CHAPTER 36

Deploying BusinessObjects Enterprise in a Complex Network Environment

In this chapter

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Introduction

One key design consideration for BusinessObjects Enterprise was for the delivery of information to be deployed as part of any Web-based delivery platform—intranet, extranet, or Internet. Increasingly, organizations are looking to standardize the access to corporate information within a Web-based infrastructure. Companies are now able to support a close relationship with their external constituents—be they customers or suppliers—through the delivery of information over the Web. Furthermore, considerable economies of scale can be realized by using the same architecture to deliver information internally.

Often, the means by which information can be rendered is through the display of a Crystal Report (or multiple Crystal Reports) as an integral part of a web page executing on a client browser. Such integration with a company's Web-based information delivery system requires that the vehicle for providing that information (for example, a Crystal Report managed by BusinessObjects Enterprise and integrated completely into a web page) can also conform to the company's security requirements. In a nutshell, no matter what firewall standards a company chooses to adopt, BusinessObjects Enterprise not only must be able to be configured within these standards, it also must do so without compromising the integrity (or performance) of information management and delivery.

This chapter concentrates on how the architecture of BusinessObjects Enterprise allows for complete integration into complex networks with firewall systems to provide information delivery across intranets and the Internet without compromising network security. More often than not, providing examples of how BusinessObjects Enterprise works with complex firewall scenarios produces enough information to relate this chapter to other network deployment scenarios.

To understand how BusinessObjects Enterprise works in a complex network environment, a review of several server and system processes is provided in this chapter, extending discussions put forth from earlier chapters in this book.

Essentially, this chapter concentrates on firewalls and illustrates how BusinessObjects Enterprise can be deployed within the various firewall architectures commonly available. First, however, you start by learning to understand firewalls and looking at the supporting technology.

A *firewall* is a set of related programs located at a network gateway server (that is, the point of entry into a network), which protect the resources of a private network from users of other networks. It restricts people to entering and leaving your network at a carefully controlled point. A firewall is put in place to protect a company's intranet from being improperly accessed through the Internet. Additionally, firewalls can be used to enforce security policies and to log Internet activity.

Understanding Network Protocols

To have a clear understanding of how firewalls operate (and how BusinessObjects Enterprise is configured within a firewall), review the major protocols used within the Internet.

MAJOR INTERNET PROTOCOLS AND SERVICES

A standard number of Internet services work in conjunction with firewalls. These services are the primary reason for firewalls because companies want to control who and what goes over these services to their internal network.

HYPERTEXT TRANSFER PROTOCOL

HTTP is the primary protocol that underlies the Web: It provides users access to the files that make up the Web. These files can be in many different formats (text, graphics, audio, video, and so on). This protocol is in clear text and usually operates over TCP/IP. So a typical command in HTTP asking for a red picture might look like `192.168.0.16 -> naisan.net GET /~bigdir/agenmc/red.gif HTTP/1.0`.

SIMPLE MAIL TRANSFER PROTOCOL

SMTP is the Internet standard protocol for sending and receiving electronic mail. The most common SMTP server on Windows NT is Microsoft Exchange. Although SMTP is used to exchange electronic mail between servers, users who are reading electronic mail that has already been delivered to a mail server do not use SMTP. When they transfer that mail from the server to their desktop they use another protocol, POP (Post Office Protocol). SMTP is also a clear text protocol, so you could send an e-mail by connecting to a SMTP server, and then entering this:

```
MAIL From:ruhi@abha.net
RCPT To:arsel@futbol-khoreh.org
DATA Dude! Who stole my soccer ball?
.
QUIT
```

FILE TRANSFER PROTOCOL

FTP is the Internet standard protocol for file transfers. Most Web browsers support FTP, as well as HTTP, and automatically use FTP to access locations with names that begin `ftp.` so many people use FTP without ever being aware of it. FTP was the initial transfer protocol used for the Internet before the advent of the World Wide Web. FTP is also an open text protocol.

REMOTE TERMINAL ACCESS

Remote terminal access is most commonly known as *Telnet*. Telnet is the standard for remote terminal access on the Internet, and enables you to provide remote text access for your users.

DNS HOSTNAME/ADDRESS LOOKUP

A naming service translates between the names that people use and the numerical addresses that machines use. The primary name lookup system on the Internet is Domain Name System (DNS), which converts between hostnames and IP addresses.

TCP/IP

TCP/IP (Transmission Control Protocol/Internet Protocol) is a family of basic communications protocols used on the Internet. TCP/IP uses what is termed a *data packet* to transfer information over the Internet from one computer to another. Packets contain the data that your browser shows when it is surfing the Net. Each packet is small, so many packets are needed to transmit the data contained on one HTML page. As more and more people access the Net and transmit data, more and more packets are being transferred. This increases the need to make sure all the packets that arrive at your door (Web server) are really supposed to come in.

The TCP/IP Protocol Stack

The TCP/IP protocol stack, which makes up each packet, is constructed of the following layers, from the highest to lowest:

- Application layer (FTP, Telnet, HTTP)
- Transport layer (TCP or UDP)
- Internet layer (IP)
- Network Access layer (Ethernet, ATM)

Packets are constructed in such a way that layers for each protocol used for a particular connection are built atop one another.

At the Application layer the packet consists simply of the data to be transferred, such as an HTML page, which is simply text. As it moves down the layers, trying to reach the wire (network cable) that it needs to go out on, each layer adds a header to the packet; this preserves the data from the previous level. These headers are then used to determine where the packet is going and to make sure it all gets there in one piece. When the data packet reaches its destination, the process is reversed. In the end, therefore, all that TCP/IP is responsible for is specifying how data can make its way from one computer to another. These computers might reside on the same network or in completely different locations. As far as firewalls are concerned, the main thing to remember is that it is not so much about how the packet physically gets to its destination but what is in that packet and whether it is supposed to be there.

TCP/IP Rules

TCP/IP is ideally suited to being the standard protocol for the delivery of information through both external and internal network architectures for the following reasons:

- TCP/IP is packet-based. There are no set limits to the size of a given message because long messages are broken down into multiple (and linked) packets.
- TCP/IP provides for decentralized control. After you own the domain name/number (`businessobjects.com`) you can assign anything in front of it to expand your domain.

`Support.businessobjects.com` is an expansion to route traffic specifically to technical support within the Business Objects organization.

- Communicating devices are peers; every computer on the network is a peer. Each device can take on the role of either requester or server in the flow of information across multiple computers.
- TCP/IP is routable and easy to transmit between networks. The same rules apply whether communicating through an external or internal network.
- TCP/IP is an open free standard, an important consideration because this, combined with the other reasons detailed in this list, has led to widespread adoption.

Network Ports

A typical server sets up services to listen on ports. A *port* is a "logical connection place" and specifically, using the Internet's protocol, TCP/IP, the way a client program specifies a particular server program on a computer in a network. Higher-level applications that use TCP/IP, such as the Web protocol HTTP, have ports with preassigned numbers. These are known as *well-known ports* that have been assigned by the Internet Assigned Numbers Authority (IANA). Other application processes are given port numbers dynamically for each connection. When a service starts (or is initialized), it is said to *bind* to its designated port number. Any client program that wants to use that service must issue its request to the designated port number.

