Classifying and Scheduling Packets for the ASR 1000 Series Aggregation Services Routers

This chapter provides an overview of the release history, prerequisites, restrictions, overview of classification and scheduling and configuring the classification and scheduling for ingress packets on the Cisco ASR 1000 Series Aggregation Services Routers.

This chapter includes the following sections:

- Release History, on page 1
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Release History

Table 1: Ingress Classification and Scheduling Release History

Release	Modification
Cisco IOS XE Software, Release 3.1S	Classification and scheduling for ingress packets was introduced on the Cisco ASR 1000 Series Aggregation Services Routers to resolve the oversubscription of bandwidth on ingress side.

Overview of Ingress Classification and Scheduling

The ASR 1000 Series Aggregation Services Routers contain a variety of SIPs and SPAs with a combination of low and high speed interfaces ranging from DS1 to 10 Gbps. Due to a variety of SPAs inserted in the ASR 1000 Series Router, both the Carrier Card (CC) and the SPA get oversubscribed in the ingress or egress direction. Currently, all the existing components of the ASR 1000 Series Aggregation Services Routers such as CC and ESP, prioritize the traffic in the egress direction. To resolve the oversubscription issue on the ingress side, ingress classification and scheduling have been introduced in Cisco IOS XE Software, Release 3.1S.

This technology provides the following advantages:

- Classifies and schedules the packets marked as high priority.
- Reduces the latency and jitters for packets (example video and voice) classified as high priority.

Prerequisites for Ingress Classification and Scheduling

The following table shows the hardware and software compatibility prerequisites for the ingress classification and scheduling feature.

Table 2: Hardware and Software Compatibility for Ingress Classification Scheduling

Platform	Processor Engine	Forwarding Processors, Carrier Cards, and SPA Types Supported	New and Modified Commands
Cisco ASR 1000 Series Router	Cisco IOS XE Release 3.1S • Route Processor 1 (RP1) • Route Processor 2 (RP2)	Forwarding Processors supported • ESP 5, ESP 10, ESP 20, ESP 40 SIPs supported • CC 10 • CC 40 SPAs supported • POS SPA: OC3, OC12, OC48, and OC192 flavors • Channelized SPA: ChT1/ E1, ChT3/ DS0, ChSTM1/ OC3, and ChOC12/ DS0 SPAs • Clear Channel SPA: T3/ E3 and 12-in-1 SPAs • Ethernet SPAs: FE, 1 GE, 10 GE SPAs. • ATM SPAs: OC-3 and OC-12 flavour SPAs.	Following is the list of new and modified commands: • **ingress-class-map** • **map ip all queue** • **map ip dscp-based** • **map ip dscp** • **map ip precedence-based** • **map ip precedence** • **map ipv6 all queue** • **map ipv6 tc** • **map mpls all queue** • **map mpls exp** • **plim qos input class-map** • **show ingress-class-map** • **plim qos input map cos {enable | inner-based | outer-based | {inner | outer} {cos-value | cos-range} queue {strict-priority | 0}}** • **hw-module subslot** {*slot/subslot*} **qos input {weight weight}**

Note The above listed new commands for ingress classification and scheduling are documented in the *Cisco IOS Quality of Service Solutions Command Reference guide* at the URL http://www.cisco.com/en/US/docs/ios/qos/command/reference/qos_book.html.

Classification and Scheduling Restrictions

Following are the restrictions pertaining to the classification feature:

- The maximum number of ingress class map templates configured per CC is 62 templates.
- Classification support is not enabled for logical interfaces such as multilink and tunnel interfaces.
- Packet classification CLI is disabled for multilink member links.
- Classification CLI cannot be enabled for frame relay subinterfaces.
- Classification is not supported for service SPAs such as WebEx.

Following are the restrictions pertaining to the scheduling feature:

- For clear-channel SPAs such as Ethernet, Serial, POS, and ATM SPAs, excess bandwidth settings are configured at the physical interface level. For channelized SPAs, the excess bandwidth settings can be set at the SPA level.
- Configurations built using high capacity CC or ESP, will be restored with best effort when a low-capacity CC or ESP replaces the high-capacity CC or ESP. Also, any per-CC minimum bandwidth configuration exceeding its ESI link capacity will be replaced with the corresponding ESI link's maximum capacity.
- When configuring the minimum CC bandwidth, the available range is 0 to the minimum carrier-card bandwidth and ESP bandwidth.

