NetFlow Configuration for Traffic Monitoring and Analysis

This page will help you understand the fundamental principles, variations, benefits, and limitations associated with NetFlow. Additionally, it offers guidance on configuring NetFlow.

NetFlow Essential Concepts and Terms

- **Data source:** Specific locations within the router, such as physical interfaces and VLANs, where traffic measurements can be taken.
- **Flow**: Indicates a collection of IP or MPLS packets traversing the router during a time period. All packets belonging to a particular Flow share common attributes derived from the packet's data
- **Flow record**: Is a set of key and non-key NetFlow field values used to characterize flows in the NetFlow cache. It is generated by examining packet headers, and adding a description of packet details in the NetFlow cache.
- **Exporter**: Positioned within the router that has NetFlow enabled, an Exporter monitors incoming packets, and generates Flows from them. The Exporter transmits information derived from these Flows, encapsulates as Flow Records, to the NetFlow Collector.
- **Collector**: An external device designed to receive Flow Records from one or multiple Exporters. The Collector processes the incoming export packets, and stores the associated Flow record details. Optionally, Flow records can undergo aggregation before storing it onto the hard disk.

- **NetFlow Cache**: The Cache is a segment of memory that stores flow entries prior to their exportation to an external collector. This includes two cache types: the normal cache and the permanent cache.
- **Netflow Analyser**: Is an external device or an application responsible for collecting and scrutinizing flow records to furnish valuable insights.
- **Collector address:** This comprises the IP address and a UDP port number. By default, the designated destination port number is 2055.

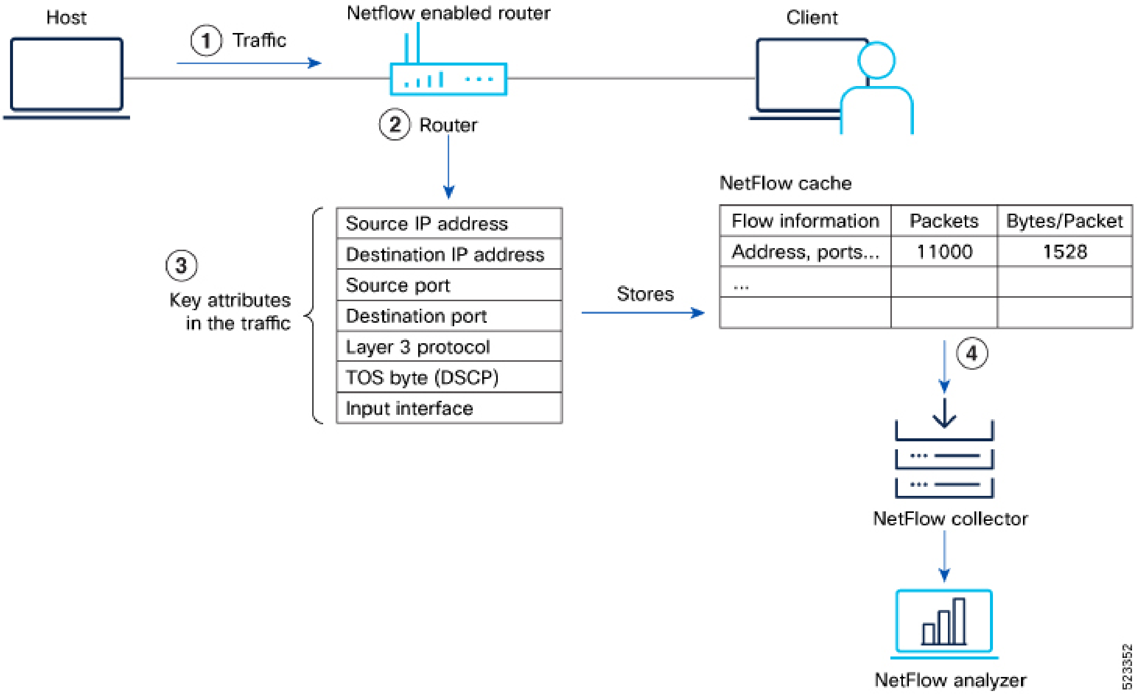
How NetFlow Works

NetFlow serves as a network monitoring protocol that facilitates the logging of metadata for each flow that traverses the router, both entering or leaving it. This protocol provides comprehensive insights into network flows, including details such as source and destination IP addresses, ports, and packet counts. It's commonly applied for traffic analysis, capacity planning, and network troubleshooting.

Recording of Packet Flows in NetFlow

The packet in NetFlow is recorded as follows:

Figure 1: Packet Flows in NetFlow



Flow information	Packets	Bytes/Packet
Address, ports...	11000	1528
...		

In NetFlow, the focus is on recording and collecting full packet flows in the network traffic data. When NetFlow is configured on the router, the router collects flow data by extracting key field attributes from the packet streams, and generates a flow record. This record, along with accounting information, is stored in the database or NetFlow Cache. The extracted records, once sampled, are exported to one or more NetFlow collectors via the UDP transport layer protocol. This exported data has several purpose: enterprise accounting and ISP billing, and so on.

