CHAPTER 22

# Implementing Cisco IOS Firewalls

Using a router as a firewall is a viable solution for many networks. This chapter explores how to use Cisco IOS Software features to set up and monitor a firewall. Although this chapter does not go into the design concepts of security, it does show you how to quickly configure the Cisco IOS features to secure your network.

## "Do I Know This Already?" Quiz

The purpose of the "Do I Know This Already?" quiz is to help you decide whether you really need to read the entire chapter. If you already intend to read the entire chapter, you do not necessarily need to answer these questions now.

The 9-question quiz, derived from the major sections in the "Foundation Topics" portion of the chapter, helps you to determine how to spend your limited study time.

Table 22-1 outlines the major topics discussed in this chapter and the "Do I Know This Already?" quiz questions that correspond to those topics.

**Table 22-1** *"Do I Know This Already?" Foundation Topics Section-to-Question Mapping*

| Foundation Topics Section | Questions Covered in This Section | Score |
|---|---|---|
| Configure a Cisco IOS Firewall Using the CLI | 1–4 | |
| Configure a Basic Firewall Using SDM | 5–6 | |
| Configure an Advanced Firewall Using SDM | 7–9 | |
| **Total Score** | | |

**CAUTION** The goal of self-assessment is to gauge your mastery of the topics in this chapter. If you do not know the answer to a question or are only partially sure of the answer, you should mark this question wrong for purposes of self-assessment. Giving yourself credit for an answer that you correctly guess skews your self-assessment results and might provide you with a false sense of security.

1. Which of the following is the proper syntax to define an inspection rule named "myrule" that will inspect FTP packets?
   a. **ip inspect name inspection-name myrule protocol alert on timeout 30**
   b. **ip inspect name myrule protocol ftp alert on timeout 30**
   c. **ip inspect name myrule ftp alert on timeout 30**
   d. **ip inspect name inspection-name myrule protocol ftp alert on timeout 30**
2. Which of the following is the correct command to apply the inspection rule named "myrule" to an interface to inspect packets traveling into the interface?
   a. **ip inspect myrule**
   b. **ip inspect in myrule**
   c. **ip inspect inbound myrule**
   d. **ip inspect myrule in**
3. Which of the following is the correct syntax used to enable real-time alerts?
   a. **ip-inspect alert**
   b. **no ip-inspect alert-off**
   c. **ip-inspect alert-on**
   d. **ip-inspect alert-on**
4. What is the default time between alert updates when using IP inspection?
   a. 10 seconds
   b. 20 seconds
   c. 30 seconds
   d. 60 seconds
5. Which of the following is true regarding the Basic Firewall Wizard used in SDM?
   a. The Basic Firewall Wizard allows only two interfaces to be configured.
   b. The Basic Firewall Wizard allows multiple trusted interfaces to be configured.
   c. The Basic Firewall Wizard allows only one DMZ to be configured.
   d. The Basic Firewall Wizard allows multiple untrusted interfaces to be configured.
6. Which of the following is not true regarding the Basic Firewall Wizard used in SDM?
   a. You may edit policies for a specific protocol and interface within the Basic Firewall Wizard.
   b. You must use the CLI or the Advanced Firewall Wizard to edit policies for a specific protocol on an interface.

c. You may use the Basic Firewall Wizard on a router with more than two trusted interfaces.

d. You may use the Basic Firewall Wizard on a router with more than one DMZ.

7. Which of the following is true regarding the Advanced Firewall Wizard?

a. You must already have defined a security policy in order to use it inside the Advanced Firewall Wizard.

b. There are four default application security policies built into SDM (None, Low, Medium, and High).

c. There are three default application security policies built into SDM (Low, Medium, and High).

d. Application security policies are not used in conjunction with the Advanced Firewall Wizard.

8. Which of the following is true regarding the Advanced Firewall Wizard?

a. Auditing is configured on a global level, affecting all protocols simultaneously.

b. Auditing is available only if logging is enabled.

c. Auditing is configured on a per-protocol level.

d. Logging is available only if auditing has been enabled.

9. Which is true regarding the Advanced Firewall Wizard?

a. Logging must be configured through the CLI before starting the wizard.

b. Logging may be configured through the wizard.

c. The logging hosts must be configured through the CLI before starting the wizard

d. The wizard allows a maximum of three logging hosts.

The answers to the "Do I Know This Already?" quiz are found in Appendix A, "Answers to the 'Do I Know This Already?' Quizzes and Q&A Sections." The suggested choices for your next step are as follows:

- **5 or fewer overall score**—Read the entire chapter. This includes the "Foundation Topics," "Foundation Summary," and "Q&A" sections.
- **6 or 7 overall score**—Begin with the "Foundation Summary" section, and then go to the "Q&A" section.
- **8 or 9 overall score**—If you want more review on these topics, skip to the "Foundation Summary" section, and then go to the "Q&A" section. Otherwise, move to the next chapter.

# Foundation Topics

## Configure a Cisco IOS Firewall Using the CLI

Configuring a Cisco IOS firewall using the CLI is simple. You already know how to make and access ACLs. A Cisco IOS firewall allows you to add inspection rules to the interface. An inspection rule is simply another method of ensuring the safety of that interface. The router drops packets that are unsafe in the context of the already established connections. For example, when a TCP inspection rule is added to an interface, a TCP reset (RST) packet is not allowed into the interface unless there has previously been a TCP connection established with the machine sending the reset.

When using inspection rules, you must apply an ACL to the interface. Any packet may be rejected by the inspection rule, the ACL, or both. The packet is first examined by the access list. If the packet passes the access list, then the inspection rule is checked next to determine whether that packet may transition the interface.

There are five simple steps to implementing inspection rules through the CLI:

**Step 1** Choose the interface and packet direction to inspect.

**Step 2** Configure an IP ACL for the interface.

**Step 3** Define the inspection rules.

**Step 4** Apply the inspection rules and the ACL to the interface.

**Step 5** Verify the configuration.

### Step 1: Choose an Interface and Packet Direction to Inspect

Choosing an interface is generally very easy. There are two general guidelines that will help you decide where to apply an ACL and inspection rule. Although every network is different, these two general guidelines will help you decide how and where to apply the ACL and inspection rule:

- On an interface where untrusted traffic originates:
  - Apply the ACL on the inbound direction of the interface so that only traffic allowed by the ACL is inspected.
  - Apply the inspection rule on the inbound direction of the interface so that only traffic considered safe transits the interface.