Information About Ingress Classification

The following sections provide details of the Ingress classification feature:

Ingress Classification Architecture

The Cisco ASR 1000 Series Aggregation Services Routers support ingress oversubscription. However, in case of oversubscription, it is important that the processing of the high-priority packets such as Internet control, L2 keepalives, signaling protocols, and high-priority data packets is done by the SIP or SPA over the low-priority packets. The following table illustrates the various SPA and ESP combinations that cause oversubscription with SIP-10 installed.

Table 3: SIP-10 Oversubscription Details

ASR 1000 Chassis Type	ESP Type	Oversubscription State
• ASR1000-SIP10G • Incoming rate from SPAs. Maximum 4 multiplied by 11.2 Gbps • Outgoing rate towards ESP 11.2 Gbps Conclusion: SIP10G is always oversubscribed.	ESP-2.5 G and ESP-5 G (Supported only on ASR-1002)	No ESP oversubscription. ESPs interconnect device handles the entire 10G incoming traffic.
	ESP-10G	ESP is oversubscribed. Example: Input rate from (example) 3 carrier cards is 3 multiplied by 11.2Gbps Output rate towards QFP=12.8Gbps
	ESP-20G	ESP is oversubscribed. Example: Input rate from (example) 3 carrier cards is 3 multiplied by 11.2Gbps Output rate towards QFP=25.6 Gbps
	ESP-40G	No ESP oversubscription. Example: Input rate from (example) 3 carrier cards is 3 multiplied by 11.2Gbps Output rate towards QFP=2*25.6 Gbps
	ESP-100G	No ESP oversubscription. Example: Input rate from (example) 3 carrier cards is 3 multiplied by 11.2Gbps Output rate towards Yoda=4*25.6 Gbps

The following table illustrates the SPA an ESP combinations that cause oversubscription with SIP-40 installed.

Table 4: SIP-40 Oversubscription Details

ASR 1000 Chassis Type	ESP Type	Oversubscription State
• ASR1000-SIP40G • Incoming rate from SPAs. Maximum 4 multiplied by 11.2 Gbps • Outgoing rate towards ESP depends on the ESP type Conclusion: SIP40G oversubscription depends on the ESP type.	ESP-2.5 G and ESP-5 G (Supported only on ASR-1002)	Not supported.
	ESP-10G	ASR1000-SIP40G operates as ASR1000-SIP10G. Example: Input rate from (example) 3 carrier cards is 3 multiplied by 11.2 Gbps Output rate towards QFP=12.8 Gbps ESP is oversubscribed.
	ESP-20G	ASR1000-SIP40G operates as ASR1000-SIP10G. Example: Input rate from (example) 3 carrier cards is 3 multiplied by 11.2 Gbps Output rate towards QFP=25.6 Gbps ESP is oversubscribed.
	ESP-40G	ASR1000-SIP40G operates as ASR1000-SIP40G. Example: Input rate from (example) 3 carrier cards is 3 multiplied by 23 Gbps Output rate towards QFP=51.2 Gbps ESP is oversubscribed.
	ESP-100G	ASR1000-SIP40G operates as ASR1000-SIP40G. Example: Input rate from (example) 3 carrier cards is 3 multiplied by 23 Gbps Output rate towards Yoda=100 Gbps ESP is not oversubscribed.

Resolving Oversubscription

Following are the two high-level tasks which need to performed to resolve the bandwidth oversubscription on the ingress side:

- Classifying the incoming traffic as high priority and low priority. Depending on the SPA type, the classification is done by either a SIP or a SPA.

- Scheduling the high-priority packets first and then processing the low-priority traffic. Depending on the scheduling configuration, weight can be assigned to low-priority packets.

Ingress Classification Overview

To solve the bandwidth oversubscription issue, packets must be classified as high-priority data traffic and control traffic, and guarantee their transmit to the QFP. Ingress Classification can be broadly divided into two:

- SPA-based classification—Some of the SPAs support the classification performed within the SPA hardware.
- SIP-based classification—SPAs rely on the classification performed inside the CC.