Port numbers range from 0 to 65536. Ports 0 to 1024 are reserved for use by certain privileged services. For example, for the HTTP service, port 80 is defined as a default. When a client makes a request, the server will assign that request to a port above 1024. Two pieces of information need to be passed in the TCP/IP header: the originating address of the source request, and the target address of the destination computer. This establishes the connection points for message exchange. You typically use the shorthand *IP:port* to denote an address, such as 192.9.0.95:1844, which refers to IP address 192.9.0.95 and port 1844 of that IP address.

Understanding Firewall Types

Firewalls primarily function using at least one of three methods: packet filtering, Network Address Translation (NAT), and proxy services. BusinessObjects Enterprise works with each of these firewall types. Packet filtering rejects TCP/IP packets from unauthorized hosts and rejects connection attempts to unauthorized services. NAT translates the IP address of internal hosts to hide them from outside access—NAT is often referred to as "IP masquerading." Proxy services make high-level application connections on behalf of internal hosts to completely break the network layer connection between internal and external hosts. Let's look at these different types in more detail.

Packet Filtering

Packet filtering inspects and selectively deletes packets before they are delivered to the destination computer. Packet filtering can delete packets based on the following:

- The address from which the data is coming
- The address to which the data is going
- The session and application ports being used to transfer the data
- The data contained by the packet

Typically, there are two types of packet filtering: stateful and stateless. *Stateful* packet filters remember the state of connections at the network and session layers by recording the established session information that passes through the filter gateway. The filter then uses that information to discriminate valid return packets from invalid connection attempts. *Stateless* packet filters do not retain information about connections in use; they make determinations packet-by-packet based only on the information contained within the packet.

Understanding NAT

NAT converts private IP addresses in a private network to globally unique public IP addresses for use on the Internet. Its main purpose is hiding internal hosts. It makes it appear that all traffic from your site comes from a single IP address. NAT hides internal IP addresses by converting all internal host addresses to the address of the firewall as packets are routed through the firewall. The firewall then retransmits the data payload of the internal host from its own address using a translation table to keep track of which sockets (connections) on the exterior interface equate to which sockets on the interior interface. This is also a simple proxy.

There are several NAT types including the following:

- **Static translation (port forwarding)**—This is when a specific internal network resource has a fixed translation that never changes. If you're running an e-mail server inside a firewall, a static route for port 25 of the external address can be established through the firewall that maps to the right machine internally.
- **Dynamic translation (automatic, hide mode, or IP masquerade)**—This is where a large group of internal clients share a small group of external IP addresses for the purpose of expanding the internal network address space. Because a translation entry does not exist until an interior client establishes a connection out through a firewall, external computers have no method to address an internal host that is protected using a dynamically translated IP address.
- **Load balance translation**—In this configuration, a single IP address and port is translated to a pool of identically configured servers—a single IP address serves a group of servers. This allows you to spread the load of one very popular website across several different servers by using the firewall to choose which internal server each external client should connect to on either a round-robin or balanced load basis. This is somewhat

similar to dynamic translation in reverse—the firewall chooses which server each connection attempt should be directed to from among a pool of clones.

- **Network redundancy translation**—Multiple Internet connections are attached to a single NAT firewall. The firewall chooses and uses each Internet connection based on load and availability. The firewall is connected to multiple ISPs through multiple interfaces and has a public masquerade address for each ISP. Each time an internal host makes a connection through the firewall, that firewall decides, on a least-loaded basis, on which network to establish the translated connection. In this way, the firewall is able to spread the internal client load across multiple networks.

UNDERSTANDING PROXY SERVERS

Proxy servers were originally developed to cache web pages that were frequently accessed. As the Web went supernova the proxies became less effective as caching mechanisms, but another asset of proxy servers became evident: Proxy servers can hide all the real users of a network behind a single machine, and they can filter URLs and drop suspicious or illegal content, or hide the identity of a user. The primary purpose of the majority of proxy servers is now serving as a sort of firewall rather than Web caching.

Proxy servers regenerate high-level service requests on an external network for their clients on a private network. This effectively hides the identity and number of clients on the internal network from examination by an external network user.

Proxies work by listening for service requests from internal clients and then sending those requests on the external network as if the proxy server itself was the originating client. When the proxy server receives a response from the public server, it returns that response to the original client as if it were the originating public server. You can even use the proxy server to load balance similar to the NAT load balancing. As far as the user is concerned, talking to the proxy server is just like talking directly to the real server. As far as the real server is concerned, it's talking to a user on the host that is running the proxy server; it doesn't know that the user is really somewhere else.

The use of proxies does not require any special hardware, but something somewhere has to be certain that the proxy server gets the connection. This might be done on the client end by telling it to connect to the proxy server (Socks), or it might be done by intercepting the connection without the client's knowledge and redirecting it to the proxy server.

Socks is a protocol that a proxy server can use to accept requests from client users in a company's network so that it can forward them across the Internet. Socks uses sockets, a method for communication between a client program and a server program in a network. A socket is an end point in a connection. Sockets are created and used with a set of programming requests or function calls to represent and keep track of individual connections. A proxy must exist for each service. Protocols for which no proxy service is available cannot be connected through a proxy except by a generic TCP proxy service that would work similar to a NAT.

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Configuring the BusinessObjects Enterprise Architecture for Your Network Environment

Chapter 25, "BusinessObjects Enterprise Architecture," introduced the components that make up the BusinessObjects Enterprise architecture. However, before looking at how BusinessObjects Enterprise can be configured to support the implementation of the firewall types described previously, it is necessary to review the architecture of BusinessObjects Enterprise, concentrating on how the components that make up the complete product architecture communicate with each other. In fact, the mechanism employed to support server communications has a significant bearing on how BusinessObjects Enterprise can be deployed with one or multiple firewalls.

Additionally, more detail needs to be provided about the relationship between the WC, the Web server, and the Web Component Server. This will be done in a later section; first, you will examine the core of BusinessObjects Enterprise server communication—the Framework.

Reviewing the Framework

From your investigation of the BusinessObjects Enterprise architecture in previous chapters, you know that at the core of BusinessObjects Enterprise is a communication layer called the BusinessObjects Enterprise Framework. The Framework is made up of a collection of services, which provides a series of Business Intelligence–related functions implemented by one or more BusinessObjects Enterprise services. It is, effectively, a CORBA bus integrating Enterprise information management facilities (Security, Deployment, Administration, and so on) with the CORBA 2 Open Standard services (Naming, Trading, Event, and so on). *Common Object Request Broker Architecture (CORBA)* is an architecture and specification for creating, distributing, and managing distributed program objects in a network. It allows programs in different locations to communicate in a network through an "interface broker."

Although CORBA is at the core of the Framework, it is hidden from BusinessObjects Enterprise administrators and developers (and, therefore, does not form part of the discussion of administration in Chapter 27, "Administering and Configuring BusinessObjects Enterprise"). No configuration needs be done with CORBA that would be done differently from any other TCP/IP application. Some definition of port numbers is all that is required as far as Framework Administration is concerned.

However, for the purpose of using firewalls one concept about CORBA needs to be understood—the IOR. The *IOR (Interoperable Object Reference)* is a unique identifier for an object and contains information about the CORBA object itself. For example, the Report Job Server appears to other CORBA clients using the Framework as an object that is available for those clients to use. Each time a server in the Framework requires the use of another server object, it requests information about that object. This information comes in the form of an IOR. The IOR includes the IP address and port to be used for returning messages—critical when working with firewalls.

To summarize, BusinessObjects Enterprise uses CORBA for intra-server communication. Administrators and developers are not exposed to the technology, nor are they required to work with it; however, it can become important in terms of firewall configuration.

