Classifying Network Traffic Using NBAR in Cisco IOS XE Software

Last Updated: December 1, 2011

Network-Based Application Recognition (NBAR) is a classification engine that recognizes and classifies a wide variety of protocols and applications. When NBAR recognizes and classifies a protocol or application, the network can be configured to apply the appropriate quality of service (QoS) for that application or traffic with that protocol.

This module contains an overview of classifying network traffic using NBAR in Cisco IOS XE software.

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Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for Classifying Network Traffic Using NBAR

NBAR does not support the following applications:

- Non-IP traffic.
Multiprotocol Label Switching (MPLS)-labeled packets. NBAR classifies IP packets only. You can, however, use NBAR to classify IP traffic before the traffic is handed over to MPLS. Use the modular QoS CLI (MQC) to set the IP differentiated services code point (DSCP) field on the NBAR-classified packets and make MPLS map the DSCP setting to the MPLS experimental (EXP) setting inside the MPLS header.

- NBAR processing. By design, NBAR processing is temporarily disabled during the In-Service Software Upgrade (ISSU). The following syslog message indicates the restart of the NBAR classification once ISSU is complete: "%NBAR_HA-5-NBAR_INFO: NBAR sync DONE!".
- Multicast packet classification.
- Asymmetric packet classification.
- Packets that originate from or destined to the router running NBAR.

**Note**

In the NBAR context, asymmetric flows are flows in which different packets of the flow go through different routers, for reasons such as load balancing implementation or asymmetric routing, where packets flow through different routes in different directions.

NBAR is not supported on the following logical interfaces:

- Dialer interfaces
- Dynamic tunnels such as Dynamic Virtual Tunnel Interface (DVTI)
- Fast Etherchannels
- IPv6 tunnels that terminate on the router
- Multilink interfaces such as Multilink Point-to-Point Protocol (MLPPP) and Multilink Frame Relay (MLFR)
- MPLS
- Overlay Transport Virtualization (OTV) overlay interfaces
- Port channels
- VRF-Aware Service Infrastructure (VASI)

**Note**

If encapsulation is not supported by NBAR on some of the links, you can apply NBAR on other interfaces of the router to perform input classification. For example, you can configure NBAR on LAN interfaces to classify output traffic on the WAN link.

The following virtual interfaces are supported in Cisco IOS XE Release 3.5S and later releases:

- Generic routing encapsulation (GRE)
- IPsec IPv4 tunnel (including tunneled IPv6) in protocol discovery mode and MQC mode (cryptomap mode is not supported)
- IPsec IPv6 tunnel in protocol discovery mode but not in MQC mode (cryptomap mode is not supported)
- Multipoint GRE/Dynamic Multipoint VPN in protocol discovery mode

**Note**

NBAR requires more CPU power when NBAR is enabled on tunneled interfaces.

If protocol discovery is enabled on both the tunnel interface and the physical interface on which the tunnel interface is configured, the packets that are designated to the tunnel interface are counted on both
interfaces. On the physical interface, the packets are classified and are counted based on the encapsulation. On the tunnel interface, the packets are classified and are counted based on the L7 protocol.

Information About Classifying Network Traffic Using NBAR

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- How to Configure Attribute-Based Protocol Match, page 80

NBAR Functionality

NBAR is a classification engine that recognizes and classifies a wide variety of protocols and applications, including web-based and other difficult-to-classify applications and protocols that use dynamic TCP/UDP port assignments.

When NBAR recognizes and classifies a protocol or application, the network can be configured to apply the appropriate QoS for that application or traffic with that protocol. The QoS is applied using the MQC.

Note

For more information about the MQC, see the "Applying QoS Features Using the MQC" module.

NBAR introduces several classification features that identify applications and protocols from Layer 4 through Layer 7. These classification features are as follows:

- Statically assigned TCP and UDP port numbers.
- Non-TCP and non-UDP IP protocols.
- Dynamically assigned TCP and UDP port numbers. This kind of classification requires stateful inspection, that is, the ability to inspect a protocol across multiple packets during packet classification.
- Subport classification or classification based on deep packet inspection, that is, classification inspecting the packets.
Note
Access Control Lists (ACLs) can also be used for classifying static port protocols. However, NBAR is easier to configure and can provide classification statistics that are not available when ACLs are used.

NBAR includes a Protocol Discovery feature that provides an easy way to discover application protocols that are operating on an interface. For more information about Protocol Discovery, see the "Enabling Protocol Discovery" module.

Note
NBAR classifies network traffic by application or protocol. Network traffic can be classified without using NBAR. For information about classifying network traffic without using NBAR, see the "Classifying Network Traffic" module.

NBAR includes the Protocol Pack feature that provides an easy way to load protocols and helps NBAR recognize additional protocols for network traffic classification. A protocol pack is set a of protocols developed and packed together. A new protocol pack can be loaded on the router to replace the default IOS protocol pack that is already present in the router.

**NBAR Benefits**

Identifying and classifying network traffic is an important first step in implementing QoS. A network administrator can more effectively implement QoS in a networking environment after identifying the number and types of applications and protocols that are running on a network.

NBAR gives network administrators the ability to see the different types of protocols and the amount of traffic generated by each protocol. After NBAR gathers this information, users can organize traffic into classes. These classes can then be used to provide different levels of service for network traffic, thereby allowing better network management by providing the appropriate level of network resources for the network traffic.

**NBAR and Classification of HTTP Traffic**

This section includes information about the following topics:

- Classification of HTTP Traffic by URL Host or MIME, page 4
- Classification of HTTP Traffic Using HTTP Header Fields, page 5
- Combinations of Classification of HTTP Headers and URL Host or MIME Type to Identify HTTP Traffic, page 6

**Classification of HTTP Traffic by URL Host or MIME**

NBAR can classify application traffic by looking beyond the TCP/UDP port numbers of a packet. This is called subport classification. NBAR looks into the TCP/UDP payload itself and classifies packets based on content within the payload such as the transaction identifier, message type, or other similar data.

Classification of HTTP traffic by URL, host, or Multipurpose Internet Mail Extension (MIME) type is an example of subport classification. NBAR classifies HTTP traffic by text within the URL or host fields of a request using regular expression matching. HTTP client request matching in NBAR supports most HTTP request methods such as GET, PUT, HEAD, POST, DELETE, OPTIONS, CONNECT, and TRACE. The NBAR engine then converts the specified match string into a regular expression.
The figure below illustrates a network topology with NBAR in which Router Y is the NBAR-enabled router.

When specifying a URL for classification, include only the portion of the URL that follows the www.hostname.domain in the match statement. For example, for the URL www.cisco.com/latest/whatsnew.html, include only /latest/whatsnew.html with the match statement (for instance, match protocol http url /latest/whatsnew.html).

Host specifications are identical to URL specifications. NBAR performs a regular expression match on the host field contents inside an HTTP packet and classifies all packets from that host. For example, for the URL www.cisco.com/latest/whatsnew.html, include only www.cisco.com.