Here's how NetFlow handles the recording of packet flows:

1. Flow Creation: NetFlow creates flow records by monitoring network traffic passing through the router. As a packet stream traverses a router interface, the packets are collected and an internal header is appended. These packets are dispatched to the line card's CPU, which generate a flow record. The router extracts pertinent header details from the packets and creates cache entries. The packets are subject to a policer, which helps protect the internal control plane. With each subsequent arrival of a packet from the same flow, the cache entry is updated. Flow records persist within the line card's cache until they age out due to timer expiration.

   When the expiry of the set timer occurs, the NetFlow is generated. There are timers (two of them) running for flow aging.

   - The active timer signifies the maximum allowable duration for a particular cache entry's existence, even if matched by received sampled packets.

   - The inactive timer represents the duration without receipt of a sampled packet corresponding to a specific cache entry.

2. Datagram Generation: The NetFlow agent generates NetFlow datagrams that contain information about the packets. These datagrams include details such as source and destination IP addresses, port numbers, protocol information, and various flow statistics.

3. Data Export: The NetFlow datagrams are periodically exported from the NetFlow agent to a designated NetFlow collector or analyzer. The export can be done using protocols like UDP or TCP, and the datagrams are typically sent in a structured format like IPFIX or JSON.

   A flow record is sent to the NetFlow collector in the following scenarios:

   - The flow has been inactive or active for an extended period.

   - The user triggers the export of the flow.

   - The flow concludes, which is particularly relevant when TCP connections are terminated.

4. Analysis and Reporting: Upon receiving the NetFlow data, the NetFlow collector or analyzer processes and analyzes the information. It aggregates the sampled data to provide statistical insights into network traffic, including top talkers, protocol distribution, traffic patterns, and other metrics.

Flow monitoring on Egress Interface

Table 1: Feature History Table

Feature Name	Release Information	Description
Flow monitoring on Egress Interface	Release 24.1.1	You can now get precise insights into encapsulated and decapsulated data, prioritize critical outbound traffic, and ensure implementation of security measures. This is accomplished by activating egress flow monitoring on outbound interfaces within your network using Netflow and sFlow.

Egress Interface Flow Monitoring enhances network visibility and control by prioritizing outbound traffic. This capability offers advanced monitoring and management of data exiting the network, providing a more comprehensive understanding of network dynamics. The key focus of this feature is to monitor packets that are either encapsulated or decapsulated through egress NetFlow and sFlow.

Encapsulated and decapsulated data monitoring in NetFlow and sFlow serves a crucial role in safeguarding sensitive information transmitted across the network. The process involves encapsulating data with an additional layer of information, enabling verification of its authenticity and integrity. This added layer makes it challenging for attackers to intercept or modify data during transmission. Conversely, decapsulation entails removing the encapsulated data layer, empowering network devices to analyze the information and take appropriate actions in real-time. This proactive approach aids in identifying and preventing attacks or anomalies, enhancing the overall security of the network.

Key Attributes Within IP and MPLS Packets

NetFlow extends its support to IPv4, IPv6, and MPLS flow types, providing the capacity to monitor a diverse range of packet information. These encompass, and extend beyond:

- Source and Destination IP Addresses
- Source and Destination MAC Addresses
- Source and Destination Ports for TCP/User Datagram Protocol (UDP) ports
- Differentiated Services Code Point (DSCP)
- Layer 3 Protocol
- Type of Service (ToS) Byte
- Traffic receiving Interface
- Complete IPv4 Header fields, including IP-ID and TTL, among others
- Routing information (next-hop address, source autonomous system (AS) number, destination AS number, source prefix mask, destination prefix mask, BGP Next Hop, BGP Policy Accounting traffic index)
- Counts for Packets and Bytes

- Full Spectrum of IPv6 Header fields, encompassing Flow Label and Option Header, among others
- Flow timestamps
- MPLS labels

Interface Types Supported with NetFlow

- Physical main interfaces
- L3 interfaces
- L3 subinterfaces
- L2 interfaces
- Bundle interfaces
- Bundle sub-interfaces
- PW-Ether interfaces

NetFlow Guidelines and Limitations

- NetFlow is supported in the ingress direction for all routers, while NetFlow in egress is supported on the following routers: Cisco 8201, Cisco 8202, and Cisco 8201-32FH.
- Netflow exporter packet does not transport support TCP.
- A source interface or source address must be configured to enable the exporter. If you do not configure a source interface, the exporter remains in a disabled state. If both a source interface and a source address are configured, the source address takes precedence.
- NetFlow supports export format Version 9 and IPFIX.
- NetFlow filtering using ACL is not supported.
- A valid record type such as IPv4, IPv6, or MPLS must be configured for every flow monitor map.
- NetFlow is not supported on Bridge Virtual Interface (BVI).
- Destination-based NetFlow accounting is not supported.
- Output interface field is not updated in data and flow records when the traffic is routed through ACL-based forwarding (ABF).
- The data and flow records for GRE transit traffic do not have the output interface, source, and destination prefix lengths fields set.
- Full Packet Capture (FPC) feature is not supported.
- We do not recommend using the management interface to export the NetFlow packets.
- If IPFIX 315 is enabled on a line card, then all the ports on that line card should have IPFIX315 configured.

