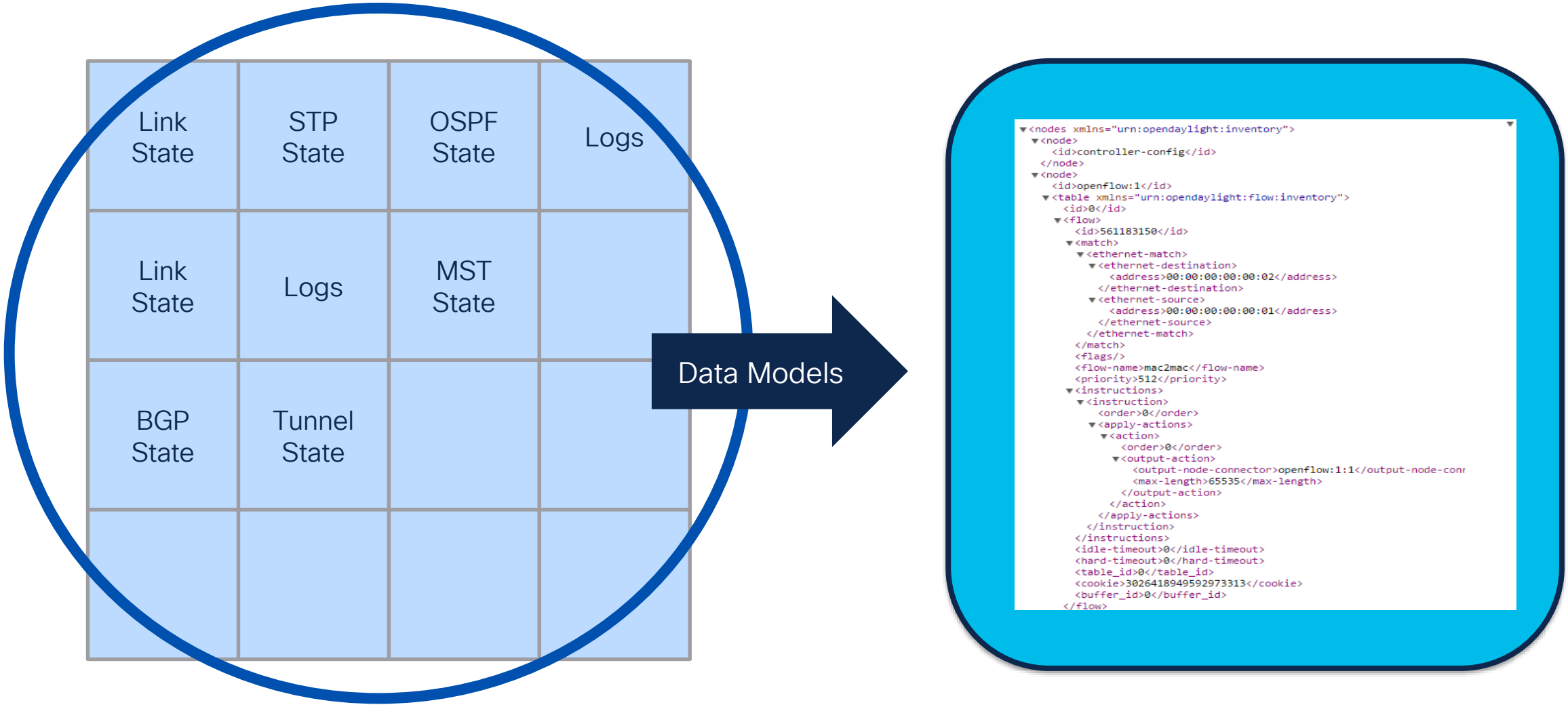
Open IOS XE – Hardware DB



Link State	STP State	OSPF State	Logs
Link State	Logs	MST State	
BGP State	Tunnel State		

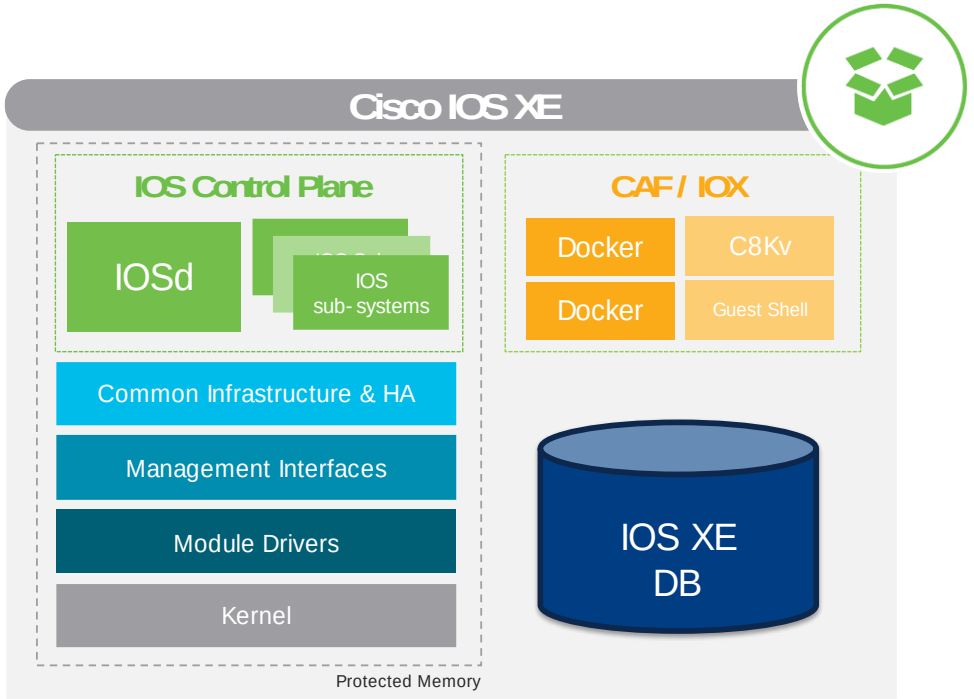
The IOS XE DB contains Configuration & Operational States

Open IOS XE DB – Data Models



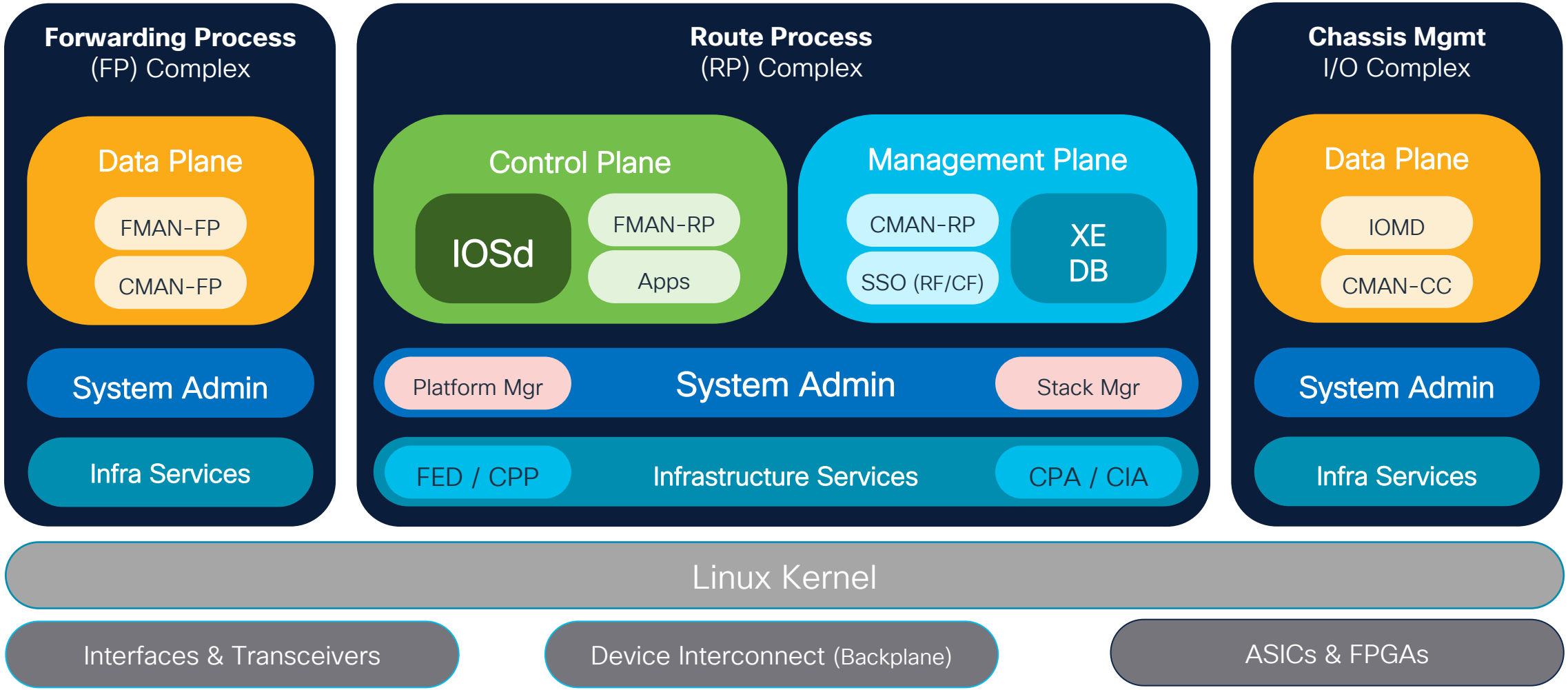
Basic Components

- **IOS XE Architecture**
  - Control Plane
  - Data Plane
  - System Plane
  - Management Plane
- **IOS XE on Catalyst 9K**

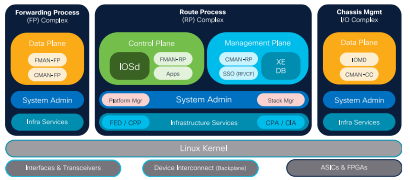


Cisco IOS XE Architecture

Modularized Components for Software Abstraction



Cisco IOS XE Software
PI vs. PD Software Components



Platform Independent (PI)

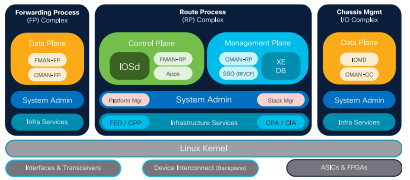
- **IOS** – Internetwork Operating System
- **FMAN** – Forwarding Manager
- **RP** – Routing Process
- **FP** – Forwarding Process
- **CGM** – Classification Group Manager
- **WCM** – Wireless Controller Module
- **IFM** – Interface Manager
- **PDS** – Packet Distribution Service
- **LSMPI** –

Platform Dependent (PD)

- **CPA** – Common Platform Abstraction
- **IOMD** – I/O Manager
- **CMAN** – Chassis Manager
- **PMAN** – Platform Manager
- **SMAN** – Stack Manager
- **XCVR** = Transceiver/Optics
- **Table Manager** – Client & Server
- **Punject** – Punt+Inject (CPU) interface
- **FED** – Forwarding Engine Driver

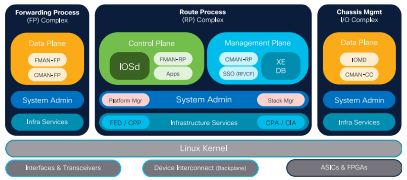
Cisco IOS XE Architecture

High Level Overview



1. Control Plane
2. Data Plane
3. System Plane
4. Management Plane
5. Infrastructure Services
6. Linux Kernel & Platform Drivers

Cisco IOS XE - Control Plane



1 Control Plane

Data Plane

System Plane

Management Plane

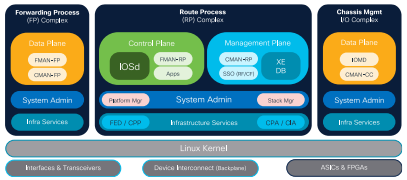
Infrastructure Services

Linux Kernel & Platform Drivers

This is the 'brain' of the network stack

- Most control-plane logic runs within IOSd
- Home to routing & bridging protocols (network learning)
- Richest networking features in industry (~5000 features)
- Distributes protocol (RP) forwarding states to data-plane (FP)

Cisco IOS XE - Data Plane



Control Plane

2

Data Plane

System Plane

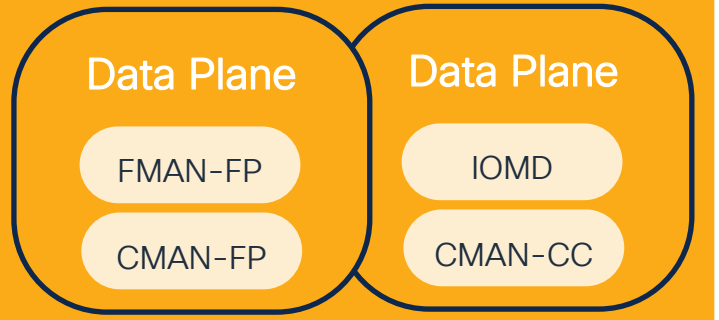
Management Plane

Infrastructure Services

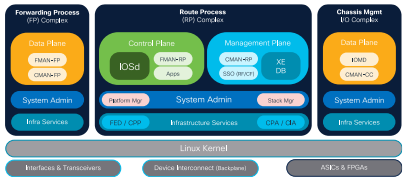
Linux Kernel & Platform Drivers

Handles high-speed Packet Forwarding

- Touches every packet! High-throughput and low-latency forwarding
- Programming from control-plane abstracted by well defined APIs
- Supports multiple forwarding architectures: standalone & modular
- Forwarding is generally handled in special hardware (e.g. UADP & QFP)



Cisco IOS XE - System Plane



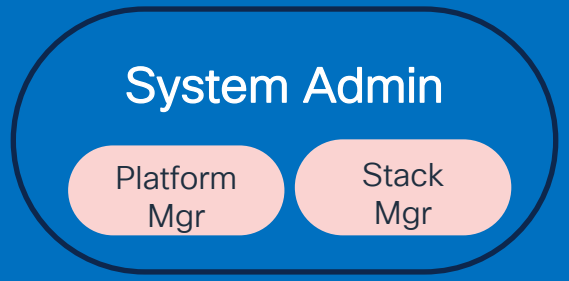
Control Plane | Data Plane | 3 System Plane | Management Plane

Infrastructure Services

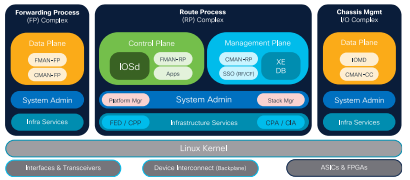
Linux Kernel & Platform Drivers

General Administration & functions of the System

- manages the chassis, modules, I/O, power, fans
- manages stacking & virtual chassis processing
- Also manages software image management & patching



