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Expert Series Webcast

Catalyst 2960X/XR Series Enterprise Switches

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Technical Leader

May 10, 2016

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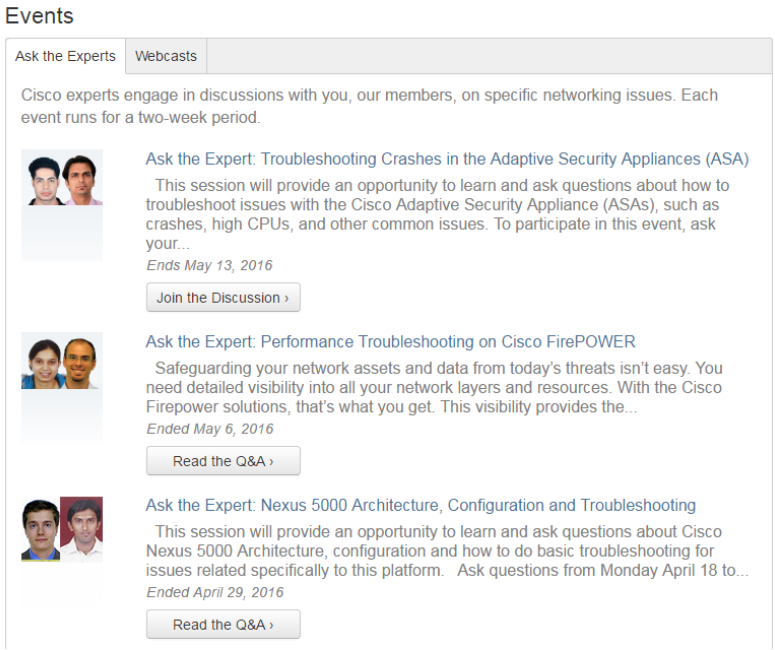

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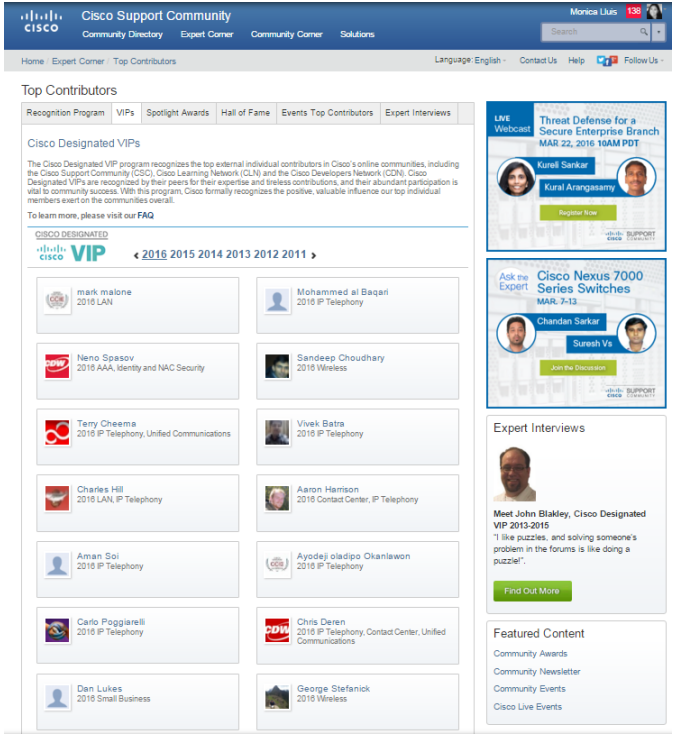

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Ask the Expert Event following the Webcast

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https://supportforums.cisco.com/discussion/12982571/ask-expert-catalyst-2960-x-and-2960-xr-switches-overview-configuration-and

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Use the Q & A panel to submit your questions and the panel of experts will respond.

Please take a moment to complete the survey at the end of the webcast

Agenda

- Comparison and differences in Cisco Catalyst 2960X and 2960XR series switches
- Switches Architecture – 2960X/XR
- Flex Stack Plus in 2960X/XR
- Overview on various features on the 2960X/XR
- Configuration examples
- Troubleshooting best practices and hints

Agenda

- **Comparison and differences in Cisco Catalyst 2960X and 2960XR series switches**
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Polling Question 1

Which Catalyst switch comes to your mind when we speak of the Catalyst 2960 family

A. 2960

B. 2960P

C. 2960S

D. 2960X

E. 2960XR

The New Catalyst 2960 Family

Layer 2 Stand-alone

Catalyst 2960-Plus

1G SFP/BASE-T Uplinks
802.3af PoE

Advanced Layer 2 STACKABLE

Catalyst 2960-SF

1G SFP Uplinks
40G FlexStack
Full PoE, PoE+
IPv6 FHS

Advanced Layer 2 STACKABLE

Catalyst 2960-S

10G SFP+ Uplinks
40G FlexStack
Full PoE, PoE+
IPv6 FHS

Advanced Layer 2 STACKABLE

Catalyst 2960-X

10G/1G SFP+/SFP
80G FlexStack+
Full PoE, PoE+
IPv6 FHS
NetFlow Lite

Advanced Layer 2/3 STACKABLE + RESILIENT

Catalyst 2960-XR

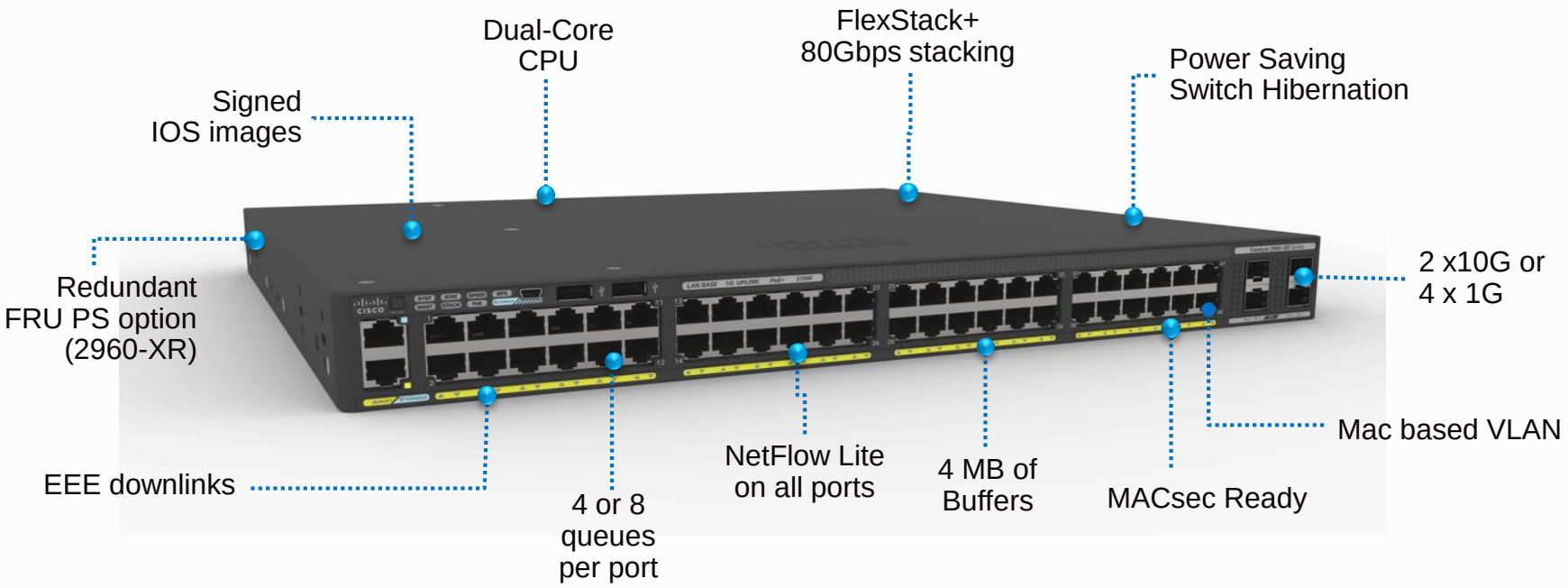
2960-X Features plus:
IP Lite – L3/Routing
Redundant PSU

Fast Ethernet | **Gigabit Ethernet**

EASE-OF-USE | **ROBUST SECURITY** | **ENHANCED LIFETIME WARRANTY** | **ENERGY EFFICIENCY** | **LOWER TCO**

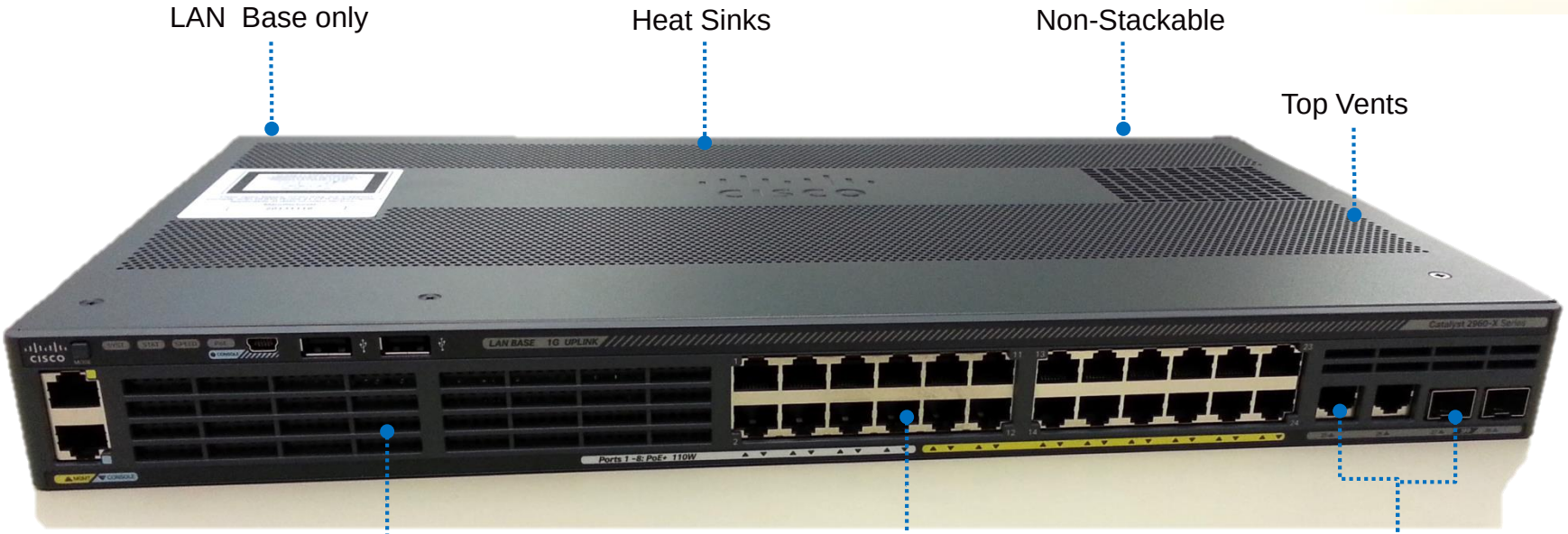
Feature Leadership and Cisco Quality at Competitive Prices

Cisco Catalyst 2960-X & 2960-XR



2960-X Fan Less Model

Silent Operation : co-locate with end users (WS-C2960X-24PSQ-L))



Redundant Inline Power with 2960-XR

Field-replaceable Power Supplies for Resilient Switching & PoE

250 W AC — Non-PoE

640 W AC — 370W PoE

1025 W AC — 740W PoE

3 FRU PSU options

Non-stop power in 1 RU

Optional power redundancy with dual supplies

Easy field replacement

Of failed PSU or integrated fans

Standby Mode

PoE budget does not increase with second PS

2960-X Power Redundancy – RPS 2300

C2960-X

22 Pin connector

RPS 2300

- Protection against device Power Supply Failure
- Seamless Failover < 600-µs
- Increases availability of data and PoE

CAB-RPS2300-E=

Switch Hibernation Mode

- When the switch is not in use, Switch Hibernation Mode can be scheduled to save power.
- Power off CPU Cores , ASIC and Connected PoE devices.
- DRAM is in refresh mode, keeping data intact
- Power to most components is off except DRAM, FANs and MCU.
- Wake on Mode Button trigger
- Wake on Scheduled Real Time Clock alarm / Interrupt
- Mode Button trigger has precedence over all other wake on events.
- On wake up alarm, The CPU Cores are powered on and DRAM is put out of self refresh.

Energy Efficient 2960-X & 2960-XR

Switch Hibernation Mode
Powers down components

PID	AC Power (W) **100% traffic**	AC Power (W) **HW Sleep**	**% Saving**
C2960X-48FP	66.7	26.0	**61%**
C2960X-48LP	62.0	23.1	**63%**
C2960X-24P	53.1	22.6	**58%**
C2960X-48T	47.8	8.7	**82%**
C2960X-24T	33.1	6.4	**81%**

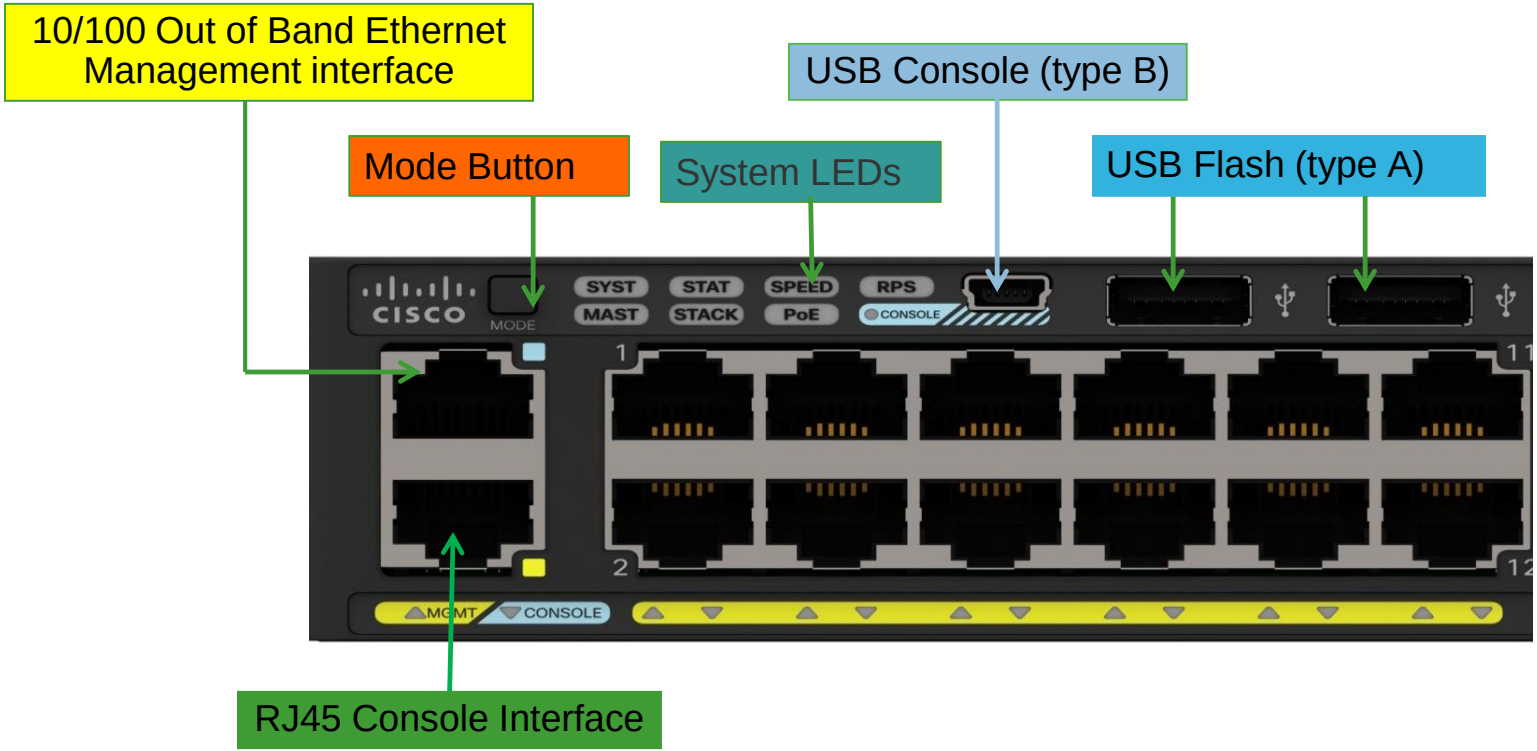
Efficient Power Supply
less power usage - energy savings

Energy Efficient Ethernet
Reduced power draw on downlinks

EnergyWise
Switch and endpoint monitoring and control

2960-X / 2960-XR Front Panel

System Management Interfaces



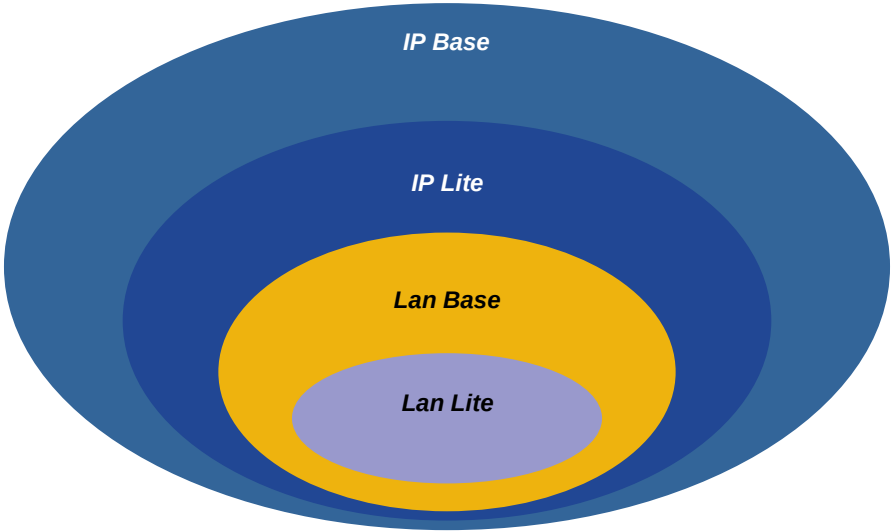
Dynamic Routing with 2960-XR

New IP Lite Feature Set Delivers basic Layer-3 Functionality

	LAN Lite	LAN Base	IP Lite	IP Base	IP Services
	Basic L2	Complete L2	Basic L3	Complete L3 + CA(o)	Advanced L3 + CA(o)
2960-plus / 2960-S/SF	✓	✓			
2960-X	✓	✓			
2960-XR			✓		
3650 / 3850/3750/3560		✓		✓	✓

cisco

IP Lite - Basic L3 features in Catalyst 2960 Series



IP Lite is subset of IP Base features

IP Lite L3 features

- RIPv1, RIPv2
- OSPF Routed Access
- EIGRP (IPv4)
- Policy Based Routing
- Host Standby Router Protocol (HSRP)
- VRRP
- PIM (SM, DM, SDM)
- IPv6 PIM (SM, SSM)

2960 GE model Comparison

For Your Reference

Capability	2960-S (LAN Base)	2960-X (LAN Base)	2960XR (IPLITE)
CPU	Single Core @400MHz	Dual Core @600MHz	Dual Core @600MHz
Stacking Technology	FlexStack	FlexStack-Plus	FlexStack-Plus
Stacking BW/ Members	40Gbps / 4	80Gbps / 8	80Gbps / 8
Power Supply	Single Fixed	Single Fixed	Redundant
Flash On board	64MB	128MB	128MB
DRAM	128MB	512MB	512MB
EEE downlinks	No	Yes	Yes
Switch Hibernation Mode	No	Yes	Yes