BusinessObjects Enterprise and TCP/IP Communication

With standard TCP/IP communications, two servers that communicate with each other do so over a single point-to-point connection. The use of CORBA in the BusinessObjects Enterprise Framework, however, lends a slightly different flavor. In an environment where many requests are to be served, traffic on a particular port can be overwhelming and slow the operations of the server—leading, obviously, to performance problems. BusinessObjects Enterprise avoids this by listening on one port and sending on others. Within the BusinessObjects Enterprise environment, therefore, communication consists of the opening and closing of multiple ports for a single request/service interaction. In BusinessObjects Enterprise server-to-server communication, after the initial connection is complete, communication stops on this channel. Instead, another channel is established to send data back and forth, leaving the server that is listening on a given port free to service the next connection request quickly and efficiently.

Understanding Web Connector and Web Component Server Communication

The gateways to the BusinessObjects Enterprise information delivery environment are either the Web Component Server (WCS) in the COM environment, the Java application server in the Java environment, or the .NET application server in the .NET environment. These communicate via the CE-SDK to the BusinessObjects Enterprise Framework. Because there are multiple configurations available with BusinessObjects Enterprise depending on the platform and technologies used in each organization, a brief exploration clarifies the remainder of this chapter.

Three main types of configuration are possible at the application level of the BusinessObjects Enterprise Architecture: the COM configuration, Java configuration, and .NET configuration. Note that *all* of these configurations could be connected to one BusinessObjects Enterprise installation, allowing a diverse organization to leverage existing technology to write applications against one installation of BusinessObjects Enterprise.

NOTE

BusinessObjects Enterprise supports three implementations of its SDK simultaneously. That means one implementation can support communication from Java, .NET, and COM environments at the same time. This enables organizations to leverage their inherent skill-sets when developing with BusinessObjects Enterprise and also facilitates ongoing system availability through enterprise development standards changes (for example, moving from a COM-based shop to a J2EE-based organization).

The COM environment is common on Windows platforms and uses the BusinessObjects Enterprise COM SDK, CSP or ASP pages, a BusinessObjects Enterprise WCS, and a

BusinessObjects Enterprise Web Connector (WC) installed on the Web server. In this configuration two possible levels of communication are possible: the WC communicates with the WCS over TCP/IP, which in turn communicates with the BusinessObjects Enterprise Framework; or ASP pages use the COM SDK, which communicates directly with the Framework.

The Java configuration installs by default in Unix environments, or can be installed when working with a Java Application Server in a Windows environment. Instead of a WC and WCS, the Java configuration uses a BusinessObjects Enterprise Web Component Adapter (WCA) installed on the Application Server, and no WC or WCS. The BusinessObjects Enterprise Java SDK also installs on the Application Server and causes the Application Server (for example, IBM's WebSphere or BEA's WebLogic) to communicate directly with the BusinessObjects Enterprise Framework via TCP/IP.

The .NET environment uses .NET assemblies, which in turn directly communicate with the Framework via TCP/IP. In the .NET configuration no WCS, WC, or WCA are installed.

The remainder of this chapter discusses the COM configuration because it is the most complex. This discussion can easily be applied to the Java and .NET environments by considering that any IP and port configuration applied to the WCS should be applied to the initialization files for the Java Application Server. In .NET deployments, all port configurations are made within the various services as the Framework does not make outbound calls to the .NET server (in other words, IIS). The basic concepts for these alternate configurations, however, are the same.

The configuration for the WCA in the Java environment is done via modification of the file web.xml. This file can be found in Unix environments in the WEB-INF subdirectory of the webcompadapter.war file stored in the *`crystal_root`*`/enterprise/JavaSDK/applications` directory on Unix, or `X:\Program Files\Common Files\Crystal Decisions\2.5\jars\JavaSDK\applications` on Windows. In this file you can set context parameters by entering XML such as

```
<context-param>
<param-name>viewrpt.groupTreeGenerate</param-name>
<param-value>true</param-value>
</context-param>
```

This chapter will deal primarily with setting IP addresses and ports, and so will involve setting the following two context parameters in the web.xml file:

- `connection.cms` sets the name and port number of the CMS. Equivalent to setting command-line argument `-requestport` for the WCS.
- `connection.listeningPort` defines the default ports that the WCA applets are running on. Equivalent to setting command-line argument `-port` for the WCS.

Thus, in any discussions in the remainder of this chapter, treat the Java Application Server and WCA together as equivalent to the WC in terms of network settings. Also, because the WCA carries out functions of the WCS, remember that no WCS will be installed.

If operating in a Java or .NET environment, you can draw a parallel between the WC and the application server. Because the application server communicates with the Framework, you will need to configure support for the application server to "talk" to the Framework the same way that you would configure the WC to "talk" to the WCS.

INTERACTION BETWEEN THE WCS AND THE WC

To demonstrate the interaction between the WC and the WCS, it's easiest to review the process of displaying a Crystal Report on a Crystal Viewer to examine exactly what traffic is being passed between the browser, Web server, WC, and the BusinessObjects Enterprise report processing tier.

1. A request is made from the browser to the Web server for a specific report viewer. In this example, the user has clicked on a hyperlink (`http://<Server Name>/directory/viewrpt.csp&rptid=1863`), meaning that a request has been made to view a Crystal Report within the Crystal Viewer.
2. The WC on the Web server forwards the request to the WCS.
3. The WCS processes the CSP and calls the BusinessObjects Enterprise SDK to invoke a report viewer object, which renders the report on the Page Server, passes the first page onto the Cache server, and then tells the WCS to send the appropriate HTML to the browser.
4. The viewer HTML is sent from the WCS to the WC, through the Web server, and to the user's browser.

For the purposes of the discussion of firewall configuration, there are essentially three discrete BusinessObjects Enterprise entities that are likely to be deployed at different positions of a firewall architecture, seen in Figure 36.1. (The Web browser will be ignored because this is clearly outside the scope of the firewall.)

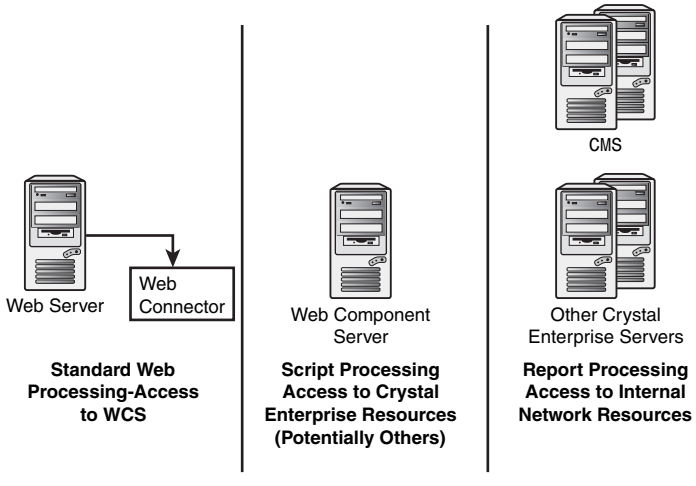


Figure 36.1
BusinessObjects Enterprise has three levels at which security must be determined.

