CHAPTER 29

Configuring Network Security with ACLs

This chapter describes how to configure network security on a Catalyst 2950 or Catalyst 2955 switch by using access control lists (ACLs), which are also referred to in commands and tables as *access lists*.

You can create ACLs for physical interfaces or management interfaces. A management interface is defined as a management VLAN or any traffic that is going directly to the CPU, such as SNMP, Telnet, or web traffic. You can create ACLs for management interfaces with the standard software image (SI) or the enhanced software image (EI) installed on your switch. However, you must have the EI installed on your switch to apply ACLs to physical interfaces.

Note An ACLs that applied is to a physical interface has a limitation of one mask, and certain keywords are not supported. For more information, see the "Guidelines for Applying ACLs to Physical Interfaces" section on page 29-6.

Note For complete syntax and usage information for the commands used in this chapter, refer to the command reference for this release and the "Configuring IP Services" section of the *Cisco IOS IP and IP Routing Configuration Guide, Cisco IOS Release 12.1* and the *Cisco IOS IP and IP Routing Command Reference, Cisco IOS Release 12.1*.

This chapter consists of these sections:

You can configure ACLs by using the Cluster Management Suite (CMS) or through the command-line interface (CLI). Refer to the CMS online help for step-by-step configuration procedures through CMS. For information about accessing and using CMS, see Chapter 4, "Getting Started with CMS."

You can also use the security wizard to filter inbound traffic on the switches. Filtering can be based on network addresses, Transmission Control Protocol (TCP) applications, or User Datagram Protocol (UDP) applications. You can choose whether to drop or to forward packets that meet the filtering criteria. To use this wizard, you must know how the network is designed and how interfaces are used on the filtering device. Refer to the security wizard online help for step-by-step configuration procedures about using this wizard.

Understanding ACLs

Packet filtering can limit network traffic and restrict network use by certain users or devices. ACLs can filter traffic as it passes through a switch and permit or deny packets at specified interfaces. An ACL is a sequential collection of permit and deny conditions that apply to packets. When a packet is received on an interface, the switch compares the fields in the packet against any applied ACLs to verify that the packet has the required permissions to be forwarded, based on the criteria specified in the access lists. The switch tests the packet against the conditions in an access list one by one. The first match determines whether the switch accepts or rejects the packet. Because the switch stops testing conditions after the first match, the order of conditions in the list is critical. If no conditions match, the switch rejects the packet. If there are no restrictions, the switch forwards the packet; otherwise, the switch drops the packet.

You configure access lists on a Layer 2 switch to provide basic security for your network. If you do not configure ACLs, all packets passing through the switch could be allowed onto all parts of the network. You can use ACLs to control which hosts can access different parts of a network or to decide which types of traffic are forwarded or blocked at switch interfaces. For example, you can allow e-mail traffic to be forwarded but not Telnet traffic. ACLs can be configured to block inbound traffic.

An ACL contains an ordered list of access control entries (ACEs). Each ACE specifies *permit* or *deny* and a set of conditions the packet must satisfy in order to match the ACE. The meaning of *permit* or *deny* depends on the context in which the ACL is used.

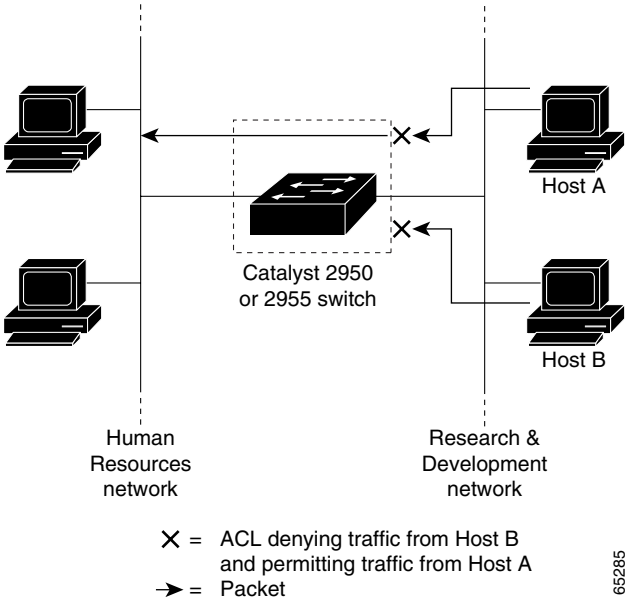
The switch supports these types of ACLs on physical interfaces in the inbound direction:

- IP ACLs filter IP, TCP, and UDP traffic.
- Ethernet or MAC ACLs filter Layer 2 traffic.
- MAC extended access lists use source and destination MAC addresses and optional protocol type information for matching operations.
- Standard IP access lists use source addresses for matching operations.
- Extended IP access lists use source and destination addresses and optional protocol type information for matching operations.

The switch examines access lists associated with features configured on a given interface. As packets enter the switch on an interface, ACLs associated with all inbound features configured on that interface are examined.

ACLs permit or deny packet forwarding based on how the packet matches the entries in the ACL. For example, you can use ACLs to allow one host to access a part of a network, but to prevent another host from accessing the same part. In Figure 29-1, ACLs applied at the switch input allow Host A to access the Human Resources network, but prevent Host B from accessing the same network.

Figure 29-1 Using ACLs to Control Traffic to a Network



Handling Fragmented and Unfragmented Traffic

IP packets can be fragmented as they cross the network. When this happens, only the fragment containing the beginning of the packet contains the Layer 4 information, such as TCP or UDP port numbers, Internet Control Message Protocol (ICMP) type and code, and so on. All other fragments are missing this information.

Some ACEs do not check Layer 4 information and therefore can be applied to all packet fragments. ACEs that do test Layer 4 information cannot be applied in the standard manner to most of the fragments in a fragmented IP packet. When the fragment contains no Layer 4 information and the ACE tests some Layer 4 information, the matching rules are modified:

- Permit ACEs that check the Layer 3 information in the fragment (including protocol type, such as TCP, UDP, and so on) are considered to match the fragment regardless of what the missing Layer 4 information might have been.
- Deny ACEs that check Layer 4 information never match a fragment unless the fragment contains Layer 4 information.