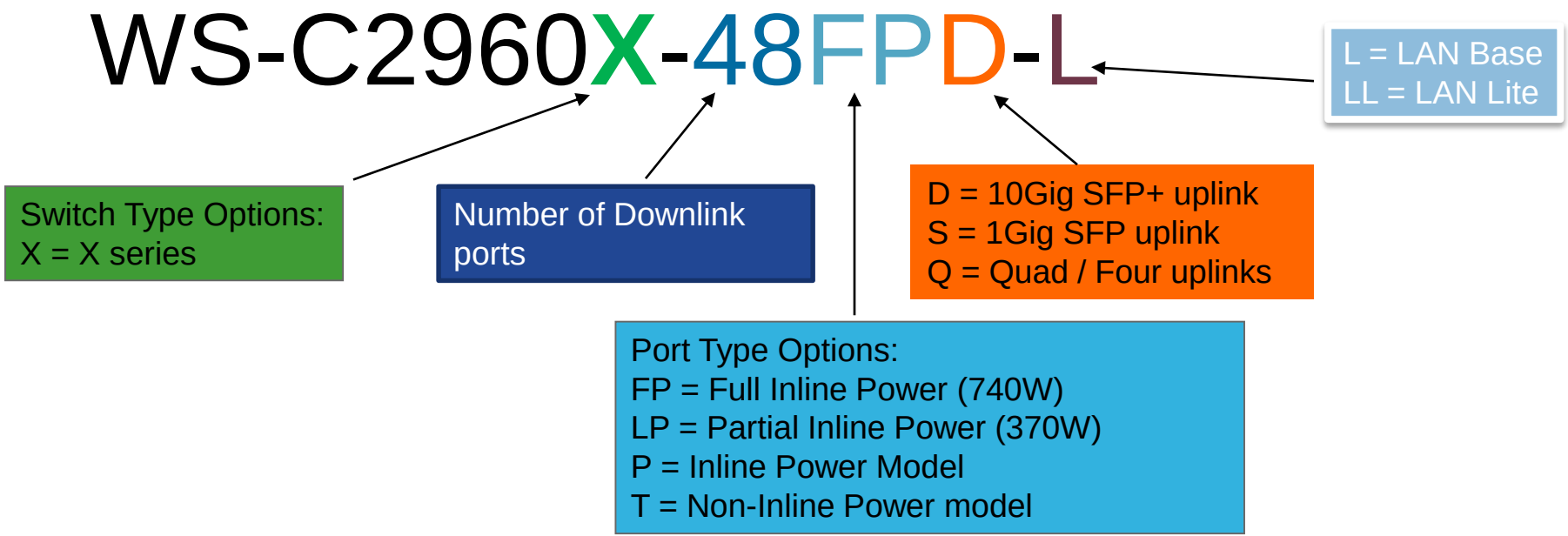
2960 GE model Comparison

For Your Reference

Capability	2960-S (LAN Base)	2960-X (LAN Base)	2960-XR (IP Lite)
Active VLANs	255	1k	1k
STP Instances	128	128	128
Etherchannel Groups	6	24	48
Queues per port	4	4 / 8* (configurable)	4 / 8* (configurable)
Ingress Policers	64	256	256
Egress Buffer	2MB	4MB	4MB
SPAN sessions	2	4	4
NetFlow-Lite	No	Yes	Yes

*available in standalone mode only

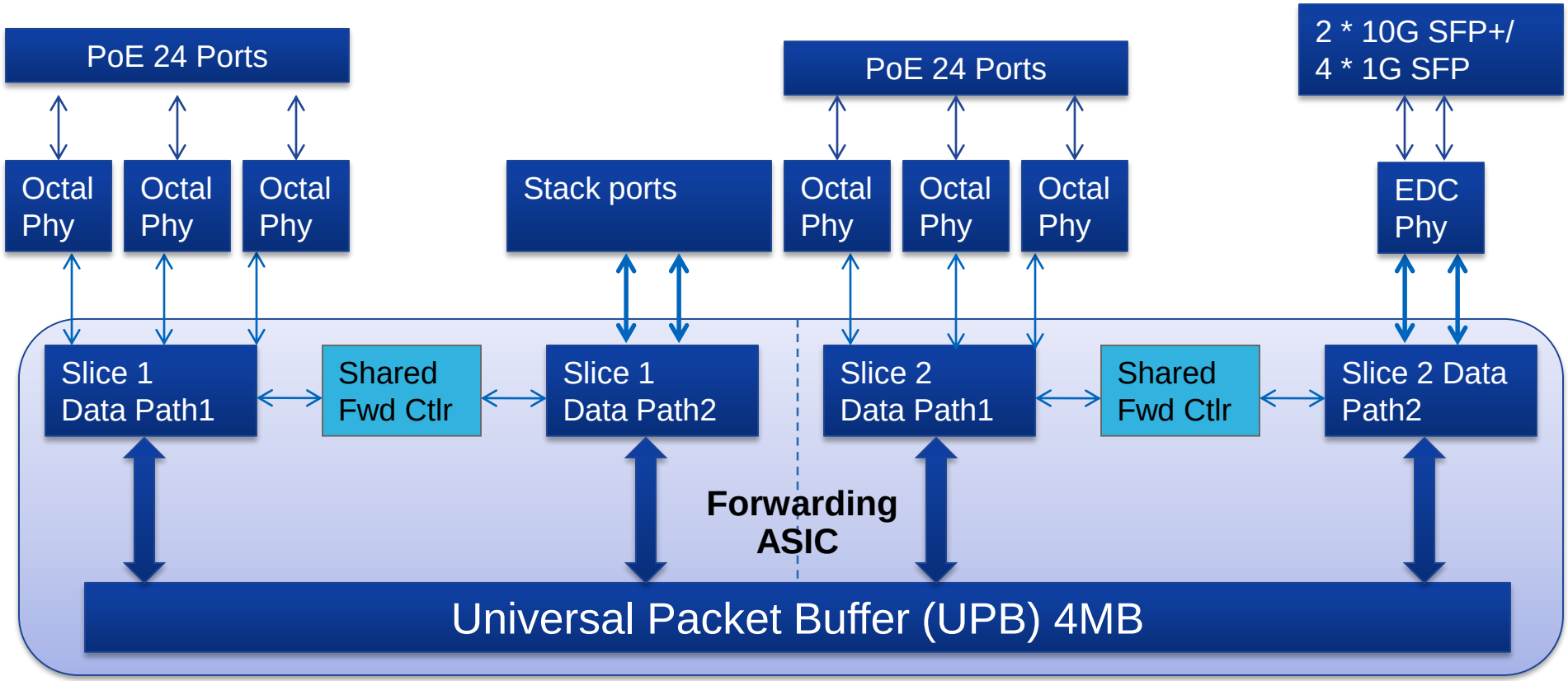
How to read the PID



Agenda

- Comparison and differences in Cisco Catalyst 2960X and 2960XR series switches
- **Switches Architecture – 2960X/XR**
  - **Architecture**
  - **Packet Walk through**
- Flex Stack Plus in 2960X/XR
- Overview on various features on the 2960X/XR
- Configuration examples
- Troubleshooting best practices and hints

2960-X Architecture

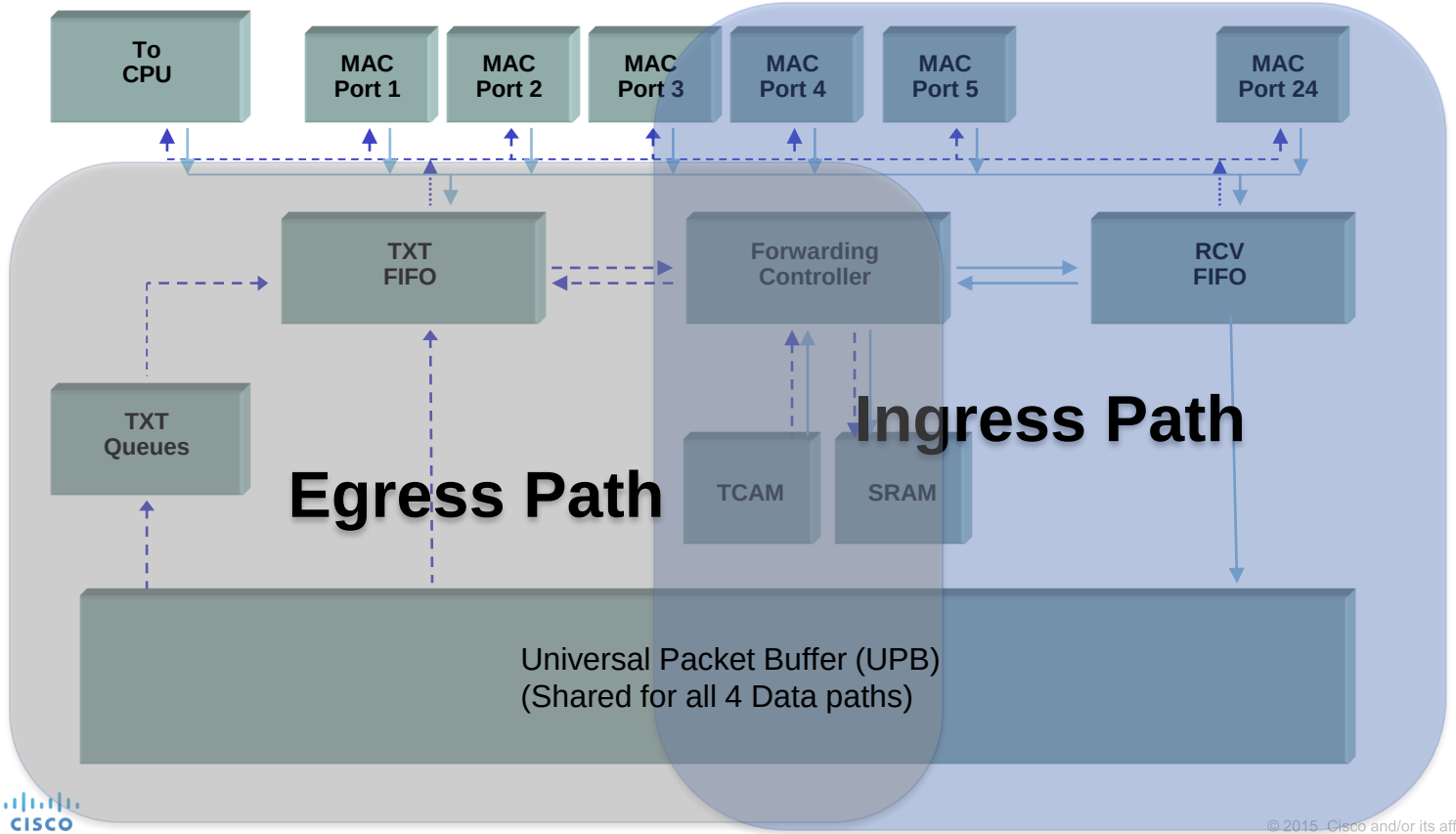


How to check ASIC to port mapping

```
C2960X#sh platform pm if-numbers

interface gid  gpn  lpn  port slot unit slun port-type lpn-idb gpn-idb
-------------------------------------------------------------------------
Gi1/0/1   1    1    1    1/2  1    1    1    local     Yes     Yes
Gi1/0/2   2    2    2    1/1  1    2    2    local     Yes     Yes
Gi1/0/3   3    3    3    1/4  1    3    3    local     Yes     Yes
Gi1/0/4   4    4    4    1/3  1    4    4    local     Yes     Yes
Gi1/0/5   5    5    5    1/6  1    5    5    local     Yes     Yes
Gi1/0/6   6    6    6    1/5  1    6    6    local     Yes     Yes
Gi1/0/7   7    7    7    1/8  1    7    7    local     Yes     Yes
Gi1/0/8   8    8    8    1/7  1    8    8    local     Yes     Yes
Gi1/0/9   9    9    9    1/10 1    9    9    local     Yes     Yes
Gi1/0/10  10   10   10   1/9  1    10   10   local     Yes     Yes
Gi1/0/11  11   11   11   1/12 1    11   11   local     Yes     Yes
Gi1/0/12  12   12   12   1/11 1    12   12   local     Yes     Yes
Gi1/0/13  13   13   13   1/16 1    13   13   local     Yes     Yes
Gi1/0/14  14   14   14   1/15 1    14   14   local     Yes     Yes
Gi1/0/15  15   15   15   1/18 1    15   15   local     Yes     Yes
Gi1/0/16  16   16   16   1/17 1    16   16   local     Yes     Yes
```

Within the ASIC – Single Data Path



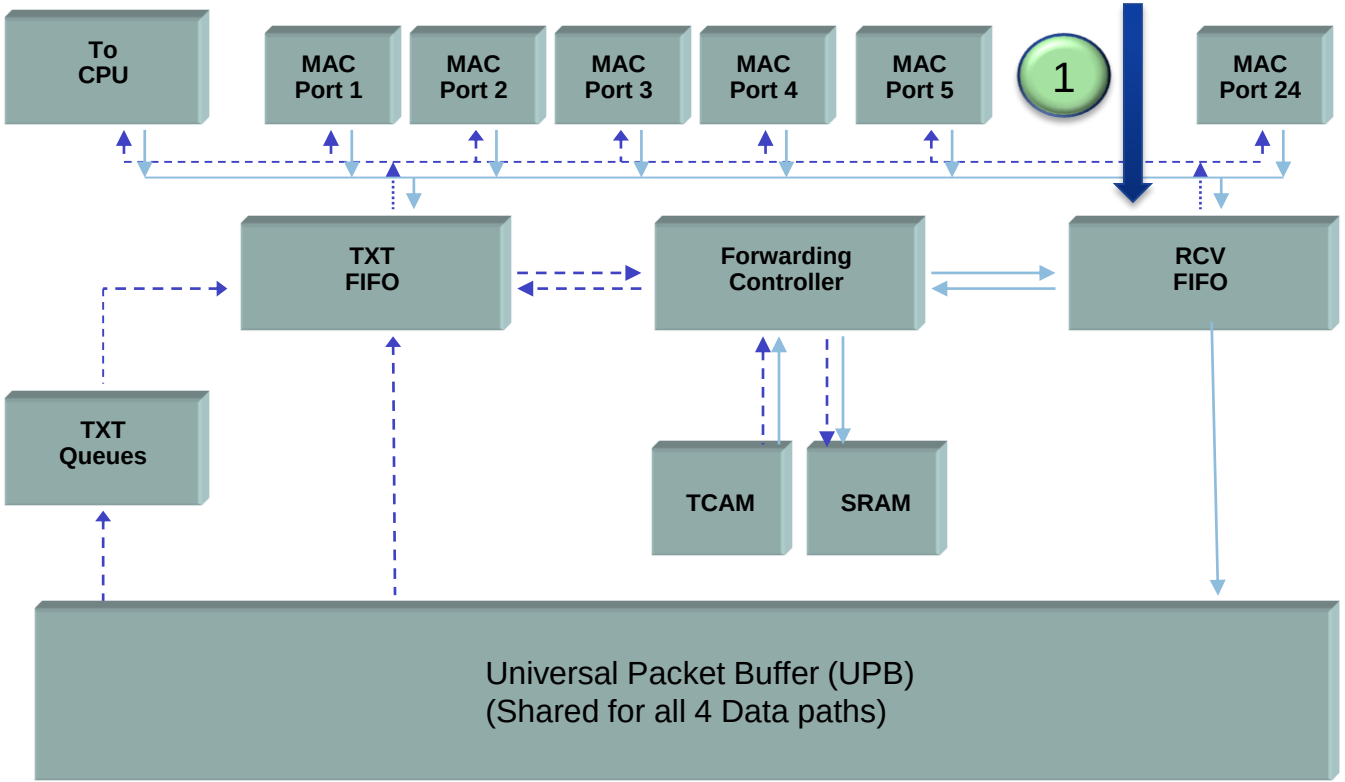
Switch Database Management (SDM) Templates

- Flexibility to configure system resources
- Optimize system resources for various deployments – Switching, Routing

SDM Template	Default	VLAN	IPv4
L2 - MAC	16K	32K	16K
L3 - Routes	5.25K	0.5K	24K
Multicast (v4/v6)	1K / 1K	1K / 1K	1K / 0
QoS ACE (v4/v6)	500 / 250	500 / 500	500 / 0
Security ACE (v4/v6)	1K / 500	1K / 500	875 / 60

2960-XR SDM templates

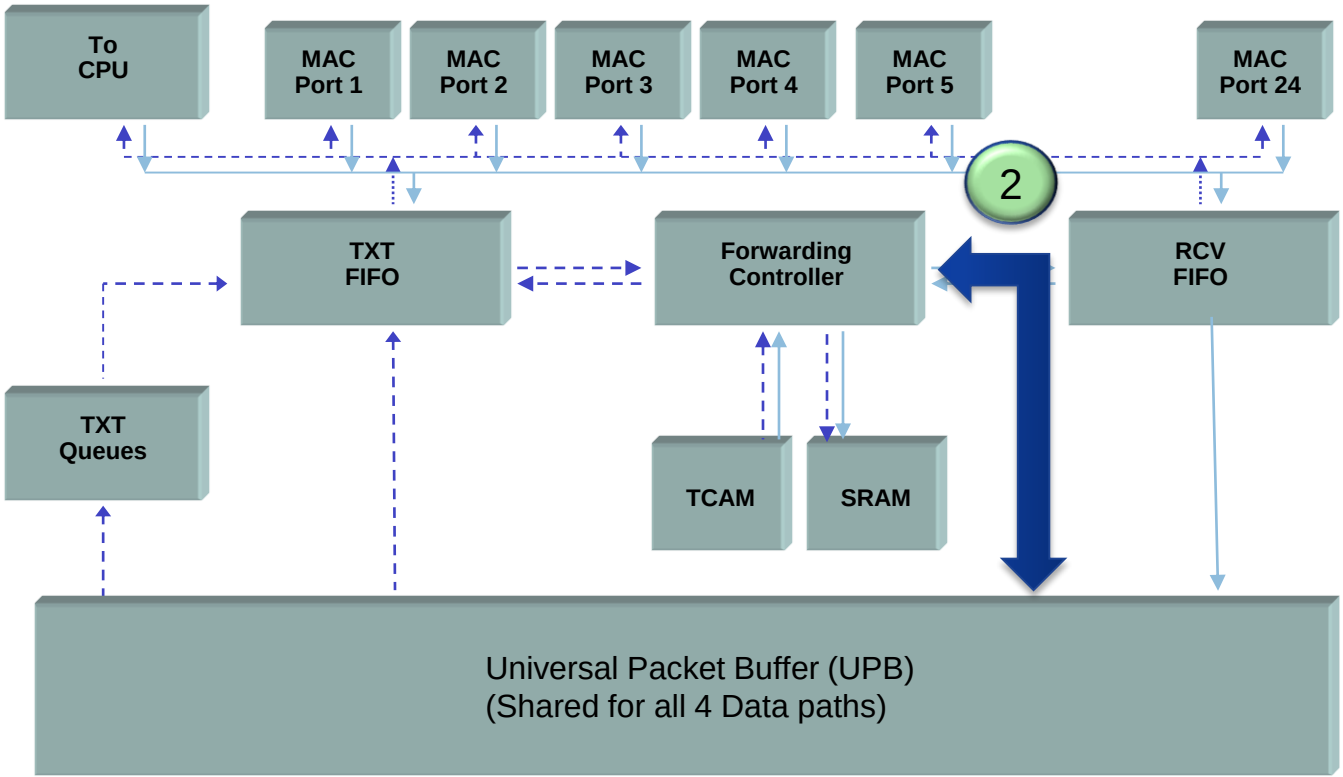
Packet walk - Ingress



1

Packets entering the switch are received by the Receive FIFO after VLAN decapsulation

Packet walk - Ingress

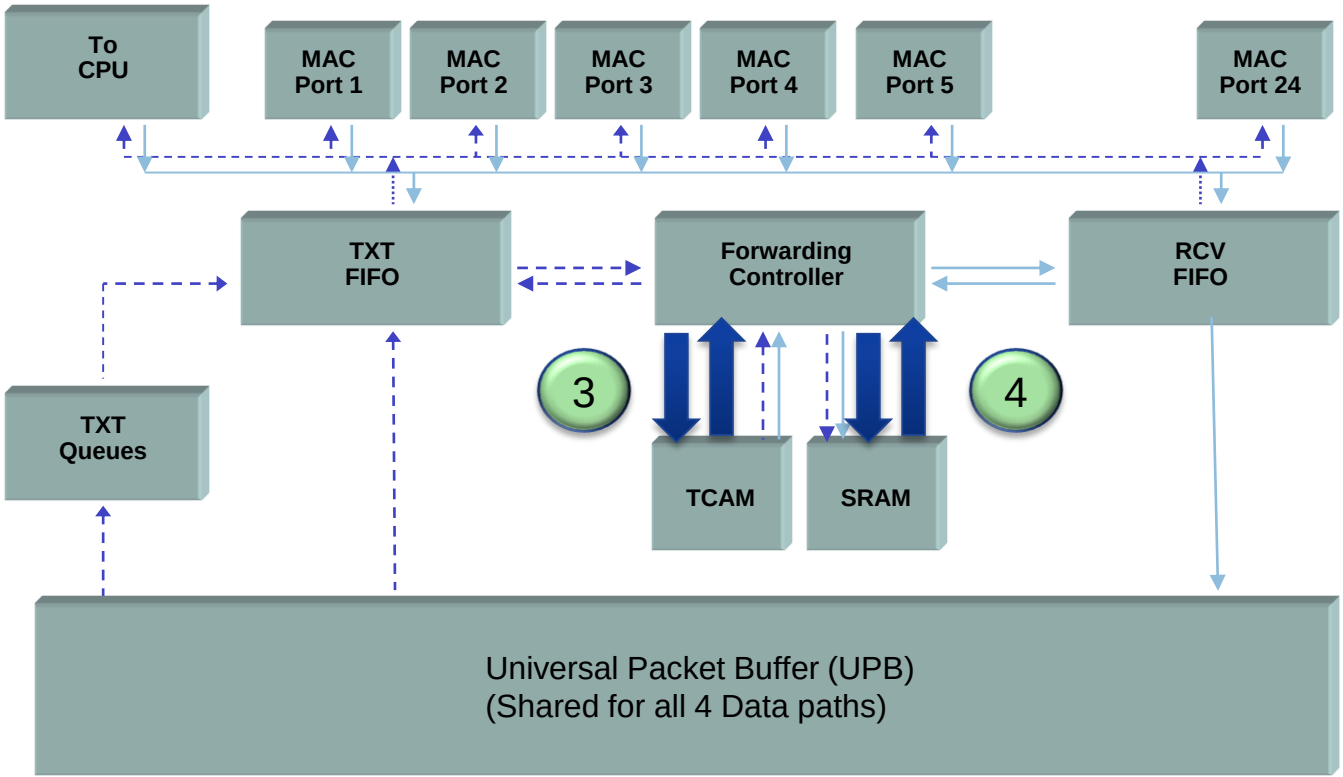


2

Copy of the first 200 bytes is sent into the Forwarding Controller for processing (forwarding, ACL, QOS lookups)

