FIREWALL :

The ability to connect any computer, anywhere, to any other computer, anywhere, is a mixed blessing. For individuals at home, wandering around the Internet is lots of fun. For corporate security managers, it is a terrible. Most companies have large amounts of confidential information on-line-trade secrets, product development plans, marketing strategies, financial analyses, etc. Disclosure of this information to a competitor could have horrible consequences.

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In addition to the danger of information leaking out, there is also a danger of information leaking in. In particular, viruses, worms, and other digital pests can breach security, destroy valuable data, and waste large amounts of administrators' time trying to clean up the mess they leave. Often they are imported by careless employees who want to play some nifty new game.

Consequently, mechanisms are needed to keep "good" bits in and "bad" bits out. One method is to use IPsec(IP security). This approach protects data in transit between secure sites. However, IPsec does nothing to keep digital pests and intruders from getting onto the company LAN. To see how to accomplish this goal, we need to look at firewalls.

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Firewalls are just a modern adaptation of that old medieval security. This design forced everyone entering or leaving the castle to pass over a single drawbridge, where they could be inspected by the I/O police. With networks, the same trick is possible: a company can have many LANs connected in arbitrary ways, but all traffic to or from the company is forced through an electronic drawbridge (firewall), as shown in Figure.

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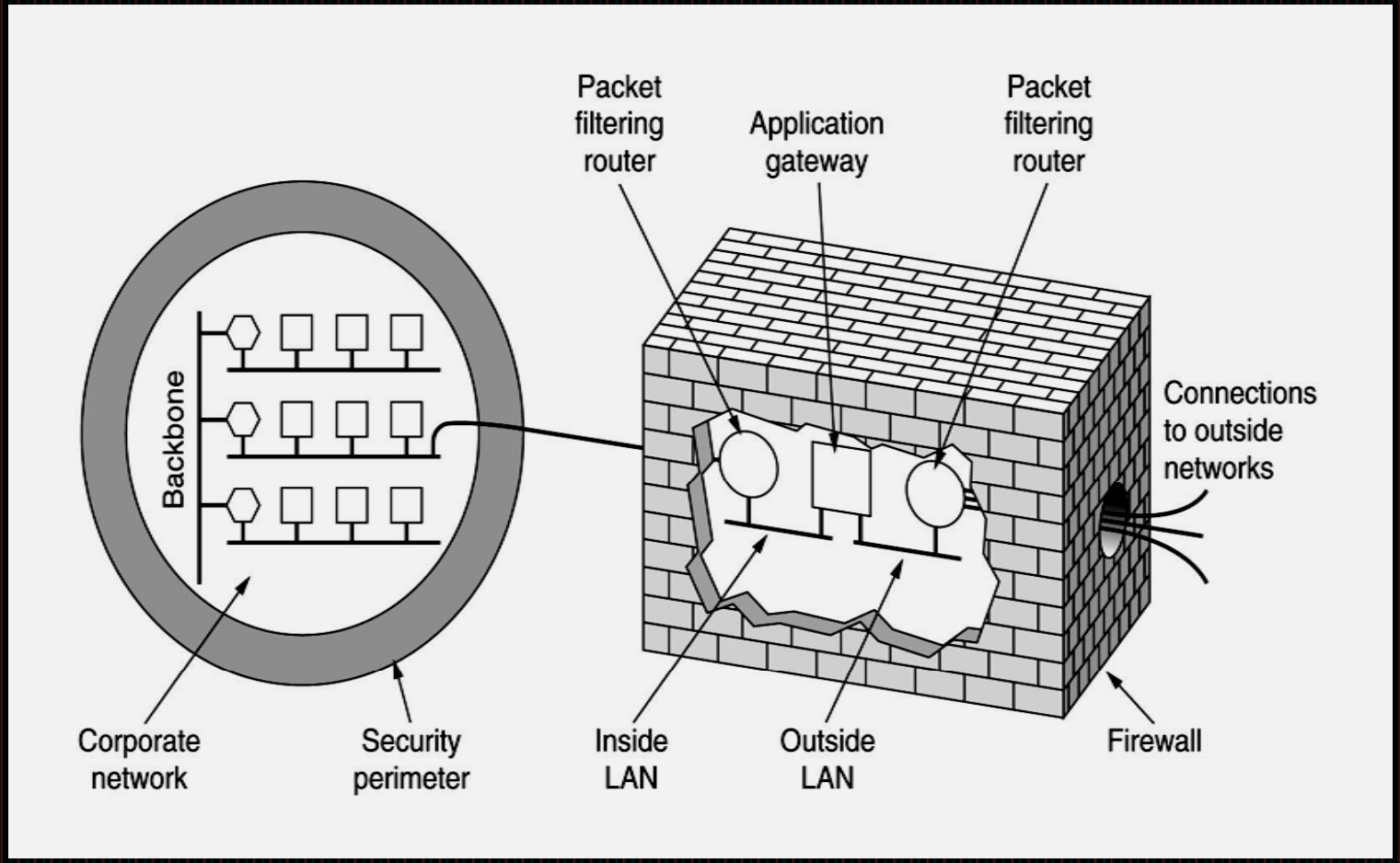

A firewall consisting of two packet filters and an application gateway.

