Chapter 9: Access Control Lists

Routing & Switching

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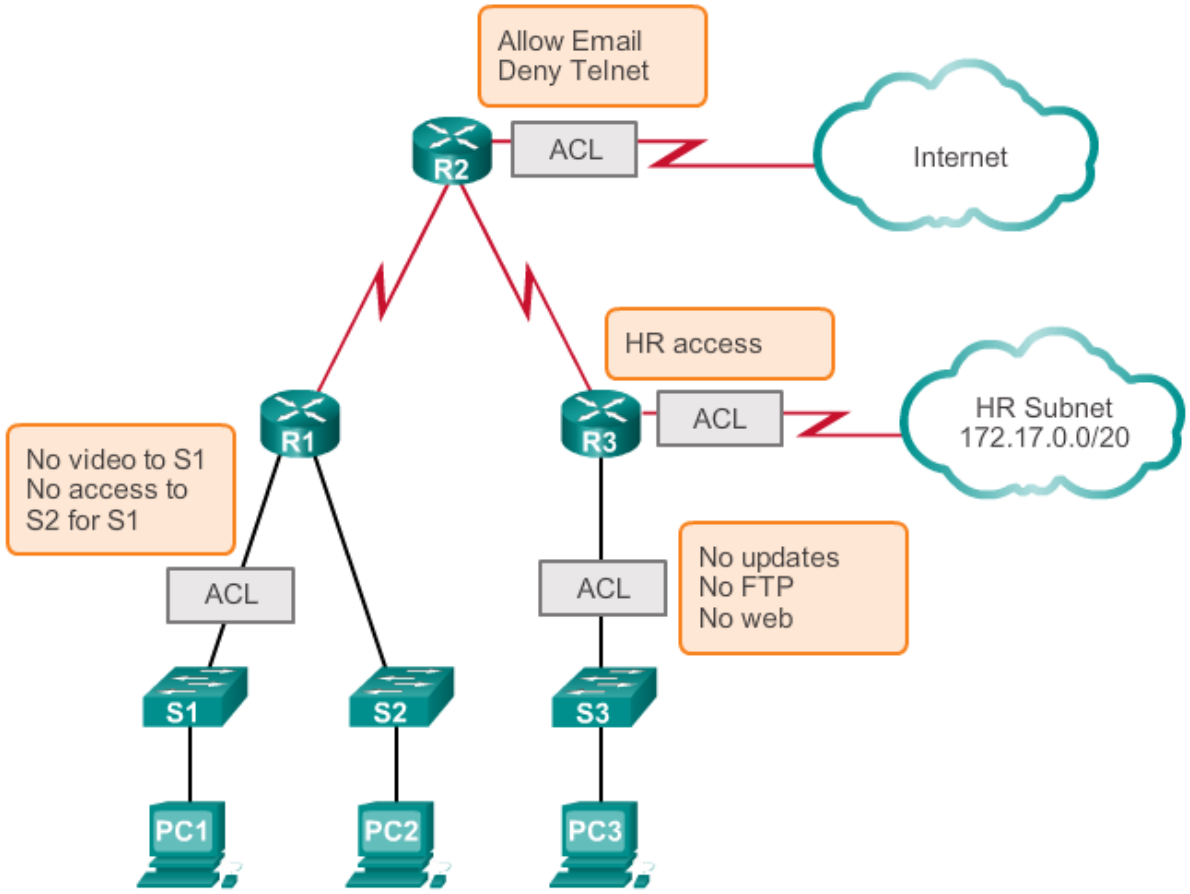
Purpose of ACLs

What is an ACL?



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Packet Filtering

- Packet filtering, sometimes called static packet filtering, controls access to a network by analyzing the incoming and outgoing packets and passing or dropping them based on given criteria, such as the source IP address, destination IP addresses, and the protocol carried within the packet.
- A router acts as a packet filter when it forwards or denies packets according to filtering rules.
- An ACL is a sequential list of permit or deny statements, known as access control entries (ACEs).