The whole packet is sent to UPB

Packet walk - Ingress



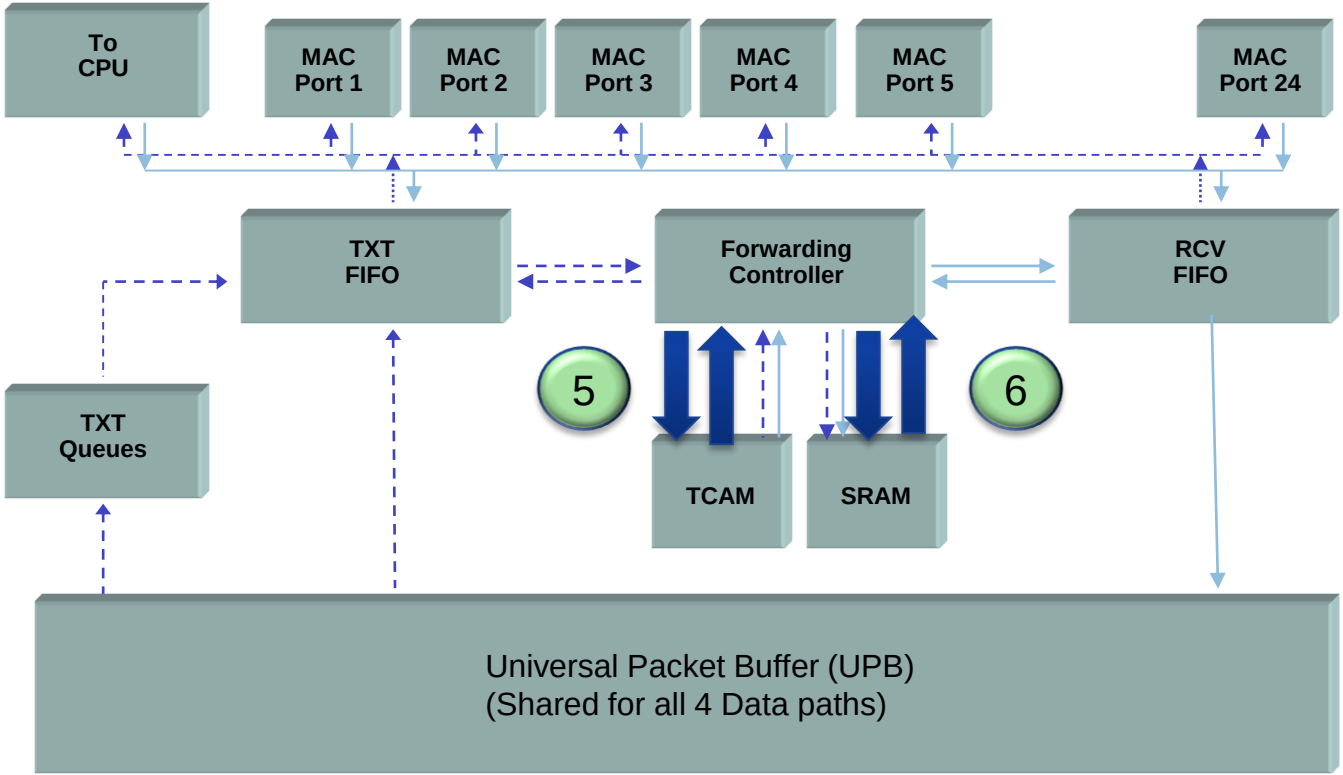
3

Search Engine in the Forwarding Controller does Learning lookup in TCAM and receives the index

4

The Forwarding Controller queries the SRAM with the index to get the L2 Address table info for learning .

Packet walk - Ingress



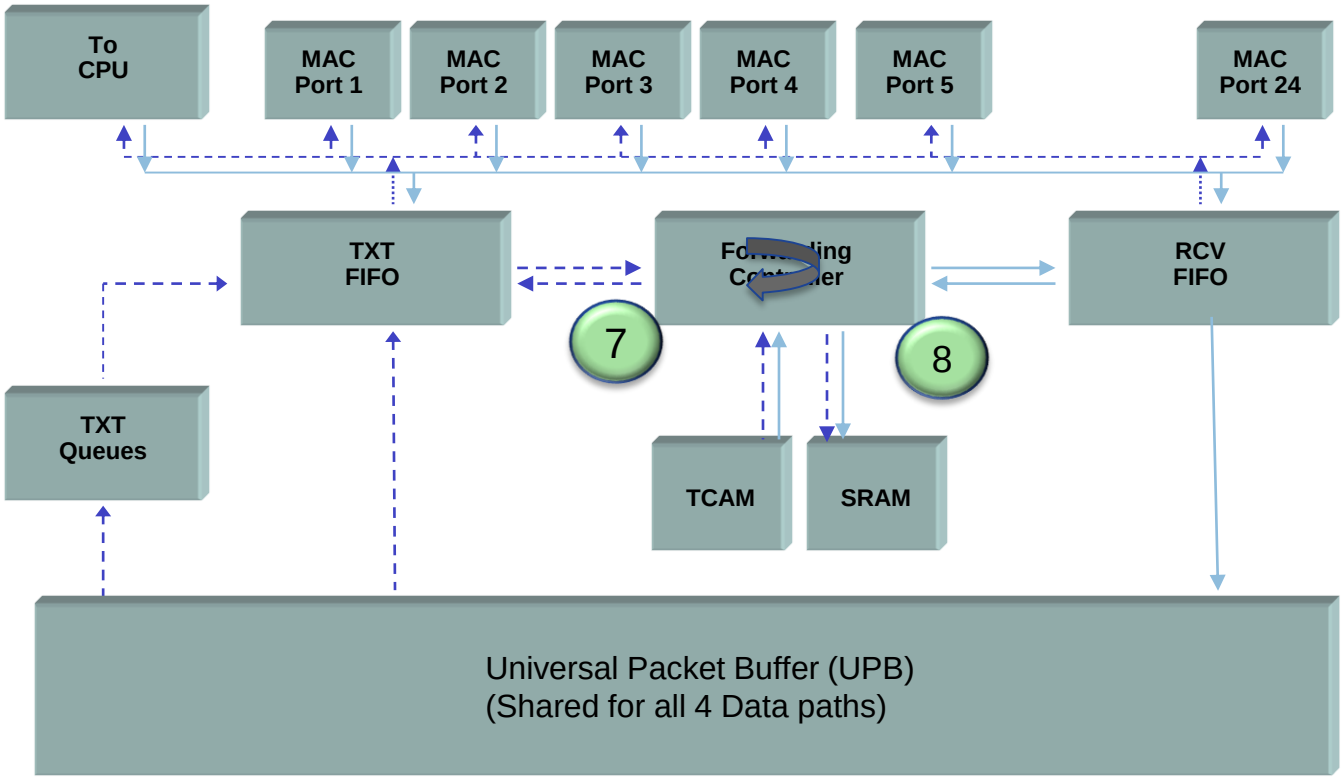
5

Search Engine in Forwarding Controller does QOS and ACL Look up in TCAM. Index returned

6

Forwarding Controller queries the SRAM for the respective Ingress ACL and QOS response

Packet walk - Ingress



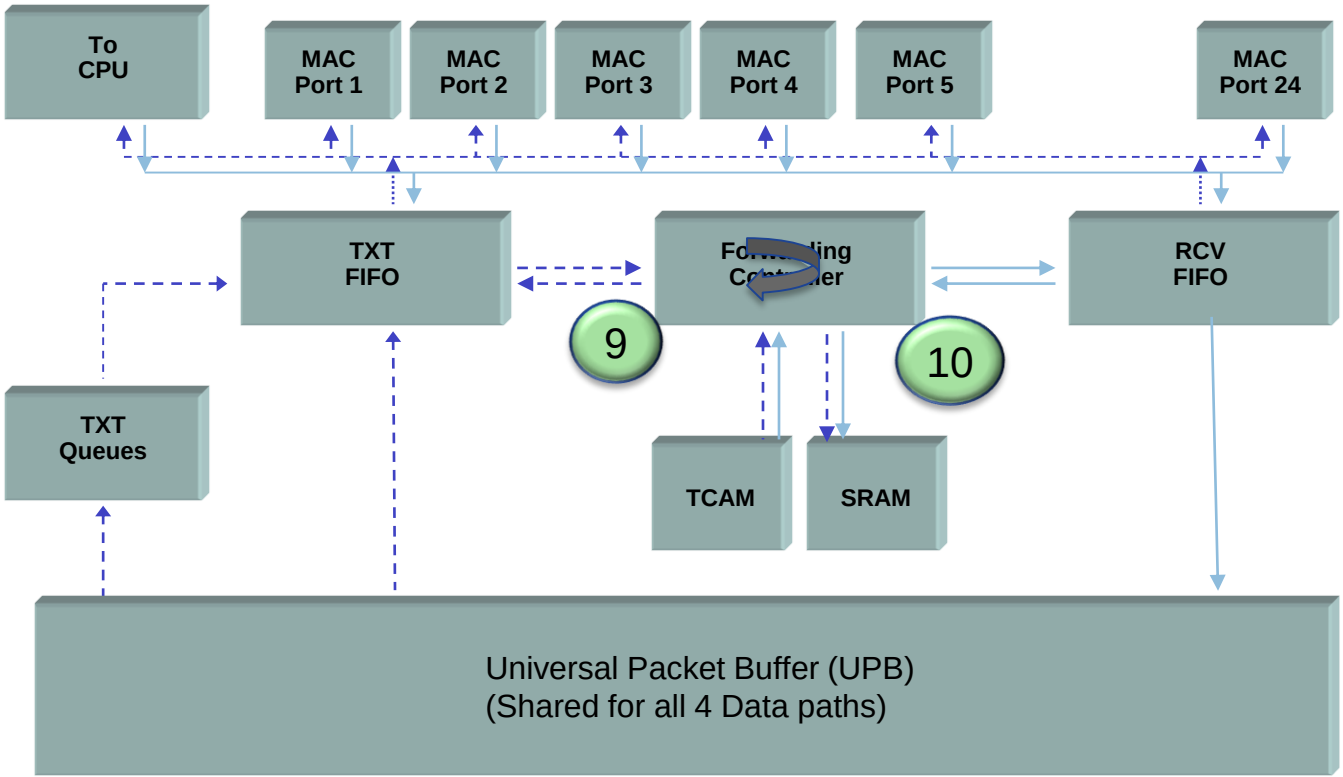
7

Look up to the policer. How much policing to do?

8

Policing information returned

Packet walk - Ingress



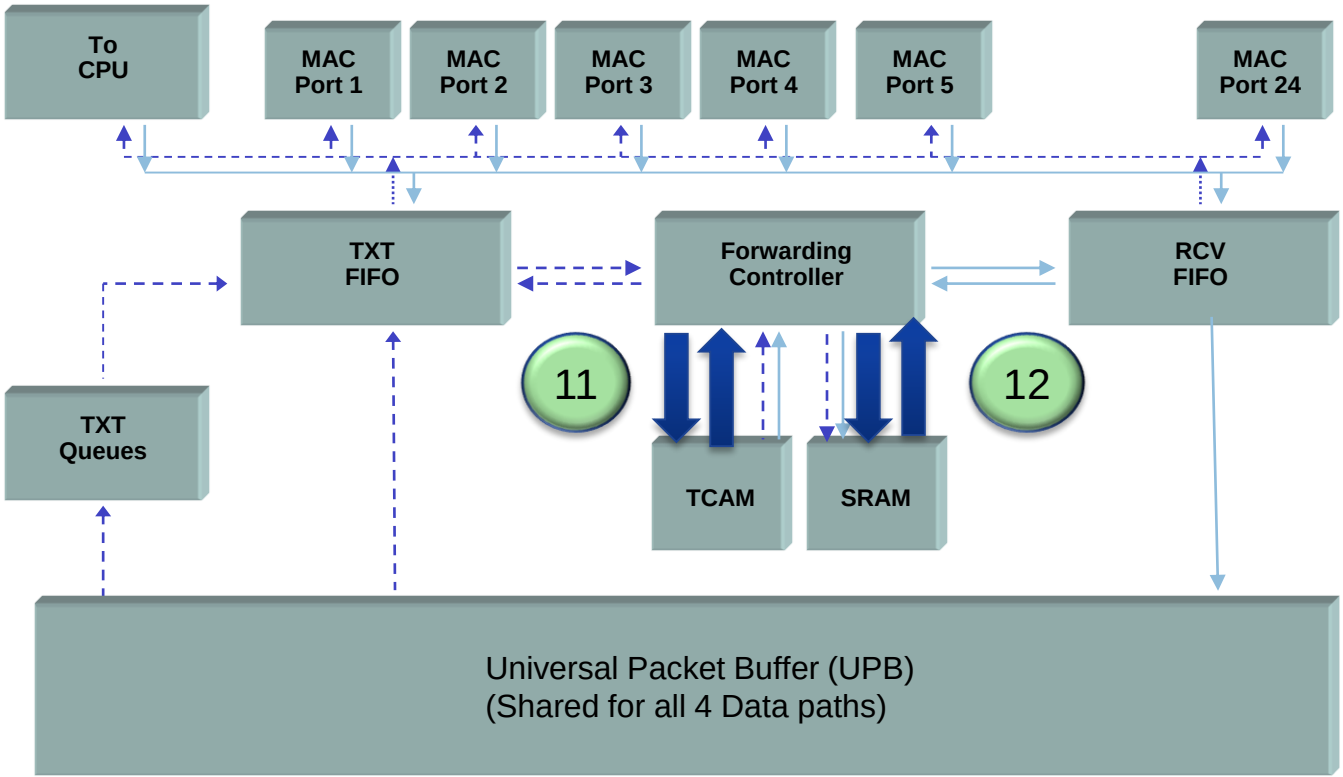
9

Look up to the NetFlow record. Index retuned

10

Update the NetFlow result table entry pointed by the Index

Packet walk - Ingress



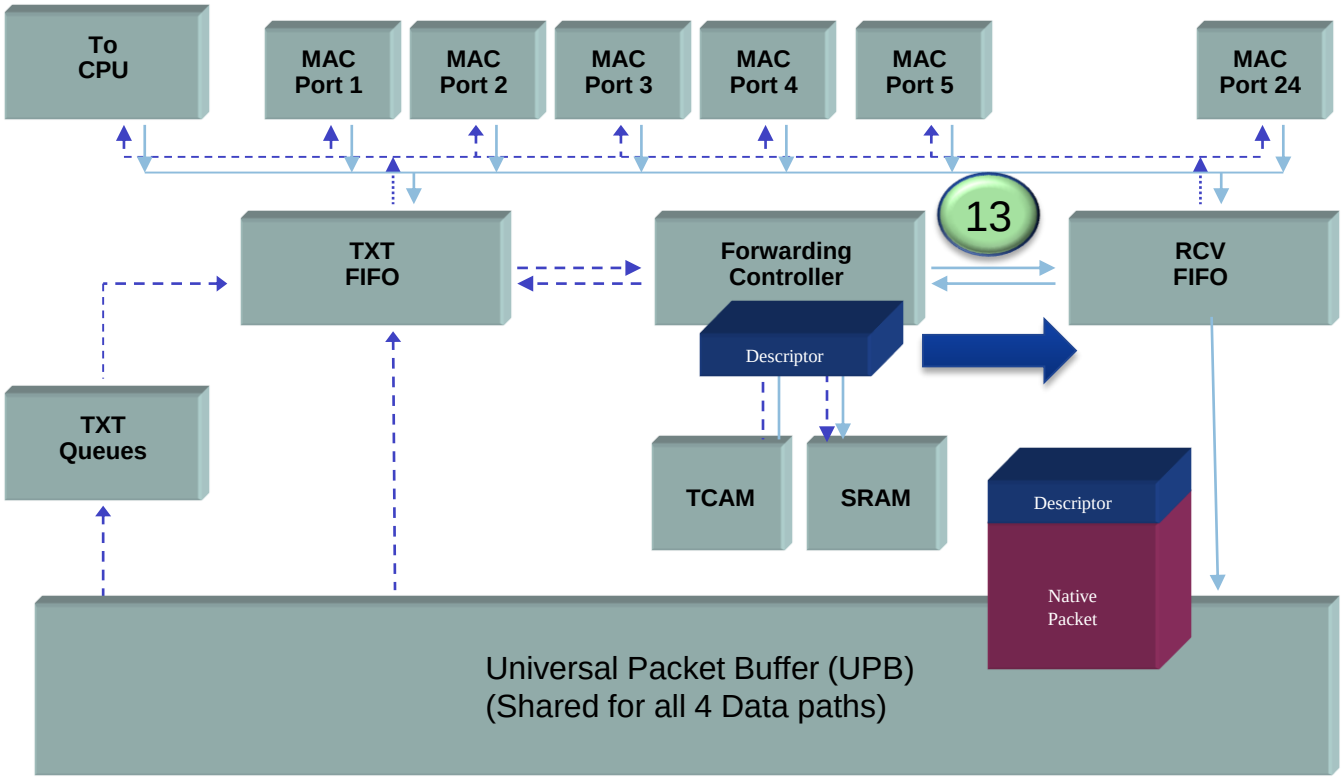
11

Search Engine in Forwarding Controller does L2/L3 Forwarding Look up in TCAM. Index returned

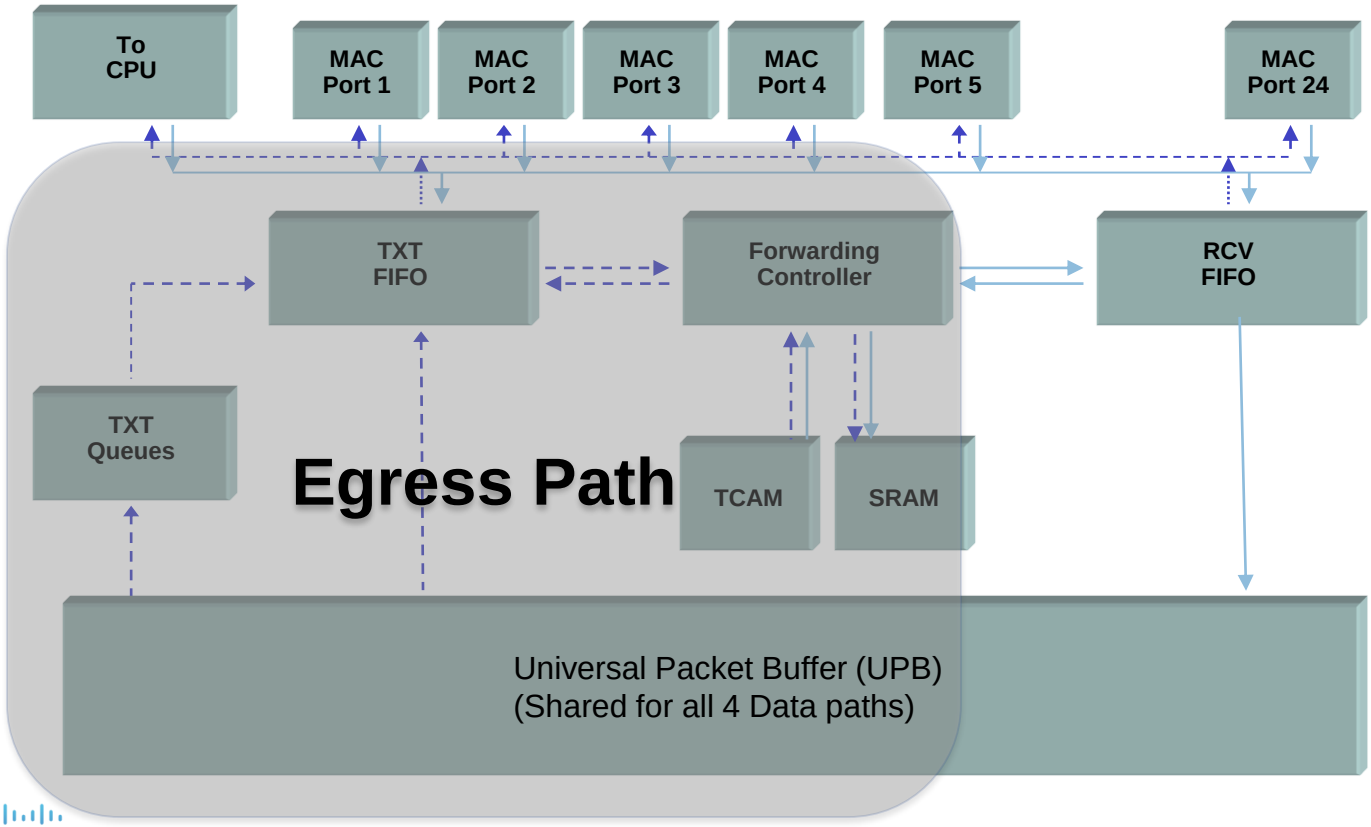
12

Forwarding Controller sends Index to the SRAM for destination details. Destination information returned