- IPFIX 315 is supported on the main interface only. The traffic on all sub-interfaces (on which netflow is enabled) under the main interface is exported.
- The incoming and outgoing interface will have information of main interface and not the sub-interface even if the packet is routed via sub-interface. Incase of bundles it will point to bundle main interface for IPFIX 315.
- IPFIX 315 sampling rate for bundles is per member-link and not per bundle interface.
- For IPFIX 315, the outgoing interface information may not be correct incase of packets that are multicasted or broadcasted on multiple ports.
- On a dual RP system, IPFIX 315 or Sflow has to be enabled on both RP systems. Otherwise, the system displays an error message during configuration.
- The configuration of sampler rate as 1 out of 1 is not supported.
- Ingress Layer 2 netflow or IPFIX is not supported in the Release 7.9.x.
- You can configure only one active sampler per system.

Guidelines for BGP Attributes - MPLS Record Types on Cisco 8010 Series Routers

- On edge nodes, only ingress direction is supported.
- The MPLS record types, such as **mpls ipv4-fields**, **mpls ipv6-fields**, and **mpls ipv4-ipv6-fields**, are only supported.
- At the edge node on MPLS or SR-MPLS core with Penultimate Hop Popping (PHP) or Ultimate Hop Popping (UHP) disabled, the packets that are sampled should contain the MPLS label to fetch the BGP attributes.
- VPN scenarios of SR-MPLS is not supported.

Comparative Overview of NetFlow Version 9 and Version 10 (IPFIX)

Multiple versions of the NetFlow protocol exist. This section provides a comprehensive overview of the distinct versions within the NetFlow monitoring protocol, including NetFlow v9 and NetFlow v10 (IPFIX). It highlights the variations between these protocols.

NetFlow Version 9

NetFlow Version 9 is a template-based approach that provides flexibility in the record format. It enables enhancements to NetFlow services without concurrently altering the basic flow-record format.

NetFlow Options Template

The NetFlow Options Template serves as a distinctive template record designed to communicate the format of data associated with the NetFlow operation. Instead of sharing details about IP flows, these options serve the purpose of providing metadata pertaining to the NetFlow process itself. There are distinct options templates: the sampler options template and the interface options template. The NetFlow process exports these two tables. Furthermore, the NetFlow process also exports the VRF (Virtual Routing and Forwarding) table.

Sampler Table

The Sampler Table and Interface Option Templates play a significant role in organizing information.

The Sampler Options Template consists of a sampler table, while the Interface Option Templates consists of an interface table. Enabling these options for the sampler and interface tables simplifies the process for the collector to determine data flow information.

The sampler table offers insights into active samplers. Its primary purpose is to aid the collector in estimating the sampling rate for individual data flows. The sampler table provides the following information for each sampler:

Element ID	Field Name	Value
48	SamplerID	This ID is assigned to the sampler. It is used by the collector to retrieve information about the sampler for a data flow record.
49	SamplerMode	This field indicates the mode in which the sampling has been performed.
50	SamplerRandomInterval	This field indicates the rate at which the sampling is performed.
84	SamplerName	This field indicates the name of the sampler.

Interface Table

The interface table, contains data about interfaces that are monitored for data flow. With this data, the collector derives the interface names linked to the data flow. The interface table contains the following information:

Field Name	Value
ingressInterface	This field indicates the SNMP index assigned to the interface. By matching this value to the Ingress interface in the data flow record, the collector is able to retrieve the name of the interface.
interfaceDescription	This field indicates the name of the interface.

VRF Table

The VRF table consists mapping of VRF IDs to the VRF names. Using this information, the collector determines the name of the required VRF.

The VRF table is exported at intervals specified by the optional **timeout** keyword that can be configured manually. The default value is 1800 seconds.

The VRF table consists of the following information:

Field Name	Value
ingressVRFID	The identifier of the VRF with the name in the VRF-Name field.

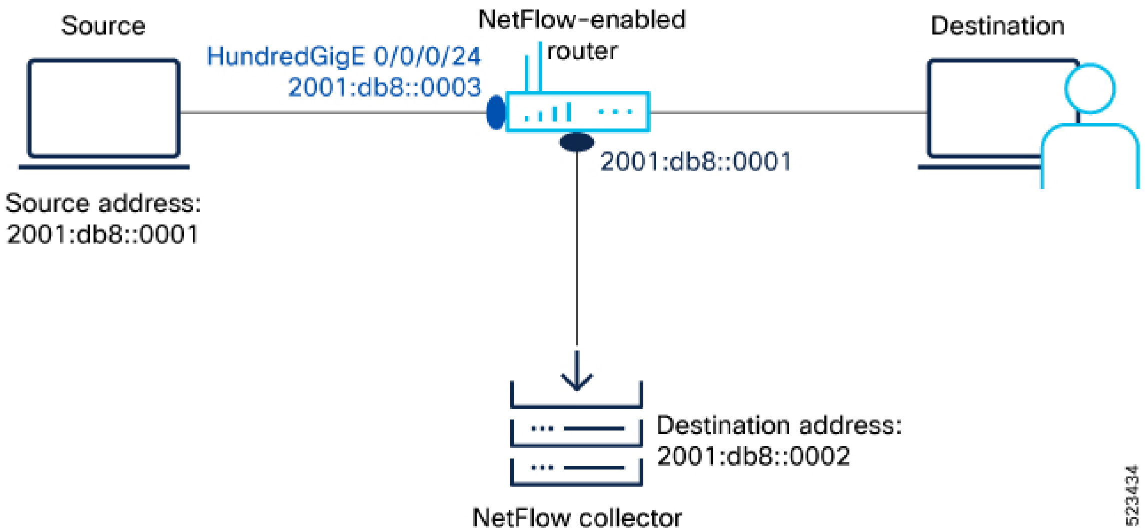
Field Name	Value
VRF-Name	The VRF name has the VRFID value ingressVRFID. The value "default" indicates that the interface is not assigned explicitly to a VRF.