Consider access list 102, configured with these commands, applied to three fragmented packets:

```
Switch (config)# access-list 102 permit tcp any host 10.1.1.1 eq smtp
Switch (config)# access-list 102 deny tcp any host 10.1.1.2 eq telnet
Switch (config)# access-list 102 deny tcp any any
```

Note In the first and second ACEs in the examples, the *eq* keyword after the destination address means to test for the TCP-destination-port well-known numbers equaling Simple Mail Transfer Protocol (SMTP) and Telnet, respectively.

- Packet A is a TCP packet from host 10.2.2.2, port 65000, going to host 10.1.1.1 on the SMTP port. If this packet is fragmented, the first fragment matches the first ACE (a permit), as if it were a complete packet because all Layer 4 information is present. The remaining fragments also match the first ACE, even though they do not contain the SMTP port information because the first ACE only checks Layer 3 information when applied to fragments. (The information in this example is that the packet is TCP and that the destination is 10.1.1.1.)
- Packet B is from host 10.2.2.2, port 65001, going to host 10.1.1.2 on the Telnet port. If this packet is fragmented, the first fragment matches the second ACE (a deny) because all Layer 3 and Layer 4 information is present. The remaining fragments in the packet do not match the second ACE because they are missing Layer 4 information.
- Because the first fragment was denied, host 10.1.1.2 cannot reassemble a complete packet, so packet B is effectively denied. However, the later fragments that are permitted will consume bandwidth on the network and the resources of host 10.1.1.2 as it tries to reassemble the packet.
- Fragmented packet C is from host 10.2.2.2, port 65001, going to host 10.1.1.3, port ftp. If this packet is fragmented, the first fragment matches the third ACE (a deny). All other fragments also match the third ACE because that ACE does not check any Layer 4 information and because Layer 3 information in all fragments shows that they are being sent to host 10.1.1.3, and the earlier permit ACEs were checking different hosts.

Understanding Access Control Parameters

Before configuring ACLs on the switches, you must have a thorough understanding of the access control parameters (ACPs). ACPs are referred to as *masks* in the switch CLI commands, output, and CMS.

Each ACE has a mask and a rule. The Classification Field or mask is the field of interest on which you want to perform an action. The specific values associated with a given mask are called *rules*.

Packets can be classified on these Layer 2, Layer 3, and Layer 4 fields:

- Layer 2 fields:
  - Source MAC address (Specify all 48 bits.)
  - Destination MAC address (Specify all 48 bits.)
  - Ethertype (16-bit ethertype field)

  You can use any combination or all of these fields simultaneously to define a flow.
- Layer 3 fields:
  - IP source address (Specify all 32 IP source address bits to define the flow, or specify an user-defined subnet. There are no restrictions on the IP subnet to be specified.)
  - IP destination address (Specify all 32 IP destination address bits to define the flow, or specify an user-defined subnet. There are no restrictions on the IP subnet to be specified.)

  You can use any combination or all of these fields simultaneously to define a flow.

- Layer 4 fields:
  - TCP (You can specify a TCP source, destination port number, or both at the same time.)
  - UDP (You can specify a UDP source, destination port number, or both at the same time.)

Note A mask can be a combination of either multiple Layer 3 and Layer 4 fields or of multiple Layer 2 fields. Layer 2 fields cannot be combined with Layer 3 or Layer 4 fields.

There are two types of masks:

- User-defined mask—masks that are defined by the user.
- System-defined mask—these masks can be configured on any interface:

```
Switch (config-ext-nacl)# permit tcp any any
Switch (config-ext-nacl)# deny tcp any any
Switch (config-ext-nacl)# permit udp any any
Switch (config-ext-nacl)# deny udp any any
Switch (config-ext-nacl)# permit ip any any
Switch (config-ext-nacl)# deny ip any any
Switch (config-ext-nacl)# deny any any
Switch (config-ext-nacl)# permit any any
```

Note In an IP extended ACL (both named and numbered), a Layer 4 system-defined mask cannot precede a Layer 3 user-defined mask. For example, a Layer 4 system-defined mask such as **permit tcp any any** or **deny udp any any** cannot precede a Layer 3 user-defined mask such as **permit ip 10.1.1.1 any**. If you configure this combination, the ACL is not allowed on a Layer 2 interface. All other combinations of system-defined and user-defined masks are allowed in security ACLs.

The switch ACL configuration is consistent with other Cisco Catalyst switches. However, there are significant restrictions for configuring ACLs on the switches.

Only four user-defined masks can be defined for the entire system. These can be used for either security or quality of service (QoS) but cannot be shared by QoS and security. You can configure as many ACLs as you require. However, a system error message appears if ACLs with more than four different masks are applied to interfaces. For more information about error messages, see the system message guide for this release.

Table 29-1 lists a summary of the ACL restrictions on the switches.

Table 29-1 Summary of ACL Restrictions

Restriction	Number Permitted
Number of user-defined masks allowed in an ACL	1
Number of ACLs allowed on an interface	1
Total number of user-defined masks for security and QoS allowed on a switch	4

Guidelines for Applying ACLs to Physical Interfaces

When applying ACLs to physical interfaces, follow these configuration guidelines:

- Only one ACL can be attached to an interface. For more information, refer to the **ip access-group** interface command in the command reference for this release.
- All ACEs in an ACL must have the same user-defined mask. However, ACEs can have different rules that use the same mask. On a given interface, only one type of user-defined mask is allowed, but you can apply any number of system-defined masks. For more information on system-defined masks, see the "Understanding Access Control Parameters" section on page 29-4.

  This example shows the same mask in an ACL:

  ```
  Switch (config)# ip access-list extended acl2
  Switch (config-ext-nacl)# permit tcp 10.1.1.1 0.0.0.0 any eq 80
  Switch (config-ext-nacl)# permit tcp 20.1.1.1 0.0.0.0 any eq 23
  ```

  In this example, the first ACE permits all the TCP packets coming from host 10.1.1.1 with a destination TCP port number of 80. The second ACE permits all TCP packets coming from host 20.1.1.1 with a destination TCP port number of 23. Both the ACEs use the same mask; therefore, a switch supports this ACL.
- When you apply an ACL to a physical interface, some keywords are not supported and certain mask restrictions apply to the ACLs. See the "Creating a Numbered Standard ACL" section on page 29-9 and the "Creating a Numbered Extended ACL" section on page 29-10 for creating these ACLs.