Cisco IOS XE – Management & Infra



Control Plane

Data Plane

System Plane

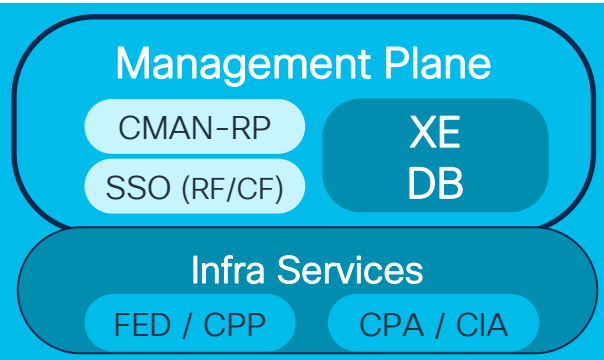
4 Management Plane

5 Infrastructure Services

Linux Kernel & Platform Drivers

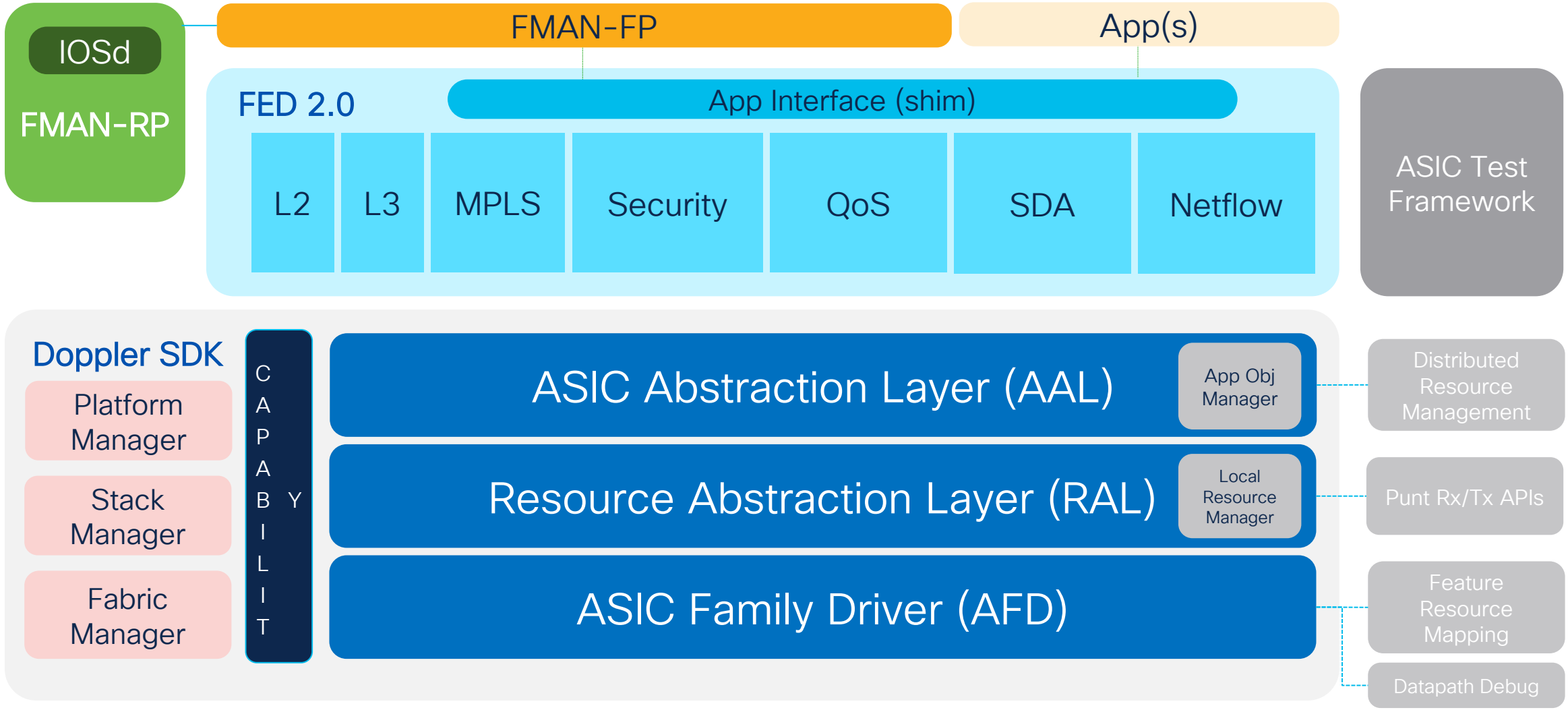
Device-Specific Services

- XE Database
- TDL DSL
- HW Drivers
- HA & ISSU
- Messaging
- Licensing
- Compiler
- Btrace
- Buildtime tools

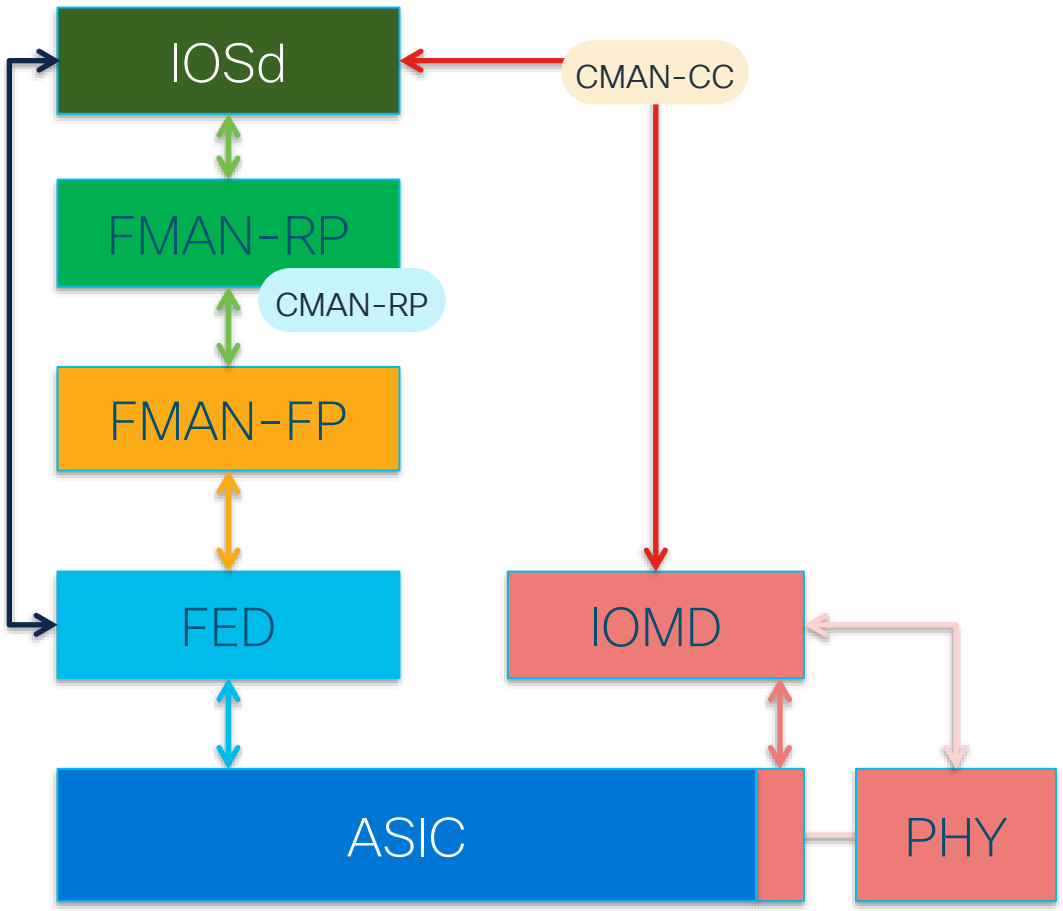


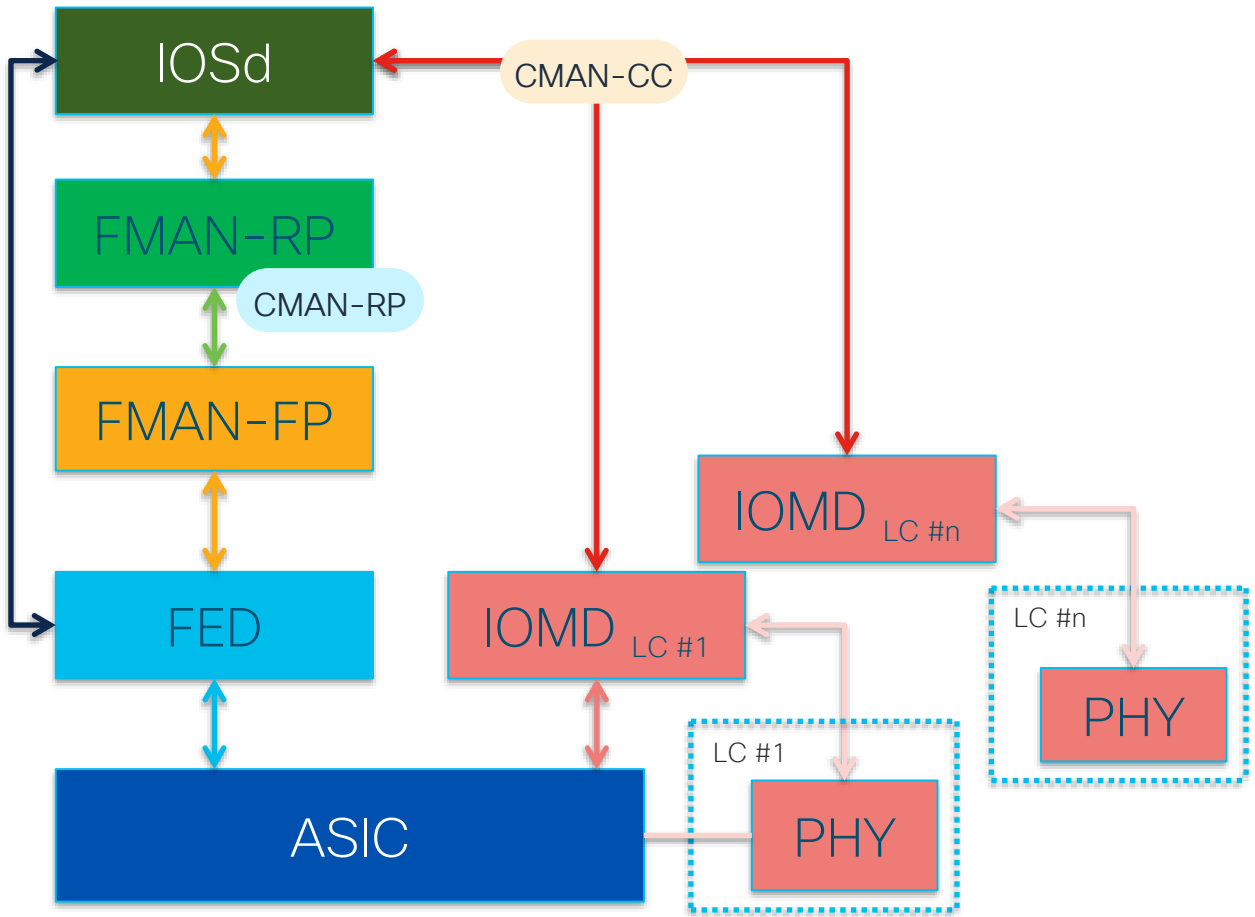
Cisco IOS XE on Catalyst 9000 Series

Hardware Forwarding Architecture

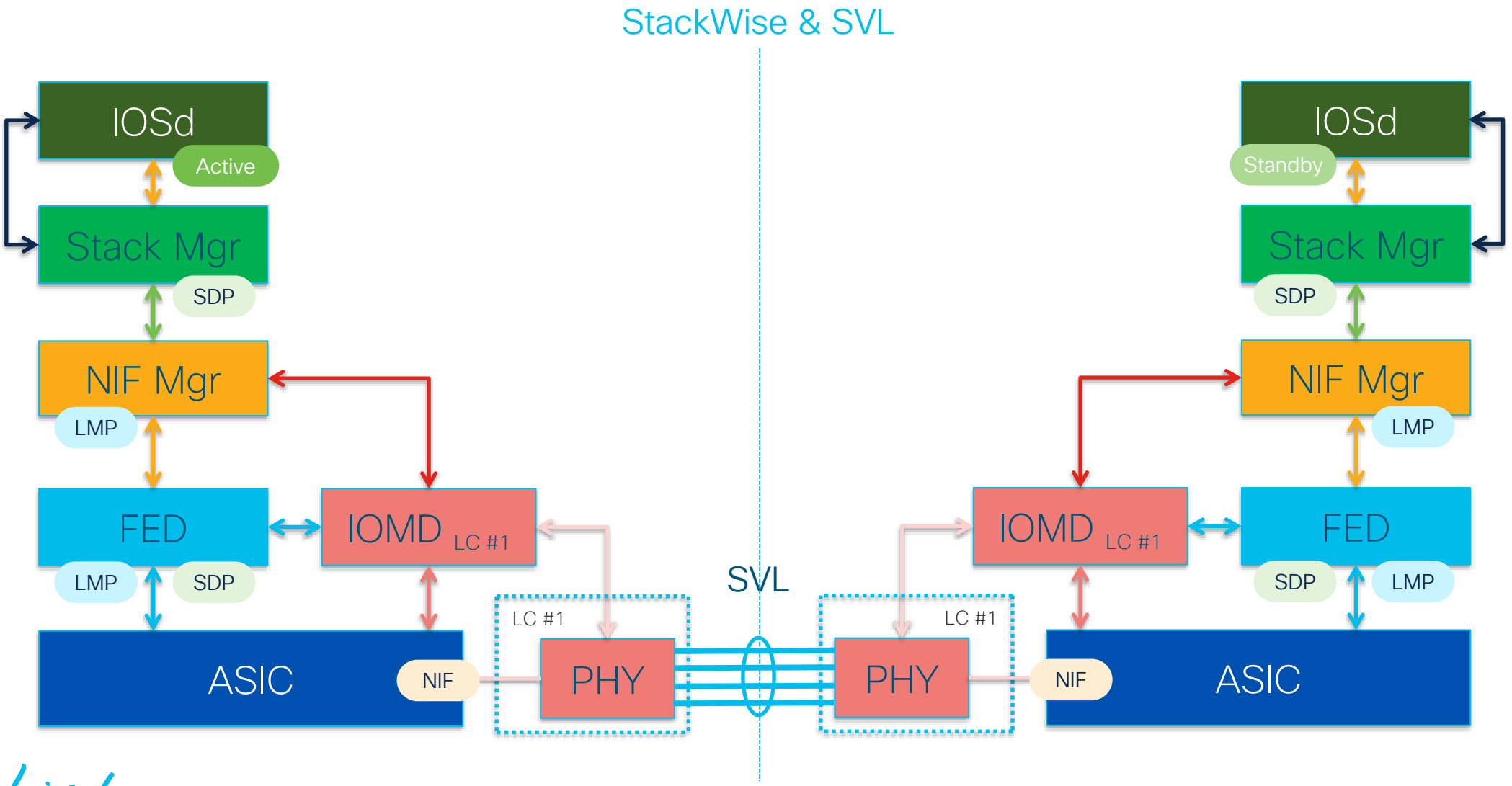


C9K IOS XE – System View





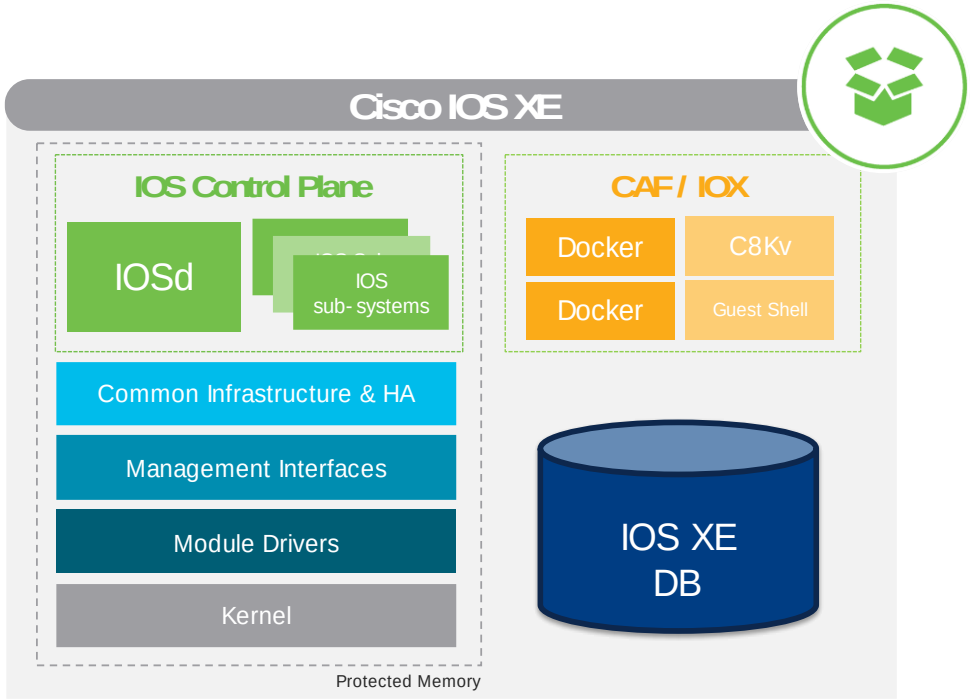
C9K IOS XE – System View



Cisco Catalyst 9000 Series IOS XE Software

Features of IOS XE

- **High Availability** (SSO & StackWise)
- **Install Mode** (SMU & ISSU/xFSU)
- **Model-Driven Telemetry**
- **Application Hosting**