The data records contain ingressVRFID as an extra field in each record. The values of these fields are used to lookup the VRF Table to find the VRF names. A value of 0 in these fields indicates that the VRF is unknown.

Configure NetFlow Version 9

Let's consider the following topology to configure NetFlow.

Figure 2: NetFlow Version 9 Configuration



To monitor traffic, you must configure one or more Flow Exporter and associate it to a Flow Monitor Flow Monitor and enable NetFlow on the interface either in egress or ingress direction. Optionally, you can configure a Flow Sampler to set the sampling rate for flow samples.

Step 1 First, let's gather the required details to enable NetFlow on a router:

- The IP address of the source : `2001:db8::0003`
- The IP address of the NetFlow Collector (Destination address): `2001:db8::0002`
- Interface of the router where we will enable Netflow: `HundredGigE 0/0/0/24`
- NetFlow version used to transport the data to the collector: `version 9`

Step 2 Configure a Flow Exporter using the flow exporter-map command to specify where and how the packets should be exported.

```
Router# configure
Router(config)# flow exporter-map Expo1
Router(config-fem)# source-address 2001:db8::0003
Router(config-fem)# destination 2001:db8::0002
Router(config-fem)# transport udp 1024
Router(config-fem)# version v9
Router(config-fem-ver)# options interface-table
Router(config-fem-ver)# commit
Router(config-fem-ver)# root
Router(config)#exit
```

Verify the Flow Exporter configuration using the show flow exporter-map command.

```
Router#show flow exporter-map Expo1
Flow Exporter Map : Expo1
-------------------------------------------------
Id                   : 1
Packet-Length        : 1468
DestinationIpAddr    : 2001:db8::2
VRFName              : default
SourceIfName         :
SourceIpAddr         : 2001:db8::3
DSCP                 : 0
TransportProtocol    : UDP
TransportDestPort    : 1024
Do Not Fragment      : Not Enabled

Export Version: 9
  Common Template Timeout : 1800 seconds
  Options Template Timeout : 1800 seconds
  Data Template Timeout : 1800 seconds
  Interface-Table Export Timeout : 1800 seconds
  Sampler-Table Export Timeout : 0 seconds
  VRF-Table Export Timeout : 0 seconds
```

Step 3 Create a Flow Monitor using the flow monitor-map command to define the type of traffic to be monitored. You can include one or more exporter maps in the monitor map. A single flow monitor map can support up to eight exporters.

The record type specifies the type of packets that are sampled as the packets pass through the router. MPLS, IPv4, and IPv6 packet sampling is supported.

```
Router#configure
Router(config)# flow monitor-map fmm-ipv6
Router(config-fmm)# record ipv6
Router(config-fmm)# cache entries 500000
Router(config-fmm)# cache timeout active 60
Router(config-fmm)# cache timeout inactive 20
Router(config-fmm)# exporter Expo1
outer(config-fmm)# commit
Router(config-fmm)# root
Router(config)#exit
```

Verify the Flow Monitor configuration using the show flow monitor-map command.

```
Router#show flow monitor-map fmm-ipv6

Flow Monitor Map : fmm-ipv6
-------------------------------------------------
Id:                1
RecordMapName:     ipv6
ExportMapName:     Expo1
CacheAgingMode:    Normal
CacheMaxEntries:   500000
CacheActiveTout:   60 seconds
CacheInactiveTout: 20 seconds
CacheUpdateTout:   N/A
CacheRateLimit:    2000
```

```
HwCacheExists:     False
HwCacheInactTout:  50
```

Here are additional examples to record MPLS packets, BGP packets.

In this example, you create a flow monitor map to record the MPLS packets.

```
Router(config)#flow monitor-map fmm-mpls-ipv6
Router(config-fmm)#record mpls ipv6-fields labels 3
Router(config-fmm)#exporter Expo1
Router(config-fmm)#cache entries 2000000
Router(config-fmm)#cache permanent
Router(config-fmm)#exit
```

In this example, you create a flow monitor map to record the BGP packets with the permanent cache.

```
Router(config)# router bgp 50
Router(config-bgp)# address-family ipv6 unicast
Router(config-bgp-af)# bgp attribute-download
Router(config-bgp-af)#root
Router(config)#flow monitor-map fmm-bgp
Router(config-fmm)#record ipv6 peer-as
Router(config-fmm)#exporter Expo1
Router(config-fmm)#cache entries 2000000
Router(config-fmm)#exit
```

Note In NetFlow Version 9, to fetch the BGP AS path and community string, you should configure the **option bgpattr** command under the **flow monitor-map** configuration.