For MIME type matching, the MIME type can contain any user-specified text string. A list of the Internet Assigned Numbers Authority (IANA) supported MIME types can be found at the following URL: http://www.iana.org/assignments/media-types/

When matching by MIME type, NBAR matches a packet containing the MIME type and all subsequent packets until the next HTTP transaction.

NBAR supports URL and host classification in the presence of persistent HTTP. NBAR does not classify packets that are part of a pipelined request. With pipelined requests, multiple requests are pipelined to the server before previous requests are serviced. Pipelined requests are not supported with subclassification and tunneled protocols that use HTTP as the transport protocol.

The NBAR Extended Inspection for HTTP Traffic feature allows NBAR to scan TCP ports that are not well known and to identify HTTP traffic that traverses these ports. HTTP traffic classification is no longer limited to the well-known and defined TCP ports.

Classification of HTTP Traffic Using HTTP Header Fields

NBAR introduces expanded ability for users to classify HTTP traffic using information in the HTTP header fields.

HTTP works using a client/server model. HTTP clients open connections by sending a request message to an HTTP server. The HTTP server then returns a response message to the HTTP client (this response message is typically the resource requested in the request message from the HTTP client). After delivering the response, the HTTP server closes the connection and the transaction is complete.

HTTP header fields are used to provide information about HTTP request and response messages. HTTP has numerous header fields. For additional information on HTTP headers, see section 14 of RFC 2616: Hypertext Transfer Protocol--HTTP/1.1. This RFC can be found at the following URL:
http://www.w3.org/Protocols/rfc2616/rfc2616-sec14.html

NBAR is able to classify the following HTTP header fields:

- For request messages (client to server), the following HTTP header fields can be identified using NBAR:
• User-Agent
• Referer
• From

• For response messages (server to client), the following HTTP header fields can be identified using NBAR:
  ◦ Server
  ◦ Location
  ◦ Content-Base
  ◦ Content-Encoding

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**Note**

In Cisco IOS XE Release 3.1S and later releases, up to 56 parameters or subclassifications per protocol per router can be specified with the `match protocol http` command. These parameters or subclassifications can be a combination of any of the available match choices, such as host matches, MIME matches, server matches, and URL matches. For other Cisco IOS XE releases and platforms, the maximum is 24 parameters or subclassifications per protocol per router.

Within NBAR, the `match protocol http c-header-field` command is used to specify that NBAR identify request messages (the "c" in the `c-header-field` portion of the command is for client). The `match protocol http s-header-field` command is used to specify response messages (the "s" in the `s-header-field` portion of the command is for server).

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**Note**

In Cisco IOS XE Release 3.1S and later releases, the `c-header-field` and `s-header-field` keywords and associated arguments in the `match protocol http` command are not available. The same functionality is achieved by using the individual keywords and arguments. For more information, see the syntax of the `match protocol http` command in the Cisco IOS Quality of Service Solutions Command Reference.

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**Note**

The `c-header-field` performs subclassifications based on a single value in the user-agent, the referrer, or from header field values. The `s-header-field` performs subclassifications based on a single value in the server, location, content-encoding, or content-base header field values. These header field values are not related to each other. Hence, the `c-header` and `s-header` fields are replaced by the user-agent, referrer, from, server, content-base, content-encoding, and location parameters as per the intent and need of HTTP subclassification.

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**Combinations of Classification of HTTP Headers and URL Host or MIME Type to Identify HTTP Traffic**

Note that combinations of URL, Host, MIME type, and HTTP headers can be used during NBAR configuration. These combinations provide customers with more flexibility to classify specific HTTP traffic based on their network requirements.

**NBAR and Classification of Citrix ICA Traffic**

NBAR can classify Citrix Independent Computing Architecture (ICA) traffic and perform subport classification of Citrix traffic based on the published application name or ICA tag number.
This section includes information about the following topics:

- Classification of Citrix ICA Traffic by Published Application Name, page 7
- Classification of Citrix ICA Traffic by ICA Tag Number, page 8

## Classification of Citrix ICA Traffic by Published Application Name

NBAR can monitor Citrix ICA client requests for a published application destined to a Citrix ICA Master browser. After the client requests the published application, the Citrix ICA Master browser directs the client to the server with the most available memory. The Citrix ICA client then connects to this Citrix ICA server for the application.

**Note**

For Citrix to monitor and classify traffic by the published application name, Server Browser Mode on the Master browser must be used.

In Server Browser Mode, NBAR statefully tracks and monitors traffic and performs a regular expression search on the packet contents for the published application name specified by the `match protocol citrix` command. The published application name is specified by using the `app` keyword and the `application-name-string` argument of the `match protocol citrix` command. For more information about the `match protocol citrix` command, see the Cisco IOS Quality of Service Solutions Command Reference.

The Citrix ICA session triggered to carry the specified application is cached, and traffic is classified appropriately for the published application name.

- Citrix ICA Client Modes, page 7

## Citrix ICA Client Modes

Citrix ICA clients can be configured in various modes. NBAR cannot distinguish among Citrix applications in all modes of operation. Therefore, network administrators might need to collaborate with Citrix administrators to ensure that NBAR properly classifies Citrix traffic.

A Citrix administrator can configure Citrix to publish Citrix applications individually or as the entire desktop. In the Published Desktop mode of operation, all applications within the published desktop of a client use the same TCP session. Therefore, differentiation among applications is impossible, and NBAR can be used to classify Citrix applications only as aggregates (by looking at port 1494).

The Published Application mode for Citrix ICA clients is recommended when you use NBAR. In Published Application mode, a Citrix administrator can configure a Citrix client in either seamless or nonseamless (windows) modes of operation. In nonseamless mode, each Citrix application uses a separate TCP connection, and NBAR can be used to provide interapplication differentiation based on the name of the published application.

Seamless mode clients can operate in one of two submodes: session sharing or nonsession sharing. In seamless session sharing mode, all clients share the same TCP connection, and NBAR cannot differentiate among applications. Seamless sharing mode is enabled by default in some software releases. In seamless nonsession sharing mode, each application for each particular client uses a separate TCP connection. NBAR can provide interapplication differentiation in seamless nonsession sharing mode.

**Note**

NBAR operates properly in Citrix ICA secure mode. Pipelined Citrix ICA client requests are not supported.
Classification of Citrix ICA Traffic by ICA Tag Number

Citrix uses one TCP session each time an application is opened. In the TCP session, a variety of Citrix traffic may be intermingled in the same session. For example, print traffic may be intermingled with interactive traffic, causing interruption and delay for a particular application. Most users likely would prefer that printing be handled as a background process and that printing not interfere with the processing of higher-priority traffic.

To accommodate this preference, the Citrix ICA protocol includes the ability to identify Citrix ICA traffic based on the ICA tag number of the packet. The ability to identify, tag, and prioritize Citrix ICA traffic is referred to as ICA Priority Packet Tagging. With ICA Priority Packet Tagging, Citrix ICA traffic is categorized as high, medium, low, and background, depending on the ICA tag of the packet.