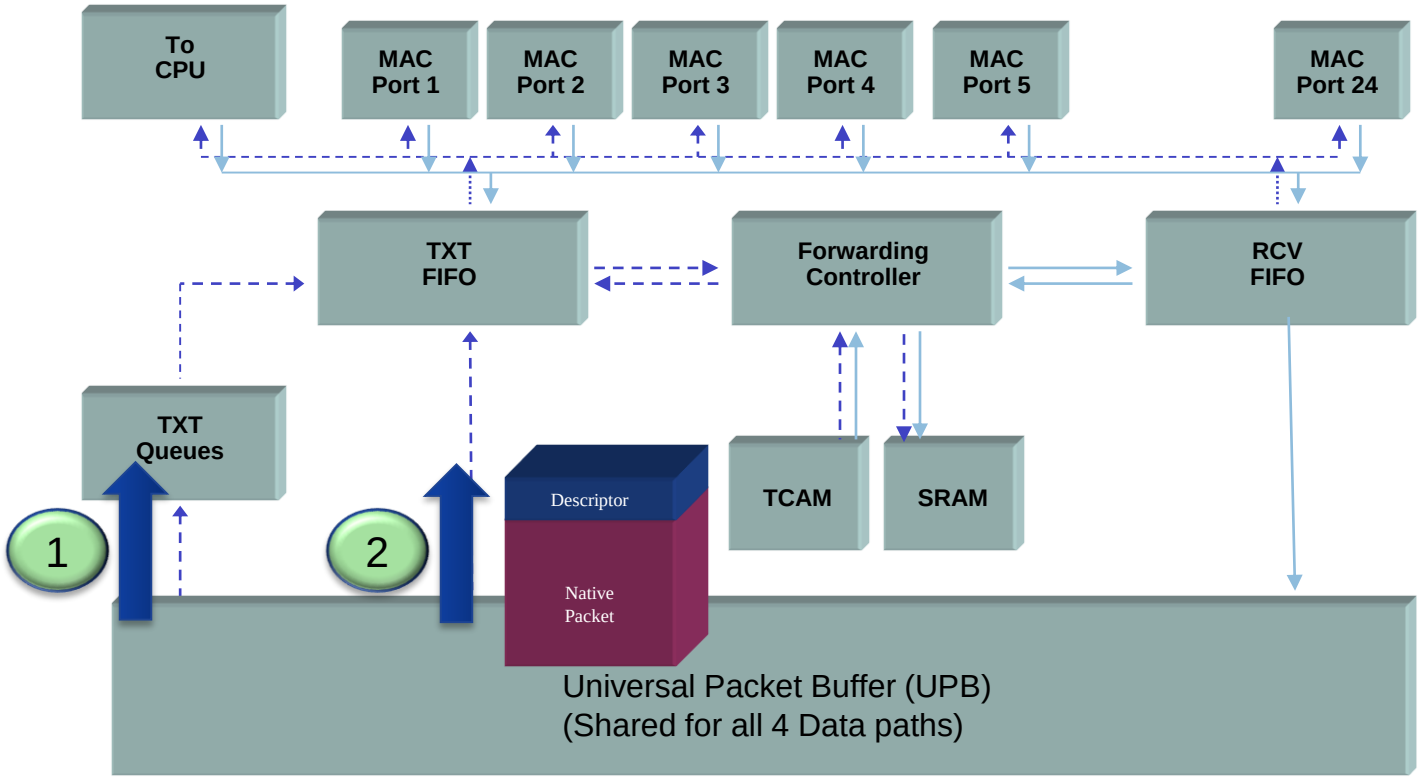
Packet walk - Ingress



Within the ASIC – Single Data Path



Packet walk - Egress



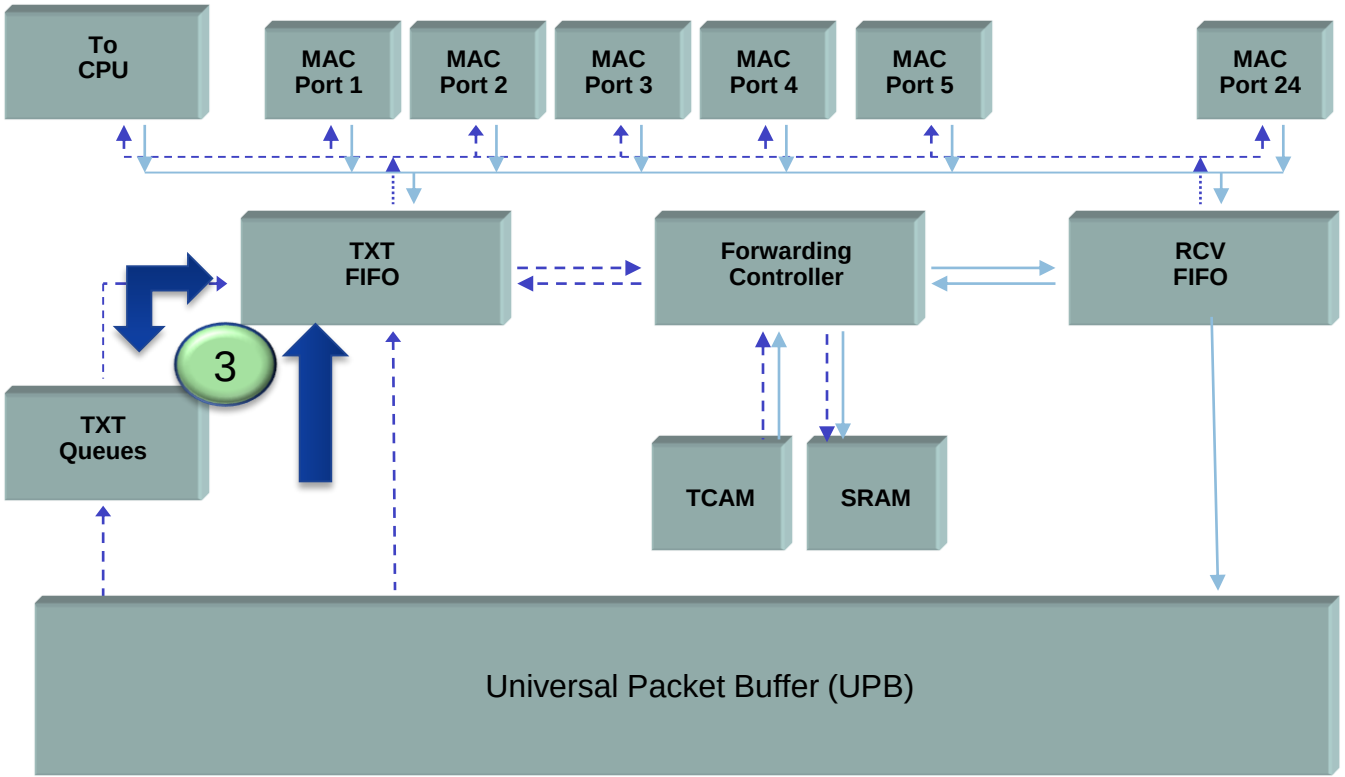
1

Pointer to the frame is placed on targeted Transmit Queue

2

Frame data from UPB is transferred to Transmit FIFO

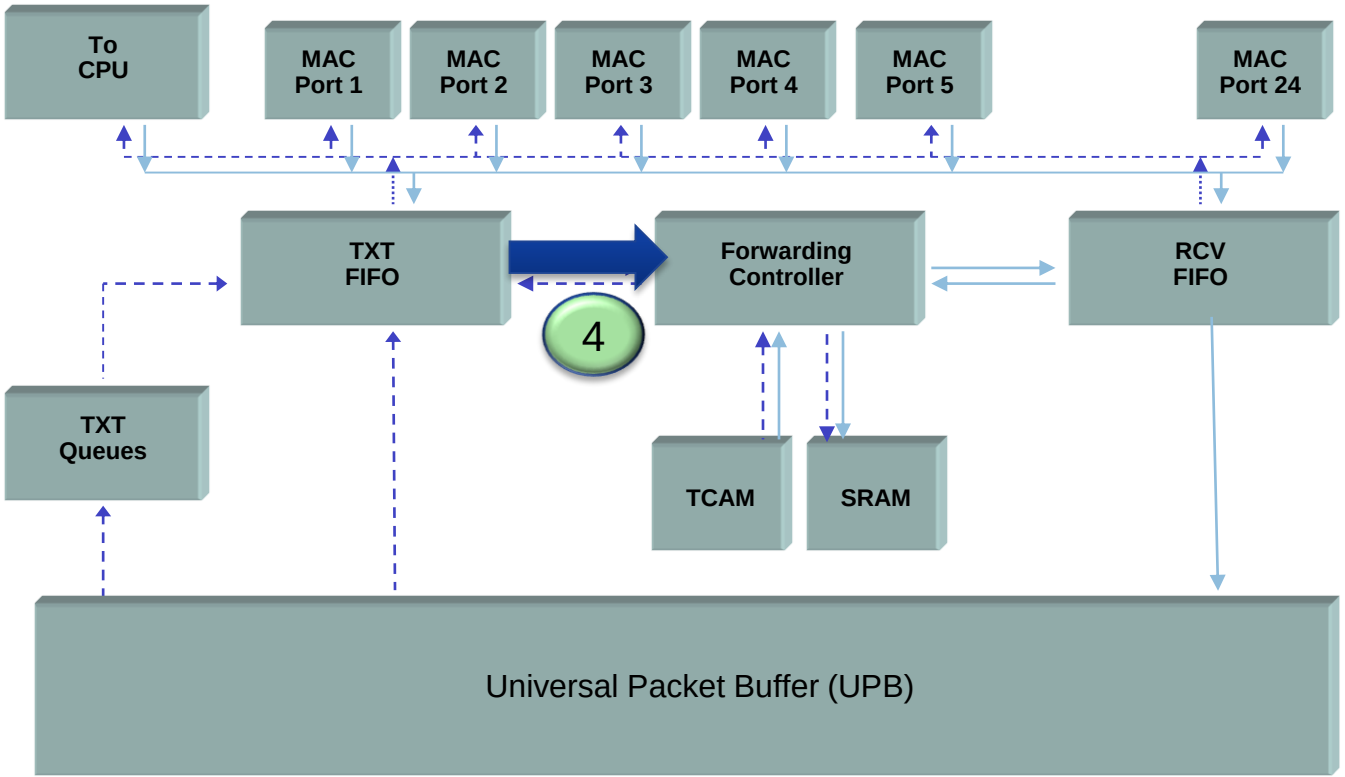
Packet walk - Egress



3

Packets egresses and is stored in the Transmit FIFO for egress processing

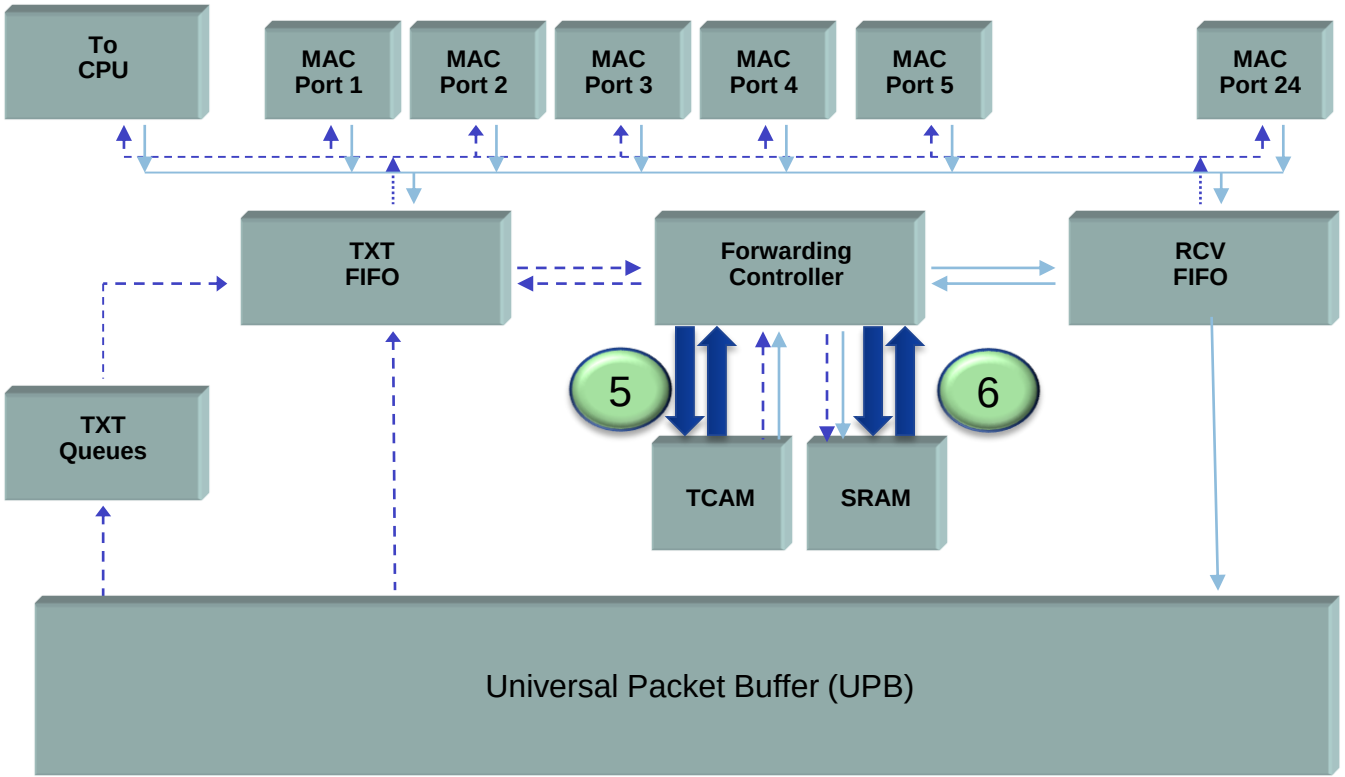
Packet walk - Egress



4

First 200 bytes & descriptor sent to the Forwarding Controller for egress processing

Packet walk - Egress



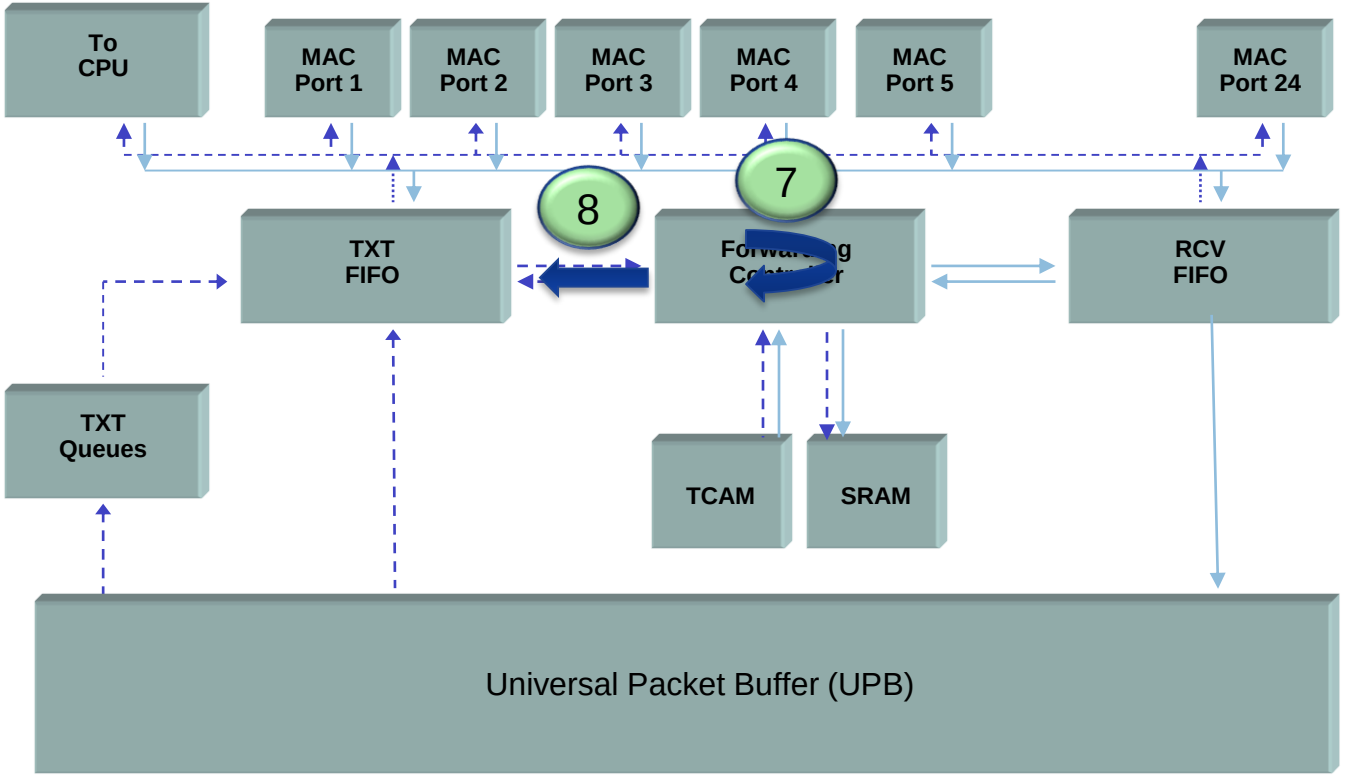
5

Search Engine in Forwarding Controller sends Destination Lookup to TCAM. Index returned.

6

Forwarding Controller uses index to get the L2/L3 forwarding info

Packet walk - Egress



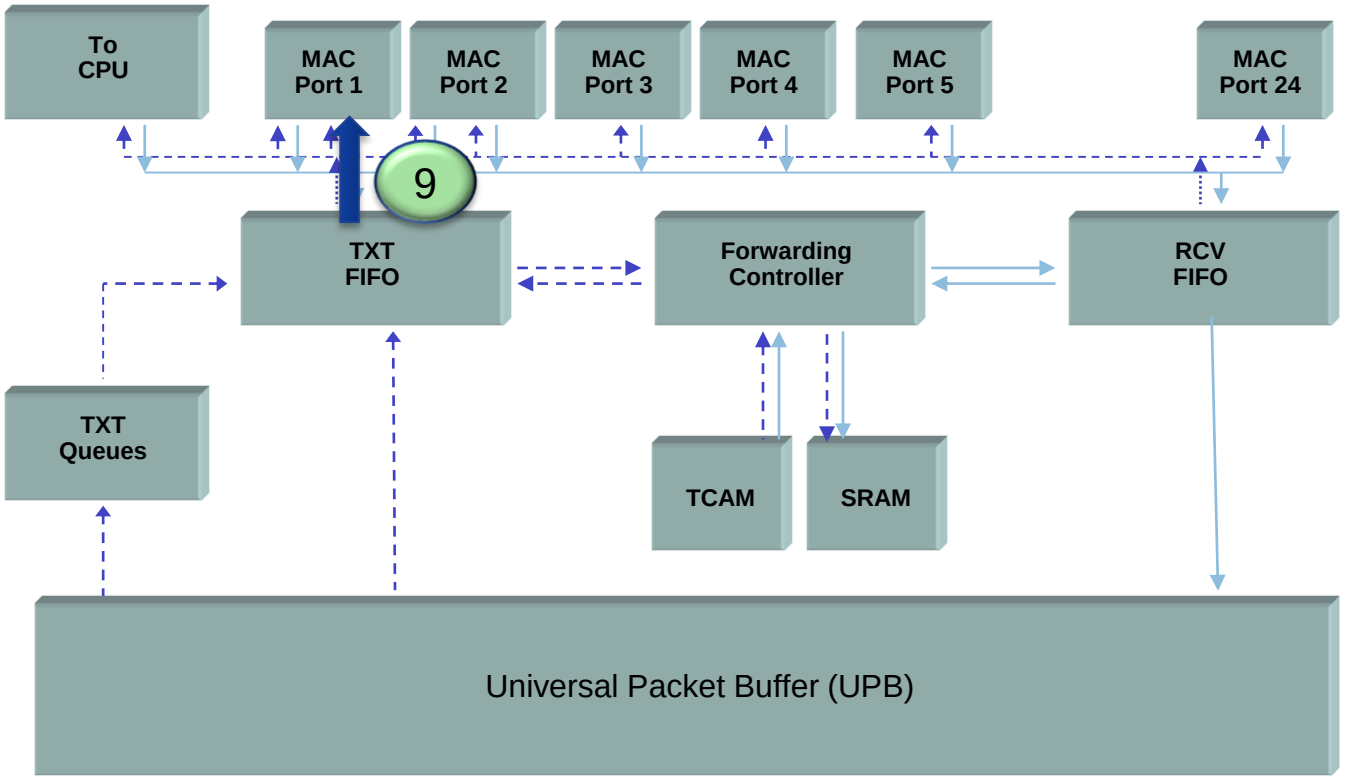
7

Packet Header prepared in the Forwarding Controller

8

Forwarding Controller sends the header info to the TXT FIFO where the final packet is assembled

Packet walk - Egress



9

Final packet sent to the egress port.