- For all other interfaces, apply the ACL on the outbound direction of the interface so that all unwanted traffic is dropped rather than sent over the network.

## Step 2: Configure an IP ACL for the Interface

You must use extended access lists when you are also using inspection rules. If you are not familiar with extended access lists or need to review them, you are encouraged to do so now. A full explanation of extended access lists can be found at Cisco.com.

The access list in Example 22-1 would be applied to the outside interface. This access list allows users outside the network to connect to the SMTP server residing at 10.10.1.9 and the HTTP server residing at 10.10.1.15.

**Example 22-1** *Extended Access List*

```
ip access-list extended acl_from_outside
 permit tcp any host 10.10.1.9 eq 25
 permit tcp any host 10.10.1.15 eq 80
 deny ip any any log
```

## Step 3: Define the Inspection Rules

An inspection rule is defined through the **ip inspect** command, the syntax for which is as follows:

```
[no] ip inspect name inspection-name protocol [alert {on ¦ off}] [timeout seconds]
```

Table 22-2 lists the parameters available for this command.

**Table 22-2** **ip inspect** *Command Parameters*

| Parameter | Description |
|---|---|
| *inspection-name* | Defines the name of the inspection rule. |
| *protocol* | Defines the protocol to be inspected. There are more than 170 supported protocols, some of which are as follows: TCP, UDP, ICMP, SMTP, ESMTP, SMTP, EMSTP, CUSEEME, FTP, FTPS, HTTP, H323, NETSHOW, RCMD, RealAudio, RPC, RTSP, SIP, SKINNY, SQLNET, TFTP, VDOLive. |
| **alert** {**on** \| **off**} | Toggles alerts on or off. |
| **timeout** *seconds* | Defines the time interval in seconds between alert updates (default is 10 seconds). |

Example 22-2 shows how to define the inspection rules for this example.

**Example 22-2** *IP Inspection Rules*

```
Router(config)#ip inspect name from_outside ftp alert off audit-trail on timeout 60
Router(config)#ip inspect name from_outside http alert on audit-trail on timeout 30
```

The preceding example sets the timeout for FTP to 60 seconds. No alerts are sent for FTP. The HTTP setting decreases the timeout to 30 seconds and sends alerts regarding HTTP. Both FTP and HTTP in this example use audit trails.

## Step 4: Apply the Inspection Rules and the ACL to the Interface

Now that the ACL and inspection rules have been defined, you must apply these to the interface. Audit trails will be used, so your first task is to enable audit trails in the global configuration. Alerts have also been chosen. These are simple to set up with the global commands executed in Example 22-3.

**Example 22-3** *Global Configuration for Logging and Alerts*

```
Router(config)#ip inspect audit-trail
! enables the delivery of audit trail messages using syslog
Router(config)#logging on
! turns on logging
Router(config)#logging host 10.10.1.20
! sets out logging server to 10.10.1.20
Router(config)#no ip inspect alert-off
! turns on real-time alerts
```

Now that the global configuration is established, you simply apply the previously defined inspection rules to the individual interface. While you are in the interface configuration mode, you will also apply the ACL to that interface as demonstrated in Example 22-4.

**Example 22-4** *Apply Inspection Rules to the Interface*

```
Router(config)#int e0/0
Router(config-if)#ip inspect from_outside in
Router(config-if)#ip access-group acl_from_outside in
Router(config-if)#^z
```

The configuration is now complete. The next step is to verify your configuration.

## Step 5: Verify the Configuration

Verification of the setup is very simple. The **show ip inspect** command displays how the inspection rules have been configured. The syntax for the **show ip inspect** command is as follows:

```
show ip inspect [name inspection-name ¦ config ¦ interface ¦ session {detail} ¦
  statistics ¦ all]
```

A number of options are available with this command, as described in Table 22-3.

**Table 22-3** **show ip inspect** *Command Options*

| Parameter | Description |
|---|---|
| **name** *inspection-name* | Displays the configured inspection with the defined inspection name |
| **config** | Displays the entire IP inspection configuration |
| **interface** | Displays the configurations used within the interface mode |
| **session** | Displays sessions that are currently being tracked |
| **detail** | Displays additional details about current sessions |
| **statistics** | Displays statistical information |
| **all** | Displays all information |

The output from this command is simple to understand, as demonstrated in Example 22-5.

**Example 22-5** **show ip inspect session** *Command Output*

```
Router#show ip inspect session
Established Sessions
 Session 70A64274 (172.16.1.12:32956)=>(10.10.1.5:25) tcp SIS_OPEN
   Created 00:00:07, Last heard 00:00:03
   Bytes sent (initiator:responder) [137:319] acl created 2
      Inbound access-list acl_from_outside applied to interface Ethernet0/0
```

Example 22-6 shows the output from a **show ip inspect all** command.

**Example 22-6** **show ip inspect all** *Command Output*

```
Router#show ip inspect all
Session audit trail is enabled
one-minute (sampling period) thresholds are [400:500] connections
max-incomplete sessions thresholds are [400:500]
max-incomplete tcp connections per host is 50. Block-time 0 minute.
tcp synwait-time is 30 sec -- tcp finwait-time is 5 sec
tcp idle-time is 3600 sec -- udp idle-time is 30 sec
dns-timeout is 5 sec
Inspection Rule Configuration
 Inspection name inspect_from_outside
```

*continues*

**Example 22-6** **show ip inspect all** *Command Output (Continued)*

```
    tcp timeout 3600
    udp timeout 30
    ftp timeout 3600
Interface Configuration
 Interface Ethernet0
  Inbound inspection rule is inspect_from_outside
    tcp timeout 3600
    udp timeout 30
    ftp timeout 3600
  Outgoing inspection rule is not set
  Inbound access list is acl_from_outside
  Outgoing access list is not set
 Established Sessions
 Session 25A6E1C (10.3.0.1:46065)=>(10.1.1.9:25) ftp SIS_OPEN
 Session 25A34A0 (10.1.1.9:20)=>(10.3.0.1:46072) ftp-data SIS_OPEN
```

Although debugging IP inspection is beyond the scope of this book, it can be helpful to know a few of the **debug** commands associated with inspection. Table 22-4 shows the most common **debug** commands associated with IP inspection and describes their purpose.