When ICA traffic priority tag numbers are used, and the priority of the traffic is determined, QoS features can be implemented to determine how the traffic will be handled. For example, QoS traffic policing can be configured to transmit or drop packets with a specific priority.

- Citrix ICA Packet Tagging, page 8

Citrix ICA Packet Tagging

The Citrix ICA tag is included in the first two bytes of the Citrix ICA packet, after the initial negotiations are completed between the Citrix client and server. These bytes are not compressed or encrypted.

The first two bytes of the packet (byte 1 and byte 2) contain the byte count and the ICA priority tag number. Byte 1 contains the low-order byte count, and the first two bits of byte 2 contain the priority tags. The other six bits contain the high-order byte count.

The ICA priority tag value can be a number from 0 to 3. The number indicates the packet priority, with 0 being the highest priority and 3 being the lowest priority.

To prioritize Citrix traffic by the ICA tag number of the packet, you must specify the tag number using the ica-tag keyword and the ica-tag-value argument of the match protocol citrix command. For more information about the match protocol citrix command, see the Cisco IOS Quality of Service Solutions Command Reference.

The table below contains information about different Citrix traffic and the respective priority tags.

<table>
<thead>
<tr>
<th>Priority</th>
<th>ICA Bits (decimal)</th>
<th>Sample Virtual Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0</td>
<td>Video, mouse, and keyboard screen updates</td>
</tr>
<tr>
<td>Medium</td>
<td>1</td>
<td>Program neighborhood, clipboard, audio mapping, and license management</td>
</tr>
<tr>
<td>Low</td>
<td>2</td>
<td>Client common equipment (COM) port mapping and client drive mapping</td>
</tr>
</tbody>
</table>
NBAR and RTP Payload Type Classification

Real-time Transport Protocol (RTP) is a packet format for multimedia data streams. It can be used for media-on-demand and for interactive services such as Internet telephony. RTP consists of a data part and a control part. The control part is called Real-Time Transport Control Protocol (RTCP). RTCP is a separate protocol that is supported by NBAR. It is important to note that the NBAR RTP Payload Type Classification feature does not identify RTCP packets and that RTCP packets run on odd-numbered ports and RTP packets run on even-numbered ports.

The data part of RTP is a thin protocol that provides support for applications with real-time properties such as continuous media (audio and video), which includes timing reconstruction, loss detection, and security and content identification. RTP is discussed in RFC 1889 (A Transport Protocol for Real-Time Applications) and RFC 1890 (RTP Profile for Audio and Video Conferences with Minimal Control).

The RTP payload type is the data transported by RTP in a packet, for example audio samples or compressed video data.

NBAR RTP Payload Type Classification feature not only allows real-time audio and video traffic to be statefully identified, but can also differentiate on the basis of audio and video codecs to provide more granular QoS. The RTP Payload Type Classification feature, therefore, looks deep into the RTP header to classify RTP packets.

For more information on the classification of RTP with NBAR, see http://www.cisco.com/en/US/products/ps6616/products_white_paper09186a0080110040.shtml

NBAR and Classification of Custom Protocols and Applications

NBAR supports the use of custom protocols to identify custom applications. Custom protocols support static port-based protocols and applications that NBAR does not currently support. You can add to the set of protocols and application types that NBAR recognizes by creating custom protocols.

Custom protocols extend the capability of NBAR Protocol Discovery to classify and monitor additional static port applications and allow NBAR to classify nonsupported static port traffic.

Once the custom protocols are defined, you can then use them with the help of NBAR Protocol Discovery and the MQC to classify the traffic.

With NBAR supporting the use of custom protocols, NBAR can map static TCP and UDP port numbers to the custom protocols.

There are two types of custom protocols:

- Predefined custom protocols
- User-defined custom protocols

NBAR includes the following features related to predefined custom protocols and applications:

- Custom protocols have to be named custom-xx, with xx being a number.
- Ten custom applications can be assigned using NBAR, and each custom application can have up to 16 TCP and 16 UDP ports each mapped to an individual custom protocol. The real-time statistics of each custom protocol can be monitored using Protocol Discovery.
When you create a custom protocol after creating a variable, you can use the `match protocol` command to classify traffic on the basis of a specific value in the custom protocol.

NBAR includes the following features related to user-defined custom protocols and applications:

- The ability to inspect the payload for certain matching string patterns at a specific offset.
- The ability to allow users to define the names of their custom protocol applications. The user-named protocol can then be used by Protocol Discovery, the Protocol Discovery MIB, the `match protocol` command, and the `ip nbar port-map` command as an NBAR-supported protocol.
- The ability of NBAR to inspect custom protocols specified by traffic direction (that is, traffic heading toward a source or destination rather than traffic in both directions), if desired by the user.
- CLI support that allows a user configuring a custom application to specify a range of ports rather than to specify each port individually.
- The `variable` keyword, the `field-name` argument, and the `field-length` argument were added to the `ip nbar custom` command.

This additional keyword and two additional arguments allow for creation of more than one custom protocol based on the same port numbers.

**Note**
Defining a user-defined custom protocol restarts the NBAR feature, whereas defining predefined custom protocol does not restart the NBAR feature.

## NBAR and Classification with Dynamic PDLMs

Dynamic Packet Description Language Modules (PDLM) allow new protocol support or enhance existing protocol support for NBAR without the requirement of a Cisco IOS XE release upgrade and router reload. If the support is for enhancing protocols for NBAR, then the module version of the PDLM should be greater than the existing version of the PDLM. Subsequent Cisco IOS XE releases incorporate support for these new protocols.

**Note**
PDLMs must be loaded on both Route Processors (RPs) when using the ASR 1006 redundant hardware setup.

Dynamic PDLMs are platform-specific and have Software Family Identifier (SFI) embedded in them. Dynamic PDLMs of other platforms cannot be loaded on Cisco ASR 1000 Series Routers.

## NBAR and Classification of Peer-to-Peer File-Sharing Applications

The following applications are the most common peer-to-peer file-sharing applications supported by NBAR:

- BitTorrent
- DirectConnect
- eDonkey
- eMule
- FastTrack
- KazaA (and KazaA Lite and KazaA Lite Resurrection)
- Win MX
- POCO
In Cisco IOS XE Release 2.5 the DirectConnect and the eDonkey P2P protocols support the following subclassifications:

- eDonkey supports the following subclassification options:
  - file-transfer
  - search-file-name
  - text-chat
- KazaA, FastTrack, and Gnutella support the file-transfer subclassification.

The Gnutella file sharing became classifiable using NBAR in Cisco IOS XE Release 2.5. Applications that use the Gnutella protocol are Bearshare, Gnewtellium, Gnucleus, Gтик-Gnutella, Limewire, Mutella, Phex, Qtella, Swapper, and Xolo. The traffic from the applications that use the Gnutella protocol will be classified as Gnutella and not as the respective application.

**NBAR Scalability**

- [Interface Scalability, page 11](#)
- [Flow Scalability, page 11](#)
- [Flow Table Sizing, page 12](#)

**Interface Scalability**

In Cisco IOS XE Release 2.4 and earlier releases, there is no limit on the number of interfaces on which protocol discovery can be enabled.