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The firewall in this configuration has two components: two routers that do packet filtering and an application gateway. Simpler configurations also exist, but the advantage of this design is that every packet must transit two filters and an application gateway to go in or out. No other route exists. Readers who think that one security checkpoint is enough clearly have not made an international flight on a scheduled airline recently.

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Each packet filter is a standard router equipped with some extra functionality. The extra functionality allows every incoming or outgoing packet to be inspected. Packets meeting some criterion are forwarded normally. Those that fail the test are dropped.

In Figure, most likely the packet filter on the inside LAN checks outgoing packets and the one on the outside LAN checks incoming packets. Packets crossing the first hurdle go to the application gateway for further examination. The point of putting the two packet filters on different LANs is to ensure that no packet gets in or out without having to pass through the application gateway: there is no path around it.

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Packet filters are typically driven by tables configured by the system administrator. These tables list sources and destinations that are acceptable, sources and destinations that are blocked, and default rules about what to do with packets coming from or going to other machines.

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In the common case of a TCP/IP setting, a source or destination consists of an IP address and a port. Ports indicate which service is desired. For example, TCP port 23 is for telnet, TCP port 79 is for finger, and TCP port 119 is for USENET news.

A company could block incoming packets for all IP addresses combined with one of these ports. In this way, no one outside the company could log in via telnet or look up people by using the Finger daemon. Furthermore, the company would be spared from having employees spend all day reading USENET news.

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Blocking outgoing packets is trickier because although most sites stick to the standard port numbering conventions, they are not forced to do so. Furthermore, for some important services, such as FTP (File Transfer Protocol), port numbers are assigned dynamically.

In addition, although blocking TCP connections is difficult, blocking UDP packets is even harder because so little is known a priori about what they will do. Many packet filters are configured to simply ban UDP traffic altogether.

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The second half of the firewall is the APPLIATION GATEWAY. Rather than just looking at raw packets, the gateway operates at the application level. A mail gateway, for example, can be set up to examine each message going in or coming out.

For each one, the gateway decides whether to transmit or discard the message based on header fields, message size, or even the content (e.g. at a military installation, the presence of words like “nuclear” or “bomb” might cause some special action to be taken).

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Installations are free to set up one or more application gateways for specific applications, but it is not uncommon for suspicious organizations to permit e-mail in and out, and perhaps permit use of the World Wide Web, but to ban everything else as too risky. Combined with encryption and packet filtering, this arrangement offers a limited amount of security at the cost of some inconvenience.

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Even if the firewall is perfectly configured, plenty of security problems still exist. For example, if a firewall is configured to allow in packets from only specific networks (e.g., the company's other plants), an intruder outside the firewall can put in false source addresses to bypass this check.

If an insider wants to ship out secret documents, he can encrypt them or even photograph them and ship the photos as JPEG files, which bypasses any word filters. And we have not even discussed the fact that 70% of all attacks come from inside the firewall, for example, from unhappy employees.

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In addition, there is a whole other class of attacks that firewalls cannot deal with. The basic idea of a firewall is to prevent intruders from getting in and secret data from getting out. Unfortunately, there are people who have nothing better to do than try to bring certain sites down.

They do this by sending legitimate packets at the target in great numbers until it collapses under the load. For example, to cripple a Web site, an intruder can send a TCP *SYN* packet to establish a connection. The site will then allocate a table slot for the connection and send a *SYN + ACK* packet in reply. If the intruder does not respond, the table slot will be tied up for a few seconds until it times out.

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If the intruder sends thousands of connection requests, all the table slots will fill up and no legitimate connections will be able to get through. Attacks in which the intruder's goal is to shut down the target rather than steal data are called DoS (Denial of Service) attacks. Usually, the request packets have false source addresses so the intruder cannot be traced easily.

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An even worse variant is one in which the intruder has already broken into hundreds of computers elsewhere in the world, and then commands all of them to attack the same target at the same time. Not only does this approach increase the intruder's firepower, it also reduces his chance of detection, since the packets are coming from a large number of machines belonging to unsuspecting users. Such an attack is called a DDoS (Distributed Denial of Service) attack.

This attack is difficult to defend against. Even if the attached machine can quickly recognize a bogus request, it does take some time to process and discard the request, and if enough requests per second arrive, the CPU will spend all its time dealing with them.