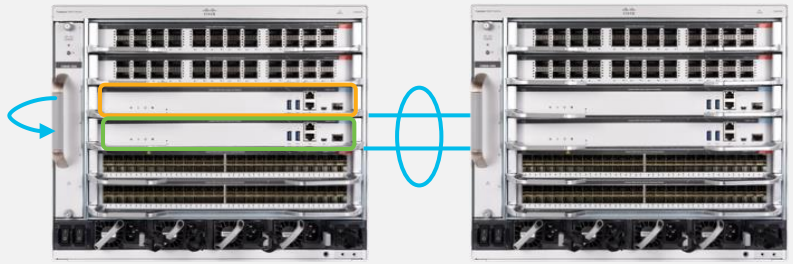
Mission-Critical Resiliency

Your business stops if the network is down

Cost of only **one hour** of downtime to an average enterprise > $300,000**

** Based on industry reports from Gartner and ITIC

Catalyst 9600 Series
(Dual chassis w/ StackWise Virtual)



Catalyst 9400 Series

Catalyst 9500 Series

Architecture

StackWise® and StackWise Virtual

- Virtualized redundant systems for simplified configuration & protocols

Graceful Insertion/Removal (GIR)

- No downtime when device in maintenance mode

Operating System

Hot Patching (SMU)

- Minimal or no downtime for critical fixes

In-Service Software Upgrade (ISSU)

- Upgrade with minimal or no traffic loss

xFSU on C9300/L Stack New

- < 30 sec downtime - Stack upgrade

Platform

Redundant Supervisors

- Modular with SSO/NSF
- SVL Quad-SUP RPR New

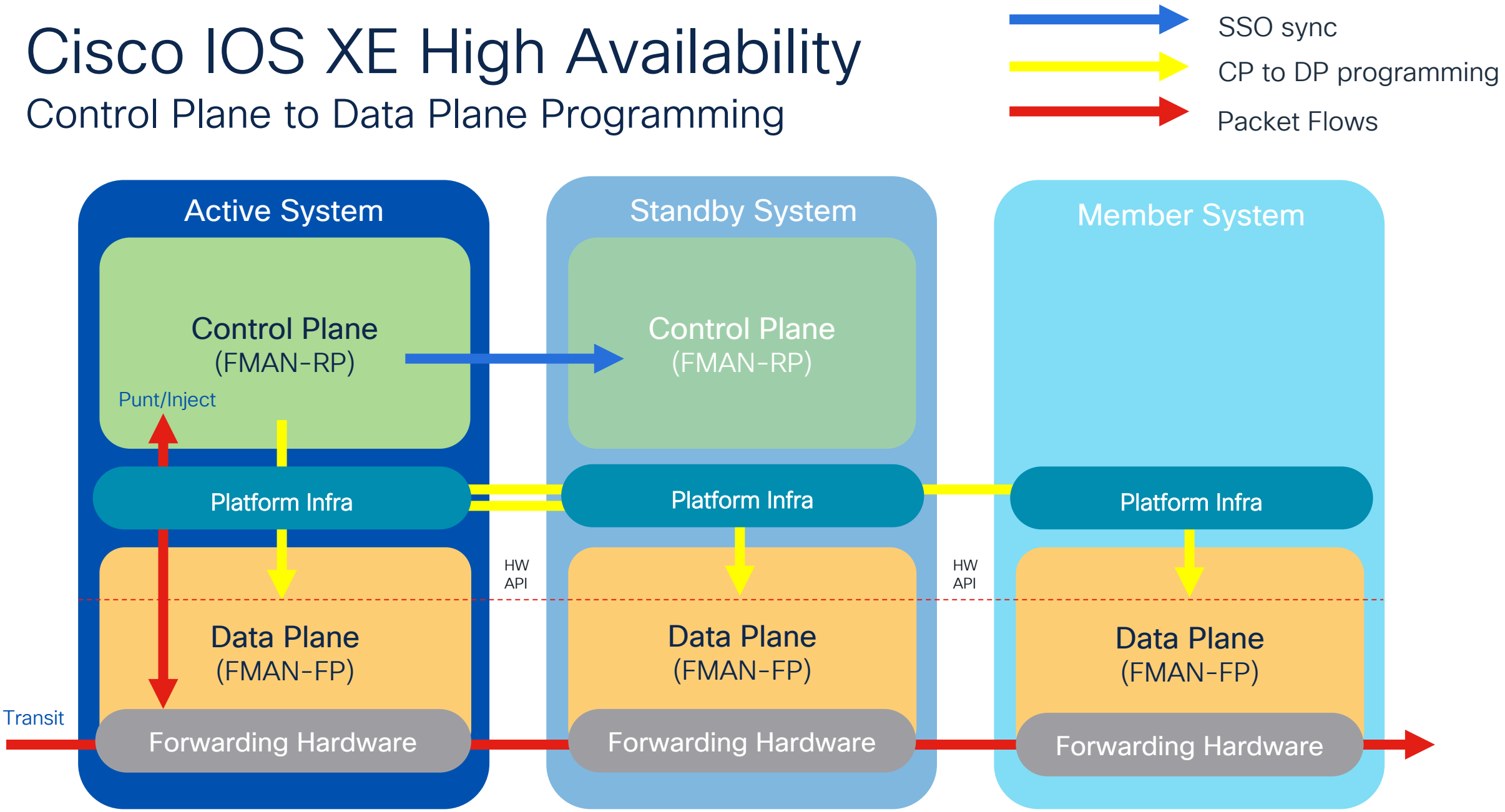
Redundant Power & Fans

- In case of any hardware failure

Eliminate downtime with *High Availability* designed at every level

Cisco IOS XE High Availability

Control Plane to Data Plane Programming



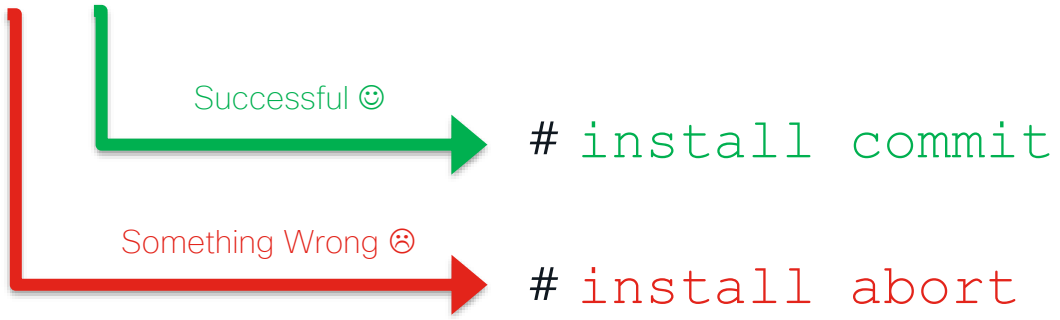
Cisco IOS XE - Install Mode

Single CLI set for Software Install, Patch & Upgrade

```
# install add <tftp://cisco.com/image.bin>
# install activate
```

Workflow Steps:

- **Install Add** command will **perform the image download** from Cisco CCO Posted location
- **Install Activate** command **upgrade the control plane** with new software version
- **Install Commit** command **makes the changes permanent** (and deletes the older version)
- **Install Abort** you can issue an abort command to **revert the software** back to the original state



IOS XE Install – SMU patches

Ready for software patching

A **Software Maintenance Update (SMU)** is an emergency point fix positioned for expedited delivery to a customer in case of a network down or revenue-affecting scenario.

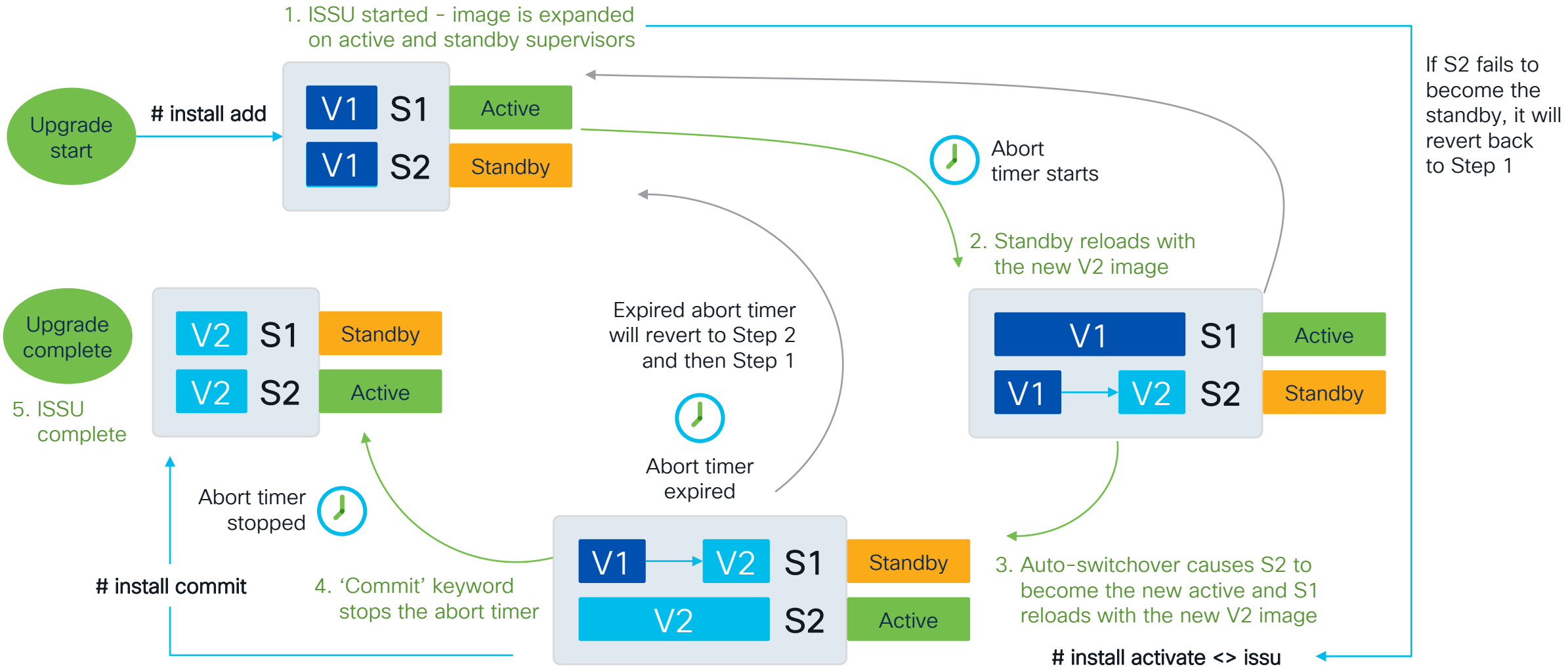
Cold Patching:
Install of an SMU requires a system reload in the first release. It is traffic impacting.

Hot Patching:
Install of an SMU does not require a reload. No traffic impact.

Install Add → Install Activate → Install Commit

In-Service Software Upgrade (ISSU)

Leverages SSO between IOS XE versions for seamless upgrade



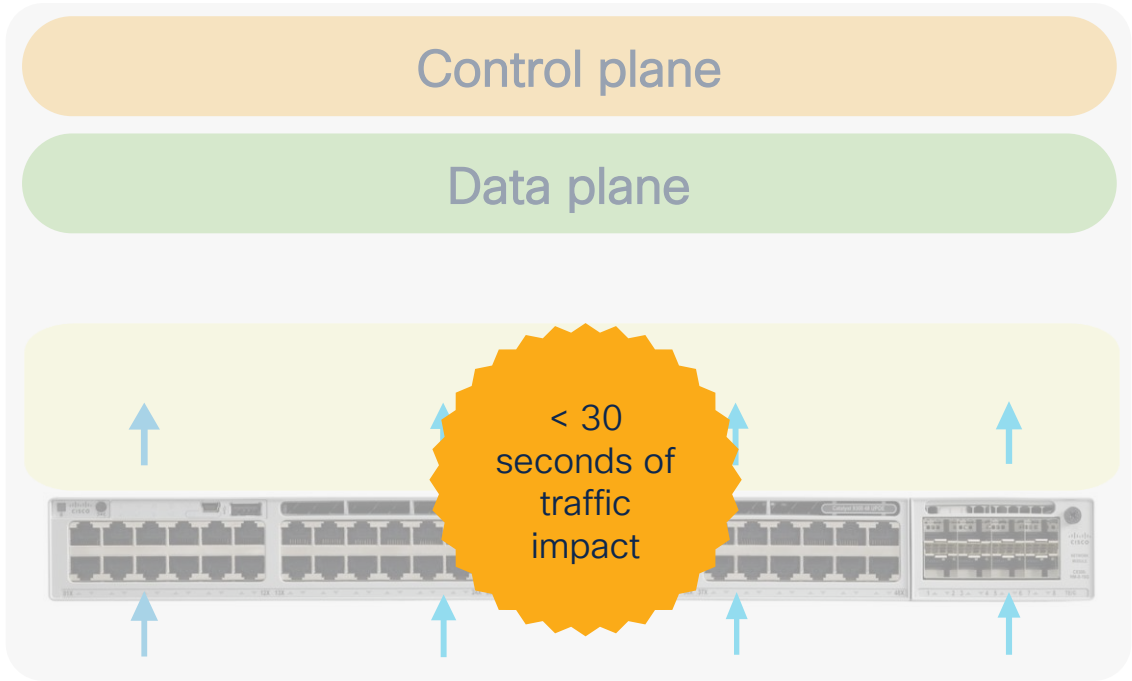
Extended Fast Software Upgrade (xFSU)