Note You can also apply ACLs to a management interface without the above limitations. For information, refer to the "Configuring IP Services" section of the *Cisco IOS IP and IP Routing Configuration Guide, Cisco IOS Release 12.1* and the *Cisco IOS IP and IP Routing Command Reference, Cisco IOS Release 12.1*.

Configuring ACLs

This section includes these topics:

Configuring ACLs on a Layer 2 interface is the same as configuring ACLs on Cisco routers. The process is briefly described here. For more detailed information about configuring router ACLs, refer to the "Configuring IP Services" chapter in the *Cisco IP and IP Routing Configuration Guide, Cisco IOS Release 12.1*. For detailed information about the commands, refer to the *Cisco IOS IP and IP Routing Command Reference, Cisco IOS Release 12.1*. For a list of Cisco IOS features not supported on the switch, see the "Unsupported Features" section on page 29-7.

Unsupported Features

The switch does not support these Cisco IOS router ACL-related features:

- Non-IP protocol ACLs (see Table 29-2 on page 29-8)
- Bridge-group ACLs
- IP accounting
- ACL support on the outbound direction
- Inbound and outbound rate limiting (except with QoS ACLs)
- IP packets that have a header length of less than 5 bytes
- Reflexive ACLs
- Dynamic ACLs (except for certain specialized dynamic ACLs used by the switch clustering feature)
- ICMP-based filtering
- Interior Gateway Routing Protocol (IGMP)-based filtering

Creating Standard and Extended IP ACLs

This section describes how to create switch IP ACLs. The switch tests packets against the conditions in an access list one by one. The first match determines whether the switch accepts or rejects the packet. Because the switch stops testing conditions after the first match, the order of the conditions is critical. If no conditions match, the switch denies the packet.

Follow these steps to use ACLs:

Step 1 Create an ACL by specifying an access list number or name and access conditions.

Step 2 Apply the ACL to interfaces or terminal lines.

The software supports these kinds of IP access lists:

- Standard IP access lists use source addresses for matching operations.
- Extended IP access lists use source and destination addresses for matching operations and optional protocol-type information for finer granularity of control.

Note MAC extended access list use source and destination MAC addresses and optional protocol type information for matching operations. For more information, see the "Creating Named MAC Extended ACLs" section on page 29-18.

The next sections describe access lists and the steps for using them.

ACL Numbers

The number you use to denote your ACL shows the type of access list that you are creating. Table 29-2 lists the access list number and corresponding type and shows whether or not they are supported by the switch. The switch supports IP standard and IP extended access lists, numbers 1 to 199 and 1300 to 2699.

Table 29-2 Access List Numbers

ACL Number	Type	Supported
1–99	IP standard access list	Yes
100–199	IP extended access list	Yes
200–299	Protocol type-code access list	No
300–399	DECnet access list	No
400–499	XNS standard access list	No
500–599	XNS extended access list	No
600–699	AppleTalk access list	No
700–799	48-bit MAC address access list	No
800–899	IPX standard access list	No
900–999	IPX extended access list	No
1000–1099	IPX SAP access list	No
1100–1199	Extended 48-bit MAC address access list	No
1200–1299	IPX summary address access list	No
1300–1999	IP standard access list (expanded range)	Yes
2000–2699	IP extended access list (expanded range)	Yes

Note In addition to numbered standard and extended ACLs, you can also create named standard and extended IP ACLs by using the supported numbers. That is, the name of a standard IP ACL can be 1 to 99; the name of an extended IP ACL can be 100 to 199. The advantage of using named ACLs instead of numbered lists is that you can delete individual entries from a named list.

Creating a Numbered Standard ACL

Note For information about creating ACLs to apply to a management interface, refer to the "Configuring IP Services" section of the *Cisco IOS IP and IP Routing Configuration Guide, Cisco IOS Release 12.1* and the *Cisco IOS IP and IP Routing Command Reference, Cisco IOS Release 12.1*. You can these apply these ACLs only to a management interface.

Beginning in privileged EXEC mode, follow these steps to create a numbered standard IP ACL:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**access-list** *access-list-number* {**deny** | **permit** | **remark**} {*source source-wildcard* | **host** *source* | **any**}	Define a standard IP ACL by using a source address and wildcard. The *access-list-number* is a decimal number from 1 to 99 or 1300 to 1999. Enter **deny** or **permit** to specify whether to deny or permit access if conditions are matched. The *source* is the source address of the network or host from which the packet is being sent: • The 32-bit quantity in dotted-decimal format. • The keyword **any** as an abbreviation for *source* and *source-wildcard* of 0.0.0.0 255.255.255.255. You do not need to enter a source wildcard. • The keyword **host** as an abbreviation for *source* and *source-wildcard* of *source* 0.0.0.0. (Optional) The *source-wildcard* applies wildcard bits to the source. (See first bullet item.) **Note** The **log** option is not supported on the switches.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show access-lists** [*number* | *name*]	Show the access list configuration.
Step 5	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

Use the **no access-list** *access-list-number* global configuration command to delete the entire ACL. You cannot delete individual ACEs from numbered access lists.

Note When creating an ACL, remember that, by default, the end of the ACL contains an implicit deny statement for all packets that it did not find a match for before reaching the end. With standard access lists, if you omit the mask from an associated IP host address ACL specification, 0.0.0.0 is assumed to be the mask.

This example shows how to create a standard ACL to deny access to IP host 171.69.198.102, permit access to any others, and display the results.

```
Switch (config)# access-list 2 deny host 171.69.198.102
Switch (config)# access-list 2 permit any
Switch(config)# end
Switch# show access-lists
Standard IP access list 2
    deny   171.69.198.102
    permit any
```

Creating a Numbered Extended ACL

Although standard ACLs use only source addresses for matching, you can use an extended ACL source and destination addresses for matching operations and optional protocol type information for finer granularity of control. Some protocols also have specific parameters and keywords that apply to that protocol.

These IP protocols are supported on physical interfaces (protocol keywords are in parentheses in bold): Internet Protocol (**ip**), Transmission Control Protocol (**tcp**), or User Datagram Protocol (**udp**).

Supported parameters can be grouped into these categories:

- TCP
- UDP

Table 29-3 lists the possible filtering parameters for ACEs for each protocol type.