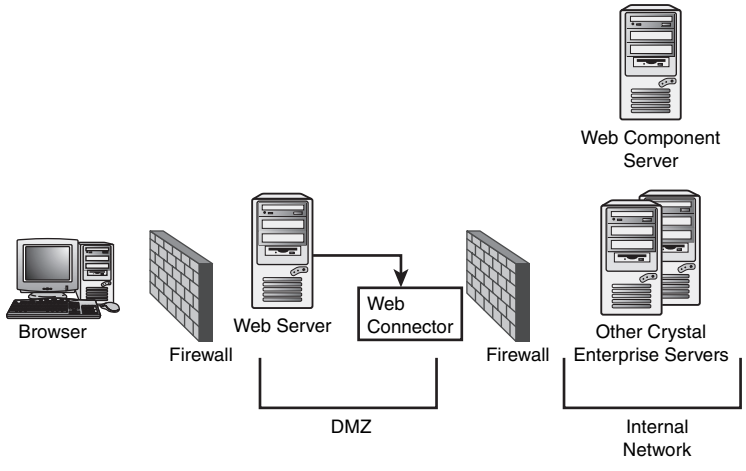
Each of these entities is likely to require different levels of firewall protection determined by their closeness to the internal network.

In cases where you do not deploy a WCS (such as the Java, COM-SDK, and .NET scenarios) there are only two entities, however: the SDK running on the application server and the BusinessObjects Enterprise services or daemons.

As previously mentioned, the barriers that a secure system provides are commonly broken down into distinct layers (with each layer defining a security measurement and effectively denoting an acceptable level of exposure). Each layer is identified by the communication from one network to another network via a firewall. Then, a detailed example involving BusinessObjects Enterprise communication through a firewall will be provided as well as what the appropriate system settings should be and how the communication will be addressed at an IP/port level.

Figure 36.2 shows the most typical example of a firewall implementation. In this scenario, the browser-to-Web server communication is controlled through the standard firewall control, allowing only HTTP requests to be forwarded through to the Web server on port 80 (other services such as Telnet and mail might be permitted through other predefined ports as well). Clearly, BusinessObjects Enterprise is not involved at this stage of the firewall. This does, however, represent the entry point into the resources managed by the target environment. From this point forward, internal network resources will be used; this interim environment is normally called the DMZ (or Demilitarized Zone). The DMZ, therefore, is a network added between a protected network and an external network.

Figure 36.2
BusinessObjects Enterprise can be divided into tiers for firewall deployment.



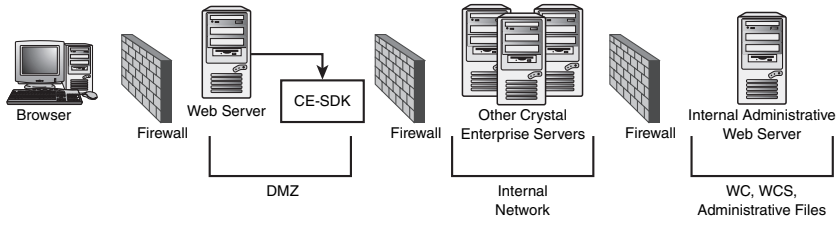
The architecture of BusinessObjects Enterprise fits conveniently into this infrastructure. The separation of the WC from the WCS enables the WC to remain within the DMZ along with the Web server. Consequently, an additional firewall can easily be deployed to

protect the requests forwarded through the WCS—this, after all, will be communicating directly to the other BusinessObjects Enterprise servers and is a component on the Crystal eBusiness Framework. Alternatively, the various application server deployments (Java, COM, or .NET) would also reside in the DMZ on the application server.

Because the WC and WCS allow for support of URL-level requests to support legacy BusinessObjects Enterprise applications, some enterprises choose not to implement the WC and WCS in an extranet environment. Instead the application-server deployment with the CE-SDK allows for application-level control of the interaction between the Web (application) server facilitating tighter security at this level. Please refer to Figure 36.3 for an illustration.

For instance, organizations might not desire any extranet access to the Crystal Management Console (CMC). By not installing the WC and WCS in the extranet DMZ, no access to the CMC can occur from the extranet, perhaps alleviating security concerns in an extranet environment where malicious attacks are routine.

Figure 36.3
This is how to configure a firewall in a non-WCS deployment.

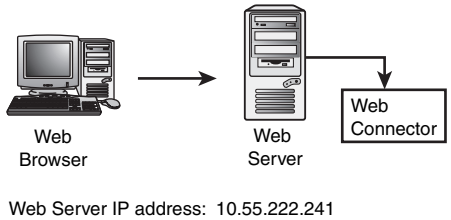


To examine the details of the communication of the WC to the WCS through the second firewall, the discussion will be broken down into two distinct portions: the initialization of the communication (a request for service), and servicing of the request after the communication has been established. This two-stage nature of communication was detailed in the eBusiness Framework in an earlier section in this chapter.

UNDERSTANDING INITIAL TCP/PORT PROCESSING

When the Web server receives a BusinessObjects Enterprise resource request from a Web browser, it forwards the request to the WC or processes the request internally in the case of the SDK. For this example, assume that the Web server has an IP address of 10.55.222.241 (see Figure 36.4).

Figure 36.4
Browser requesting information from the Web server.



The WC prepares to make a TCP connection to the WCS. A TCP connection request has four critical elements:

- Destination IP address (where it's going)
- Destination port (at which port/socket the request will be expected)
- Source IP (address of the sender, where to send return messages)
- Source port (port the sender will be listening on for a response)

The destination portion of this communication is determined by settings entered in the WC configuration dialog box in the Crystal Configuration Manager.

When making up the destination information, the WC reads this information from these settings. Because this is the machine name of the WCS, the IP address of the WCS is determined by network name resolution. The port destination takes less work—it's simply the number as entered in this dialog box. By default, this port is 6401. The only requirement is that this port number is the same as the WCS was set to use when the WCS started. The source portion of the requests are both determined by the Web server's operating system.

The Source IP is the IP address of the machine sending the request—the Web server. This IP address is determined by a request to the operating system. The port is also chosen by an operating system request. The WC asks for an available socket (or port) that is not in use. The operating system randomly chooses an unused socket. The WC begins temporarily listening on this port for a response from the WCS as soon as the initialization request is sent. It will only accept a response from the IP address of the WCS—any other requests at this port will be dropped. At this point, the TCP connection request is ready to be sent with this information:

- **Source IP**—IP address of the Web server machine as determined by a call to the operating system.
- **Source port**—Port deemed to be available by the operating system. This will be a port number higher than 1024.
- **Destination IP**—IP address of WCS as determined by network name resolution.
- **Destination port**—Port as entered into the WC Configuration dialog box in Crystal Configuration Manager. This must match the configured port for the WCS.

Assuming that the WCS has an IP address of 10.55.222.242 and that the assigned port (retrieved by an operating system call) is 3333, for this example, the completed request will be as follows (these are formatted as IP address:port):

- **Destination IP**—10.55.222.242:6401
- **Source IP**—10.55.222.241:3333

The WCS is constantly listening on its defined port for service requests (the default 6401 in your example, though another port could be used for listening if configured to do so).

When the WCS receives the TCP Connection Request from the WC, it begins to form a response. The response will have the same four primary components that the request had—a source port and IP and a destination port and IP. Embedded in this response is the IOR of the WCS. The IOR of WCS contains the IP address of the WCS, as well as the port number specified in the `-requestport` option.

NOTE

When in a Java environment, the web.xml file configures the port of choice. When in the .NET environment, the port that the SDK uses to connect to the various services is determined by those services because no outgoing communication is necessary from the BusinessObjects Enterprise Framework to the .NET application server and CE-SDK.