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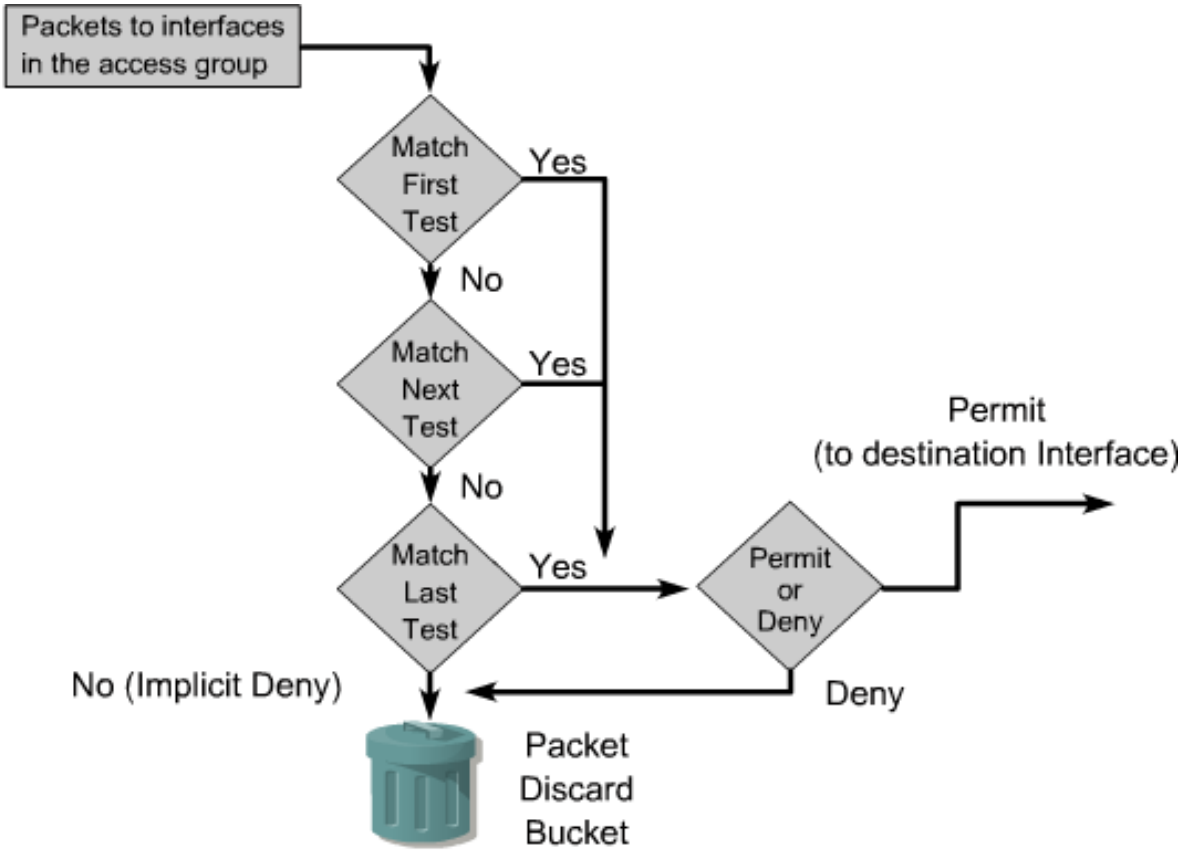
How ACLs Work



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ACL Operation

An inbound ACL filters packets coming into a specific interface and before they are routed to the outbound interface.

An outbound ACL filters packets after being routed, regardless of the inbound interface.

The last statement of an ACL is always an implicit deny. This statement is automatically inserted at the end of each ACL even though it is not physically present. The implicit deny blocks all traffic. Because of this implicit deny, an ACL that does not have at least one permit statement will block all traffic.

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Standard versus Extended IPv4 ACLs

Types of Cisco IPv4 ACLs

Standard ACLs

```
access-list 10 permit 192.168.30.0 0.0.0.255
```

Standard ACLs filter IP packets based on the source address only.

Extended ACLs

```
access-list 103 permit tcp 192.168.30.0 0.0.0.255 any eq 80
```

Extended ACLs filter IP packets based on several attributes, including the following:

- Source and destination IP addresses
- Source and destination TCP and UDP ports
- Protocol type/ Protocol number (example: IP, ICP, UDP, TCP, etc.)

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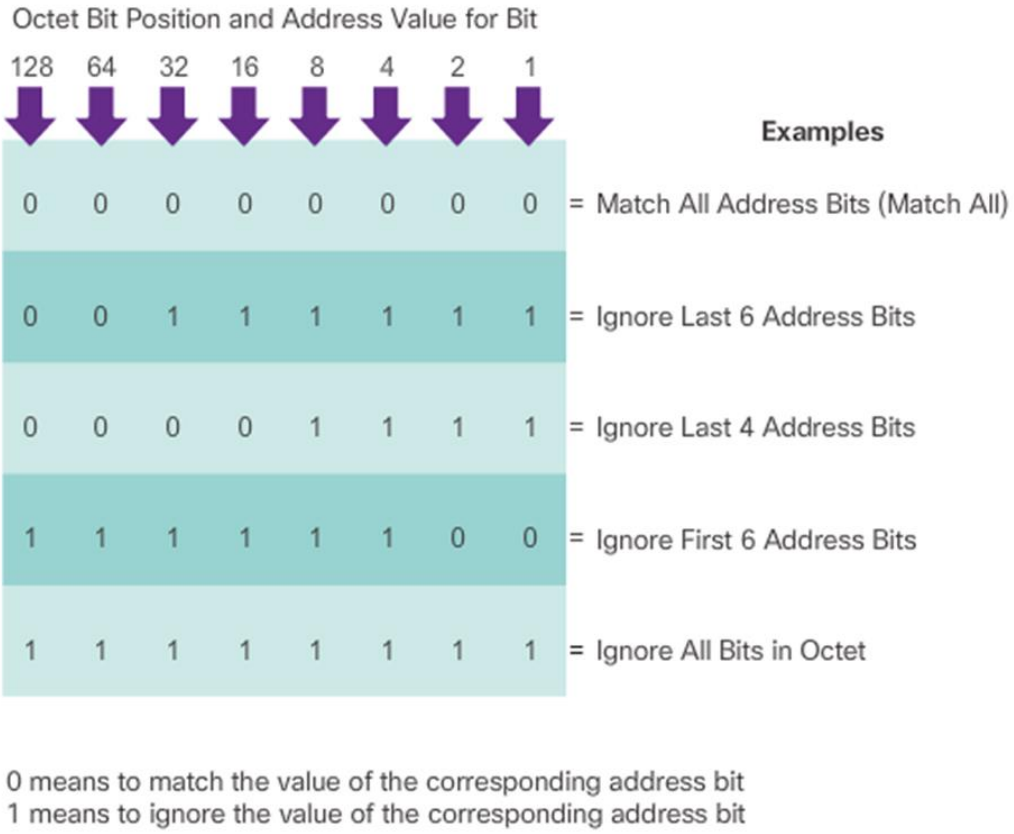
Introducing ACL Wildcard Masking

Wildcard masks and subnet masks differ in the way they match binary 1s and 0s. Wildcard masks use the following rules to match binary 1s and 0s:

- Wildcard mask bit 0 - Match the corresponding bit value in the address.
- Wildcard mask bit 1 - Ignore the corresponding bit value in the address.