Table 29-3 Filtering Parameter ACEs Supported by Different IP Protocols

Filtering Parameter[1]	TCP	UDP
Layer 3 Parameters:		
IP type of service (ToS) byte[2]	–	–
Differentiated Services Code Point (DSCP)	X	X
IP source address	X	X
IP destination address	X	X
Fragments	–	–
TCP or UDP	X	X
Layer 4 Parameters		
Source port operator	X	X
Source port	X	X
Destination port operator	X	X
Destination port	X	X
TCP flag	–	–

1. X in a protocol column means support for the filtering parameter.
2. No support for type of service (ToS) minimize monetary cost bit.

For more details about the specific keywords relative to each protocol, refer to the *Cisco IP and IP Routing Command Reference, Cisco IOS Release 12.1.*

Note The switch does not support dynamic or reflexive access lists. It also does not support filtering based on the minimize-monetary-cost type of service (ToS) bit.

When creating ACEs in numbered extended access lists, remember that after you create the list, any additions are placed at the end of the list. You cannot reorder the list or selectively add or remove ACEs from a numbered list.

Note For information about creating ACLs to apply to management interfaces, refer to the "Configuring IP Services" section of *Cisco IOS IP and IP Routing Configuration Guide, Release 12.1* and the *Cisco IOS IP and IP Routing Command Reference, Cisco IOS Release 12.1*. You can apply ACLs only to a management interface or the CPU, such as SNMP, Telnet, or web traffic.

Beginning in privileged EXEC mode, follow these steps to create an extended ACL:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**access-list** *access-list-number* {**deny** | **permit** | **remark**} *protocol* {*source source-wildcard* | **host** *source* | **any**} [*operator port*] {*destination destination-wildcard* | **host** *destination* | **any**} [*operator port*] [**dscp** *dscp-value*] [**time-range** *time-range-name*]	Define an extended IP access list and the access conditions. The *access-list-number* is a decimal number from 100 to 199 or 2000 to 2699. Enter **deny** or **permit** to specify whether to deny or permit the packet if conditions are matched. For *protocol*, enter the name or number of an IP protocol: IP, TCP, or UDP. To match any Internet protocol (including TCP and UDP), use the keyword **ip**. The *source* is the number of the network or host from which the packet is sent. The *source-wildcard* applies wildcard bits to the source. The *destination* is the network or host number to which the packet is sent. Define a destination or source port. • The *operator* can be only **eq** (equal). • If operator is after *source source-wildcard*, conditions match when the source port matches the defined port. • If operator is after *destination destination-wildcard*, conditions match when the destination port matches the defined port. • The *port* is a decimal number or name of a TCP or UDP port. The number can be from 0 to 65535. • Use TCP port names only for TCP traffic. • Use UDP port names only for UDP traffic. The *destination-wildcard* applies wildcard bits to the destination. *Source*, *source-wildcard*, *destination*, and *destination-wildcard* can be specified in three ways: • The 32-bit quantity in dotted-decimal format. • The keyword **any** as an abbreviation for *source* and *source-wildcard* of 0.0.0.0 255.255.255.255 or any source host. • The keyword **host,** followed by the 32-bit quantity in dotted-decimal format, as an abbreviation for a single host with *source* and *source-wildcard* of *source* 0.0.0.0. **dscp**—Enter to match packets with any of the supported 13 DSCP values (0, 8, 10, 16, 18, 24, 26, 32, 34, 40, 46, 48, and 56), or use the question mark (**?**) to see a list of available values. The **time-range** keyword is optional. For an explanation of this keyword, see the "Applying Time Ranges to ACLs" section on page 29-15.
Step 3	**show access-lists** [*number* | *name*]	Verify the access list configuration.
Step 4	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

Use the **no access-list** *access-list-number* global configuration command to delete the entire access list. You cannot delete individual ACEs from numbered access lists.

This example shows how to create and display an extended access list to deny Telnet access from any host in network 171.69.198.0 to any host in network 172.20.52.0 and permit any others. (The **eq** keyword after the destination address means to test for the TCP destination port number equaling Telnet.)

```
Switch(config)# access-list 102 deny tcp 171.69.198.0 0.0.0.255 172.20.52.0 0.0.0.255 eq
telnet
Switch(config)# access-list 102 permit tcp any any
Switch(config)# end
Switch# show access-lists
Extended IP access list 102
    deny tcp 171.69.198.0 0.0.0.255 172.20.52.0 0.0.0.255 eq telnet
    permit tcp any any
```

After an ACL is created, any additions (possibly entered from the terminal) are placed at the end of the list. You can add ACEs to an ACL, but deleting any ACE deletes the entire ACL.

Note When creating an ACL, remember that, by default, the end of the access list contains an implicit deny statement for all packets if the access list does not find a match before reaching the end. With standard access lists, if you omit the mask from an associated IP host address ACL specification, 0.0.0.0 is assumed to be the mask.

After creating an ACL, you must apply it to a line or interface, as described in the "Applying ACLs to Terminal Lines or Physical Interfaces" section on page 29-20.

Creating Named Standard and Extended ACLs

You can identify IP ACLs with an alphanumeric string (a name) rather than a number. You can use named ACLs to configure more IP access lists on a switch than if you use numbered access lists. If you identify your access list with a name rather than a number, the mode and command syntax are slightly different. However, not all commands that use IP access lists accept a named ACL.

Note The name you give to a standard ACL or extended ACL can also be a number in the supported range of access list numbers. That is, the name of a standard IP ACL can be 1 to 99; the name of an extended IP ACL can be 100 to 199. The advantage of using named ACLs instead of numbered lists is that you can delete individual entries from a named list.

Consider these guidelines and limitations before configuring named ACLs:

- A standard ACL and an extended ACL cannot have the same name.
- Numbered ACLs are also available, as described in the "Creating Standard and Extended IP ACLs" section on page 29-7.