Agenda

- Comparison and differences in Cisco Catalyst 2960X and 2960XR series switches
- Switches Architecture – 2960X/XR
- **Flex Stack Plus in 2960X/XR**
  - **FlexStack-Plus Architecture**
  - **FlexStack-Plus Packet Flow Examples**
- Overview on various features on the 2960X/XR
- Configuration examples
- Troubleshooting best practices and hints

FlexStack-Plus Stack Module –2960X/2960XR

- FlexStack-Plus module provides an option for stacking
- FlexStack-Plus module are Hot Swappable – Plug & Play
- Powered using the switch-based power supply
- Stack bandwidth of 80Gbps bi-directional traffic
- FlexStack-Plus Supports stacking up to 8 members
- FlexStack-Plus Technology is backward compatible with FlexStack.
- FlexStack-Plus and FlexStack modules are not inter changeable.

Why FlexStack or FlexStack-Plus?

- Manages all the switches as single virtual switch
- Allows access to all switches with a single IP address
- Automatic Master selection & backup 1:N redundancy
- Automatic IOS versioning and Update!
- Automatic configuration of new members
- Automatic unit replacement (configuration of old switch retained)
- Stateful switch over in case of master failures
- Sub-millisecond Master failover
- Smart Multicast – Local Replication of multicast packets
- Cross-stack features (Etherchannel and QoS)

Stack Master Election Criteria

The stack (or switch) whose master has the higher user configurable mastership priority 1–15

```
Switch (config)# switch 3 priority 15
```

The stack (or switch) whose master is not using the default configuration

The stack (or switch) whose master has the longest uptime

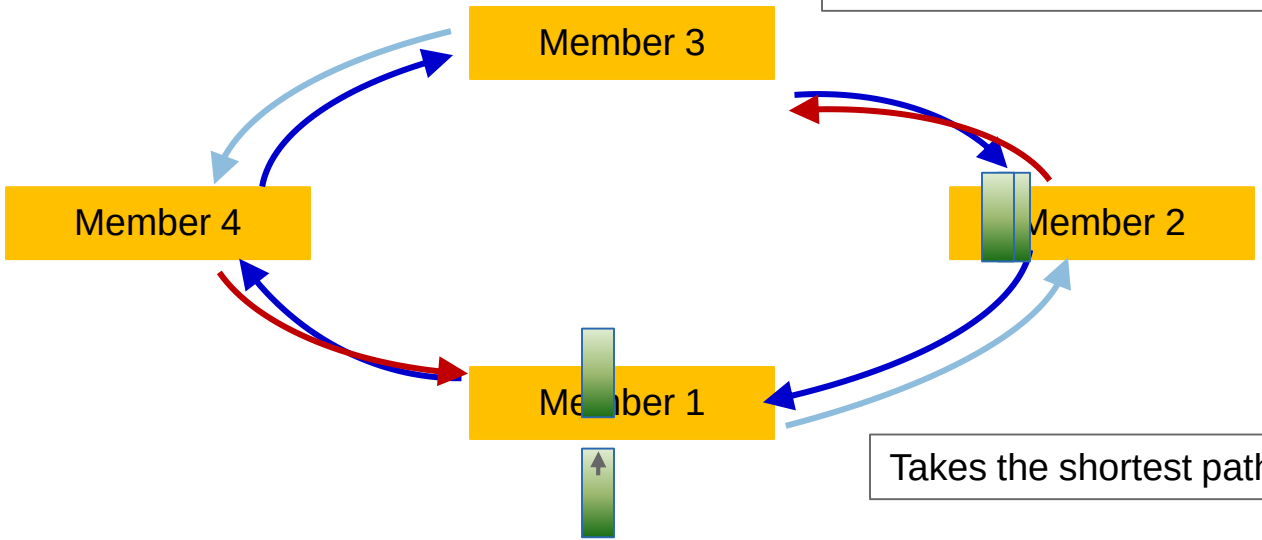
The switch or stack whose master has the lowest MAC address

FlexStack-Plus Architecture Overview

- Both Stack Links are active and Forwarding
- Not a Ring Architecture – hop by hop
- Local switching support
- Packet path determined using “SPF”
- No load balancing on stack ports
- All members see flooded packets once
- Passive link prevent Broadcast storm
- 38 byte stack header – contains the ingress mem

C2960-X FlexStack-Plus Packet Flow, Unicast

Whole Packet is transmitted
No load balancing on stack ports
Destination stripping

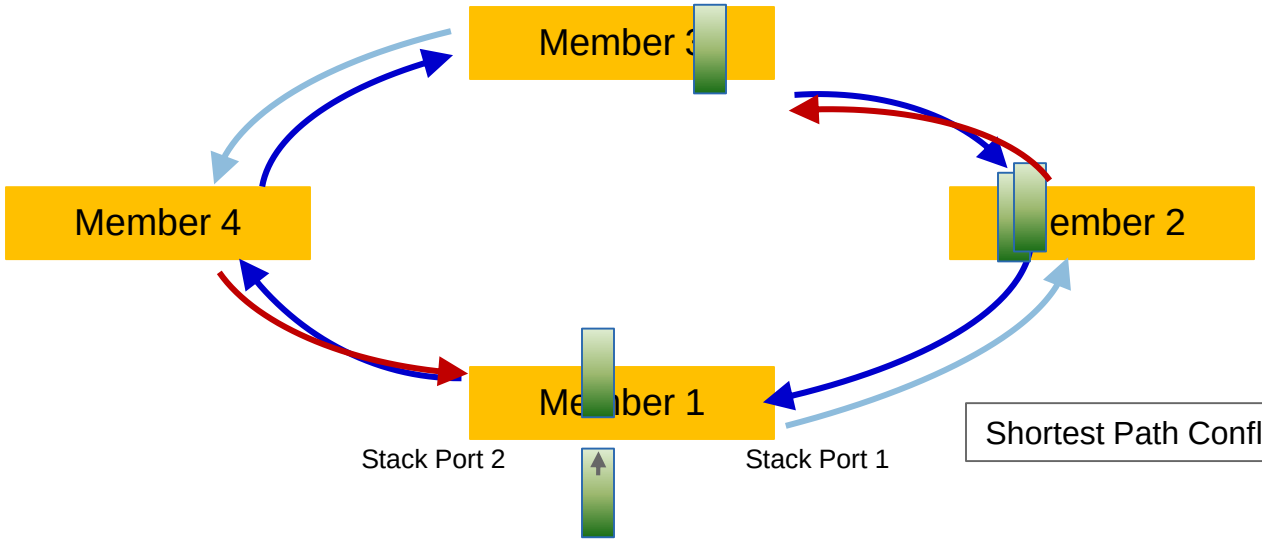


Takes the shortest path

Unicast Packet
Ingresses member 1
Egressing member 2

C2960-X FlexStack-Plus Packet Flow, Unicast

Packet traverses Hop by Hop
Ingress Look-ups ignored if received on stack port
Egress Loop-ups ignored if sent out of stack port



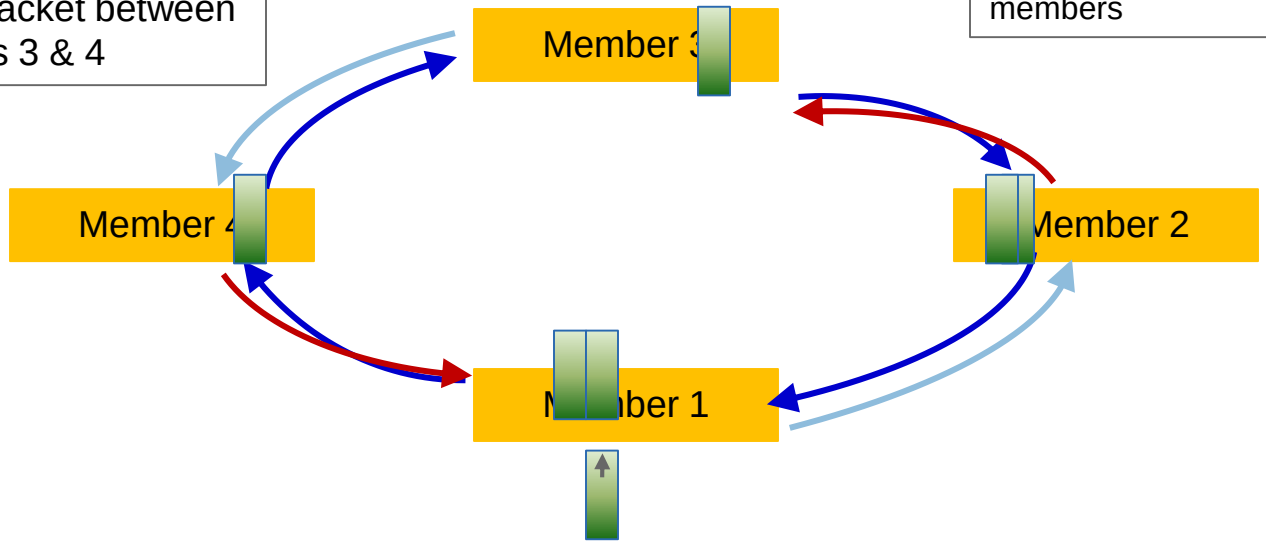
Shortest Path Conflict – Use Stack Port 1

Unicast Packet
Ingresses member 1
Egressing member 3

C2960-X FlexStack-Plus Packet Flow, BCAST

Passive Link prevents Fwd of packet between members 3 & 4

BCAST packet egresses on all interfaces FWDing on that vlan for all members



Bcast Packet ingresses member 1

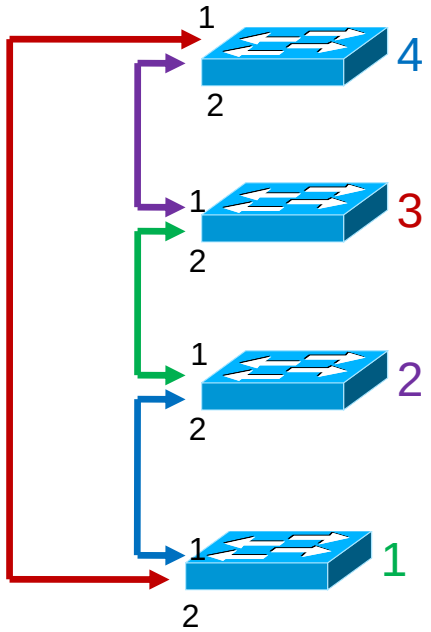
C2960-X FlexStack-Plus

Stage 1 : Stack Neighbor Discovery

Stage 2 : Topology Discovery

```
C2960X#show switch neighbors
  Switch #     Port 1       Port 2
  --------     ------       ------
       1          2            4
       2          3            1
       3          4            2
       4          1            3
```

4 Member Stack Link Neighbor Table

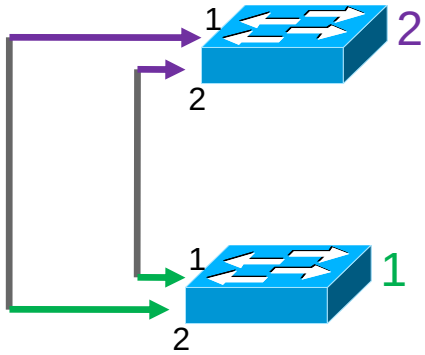


C2960-X Drop Table - 2 Member

- 2 member stack – special case
- Stack port 1 on both members forward data packets.
- Stack port 2 unused except for FlexStack protocol packets

```
C2960X# show platform dtm drop-table
Stack Port 1 Drop Tables:
Node ID BLOCK/FORWARD
1        FORWARD
2       BLOCK

Stack Port 2 Drop Tables:
Node ID BLOCK/FORWARD
1        FORWARD
2       BLOCK
```



Member 1 drop table

Agenda

- Comparison and differences in Cisco Catalyst 2960X and 2960XR series switches
- Switches Architecture – 2960X/XR
- Flex Stack Plus in 2960X/XR
- **Overview on various features on the 2960X/XR**
  - **Security**
  - **QoS**
  - **Netflow**
  - **Ease of USE**
- Configuration examples
- Troubleshooting best practices and hints

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Polling Question 2

How important is Security at the access layer?

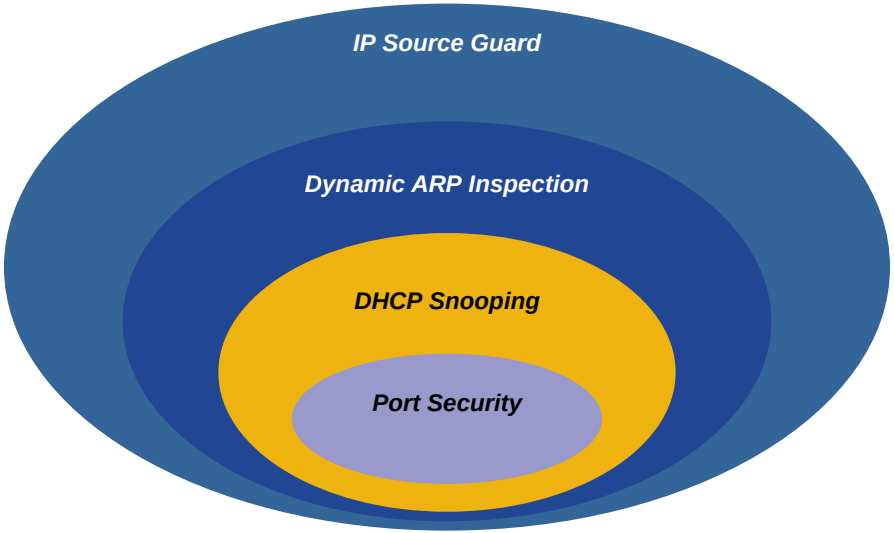
A. Very important

B. Important

C. Somewhat important

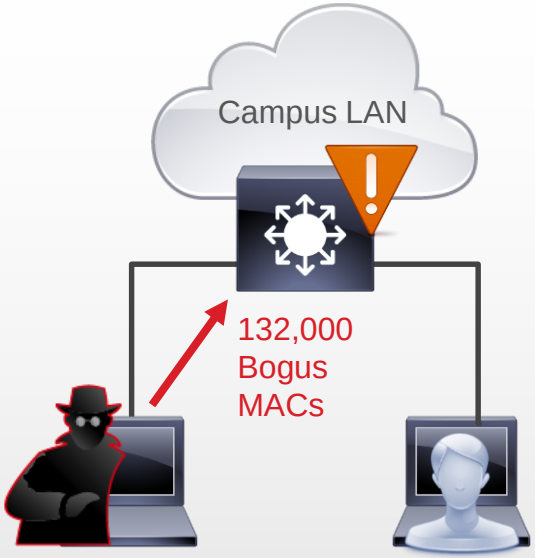
D. Not important at all

Catalyst Integrated Security Features



Attack	Catalyst Feature
MAC Address Flooding	Port Security
DHCP Rogue Server for Default Gateway Interception	DHCP Snooping
ARP Spoofing or ARP Poisoning	Dynamic ARP Inspection
IP Spoofing or MAC Spoofing	IP Source Guard

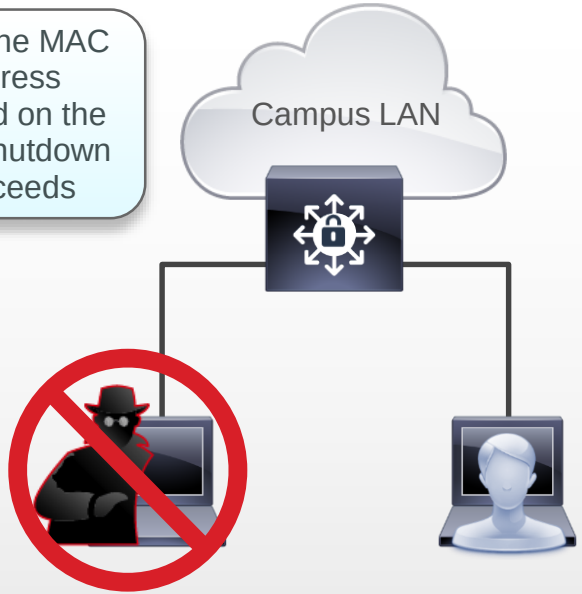
Port Security



Problem

"Script Kiddie" hacking tools enable attackers to flood switch CAM tables with bogus macs; turning the VLAN into a "hub" and eliminating privacy

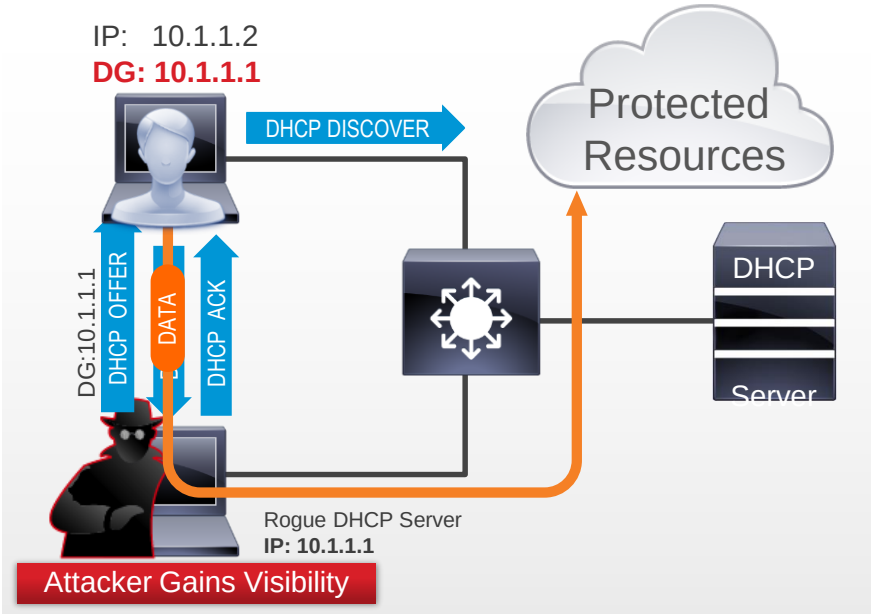
Only One MAC Address Allowed on the Port: Shutdown if Exceeds



Solution

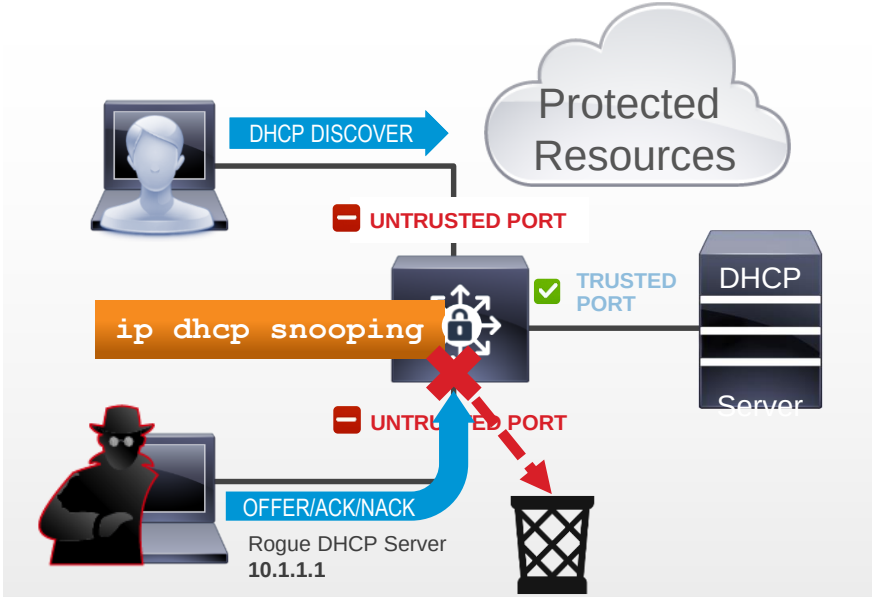
Catalyst Security Toolkit recognizes MAC flooding attack and locks down the port and sends an SNMP trap