The table below provides the details of the protocol discovery supported interface and the release number.

<table>
<thead>
<tr>
<th>Release</th>
<th>Number of Interfaces Supported with Protocol Discovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS XE Release 2.5</td>
<td>128</td>
</tr>
<tr>
<td>Cisco IOS XE Release 2.6</td>
<td>256</td>
</tr>
<tr>
<td>Cisco IOS XE Release 2.7</td>
<td>32</td>
</tr>
<tr>
<td>Cisco IOS XE Release 3.2S and later releases</td>
<td>32</td>
</tr>
</tbody>
</table>

**Flow Scalability**

In Cisco IOS XE Release 2.5, the following flows are supported:

- A maximum of 250K bidirectional flows on Edge Services Processor (ESP)10 and ESP20 hardware.
- A maximum of 125K bidirectional flows on ESP5.

If this limit is exceeded or there is a flow memory constraint, new flows will be classified as Unknown.

In Cisco IOS XE Release 3.1, the following flows are supported:

- A maximum of 125K bidirectional flows on Forwarding Processor (FP)5 platform.
- A maximum of 250K bidirectional flows on FP10, FP20, and FP40 platform.
If this limit is exceeded or there is a flow memory constraint, new flows will be classified as Unknown.

In Cisco IOS XE Release 3.2, the following flows are supported:

- A maximum of 500K bidirectional flows on FP5/1 Rack Units (RU) platform.
- A maximum of 1M bidirectional flows on 10/10/40 platform.

If this limit is exceeded or there is a flow memory constraint, new flows will be classified as Unknown.

In Cisco IOS XE Release 3.3S, the number of bidirectional flows and the platforms supported are the same as in Cisco IOS XE Release 3.2. A new method to reduce the number of active flows based on quick aging is introduced.

Quick aging occurs under the following conditions:

- TCP flows that do not reach the established state.
- UDP flows with fewer than five packets that are not classified within the specified quick aging timeout.
- Flows that are not classified within the specified quick aging timeout.

The quick aging method reduces the number of flows required for NBAR operation up to three times or more depending on the network behavior.

In Cisco IOS XE Release 3.4S, the following flows are supported:

- A default flow capacity of 500K bidirectional flows on ESP5/1 Rack Units (RU) platform.
- A default flow capacity of 1M bidirectional flows on 10/20/40 platform.

Flow Table Sizing

The `ip nbar resources flow max-sessions` command provides the option to override the default maximum flow sessions to be allowed in a flow table. The performance of the router with the NBAR feature depends on the memory size and the number of flows configured for the flow table. The flexibility to change the number of flows helps in increasing the performance of the system depending on the capacity of the router.

To verify the NBAR flow statistics, use the `show ip nbar resources flow` command.

The following table provides the details of the platform and the flow size limits.

<table>
<thead>
<tr>
<th>Platform</th>
<th>Maximum number of flows</th>
<th>Default number of flows</th>
<th>Memory upper limit [MB] (70% of platform memory)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESP5/1RU</td>
<td>750,000</td>
<td>500,000</td>
<td>179</td>
</tr>
<tr>
<td>ESP10</td>
<td>1,650,000</td>
<td>1,000,000</td>
<td>358</td>
</tr>
<tr>
<td>ESP20</td>
<td>3,500,000</td>
<td>1,000,000</td>
<td>716</td>
</tr>
<tr>
<td>ESP40</td>
<td>3,500,000</td>
<td>1,000,000</td>
<td>716</td>
</tr>
</tbody>
</table>

The recommended number of flow configuration on all the platforms is 50,000 flows.

**Note**

The flow size cannot be increased if the overall system memory usage is already 90%.
**NBAR-Supported Protocols**

The *match protocol*(NBAR) command is used to classify traffic on the basis of protocols supported by NBAR. NBAR can classify the following types of protocols:

- Non-UDP and non-TCP IP protocols
- TCP and UDP protocols that use statically assigned port numbers
- TCP and UDP protocols that use statically assigned port numbers, but still require stateful inspection.
- TCP and UDP protocols that dynamically assign port numbers and therefore require stateful inspection.

The table below lists the NBAR-supported protocols available in Cisco IOS XE software, sorted by category. The table also provides information about the protocol type, the well-known port numbers (if applicable), the syntax for entering the protocol in NBAR, and the Cisco IOS XE software release in which the protocol was initially supported. This table is updated when a protocol becomes supported in Cisco IOS XE software.

<table>
<thead>
<tr>
<th>Category</th>
<th>Protocol</th>
<th>Type</th>
<th>WKP/IP Protocol</th>
<th>Description</th>
<th>Syntax</th>
<th>Cisco IOS XE Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise</td>
<td>Novadigm</td>
<td>TCP/UDP</td>
<td>3460-3465</td>
<td>Novadigm Enterprise Desktop Manager (EDM)</td>
<td>novadigm</td>
<td>Cisco IOS XE Release 2.3</td>
</tr>
<tr>
<td>Applications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citrix (ICA, CGP, IMA, SB)</td>
<td></td>
<td>TCP/UDP</td>
<td>TCP: 1494, 2512, 2513, 2598, UDP: 1604</td>
<td>Citrix ICA traffic</td>
<td>citrix citrix app citrix ica-tag</td>
<td>Cisco IOS XE Release 2.5</td>
</tr>
<tr>
<td>Oracle</td>
<td></td>
<td>TCP</td>
<td>1525</td>
<td>Oracle</td>
<td>ora-srv</td>
<td>Cisco IOS XE Release 2.3</td>
</tr>
<tr>
<td>PCAnywhere</td>
<td></td>
<td>TCP/UDP</td>
<td>TCP: 5631, 65301, UDP: 22, 5632</td>
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1 For Cisco IOS XE Release 2.5, Cisco supports Exchange 03 and 07 only. MS client access is recognized, but web client access is not recognized.
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2 Cisco software supports Skype 1.0, 2.5, 3.0, and 4.0. In Skype 4.0, the classification may not be complete.

3 BitTorrent classifies only unencrypted traffic.

4 eDonkey classifies only unencrypted traffic.
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NBAR-Supported Protocols

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**NBAR-Supported Protocols**

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NBAR-Supported Protocols

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Cisco IOS XE Release 3.2S
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</table>
### NBAR Protocol Discovery

NBAR includes a feature called Protocol Discovery. Protocol discovery provides an easy way to discover protocol packets passing through an interface. For more information about Protocol Discovery, see the "Enabling Protocol Discovery" module.

### NBAR Protocol Discovery MIB

The NBAR Protocol Discovery MIB expands the capabilities of NBAR Protocol Discovery by providing the following new functionality through Simple Network Management Protocol (SNMP):

- Enable or disable Protocol Discovery per interface.
- Display Protocol Discovery statistics.
- Configure and display multiple top-n tables that list protocols by bandwidth usage.
- Configure thresholds based on traffic of particular NBAR-supported protocols or applications that report breaches and send notifications when these thresholds are exceeded.