C9300/L- 17.3.2

C9300X- 17.7.1

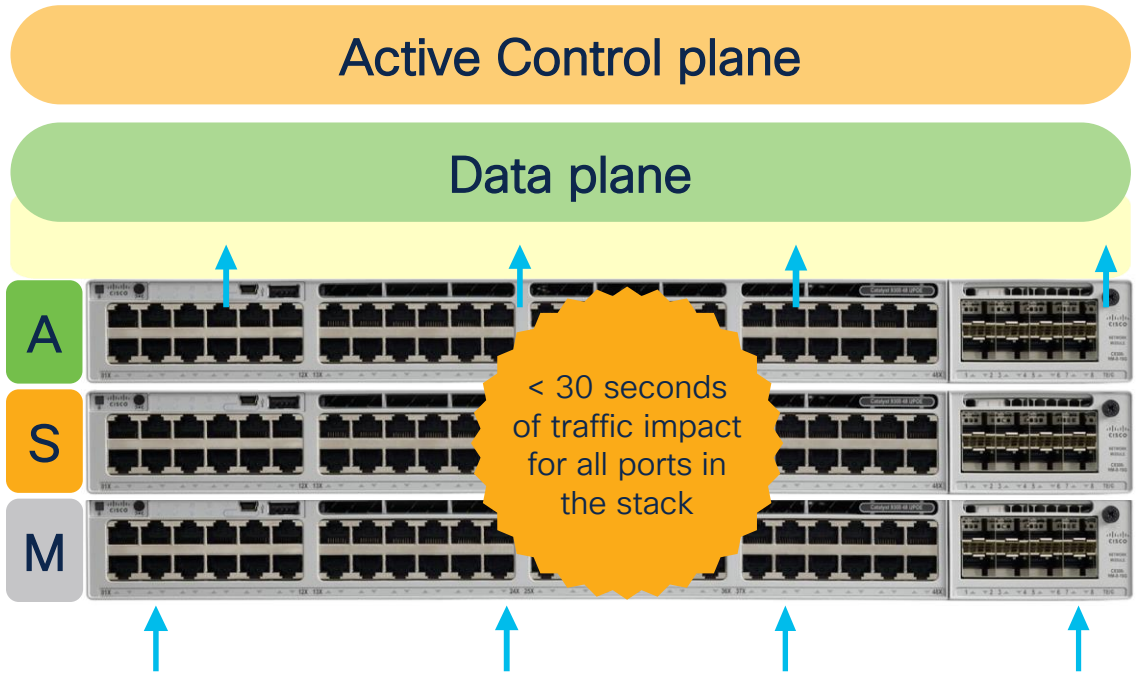
Catalyst® 9300/9300L/9300X standalone

#install add file image activate reloadfast commit



Catalyst 9300/9300L/9300X stack

#install add file image activate reloadfast commit



Cisco IOS XE Programmability

Telemetry “Stack”

DEVNET

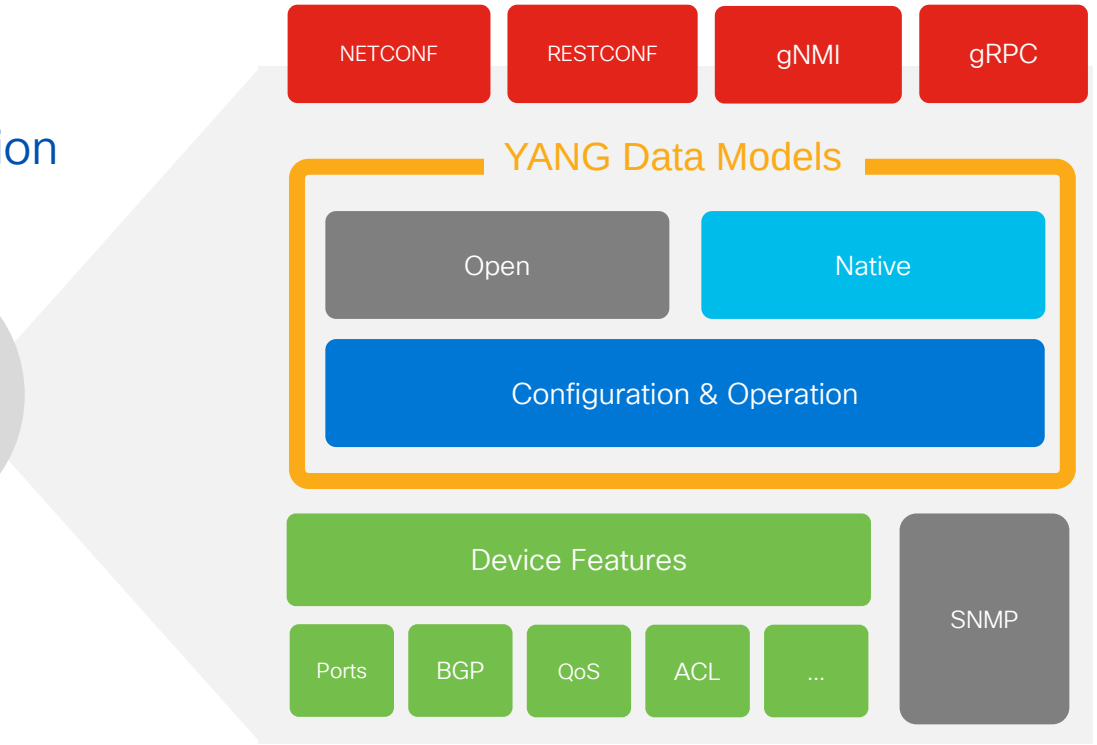
developer.cisco.com/site/IOS XE

CLI

WebUI

NETCONF, RETCONF, gNMI & gRPC are **programmatic interfaces** that provide **additional methods** for interfacing with an IOS XE device

YANG data models define the what’s available for configuration and streaming telemetry



IETF

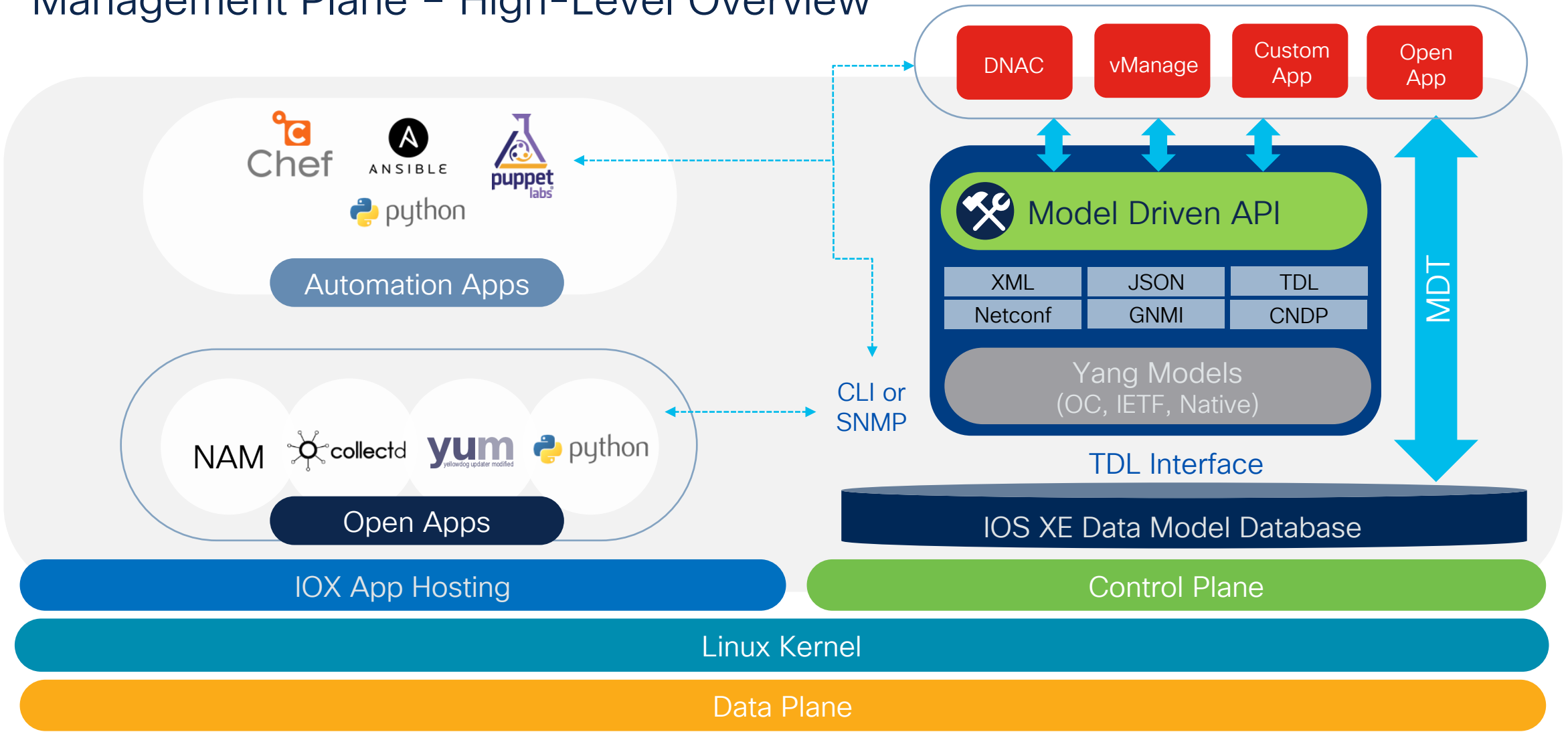
OpenConfig

IEEE

cisco

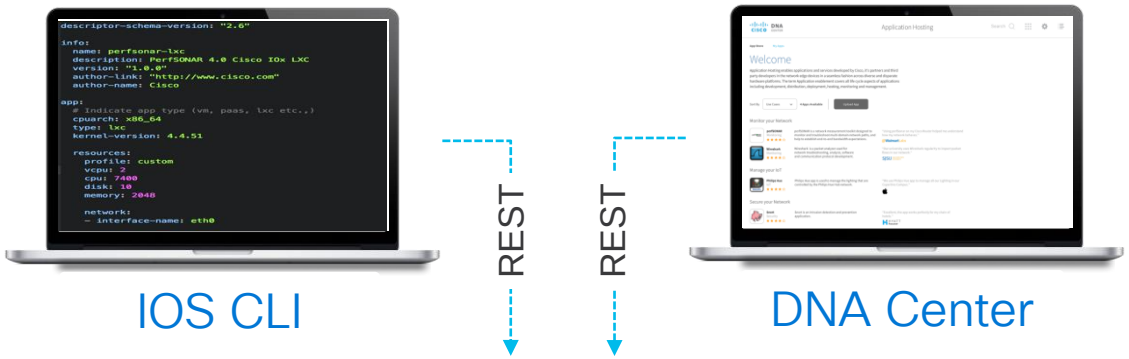
Cisco IOS XE – Management

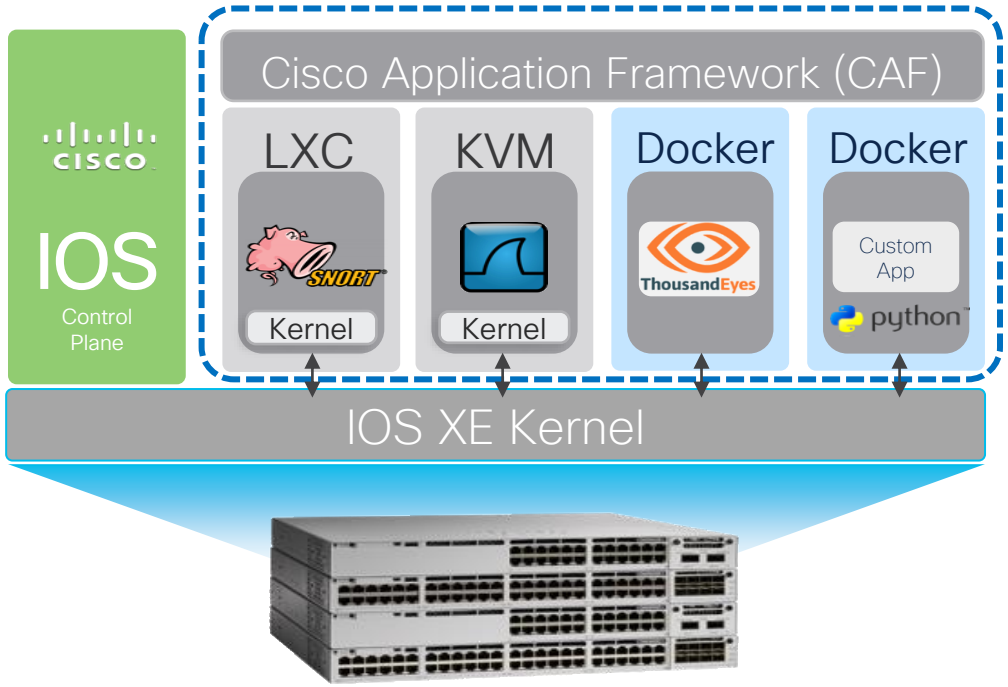
Management Plane – High-Level Overview



Cisco IOS XE

Application Hosting





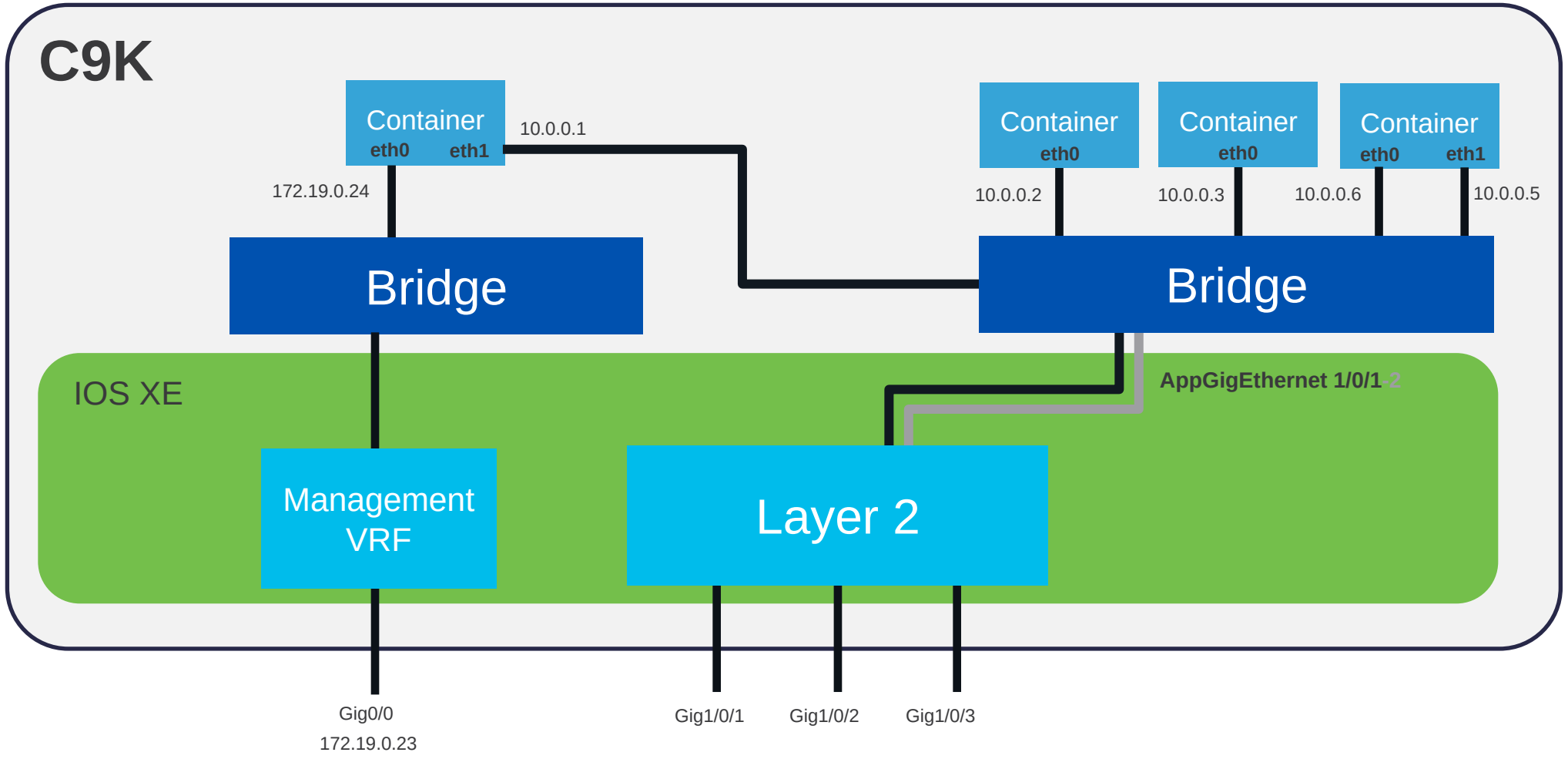
Catalyst 9000

Application Ecosystem

- Cisco will not support third-party apps or open-source apps, unless specifically called out
- Such apps, however, will be validated for compatibility on Catalyst 9000 switches
- DevNet ecosystem will indicate the partners who have worked on Catalyst 9000 switches