Step 4 Configure a Flow Sampler using the sampler-map command to define the rate at which the packet sampling should be performed at the interface where NetFlow is enabled. Use the same sampler map configuration on the sub-interfaces and physical interfaces under a port.

```
Router(config)# configure
Router(config)# sampler-map fsm1
Router(config-sm)# random 1 out-of 262144
Router(config)# exit
Router(config)#commit
Router(config)#exit
Router#
```

Verify the sampler map configuration using the show sampler-map command.

```
Router#show sampler-map fsm1

Sampler Map : fsm1
-------------------------------------------------
Id:      1
Mode:    Random (1 out of 262144 Pkts)
Router#
```

Step 5 Apply a Flow Monitor Map and a Flow Sampler to a physical interface using the flow command to enable NetFlow on the router. You can choose to enable IPv4, IPv6, MPLS-aware NetFlow on the interface. Enable NetFlow in the ingress direction to monitor the incoming packets and enable NetFlow in the egress direction to monitor egress traffic.

Note Consider these points before applying the sampler map:

- Remove any existing Netflow or sFlow configurations before applying a new Flow sampler on an interface using the no form of the command.
- Use the same sampler map configuration on the sub-interfaces and physical interfaces under a port.

```
Router#configure
Router(config)#interface HundredGigE 0/0/0/24
Router(config-if)#flow ipv6 monitor fmm-ipv6 sampler fsm1 ingress
Router(config-if)#commit
Router(config-if)#root
Router(config)#exit
```

The below example shows the configuration for enabling NetFlow in the egress direction to monitor the egress traffic.

```
Router#configure
Router(config)#interface HundredGigE 0/0/0/24
Router(config-if)#flow ipv6 monitor fmm-ipv6 sampler fsm1 egress
Router(config-if)#commit
Router(config-if)#root
Router(config)#exit
```

Step 6 View the running configuration to verify the configuration that you have configured.

```
Router# show run

flow exporter-map Expo1
 version v9
  options interface-table
 !
 transport udp 1024
 source-address 2001:db8::3
 destination 2001:db8::2
!
flow monitor-map fmm-ipv6
 record ipv6
 exporter Expo1
 cache entries 500000
 cache timeout active 60
 cache timeout inactive 20
!
sampler-map fsm1
 random 1 out-of 262144
!

interface HundredGigE0/0/0/24
 shutdown
 flow ipv6 monitor fmm-ipv6 sampler fsm1 ingress
!
end
```

Step 7 Verify the flows captured using the show flow monitor name cache command.

In the following example, you can verify the amount of flows added and exported.

```
Router#show flow monitor fmm-ipv6 cache summary location 0/0/CPU0
Cache summary for Flow Monitor monitor1:
Cache size: 1000000
Current entries: 295
Flows added: 184409
Flows not added: 0
Ager Polls: 9824
 - Active timeout 183855
 - Inactive timeout 259
 - Immediate 0
 - TCP FIN flag 0
 - Emergency aged 0
 - Counter wrap aged 0
 - Total 184114
Periodic export:
- Counter wrap 0
- TCP FIN flag 0
Flows exported 184114
```

This verifies that the data is successfully exported to the collector.

In the following example, you can verify the QoS type of service (TOS)/DSCP from the IPv6PostTC field.

```
Router#show flow monitor fmm-ipv6 cache record location 0/0/CPU0
========== Record number: 1 ==========
IPv6SrcAddr      : 2001:db8::3
IPv6DstAddr      : 2001:db8::2
BGPDstOrigAS     : 0
BGPSrcOrigAS     : 0
BGPNextHopV6     : 1000:1::2
IPv6TC           : 0
IPv6PostTC       : 48
IPv6FlowLabel    : 0
IPv6OptHdrs      : 0x10
IPV6Prot         : 59
L4SrcPort        : 0
L4DestPort       : 0
L4TCPFlags       : 0
IPV6DstPrfxLen   : 128
IPV6SrcPrfxLen   : 128
InputInterface   : FH0/0/0/0
OutputInterface  : FH0/0/0/12
ForwardStatus    : Fwd
FirstSwitched    : 00 00:59:02:416
LastSwitched     : 00 00:59:02:416
ByteCount        : 46
PacketCount      : 1
Dir              : Ing
SamplerID        : 1
InputVRFID       : default
OutputVRFID      : default
```

What to do next

You can now analyse the exported data using a NetFlowAnalyser.

Modify NetFlow Configuration

You can modify only the following flow attributes that is already applied to an interface for a monitor map, exporter map, or a sampler map.

Note that when you modify the flow attributes, the cache counters are cleared and results in resetting of the counters. As a result there could be flow accounting mismatch.

Table 2: Flow Entities and Flow Attributes that can be altered

Flow Entity	Flow Attribute	Command
Monitor map	cache timeout • active • inactive • update • rate-limit	cache timeout
	exporter	exporter
	cache entries	cache entries
	cache permanent	cache permanent
	options outphysint | bgpattr | filtered | outbundlemember	options
Exporter Map	source <*source interface*>	source
	destination <*destinaiton address*>	destination
	dscp <*dscp_value*>	dscp
	version v9 | ipfix	version ipfix
Sampler Map	sampling interval	**sampling interval**

IPFIX (NetFlow Version 10)

Internet Protocol Flow Information Export (IPFIX) has been standardized by the Internet Engineering Task Force (IETF) as an export protocol for transmitting NetFlow packets. Building upon NetFlow version 9, IPFIX introduces efficient flow data formatting through templates, ensuring scalability and adaptability to diverse network environments. Utilizing UDP as the transport protocol, IPFIX facilitates the seamless transfer of NetFlow information from exporters to collectors. With native support for IPv6 flow records, the inclusion of optional data fields, and the ability to send data to multiple collectors, IPFIX proves to be a versatile and powerful solution for network administrators, enabling comprehensive traffic analysis, monitoring, and enhanced visibility into network behavior.