Beginning in privileged EXEC mode, follow these steps to create a standard named access list using names:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**ip access-list standard** {*name* | *access-list-number*}	Define a standard IP access list by using a name, and enter access-list configuration mode. **Note** The name can be a number from 1 to 99.
Step 3	**deny** {*source source-wildcard* | **host** *source* | **any**} or **permit** {*source source-wildcard* | **host** *source* | **any**}	In access-list configuration mode, specify one or more conditions denied or permitted to determine if the packet is forwarded or dropped. • **host** *source* represents a *source* and *source-wildcard* of *source* 0.0.0.0. • **any** represents a *source* and *source-wildcard* of 0.0.0.0 255.255.255.255. **Note** The **log** option is not supported on the switches.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show access-lists** [*number* | *name*]	Show the access list configuration.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

Beginning in privileged EXEC mode, follow these steps to create an extended named ACL using names:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**ip access-list extended** {*name* | *access-list-number*}	Define an extended IP access list by using a name, and enter access-list configuration mode. **Note** The name can be a number from 100 to 199.
Step 3	{**deny** | **permit**} *protocol* {*source source-wildcard* | **host** *source* | **any**} [*operator port*] {*destination destination-wildcard* | **host** *destination* | **any**} [*operator port*] [**dscp** *dscp-value*] [**time-range** *time-range-name*]	In access-list configuration mode, specify the conditions allowed or denied. See the "Creating a Numbered Extended ACL" section on page 29-10 for definitions of protocols and other keywords. • **host** *source* represents a *source* and *source-wildcard* of *source* 0.0.0.0, and **host** *destination* represents a *destination* and *destination-wildcard* of *destination* 0.0.0.0. • **any** represents a *source* and *source-wildcard* or *destination* and *destination-wildcard* of 0.0.0.0 255.255.255.255. **dscp**—Enter to match packets with any of the supported 13 DSCP values (0, 8, 10, 16, 18, 24, 26, 32, 34, 40, 46, 48, and 56), or use the question mark (**?**) to see a list of available values. The **time-range** keyword is optional. For an explanation of this keyword, see the "Applying Time Ranges to ACLs" section on page 29-15.
Step 4	**end**	Return to privileged EXEC mode.

	Command	Purpose
Step 5	**show access-lists** [*number* | *name*]	Show the access list configuration.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

When making the standard and extended ACL, remember that, by default, the end of the ACL contains an implicit deny statement for everything if it did not find a match before reaching the end. For standard ACLs, if you omit the mask from an associated IP host address access list specification, 0.0.0.0 is assumed to be the mask.

After you create an ACL, any additions are placed at the end of the list. You cannot selectively add ACEs to a specific ACL. However, you can use **no permit** and **no deny** commands to remove ACEs from a named ACL. This example shows how you can delete individual ACEs from a named ACL:

```
Switch(config)# ip access-list extended border-list
Switch(config-ext-nacl)# no permit ip host 10.1.1.3 any
```

Being able to selectively remove lines from a named ACL is one reason you might use named ACLs instead of numbered ACLs.

After creating an ACL, you must apply it to a line or interface, as described in the "Applying ACLs to Terminal Lines or Physical Interfaces" section on page 29-20.

Applying Time Ranges to ACLs

You can implement extended ACLs based on the time of day and week by using the **time-range** global configuration command. First, define the name and times of the day and week of the time range, and then reference the time range by name in an ACL to apply restrictions to the access list. You can use the time range to define when the permit or deny statements in the ACL are in effect. The **time-range** keyword and argument are referenced in the named and numbered extended ACL task tables in the "Creating Standard and Extended IP ACLs" section on page 29-7, and the "Creating Named Standard and Extended ACLs" section on page 29-13.

These are some of the many benefits of using time ranges:

- You have more control over permitting or denying a user access to resources, such as an application (identified by an IP address mask pair and a port number).
- You can control logging messages. ACL entries can log traffic at certain times of the day, but not constantly. Therefore, you can simply deny access without having to analyze many logs generated during peak hours.

Note The time range relies on the switch system clock. Therefore, you need a reliable clock source. We recommend that you use Network Time Protocol (NTP) to synchronize the switch clock. For more information, see the "Managing the System Time and Date" section on page 8-1.

Beginning in privileged EXEC mode, follow these steps to configure a time-range parameter for an ACL:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**time-range** *time-range-name*	Identify the time-range by a meaningful name (for example, *workhours*), and enter time-range configuration mode. The name cannot contain a space or quotation mark and must begin with a letter.

	Command	Purpose
Step 3	**absolute** [**start** *time date*] [**end** *time date*] or **periodic** *day-of-the-week hh:mm to* [*day-of-the-week*] *hh:mm* or **periodic** {**weekdays** | **weekend** | **daily**} *hh:mm to hh:mm*	Specify when the function it will be applied to is operational. Use some combination of these commands; multiple **periodic** statements are allowed; only one **absolute** statement is allowed. If more than one absolute statement is configured, only the one configured last is executed.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show time-range**	Verify the time-range configuration.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To remove a configured time-range, use the **no time-range** *time-range-name* global configuration command.

Repeat the steps if you have multiple items that you want operational at different times.

This example shows how to configure time ranges for *workhours* and for company holidays and how to verify your configuration.

```
Switch(config)# time-range workhours
Switch(config-time-range)# periodic weekdays 8:00 to 12:00
Switch(config-time-range)# periodic weekdays 13:00 to 17:00
Switch(config-time-range)# exit
Switch(config)# time-range new_year_day_2000
Switch(config-time-range)# absolute start 00:00 1 Jan 2000 end 23:59 1 Jan 2000
Switch(config-time-range)# exit
Switch(config)# time-range thanksgiving_2000
Switch(config-time-range)# absolute start 00:00 22 Nov 2000 end 23:59 23 Nov 2000
Switch(config-time-range)# exit
Switch(config)# time-range christmas_2000
Switch(config-time-range)# absolute start 00:00 24 Dec 2000 end 23:50 25 Dec 2000
Switch(config-time-range)# end
Switch# show time-range
time-range entry: christmas_2000 (inactive)
   absolute start 00:00 24 December 2000 end 23:50 25 December 2000
time-range entry: new_year_day_2000 (inactive)
   absolute start 00:00 01 January 2000 end 23:59 01 January 2000
time-range entry: thanksgiving_2000 (inactive)
   absolute start 00:00 22 November 2000 end 23:59 23 November 2000
time-range entry: workhours (inactive)
   periodic weekdays 8:00 to 12:00
   periodic weekdays 13:00 to 17:00
```

To apply a time range, you must reference it by name (for example, *workhours*) in an extended ACL that can implement time ranges. This example shows how to create and verify extended access list 188 that denies TCP traffic from any source to any destination during the defined holiday time ranges and permits all TCP traffic during work hours.

```
Switch(config)# access-list 188 deny tcp any any time-range new_year_day_2000
Switch(config)# access-list 188 deny tcp any any time-range thanskgiving_2000
Switch(config)# access-list 188 deny tcp any any time-range christmas_2000
Switch(config)# access-list 188 permit tcp any any time-range workhours
Switch(config)# end
```

```
Switch# show access-lists
Extended IP access list 188
    deny tcp any any time-range new_year_day_2000 (inactive)
    deny tcp any any time-range thanskgiving_2000 (active)
    deny tcp any any time-range christmas_2000 (inactive)
    permit tcp any any time-range workhours (inactive)
```