**Table 22-4** **debug ip inspect** *Commands*

| Command | Description |
|---|---|
| **debug ip inspect function-trace** | Debugs the functions used by **ip inspect** |
| **debug ip inspect object-creation** | Debugs the creation of objects used by **ip inspect** |
| **debug ip inspect object-deletion** | Debugs the deletion of objects used by **ip inspect** |
| **debug ip inspect events** | Debugs events within **ip inspect** |
| **debug ip inspect timers** | Debugs timers used in **ip inspect** |
| **debug ip inspect detail** | Provides detailed debugging of **ip inspect** |

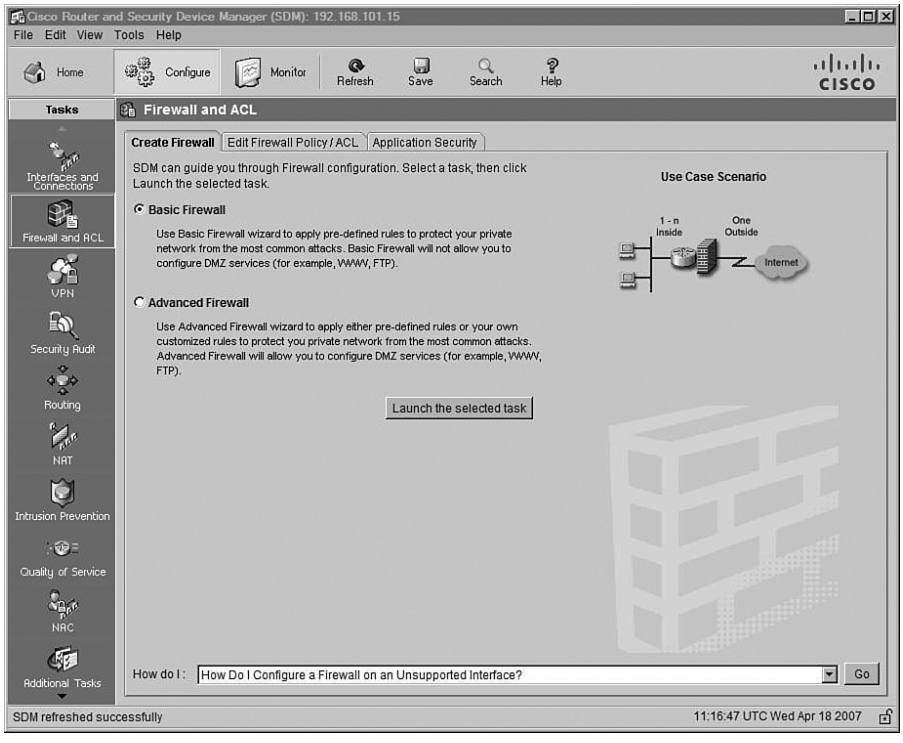
## Configure a Basic Firewall Using SDM

SDM provides a graphical interface that allows you to configure security on Cisco routers quickly. The ease of use and automatic features of SDM can be a great benefit to the administrator. When using SDM to configure a basic firewall, you use the same five steps that you used with the CLI, as described in the previous section. However, because you are using a graphical interface, these steps are not easily distinguishable from each other.

This section describes how to use SDM to configure a basic firewall. If you have never used SDM before, you will be amazed by how quickly you can complete a simple configuration. The next section describes how to use SDM to configure an advanced firewall.

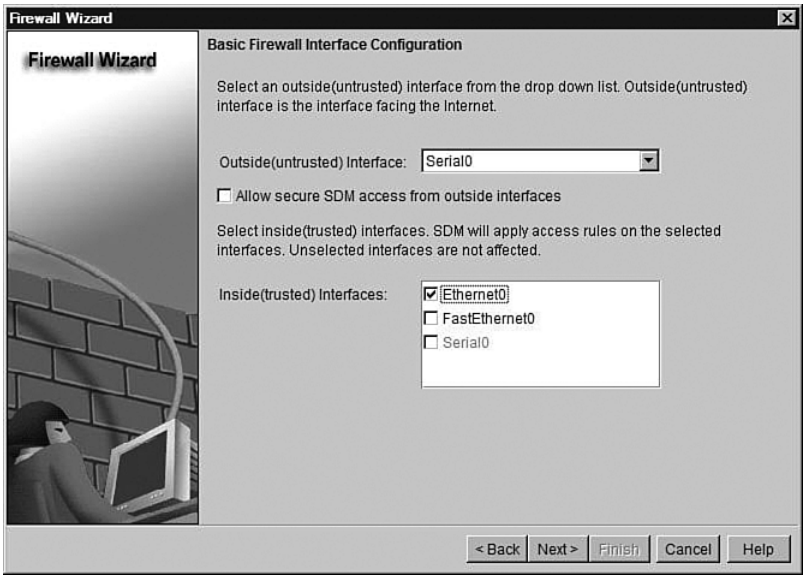
After you start SDM, click the **Configure** button at the top of the window. Next, click **Firewall and ACL** in the Tasks bar on the left. As Figure 22-1 shows, the default choice is Basic Firewall. Before you click the Launch the Selected Task button, notice the How do I pull-down menu at the bottom of the window. This menu provides help on the most common tasks when using SDM.

**Figure 22-1** *Basic Firewall Creation*



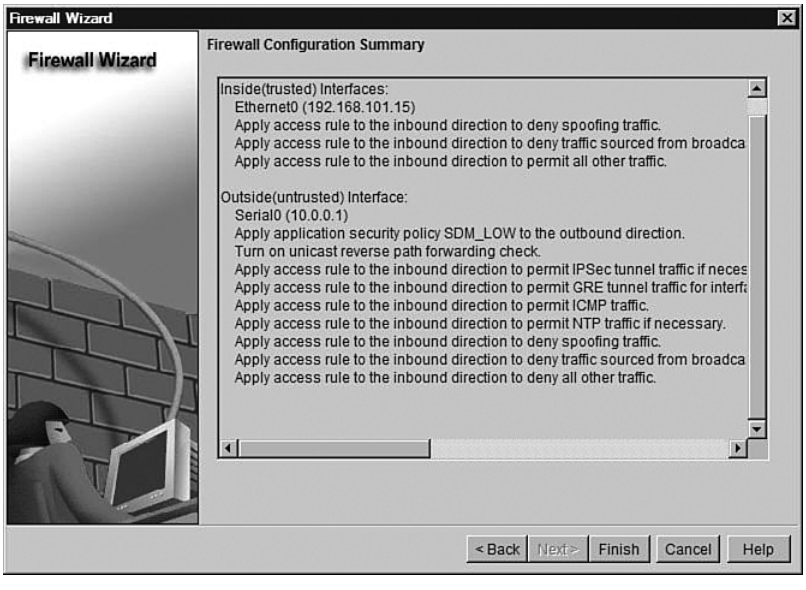

Click the **Launch the selected task** button. You are taken to the Basic Firewall Interface Configuration window, shown in Figure 22-2, where you decide which interfaces are trusted and which are not trusted. Notice that this window also provides you with the option to allow SDM access through the untrusted interface. Assign the trust levels to the interfaces and click the **Next>** button.