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Calculating the Wildcard Mask

Calculating wildcard masks can be challenging. One shortcut method is to subtract the subnet mask from 255.255.255.255.

Example 1

	255.255.255.255
–	255.255.255.000
	000.000.000.255

Example 2

	255.255.255.255
–	255.255.255.240
	000.000.000.015

Example 3

	255.255.255.255
–	255.255.252.000
	000.000.003.255

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Guidelines for ACL creation

General Guidelines for Creating ACLs

- Use ACLs in firewall routers positioned between your internal network and an external network such as the Internet.
- Use ACLs on a router positioned between two parts of your network to control traffic entering or exiting a specific part of your internal network.
- Configure ACLs on border routers, that is routers situated at the edges of your networks.
- Configure ACLs for each network protocol configured on the border router interfaces.

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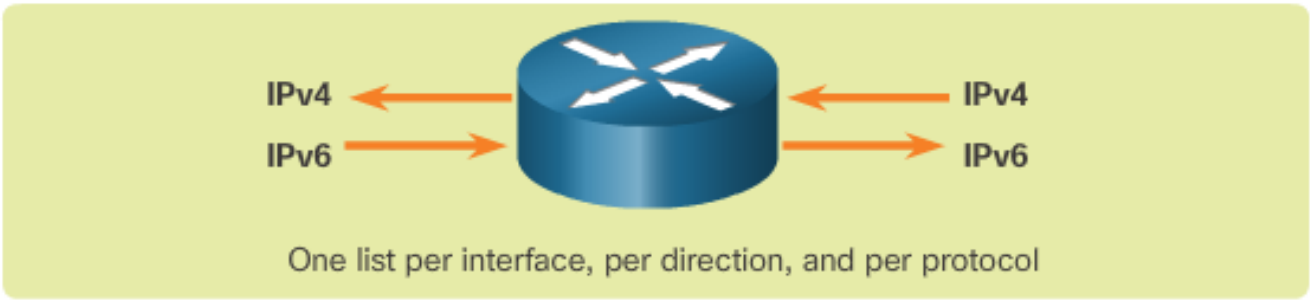
Guidelines for ACL Creation

General Guidelines for Creating ACLS

ACL Traffic Filtering on a Router



With two interfaces and two protocols running, this router could have a total of 8 separate ACLs applied.

The Rules for Applying ACLs

You can only have one ACL per protocol, per interface, and per direction:

- One ACL per protocol (e.g., IPv4 or IPv6)
- One ACL per direction (i.e., IN or OUT)
- One ACL per interface (e.g., GigabitEthernet0/0)

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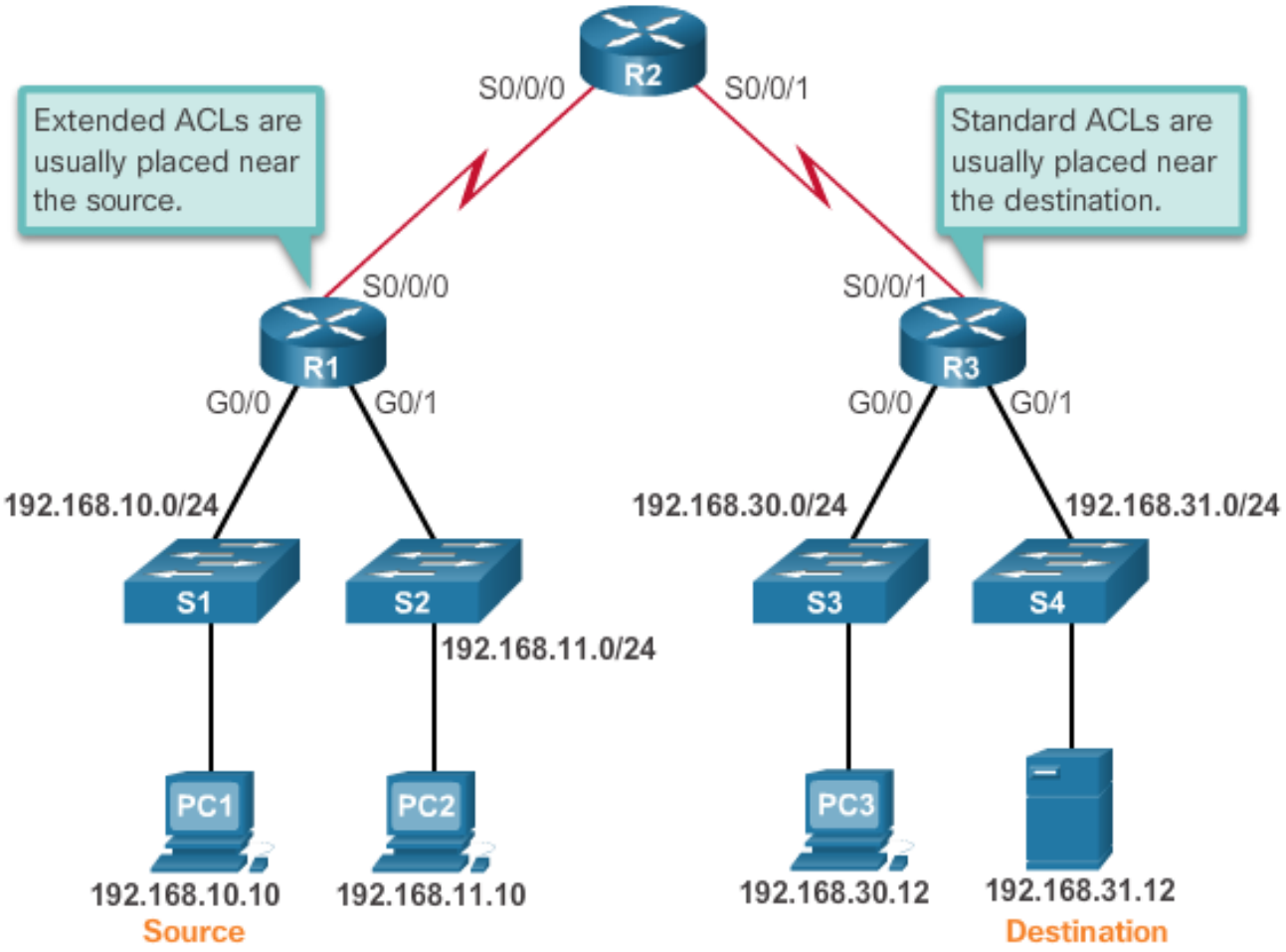
Guidelines for ACL Placement