This example uses named ACLs to permit and deny the same traffic.

```
Switch(config)# ip access-list extended deny_access
Switch(config-ext-nacl)# deny tcp any any time-range new_year_day_2000
Switch(config-ext-nacl)# deny tcp any any time-range thanksgiving_2000
Switch(config-ext-nacl)# deny tcp any any time-range christmas_2000
Switch(config-ext-nacl)# exit
Switch(config)# ip access-list extended may_access
Switch(config-ext-nacl)# permit tcp any any time-range workhours
Switch(config-ext-nacl)# end
Switch# show ip access-lists
Extended IP access list deny_access
    deny tcp any any time-range new_year_day_2000 (inactive)
    deny tcp any any time-range thanksgiving_2000 (inactive)
    deny tcp any any time-range christmas_2000 (inactive)
Extended IP access list may_access
    permit tcp any any time-range workhours (inactive)
```

Including Comments About Entries in ACLs

You can use the **remark** command to include comments (remarks) about entries in any IP standard or extended ACL. The remarks make the ACL easier for you to understand and scan. Each remark line is limited to 100 characters.

The remark can go before or after a permit or deny statement. You should be consistent about where you put the remark so that it is clear which remark describes which permit or deny statement. For example, it would be confusing to have some remarks before the associated permit or deny statements and some remarks after the associated statements.

For IP numbered standard or extended ACLs, use the **access-list** *access-list number* **remark** *remark* global configuration command to include a comment about an access list. To remove the remark, use the **no** form of this command.

In this example, the workstation belonging to Jones is allowed access, and the workstation belonging to Smith is not allowed access:

```
Switch(config)# access-list 1 remark Permit only Jones workstation through
Switch(config)# access-list 1 permit 171.69.2.88
Switch(config)# access-list 1 remark Do not allow Smith workstation through
Switch(config)# access-list 1 deny 171.69.3.13
```

For an entry in a named IP ACL, use the **remark** access-list global configuration command. To remove the remark, use the **no** form of this command.

In this example, the Jones subnet is not allowed to use outbound Telnet:

```
Switch(config)# ip access-list extended telnetting
Switch(config-ext-nacl)# remark Do not allow Jones subnet to telnet out
Switch(config-ext-nacl)# deny tcp host 171.69.2.88 any eq telnet
```

Creating Named MAC Extended ACLs

You can filter Layer 2 traffic on a physical Layer 2 interface by using MAC addresses and named MAC extended ACLs. The procedure is similar to that of configuring other extended named access lists.

Note Named MAC extended ACLs are used as a part of the **mac access-group** privileged EXEC command.

For more information about the supported non-IP protocols in the **mac access-list extended** command, refer to the command reference for this release.

Note Matching on any SNAP-encapsulated packet with a nonzero Organizational Unique Identifier (OUI) is not supported.

Beginning in privileged EXEC mode, follow these steps to create a named MAC extended ACL:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**mac access-list extended** *name*	Define an extended MAC access list by using a name.
Step 3	{**deny** | **permit**} {**any** | **host** *source MAC address*} {**any** | **host** *destination MAC address*} [**aarp** | **amber** | **appletalk** | **dec-spanning** | **decnet-iv** | **diagnostic** | **dsm** | **etype-6000** | **etype-8042** | **lat** | **lavc-sca** | **mop-console** | **mop-dump** | **msdos** | **mumps** | **netbios** | **vines-echo** |**vines-ip** | **xns-idp**]	In extended MAC access-list configuration mode, specify to **permit** or **deny any** source MAC address or a specific **host** source MAC address and **any** destination MAC address. (Optional) You can also enter these options: **aarp** | **amber** | **appletalk** | **dec-spanning** | **decnet-iv** | **diagnostic** | **dsm** | **etype-6000** | **etype-8042** | **lat** | **lavc-sca** | **mop-console** | **mop-dump** | **msdos** | **mumps** | **netbios** | **vines-echo** |**vines-ip** | **xns-idp**—(a non-IP protocol).
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show access-lists** [*number* | *name*]	Show the access list configuration.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

Use the **no mac access-list extended** *name* global configuration command to delete the entire ACL. You can also delete individual ACEs from named MAC extended ACLs.

This example shows how to create and display an access list named *mac1*, denying only EtherType DECnet Phase IV traffic, but permitting all other types of traffic.

```
Switch(config)# mac access-list extended mac1
Switch(config-ext-macl)# deny any any decnet-iv
Switch(config-ext-macl)# permit any any
Switch(config-ext-macl)# end
Switch # show access-list
Extended MAC access list mac1
    deny   any any decnet-iv
    permit any any
```

Creating MAC Access Groups

Beginning in privileged EXEC mode, follow these steps to create MAC access groups and to apply a MAC access list to an interface:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Identify a specific interface for configuration, and enter interface configuration mode. The interface must be a Layer 2 interface.
Step 3	**mac access-group** {*name*} {**in**}	Control access to the specified interface by using the MAC access list name.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show mac-access group**	Display the MAC ACLs applied on the switch.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

This example shows how to apply ACL 2 on Gigabit Ethernet interface 0/1 to filter packets entering the interface:

```
Switch(config)# interface gigabitethernet0/1
Router(config-if)# mac access-group 2 in
```

Note The **mac access-group** interface configuration command is only valid when applied to a Layer 2 interface.

For inbound ACLs, after receiving a packet, the switch checks the packet against the ACL. If the ACL permits the packet, the switch continues to process the packet. If the ACL rejects the packet, the switch discards the packet. The MAC ACL applies to both IP and non-IP packets.

When you apply an undefined ACL to an interface, the switch acts as if the ACL has not been applied to the interface and permits all packets. Remember this behavior if you use undefined ACLs as a means of network security.

Applying ACLs to Terminal Lines or Physical Interfaces

Note Before applying an ACL to a physical interface, see the "Guidelines for Applying ACLs to Physical Interfaces" section on page 29-6.