Catalyst 9000 Series – App Hosting

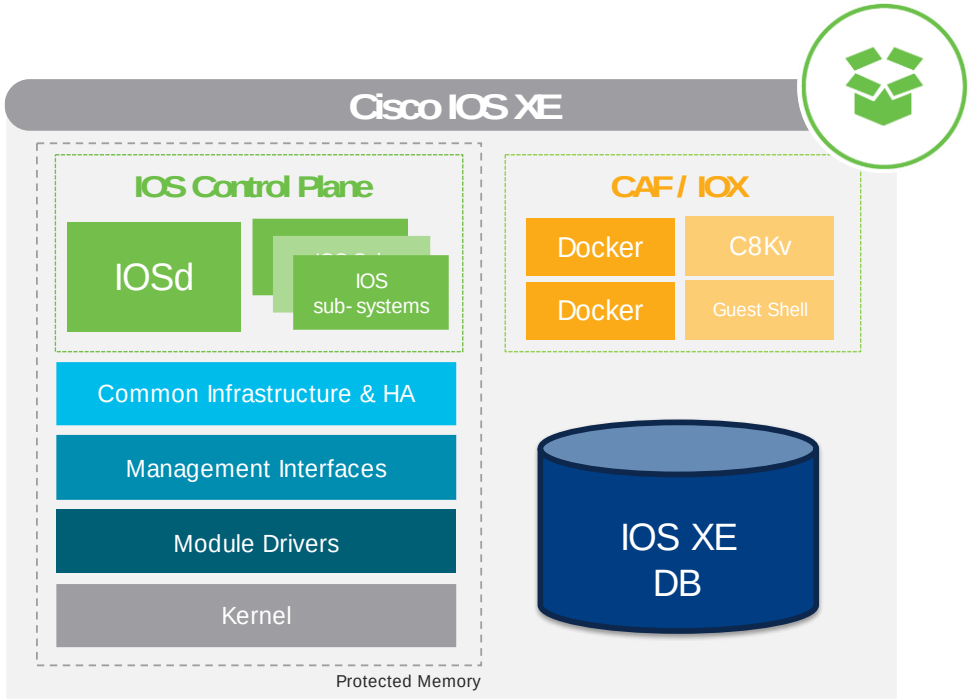
Container Networking



Cisco Catalyst 9000 Series IOS XE Software

IOS XE up to 17.6.x

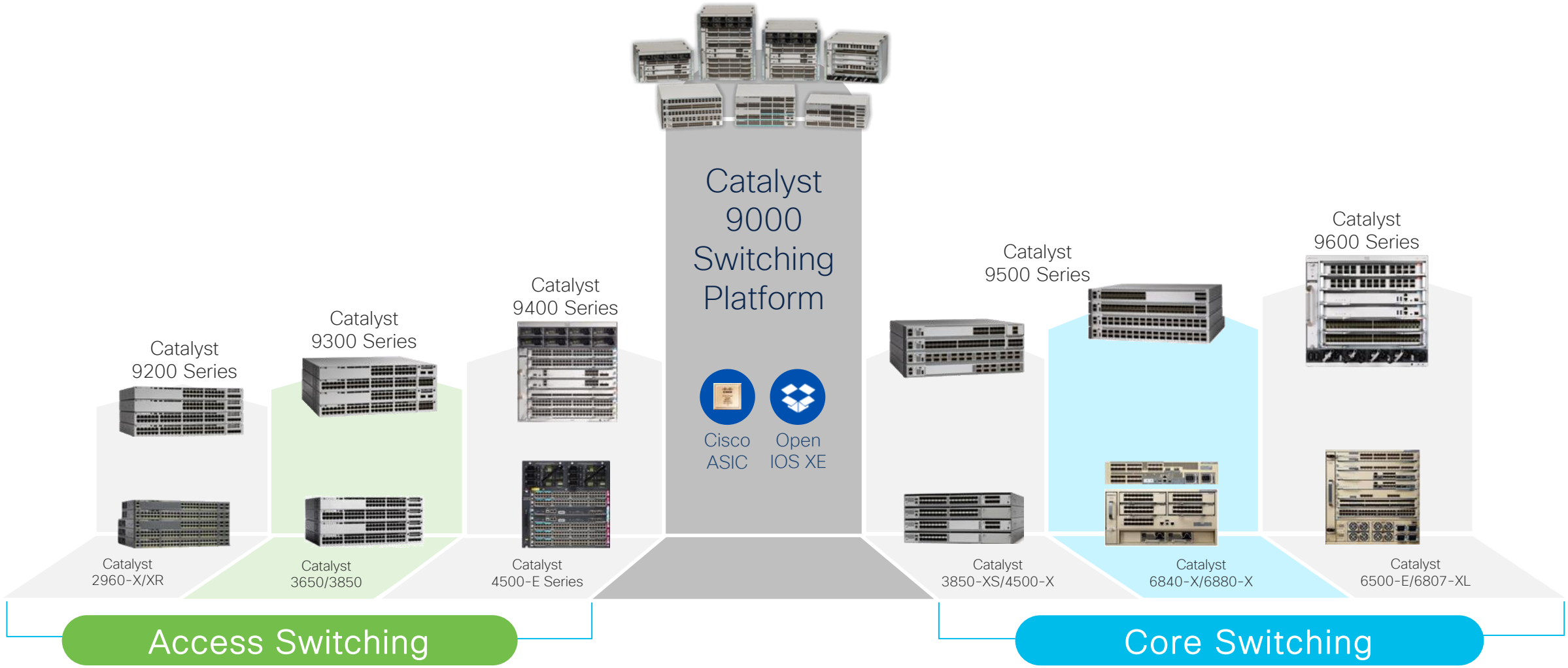
- **History of Cisco IOS®**
- **IOS evolves into IOS XE**
- **Nova IOS XE** (Catalyst 3K)
- **Polaris IOS XE** (Catalyst 9K)



Cisco Catalyst 9000 Switching Portfolio

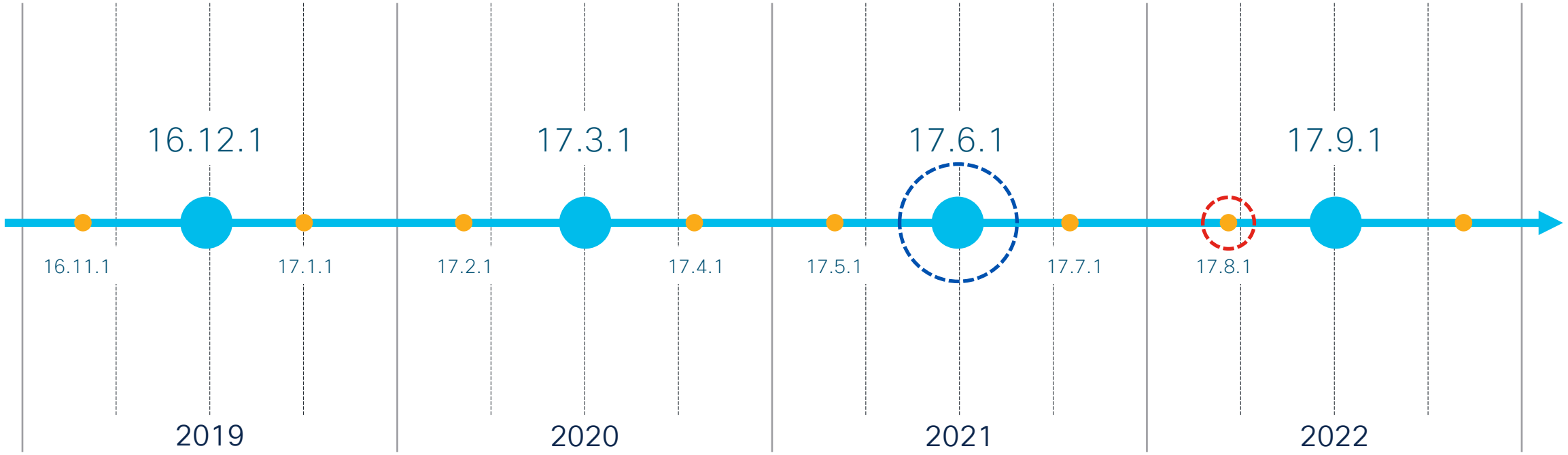
One Family from Access to Core – Common Hardware & Software

IOS XE
17.3.x - 17.6.x



Cisco IOS XE – Release Schedule

3 Releases Annually (approx. every 4 months)



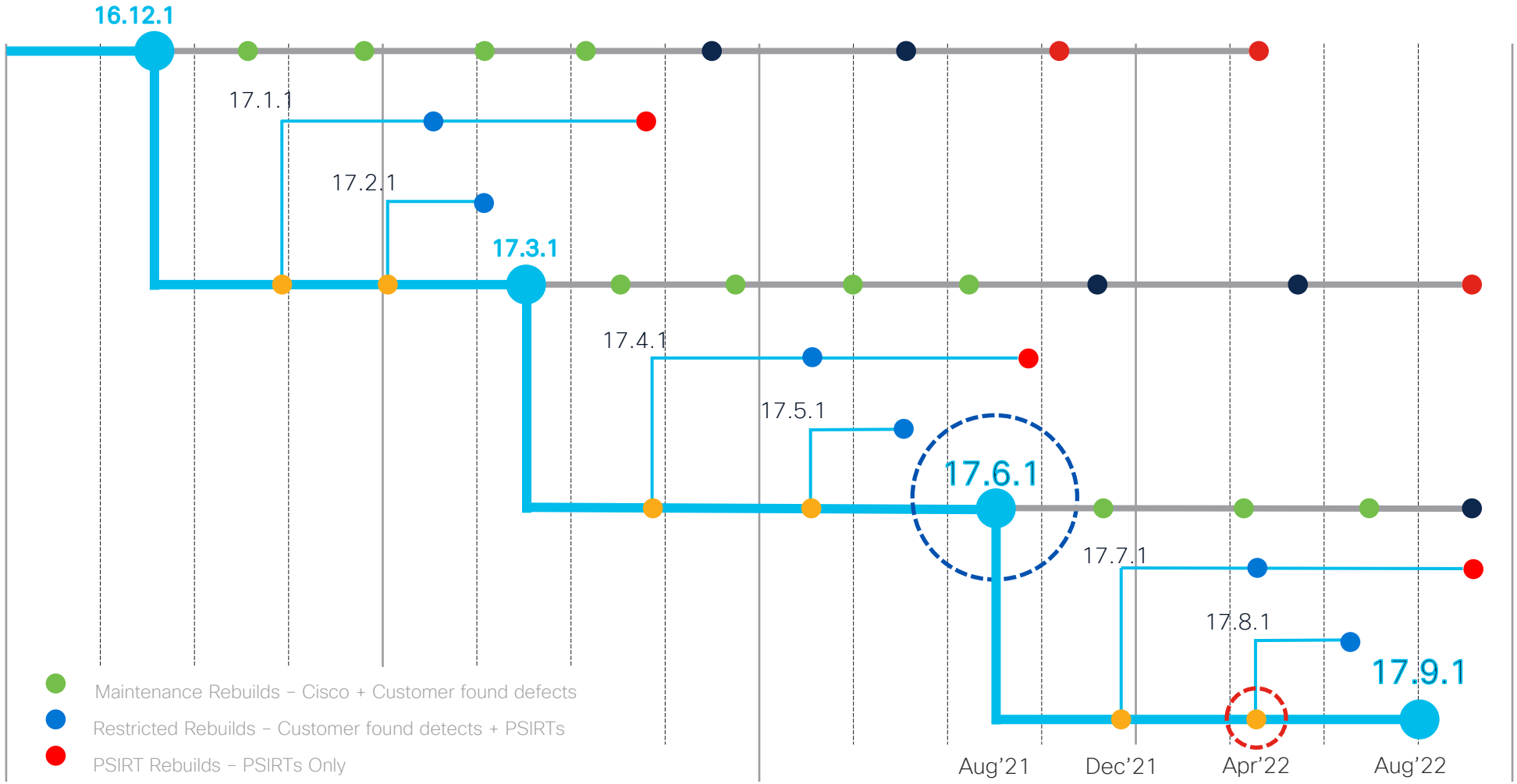
Extended Maintenance Release (EMR) – 36 months support

Recommended for wide-scale production deployments – Supports patches (SMU) and ISSU