The SPAs supported on a Cisco ASR 1000 Series Aggregation Services Router can be broadly classified into the following categories:

- Ethernet SPAs—Fast Ethernet (FE), 1-Gigabit Ethernet (GE), 10-Gigabit Ethernet SPAs
- ATM SPAs—OC3 and OC12 flavours
- Channelized SPAs—ChT1/ E1, ChT3/ DS0, ChSTM1/ OC3, and ChOC12/ DS0 SPAs
- Clear Channel SPAs—T3/ E3 and 12-in-1 SPAs
- POS SPAs—OC3, OC12, OC48, and OC192 flavors

Note The Ethernet and ATM SPAs have classification capability at the SPA level, while the other types of SPAs rely on the SIP for ingress classification.

The following table shows the classification models followed by the various SPAs:

Table 5: SPA–Based Matrix for Ingress Classification at SIP/SPA Level

Classification at the SPA Level	Classification at the SIP Level
Ethernet SPAs • SPA-4X1FE-TX-V2 • SPA-8X1FE-TX-V2 • SPA-2X1GE-V2 • SPA-5X1GE-V2 • SPA-8X1GE-V2 • SPA-10X1GE-V2 • SPA-1X10GE-L-V2	Serial and Channelized SPA • SPA-2XCT3/DS0 • SPA-4XCT3/DS0 • SPA-8XCHT1/E1 • SPA-8XCHT1/E1-V2 • SPA-1XCHSTM1/OC3 • SPA-1XCHOC12/DS0 • SPA-2xT3/E3 • SPA-4xT3/E3 • SPA-4xT-SERIAL

Classification at the SPA Level	Classification at the SIP Level
—	POS SPAs • SPA-2XOC3-POS • SPA-4XOC3-POS • SPA-4XOC3-POS-V2 • SPA-1XOC12-POS • SPA-2XOC12-POS • SPA-4XOC12-POS • SPA-8XOC12-POS • SPA-8XOC3-POS • SPA-1XOC48POS/RPR • SPA-2XOC48POS/RPR • SPA-4XOC48POS/RPR • SPA-OC192POS-XFP

SPA-Based Classification

Ethernet and ATM SPAs perform classification at the SPA level. In the SPA-based classification model, the SPA performs both L2 and L3 classification, and decides on the priority of the packet. After classifying the packets into high priority and low priority, the SPA has unique SPI4 channels per priority, and all the high-priority packets are sent on separate SPI4 channels other than the low-priority SPI4 channel. In such a scenario, the SPA queues the packets on high SPI4 channels to high-priority buffers and low-SPI4 channels to low-priority buffers. After the packets are classified into high priority and low priority, the packets are sent to the ESP for further processing.

SIP-Based Classification

POS SPAs, channelized, and clear-channel SPAs support packet classification at SIP level. In SIP-based classification, the SIP does the classification for SPAs and classifies the packet into high-priority and low-priority.

Commands have been introduced in Release 3.1S to configure SIP based classification. To classify high-priority packets such as IPv4, IPv6, or MPLS, in a SIP or SPA, the classification template is defined using the **ingress-class map** *index* command. The classification template-specific details are defined inside the template, and the template is attached to an interface using the **plim qos class-map** *index* command.

Default Classification

Commands are used to configure the L3 packet classification criteria. If no L3 classification rule has been configured, the SIP classifies the packet with the following L3 settings as high priority by default:

- IPv4 DSCP-based— If no values are specified as high priority for IPv4 DSCP values, the system considers packets with DSCP EF as high priority.
- IPv4 precedence-based— If no values are specified as high priority for IPv4 precedence values, the system considers packets with precedence 6-7 as high priority.
- IPv6 TC-based— If no values are specified as high-priority for IPv6 DSCP values, the system considers packets with DSCP EF as high priority.
- MPLS EXP bits— If no values are specified as high-priority for MPLS EXP values, the system considers packets with EXP values 6-7 as high priority.