You can apply ACLs to any management interface. For information on creating ACLs on management interfaces, refer to the "Configuring IP Services" section of the *Cisco IOS IP and IP Routing Configuration Guide, Cisco IOS Release 12.1* and the *Cisco IOS IP and IP Routing Command Reference, Cisco IOS Release 12.1*.

Note The limitations that apply to ACLs on physical interfaces do not apply to ACLs on management interfaces.

After you create an ACL, you can apply it to one or more management interfaces or terminal lines. ACLs can be applied on inbound interfaces. This section describes how to accomplish this task for both terminal lines and network interfaces. Note these guidelines:

- When controlling access to a line, you must use numbered IP ACLs or MAC extended ACLs.
- When controlling access to an interface, you can use named or numbered ACLs.
- Set identical restrictions on all the virtual terminal lines because a user can attempt to connect to any of them.
- If you apply ACLs to a management interface, the ACL only filters packets that are intended for the CPU, such as SNMP, Telnet, or web traffic.
- If you apply ACLs to a management VLAN, see the "Management VLAN" section on page 7-19.

Applying ACLs to a Terminal Line

Beginning in privileged EXEC mode, follow these steps to restrict incoming connections between a virtual terminal line and the addresses in an ACL:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**line** [**console** | **vty**] *line-number*	Identify a specific line for configuration, and enter in-line configuration mode. Enter **console** for the console terminal line. The console port is DCE. Enter **vty** for a virtual terminal for remote console access. The *line-number* is the first line number in a contiguous group that you want to configure when the line type is specified. The range is from 0 to 16.
Step 3	**access-class** *access-list-number* {**in**}	Restrict incoming and outgoing connections between a particular virtual terminal line (into a device) and the addresses in an access list.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Display the access list configuration.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

Applying ACLs to a Physical Interface

Beginning in privileged EXEC mode, follow these steps to control access to a Layer 2 interface:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Identify a specific interface for configuration and enter interface configuration mode. The interface must be a Layer 2 or management interface or a management interface VLAN ID.
Step 3	**ip access-group** {*access-list-number* | *name*} {**in**}	Control access to the specified interface.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Display the access list configuration.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

This example shows how to apply access list 2 on Gigabit Ethernet interface 0/2 to filter packets entering the interface:

```
Switch(config)# interface gigabitethernet0/2
Router(config-if)# ip access-group 2 in
```

Note The **ip access-group** interface configuration command is only valid when applied to a management interface or a Layer 2 physical interface. ACLs cannot be applied to interface port-channels.

For inbound ACLs, after receiving a packet, the switch checks the packet against the ACL. If the ACL permits the packet, the switch continues to process the packet. If the ACL rejects the packet, the switch discards the packet.

When you apply an undefined ACL to an interface, the switch acts as if the ACL has not been applied to the interface and permits all packets. Remember this behavior if you use undefined ACLs for network security.

Displaying ACL Information

You can display the ACLs that are configured on the switch, and you can display the ACLs that have been applied to physical and management interfaces. This section consists of these topics:

Displaying ACLs

You can display existing ACLs by using **show** commands.

Beginning in privileged EXEC mode, follow these steps to display access lists:

	Command	Purpose
Step 1	**show access-lists** [*number* | *name*]	Show information about all IP and MAC address access lists or about a specific access list (numbered or named).
Step 2	**show ip access-list** [*number* | *name*]	Show information about all IP address access lists or about a specific IP ACL (numbered or named).

This example shows all standard and extended ACLs:

```
Switch# show access-lists
Standard IP access list 1
    permit 172.20.10.10
Standard IP ACL 10
    permit 12.12.12.12
Standard IP access list 12
    deny   1.3.3.2
Standard IP access list 32
    permit 172.20.20.20
Standard IP access list 34
    permit 10.24.35.56
    permit 23.45.56.34
Extended IP access list 120
Extended MAC access list mac1
```

This example shows only IP standard and extended ACLs.

```
Switch# show ip access-lists
Standard IP access list 1
    permit 172.20.10.10
Standard IP access list 10
    permit 12.12.12.12
Standard IP access list 12
    deny   1.3.3.2
Standard IP access list 32
    permit 172.20.20.20
Standard IP access list 34
    permit 10.24.35.56
    permit 23.45.56.34
Extended IP access list 120
```

Displaying Access Groups

Note This feature is available only if your switch is running the EI.

You use the **ip access-group** interface configuration command to apply ACLs to a Layer 3 interface. When IP is enabled on an interface, you can use the **show ip interface** *interface-id* privileged EXEC command to view the input and output access lists on the interface, as well as other interface characteristics. If IP is not enabled on the interface, the access lists are not shown.

This example shows how to view all access groups configured for VLAN 1 and for Gigabit Ethernet interface 0/2:

```
Switch# show ip interface vlan 1
GigabitEthernet0/2 is up, line protocol is down
  Internet address is 10.20.30.1/16
  Broadcast address is 255.255.255.255
  Address determined by setup command
  MTU is 1500 bytes
  Helper address is not set
  Directed broadcast forwarding is disabled
  Outgoing access list is permit Any
  Inbound  access list is 13

<information truncated>

Switch# show ip interface fastethernet0/9
FastEthernet0/9 is down, line protocol is down
  Inbound  access list is ip1
```

The only way to ensure that you can view all configured access groups under all circumstances is to use the **show running-config** privileged EXEC command. To display the ACL configuration of a single interface, use the **show running-config interface** *interface-id* command.