For more information about the NBAR Protocol Discovery MIB, see the "Network-Based Application Recognition Protocol Discovery Management Information Base" module.

### NBAR Configuration Processes

You can configure NBAR in the following two ways:

- Configuring NBAR using the MQC
- Enabling Protocol Discovery

For more information about the NBAR configuration, see the Cisco IOS XE QoS Configuration Guide.

### Restarting NBAR

NBAR is restarted under the following circumstances.

- Custom protocol addition via CLI
- PDLM load
- RP switchover
- FP switchover
- Protocol pack installation
- Link-age change

---

### Table: NBAR Protocol Discovery

<table>
<thead>
<tr>
<th>Category</th>
<th>Protocol</th>
<th>Type</th>
<th>WKP/IP Protocol</th>
<th>Description</th>
<th>Syntax</th>
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<td></td>
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</tbody>
</table>

---

Flow Table Sizing
Restart involves deactivating and reactivating NBAR. During this time, all packets are classified as ‘Unknown’ by NBAR. Once NBAR is reactivated, classification is activated.

**Note**
Protocol Discovery statistics will be lost with RP Switchover.

**NBAR Protocol Pack**

The NBAR Protocol Pack provides an easy way to update protocols supported by NBAR without replacing the base IOS image that is already present in the router. A protocol pack is a set of protocols developed and packed together. For more information about the NBAR Protocol Pack, see the NBAR Protocol Pack feature document in Cisco IOS XE QoS Configuration Guide.

**NBAR and Multipacket Classification**

In Cisco IOS XE Release 3.3S, NBAR provides the ability to search large number of multipacket signatures simultaneously. This new technique is supported for many of the new protocols in Cisco IOS XE Release 3.3S and later releases. This technique also provides improved performance and accuracy for other protocols. Along with the support for new signatures, the multipacket classification capabilities change NBAR behavior in the following ways:

1. NBAR classification requires any number of payload packets between 1 and 15 packets in a flow depending on the protocol. Retransmitted packets are not counted in this process of calculation.
2. NBAR will not classify flows without any payload packets or any TCP payload packet with a wrong sequence number even if there are 15 payload packets for classification.
3. TCP retransmitted packets are not counted as valid packets for classification in the Multipacket Engine module. These type of packets can delay the classification until a sufficient number of valid payload packets are accumulated.
4. Payload packets with only static signatures in NBAR are classified after the single-packet and multipacket protocols are processed and failed. Therefore, a maximum of 15 payload packets can be classified as unknown until the final (static) classification decision is taken.
5. Due to these restrictions, custom protocols can be used to force the classification of the first packet, ignoring the existence of payload or correct sequence numbers in the port-based classification.

**NBAR on VRF Interfaces**

In Cisco IOS XE Release 3.3S and later releases, the NBAR IPv4 and IPv6 classification on VRF interfaces is supported.

**Note**
Classification for Citrix protocol with "app" subclassification is not guaranteed on VRF interfaces when NBAR is enabled on VRF interfaces.

**NBAR and IPv6**

In Cisco IOS XE Release 3.3S and later releases, the following types of classification are supported:

- NBAR provides static port-based classification and IP protocol-based classification for IPv6 packets.
- NBAR supports IPv6 classification in protocol discovery mode, but not in MQC mode.
NBAR always reads the next header field in the fixed IPv6 header to determine the transport layer protocol used by the packet’s payload for IPv6 packets. If an IPv6 packet contains one or more extension headers, NBAR will not skip to the last IPv6 extension header to read the actual protocol type instead, NBAR classifies the packet as an IPv6 extension header packet.

- NBAR Support for IPv6 from Cisco IOS XE Release 3.5S and Later Releases, page 79

**NBAR Support for IPv6 from Cisco IOS XE Release 3.5S and Later Releases**

In Cisco IOS XE Release 3.5S and later releases, NBAR supports the following types of classification:

- Native IPv6 classification.
- Classification of IPv6 traffic flows inside tunneled IPv6 over IPv4 and teredo.
- IPv6 classification in protocol discovery mode and in MQC mode.
- Static and stateful classification.

NBAR supports IPv6 in IPv4 (6to4, 6rd, and ISATAP), and teredo tunneled classification. The `ip nbar classification tunneled-traffic` command is used to enable the tunneled traffic classification. When the tunneled traffic classification is enabled, NBAR performs an application classification of the IPv6 packets carried inside IPv4 traffic. If the `ip nbar classification tunneled-traffic` command is disabled, the tunneled IPv6 packets are handled as IPv4 packets.

NBAR supports the capture of IPv6 fields and allows the creation of IPv6 traffic-based flow monitors. When you enable the `ipv6 flow monitor` command, the monitor is bound to the interface, NBAR classification is applied to the IPv6 traffic type, and Flexible NetFlow captures the application IDs in the IPv6 traffic flow.

**NBAR Categorization and Attributes**

The NBAR Categorization and Attributes feature provides the mechanism to match protocols or applications based on certain attributes. As there are many protocols and applications, categorizing them into different groups will help with reporting as well as performing group actions, such as applying QoS policies, on them. Attributes are statically assigned to each protocol or application, and they are not dependent on the traffic. The following attributes are available to configure the match criteria using the `match protocol attribute` command. They are:

- **application-group**: The `application-group` attribute allows the configuration of applications grouped together based on the same networking application as the match criteria. For example, Yahoo-Messenger, Yahoo-VoIP-messenger, and Yahoo-VoIP-over-SIP are grouped together under the yahoo-messenger-group.

- **category**: The `category` attribute allows you to configure applications that are grouped together based on the first level of categorization for each protocol as the match criteria. Similar applications are grouped together under one category. For example, the email category contains all email applications such as, Internet Mail Access Protocol (IMAP), Simple Mail Transfer Protocol (SMTP), Lotus Notes, and so forth.

- **sub-category**: The `sub-category` attribute provides the option to configure applications grouped together based on the second level of categorization for each protocol as the match criteria. For example, clearcase, dbase, rda, mysql and other database applications are grouped under the database group.

- **encrypted**: The `encrypted` attribute provides the option to configure applications grouped together based on whether the protocol is an encrypted protocol or not as the match criteria. Applications are grouped together based on whether they are encrypted and non-encrypted status of the applications.
Protocols for which the NBAR does not provide any value are categorized under the unassigned encrypted group.

- **tunnel**: The tunnel attribute provides the option to configure protocols based on whether or not a protocol tunnels the traffic of other protocols. Protocols for which the NBAR does not provide any value are categorized under the unassigned tunnel group. For example, Layer 2 Tunneling Protocols (L2TP).

**Note**
Attribute-based protocol match configuration does not impact the granularity of classification either in reporting or in the protocol discovery information.

### How to Configure Attribute-Based Protocol Match

- Configuring Attribute-Based Protocol Match, page 80

#### Configuring Attribute-Based Protocol Match

Perform this task to configure the attribute-based protocol match.