Where to Place ACLs



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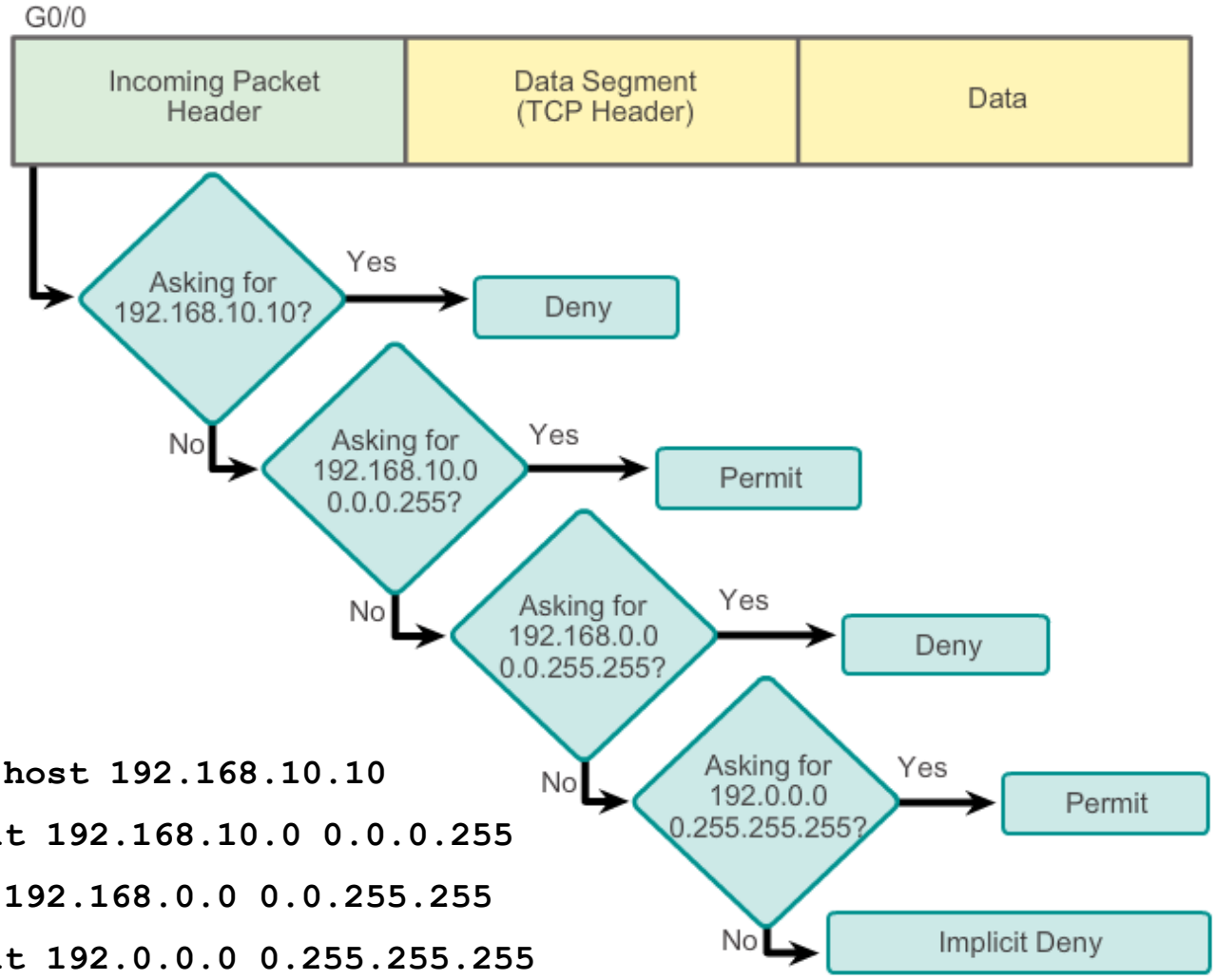
Configuring a Standard ACL