If the option is not specified, a free port is picked up at random by the CORBA library by asking the operating system for an available port. At this point, the WCS responds to the WC to complete the TCP connection. This TCP connection response will have this information:

- **Source IP**—IP address of the WCS as determined by a call to the operating system.
- **Source port**—A random port number, as determined by making a call to the operating system.
- **Destination IP**—The IP address as read from the Source IP address in the TCP Connection Request received from the WC.
- **Destination port**—The port as read from the source port in the TCP Connection Request received from the WC.

Assuming a randomly generated source port of 2345, you'll have the TCP connection confirmation of the following:

- **Destination IP:port**—10.55.222.241:3333
- **Source IP:port**—10.55.222.242:2345

While the WCS has been building its confirmation response, the Web server machine has been listening for the response on the chosen port.

The Web server/Connector will only accept packets from the IP to which it sent the request—this is for security. In this example, the operating system of the Web server machine has been listening on port 3333. When the TCP Connection Response/Confirmation is received, the OS of the Web server machine will determine whether it's from the correct location. If it is from the correct IP, it will accept the data and complete the TCP connection. The IOR is embedded inside this request, and the operating system passes it onto the WC for processing.

Now that all this work has been done to establish this connection, the WC immediately closes it. This was merely to establish that both client and server are up and running and accepting connections. The WC also received the IOR of the WCS in this short

connection. The listening port on the WCS resumes listening to other clients, and the work of sending IP packets back and forth will be done on a second TCP connection.

Understanding Secondary TCP/Port Processing

It is in establishing the second TCP connection that BusinessObjects Enterprise works differently from most TCP/IP applications. The WC reads the IOR of the WCS and acquires the IP address and port number from it. Using this port number and IP address a second connection is made—one that will be used for actually transferring the data. (A straight TCP/IP application doesn't have an IOR from which to read the IP and port of the server. It uses the source IP and port from the TCP connection confirmation to establish this second connection.) The BusinessObjects Enterprise application uses the information in the IOR and discards the source IP and port from the TCP connection confirmation.

Continuing your example, upon reading the port and IP information from the IOR of the WCS, the WC initiates a second TCP connection. This request will use this information:

- **Destination IP**—The IP address of the WCS as reported in the IOR.
- **Destination port**—The port number to be used for communication as reported in the IOR. If the `-requestport` directive is used, it will be that port; otherwise, it will be a randomly generated port number (you will use this).
- **Source IP**—The IP address of the Web server.
- **Source port**—The port on the Web server to be used for this connection. This is determined by asking the operating system for an available port.

In this example, assume that the randomly generated destination port number is 2345 and the generated source port is 1061. You'll have the TCP connection confirmation of the following:

- **Destination IP:port**—10.55.222.242:4000
- **Source IP:port**—10.55.222.241:1061

When the WCS receives this request, it will respond to the WC to complete the connection. The address to which it will send this connection is 10.55.222.241:1061. This destination and port was determined by reading the source information of the incoming TCP connection request. This is where the WCS's connection response gets its destination. As demonstrated in the following list, this is really just the reversal of the information received from the WC. Completing your example, therefore, the WCS will communicate as follows:

- **Destination IP:port**—10.55.222.241:1061
- **Source IP:port**—10.55.222.242:4000

After the Web server/Connector machine receives the TCP connection response from the WCS, it is able to complete the TCP connection. Now that the TCP connection is made, IP packets will be sent back and forth on this channel. IP datagrams will be forwarded back and forth from the Web server (10.55.222.241:1061) to the WCS (10.55.222.242:4000), and

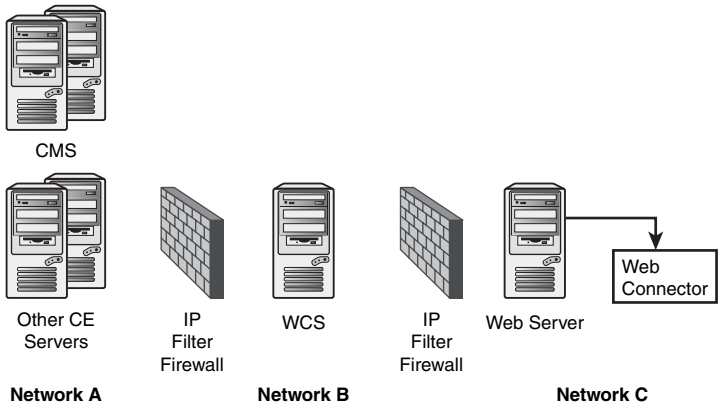
vice versa, on these ports. The secondary connection, therefore, is the one that does nearly all the data transference.

Now that you have seen exactly how the IP/port allocation is determined in the BusinessObjects Enterprise environment, you can look at a fully worked example applying a specific firewall technology. Initially, you will look at packet filtering and then apply NAT on top of this. Then this chapter briefly discusses how BusinessObjects Enterprise would fit in with the application of a Proxy Server (Socks) firewall.

DEPLOYING BUSINESSOBJECTS ENTERPRISE WITH AN IP PACKET FILTERING FIREWALL

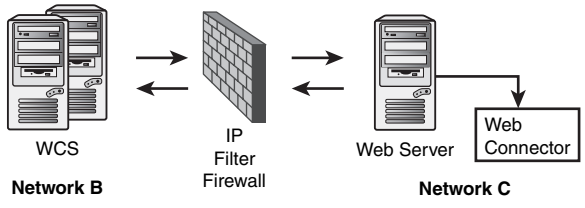
Earlier this chapter noted that IP Filter firewalls restrict network traffic based on IP address and port number. BusinessObjects Enterprise works well with IP Filter firewalls with the proviso that the IP address and TCP port number used by the servers are predetermined. This section discusses a scenario where the BusinessObjects Enterprise WC/Web server and WCS has one IP Filter between the two of them and the WCS is separated from the rest of the BusinessObjects Enterprise servers by a second firewall. In other words, it's the common firewall scenario you looked at in the previous section. This is illustrated in Figure 36.5.

Figure 36.5
IP Filtering–firewall definition.



Let's look at two distinct parts of communication across the networks: first, the most external portion (that is, between Network C and Network B), and second, the communication between the WCS and the other BusinessObjects Enterprise servers—the internal portion between Network B and Network A (see Figure 36.6).

Figure 36.6
Configuration with IP Filtering–external firewall.



An External Packet Filtering Firewall Scenario

Any requests of the WC machine would follow the same steps as described in the previous section. Initially, the WC would have to establish a TCP connection to the WCS. The WC would initiate this handshake communication. The IP Filter firewall would certainly stand to convolute this communication:

- **Destination IP**—The IP of the WCS as determined by network name resolution. The lookup would occur on the side of the Web server—usually by a DNS server in this zone.
- **Destination port**—The port to use for this communication is taken from the Registry—it's the value as entered in the WC Configuration dialog box in the Crystal Configuration Manager. By default, this is port 6401.
- **Source IP:port**—The IP:port of the Web server/WC machine as determined by a call to the operating system.