**SUMMARY STEPS**

1. enable
2. configure terminal
3. class-map [type] [match-all | match-any] class-map-name
4. match protocol attribute application-group application-group [application-name]
5. match protocol attribute category application-category [application-name]
6. match protocol attribute encrypted {encrypted-no | encrypted-unassigned | encrypted-yes} [application-name]
7. match protocol attribute sub-category application-category [application-name]
8. match protocol attribute tunnel {tunnel-no | tunnel-unassigned | tunnel-yes} [application-name]
9. end

**DETAILED STEPS**

**Step 1**  enable

**Example:**
Router> enable
Enables privileged EXEC mode.
- Enter your password if prompted.

**Step 2**  configure terminal
Example:
Router# configure terminal
Enters global configuration mode.

Step 3  
**class-map [type] [match-all | match-any] class-map-name**

Example:
Router(config)# class-map cmap1
Creates a class map to be used for matching packets to a specified class and enters class-map configuration mode.

- Enter the name of the class map.

Step 4  
**match protocol attribute application-group application-group [application-name]**

Example:
Router(config-cmap)# match protocol attribute application-group skype
Configures the specified application group as the match criterion.

- (Optional) Use the **application-name** attribute to configure the application and not the application group as the match criterion. The configuration is saved as **match protocol application-name** instead of **match protocol attribute application-group application-group**.

Step 5  
**match protocol attribute category application-category [application-name]**

Example:
Router(config-cmap)# match protocol attribute category email
Configures the specified category as the match criteria attribute.

- (Optional) Use the **application-name** attribute to configure a specific application, and not the application category, as the match criterion. The configuration is saved as **match protocol application-name** instead of **match protocol attribute category application-category**.

Step 6  
**match protocol attribute encrypted {encrypted-no | encrypted-unassigned | encrypted-yes} [application-name]**

Example:
Router(config-cmap)# match protocol attribute encrypted encrypted-yes
Configures the specified encryption status as the match criterion.

- Enter the **encrypted-yes** keyword to match all encrypted applications.

  or

- Enter the **encrypted-no** keyword to match all nonencrypted applications.

  or

- Enter the **encrypted-unassigned** keyword to match all applications that are not assigned any encryption status.

  - (Optional) Use the **application-name** attribute to configure application within the specified encrypted status as the match criterion. The configuration is saved as **match protocol application-name** instead of **match protocol attribute encrypted {encrypted-no | encrypted-unassigned | encrypted-yes}**.

Step 7  
**match protocol attribute sub-category application-category [application-name]**
**Example:**

Router(config-cmap)# match protocol attribute sub-category client-server

Configures the specified sub-category as the match criteria attribute.

- (Optional) Use the `application-name` attribute to configure a specific application, and not the sub-category, as the match criterion. The configuration is saved as `match protocol application-name` instead of `match protocol attribute sub-category application-category`.

**Step 8**

`match protocol attribute tunnel {tunnel-no | tunnel-unassigned | tunnel-yes} [application-name]`

**Example:**

Router(config-cmap)# match protocol attribute tunnel tunnel-yes

Configures the specified encryption status as the match criterion.

- Enter the `tunnel-no` keyword to specify the applications that are not tunneled as the match criterion.
  
  or
  
  Enter the `tunnel-unassigned` keyword to specify the applications that are unassigned for tunneling as the match criterion.
  
  or
  
  Enter the `tunnel-yes` keyword to specify the tunneled applications as the match criterion.

- (Optional) Use the `application-name` attribute to configure a specific application within the specified tunneling status as the match criterion. The configuration is saved as `match protocol application-name` instead of `match protocol attribute tunnel {tunnel-no | tunnel-unassigned | tunnel-yes}`.

**Step 9**

`end`

**Example:**

Router(config-cmap)# end

Exits class-map configuration mode and returns to privileged EXEC mode.

---

**Configuration Examples for Classifying Network Traffic Using NBAR in Cisco IOS XE Software**

- Example: Classification of HTTP Traffic Using the HTTP Header Fields, page 83
- Example: Combinations of Classification of HTTP Headers and URL Host or MIME Type to Identify HTTP Traffic, page 83
- Example: NBAR and Classification of Custom Protocols and Applications, page 84
- Example: NBAR and Classification of Peer-to-Peer File-Sharing Applications, page 84
- Example: Configuring Attribute-Based Protocol Match, page 85
Example: Classification of HTTP Traffic Using the HTTP Header Fields

In the following example, any request message that contains "somebody@cisco.com" in the User-Agent, Referer, or From field will be classified by NBAR. Typically, a term with a format similar to "somebody@cisco.com" would be found in the From header field of the HTTP request message.

class-map match-all class1
  match protocol http from "somebody@cisco.com"

In the following example, any request message that contains "http://www.cisco.com/routers" in the User-Agent, Referer, or From field will be classified by NBAR. Typically, a term with a format similar to "http://www.cisco.com/routers" would be found in the Referer header field of the HTTP request message.

class-map match-all class2
  match protocol http referer "http://www.cisco.com/routers"

In the following example, any request message that contains "CERN-LineMode/2.15" in the User-Agent, Referer, or From field will be classified by NBAR. Typically, a term with a format similar to "CERN-LineMode/2.15" would be found in the User-Agent header field of the HTTP request message.

class-map match-all class3
  match protocol http user-agent "CERN-LineMode/2.15"

In the following example, any response message that contains "CERN/3.0" in the Content-Base (if available), Content-Encoding, Location, or Server header field will be classified by NBAR. Typically, a term with a format similar to "CERN/3.0" would be found in the Server header field of the response message.

class-map match-all class4
  match protocol http server "CERN/3.0"

In the following example, any response message that contains "http://www.cisco.com/routers" in the Content-Base (if available), Content-Encoding, Location, or Server header field will be classified by NBAR. Typically, a term with a format similar to "http://www.cisco.com/routers" would be found in the Content-Base (if available) or Location header field of the response message.

class-map match-all class5
  match protocol http location "http://www.cisco.com/routers"

In the following example, any response message that contains "gzip" in the Content-Base (if available), Content-Encoding, Location, or Server header field will be classified by NBAR. Typically, the term "gzip" would be found in the Content-Encoding header field of the response message.

class-map match-all class6
  match protocol http content-encoding "gzip"

Example: Combinations of Classification of HTTP Headers and URL Host or MIME Type to Identify HTTP Traffic

In the following example, HTTP header fields are combined with a URL to classify traffic. In this example, traffic with a User-Agent field of "CERN-LineMode/3.0" and a Server field of "CERN/3.0," along with URL "www.cisco.com/routers," will be classified using NBAR:

class-map match-all c-http
  match protocol http user-agent "CERN-LineMode/3.0"
Example: NBAR and Classification of Custom Protocols and Applications

In the following example, the custom protocol app-sales1 will identify TCP packets that have a source port of 4567 and that contain the term "SALES" in the fifth byte of the payload:

```
Router(config)# ip nbar custom app-sales1 5 ascii SALES source tcp 4567
```