**Figure 22-2** *Basic Firewall Interface Configuration*



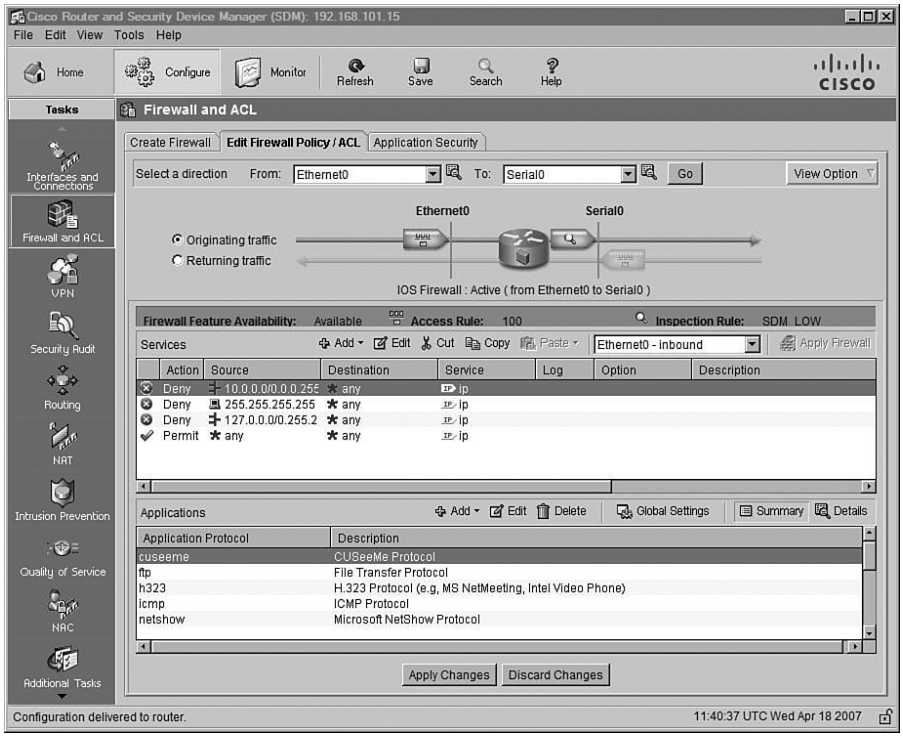

Next, you see the Firewall Configuration Summary window, shown in Figure 22-3. Although this is one of the most basic configurations possible, you can see that many configuration options have been enabled with just a few mouse clicks. These options are converted into CLI commands to be saved in the configuration.

**Figure 22-3** *Firewall Configuration Summary*



At this point, the basic configuration is complete. However, you might want to adjust some parameters to allow things such as HTTP or FTP access. You so this under the Edit Firewall Policy/ACL tab. As shown in Figure 22-4, this tab enables you to permit or deny access based on source or destination address, type of service, and application. Although this is still the basic firewall configuration, the flexibility provided is more than adequate for many users' needs. Take a few moments and review this short section before moving on to the advanced configuration using SDM.

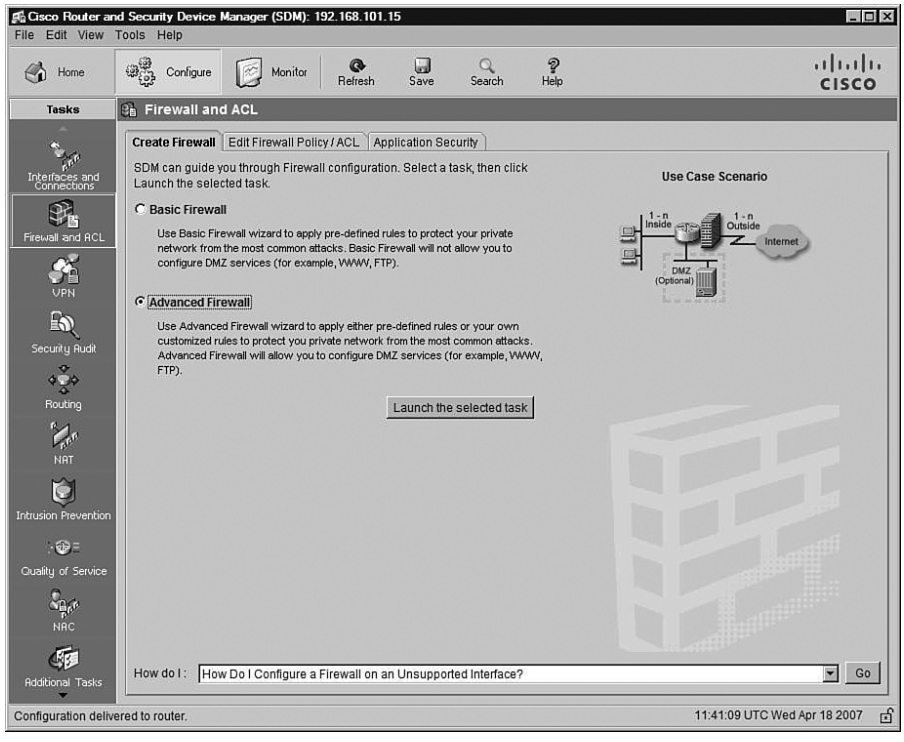
**Figure 22-4** *Edit Firewall Policy/ACL Tab*




## Configure an Advanced Firewall Using SDM

The Advanced Firewall Wizard provides easy access to some features that are not available under the Basic Firewall option. The Advanced Firewall Wizard works similarly to the Basic Firewall Wizard. As shown in Figure 22-5, simply choose **Advanced Firewall** instead of Basic Firewall on the Create Firewall tab of the Firewall and ACL window.

**Figure 22-5** *Advanced Firewall Creation*




Click **Launch the selected task** and you are presented with the Advanced Firewall Interface Configuration window. The most noticeable differences on this window compared to the Basic Firewall Interface Configuration window (shown previously in Figure 22-2) are that you can choose multiple interfaces as either inside (trusted) or outside (untrusted) and can choose an interface for use as a DMZ. Figure 22-6 shows the Advanced Firewall Interface Configuration window. In this example, Ethernet0 is selected as a trusted (inside) network, Serial0 as an untrusted (outside) network, and FastEthernet0 as a DMZ.