The network rules of this side of the firewall will quickly determine that the destination IP of this request will have to go through the firewall. Therefore, the network forwards this TCP connection request to the firewall. The firewall then evaluates the information within the request—the destination port and IP address, as well as the source IP and source port. The firewall must have rules that allow this connection to go through—it must accept requests for the WCS's IP from the WC's IP and the request must be on the specified port. At this point in the request, the firewall will have to allow traffic through it that follows this configuration:

- **Source IP**—The IP of the WC/Web server
- **Source port**—Any
- **Destination IP**—The IP of the WCS
- **Destination port**—6401 (or whichever is the WCS's listening port)
- **Action**—Accept

When the WCS receives this request, it must respond to it. It garners the information about where to respond from the information within the request. It takes the Source IP and Port and makes this the destination. Because this is a random port, the firewall must be configured to allow any ports to leave Network B and go to Network C. This is a generally accepted practice—strict port enforcement is done at the bastion host. Therefore, the firewall rules to complete this request should resemble the following:

- **Source IP**—Any IP from Network B
- **Source port**—Any
- **Destination IP**—Any IP outside the network
- **Destination port**—Any
- **Action**—Accept

When the connection request gets through the firewall, the network resolution will determine that the destination is in Network C. The request will hit the Web server/WC. At this point, there is a TCP connection between the two machines, going through the firewall. The WCS will send the WC its IOR and the WC will close this TCP connection.

The IOR contains the IP and port on which the second connection will be made. The port number in the IOR will be one of many values depending on the existence or nonexistence of the `-requestport xxxx` directive on the WCS's command line. If there is a `-requestport`, this is the value that will be in the IOR. If there isn't, it will be a random port as chosen by the WCS's operating system. Generally, a random port is not acceptable because administrators won't enable their firewall rules to accept any ports from a specific IP.

NOTE

The BusinessObjects Enterprise Administrator's Guide suggests that the use of the `-requestport` option is required with IP Filter firewalls.

When this second connection is made, the `-requestport` directive should be set to a fixed port number and this port number should be accepted if the IP is from the Web server/Connector machine. This second TCP connection information will look like this:

- **Destination IP**—The IP of the WCS as read from the IOR.
- **Destination port**—The port as read from the IOR, the recommendation being to use the `-requestport` directive to define this value.
- **Source IP**—The IP of the Web server/WC machine as determined by a call to the operating system.
- **Source port**—The free port as returned by a request to the operating system.

The firewall will evaluate this request and the port will have to be open. As an example, if the `-requestport` directive uses port 3333, the firewall rules will have to look like this:

- **Source IP**—The IP of the WC/Web server
- **Source port**—Any
- **Destination**—The IP of the WCS
- **Destination port**—3333 (or whichever is used with `-requestport` directive)
- **Action**—Accept

The WCS will respond to this request on whichever port the Web server/WC found to be available. This will be allowed through the firewall because any port is allowed from the internal network to the external. There will then be an established connection between the WCS and the WC, and IP packets will be sent on this channel. The configuration of the firewall rules for an IP Filter firewall between a WCS and WC are summarized in Table 36.1.

Table 36.1 Firewall Configuration Rules

Source	Destination	Port	Action
Network B	Any	Any	Accept
IP of WC	IP of WCS	6401, `-requestport`	Accept
Network C	Any	Any	Reject

NOTE

When the WCS is started with the `-requestport` switch, this port will have to be open going from Network B to Network C for the IP of the WCS.

An Internal Packet Filtering Firewall Scenario

There are several servers in the BusinessObjects Enterprise environment with which the WCS communicates. It must communicate with the CMS as part of logon/security procedures, while the Cache Server will also be involved in a communication with the WCS for report viewing requests. (Additionally, the WCS will communicate with the Input File Repository Server, where the report objects are maintained when the thumbnail of a report is displayed on the web page.) Obviously, traffic to each of these servers from the WCS will have to be allowed by the IP Filter firewall (see Figure 36.7).

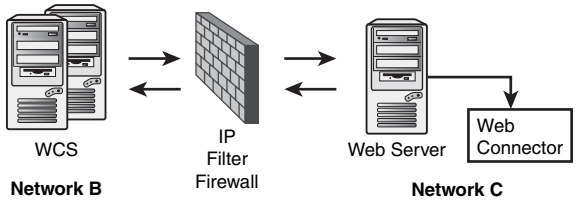


Figure 36.7
Configuring an IP Filtering–internal firewall.

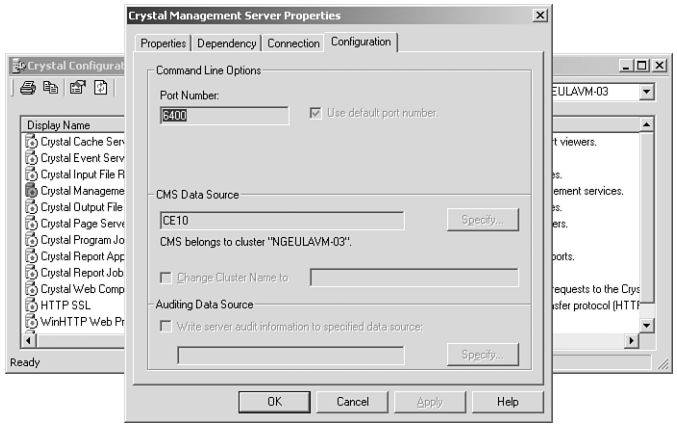
First and foremost, the WCS will have to communicate with the CMS. The CMS provides the Name Service in the BusinessObjects Enterprise environment. Without this service, the WCS will not be able to communicate with any of the servers. The CMS listens for requests on the port designated, shown in Figure 36.8 under the configuration tab in the Crystal Configuration Manager (the default value for this port is 6400).

Whenever the WCS needs to communicate with the Name Service of the CMS, it does so on port 6400 by default. The first time the WCS has to communicate with the Name Service is when it starts. When the WCS starts, it must register itself with the Name Service as part of its initialization process. This communication occurs on port 6400. A TCP connection occurs between the WCS and CMS for this to happen. The request will have the following information in it:

- **Destination IP**—The IP of the CMS as determined by network name resolution.
- **Destination port**—The port number of the CMS as defined in the SERVICES file.

- **Source IP**—The IP of the WCS as determined by a call to the OS of the WCS.
- **Source port**—A random available port as determined by a call to the OS of the WCS.

Figure 36.8
This screen shows CMS port configuration.



After the CMS receives this TCP connection request, it responds back to the WCS to complete the initial connection. This connection response contains the following information:

- **Destination IP**—The IP of the WCS as determined by reading the Source IP from the TCP connection request.
- **Destination port**—The port the WCS is using as determined by reading the Source Port from the TCP connection request.
- **Source IP**—The IP of the CMS as determined by a call to the OS of the CMS.
- **Source port**—A random port as determined by a call to the OS of the CMS.

After this initial connection is complete, the CMS sends the WCS its IOR. The WCS then closes the initial connection and establishes a connection to the CMS using the IP and port that is in the IOR. If the CMS is using the `-requestport` directive, this is the port that the WCS will use to initiate communication with the CMS. This second connection request will contain this information:

- **Source IP**—The IP of the WCS as determined by a call to the OS of the WCS.
- **Source port**—The port number of the WCS as determined by a call to the OS of the WCS.
- **Destination IP**—The IP of the CMS as read from the IOR that the CMS sent to the WCS in the initial connection.
- **Destination port**—The port the CMS put in the IOR. If using the `-requestport` directive, this is the port the CMS put in the IOR. Otherwise, it will be a port deemed available as per a request to the OS of the CMS.

The CMS responds to this request to complete the connection. This response contains the following information:

- **Source IP**—The IP of the CMS as determined by a call to the OS.
- **Source port**—A free port on the CMS as determined by a call to the OS of the CMS.
- **Destination IP**—The IP of the WCS as read from the Source IP of the connection request.
- **Destination port**—The port being used by the WCS as read from the Source Port of the connection request.