Example ACL

- `access-list 2 deny host 192.168.10.10`
- `access-list 2 permit 192.168.10.0 0.0.0.255`
- `access-list 2 deny 192.168.0.0 0.0.255.255`
- `access-list 2 permit 192.0.0.0 0.255.255.255`

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Configuring a Standard ACL

The full syntax of the standard ACL command is as follows:

```
Router(config)# access-list access-list-number
deny permit remark source [ source-wildcard ]
```

To remove the ACL, the global configuration **no access-list** command is used.

The **remark** keyword is used for documentation and makes access lists a great deal easier to understand.

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Applying Standard ACLs to Interfaces

After a standard ACL is configured, it is linked to an interface using the **ip access-group** command in interface configuration mode:

```
Router(config-if)# ip access-group { access-list-number | access-list-name } { in | out }
```

To remove an ACL from an interface, first enter the **no ip access-group** command on the interface, and then enter the global **no access-list** command to remove the entire ACL.

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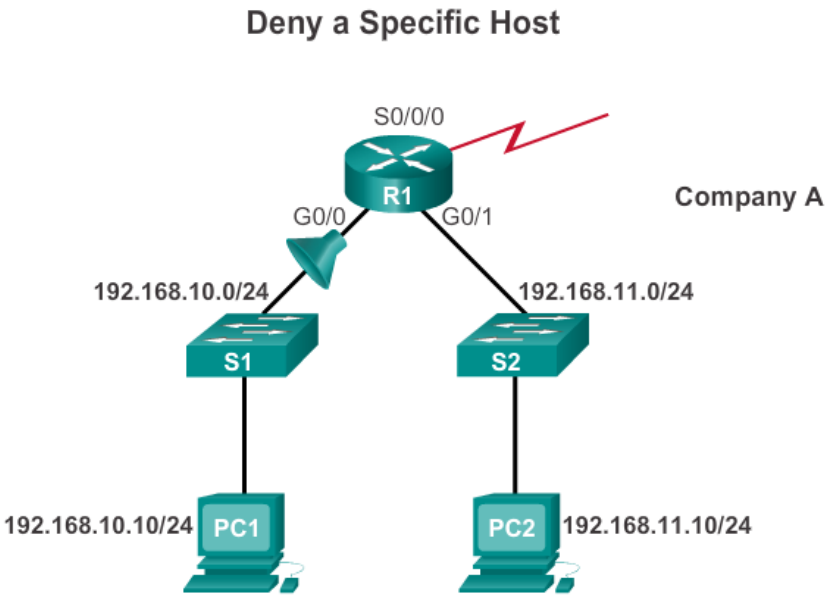
Applying Standard ACLs to Interfaces




```
R1(config)#access-list 1 deny host 192.168.10.10
R1(config)#access-list 1 permit any
R1(config)#interface g0/0
R1(config-if)#ip access-group 1 in
```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Configure Standard IPv4 ACLs

Creating Named Standard ACLs

```
Router(config)#ip access-list [standard | extended ] name
```

Alphanumeric name string must be unique and cannot begin with a number.

```
Router(config-std-nacl)#[permit | deny | remark] {source
[source- wildcard]} [log]
```

```
Router(config-if)#ip access-group name [in | out]
```

Activates the named IP ACL on an inteface.

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Modify IPv4 ACLs

Editing Standard Numbered ACLs

Editing Numbered ACLs Using a Text Editor

Configuration

```
R1(config)#access-list 1 deny host 192.168.10.99
R1(config)#access-list 1 permit 192.168.0.0 0.0.255.255
```

Step 1

```
R1#show running-config | include access-list 1
access-list 1 deny host 192.168.10.99
access-list 1 permit 192.168.0.0 0.0.255.255
```

Step 2

```
<Text editor>
access-list 1 deny host 192.168.10.10
access-list 1 permit 192.168.0.0 0.0.255.255
```

Step 3

```
R1#config t
Enter configuration commands, one per line.  End with
CNTL/Z.
R1(config)#no access-list 1
R1(config)#access-list 1 deny host 192.168.10.10
R1(config)#access-list 1 permit 192.168.0.0 0.0.255.255
```

Step 4

```
R1#show running-config | include access-list 1
access-list 1 deny host 192.168.10.10
access-list 1 permit 192.168.0.0 0.0.255.255
```


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Modify IPv4 ACLs

Editing Standard Numbered ACLs

Editing Numbered ACLs Using Sequence Numbers

Configuration

```
R1(config)#access-list 1 deny host 192.168.10.99
R1(config)#access-list 1 permit 192.168.0.0 0.0.255.255
```

Step 1

```
R1#show access-lists 1
Standard IP access list 1
    10 deny   192.168.10.99
    20 permit 192.168.0.0, wildcard bits 0.0.255.255
R1#
```

Step 2

```
R1#conf t
R1(config)#ip access-list standard 1
R1(config-std-nacl)#no 10
R1(config-std-nacl)#10 deny host 192.168.10.10
R1(config-std-nacl)#end
R1#
```