Standard Maintenance Release (SMR) – 12 months support

Cisco IOS XE – Release Schedule

Graphical Overview



Reference

Catalyst 9000 Switching – Key Features

* Limited Availability (LA) only

IOS XE 17.1.1 (Nov'19) SMR	IOS XE 17.2.1 (Mar'20) SMR	IOS XE 17.3.1 (July'20) EMR
Enhanced Security ❖ 9200/9300 – Umbrella Integration ❖ MACSEC over EoMPLS ❖ ERSPAN to v6 Destination	**Enhanced Security** ❖ TWS – Secure Swipe Clean DoD 5220.22-M standard	**Enhanced Security** ❖ Enhanced ACL Logging ❖ Wired Client Sensor* ❖ 9200/9300 – Umbrella Switch Connector with AD Integration
Overlays & Segmentation ❖ Inter-AS Option A (VRF-Lite) ❖ VPLS Flow Aware Transport (FAT) PseudoWire ❖ Extranet mVPN ❖ VXLAN aware Flexible Netflow ❖ EVPN to VRF-Lite handoff for Border Spine ❖ EVPN to MPLS handoff for Border Spine ❖ EVPN Tenant Routed Multicast (TRM)	**Overlays & Segmentation** ❖ EVPN – VxLAN ARP/ND flooding suppression. ❖ EVPN to MPLS hand off on Cat9K in Border spine role (single box) ❖ Hierarchical VPLS ❖ VPLS Multiple VCs per Spoke	**Overlays & Segmentation** ❖ mLDP: Multicast LDP* ❖ VPLS Routed PseudoWire (IRB): IPv6 Unicast ❖ MVPNv6 (Multicast 6VPE) ❖ MPLS VPN – Inter-AS Option AB ❖ BGP EVPN w VxLAN BUM rate-limiting support ❖ BGP-EVPN w VXLAN MAC/IP learning on Access ❖ Wide Area Bonjour with BGP-EVPN over VXLAN
Forwarding & Features ❖ 9600 – VRF aware PBR ❖ 9400 – NAT Profile	**Forwarding & Features** ❖ NAT – VRF aware NAT (VRF to Global)	**Forwarding & Features** ❖ 9500H/9600 : Customized SDM Template Ph1 (FIB) ❖ IP-FRRv4: LFA EIGRP and OSPFv2 per prefix ❖ Non-Stop Routing (NSR): L3 Forwarding Redundancy ❖ LACP 1:1 redundancy and dampening
High Availability ❖ 9600 – Quad Sup SVL Support (RPR) ❖ 9300 – xFSU Standalone	**High Availability** ❖ 9300 – xFSU reload with backside stacking* ❖ 9300 – xFSU support with dot1x, MAB, Webauth* ❖ 9300 – xFSU : LACP Protocol support*	**High Availability** ❖ Flexlink+ with VLAN Load Balancing ❖ 9300 – xFSU Reload: Stacked and Standalone (17.3.2)
Platform & Programmability ❖ Per port MTU support ❖ 9500H/9600 – Unified Port Buffer ❖ 9400 – Native Docker for App Hosting	**Platform & Programmability** ❖ 9400 – 9216 bytes MTU ❖ 9600 – Breakout Support ❖ gPTP/ PTPv2 support on Port Channels	**Platform & Programmability** ❖ PVLAN on Trunks and Port Channels ❖ PTPv2 and gPTP support on 9400* ❖ ETA and AVC Interoperability on same port ❖ SHA-512 secure image-bootup integrity check ❖ gRPC Model Driven Telemetry (MDT) with TLS
Hardware & Optics ❖ C9300L mGig SKUs ❖ C9600-LC-48TX mGig Linecard	**Hardware & Optics** ❖ 9500/9600 – AOC/DAC, QSFP-4SFP10G	**Hardware & Optics** ❖

Reference

Catalyst 9000 Switching – Key Features

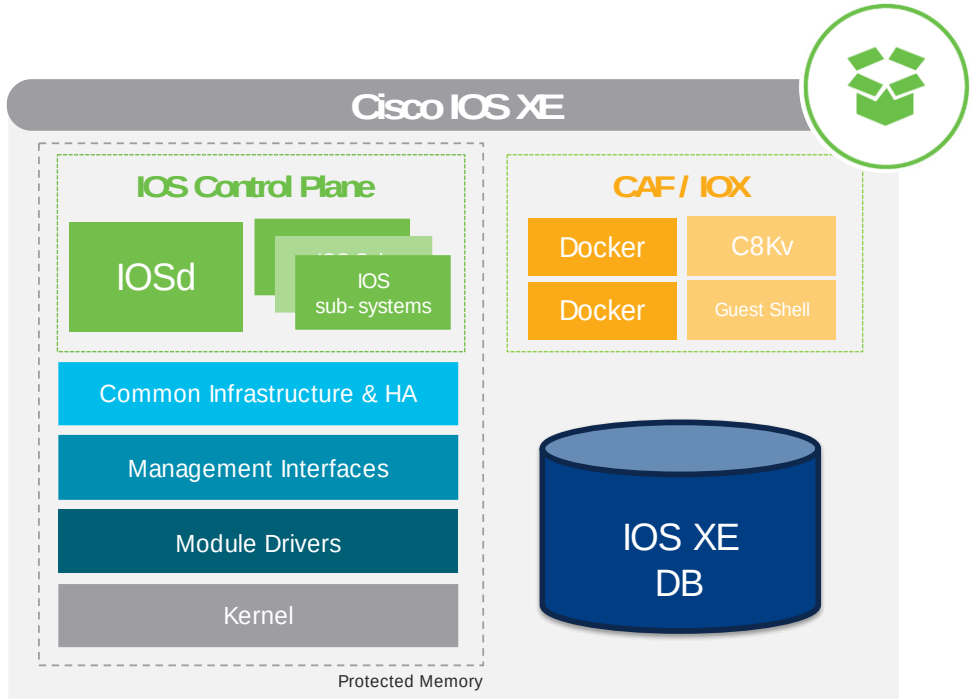
* Limited Availability (LA) only

IOS XE 17.4.1 (Nov'20) SMR	IOS XE 17.5.1 (Apr'21) SMR	IOS XE 17.6.1 (Aug'21) EMR
Enhanced Security ❖ FQDN ACLs ❖ RADSEC - Radius over TLS and DTLS ❖ Stealthwatch Cloud Integration* ❖ Wired Client Sensor with Flash*	**Enhanced Security** ❖ FQDN Redirect ACL ❖ Wired Dynamic VLAN ❖ Secure Network Analytics Connector ❖ DSCP Marking for RADIUS Packets ❖ Session timers AV Pair ❖ Interface Templates ❖ Trustworthy Systems	**Enhanced Security** ❖ 9300X – IPsec Phase1 – SVTI, IKEv2 ❖ IPv6 FQDN Redirect ACL ❖ RADSEC CoA Enhancement
Overlays & Segmentation ❖ PVLAN with BGP EVPN over VxLAN	**Overlays & Segmentation** ❖ Selective Q-in-Q ❖ BGP EVPN L2/L3 VNI scale	**Overlays & Segmentation** ❖ MPLS Traffic Engineering (TE) – Phase1 ❖ LACP/PAGP over EoMPLS ❖ MLD snooping over VPLS
Forwarding & Features ❖ 9500H/9600 - Customized SDM Template Ph2 (ACL)	**Forwarding & Features** ❖ 9500H/9600 - Customized SDM Template Ph3 (4K VLAN) ❖ Enhanced NAT scale ❖ BGP Monitoring Protocol ❖ WCCP Over GRE	**Platform Features** ❖ VRF Aware WCCP ❖ Enhanced NAT Session Monitoring ❖ NAT Precedence ❖ Bonjour mDNS SSO, FHRP Service Peer Support
High Availability	**High Availability**	**High Availability** ❖ VRRPv3 SSO
Platform & Programmability ❖ YANG model updates ❖ Smart Licensing using Policy	**Platform & Programmability** ❖ gPTP over L3 Unicast ❖ Disable USB SSD ❖ App Hosting Updates	**Platform & Programmability** ❖ App Hosting on 9300X ❖ Thousand Eyes – 4.0 Version Agent ❖ Perpetual PoE/UPOE with StackPower ❖ PTP on StackWise*, PTP over SDA ❖ Programmability & Automation updates
Hardware & Optics ❖ 9500H/9600 - SFP-10G-TX, QSFP-40/100-SR4, 9600 - 4 x 25G Breakout, GLC-GE-100FX and GLC-TE-100M	**Hardware & Optics** ❖ C9400-LC-48HN – 5G MGIG line card with 90W PoE	**Hardware & Optics** ❖ C9300X-12Y / 24Y - 10/25G Fiber Switch with Cisco UADP2.0sec ❖ C9300X-NM – 2x 40/100G, 8x 10/25G, 8x mGiG uplinks

Cisco Catalyst 9000 Series IOS XE Software

IOS XE after 17.7.x

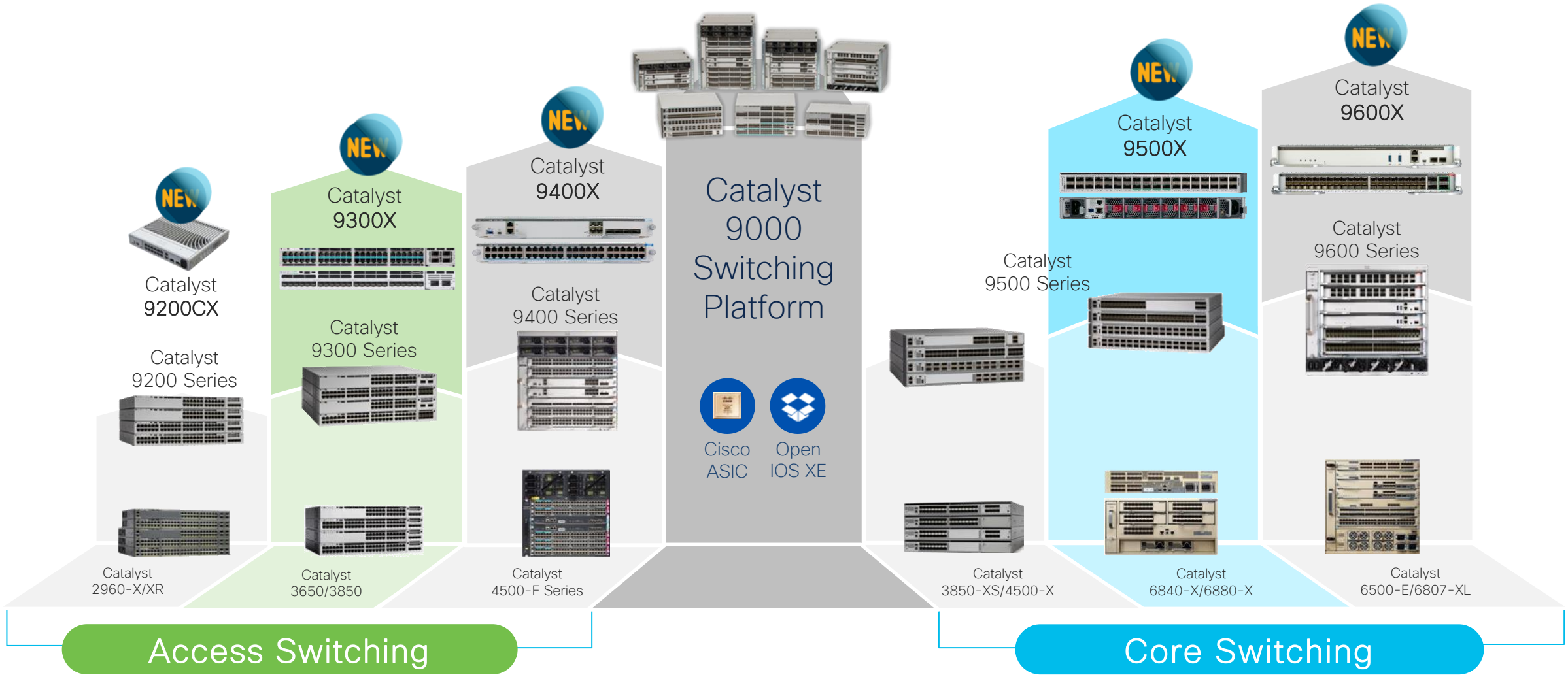
- **IOS XE Continues to Evolve**
- **New C9K Platforms**
- **Common Platform Abstraction**
- **Forwarding Engine Driver**



Cisco Catalyst 9000 Switching Portfolio

One Family from Access to Core – Common Hardware & Software

IOS XE 17.7.x - 17.9.x



Reference

Catalyst 9000 Switching – Key Features

* Limited Availability (LA) only

IOS XE 17.7.1 (Dec'21) SMR	IOS XE 17.8.1 (Apr'22) SMR	IOS XE 17.9.1 (Aug'22) EMR
Enhanced Security ❖ 9500X/9600X – MACsec ❖ 9200/9300 – API Registration for Umbrella Switch connector	**Enhanced Security** ❖ 9300X – IPsec Phase2 – Multicast (SVTI) ❖ 9500X/9600X – WAN-MACsec, with HSEC license ❖ SW SUDI 2099 Enablement	**Enhanced Security** ❖ 9300X – IPsec Phase3 – NAT Traversal ❖ 9300X – VRF-aware IPsec ❖ Reflexive ACL
Overlays & Segmentation ❖ 9500X/9600X – MPLS and TE Phase1 ❖ 9500X/9600X – EoMPLS ❖ EVPN L3 TRM with MDT Data	**Overlays & Segmentation** ❖ EVPN L2 TRM	**Overlays & Segmentation** ❖ SDA LISP Graceful Restart for MAC cache ❖ SDA VN Extranet across SDA Transit
Forwarding & Features ❖ 9500X/9600X – L3 Routing (IGP, BGP) feature set ❖ Low priority Control packet mapping to Non-LLQ ❖ Bonjour – Micro-Location services	**Forwarding & Features** ❖ 9500X/9600X – Sampled Flexible NetFlow	**Forwarding & Features** ❖ Destination IP NAT scale enhancement ❖ PAT support for Enhanced NAT scale ❖ Conditional Static NAT using Route-map
High Availability ❖ 9400X/9600X – SSO & ISSU ❖ 9300X – xFSU	**High Availability** ❖ Graceful Insertion & Removal (GIR) – 9500H & 9600	**High Availability** ❖ 9400X – StackWise Virtual (Dual-Sup)
Platform & Programmability ❖ PTP on 9300 StackWise ❖ PTP on 9600 ❖ PTP AES67 compliance ❖ AVNU Certification – 9300 & 9500 ❖ gNOI reset.proto – tooling	**Platform & Programmability** ❖ PTP – G8275.1 ITU Telcom Profile ❖ 9500X/9600X – L3 Sub-Interface Queuing ❖ C9300 System Power-Consumption Reporting ❖ gNMI Native Configuration Yang Model ❖ Guest Shell HA – Guest-Share Folder Sync	**Platform & Programmability** ❖ 9500H – AVB support ❖ 9400X – Perpetual PoE support ❖ 9400X – Support for hosting multiple applications ❖ 9400X – 432 Port-Channels ❖ 9400X – 4K VLANs support
Hardware & Optics ❖ C9300X-48TX / 48HX – 48x mGig Switch with Cisco UADP2.0sec ❖ C9400X-SUP-2/XL – Supervisor 2 with Cisco UADP3.0sec ❖ C9500X-28C8D – 100/400G Fiber switch with Cisco S1 Q200 ❖ C9600X-SUP-2 – Supervisor 2 with Cisco S1 Q200 ❖ C9600-LC-40YL4CD – 40x SFP + 4x QSFP Combo Linecard	**Hardware & Optics** ❖ C9400-LC-HX – 48x mGig Linecard ❖ C9400-LC-XS – 48x 1/10G Linecard ❖ C9600 – 3000W PSU	**Hardware & Optics** ❖ C9200CX-8P ❖ C9200CX-12P ❖ C9600-LC-32CD – 32x QSFP (32x 100G or 24x 100G + 2 x 400G)