IPFIX 315

The Internet Engineering Task Force (IETF) has standardized Internet Protocol Flow Information Export (IPFIX) as an export protocol for sending IP flow information. Router supports the IPFIX 315 format for exporting flow information. The IPFIX 315 format enables the transmission of 'n' octets of frame information starting from the Ethernet header up to the transport header of the traffic flow over the network. IPFIX 315 supports the sending of variable-sized packet records with variable payload information, such as IPv4, IPv6, MPLS, and nested packets like OuterIP-GRE-InnerIP, and more. The process involves sampling and exporting the traffic flow information. Also, along with the Ethernet frame information, the IPFIX 315 format exports the information of the incoming and outgoing interfaces of the sampled packet.

The information of the packets flowing through a device is used for a variety of purposes, including network monitoring, capacity planning, traffic management, and more.

When exporting packets, a special cache-type called Immediate Aging is used. Immediate Aging ensures that the flows are exported as soon as they are added to the cache.

Sampling and Exporting Information

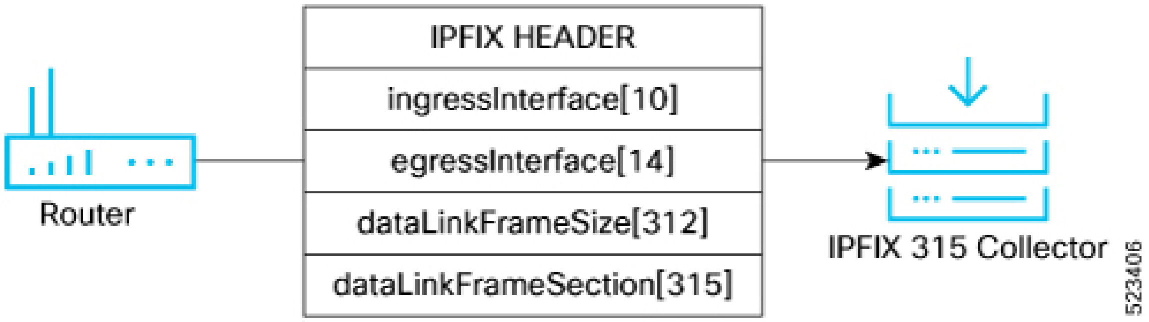
To sample the traffic flow information, configure a sampler-map that specifies the rate at which packets (one out of every 'n' packets) are sampled. Not all packets flowing through a device are exported; only the packets selected based on the sampling rate are exported.

The size of the exported packet depends on the sampled packet size and the location of the L4 header. The exported packet size is determined as follows:

- If the sampled packet size is more than 160 bytes and the L4 header is not obtained within the first 160 bytes, the exported packet size is 160 bytes.
- If the L4 header is within the first 160 bytes, the exported packet size is equal to the length of the sampled packet until the L4 header.
- If the packet size is less than 160 bytes and the L4 header isn’t within the first 160 bytes, the exported packet size is equal to the length of the packet.

This figure *IPFIX 315 Export Packet Format* shows exported packet information.

Figure 3: IPFIX 315 Export Packet Format



NetFlow v9 and NetFlow v10 (IPFIX)

This section helps you understand the NetFlow v9 and NetFlow v10 (IPFIX) based on the following factors:

Table 3: NetFlow v9 and NetFlow v10 (IPFIX)

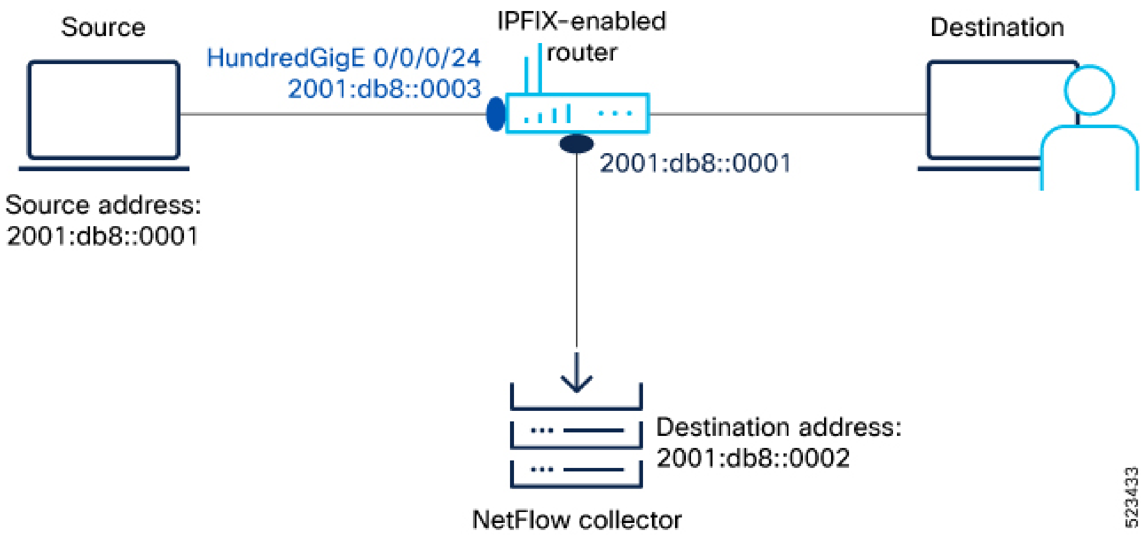
Factor	NetFlow v9	NetFlow v10 (IPFIX)
Transport	Typically uses UDP	Supports both UDP and TCP transport protocols