When this connection is complete, the WCS and CMS will hold it open and use it whenever communication between the two is required. From a firewall configuration perspective, two ports are involved in the communication between the CMS and the WCS: first, the port the CMS listens on—this is port 6400 by default—and second, the port that is established as the main communication channel between these two processes—this should be the value as defined by the `-requestport` directive. The "rules" for the firewall configuration can be defined as shown in Table 36.2.

Table 36.2 Firewall Configurations Rules (Network A to Network B)

Source	Destination	Port	Action
Network A	Any	Any	Accept
WCS	CMS	6400, `-requestport*`	Accept
Network B	Any	Any	Reject

NOTE

When the CMS is started with the `-requestport` switch, this port will have to be open going from Network B to Network A for the IP of the WCS.

However, this is only one of three servers with which the WCS would need to communicate. Requests to the Input FRS and Cache Server would still need to be allowed through the firewall. The standard practice is when servers need to communicate with one another, they ask the Name Service for a copy of the IOR of the server they need to contact. To communicate with either the Input FRS or the Cache Server, therefore, the WCS needs to ask the CMS for information about the server to which it needs access.

When these servers start, they give the Name Service portion of the CMS a copy of their IOR. As the other servers require access to it, they ask the CMS for a copy of the IOR of the server they need information about. To determine the IOR of a given server, the WCS and CMS collaborate. When the WCS has a copy of the IOR of the particular server, it attempts to make a connection to the server using the information in the IOR. The information in the IOR contains both the IP address and the port to be used for communication

and security information. If the `-requestport` directive is used, the port will be that defined port; otherwise, it's a random port. When working with firewalls, the preferred method is to use `-requestport` so you can control on which port traffic will be allowed in. As a conclusion, therefore, the firewall rules between Network B and Network A would need to be set up as shown in Table 36.3.

TABLE 36.3 FIREWALL CONFIGURATION RULES (NETWORK B TO NETWORK A)

Source	Destination	Port	Action
Network A	Any	Any	Accept
IP of WCS	IP of CMS	6400, `-requestport` for each of the servers (CMS, Input FRS, Cache Server)	Accept
Network B	Any	Any	Reject

The use of NAT within the IP Filtering firewall adds an additional level of complexity, something explored in the next section.

USING BUSINESSOBJECTS ENTERPRISE WITH NAT

NAT takes IP Filtering one level further by masking the IP address of the internal server when its packet gets through the firewall. NAT makes it appear as if all traffic from inside the network comes from a different IP address. NAT hides internal IP addresses by converting all internal host addresses to the address of the firewall as packets are routed through the firewall. The firewall then retransmits the data payload of the internal host from its own address using a translation table to keep track of which ports/sockets on the exterior interface equate to which ports/sockets on the interior interface.

EXPLORING THE NAT AND CRYSTAL ENTERPRISE RELATIONSHIP

It has been established that within BusinessObjects Enterprise, server-to-server communication takes the single TCP connection approach one step further. A second TCP connection is made when servers communicate in BusinessObjects Enterprise (listen on one, communicate on another). When it comes to firewalls, it is important to recognize that two ports need to be open.

However, with translated IP addresses in the NAT instance, there is an additional concern because it is the IOR that tells the servers which IP to use; this is not directly retrieved from the packets themselves. This section explains what is required to make BusinessObjects Enterprise work with a NAT firewall—the WC and WCS communication as an example.

When the WC communicates to the Web server, it is on the outside of the firewall. This is how it will be in most configurations and the assumption made during this chapter. The WC/Web server will reside in a DMZ and the rest of the servers inside the corporate

network. As before, when the WC needs to communicate with the WCS, it will send a TCP Connection request. To get there, it will need to resolve the name of the WCS machine. Because the WCS is inside the firewall, this can potentially create a problem with a NAT firewall. As you saw with the Telnet example in the previous section, generally the incoming rules for NAT firewalls only accept packets with destination IPs going to the firewall.

In the Telnet example, the client was inside the firewall and the outbound firewall rules allowed all IP destinations outside the wall, as well as any port (this is normal). The NAT firewall then altered the packet and sent it onto the Telnet server. The Telnet server responded back to the firewall. The firewall was expecting the response and allowed it through because it was expected. The NAT firewall altered the destination of this response back to the internal private IP of the Telnet client and routed it onto the Telnet client machine.

In BusinessObjects Enterprise, the WC needs to send the initial TCP Connection request to the WCS. This is somewhat different from the Telnet application because the machine in the external network (the WC) is initializing the communication instead of the machine inside the network. Because the request didn't originate inside the firewall, the firewall isn't expecting any communication. When the WC resolves the machine name of the WCS to an IP address, this won't always be the IP as it exists on the internal network in a NAT environment. There are a number of options available where the features of NAT firewalls could be configured to work in this situation:

- The NAT firewall could be configured to allow packets whose destination is the firewall.
- The NAT firewall could be configured to allow packets whose destination is inside the firewall and have rules on which of these are allowed.
- The NAT firewall could use a group of IP addresses in the external network that each represents one IP address in the internal network.

There is still one outstanding question, however: To which IP address should the request be sent? BusinessObjects Enterprise requires that the machine on the outside of the firewall be able to send packets to the private IP address of the WCS. It might be possible to get away with not using the private IP address for the initial connection; if the initial connection request was sent to a statically mapped IP address or to the IP address of the firewall itself, the firewall could inspect its destination and forward it on without issue.

Remember that the data that is sent in the initial connection from the WCS to the WC is the IOR of the WCS. The IOR contains the IP address and the port of the WCS. Moreover, this is the internal IP address of the WCS—it is not the address of the firewall or a static IP address of the firewall that is mapped to the internal IP address. To allow this traffic through, therefore, on a NAT firewall, the rule that needs to be in place for WC to WCS communication is that the packets to the internal IP address must be allowed through the firewall. (This might, of course, require further rules to route these packets on the firewall.)

The ports that are allowed through can be narrowed, of course. The destination port on which the WCS is listening and its request port need to be allowed through the firewall. In the end, the firewall rules with a NAT firewall are pretty much in line with what the firewall rules are on an IP Filter firewall. For example, Table 36.4 assumes the WCS is inside the network and the WC is external to the network.

Table 36.4 Firewall Configuration Rules (WCS Internal and WC External)

Source	Destination	Port	Action
Internal IP of WCS	External IP of WC	Any	Accept
External IP of WC	Internal IP of WCS	WCS listening port (6401 by default), `-requestport`	Accept
External Network	Internal Network	Any	Reject

If packets from the hosts on the external network sent to the internal IOP addresses are routed to the firewall and the firewall accepts the packets, the connection will be established successfully. Given that in many cases the external network is a DMZ and the firewall is a router on the LAN, this configuration is possible by adding static routes on the hosts in the DMZ to the firewall. Depending on network configuration, even static routes on the hosts won't be necessary if the firewall between the internal network and DMZ is the default route for all traffic.

BusinessObjects Enterprise and Proxy Servers

It is not the intention at this stage in the book to investigate how BusinessObjects Enterprise can be configured to work with proxy servers in any great detail. This is covered in some depth in the Administrator's guide that accompanies BusinessObjects Enterprise. However, some sample Socks configurations will be shown and there will be a brief discussion as to how BusinessObjects Enterprise would operate effectively with each configuration.

Socks settings for each of the BusinessObjects Enterprise servers are defined using the Crystal Configuration Manager (through the Connection tab).

Socks—The WC and WCS

Figure 36.9 illustrates the operation of Socks between the WC and the WCS.