C9K NG IOS XE – Highlights

Programmable

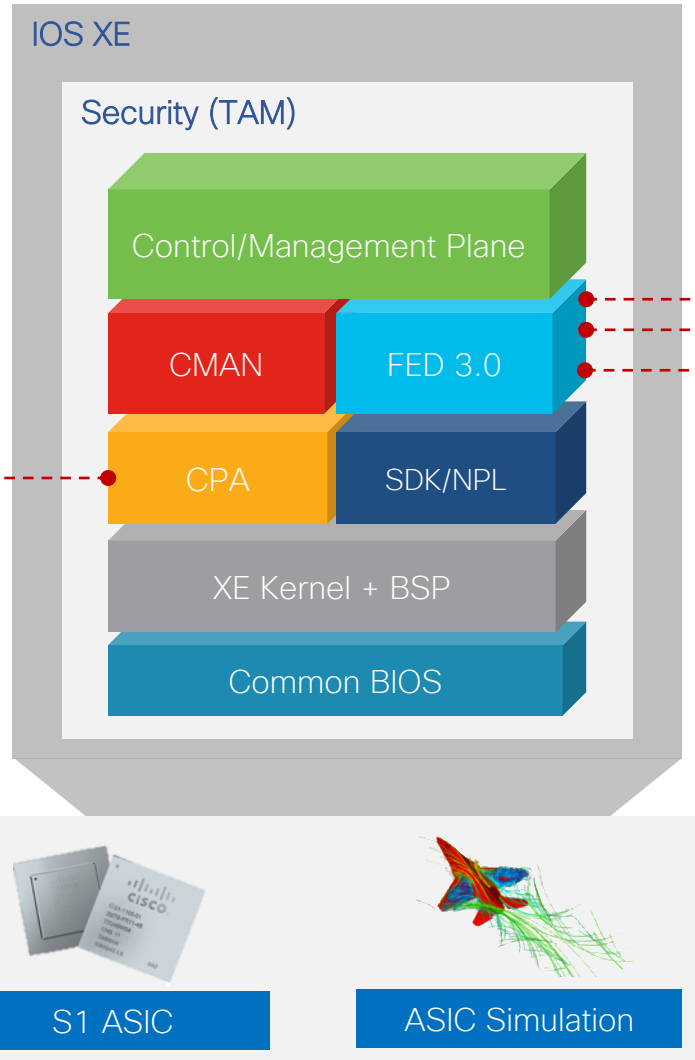
- Managed Through Models
- Programmable through YANG

CPA – Single Source of Truth, Abstraction

- CPA architecture for sharing common software across multiple platforms
- Single Source of Truth – for various devices and interconnects

Differentiated ASIC + SDK

- High capacity, programmable ASIC
- Generic SDK as an integration layer



Secure

- Secure Boot, Image Signing
- SELinux, X.509

FED3.0 – Model Driven Forwarding

- Enable Controller Visibility
- Bring Polaris infrastructure to FED
- Bring FED closer for stateful restart

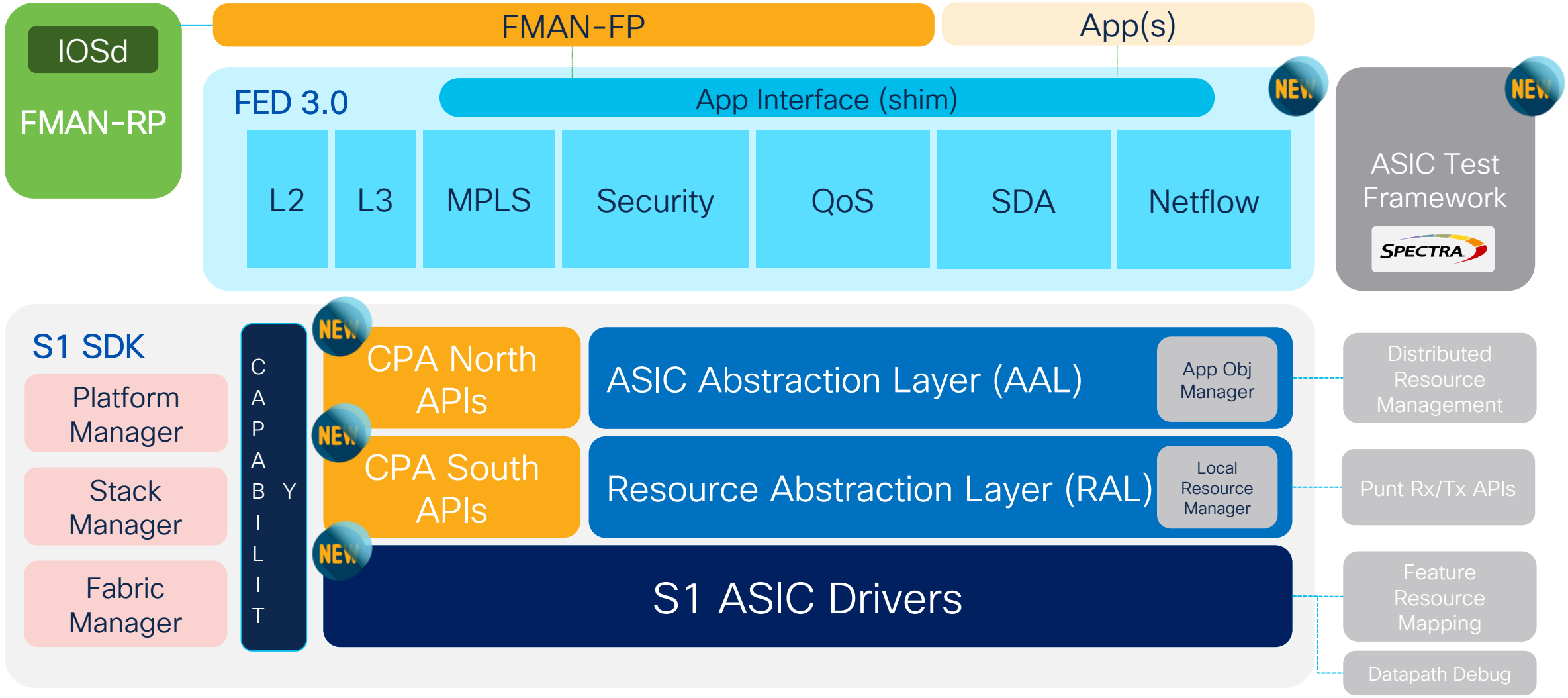
SPECTRA

Software Punt

- High Speed zero-copy punt to enable Software sampled Apps (e.g. NetFlow)

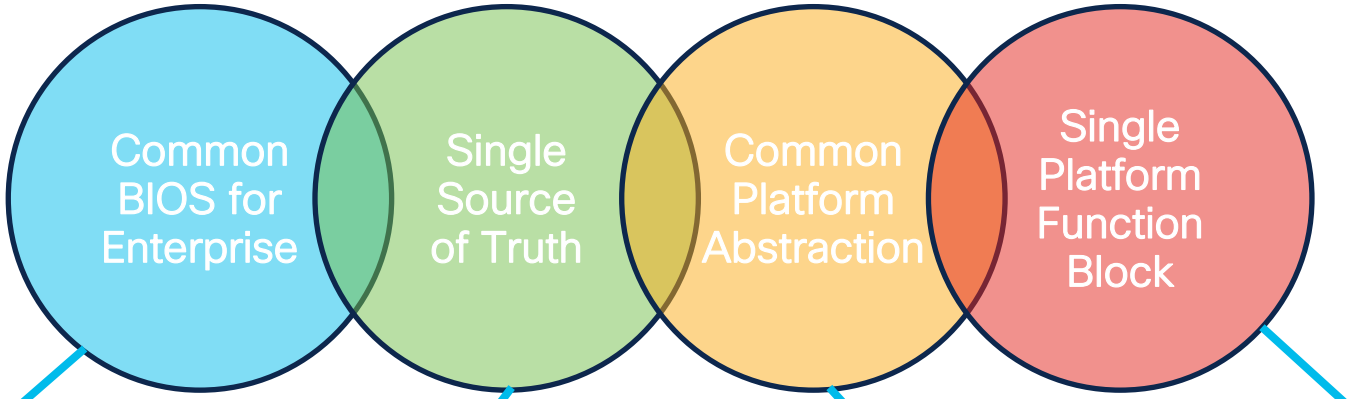
C9K NG-XE Overview

Hardware Forwarding Architecture



C9K Next-Gen IOS XE

Platform Infra Overview



Common BIOS

- Common BIOS repository for all Enterprise platforms
- Standardized customizations

Single Source of Truth

- Partially-automated way to transfer hardware attributes to software
- Single place for all engineers to go to

Common Platform Abstraction

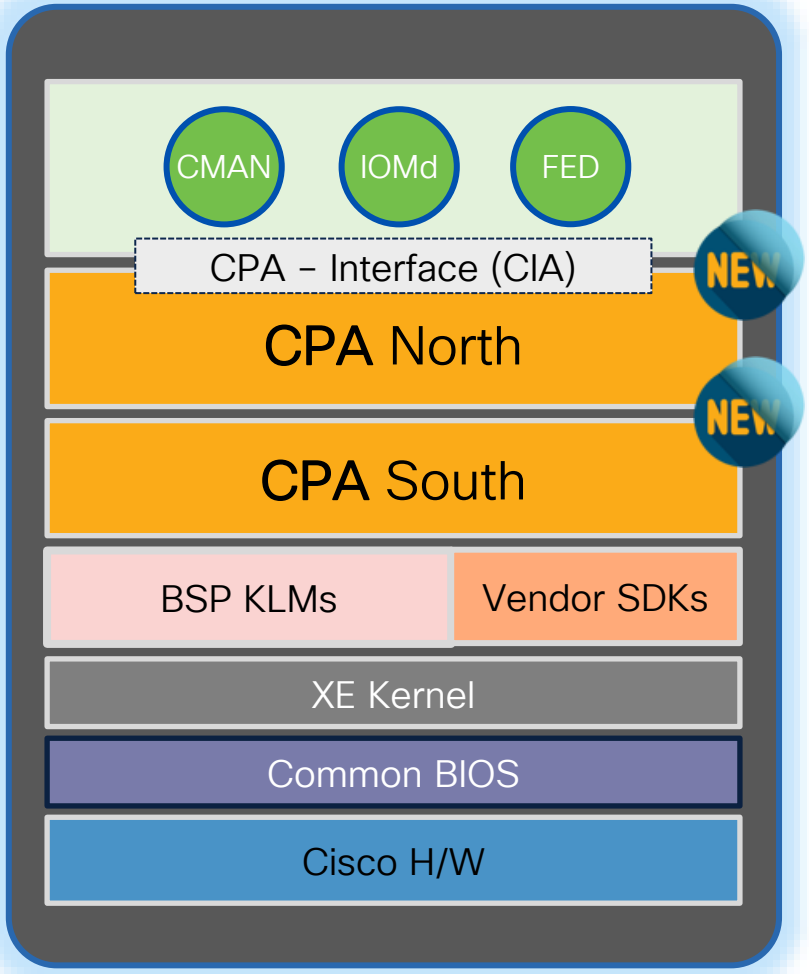
- Model-driven Device APIs consistent across Cisco
- Easier to adopt for subsequent platform (limit changes to certain files)

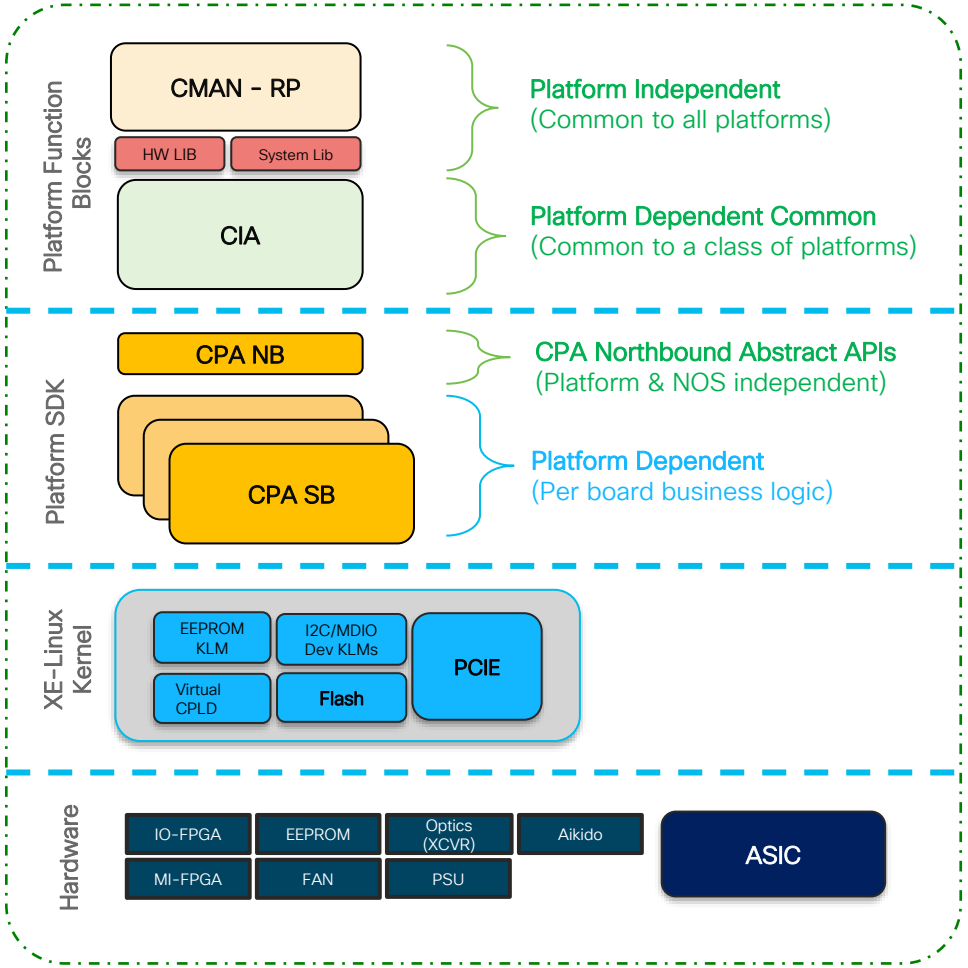
Platform Function Block

- Common CMAN, CMCC, EMD, IOMD
- For Enterprise platforms running on IOS XE (Polaris)

C9K NG IOS XE – Platform Infra

Architecture Evolution - Common Platform Architecture (CPA)





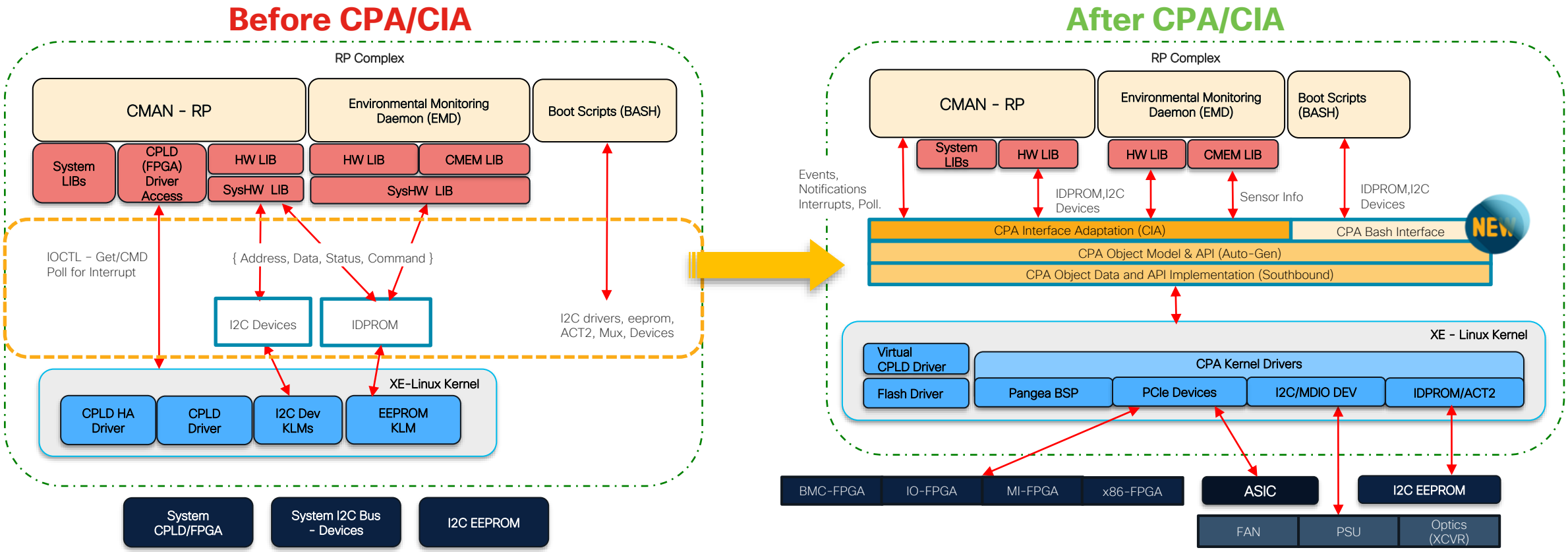
Leveraged by NG Platforms

PD code

C9K NG IOS XE- CPA Overview

Architecture Evolution – before & after

Cisco Platform Abstraction (CPA) is a model-driven HW to SW disaggregation layer for platform devices. It hides board and device connection details from upper-layers of platform features - and **acts as a "single source of truth" for hardware data**.