Click the **Next>** button, and you are taken to the Advanced Firewall DMZ Service Configuration window, where you configure aspects of the DMZ. As Figure 22-7 shows, the wizard knows that FastEthernet0 was chosen as the DMZ. Click the **Add** button to continue.

**Figure 22-6** *Advanced Firewall Interface Configuration*

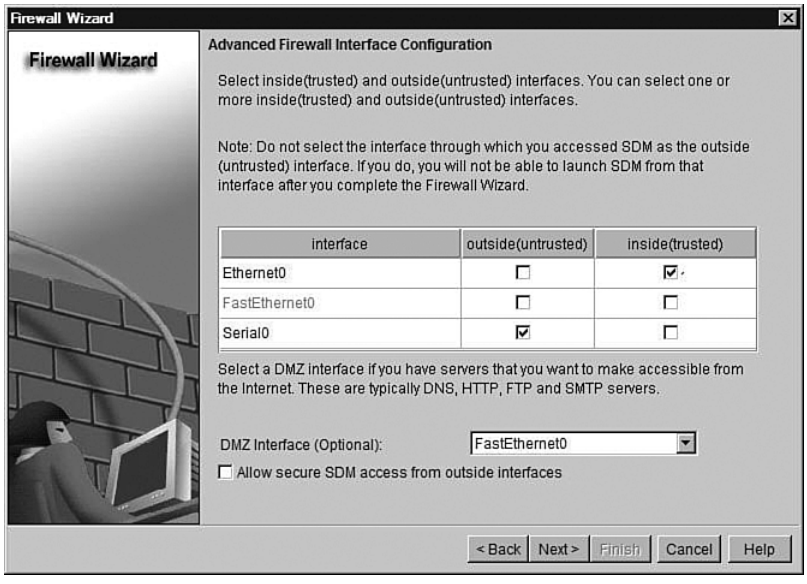
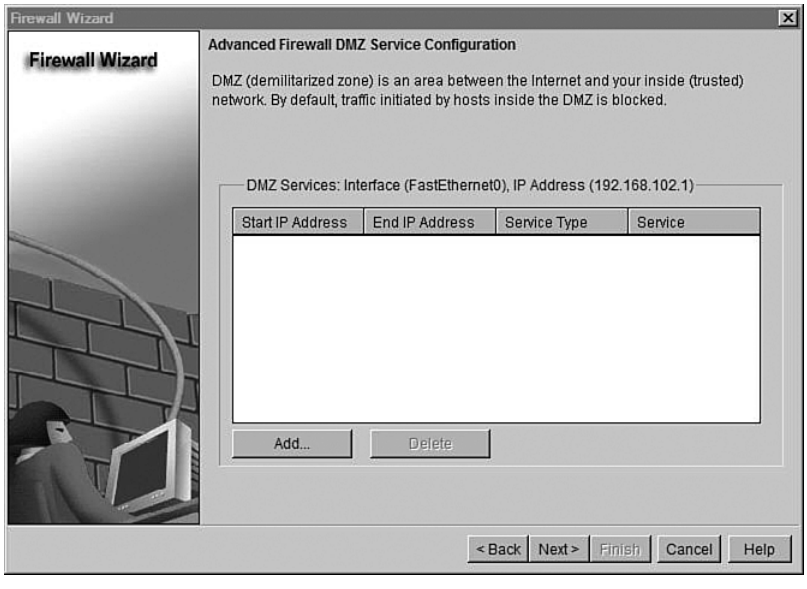
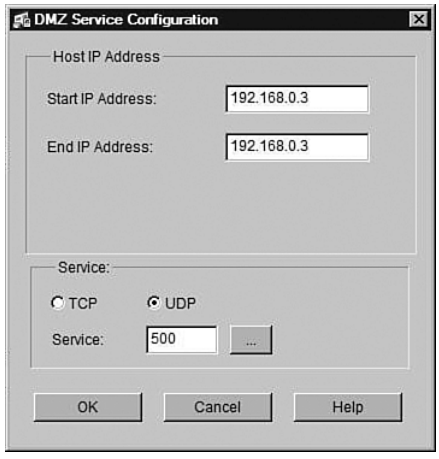



**Figure 22-7** *Advanced Firewall DMZ Service Configuration*



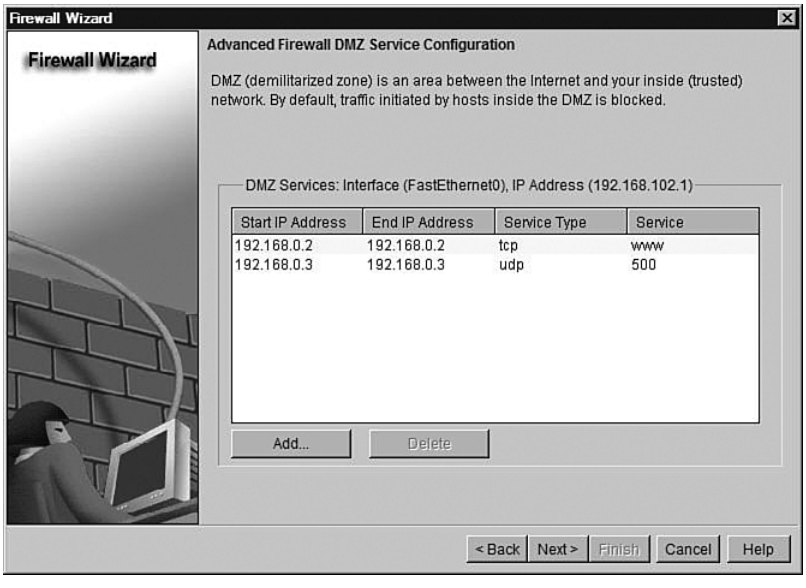
Because you need to add services to the DMZ, you are prompted for the starting and ending IP addresses for a service. You then choose whether you will use IP or UDP and the service associated with the previously entered addresses. Figure 22-8 shows that UDP with port number 500 (IKE) was chosen. Alternatively, you can choose a service such as WWW or FTP.