Given this scenario, the Socks setting through the Crystal Configuration Manager should be the following:

- On WC, specify the Socks server at the WCS Configuration tab.
- On CMS, specify the Socks server at the Connection tab.

Access control rules on the Socks server should be set to something similar to that shown in Table 36.5.

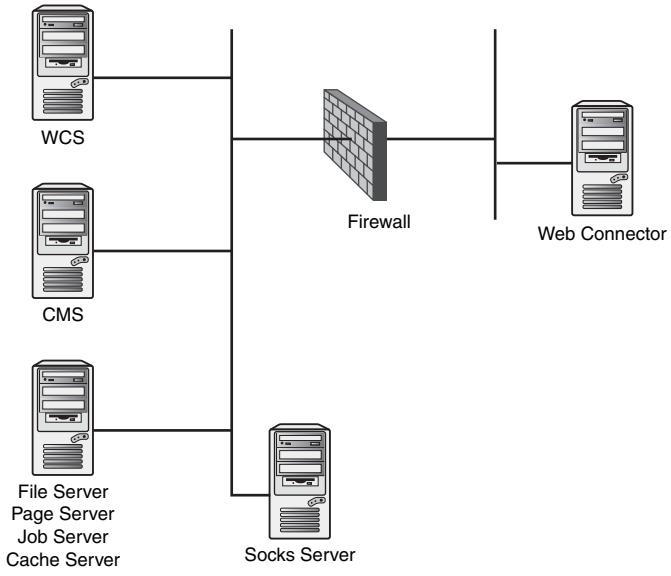


Figure 36.9
Socks configuration—WC to WCS.

Table 36.5 Socks Configuration (WC to WCS)

Source	Destination	Port	Action
WC	WCS	6401 `-requestport`	Accept
Otherwise			Reject

There are a couple of points worth noting:

- Although the WC connects to WCS, the Socks server information is set up on CMS rather than on WCS. This is because the WCS will obtain the Socks setting from CMS.
- The initialization from WC to WCS port 6401 uses the host name for the WCS in the Socks request. Therefore, the Socks server must be able to resolve the host name for WCS. For example, if the WC and WCS use NetBIOS names and the Socks server is a Unix box that doesn't support NetBIOS names, it is necessary to ensure the Socks server can resolve the same name as specified by the WC; that is, by using a local host's file.

Firewall Configuration: Socks—WCS and CMS

Figure 36.10 illustrates the operation of Socks between the WCS and the CMS.

In this instance, the Socks setting at Crystal Configuration manager should be the following:

- On WCS, specify the Socks server at the CMS Configuration tab.
- On CMS, specify the Socks server at the Connection tab.

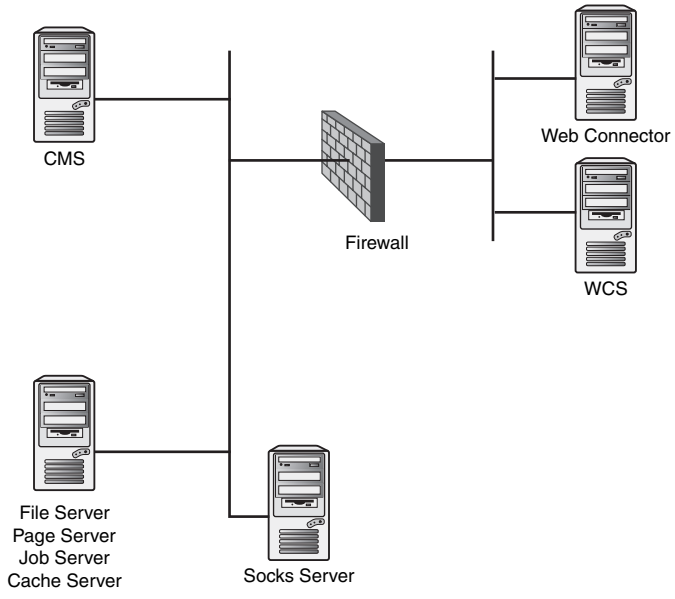


Figure 36.10
Socks configuration—WCS to CMS.

Access control rules on the Socks server should be set to something similar to that shown in Table 36.6.

Table 36.6 Socks Configuration (WCS to CMS)

Source	Destination	Port	Action
WCS	CMS	6400 `-requestport`	Accept
WCS	Other Enterprise Servers	Default ports `-requestports`	Accept
Otherwise			Reject

Please note that when WCS makes the initial connection to CMS on port 6400, it will pass the host name to the Socks server. Thus, the Socks server must resolve the CMS hostname.

Socks—Multiple BusinessObjects Enterprise Servers

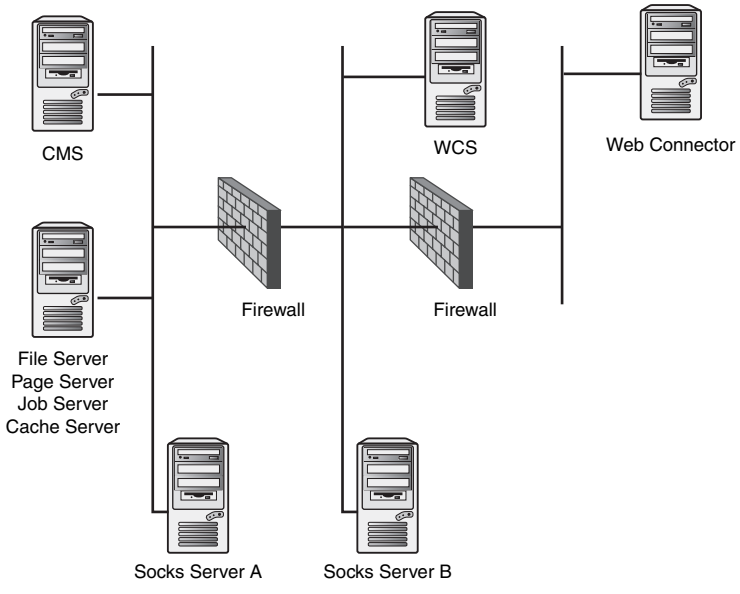
Figure 36.11 illustrates the operation of Socks between multiple servers in the BusinessObjects Enterprise environment.

When multiple Socks servers are deployed in the network, the BusinessObjects Enterprise Socks setup can facilitate the traversal of them. However, due care and attention should be taken in how the Socks servers are placed and traversed. In general, the BusinessObjects Enterprise servers see these Socks servers as a chain, and the setup in the Crystal Console Manager should specify how to traverse them from the outermost to the innermost link.

In this instance, the Socks setting at Crystal Configuration Manager should be the following:

- On WC, specify the Socks server B at the WCS Configuration tab
- On WCS, specify the Socks server A at the CMS Configuration tab
- On WCS, specify the Socks server B at the Connection tab
- On CMS, specify the Socks server B followed by A at the Connection tab

Figure 36.11
Socks configuration–multiple servers.



Access control rules on the Socks server should be set to something similar to that shown in Table 36.7.

TABLE 36.7 SOCKS CONFIGURATION (MULTIPLE SERVERS)

Source	Destination	Port	Action
WC	WCS	6401 `-requestport`	Accept
WCS	CMS	6400	Accept
WCS	Other Enterprise Servers	default ports `-requestports`	Accept
Otherwise			Reject

The point to note is that in the IOR for the CMS, the Socks server chain B-A is embedded. However, because the WCS has been configured with a local Socks server B, the program will do a comparison of these two Socks server lists and deduce that WCS only needs to go through A to reach the CMS.