High Availability and Online Insertion and Removal

- CLI configured under an interface are retained after SPA online-insertion-and-removal (OIR). When one type of SPA is replaced by another type of the SPA, the interface configuration is not retained. However, if the earlier SPA type is reinserted, the configuration added on that SPA type is restored.
- All the configurations are synced to the standby route processor (RP). Hence, the router configuration is retained even after the RP switchover.

Configuring the Ingress Classification

The following section provides configuration details for classifying IPv4, IPv6, and MPLS packets for POS, serial, channelized, and clear-channel SPAs.

Defining the L3 Classification Template

To classify high-priority packets such as IPv4, IPv6, or MPLS in either a SIP or SPA, the classification template is defined using the **ingress-class map** *index* command. The classification rules are defined inside the template, and the template is attached to an interface using the **plim qos input class-map** *index-id* command.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ingress-class-map index-id**
4. **interface {POS | Serial} interface-path-id**
5. **plim qos input class-map index-id**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password when prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters the global configuration mode.
Step 3	**ingress-class-map index-id** **Example:** `Router(config)# ingress-class-map 1`	Creates a classification template for L3 classification for POS, channelized, and clear-channel SPAs.

	Command or Action	Purpose
Step 4	**interface {POS | Serial} interface-path-id** **Example:** `Router(config)# interface POS 0/2/0`	Enters the interface configuration mode and specifies the POS or Serial interface name with the notation *slot/sub-slot/interface-id*. Possible interface types for this procedure are: • POS • Serial **Note** The example indicates a 0 port in the POS SPA adapter at sub-slot 2 in the SIP at slot 0.
Step 5	**plim qos input class-map index-id** **Example:** `Router(config-if)# plim qos input class-map 1`	Attaches the ingress classification class-map template with the specified index-id to the POS or Serial interface.

Classifying IPv4 Packets

To configure and verify IPv4 packets as either high or low based on either the DSCP value or precedence value, execute the following set of commands in the Configuration ingress class map mode:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ingress-class-map index-id**
4. **map ip all queue strict-priority**
5. **map ip dscp-based**
6. **map ip dscp dscp-value queue 0**
7. **map ip precedence-based**
8. **map ip precedence precedence-value queue strict-priority**
9. **exit**
10. **interface {POS | Serial} interface-path-id**
11. **plim qos input class-map index-id**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password when prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ingress-class-map index-id** **Example:** `Router(config-ing-class-map)# ingress-class-map 1`	Enters the ingress classification template settings for the specified template ID and enables the configuration of the classifications for IPv4, IPv6, or MPLS.
Step 4	**map ip all queue strict-priority** **Example:** `Router(config-ing-class-map)# map ip all queue strict-priority`	Sets the priority for all IPv4 packets as high.
Step 5	**map ip dscp-based** **Example:** `Router(config-ing-class-map)# map ip dscp-based`	Enables classification based on the DSCP value in IPv4.
Step 6	**map ip dscp dscp-value queue 0** **Example:** `Router(config-ing-class-map)# map ip dscp cs1 cs2 queue 0`	Classifies IPv4 packets, with DSCP values cs1 and cs2 as low-priority packets.
Step 7	**map ip precedence-based** **Example:** `Router(config-ing-class-map)# map ip precedence-based`	Enables classification for IPv4 packets based on IP precedence.
Step 8	**map ip precedence precedence-value queue strict-priority** **Example:** `Router(config-ing-class-map)# map ip precedence 5 7 queue strict-priority`	Classifies the IPv4 packets, with precedence values 5 and 7 as strict priority.
Step 9	**exit** **Example:** `Router(config-ing-class-map)# exit`	Exits the ingress-class-map mode and goes back to the global configuration mode.
Step 10	**interface {POS | Serial} interface-path-id** **Example:**	Enters the interface configuration mode and specifies the POS or Serial interface name with the notation

	Command or Action	Purpose
	`Router(config)# interface POS 0/2/0`	*slot/sub-slot/interface-id*. Possible interface types for this procedure are: • POS • Serial **Note** The example indicates a 0 port in the POS SPA adapter at sub-slot 2 in the SIP at slot 0.
Step 11	**plim qos input class-map index-id** **Example:** `Router(config-if)# plim qos input class-map 1`	Attaches the ingress classification class-map template with the specified index-id to the POS or Serial interface.