**Figure 22-8** *DMZ Service Configuration*



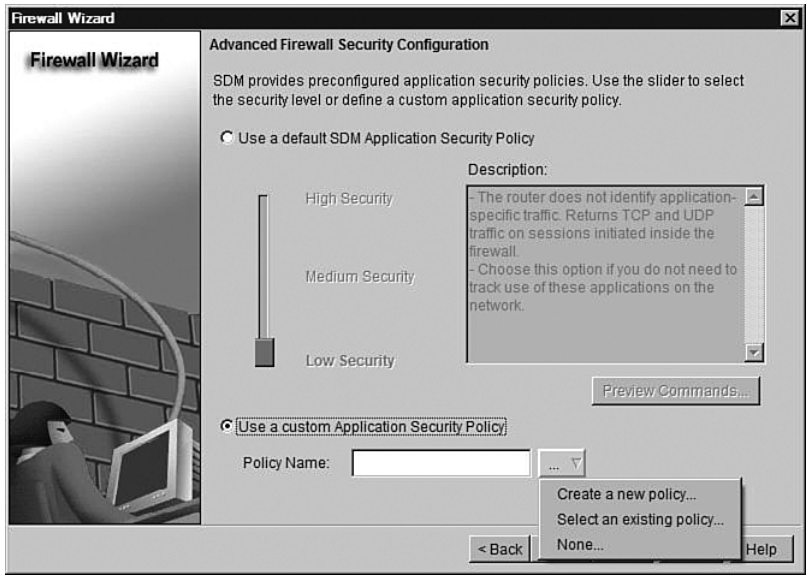

After you have added as many services as you wish to the DMZ, you see a list similar to that shown in Figure 22-9. If you have chosen more services than can be displayed in the window, you will see a scroll bar on the right side of the window.

**Figure 22-9** *Configured DMZ Services*



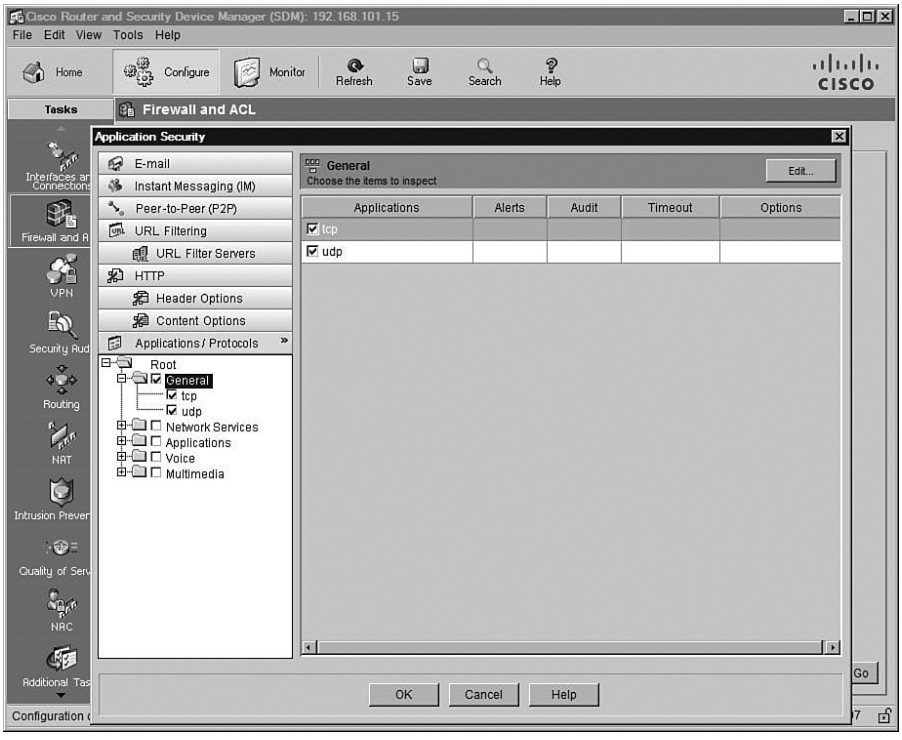
After all the services are configured, click **Next>** to go to the Advanced Firewall Security Configuration window. In this window, you can choose to use one of the three built-in SDM security policies (High Security, Medium Security, or Low Security) or a custom security policy for applications. In Figure 22-10, the option to use a custom policy has been chosen. When you choose this option, you are presented with an additional pull-down menu that allows you to select an existing policy or create a new one.

**Figure 22-10** *Advanced Firewall Security Configuration*



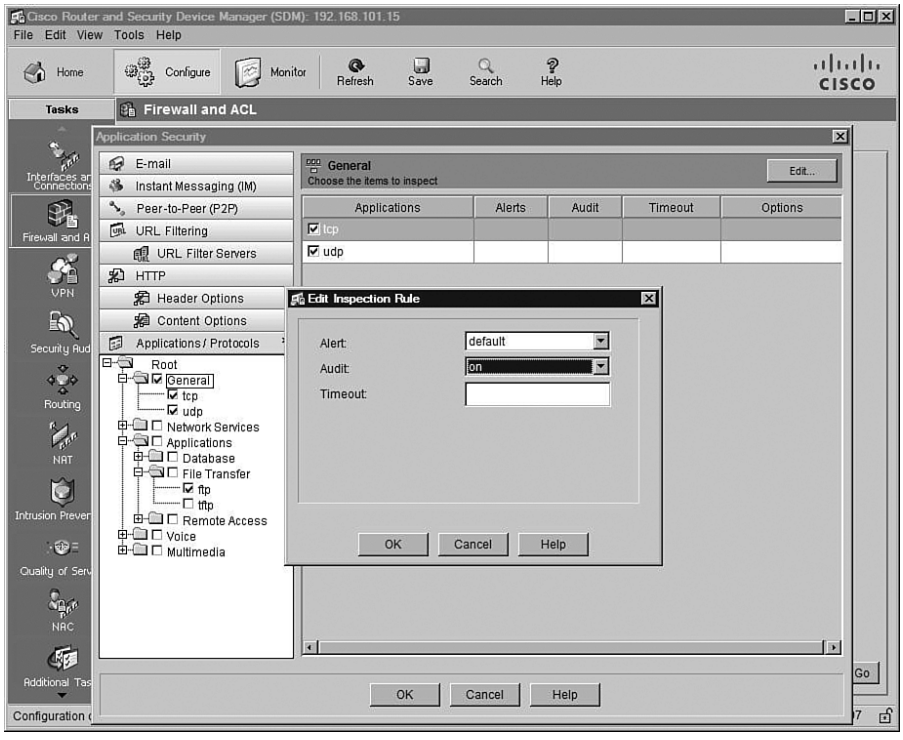

When presented with the Application Security window, you can choose any of the predefined applications from the list on the left. In Figure 22-11, the general parameters for the TCP and UDP protocols have been set up. Clicking the **Next>** button brings up the Application Security Window.