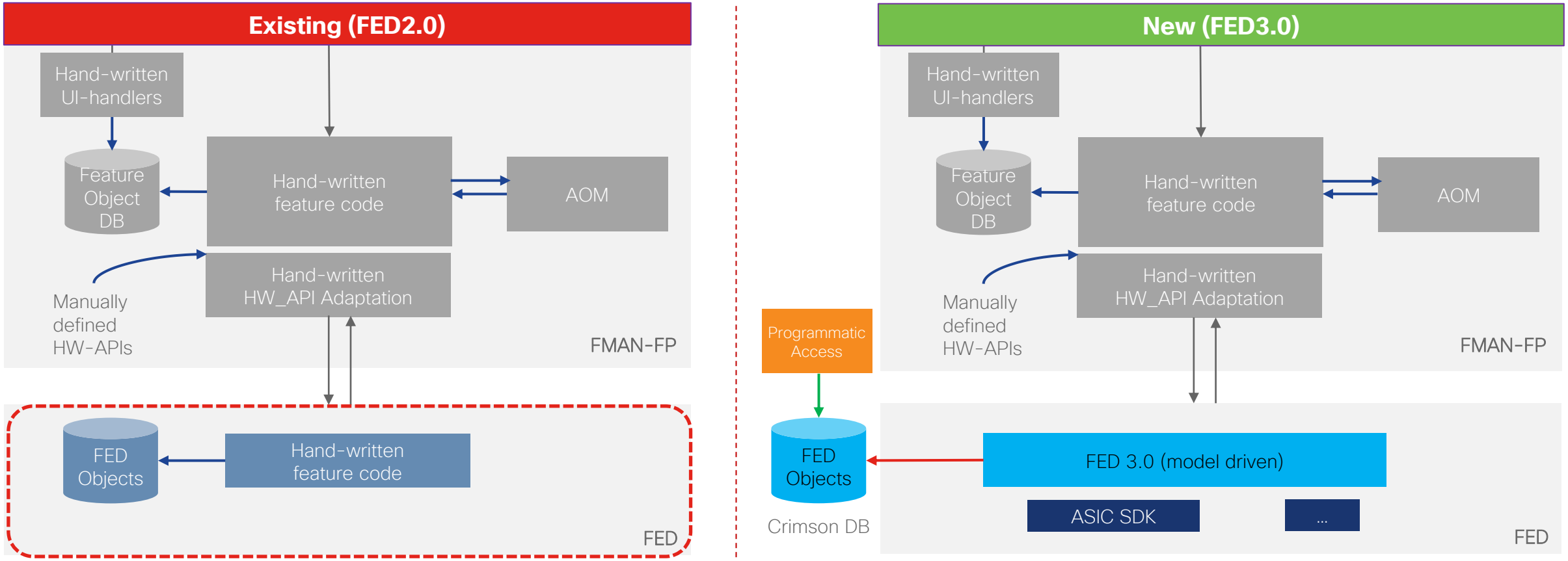


CPA provides common & consistent inventory and device-access helper functions (APIs) for admin-plane features

C9K NG-XE – FED 3.0

Before & After - Overview

IOS XE and FED have been enhanced to support various types of databases and to support automatic code-generation

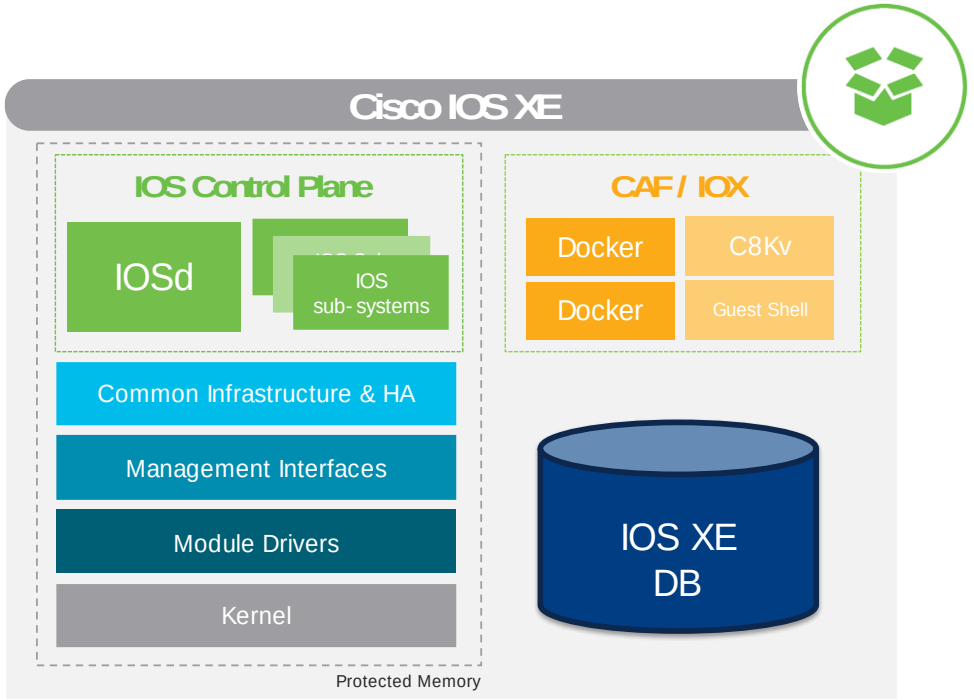


- Controller visibility of HW forwarding objects
- Time series for HW forwarding objects
- Stateful restart HW forwarding objects
- Automatic code-generation for object life-cycle

Manual
Auto-generated
New capability

Summary

- **Benefits of IOS XE**
- **Cisco IOS XE References**
- **Catalyst 9000X References**
- **Thank You!! ☺**



Why should you care?

Cisco IOS XE - Benefits for you

One Release Train

Operational Efficiency,
Consistency in Behavior,

Run Any Feature Anywhere (RAFA)

Feature Velocity
across Platforms

Software Patch Updates

Sub-package upgrades,
Cold and Hot Patching

Comprehensive Programmability

Object based model,
Netconf/REST Interfaces

Trustworthy & Secure Platform

64-bit ASLR, Secure Boot,
Hardware TAM

Would You Like to Know More?

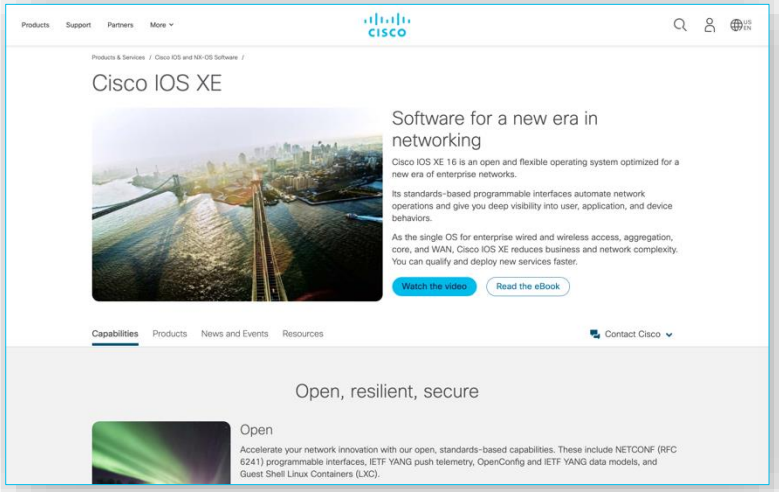
Cisco IOS-XE & Cisco DNA Resources

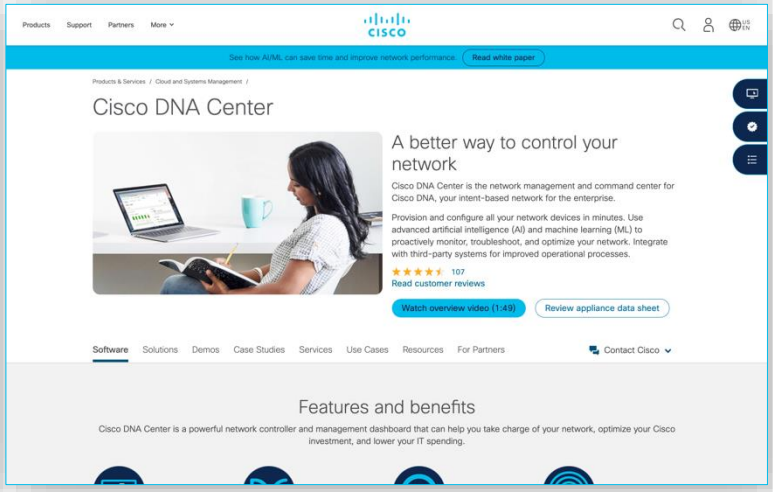
cisco.com/go/dna

cisco.com/go/iosxe

cisco.com/go/smartlicensing

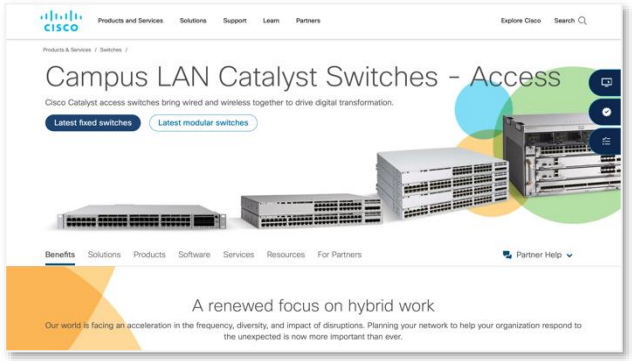
cisco.com/go/dnacenter



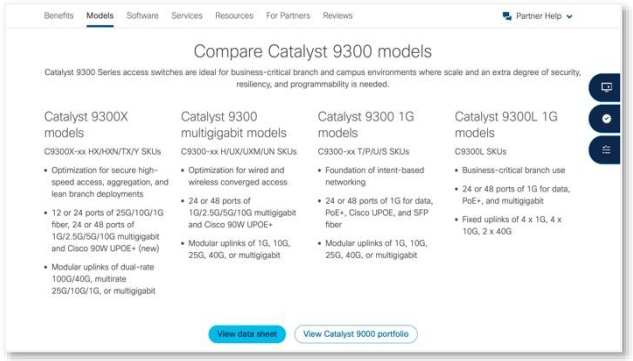


Would You Like to Know More?

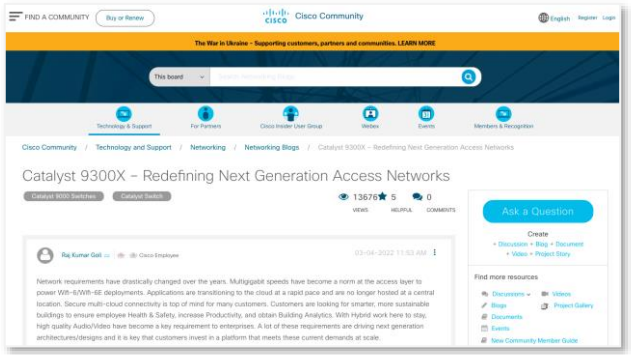
Catalyst 9000X Series Collateral



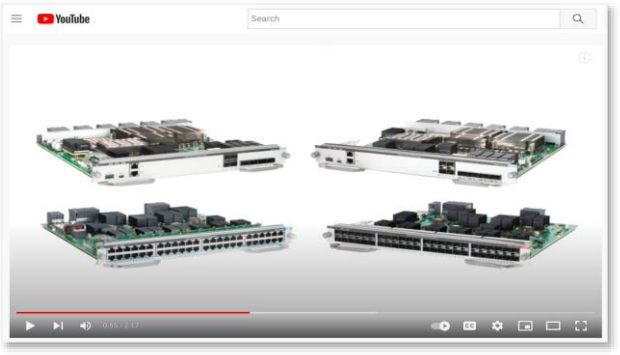
- Cisco.com – Enterprise Networks – Switching
- Catalyst 9000 Switches At-a-Glance
- Catalyst 9000 Frequently Asked Questions



- Catalyst 9300 Series Switches data sheet
- Catalyst 9400 Series Switches data sheet
- Catalyst 9500 Series Switches data sheet
- Catalyst 9600 Series Switches data sheet



- Catalyst 9300X Technical Blog (Community)
- Catalyst 9400X Technical Blog (Community)
- Catalyst 9500X Technical Blog (Community)
- Catalyst 9600X Technical Blog (Community)



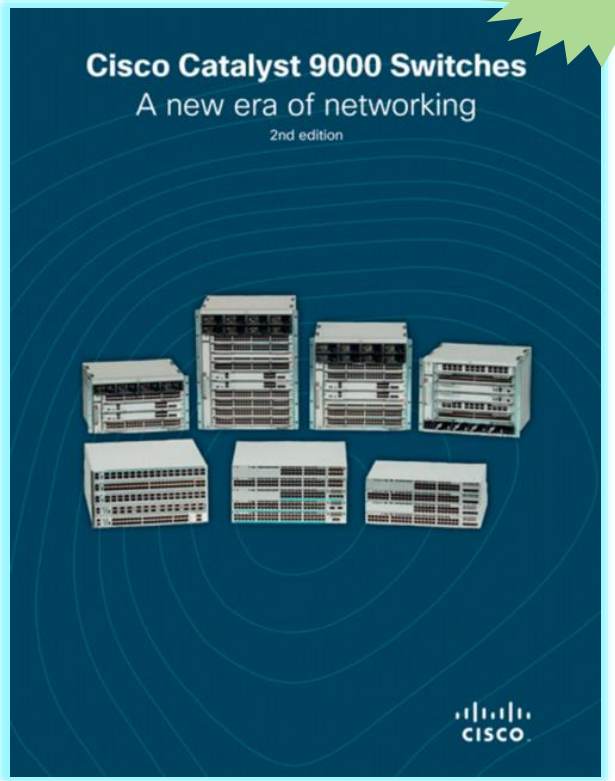
- Under the Hood of the Catalyst 9000X (TFD)
- Network Insiders Podcast
- Meet the C9300X
- Meet the C9400X
- Meet the C9500X and C9600X

Would You Like to Know More?

Catalyst 9000 Series Enterprise Switches

- **cisco.com/go/cat9K**
- Cisco Catalyst 9000 at-a-Glance
- Cisco Catalyst 9000 Family FAQ
- Catalyst 9000 Series – Cisco Community
- Catalyst 9000 Series – CiscoLive Library

FREE



cs.co/cat9kbook

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