Displaying a warning message for no form of commands

This section provides details regarding the behavioral change of displaying a warning message when no command is executed for classification commands.

Cisco IOS XE Release Number

From Cisco IOS XE Release 3.1.0s onwards, a warning message is displayed when **no** command is executed if you have not configured classification and you are trying to execute the no commands for **no plim qos input map ip precedence** *precedence-value* **queue {strict-priority | 0} and no plim qos input map ip dscp** *dscp-value* **queue {strict-priority | 0}**.

Old behavior

When the **no** form of command was executed for classification commands such as **no plim qos input map ip precedence** *precedence-value* **queue {strict-priority | 0} and no plim qos input map ip dscp** *dscp-value* **queue {strict-priority | 0}**, a warning message was not displayed when **no** form of command was executed on queues for which classification was not configured and the **no** form of command was accepted.

New Behavior

The **no** form of the classification commands returns an error message if you have not configured the classification and you are trying to execute the **no** command from Cisco IOS XE Release 3.1.0s onwards. For example, by executing the **plim qos input map ip precedence** *4 5* **queue strict-priority** command the ip precedence value is configured on queue with strict-priority. If you are executing the **no plim qos input map ip precedence** *4 5* **queue 0** for which the configuration has not been configured, it shows an error message "% Precedence 4 not configured for queue 0. Cannot use [no] option to remove it." However, if you are executing the **no** command for a queue for which configuration has been done, the **no** form of the command works fine. The error message is also displayed if **no** form of command is executed for other classification command such as **no plim qos input map ip dscp** *dscp-value* **queue {strict-priority | 0}**, if classification is not configured for the queue and you are executing the **no** form of command.

Classifying IPv6 Packets

To classify all the IPv6 packets as either high priority or low priority, or to classify the IPv6 packets with specific traffic class values such as high or low, execute the following set of commands in the Configuration ingress class map mode:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ingress-class-map 1**
4. **map ipv6 all queue strict-priority**
5. **map ipv6 tc tc-value queue strict-priority**
6. **exit**
7. **interface {POS | Serial} interface-path-id**
8. **plim qos input class-map index-id**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password when prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ingress-class-map 1** **Example:** `Router(config-ing-class-map)#`	Enters the ingress classification template settings for the specified template ID and enables the configuration of the classifications for IPv4, IPv6, or MPLS.
Step 4	**map ipv6 all queue strict-priority** **Example:** `Router(config-ing-class-map)# map ipv6 all queue strict-priority`	Sets the priority for all IPv6 packets as high.
Step 5	**map ipv6 tc tc-value queue strict-priority** **Example:** `Router(config-ing-class-map)# map ipv6 tc af43 queue strict-priority`	Classifies IPv6 traffic class values with af43 as high priority.
Step 6	**exit** **Example:** `Router(config-ing-class-map)# exit`	Exits the ingress-class-map mode and goes back to the global configuration mode.

	Command or Action	Purpose
Step 7	**interface {POS | Serial} interface-path-id** **Example:** `Router(config)# interface POS 0/2/0`	Enters the interface configuration mode and specifies the POS or Serial interface name with the notation *slot/sub-slot/interface-id*. Possible interface types for this procedure are: • POS • Serial **Note** The example indicates a 0 port in the POS SPA adapter at sub-slot 2 in the SIP at slot 0.
Step 8	**plim qos input class-map index-id** **Example:** `Router(config-if)# plim qos input class-map 1`	Attaches the ingress classification class-map template with the specified index-id to the POS or Serial interface.