DHCP Snooping



Problem

Rogue DHCP servers are often used in man-in-the-middle or denial of service attacks for malicious purposes



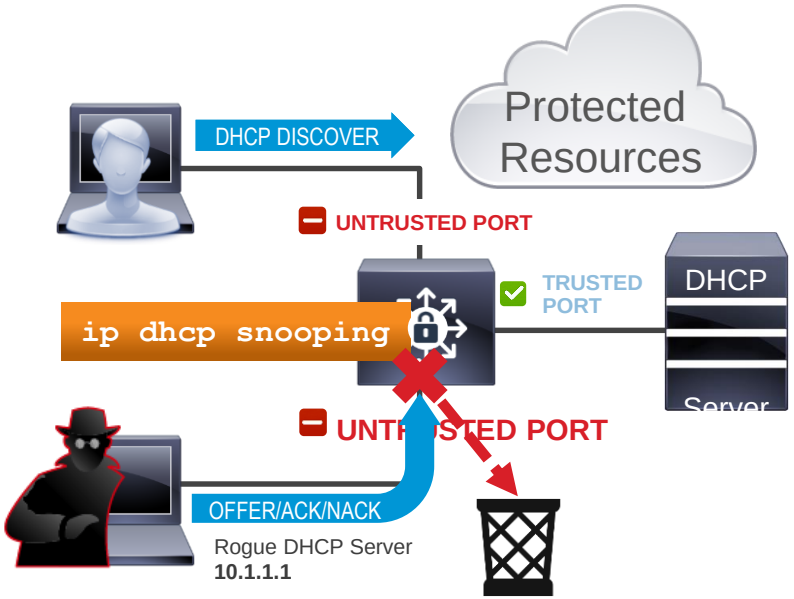
Solution

The DHCP snooping feature filters messages and rate limits rogue DHCP traffic from untrusted sources & builds DHCP binding table

DHCP Snooping

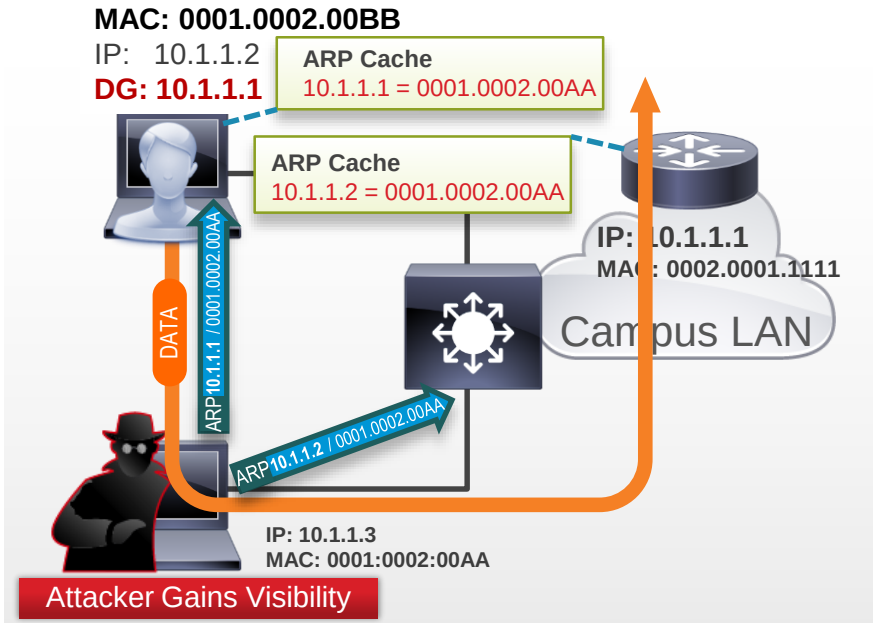
IP DHCP Snooping Table is Maintained

- Table is built by "snooping" the DHCP reply to the client
- Entries stay in the table until DHCP lease time expires



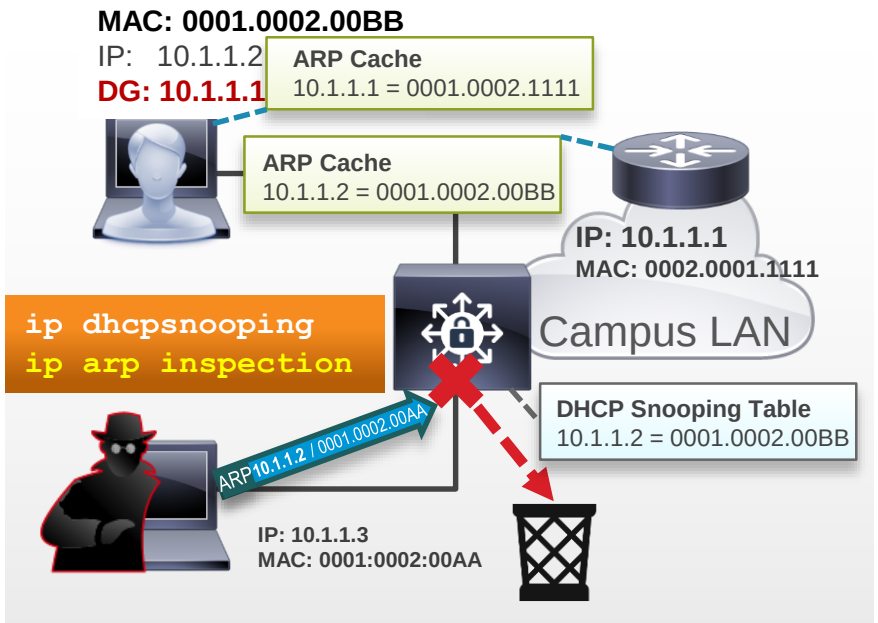

```
Switch#show ip dhcp snooping binding
MacAddress          IpAddress        Lease(sec)  Type           VLAN  Interface
------------------  ---------------  ----------  -------------  ----  --------------------
00:0C:29:3D:75:B2   172.20.100.1     370008      dhcp-snooping   100   GigabitEthernet1/1
```

CISF: Dynamic ARP Inspection (DAI)



Problem

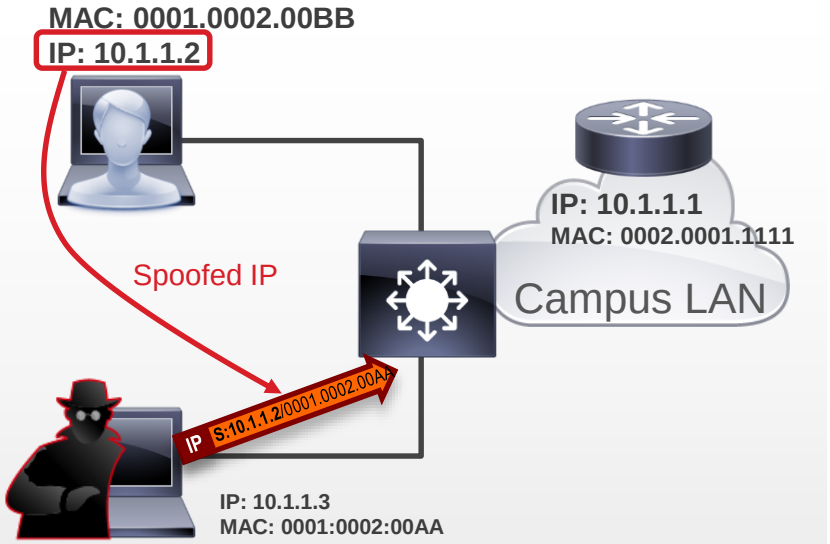
Attackers can poison the ARP cache on the destination devices and engineer the network traffic to gain visibility into it



Solution

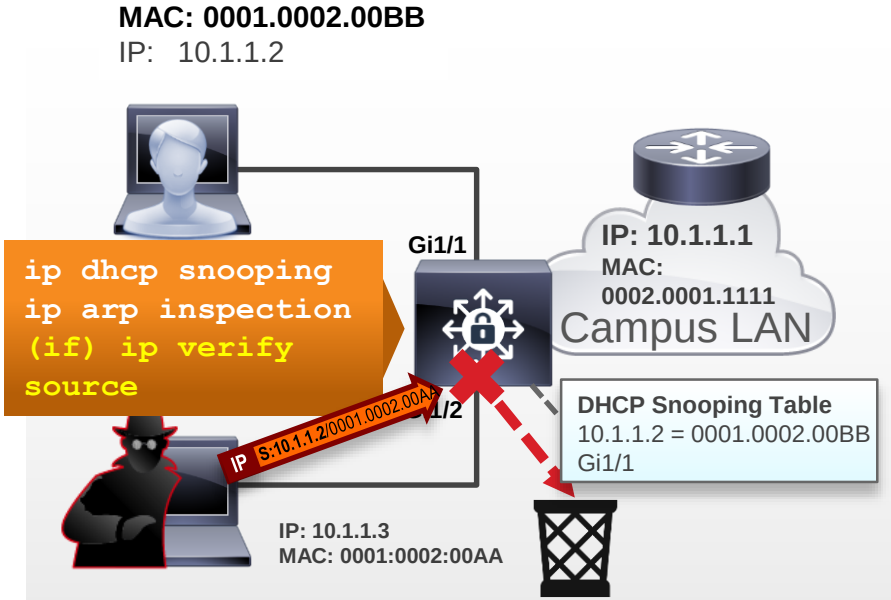
Dynamic ARP inspection (DAI) prevents ARP attacks by interception all ARP requests and responses at the access

IP Source Guard



Problem

Illegitimate hosts can spoof IP addresses and MAC addresses of authorized hosts and gain illegal access into the network



Solution

IPSG Automatically configures a Port ACL for IP address and adds a MAC address to port security based on DHCP snooping binding table. Rouge traffic is blocked

Auto Secure

- 1 Line – ‘auto security’ applies 3 simple security features
  - DHCP Snooping
  - Dynamic ARP Inspection
  - Port Security
- Global Config enables on all ports as well
- Based on port mode – access OR trunk, it applies host config or uplink config

Auto Secure – Actual Config & show Commands

2K-X
15.2(2)E

```
auto security
!
interface GigabitEthernet3/3
 description Connected to wired PC
 switchport access vlan 11
 switchport mode access
 auto security-port host
!
interface TenGigabitEthernet1/1
 description Trunk Port
 switchport mode trunk
 auto security-port uplink
```

```
Switch#sh auto security configuration
%AutoSecure provides a single CLI config 'auto secure'
 to enable Base-line security Features like
 DHCP snooping, ARP inspection and  Port-Security

Auto Secure CLIs applied globally:
----------------------------------
ip dhcp snooping
ip dhcp snooping vlan 2-1005
no ip dhcp snooping information option
ip arp inspection vlan 2-1005
ip arp inspection validate src-mac dst-mac ip


Auto Secure CLIs applied on Access Port:
----------------------------------------
switchport port-security maximum 2
switchport port-security maximum 1 vlan access
switchport port-security maximum 1 vlan voice
switchport port-security violation restrict
switchport port-security aging time 2
switchport port-security aging type inactivity
switchport port-security
ip arp inspection limit rate 100
ip dhcp snooping limit rate 100


Auto Secure CLIs applied on Trunk Port:
---------------------------------------
ip dhcp snooping trust
ip arp inspection trust
switchport port-security maximum 100
switchport port-security violation restrict
switchport port-security
```

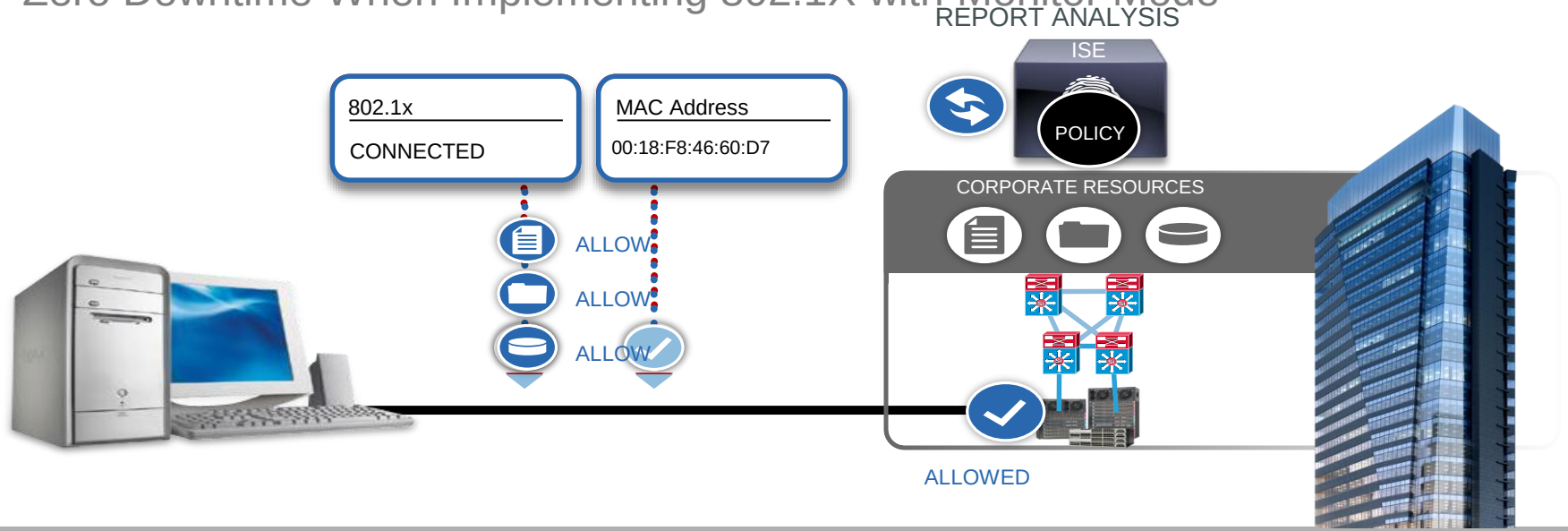
```
Switch#sh auto security
Auto Secure is Enabled globally

AutoSecure is Enabled on below
interface(s):
-----------------------------------
---------
   TenGigabitEthernet1/1
   GigabitEthernet3/1
   GigabitEthernet3/3
   GigabitEthernet3/4
   GigabitEthernet3/5
   GigabitEthernet3/6

Switch#
```

2K-X

15.0(2)EX

Authorized Access

Zero Downtime When Implementing 802.1X with Monitor Mode



The Solution

Implement in Monitor Mode

Deployment Scenario—Cisco Access Switch

Deploy Access Control

Discovery—Allows connection regardless of device types

Correct —View failed reports on ACS or ISE; troubleshoot and resolve issues; ensure future authorization

Add Authorization—Block unauthorized access; add policy for restricted resources

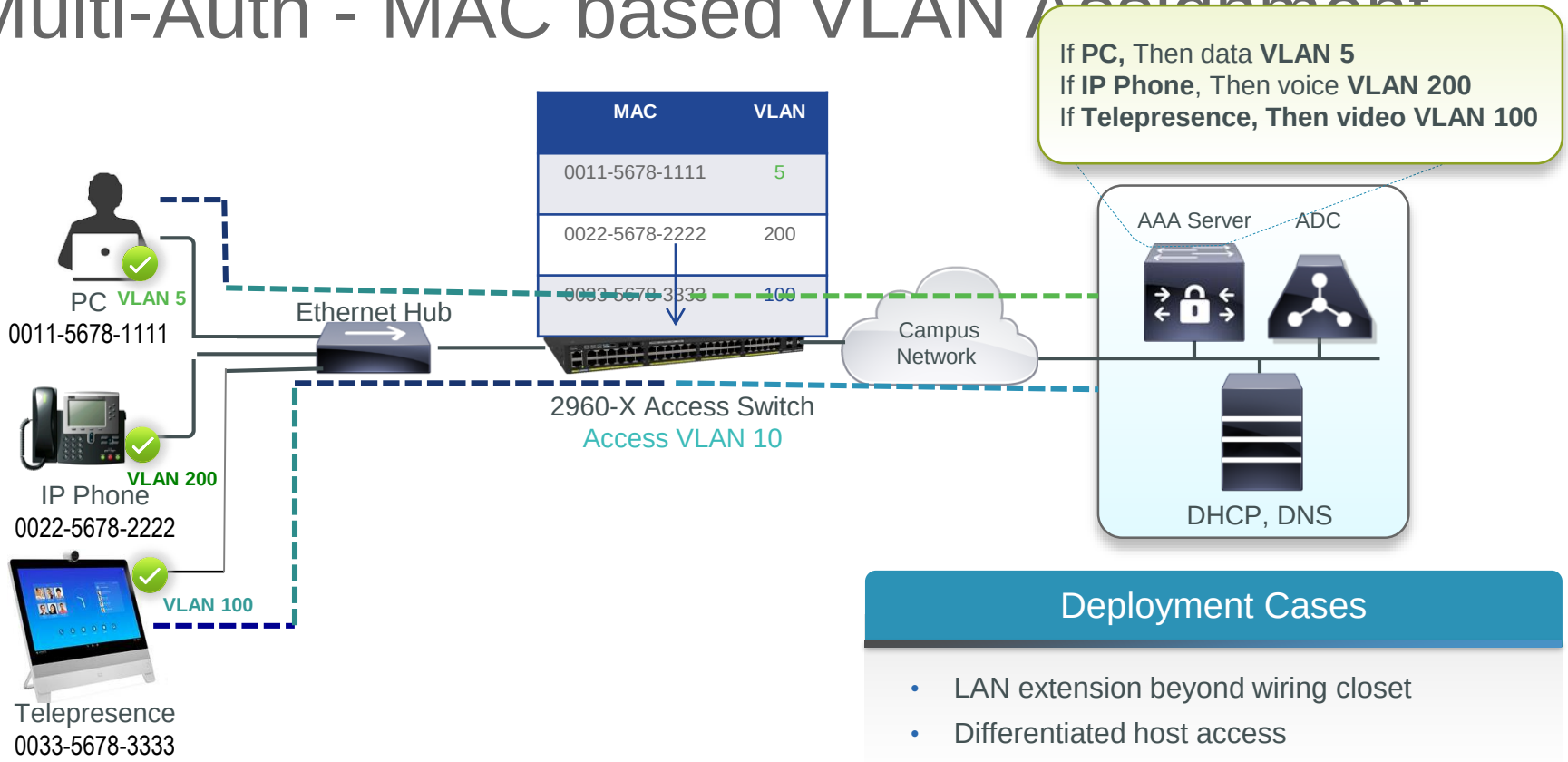
802.1X Is Not Just a Check Box

Cisco Simplifies 802.1X Deployments

Deployment Hurdle	Feature
How do you support non 802.1X clients and Guest users/devices?	• Guest VLAN • MAC Authentication Bypass, Web Authentication • Monitor Mode
How do you handle failed access?	• Failed Authentication VLAN • Monitor Mode
How do you support multiple users or devices on the same port?	• Multi domain Authentication • Multi-Authentication • MAC based VLAN assignment
How do you support various kinds of devices with different authentication mechanisms?	• Flexible Authentication via Automated 802.1X, MAB, web Auth • Different Supplicant types for different Client Operating Systems • Wake On LAN • IOS Sensor
How do you handle devices moving in your network?	• MAC Move/Replace
How do you handle Device proliferation?	• IOS Sensor • Monitor Mode

Cisco Has Many Features to Enhance 802.1x and Make Identity Networking Truly Deployable, Not Just a Check-Box

Multi-Auth - MAC based VLAN Assignment



Deployment Cases

- LAN extension beyond wiring closet
- Differentiated host access
- Segmentation of virtual machines

Dual Stack with IPv6 Enabled by De

Your Host

- IPv4 is protected by your favorite personal firewall...
- IPv6 is enabled by default (Vista, Linux, Mac OS/X, ...)