Step 3

```
R1#show access-lists
Standard IP access list 1
    10 deny   192.168.10.10
    20 permit 192.168.0.0, wildcard bits 0.0.255.255
R1#
```


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Modify IPv4 ACLs

Editing Standard Named ACLs

Adding a Line to a Named ACL

```
R1#show access-lists
Standard IP access list NO_ACCESS
    10 deny   192.168.11.10
    20 permit 192.168.11.0, wildcard bits 0.0.0.255
R1#conf t
Enter configuration commands, one per line.  End with
CNTL/Z.
R1(config)#ip access-list standard NO_ACCESS
R1(config-std-nacl)#15 deny host 192.168.11.11
R1(config-std-nacl)#end
R1#show access-lists
Standard IP access list NO_ACCESS
    10 deny   192.168.11.10
    15 deny   192.168.11.11
    20 permit 192.168.11.0, wildcard bits 0.0.0.255
R1#
```

Note: The **no sequence-number** named-ACL command is used to delete individual statements.

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Modify IPv4 ACLs

Verifying ACLs

```
R1# show ip interface s0/0/0
Serial0/0/0 is up, line protocol is up
  Internet address is 10.1.1.1/30
<output omitted>
  Outgoing access list is 1
  Inbound  access list is not set
<output omitted>

R1# show ip interface g0/0
GigabitEthernet0/0 is up, line protocol is up
  Internet address is 192.168.10.1/24
<output omitted>
  Outgoing access list is NO_ACCESS
  Inbound  access list is not set
<output omitted>
```

```
R1# show access-lists
Standard IP access list 1
    10 deny   192.168.10.10
    20 permit 192.168.0.0, wildcard bits 0.0.255.255
Standard IP access list NO_ACCESS
    15 deny   192.168.11.11
    10 deny   192.168.11.10
    20 permit 192.168.11.0, wildcard bits 0.0.0.255
R1#
```


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Modify IPv4 ACLs

ACL Statistics

```
R1#show access-lists
Standard IP access list 1
    10 deny   192.168.10.10 (4 match(es))
    20 permit 192.168.0.0, wildcard bits 0.0.255.255
Standard IP access list NO_ACCESS
    15 deny   192.168.11.11
    10 deny   192.168.11.10 (4 match(es))
    20 permit 192.168.11.0, wildcard bits 0.0.0.255
R1#
```

Output after pinging PC3 from PC1.

Matches have been incremented.

```
R1#show access-lists
Standard IP access list 1
    10 deny   192.168.10.10 (8 match(es))
    20 permit 192.168.0.0, wildcard bits 0.0.255.255
Standard IP access list NO_ACCESS
    15 deny   192.168.11.11
    10 deny   192.168.11.10 (4 match(es))
    20 permit 192.168.11.0, wildcard bits 0.0.0.255
R1#
```


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Structure of an Extended IPv4 ACL

Extended ACLs

Extended ACLs can filter on:

- Source address
- Destination address
- Protocol
- Port numbers

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Structure of an Extended IPv4 ACL

Extended ACLs

Using Port Numbers

```
access-list 114 permit tcp 192.168.20.0 0.0.0.255 any eq 23
access-list 114 permit tcp 192.168.20.0 0.0.0.255 any eq 21
access-list 114 permit tcp 192.168.20.0 0.0.0.255 any eq 20
```

Using Keywords

```
access-list 114 permit tcp 192.168.20.0 0.0.0.255 any eq telnet
access-list 114 permit tcp 192.168.20.0 0.0.0.255 any eq ftp
access-list 114 permit tcp 192.168.20.0 0.0.0.255 any eq ftp-data
```


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Configuring Extended ACLs

The procedural steps for configuring extended ACLs are the same as for standard ACLs. The extended ACL is first configured, and then it is activated on an interface. However, the command syntax and parameters are more complex to support the additional features provided by extended ACLs.

```
access-list access-list-number {deny | permit | remark}
protocol source [source-wildcard] [operator operand]
[port port-number or name] destination [destination-wildcard]
[operator operand] [port port-number or name][established]
```