Classifying MPLS Packets

To classify either all the MPLS packets or the MPLS packets based on EXP bits of the MPLS header as either high or low, execute the following set of commands in the Configuration ingress class map mode:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ingress-class-map 1**
4. **map mpls all queue strict-priority**
5. **map mpls exp exp-value queue strict-priority**
6. **exit**
7. **interface {POS | Serial} interface-path-id**
8. **plim qos input class-map index-id**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password when prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**ingress-class-map 1** **Example:** `Router(config-ing-class-map)#`	Enters the ingress classification template settings for the specified template ID and enables configuration of the classifications for IPv4, IPv6, or MPLS.
Step 4	**map mpls all queue strict-priority** **Example:** `Router(config-ing-class-map)# map mpls all queue strict-priority`	Sets the priority for all MPLS packets as high priority.
Step 5	**map mpls exp exp-value queue strict-priority** **Example:** `Router(config-ing-class-map)# map mpls exp 1 queue strict-priority`	Classifies MPLS packets with EXP value 1 as high.
Step 6	**exit** **Example:** `Router(config-ing-class-map)# exit`	Exits the ingress-class-map mode and goes back to the global configuration mode.
Step 7	**interface {POS | Serial} interface-path-id** **Example:** `Router(config)# interface POS 0/2/0`	Enters the interface configuration mode and specifies the POS or Serial interface name with the notation *slot/sub-slot/interface-id*. Possible interface types for this procedure are: • POS • Serial **Note** The example indicates a 0 port in the POS SPA adapter at sub-slot 2 in the SIP at slot 0.
Step 8	**plim qos input class-map index-id** **Example:** `Router(config-if)# plim qos input class-map 1`	Attaches the ingress classification class-map template with the specified index-id to the POS or Serial interface.

Classifying Inner or Outer VLAN COS Values

To enable packet classification based on VLAN COS values for Inner or Outer VLAN of a 802.1Q subinterface or qinq subinterface, execute the following set of commands from QinQ subinterface configuration mode:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface gigabitEthernet 0/0/0.1**

4. **plim qos input map cos inner-based**
5. **plim qos input map cos inner 5 6 queue strict-priority**
6. **plim qos input map cos outer-based**
7. **plim qos input map cos outer 4 queue strict-priority**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password when prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface gigabitEthernet 0/0/0.1** **Example:** `Router(config)# interface gigabitEthernet 0/0/0.1`	Enters the subinterface mode for Gigabit Ethernet 0/0/0.1.
Step 4	**plim qos input map cos inner-based** **Example:** `Router(config-subif)# plim qos input map cos inner-based`	Enables and allows configuration for inner VLAN COS values. **Note** The VLAN COS values can be enabled by default by executing the **plim qos input map enable** command.
Step 5	**plim qos input map cos inner 5 6 queue strict-priority** **Example:** `Router(config-subif)# plim qos input map cos inner 5 6 queue strict-priority`	Configures the COS values or the range of the inner VLAN of a qinq subinterface to high priority.
Step 6	**plim qos input map cos outer-based** **Example:** `Router(config-subif)# plim qos input map cos outer-based`	Enables configuration for outer VLAN COS values. **Note** The VLAN COS values can be enabled by default by executing the command **plim qos input map enable**.
Step 7	**plim qos input map cos outer 4 queue strict-priority** **Example:** `Router(config-subif)# plim qos input map cos outer 4 queue strict-priority`	Configures the COS values or range for outer-vlan of a qinq sub-interface to high-priority.

Information About Ingress Scheduling

The following sections provide details regarding the Ingress Scheduling feature:

Scheduling Overview

The ASR 1000 Series Aggregation Services Routers support ingress oversubscription. After the ingress packets are classified as high priority and low priority, the packets are scheduled according to the priority. The ingress classification and scheduling features have to work in conjunction to handle oversubscription. Bandwidth oversubscription occurs at two levels, the SIP level (intra carrier card scheduling) and at ESP (inter carrier card scheduling) level. The decision to configure scheduling at the SIP level is based on the number of SPAs within a SIP and the scheduling decision to configure the scheduling at either SIP or ESP level is based on the number of SIPs in a router. The following section describes intra-CC scheduling and inter-CC scheduling.

Intra-CC Scheduling

Under intra-CC scheduling, the high-priority packets that are already classified by the SIP or the SPA are scheduled and processed first. By default, all high-priority packets are processed first, and then the excess bandwidth is shared among the low-priority packets, based on either the weight assigned to the interface or the entire SPA. Configuring weights provides an option in distributing the excess bandwidth among different interfaces to schedule low priority packets. Intra-CC scheduling is supported in all SPAs, SIP-10, and SIP-40.