In the following example, the custom protocol virus-home will identify UDP packets that have a destination port of 3000 and that contain "0x56" in the seventh byte of the payload:

```
Router(config)# ip nbar custom virus-home 7 hex 0x56 destination udp 3000
```

In the following example, the custom protocol media_new will identify TCP packets that have a destination or source port of 4500 and that have a value of 90 at the sixth byte of the payload:

```
Router(config)# ip nbar custom media_new 6 decimal 90 tcp 4500
```

In the following example, the custom protocol msn1 will look for TCP packets that have a destination or source port of 6700:

```
Router(config)# ip nbar custom msn1 tcp 6700
```

In the following example, the custom protocol mail_x will look for UDP packets that have a destination port of 8202:

```
Router(config)# ip nbar custom mail_x destination udp 8202
```

In the following example, the custom protocol mail_y will look for UDP packets that have destination ports between 3000 and 4000 inclusive:

```
Router(config)# ip nbar custom mail_y destination udp range 3000 4000
```

Example: NBAR and Classification of Peer-to-Peer File-Sharing Applications

The `match protocol gnutella file-transfer regular-expression` and `match protocol fasttrack file-transfer regular-expression` commands are used to enable Gnutella and FastTrack classification in a traffic class. The `file-transfer` keyword indicates that a regular expression variable will be used to identify specific Gnutella or FastTrack traffic. The `regular-expression` variable can be expressed as "***" to indicate that all FastTrack or Gnutella traffic be classified by a traffic class.

In the following example, all FastTrack traffic is classified into class map nbar:

```
class-map match-all nbar
  match protocol fasttrack file-transfer "***
```

Similarly, all Gnutella traffic is classified into class map nbar in the following example:

```
class-map match-all nbar
  match protocol gnutella file-transfer "***
```

Wildcard characters in a regular expression can also be used to identify specified Gnutella and FastTrack traffic. These regular expression matches can be used to match on the basis of a filename extension or a particular string in a filename.
In the following example, all Gnutella files that have the .mpeg extension will be classified into class-map nbar:

```text
class-map match-all nbar
match protocol gnutella file-transfer "*.mpeg"
```

In the following example, only Gnutella traffic that contains the characters "cisco" is classified:

```text
class-map match-all nbar
match protocol gnutella file-transfer "*cisco*"
```

The same examples can be used for FastTrack traffic:

```text
class-map match-all nbar
match protocol fasttrack file-transfer "*.mpeg"
```
or

```text
class-map match-all nbar
match protocol fasttrack file-transfer "*cisco*"
```

### Example: Configuring Attribute-Based Protocol Match

The **match protocol attributes** command is used to configure different attributes as the match criteria for application recognition.

In the following example, the email-related applications category is configured as the match criterion:

```text
Router# configure terminal
Router(config)# class-map mygroup
Router(config-cmap)# match protocol attribute category email
```

In the following example, skype-group applications are configured as the match criterion:

```text
Router# configure terminal
Router(config)# class-map apps
Router(config-cmap)# match protocol attribute application-group skype-group
```

In the following example, encrypted applications are configured as the match criterion:

```text
Router# configure terminal
Router(config)# class-map my-class
Router(config-cmap)# match protocol encrypted encrypted-yes
```

In the following example, Client-server subcategory applications are configured as the match criterion:

```text
Router# configure terminal
Router(config)# class-map newmap
Router(config-cmap)# match protocol attribute sub-category client-server
```

In the following example, tunneled applications are configured as the match criterion:

```text
Router# configure terminal
Router(config)# class-map mygroup
Router(config-cmap)# match protocol attribute tunnel tunnel-yes
```

The following sample output from the **show ip nbar attribute** command displays the details of all the attributes:

```text
Router# show ip nbar attribute
  Name :  category
  Help :  category attribute
  Type :  group
  Groups :  email, newsgroup, location-based-services, instant-messaging, netg
  Need :  Mandatory
  Default :  other
  
  Name :  sub-category
  Help :  sub-category attribute
  Type :  group
```
Groups : routing-protocol, terminal, epayment, remote-access-terminal, nen
Need : Mandatory
Default : other
Name : application-group
Help : application-group attribute
Type : group
Groups : skype-group, wap-group, pop3-group, kerberos-group, tftp-group, bp
Need : Mandatory
Default : other
Name : tunnel
Help : Tunnelled applications
Type : group
Groups : tunnel-no, tunnel-yes, tunnel-unassigned
Need : Mandatory
Default : tunnel-unassigned
Name : encrypted
Help : Encrypted applications
Type : group
Groups : encrypted-yes, encrypted-no, encrypted-unassigned
Need : Mandatory
Default : encrypted-unassigned

The following sample output from the `show ip nbar protocol-attribute` command displays the details of the protocols:

Router# show ip nbar protocol-attribute

Protocol Name : ftp
  category : file-sharing
  sub-category : client-server
  application-group : ftp-group
  tunnel : tunnel-no
  encrypted : encrypted-no

Protocol Name : http
  category : browsing
  sub-category : other
  application-group : other
  tunnel : tunnel-no
  encrypted : encrypted-no

Protocol Name : egp
  category : net-admin
  sub-category : routing-protocol
  application-group : other
  tunnel : tunnel-no
  encrypted : encrypted-no

Protocol Name : gre
  category : net-admin
  sub-category : tunneling-protocols
  application-group : other
  tunnel : tunnel-yes
  encrypted : encrypted-no

---

### Additional References

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<td></td>
<td>No new or modified MIBs are supported, and support for existing MIBs has not been modified.</td>
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To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL:

http://www.cisco.com/go/mibs

## RFCs

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<td>RFC 768</td>
<td>User Datagram Protocol</td>
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<td>RFC 792</td>
<td>Internet Control Message Protocol</td>
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<tr>
<td>RFC 793</td>
<td>Transmission Control Protocol</td>
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</tr>
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<td>RFC 821</td>
<td>Simple Mail Transfer Protocol</td>
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<td>RFC 827</td>
<td>Exterior Gateway Protocol</td>
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<td>RFC 854</td>
<td>Telnet Protocol Specification</td>
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<td>RFC 888</td>
<td>“STUB” Exterior Gateway Protocol</td>
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<td>RFC 904</td>
<td>Exterior Gateway Protocol Formal Specification</td>
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<td>RFC 951</td>
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<td>Host Extensions for IP Multicasting</td>
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<td>RFC 1157</td>
<td>Simple Network Management Protocol</td>
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<td>RFC 1282</td>
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<td>RFC 1288</td>
<td>The Finger User Information Protocol</td>
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<td>RFC 1305</td>
<td>Network Time Protocol</td>
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<td>RFC 1350</td>
<td>The TFTP Protocol (Revision 2)</td>
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<td>RFC 1436</td>
<td>The Internet Gopher Protocol</td>
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<td>RFC 1459</td>
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<td>RFC 1510</td>
<td>The Kerberos Network Authentication Service</td>
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<td>RFC 1542</td>
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<td>RFC 1579</td>
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<td>RFC 1730</td>
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<td>RFC 1771</td>
<td><em>A Border Gateway Protocol 4 (BGP-4)</em></td>
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<td>RFC 1890</td>
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<td>RFC 1928</td>
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<td>RFC 2616</td>
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**Note**  This RFC updates RFC 2068.
## Feature Information for Classifying Network Traffic Using NBAR