**Figure 22-11** *Application Security*



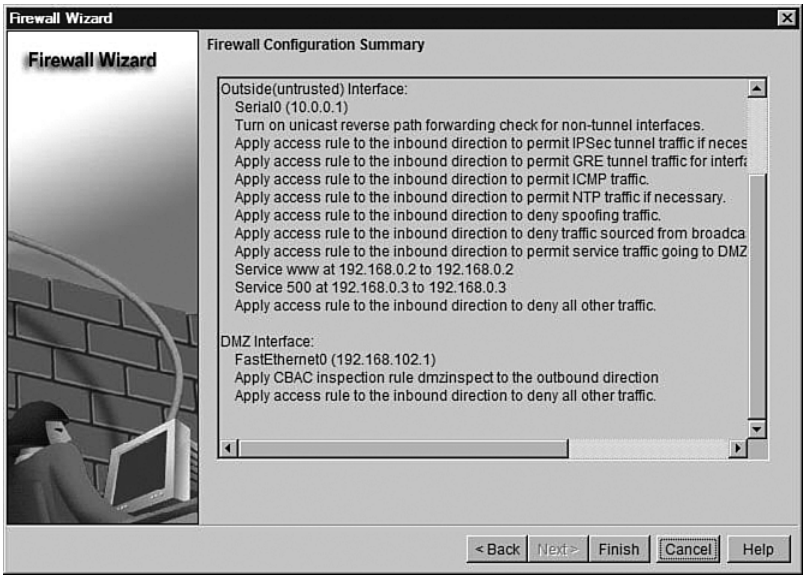

Even after you have configured all the protocols and applications that are required by the network, you can still go back to any given protocol and edit the inspection mode defaults for that protocol within the security policy. As Figure 22-12 shows, you can set alerts, auditing, and timeouts on a per-protocol basis. Clicking **OK** at the bottom of the dialog box takes you back to the Advanced Firewall Security Configuration window (see Figure 22-10), which allows you to save the policy.

**Figure 22-12** *Editing the Inspection Mode*



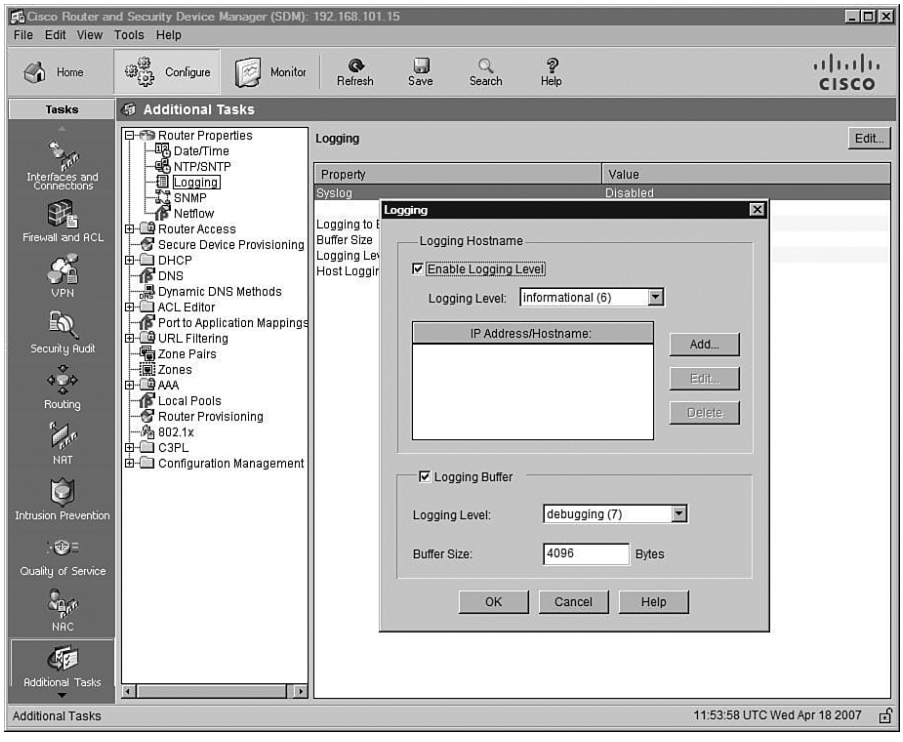

After you have finished configuring the security policy, you need to verify the policy. The Firewall Configuration Summary window shown in Figure 22-13 displays the security policies as configured by interface. Notice that numerous rules have been applied on the outside interface and that HTTP and IKE traffic is allowed to enter the interface bound for specific hosts. Several different protocols have also been filtered.

**Figure 22-13** *Firewall Configuration Summary*



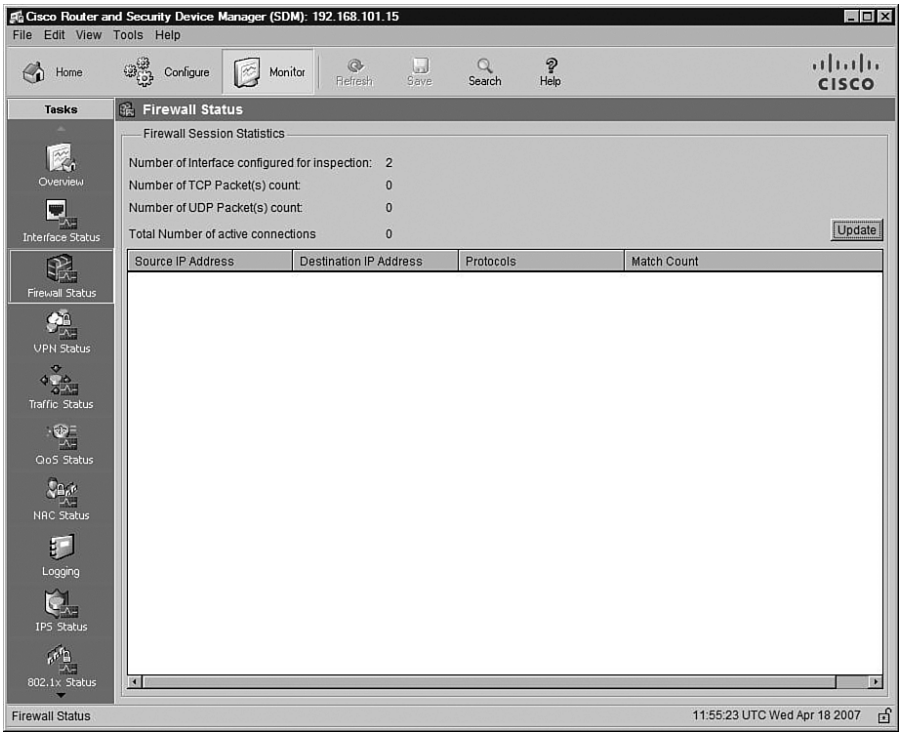

This completes the configuration of the policies, but you must still enable logging. To do so, click the **Configure** button at the top of the SDM window, click **Additional Tasks** in the Tasks bar on the left, expand **Router Properties**, and click **Logging**. Click **Edit** in the upper-right corner of the Logging pane to open the Logging dialog box. As Figure 22-14 shows, you can enable logging, set the logging levels, assign logging hosts, and set the logging buffer.