This example shows how to display the ACL configuration of Gigabit Ethernet interface 0/1:

```
Switch# show running-config interface gigabitethernet0/1
Building configuration...

Current configuration :112 bytes
!
interface GigabitEthernet0/1
 ip access-group 11 in
 snmp trap link-status
 no cdp enable
end!
```

Examples for Compiling ACLs

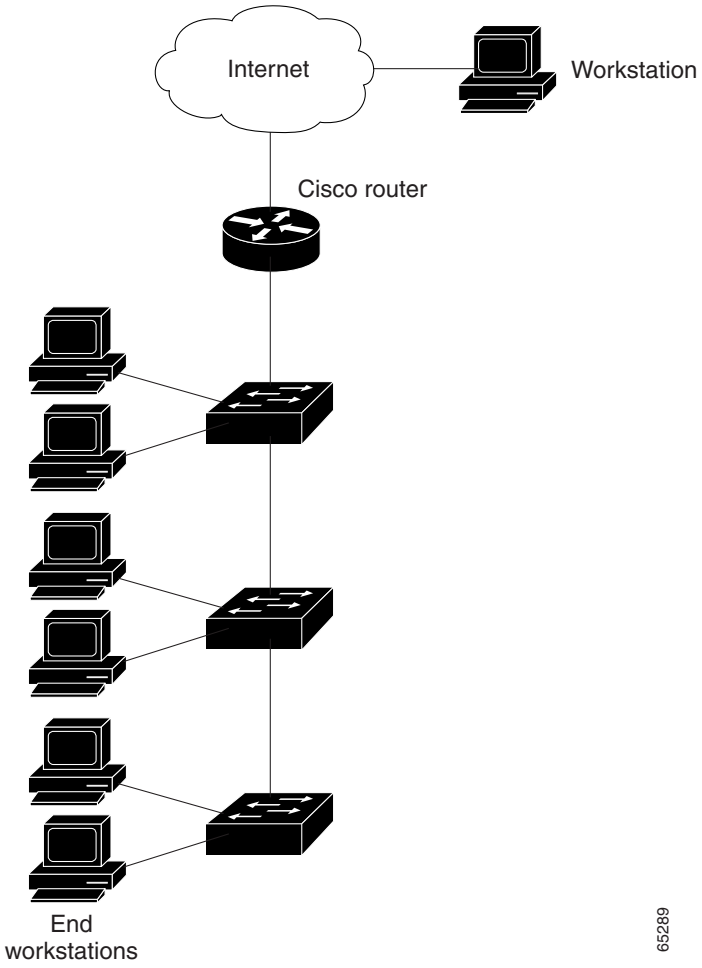
For detailed information about compiling ACLs, refer to the *Security Configuration Guide* and the "IP Services" chapter of the *Cisco IOS IP and IP Routing Configuration Guide, Cisco IOS Release 12.1.*

Figure 29-2 shows a small networked office with a stack of switches that are connected to a Cisco router. A host is connected to the network through the Internet using a WAN link.

Use switch ACLs to do these:

- Create a standard ACL, and filter traffic from a specific Internet host with an address 172.20.128.64.
- Create an extended ACL, and filter traffic to deny HTTP access to all Internet hosts but allow all other types of access.

Figure 29-2 Using Switch ACLs to Control Traffic



This example uses a standard ACL to allow access to a specific Internet host with the address 172.20.128.64.

```
Switch(config)# access-list 6 permit 172.20.128.64 0.0.0.0
Switch(config)# end
Switch(config)# interface gigabitethernet0/1
Switch(config-if)# ip access-group 6 in
```

This example uses an extended ACL to deny traffic from port 80 (HTTP). It permits all other types of traffic.

```
Switch(config)# access-list 106 deny tcp any any eq 80
Switch(config)# access-list 106 permit ip any any
Switch(config)# interface gigabitethernet0/2
Switch(config-if)# ip access-group 106 in
```

Numbered ACL Examples

This example shows that the switch accepts addresses on network 36.0.0.0 subnets and denies all packets coming from 56.0.0.0 subnets. The ACL is then applied to packets entering Gigabit Ethernet interface 0/1.

```
Switch(config)# access-list 2 permit 36.0.0.0 0.255.255.255
Switch(config)# access-list 2 deny 56.0.0.0 0.255.255.255
Switch(config)# interface gigabitethernet0/1
Switch(config-if)# ip access-group 2 in
```

Extended ACL Examples

In this example of using an extended ACL, you have a network connected to the Internet, and you want any host on the network to be able to form TCP Telnet and SMTP connections to any host on the Internet.

```
Switch(config)# access-list 102 permit tcp any 128.88.0.0 0.0.255.255 eq 23
Switch(config)# access-list 102 permit tcp any 128.88.0.0 0.0.255.255 eq 25
Switch(config)# interface gigabitethernet0/1
Switch(config-if)# ip access-group 102 in
```

SMTP uses TCP port 25 on one end of the connection and a random port number on the other end. The same port numbers are used throughout the life of the connection. Mail packets coming in from the Internet have a destination port of 25. Because the secure system behind the switch always accepts mail connections on port 25, the incoming services are controlled.

Named ACL Example

The Marketing_group ACL allows any TCP Telnet traffic to the destination address and wildcard 171.69.0.0 0.0.255.255 and denies any other TCP traffic. It permits any other IP traffic.

```
Switch(config)# ip access-list extended marketing_group
Switch(config-ext-nacl)# permit tcp any 171.69.0.0 0.0.255.255 eq telnet
Switch(config-ext-nacl)# deny tcp any any
Switch(config-ext-nacl)# permit ip any any
```

The ACLs are applied to permit Gigabit Ethernet port 0/1, which is configured as a Layer 2 port, with the Marketing_group ACL applied to incoming traffic.

```
Switch(config)# interface gigabitethernet0/1
Switch(config-if)# ip access-group marketing_group in
...
```

Commented IP ACL Entry Examples

In this example of a numbered ACL, the workstation belonging to Jones is allowed access, and the workstation belonging to Smith is not allowed access:

```
Switch(config)# access-list 1 remark Permit only Jones workstation through
Switch(config)# access-list 1 permit 171.69.2.88
Switch(config)# access-list 1 remark Do not allow Smith workstation through
Switch(config)# access-list 1 deny 171.69.3.13
```

In this example of a numbered ACL, the Winter and Smith workstations are not allowed to browse the web:

```
Switch(config)# access-list 100 remark Do not allow Winter to browse the web
Switch(config)# access-list 100 deny host 171.69.3.85 any eq www
Switch(config)# access-list 100 remark Do not allow Smith to browse the web
Switch(config)# access-list 100 deny host 171.69.3.13 any eq www
```

In this example of a named ACL, the Jones subnet is not allowed access:

```
Switch(config)# ip access-list standard prevention
Switch(config-std-nacl)# remark Do not allow Jones subnet through
Switch(config-std-nacl)# deny 171.69.0.0 0.0.255.255
```

In this example of a named ACL, the Jones subnet is not allowed to use outbound Telnet:

```
Switch(config)# ip access-list extended telnetting
Switch(config-ext-nacl)# remark Do not allow Jones subnet to telnet out
Switch(config-ext-nacl)# deny tcp 171.69.0.0 0.0.255.255 any eq telnet
```