Your Network

- Does not run IPv6

Your Assumption

- I'm safe

Reality

- You are **not** safe
- Attacker sends Router Advertisements
- Your host configures silently to IPv6
- You are now under IPv6 attack

Probably Time to Think About Ipv6 in Your Network

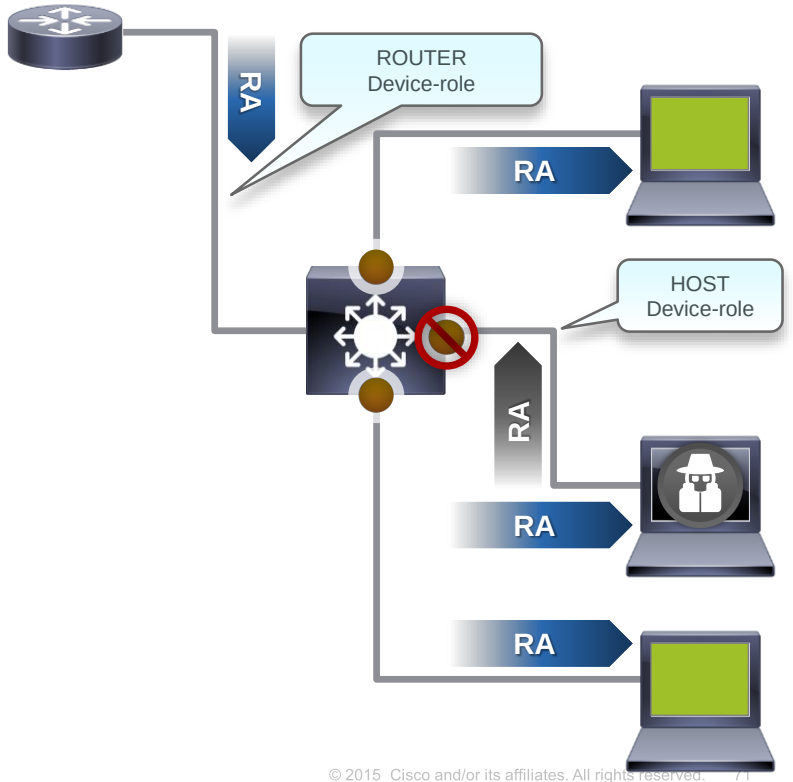
First Hop Security: RA Guard

Identify “Trusted” Ports – where router will reside

Only allow Route Advertisements from that Port

Protection against DOS Attacks

- On Address Configuration
- On Duplicate Address Detection
- Flooding attacks



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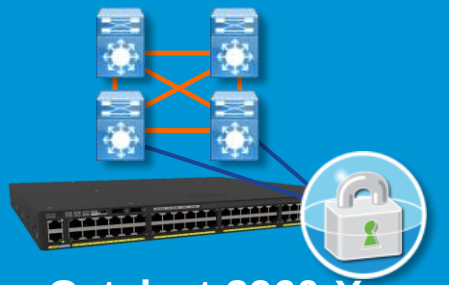
NetFlow Lite with 2960-X & -XR

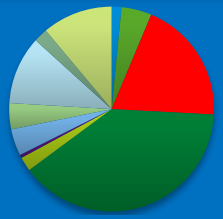
Built-in Sampled NetFlow



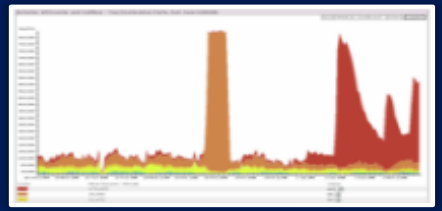
Catalyst 2960-X
NetFlow *Lite*

- v9 Export
- 16K flows
- **Sampled**
  - Random
  - Deterministic

from 1:1022 to 1:32



Identify top users and applications



Detect anomalies

ASIC-based capture
At line-rate with minimal CPU impact

Covers all ports
North-South and East-West traffic

Flexible NetFlow Export
Configurable key fields including L2, L3, L4

NetFlow-Lite Characteristics on

- NetFlow-Lite is supported on LAN Base and IP Lite SKUs only.
- NetFlow-Lite is supported in Mixed Stack, on 2960-X series ports only.
- Only Sampled NetFlow is supported.
- Ingress flows are only monitored.
- Flows are monitored on Physical Ports and VLAN Interfaces(SVI).
- One monitor per interface is supported.
- NetFlow Version 9 is supported for Exporter.
- Deterministic Sampler is not shared. Every attachment with same Deterministic Sampler uses up one free sampler.
- Random Sampler is shared. Only one sampler is used when Random Sampler is attached to different Ports or SVIs.

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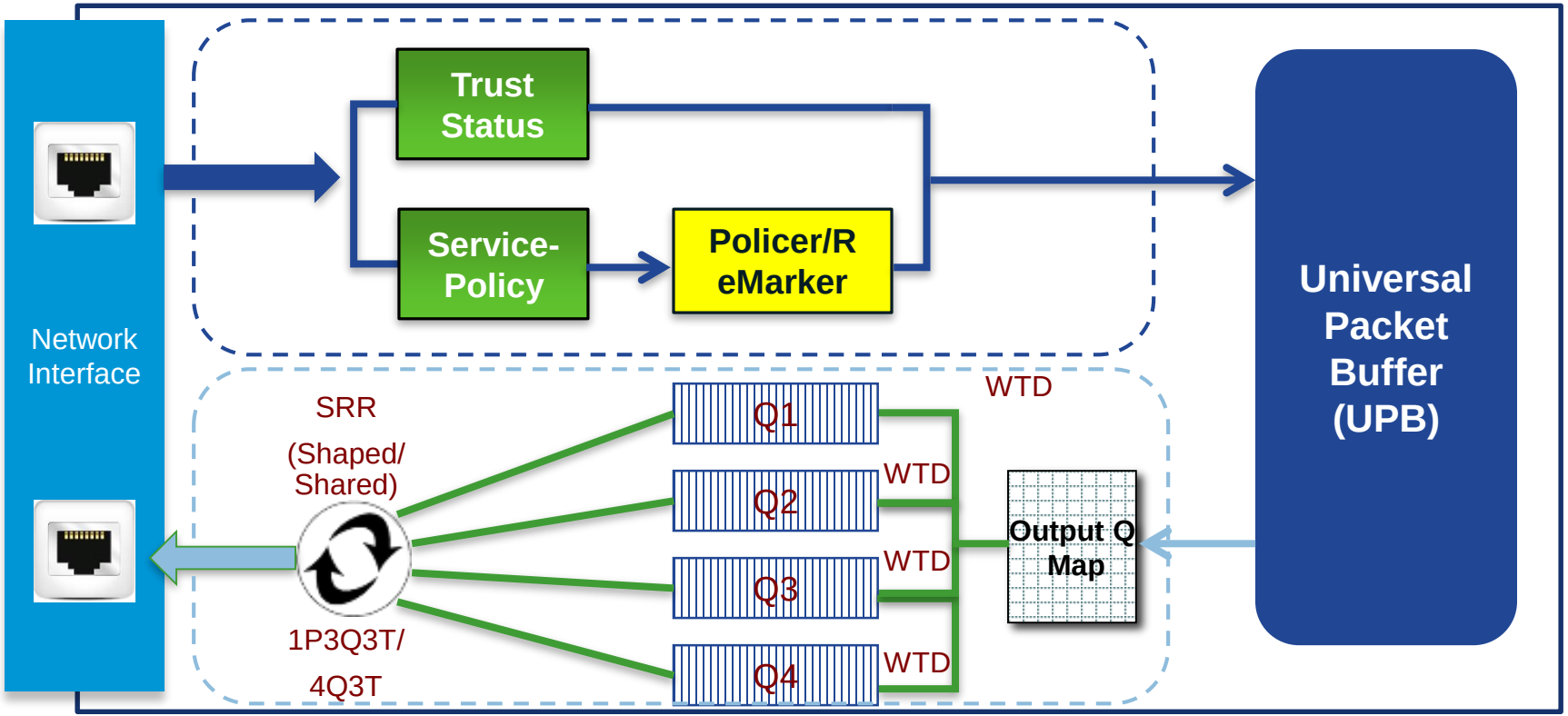
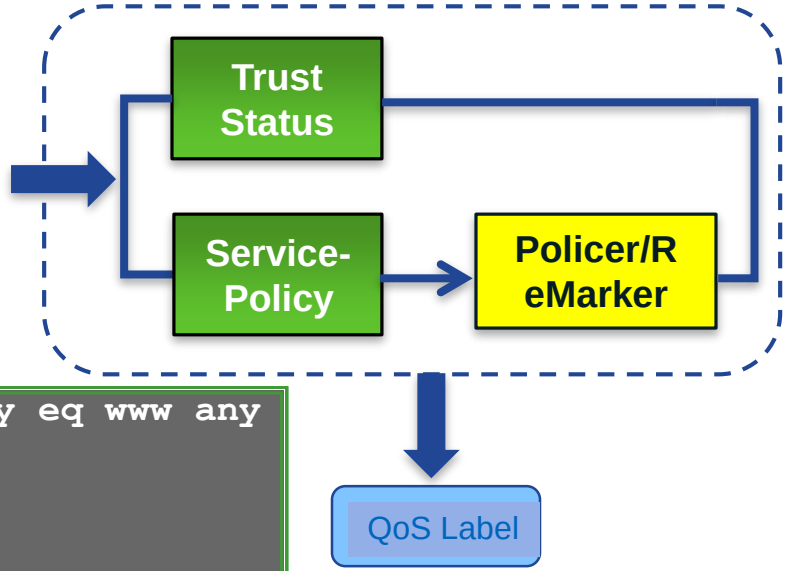
Catalyst 2K - QoS Model



Trust, Classification & Marking

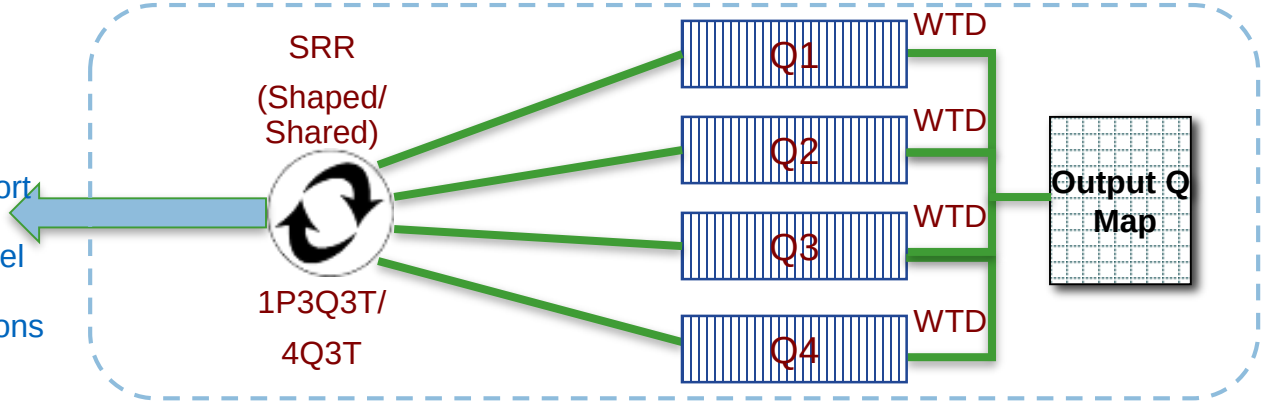
- Markings trusted by default – '`no mls qos`'
- '`mls qos`' enabled – all markings are set to BE
  - Trust Config
    - Trust COS/DSCP
    - Conditional Trust
    - Mark without trust



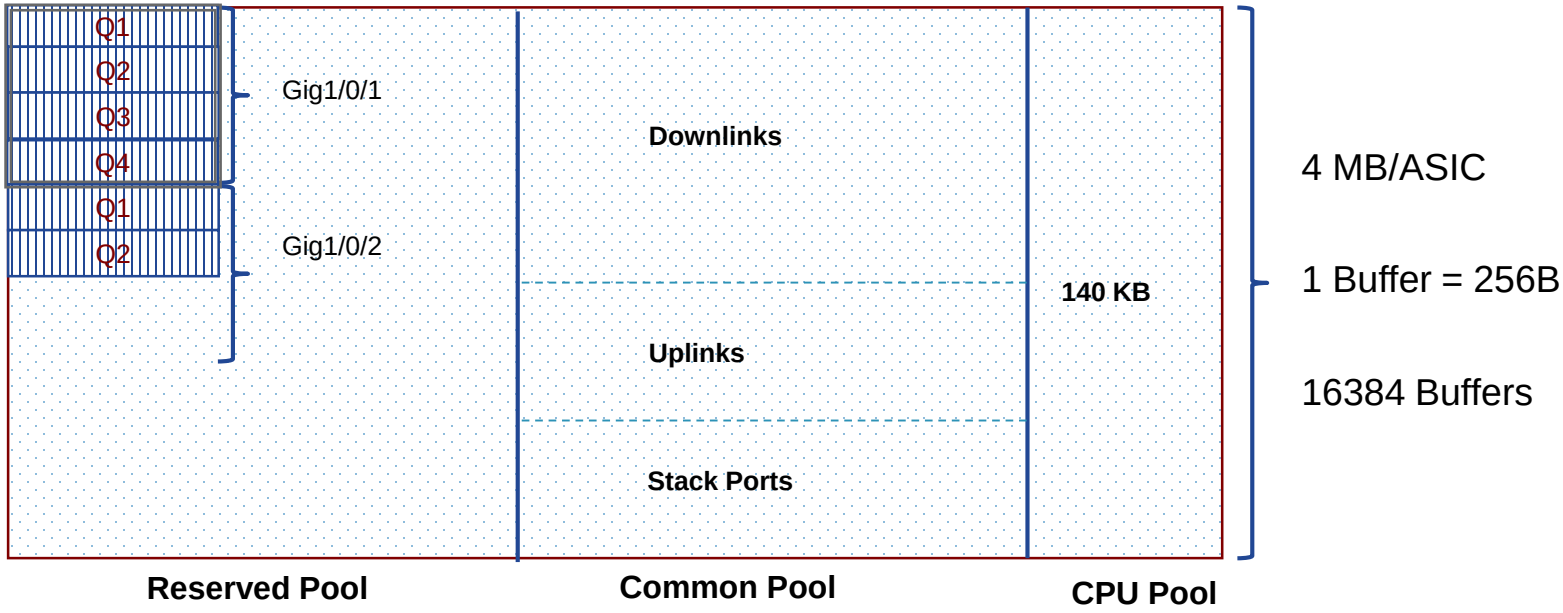

```
C2960-X(config)#access-list 101 permit tcp any eq www any
C2960-X(config)#class-map match-all http
C2960-X(config-cmap)#match access-group 101
C2960-X(config-cmap)#policy-map web-server
C2960-X(config-pmap)#class http
C2960-X(config-pmap-c)#police 500000 8000 exceed-act drop
C2960-X(config-pmap-c)#int gig1/0/11
C2960-X(config-if)#service-policy input web-server
```

Egress Queuing & Scheduling

- Queuing
  - Default Four egress queues/port
  - Configurable Eight egress queues/port
  - Queues assigned based on QoS label
  - 2 Queue-sets – 2 Queue configurations
- Dropping
  - WTD used for congestion avoidance
- Scheduling
  - Per Interface configuration
  - Strict Priority
  - SRR used to manage the queues



Egress Buffers Allocation



- Every Port has reserved egress buffers
- 10G uplinks reserved buffers = ~ 4 * 1G downlink reserved buffers
- Dedicated Common pool for uplink & Stack ports

Queue Sets & Thresholds

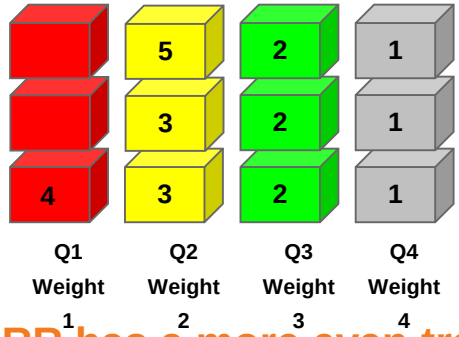
```
C2960-X(conf) #  mls qos queue-set output 1 buffers 15 25 40 20
C2960-X(conf) #  mls qos queue-set output 1 threshold 4 60 150 50 200
```

```
C2960-X#show mls qos queue-set 1
Queueset: 1
Queue     :       1       2       3       4
----------------------------------------------
buffers   :      15      25      40      20
threshold1:      50     125     100      60
threshold2:     100     125     100     150
reserved  :      50     100     100      50
maximum   :     200     400     400     200
```

```
C2960-X#show mls qos queue-set 2
Queueset: 2
Queue     :       1       2       3       4
----------------------------------------------
buffers   :      25      25      25      25
threshold1:     100     100     100     100
threshold2:     100     100     100     100
reserved  :      50      50      50      50
maximum   :     400     400     400     400
```

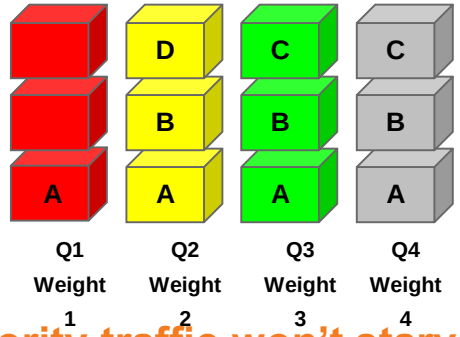
WRR vs. SRR

SRR is an evolution of WRR that protects against overwhelming buffers with huge bursts of traffic by using a smoother round-robin (SRR) mechanism



WRR

SRR

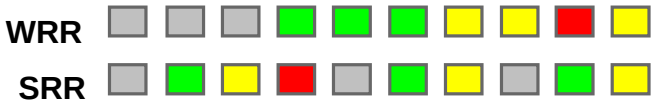


SRR has a more even traffic flow – Low Priority traffic won't starve!

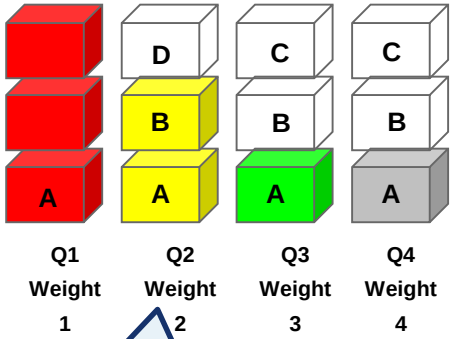
Each queue empties immediately as it is weighted

Each queue empties a weighted number of packets over a given period of time

Packet Order

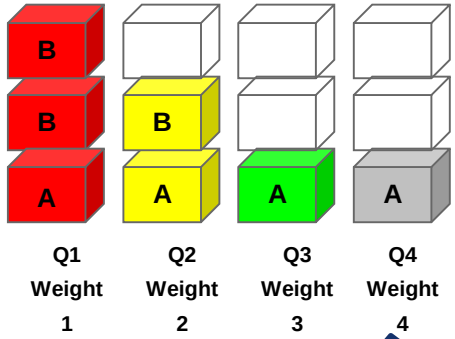


Shaped SRR vs. Shared SRR



Shaped

Shared



Lesser weight queues sit idle and wait to transmit, even if higher weight queues are empty

If higher weight queues are empty, lesser weight queues can continue to send while the higher weight queues are empty

Shared Queuing drains queues more efficiently!

Shaped SRR vs. Shared SRR

- Either Shaped SRR or Shared SRR is Good!
- Shared SRR is used to get the maximum efficiency out of a queuing system, because unused time slots can be reused by busier queues; Unlike standard WRR.
- Shaped SRR is used when one wants to shape a queue or set a hard limit on how much bandwidth a queue can use. Shaping provides a more even flow of traffic over time and reduces the peaks and valleys of bursty traffic.