**Figure 22-14** *Setting Logging Options*




At this point, the security policy configuration has been completed for this router. The final task is to monitor the router. Click the **Monitor** button at the top of the SDM window, and then click **Firewall Status** in the Tasks bar. As shown in Figure 22-15, this allows you to see what packets are flowing through the router.

**Figure 22-15** *Monitor Firewall Status*



# Foundation Summary

Configuring a router as a firewall using either the CLI or one of the wizards is not a difficult task. Take a few moments to review the highlights of this chapter. If you do not understand what is being presented, go back through the text and review.

There are five steps to implementing inspection rules:

**Step 1** Choose the interface and packet direction to inspect.

**Step 2** Configure an IP ACL for the interface.

**Step 3** Define the inspection rules.

**Step 4** Apply the inspection rules and the ACL to the interface.

**Step 5** Verify the configuration.

To configure an extended access list, enter the following:

```
ip access-list extended acl_from_outside
 permit tcp any host 10.10.1.5 eq 25
 permit tcp any host 10.10.1.10 eq 80
 deny ip any any log
```

To create an inspection rule, enter the following:

```
ip inspect name inspection-name protocol [alert {on ¦ off}] [timeout seconds]
```

Table 22-5 lists and describes the parameters available for the preceding command.

**Table 22-5** **ip inspect name** *Parameters*

| Parameter | Description |
|---|---|
| *inspection-name* | Defines the name of the inspection rule. |
| *protocol* | Defines the protocol to be inspected. The list of supported protocols is as follows: TCP, UDP, ICMP, SMTP, ESMTP, SMTP, EMSTP, CUSEEME, FTP, FTPS, HTTP, H323, NETSHOW, RCMD, RealAudio, RPC, RTSP, SIP, SKINNY, SQLNET, TFTP, VDOLive. |
| **alert** {**on** \| **off**} | Toggles alerts on or off. |
| **timeout** *seconds* | Defines the time interval in seconds between alert updates (default is 10 seconds). |

A sample IP inspection rule is as follows:

```
Router(config)#ip inspect name from_outside ftp alert off audit-trail on timeout 60
Router(config)#ip inspect name from_outside http alert on audit-trail on timeout 30
```

The **show ip inspect** command displays how the inspection rules have been configured. Table 22-6 describes the parameters for this command.

**Table 22-6** **show ip inspect** *Command Options*

| Parameter | Description |
|---|---|
| **name** *inspection-name* | Displays the configured inspection with the defined inspection name |
| **config** | Displays the entire IP inspection configuration |
| **interface** | Displays the configurations used within the interface mode |
| **session** | Displays sessions that are currently being tracked |
| **detail** | Displays additional details about current sessions |
| **statistics** | Displays statistical information |
| **all** | Displays all information |

Table 22-7 shows the most common **debug** commands associated with the **ip inspection** command and their purpose.

**Table 22-7** **debug ip inspect** *Commands*

| Command | Description |
|---|---|
| **debug ip inspect function-trace** | Debugs the functions used by **ip inspect** |
| **debug ip inspect object-creation** | Debugs the creation of objects used by **ip inspect** |
| **debug ip inspect object-deletion** | Debugs the deletion of objects used by **ip inspect** |
| **debug ip inspect events** | Debugs events within **ip inspect** |
| **debug ip inspect timers** | Debugs timers used in **ip inspect** |
| **debug ip inspect detail** | Detailed debugging of **ip inspect** |

There are many features available when using either the Basic Firewall Wizard or the Advanced Firewall Wizard. But, there are also a few major differences between the two wizards. Table 22-8 highlights the differences.

**Table 22-8** *Basic and Advanced Firewall Wizard Features*

| Feature | Basic | Advanced |
|---|---|---|
| Configure untrusted network | Yes | Yes |
| Configure multiple untrusted networks | No | Yes |
| Configure trusted network | Yes | Yes |
| Configure multiple trusted networks | Yes | Yes |

**Table 22-8** *Basic and Advanced Firewall Wizard Features (Continued)*

| Feature | Basic | Advanced |
|---|---|---|
| Configure DMZ | No | Yes |
| Configure protocol-specific alerts | Yes | Yes |
| Configure protocol-specific logging | Yes | Yes |
| Graphical interface | Yes | Yes |
| Monitoring capabilities | Yes | Yes |

# Q&A

The questions and scenarios in this book are designed to be challenging and to make sure that you know the answer. Rather than allowing you to derive the answers from clues hidden inside the questions themselves, the questions challenge your understanding and recall of the subject.

Hopefully, mastering these questions will help you limit the number of exam questions on which you narrow your choices to two options, and then guess.

You can find the answers to these questions in Appendix A. For more practice with exam-like question formats, use the exam engine on the CD-ROM.

1. Name some advantages of using the Advanced Firewall Wizard as opposed to using the CLI.
2. When is it appropriate to use the Basic Firewall Wizard instead of the Advanced Firewall Wizard?
3. What are the steps to configure a firewall using the CLI?
4. Under what circumstances should the default timeouts for alerts be changed?

## Exam Topic List

This chapter covers the following topics that you need to master for the CCNP ISCW exam:

- **IDS and IPS Functions and Operations**—Describes the functions and operations of intrusion detection systems (IDS) and intrusion prevention systems (IPS) and the difference between IDS and IPS
- **Categories of IDS and IPS**—Describes the categories of IDS and IPS
- **IDS and IPS Signatures**—Describes the four types of IDS and IPS signatures
- **Signature Reaction**—Describes what happens when a signature is matched
- **IOS Configuration**—Describes how to configure and verify Cisco IOS IPS using the CLI
- **SDM Configuration**—Describes the Cisco IOS IPS tasks that are completed with SDM