To assign excess weight to a clear-channel SPA (POS, ATM, Ethernet, or Serial SPAs), execute the **plim qos input** [**weight** *weight*] command from Main interface configuration mode. This command was earlier supported on only Ethernet SPAs. From Cisco IOS XE Release 3.1S onwards, the command is supported on all clear-channel SPA on Cisco ASR 1000 Series Router.

To assign excess weight to low-priority packets on channelized SPAs, execute the **hw-module subslot** {*slot/subslot*} **qos** [**weight** *weight*] command in Global configuration mode.

Inter-CC Scheduling

Oversubscription occurs at both the SIP level and the ESP level. Inter-CC scheduling has been introduced to handle the oversubscription at the ESP level. In this scenario, the traffic sent from all the SIPs to the ESP. It is not mandatory to configure scheduling at the ESP level. It depends on the number of SIPs connected to the ESP. Inter-CC scheduling is needed whenever an oversubscription situation is encountered or there is a need to prioritize certain traffic or there is a need to give different bandwidth allocation to different types of traffic. To configure the minimum bandwidth service for the SIP and distribute the excess weight to the low priority packets on the per ESI link per CC, execute the **hw-module slot** *slot-number* **qos input link** *link-index* {**bandwidth** *value* | **weight** *weight*} command from the Global configuration mode.

Behavioral Changes in Scheduling

In Cisco IOS XE Release 6.0 and earlier images, by default, the SIP-10 scheduler and the ESP scheduler ran in port-fairness and ESP-fairness mode where each buffer is scheduled at a rate proportional to its interface bandwidth. As a result, even high-priority packets were treated based on a rate that was proportional to its interface bandwidth. In Cisco IOS XE Release 3.1S, the SIP-10 scheduler, SIP-40 scheduler, and ESP scheduler ran in strict-priority mode. In this mode, if the high-priority queues of either a participating SPA port or a participating SIP has data to send, these queues will be scheduled first. The remaining bandwidth, if any, will

then be shared among the low-priority buffers at a weight that is proportional to the interface bandwidth or at a weight that is equal to the weight of all the SIPs.

The supported excess weight range from Cisco IOS XE Release 3.1S and onwards for intra-SIP scheduling is as follows:

- SIP-10— 40 to 10000
- SIP-40— 40 to 10000

The supported minimum bandwidth range from Cisco IOS XE Release 3.1S and onwards for Inter-SIP scheduling depends on the combination of SIP and ESP. The following is the range for minimum bandwidth configuration for various combination of SIP and ESP:

- SIP-10 with all ESP: 1 Mbps to 11.2 Gbps
- SIP-40 with ESP10/ESP20: 1 Mbps to 11.2 Gbps
- SIP-40 with ESP40: 1Mbps to 23 Gbps on each ESI link
- SIP-40 with ESP100: Up to 100 Gbps

The supported excess weight range for inter carrier card scheduling (ESP level) is as follows:

- All ESPs— 50 to 100

Configuring Intra-CC Scheduling

By default, ingress packets that are classified as high-priority by a SIP or SPA, are processed first, and then sent. After processing the high-priority packets, the available excess bandwidth can be shared by low-priority packets depending on the weight assigned to the interface or to the SPA. Execute the following commands to configure the weight on an interface or for the entire SPA:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface gigabitEthernet 0/0/0**
4. **plim qos input weight 100**
5. **exit**
6. **hw-module subslot 0/1 qos input weight 150**
7. **exit**
8. show platform hardware slot 0 plim qos input bandwidth

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. Enter your password when prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface gigabitEthernet 0/0/0** **Example:** `Router(config-if)# interface gigabitEthernet 0/0/0`	Enters the interface configuration mode for Gigabit-Ethernet 0/0/0.
Step 4	**plim qos input weight 100** **Example:** `Router(config-if)# plim qos input weight 100`	Assigns excess weight of 100 for bandwidth distribution to the Gigabit Ethernet 0/0/0. **Note** The **plim qos input weight** command is applicable for only clear-channel SPAs.
Step 5	**exit** **Example:** `Router(config-if)# exit`	Exits from the interface configuration mode, and goes back to the configuration mode.
Step 6	**hw-module subslot 0/1 qos input weight 150** **Example:** `Router(config)# hw-module subslot 0/1 qos input weight 150`	Assigns excess weight of 150 for bandwidth distribution to the channelized SPA at slot 0/1. **Note** The **hw-module subslot 0/1 qos input weight 150** command is applicable for all the channelized SPAs. The excess weight is assigned to all the channelized SPAs, while for clear-channel SPAs, weight is assigned to the SPA interface.
Step 7	**exit** **Example:** `Router#`	Exits from the configuration mode and goes back to the privilege execution mode.