Factor	NetFlow v9	NetFlow v10 (IPFIX)
Compatibility	Compatible with older NetFlow versions	Backward-compatible with NetFlow v9
Flexibility	Fixed set of predefined fields	More flexible with variable-length information elements and custom-defined attribute
Information Elements	Limited set of predefined fields	Extensive list of predefined elements

Configure IPFIX

Let's consider the following topology to configure IPFIX:

Figure 4: NetFlow IPFIX Configuration



To monitor traffic, you must configure one or more Flow Exporter and associate it to a Flow Monitor and enable IPFIX on the interface either in egress or ingress direction. Optionally, you can configure a Flow Sampler to set the sampling rate for flow samples.

Step 1 First, let's gather the required details to enable IPFIX on a router:

- The IP address of the source : `2001:db8::0001`
- The IP address of the IPFIX Collector (Destination address): `2001:db8::0002`
- Interface of the router where we will enable IPFIX: `HundredGigE 0/0/0/24`
- NetFlow version used to transport the data to the collector: `IPFIX`

Step 2 Configure a Flow Exporter using the flow exporter-map command to specify where and how the packets should be exported.

```
Router(config)# flow exporter-map fem_ipfix
Router(config-fem)# destination 2001:db8::0002
Router(config-fem)# source Loopback 0
Router(config-fem)# transport udp 9001
Router(config-fem)# exit
Router(config-fem)# version ipfix
Router(config-fem-ipfix)# template data timeout 600
Router(config-fem-ipfix)# options interface-table
Router(config-fem-ipfix)# exit
```

Verify the Flow Exporter configuration using the show flow exporter-map command.

```
Router#show exporter-map fem_ipfix
Flow Exporter Map : fem_ipfix
-------------------------------------------------
Id                   : 1
Packet-Length        : 1468
DestinationIpAddr    : 2001:db8::2
VRFName              : default
SourceIfName         :
SourceIpAddr         : 2001:db8::3
DSCP                 : 0
TransportProtocol    : UDP
TransportDestPort    : 1024
Do Not Fragment      : Not Enabled

Export Version: IPFIX
  Common Template Timeout : 1800 seconds
  Options Template Timeout : 1800 seconds
  Data Template Timeout : 1800 seconds
  Interface-Table Export Timeout : 1800 seconds
  Sampler-Table Export Timeout : 0 seconds
  VRF-Table Export Timeout : 0 seconds
```

Step 3 Create a Flow Monitor using the flow monitor-map command to define the type of traffic to be monitored. You can include one or more exporter maps in the monitor map. A single flow monitor map can support up to eight exporters.

The record type specifies the type of packets that are sampled as the packets pass through the router. MPLS, IPv4, and IPv6 packet sampling is supported.

```
Router(config)# flow monitor-map fmm1
Router(config-fmm)# record ipv6
Router(config-fmm)# option filtered
Router(config-fmm)# exporter fem_ipfix
Router(config-fmm)# cache entries 65535
Router(config-fmm)# cache timeout active 1800
Router(config-fmm)# cache timeout inactive 15
Router(config-fmm)# exit
```

Verify the Flow Monitor configuration using the show flow monitor-map command.

```
Router#show flow monitor-map fmm1

Flow Monitor Map : fmm1
-------------------------------------------------
Id:                 1
RecordMapName:      ipv6
ExportMapName:      Expo1
CacheAgingMode:     Normal
CacheMaxEntries:    500000
CacheActiveTout:    60 seconds
CacheInactiveTout:  20 seconds
```

```
CacheUpdateTout:   N/A
CacheRateLimit:    2000
HwCacheExists:     False
HwCacheInactTout:  50
```

Step 4 Configure a Flow Sampler using the sampler-map sampler-map command. .Use the same sampler map configuration on the sub-interfaces and physical interfaces under a port.

```
Router(config)# configure
Router(config)# sampler-map fsm1
Router(config-sm)# random 1 out-of 4000
Router(config)# exit
Router(config)#commit
Router(config)#exit
Router#
```

Verify the sampler map configuration using the show sampler-map show sampler-map command.

```
Router#show sampler-map fsm1

Sampler Map : fsm1
-------------------------------------------------
Id:       1
Mode:     Random (1 out of 4000 Pkts)
Router#
```