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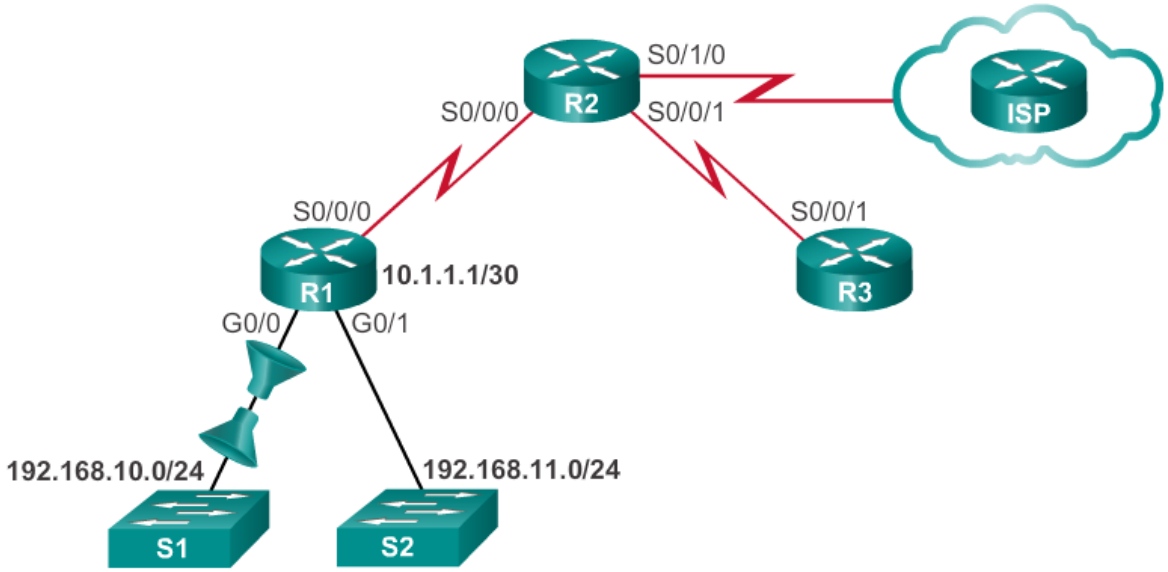
Applying Extended ACLs to Interfaces




```
R1(config)#access-list 103 permit tcp 192.168.10.0 0.0.0.255 any eq 80
R1(config)#access-list 103 permit tcp 192.168.10.0 0.0.0.255 any eq 443
R1(config)#access-list 104 permit tcp any 192.168.10.0 0.0.0.255 established
R1(config)#interface g0/0
R1(config-if)#ip access-group 103 in
R1(config-if)#ip access-group 104 out
```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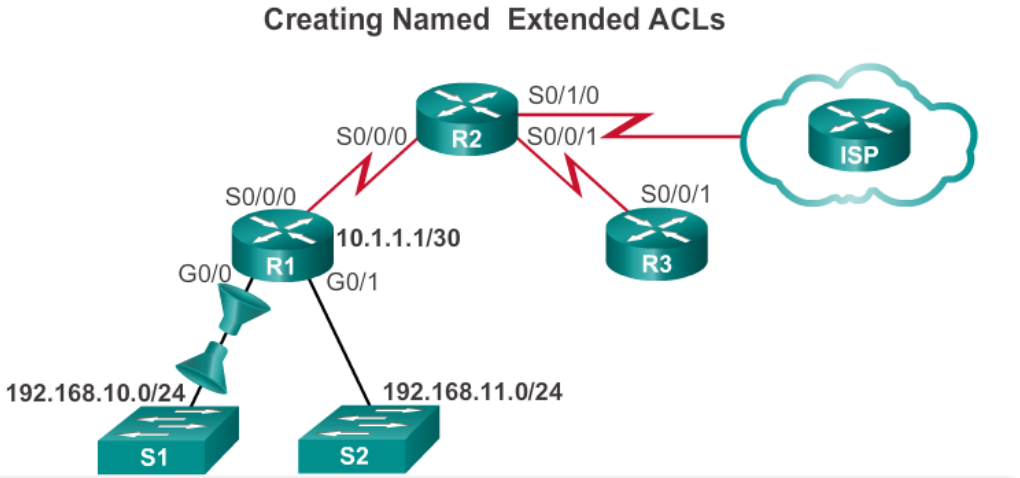
Configure Extended IPv4 ACLs

Creating Named Extended ACLs




```
R1(config)#ip access-list extended SURFING
R1(config-ext-nacl)#permit tcp 192.168.10.0 0.0.0.255 any eq 80
R1(config-ext-nacl)#permit tcp 192.168.10.0 0.0.0.255 any eq 443
R1(config-ext-nacl)#exit
R1(config)#ip access-list extended BROWSING
R1(config-ext-nacl)#permit tcp any 192.168.10.0 0.0.0.255 established
R1(config-ext-nacl)#exit
R1(config)#interface g0/0
R1(config-if)#ip access-group SURFING in
R1(config-if)#ip access-group BROWSING out
```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Configure Extended IPv4 ACLs

Verifying Extended ACLs

```
R1#show access-lists
Extended IP access list BROWSING
    10 permit tcp any 192.168.10.0 0.0.0.255 established
Extended IP access list SURFING
    10 permit tcp 192.168.10.0 0.0.0.255 any eq www
    20 permit tcp 192.168.10.0 0.0.0.255 any eq 443
R1#
R1#show ip interface g0/0
GigabitEthernet0/0 is up, line protocol is up
  Internet address is 192.168.10.1/24
<output omitted for brevity>
  Outgoing access list is BROWSING
  Inbound  access list is SURFING
<output omitted for brevity>
```


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Editing Extended ACLs

Editing an extended ACL can be accomplished using the same process as editing a standard. An extended ACL can be modified using:

- Method 1 - Text editor
- Method 2 – Sequence numbers

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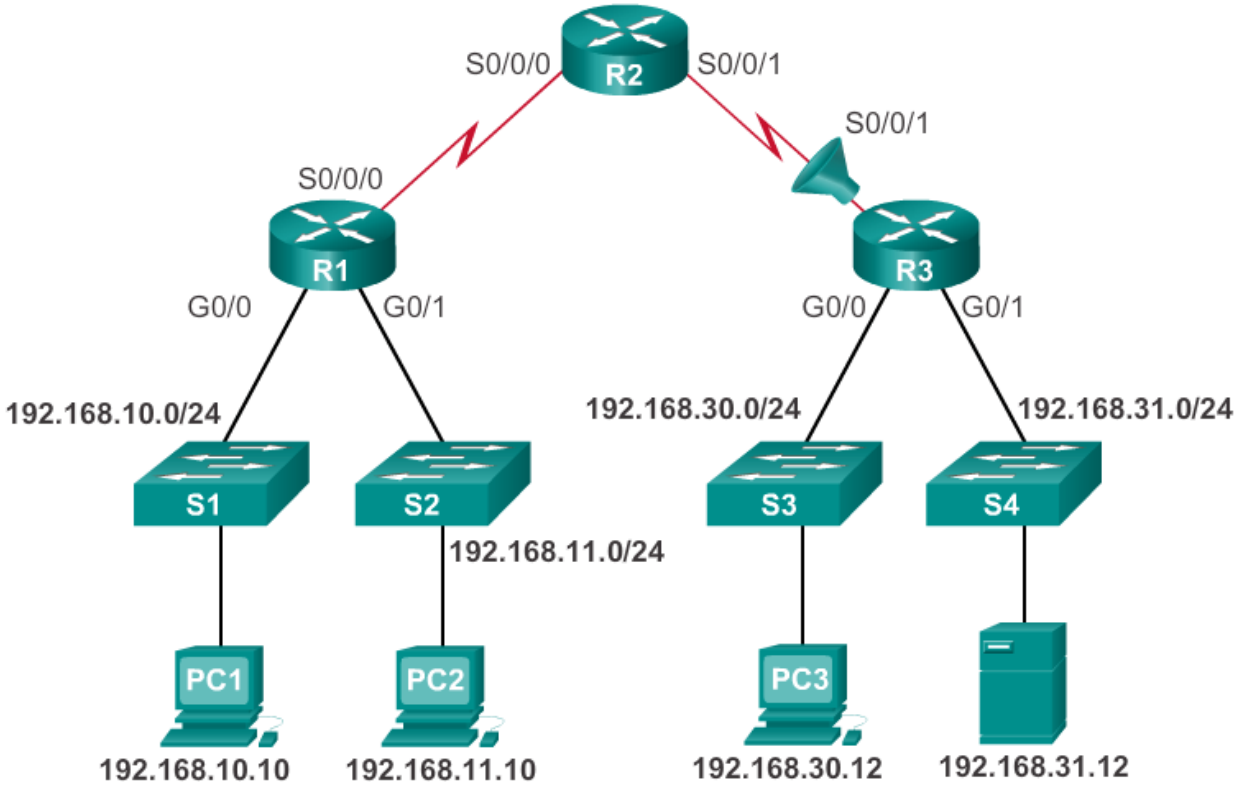
Troubleshooting Common ACL Errors - Example 1

Host 192.168.10.10

has no connectivity

with 192.168.30.12.




```
R3#show access-lists
Extended IP access list 110
    10 deny tcp 192.168.10.0 0.0.0.255 any (12 match(es))
    20 permit tcp 192.168.10.0 0.0.0.255 any eq telnet
    30 permit ip any any
```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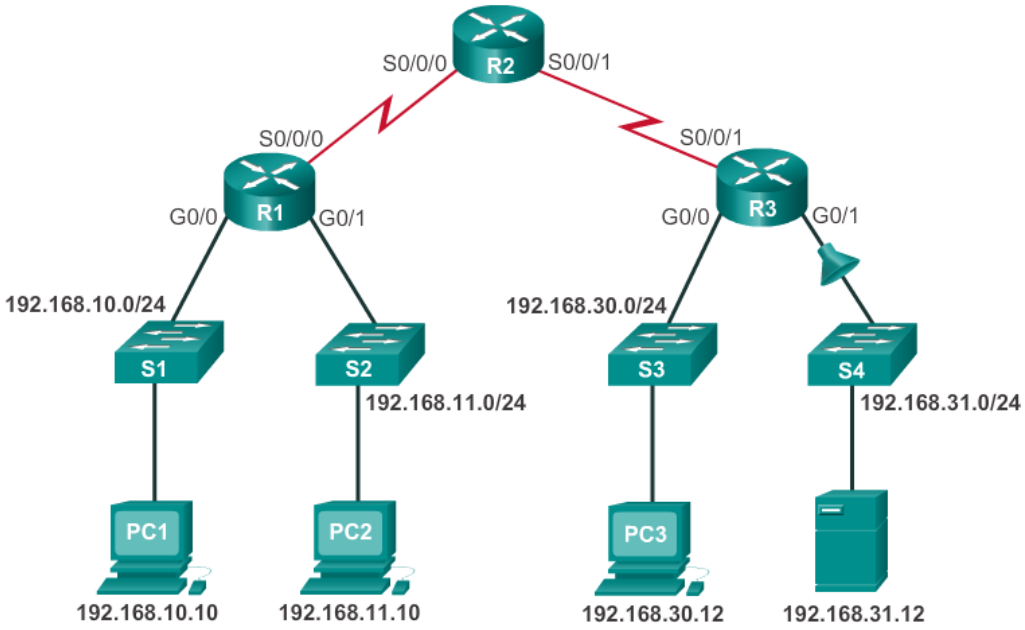
Common ACLs Errors

Troubleshooting Common ACL Errors – Example 2

Host 192.168.30.12 can use Telnet to connect to 192.168.31.12, but according to the security policy, this connection should not be allowed.

```
R2#show access-lists 150
Extended IP access list 150
    10 deny tcp any host 192.168.31.12 eq telnet
    20 permit ip any any
```



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