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to [www.cisco.com/go/cfn](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

### Table 5  Feature Information for Classifying Network Traffic Using NBAR in Cisco IOS XE software

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<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
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<tbody>
<tr>
<td>Additional PDL Support for NBAR</td>
<td>Cisco IOS XE Release 3.1S</td>
<td>The additional PDL Support for NBAR feature provides support for additional PDLs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The following section provides information about this feature: NBAR and Classification of HTTP Traffic, page 4</td>
</tr>
<tr>
<td>Enhanced NBAR</td>
<td>Cisco IOS XE Release 3.2S</td>
<td>The Enhanced NBAR feature provides additional PDLs for Cisco IOS XE Release 3.2S.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The following section provides information about this feature: NBAR-Supported Protocols, page 13</td>
</tr>
<tr>
<td>Feature Name</td>
<td>Releases</td>
<td>Feature Information</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>NBAR Categorization and Attributes</td>
<td>Cisco IOS XE Release 3.4S</td>
<td>The NBAR Categorization and Attributes feature provides the mechanism of matching the protocols grouped under specific categories based on the attributes. These categories are available for Class-Based Policy Language (CPL) as a match criteria for application recognition. The following section provides information about this feature: NBAR Categorization and Attributes, page 79</td>
</tr>
<tr>
<td>NBAR Classification Enhancements for IOS-XE3.5</td>
<td>Cisco IOS XE Release 3.5S</td>
<td>The NBAR Classification Enhancements feature provides additional classification support for native IPv6 classification and classification of flows inside tunneled IPv6 over IPv4. The following section provides information about this feature: NBAR Support for IPv6 from Cisco IOS XE Release 3.5S and Later Releases, page 79 The following commands were introduced or modified: <strong>ip nbar classification tunneled-traffic, option</strong> (FNF).</td>
</tr>
<tr>
<td>NBAR PDLM Supported in ASR 1000 Release 2.5</td>
<td>Cisco IOS XE Release 2.5,</td>
<td>This feature was integrated into Cisco IOS XE Release 2.5. NBAR-supported protocols were added for this release. The following section provides information about this feature: NBAR-Supported Protocols, page 13 The following command was modified: <strong>match protocol</strong> (NBAR).</td>
</tr>
<tr>
<td></td>
<td>Cisco IOS XE Release 3.1S</td>
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</table>

Example: Configuring Attribute-Based Protocol Match

Feature Information for Classifying Network Traffic Using NBAR
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<tr>
<th>Feature Name</th>
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<td>NBAR Protocols</td>
<td>Cisco IOS XE Release 2.3</td>
<td>This feature was integrated into Cisco IOS XE Release 2.3. NBAR-supported protocols were added for this release. The following section provides information about this feature: NBAR-Supported Protocols, page 13. The following command was modified: <code>match protocol (NBAR)</code>.</td>
</tr>
<tr>
<td>NBAR Real-time Transport Protocol Payload Classification</td>
<td>Cisco IOS XE Release 2.1</td>
<td>This feature was introduced on Cisco ASR 1000 Series Aggregation Services Routers. The following section provides information about this feature: NBAR-Supported Protocols, page 13.</td>
</tr>
<tr>
<td>NBAR Static IPv4 IANA Protocols Pack1</td>
<td>Cisco IOS XE Release 3.1S</td>
<td>This feature was introduced on Cisco ASR 1000 Series Aggregation Services Routers. The following section provides information about this feature: NBAR-Supported Protocols, page 13.</td>
</tr>
<tr>
<td>NBAR VRF aware</td>
<td>Cisco IOS XE Release 3.3S</td>
<td>This feature was introduced on Cisco ASR 1000 Series Aggregation Services Routers. The following section provides information about this feature: NBAR Scalability, page 11.</td>
</tr>
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**Glossary**

**Encryption**—Encryption is the application of a specific algorithm to data so as to alter the appearance of the data, making it incomprehensible to those who are not authorized to see the information.

**HTTP**—Hypertext Transfer Protocol. The protocol used by web browsers and web servers to transfer files, such as text and graphic files.

**IANA**—Internet Assigned Numbers Authority. An organization operated under the auspices of the Internet Society (ISOC) as a part of the Internet Architecture Board (IAB). IANA delegates authority for IP address-space allocation and domain-name assignment to the InterNIC and other organizations. IANA also maintains a database of assigned protocol identifiers used in the TCP/IP stack, including autonomous system numbers.
LAN — Local-area network. A high-speed, low-error data network that covers a relatively small geographic area (up to a few thousand meters). LANs connect workstations, peripherals, terminals, and other devices in a single building or other geographically limited area. LAN standards specify cabling and signaling at the physical and data link layers of the Open System Interconnection (OSI) model. Ethernet, FDDI, and Token Ring are widely used LAN technologies.

MIME — Multipurpose Internet Mail Extension. The standard for transmitting nontext data (or data that cannot be represented in plain ASCII code) in Internet mail, such as binary, foreign language text (such as Russian or Chinese), audio, and video data. MIME is defined in RFC 2045, *Multipurpose Internet Mail Extension (MIME) Part One: Format of Internet Message Bodies*.

MPLS — Multiprotocol Label Switching. A switching method that forwards IP traffic using a label. This label instructs the routers and the switches in the network where to forward the packets based on preestablished IP routing information.

MQC — Modular quality of service command-line interface. A CLI that allows you to define traffic classes, create and configure traffic policies (policy maps), and then attach the policy maps to interfaces. Policy maps are used to apply the appropriate quality of service (QoS) to network traffic.

Protocol Discovery — A feature included with NBAR. Protocol Discovery provides a way to discover the application protocols that are operating on an interface.

QoS — Quality of service. A measure of performance for a transmission system that reflects its transmission quality and service availability.


Stateful protocol — A protocol that uses TCP and UDP port numbers that are determined at connection time.

Static protocol — A protocol that uses well-defined (predetermined) TCP and UDP ports for communication.

Subport classification — The classification of network traffic by information that is contained in the packet payload, that is, information found beyond the TCP or UDP port number.

TCP — Transmission Control Protocol. A connection-oriented transport layer protocol that provides reliable full-duplex data transmission. TCP is part of the TCP/IP protocol stack.

Tunneling — Tunneling is an architecture that is designed to provide the services necessary to implement any standard point-to-point encapsulation scheme.

UDP — User Datagram Protocol. A connectionless transport layer protocol in the TCP/IP protocol stack. UDP is a simple protocol that exchanges datagrams without acknowledgments or guaranteed delivery, requiring that error processing and retransmission be handled by other protocols. UDP is defined in RFC 768, *User Datagram Protocol*.

WAN — Wide-area network. A data communications network that serves users across a broad geographic area and often uses transmission devices provided by common carriers.
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