Step 8	show platform hardware slot 0 plim qos input bandwidth
	Example:
	`Router# show platform hardware slot 0 plim qos input bandwidth`
	Example:
	Example:
	`Ingress QOS Scheduling Mode: Strict Priority`
	Example:
		Displays the interface-level excess weight configured for all the interfaces of all the SPAs, present in Slot 0.

	Command or Action	Purpose

	Example:
	`0/0, SPA-5X1GE-V2`
	Example:
	`  Interface 0/0/0`
	Example:
	`    BW:  1000000 Kbps, Min BW: N/A , Excessive Weight:   100000 Kbps, HP Polices`
	Example:
	`  Interface 0/0/1`
	Example:
	`    BW:  1000000 Kbps, Min BW: N/A , Excessive Weight:  1000000 Kbps, HP Polices`
	Example:
	`  Interface 0/0/2`
	Example:
	`    BW:  1000000 Kbps, Min BW: N/A , Excessive Weight:  1000000 Kbps, HP Polices`
	Example:
	`  Interface 0/0/3`
	Example:
	`    BW:  1000000 Kbps, Min BW: N/A , Excessive Weight:  1000000 Kbps, HP Polices`
	Example:
	`  Interface 0/0/4`
	Example:
	`    BW:  1000000 Kbps, Min BW: N/A , Excessive Weight:  1000000 Kbps, HP Polices`
	Example:
	Example:	

	Command or Action	Purpose
	0/1, SPA-1XCHOC12/DS0 **Example:** BW: 619968 Kbps, Min BW: N/A , Excessive Weight: 150000 Kbps, HP Polices **Example:** **Example:** 0/2, SPA-2XCT3/DS0 **Example:** BW: 88384 Kbps, Min BW: N/A , Excessive Weight: 88000 Kbps, HP Polices	

Configuring Inter-CC Scheduling

The ESP-level scheduling feature helps to assign minimum guaranteed bandwidth for the entire SIP, and to assign a specific weight to the SIP for distribution of the excess bandwidth. Execute the following commands to either assign the minimum guaranteed bandwidth or to configure the weight for the entire SIP for excess bandwidth distribution:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **hw-module slot 1 qos input link A bandwidth 512**
4. **hw-module slot 1 qos input link A weight 50**
5. **exit**
6. **show platform hardware slot f0 serdes qos**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** Router> enable	Enables privileged EXEC mode. Enter your password when prompted.
Step 2	**configure terminal** **Example:**	Enters global configuration mode.

	Command or Action	Purpose
	`Router# configure terminal`	
Step 3	**hw-module slot 1 qos input link A bandwidth 512** **Example:** `Router(config)# hw-module slot 1 qos input link A bandwidth 512`	Assigns a guaranteed minimum bandwidth of 512 Kbps for ESI link A.
Step 4	**hw-module slot 1 qos input link A weight 50** **Example:** `Router(config)# hw-module slot 1 qos input link A weight 50`	Assigns excess weight of 50 to the ESI link A of the SIP.
Step 5	**exit** **Example:** `Router(config-if)# exit`	Exits from the configuration mode and goes back to the privilege execution mode.

Step 6	**show platform hardware slot f0 serdes qos**
	Example:
	`Router# show platform hardware slot f0 serdes qos`
	Example:
	Example:
	`Qos Settings on FP:`
	Example:
	`slot # Min BW (Kbps)  Min BW Mode   Slot Weight`
	Example:
	`RP0  99975  HILO 256`
	Example:
	`SIP0  11199981  HI 50`
		Displays the minimum guaranteed bandwidth and weight configured for all the SIP slots.

What to do next