Queue level Bandwidth Allocation

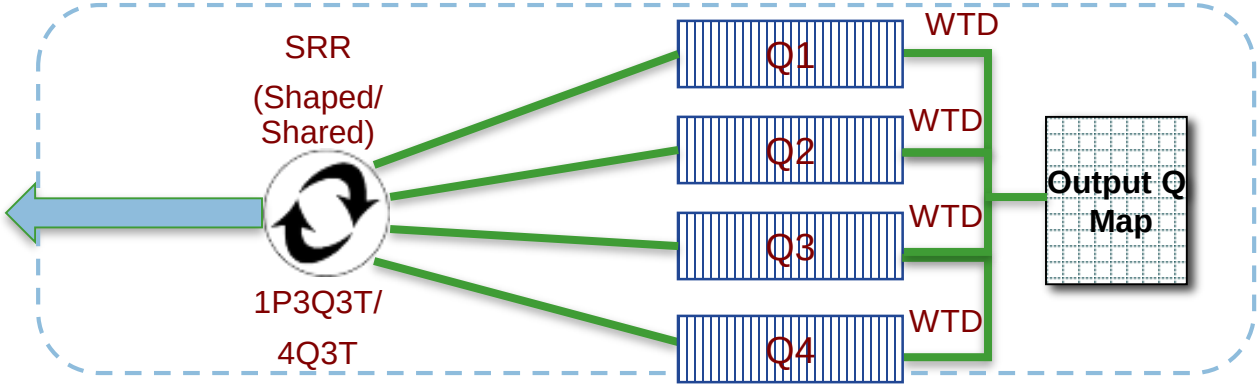
```
C2960-X(config) # interface GigabitEthernet 1/0/1
C2960-X(config-if)# srr-queue bandwidth share 1 70 25 5
      ! Q2 gets 70% of remaining BW; Q3 gets 25% and Q4 gets 5%

C2960-X(config-if)# srr-queue bandwidth shape  3  0  0  0
      ! Q1 is limited to 33% (1/3) of the total available BW

C2960-X(config) # interface GigabitEthernet 1/0/3
C2960-X(config-if)#priority-queue out
```

```
C2960-X#sh mls qos int gig1/0/1 queueing
GigabitEthernet1/0/1
Egress Priority Queue : disabled
Shaped queue weights (absolute) :  3 0 0 0
Shared queue weights  :  1 70 25 5
The port bandwidth limit : 100  (Operational
Bandwidth:100.0)
The port is mapped to qset : 1
```

```
C2960-X#sh mls qos int gig1/0/3 queueing
GigabitEthernet1/0/3
Egress Priority Queue : enabled
Shaped queue weights (absolute) :  25 0 0 0
Shared queue weights  :  10 10 60 20
The port bandwidth limit : 85  (Operational
Bandwidth:100.0)
The port is mapped to qset : 2
```

Four Egress Queues

Default Configuration - map 12 traffic classes

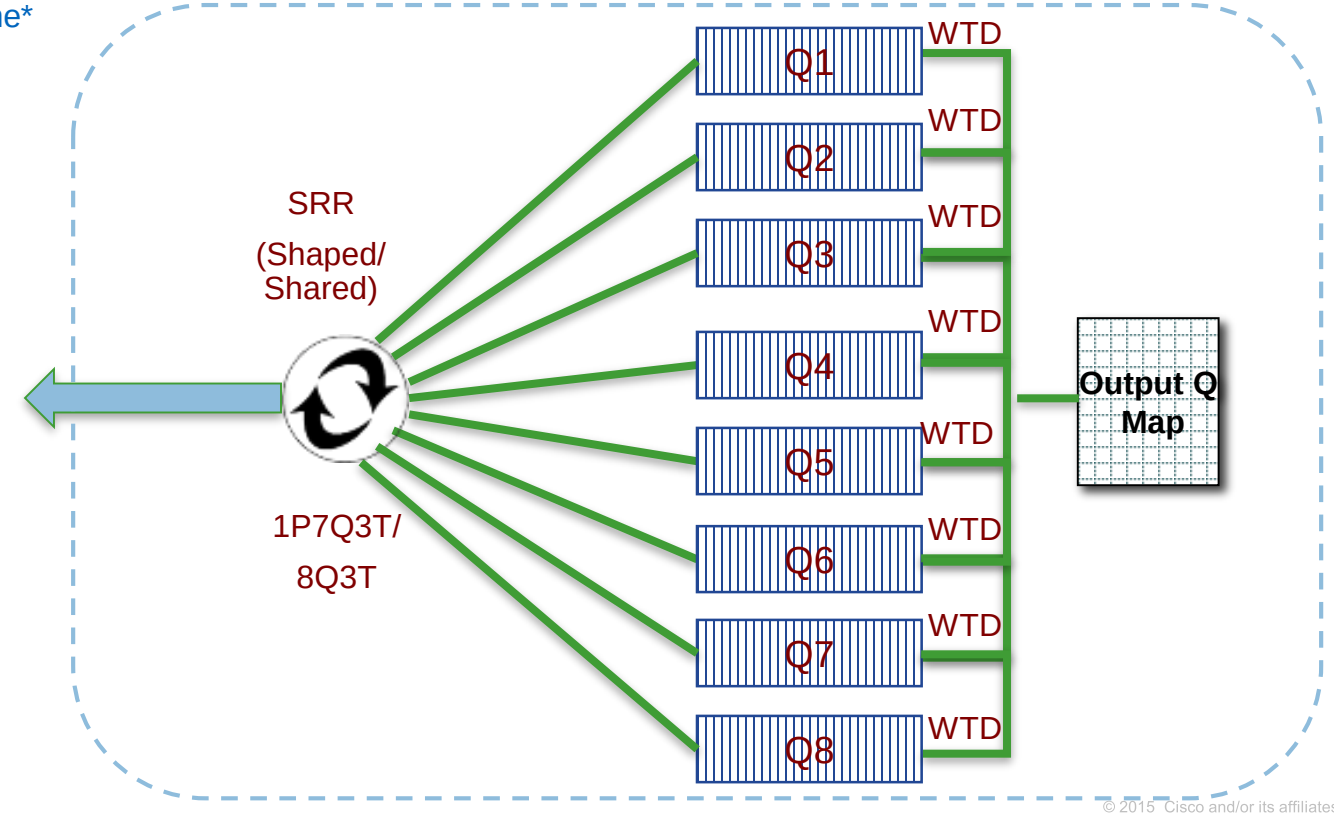



```
C2960XR#configure terminal
C2960XR(config)#mls qos srr-queue
output queues 8
```

Eight Egress Queues

Configurable - map 24 traffic classes

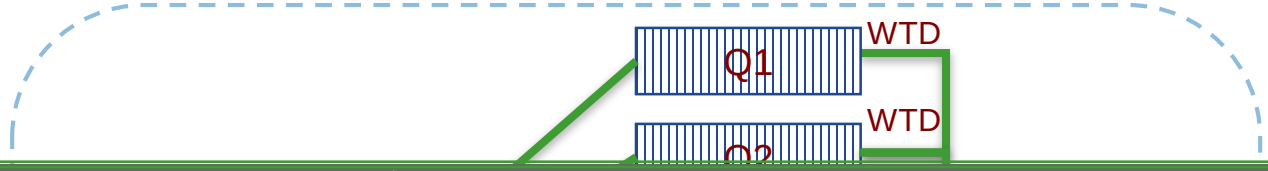
Only on Standalone*



* Roadmap to support eight queues in stack

Eight Egress Queues

Configurable - map 24 traffic classes




```
C2960XR#show mls qos queue-set 1
Queueset: 1
Queue     :       1       2       3       4       5       6       7       8
----------------------------------------------------------------------------
buffers   :      10      30      10      10      10      10      10      10
threshold1:     100    1600     100     100     100     100     100     100
threshold2:     100    2000     100     100     100     100     100     100
reserved  :     100     100     100     100     100     100     100     100
maximum   :     400    2400     400     400     400     400     400     400
```

* Roadmap to support eight queues in stack

C2960-X Stack Port Queue Set

- Buffers per Stack ports is fixed
- Buffers to Queues is configurable

- Applies to all stack ports in stack.
- Separate Common buffer pool for stack ports

```
C2960XR#show mls qos stack-qset
Queueset: Stack
Queue     :        1        2        3        4
----------------------------------------------
buffers   :       25       25       25       25

C2960XR#configure terminal
C2960XR(config)#mls qos stack-qset buffers 10 60 20 10
```

Automation with Cisco AutoQoS Switch Platform

- Single command at the interface level configures interface and global QoS
  - Support for Cisco IP Phone & Cisco IP Soft Phone
  - Support for Cisco Telepresence, IP video surveillance camera & Media Player
  - Trust Boundary is disabled when IP Phone is moved / relocated
  - Buffer Allocation & Egress Queuing dependent on interface type (GE/FE)
- Supported on Static, dynamic-access, voice VLAN access, and trunk ports
- CDP must be enabled for AutoQoS to function properly
- Cisco Catalyst 2960 supports SRR, Strict Priority Scheduling, and Strict Priority Queuing

Cisco Catalyst 2960-X
AutoQoS VoIP Model Example

```
C2960-X(config-if)#auto qos voip cisco-phone
```

```
mls qos srr-queue output cos-map queue 1 threshold 3  5
mls qos srr-queue output cos-map queue 2 threshold 3  3 6 7
mls qos srr-queue output cos-map queue 3 threshold 3  2 4
mls qos srr-queue output cos-map queue 4 threshold 2  1
mls qos srr-queue output cos-map queue 4 threshold 3  0
mls qos srr-queue output dscp-map queue 1 threshold 3  40 41 42 43 44 45 46 47
mls qos srr-queue output dscp-map queue 2 threshold 3  24 25 26 27 28 29 30 31
mls qos srr-queue output dscp-map queue 2 threshold 3  48 49 50 51 52 53 54 55
mls qos srr-queue output dscp-map queue 2 threshold 3  56 57 58 59 60 61 62 63
mls qos srr-queue output dscp-map queue 3 threshold 3  16 17 18 19 20 21 22 23
mls qos srr-queue output dscp-map queue 3 threshold 3  32 33 34 35 36 37 38 39
mls qos srr-queue output dscp-map queue 4 threshold 1  8
mls qos srr-queue output dscp-map queue 4 threshold 2  9 10 11 12 13 14 15
mls qos srr-queue output dscp-map queue 4 threshold 3  0 1 2 3 4 5 6 7
mls qos queue-set output 1 threshold 1 138 138
mls qos queue-set output 1 threshold 2 138 138 400
mls qos queue-set output 1 threshold 3 36 77 100 318
mls qos queue-set output 1 threshold 4 20 50 67 400
mls qos queue-set output 2 threshold 1 149 149 100 149
mls qos queue-set output 2 threshold 2 118 118 100 235
mls qos queue-set output 2 threshold 3 41 68 100 272
mls qos queue-set output 2 threshold 4 42 72 100 242
mls qos queue-set output 1 buffers 10 10 26 54
mls qos queue-set output 2 buffers 16 6 17 61
mls qos
!
!
interface GigabitEthernet0/1
 srr-queue bandwidth share 10 10 60 20
 srr-queue bandwidth shape  10  0  0  0
 queue-set 2
 mls qos trust device cisco-phone
 mls qos trust cos
 auto qos voip cisco-phone
!
```

Options:

auto qos voip cisco-phone

auto qos voip cisco-softphone

auto qos voip trust

auto qos video cts

auto qos video ip-camera

auto qos video media-player

Agenda

- Comparison and differences in Cisco Catalyst 2960X and 2960XR series switches
- Switches Architecture – 2960X/XR
- Flex Stack Plus in 2960X/XR
- **Overview on various features on the 2960X/XR**
  - Security
  - QoS
  - Netflow
  - **Ease of USE**
- Configuration examples
- Troubleshooting best practices and hints

Polling Question 3

Would you be interested in something that eases device deployment and configuration

A. Yes

B. Somewhat Yes

C. No

Network Plug-N-Play with APIC-EM Automates Switch Deployment & Configuration

NETWORK ADMIN

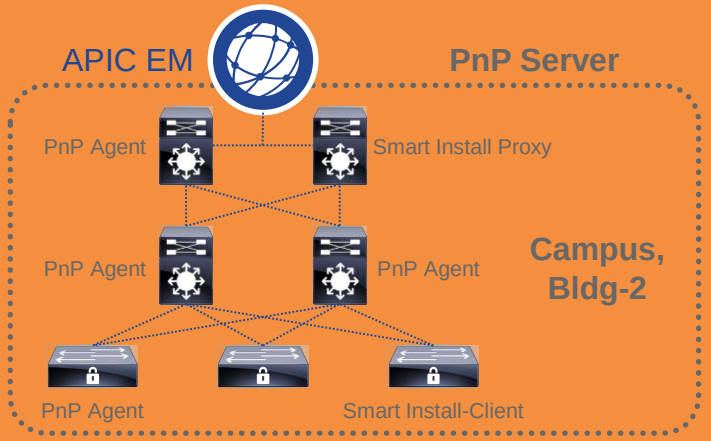
Pre Provision Projects/Sites

- Policies
- Match Rules
- Configs/Image
- IP Addressing

INSTALLER

Remote Installer

- Mount and cable devices
- Power-on



Network Admin Remotely Monitors Status of Install While in Progress

Booting Devices Call Out to PnP Server, Requesting Instructions

UNSKILLED INSTALLER | GUI BASED | CONSISTENT FOR DEVICES AND PIN (CAMPUS/BRANCH) | SECURE | RMA USE CASE | GREENFIELD AND BROWNFIELD

Network PnP – Server Discovery Options

1. **DHCP Options**

   DHCP Server configured with IP address of the PnP in Options 60 & 43, Consistent with Cisco LWAPP

2. **Domain Name**

   Uses customer Domain Name returned by DHCP server. PnP Agent adds pre-defined hostname “pnpserver.localdomainname” eg. pnpserver.cisco.com

3. **Neighbor Assisted Provisioning (NAPP)**

   When no DHCP, a NAP server which is one of the devices already up using PnP, acts as proxy for new devices

Image Install Service Workflow

- PnP server sends image location based on the UDI of the device
- PnP agent
  - ✓ Checks if the path is valid
  - ✓ Calculates disk space on the destination, if not finds an alternate disk space on the device
  - ✓ Downloads the image to the right destination where enough space is available
  - ✓ Checks the integrity of the image
  - ✓ Installs the image to all the applicable hardware (Standalone unit, HA unit, Stacked unit)
  - ✓ Notifies the server that image installation was successful
  - ✓ Reloads the device
  - ✓ If any error occurs in between the process of Image installation, the agent aborts and reports back to the server on the error

AutoConf and Interface Templates

Current Challenges

Port-Based Only | Usability/Bloated Config | Inflexible

Next-Gen Auto Smartports

- Simplified running-config
- Parsed at definition time
- Built-in templates
- Config rollback
- Precedence management
- Integrated with session-aware networking

Lower TCO

Easy to Use and Intuitive

Interface Templates
Benefits Overview

- Configuration file **Readability and Manageability**
- **Smaller Configuration** files
- **Built-in Interface Templates** for ease of use
- All Interface Templates are **Customizable**

Advantages over Auto Smart Ports

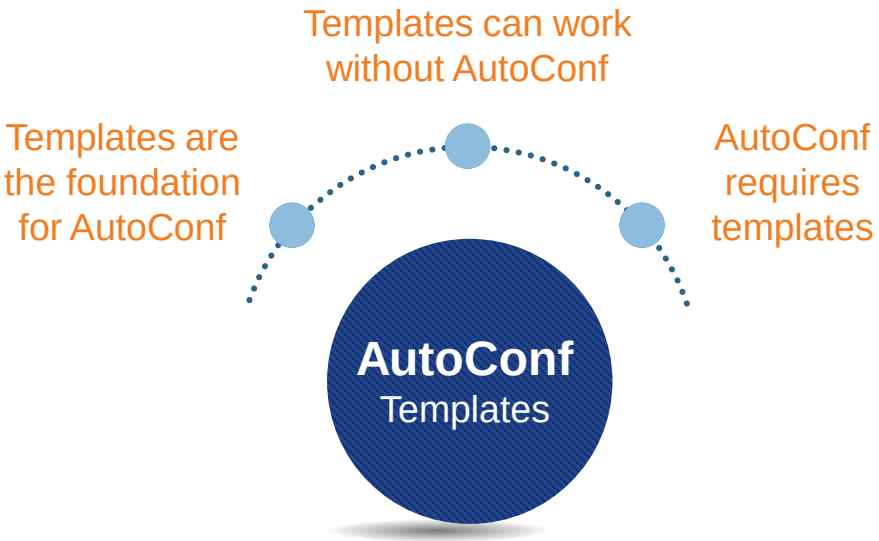
- ✓ Templates updates immediately ripple to interfaces
- ✓ Per session or Per port templates
- ✓ No change to running-config
- ✓ Full rollback and precedence management
- ✓ Compatible with AutoConf

11 Built-in Templates based on common end devices

```
Switch# show template interface brief

Template-Name                          Source
-------------------------              ---------
AP_INTERFACE_TEMPLATE                  Built-in
DMP_INTERFACE_TEMPLATE                 Built-in
IP_CAMERA_INTERFACE_TEMPLATE           Built-in
IP_PHONE_INTERFACE_TEMPLATE            Built-in
LAP_INTERFACE_TEMPLATE                 Built-in
MSP_CAMERA_INTERFACE_TEMPLATE          Built-in
MSP_VC_INTERFACE_TEMPLATE              Built-in
PRINTER_INTERFACE_TEMPLATE             Built-in
ROUTER_INTERFACE_TEMPLATE              Built-in
SWITCH_INTERFACE_TEMPLATE              Built-in
TP_INTERFACE_TEMPLATE                  Built-in
```

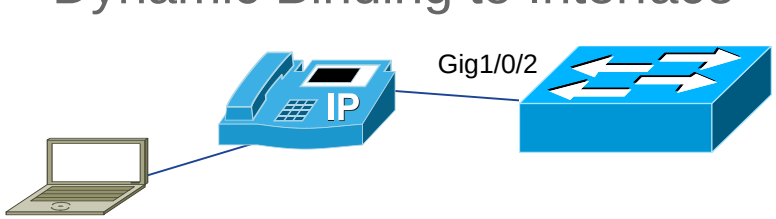
AutoConf

AutoConf = **Device Classification** [CDP, LLDP, DHCP, MAC OUI] + **Interface Templates** [Built-In or User Defined]



AutoConf In Action

Dynamic Binding to Interface




```
2960X# show template interface binding all

Template-Name                  Source          Method          Interface
-------------                  ------          ------          ---------
IP_PHONE_INTERFACE_TEMPLATE    Built-in        dynamic         Gi1/0/2

2960X# show template binding target gi1/0/2

Interface Templates
===================
Interface: Gi1/0/2

Method              Source          Template-Name
------              ------          -------------
dynamic             Built-in        IP_PHONE_INTERFACE_TEMPLATE
```

No change in run-config

```
2960X# show run interface gi1/0/2
Current configuration : 38 bytes
!
interface GigabitEthernet1/0/2
 source template IP_PHONE_INTERFACE_TEMPLATE
End
```

Full Configuration displayed with derived command

```
2960X# show derived int gi1/0/2
Derived configuration : 616 bytes
!
interface GigabitEthernet1/0/2
 switchport mode access
 switchport block unicast
 switchport port-security maximum 3
 switchport port-security maximum 2 vlan access
 switchport port-security aging time 1
 switchport port-security aging type inactivity
 switchport port-security violation restrict
 switchport port-security
 load-interval 30
 srr-queue bandwidth share 1 30 35 5
 priority-queue out
 mls qos trust cos
 storm-control broadcast level pps 1k
 storm-control multicast level pps 2k
 storm-control action trap
 spanning-tree portfast
 spanning-tree bpduguard enable
 ip dhcp snooping limit rate 15
end
```

What template is bound to interface?

Agenda

- Comparison and differences in Cisco Catalyst 2960X and 2960XR series switches
- Switches Architecture – 2960X/XR
- Flex Stack Plus in 2960X/XR
- Overview on various features on the 2960X/XR
- **Configuration examples**
- **Troubleshooting best practices and hints**

Polling Question 4

How easy is it to configure Dot1x and Netflow Lite on the switch

A. Very Difficult
B. Difficult
C. Manageable
D. Easy
E. Very Easy

DEMO

REFERENCES

- 2960X Configuration Guide - http://www.cisco.com/c/en/us/support/switches/catalyst-2960-x-series-switches/products-installation-and-configuration-guides-list.html
- 2960XR Configuration Guide - http://www.cisco.com/c/en/us/support/switches/catalyst-2960-xr-series-switches/products-installation-and-configuration-guides-list.html
- 2960X/XR Getting Started Guide – http://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst2960xr/hardware/quick/guide/b_gsg_2960xr.html

Catalyst 2960-X Series Access Switches

Next Generation Catalyst 2960 Access Switches

Most Deployed Switch Just Got Better

2x

Doubling Everything

Stack units, bandwidth & more

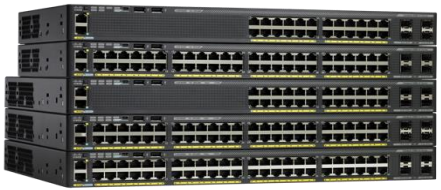
Application Visibility & Control

Layer 3 Routing

Investment Protection

Stack with Existing 2960-S/SF

Greenest Switch Ever



Scalable

Future-Proof

Smart

Intelligent & Green

Simple

Reduce TCO

Secure

One Policy

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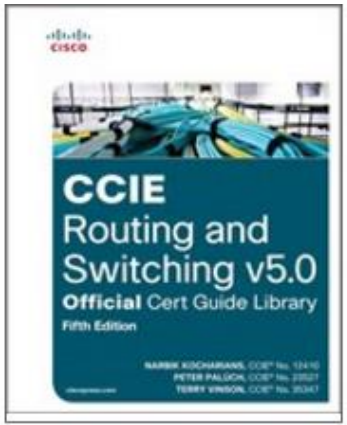

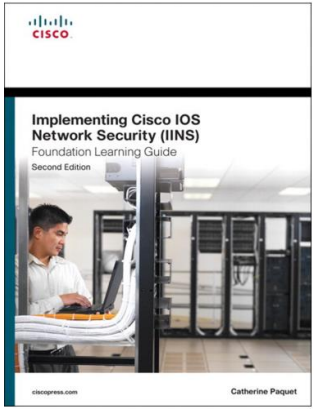

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