Step 5 View the running configuration to verify the configuration that you have configured.

```
Router#show run
Thu Nov  9 06:40:07.296 UTC
Building configuration...

flow exporter-map fem_ipfix
 version ipfix
  options interface-table
  template data timeout 600
 !
 transport udp 9001
 source Loopback0
 destination 2001:db8::2
!
flow monitor-map fmm1
 record ipv6
 option filtered
 exporter fem_ipfix
 cache entries 65535
 cache timeout active 1800
 cache timeout inactive 1
!
sampler-map fsm1
 random 1 out-of 4000
!
interface FourHundredGigE0/0/0/1
 shutdown
!
interface HundredGigE0/0/0/24
 shutdown
 flow ipv4 monitor fmm1 sampler fsm1 ingress
 flow ipv6 monitor fmm-ipv6 sampler fsm1 ingress
!
end
```

```
Router#show run
Thu Nov  9 06:40:07.296 UTC
Building configuration...

flow exporter-map fem_ipfix
 version ipfix
  options interface-table
  template data timeout 600
 !
 transport udp 9001
 source Loopback0
 destination 2001:db8::2
!
flow monitor-map fmm1
 record ipv6
 option filtered
 exporter fem_ipfix
 cache entries 65535
 cache timeout active 1800
 cache timeout inactive 1
!
sampler-map fsm1
 random 1 out-of 4000
!
interface TenGigE 0/0/0/1
 shutdown
 flow ipv4 monitor fmm1 sampler fsm1 ingress
 flow ipv6 monitor fmm-ipv6 sampler fsm1 ingress
!
end
```

Step 6 Apply a Monitor Map and a Sampler Map to a physical interface using the flow command to enable IPFIX on the router.

```
Router(config)#interface HundredGigE 0/0/0/24TenGigE 0/0/0/1
Router(config-if)#flow ipv4 monitor fmm1 sampler fsm1 ingress
Router(config-if)#exit
```

Configure IPFIX 315

This section provides you instructions to enable IPFIX 315 on Cisco IOS XR Software.

Step 1 Enable IPFIX 315 for flow monitoring.

```
Router(config)# hw-module profile netflow ipfix315-enable
```

Step 2 Configure an exporter map with IPFIX as the exporter version using the flow exporter-map command in global configuration mode to specify where and how the packets should be exported.

```
Router(config)# flow exporter-map ipfix_exp
Router(config-fem)# version ipfix
Router(config-fem-ipfix)# template data timeout 10
Router(config-fem)# dscp 63
Router(config-fem)# transport udp 12000
Router(config-fem)# source Loopback 0
Router(config-fem)# destination 100.10.1.159
Router(config-fem)# exit
```

Step 3 Create a flow monitor using the flow monitor-mapcommand in global configuration mode to define the type of traffic to be monitored. You can include one or more exporter maps in the monitor map.

```
Router(config)# flow monitor-map ipfix_mon
Router(config-fmm)# record datalinksectiondump
Router(config-fmm)# exporter ipfix_exp
Router(config-fmm)# cache immediate
Router(config-fmm)# exit
```

Step 4 Configure a sampler map using the sampler-mapcommand to define the rate at which the packet sampling should be performed at the interface where IPFIX is enabled.

```
Router# sampler-map ipfix_sm
Router(config-sm)# random 1 out-of 32000
Router(config)# exit
```

Step 5 Apply a monitor map and a Sampler Map to a physical interface using the flowcommand to enable IPFIX on the router.

```
Router(config)#interface TenGigE0/0/0/5interface TenGigE0/0/0/1
Router(config-if)#ipv4 address 192.1.108.2 255.255.255.0
Router(config-if)#ipv6 address 1:108::2/64
Router(config-if)#flow datalinkframesection monitor ipfix_mon sampler ipfix_sm ingress
Router(config-if)#encapsulation dot1q 139
```

Step 6 Verify the sampled and exported flow statistics using the show flow platform producer statistics location command.

In this show output, you can see that the system has actively received and monitored a total of 630,478 IPFIX 315 packets.

```
Router#show flow platform producer statistics location 0/0/0/5show flow platform producer statistics
 location 0/0/CPU0
Netflow Platform Producer Counters:
IPv4 Ingress Packets: 0
IPv4 Egress Packets: 0
IPv6 Ingress Packets: 0
IPv6 Egress Packets: 0
MPLS Ingress Packets: 0
MPLS Egress Packets: 0
IPFIX315 Ingress Packets: 630478
IPFIX315 Egress Packets: 0
Drops (no space): 0
Drops (other): 0
Unknown Ingress Packets: 0
Unknown Egress Packets: 0
Worker waiting: 2443
```

Step 7 Verify the flow monitor stats statistics using the show flow monitor cache location command.

This example shows that there were 50399 flows added to the cache and exported.

```
Router#show flow platform producer statistics location 0/0/0/5show flow platform producer statistics
 location 0/0/CPU0
Cache summary for Flow Monitor ipfix_mon:
Cache size: 65535
Current entries: 0
Flows added: 50399
Flows not added: 0
Ager Polls: 2784
- Active timeout 0
- Inactive timeout 0
- Immediate 50399
- TCP FIN flag 0
- Emergency aged 0
- Counter wrap aged 0
- Total 50399
Periodic export:
- Counter wrap 0
- TCP FIN flag 0
Flows exported 50399
Matching entries: 0
```