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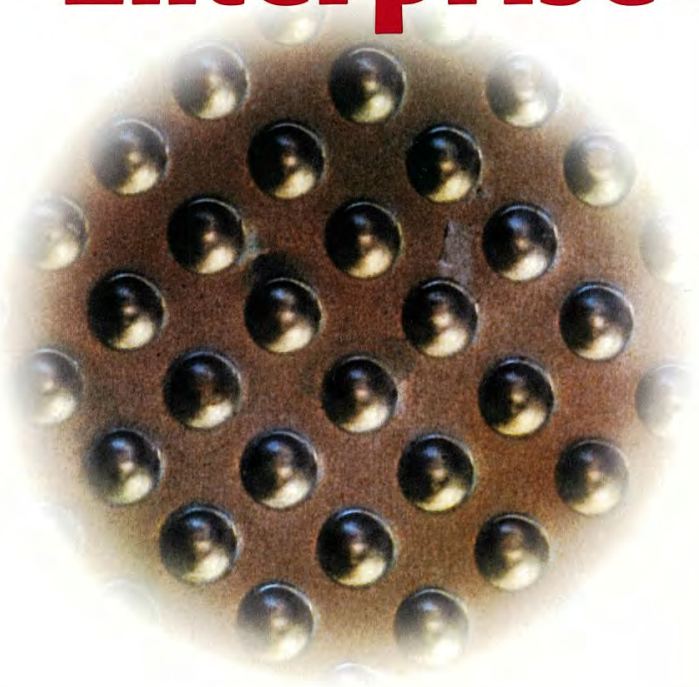

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extended state-oriented packet filters as *stateful inspection*, *smart filtering*, or *adaptive screening*. With this extended functionality, they are often offered as user-oriented packet filters. Figure 4-15 illustrates state-oriented packet filters.

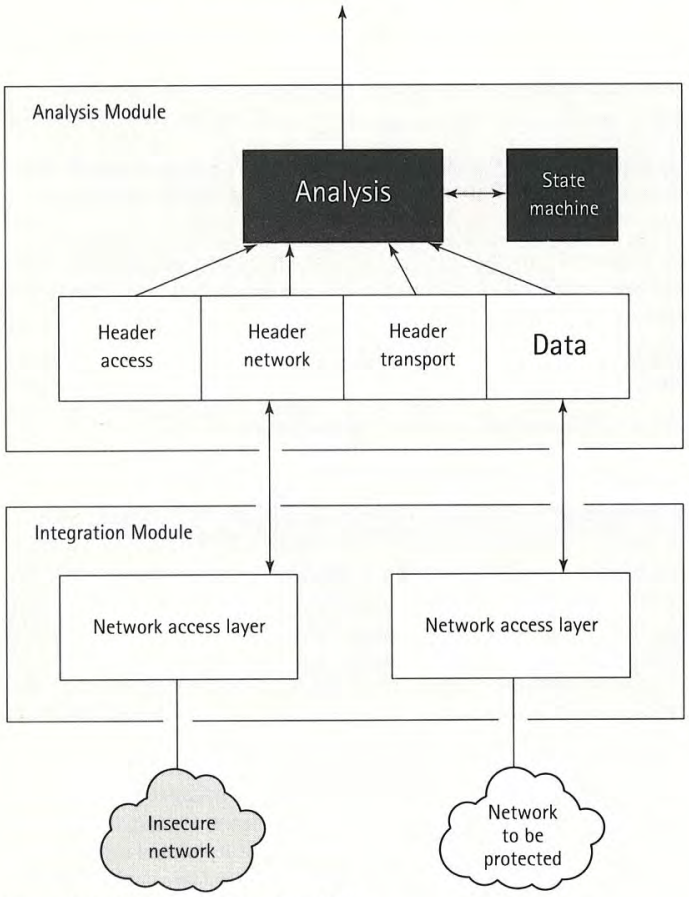

Figure 4-15: State-oriented packet filters

State-oriented packet filters have the same advantages as packet filters, but they can also check the applications. Some risks remain because the services are not directly isolated from each other.

Because it is a complex matter to simultaneously hold and interpret the communications data in the different communications layers, state-oriented packet filters generally have a shallower depth of analysis, or they are particularly prone to

errors connected with their very powerful software. Basically, you can't test the complex software of state-oriented packet filters sufficiently or comprehensively to prove that errors cannot occur in any operating state. For this reason, one must continue to assume that the complex programs contain potential security risks that could be used to perpetrate an attack.

A better and more secure way to analyze the application data is to use application gateways with proxies. This approach is described in the next section.

Network Address Translation

As its name implies, *NAT (Network Address Translation)* works by using one set of addresses for communications on the Internet and a separate set of addresses for communications on the internal network. To fully support this translation, the IANA set aside three ranges of IP addresses in RFC 1918:

- 10.0.0.0 through 10.255.255.255 (10.0.0.0/8)
- 172.16.0.0 through 172.31.255.255 (172.16.0.0/12)
- 192.168.0.0 through 192.168.255.255 (192.168.0.0/16)

These addresses are reserved for internal use only and, as a consequence, are nonroutable on the Internet. Attempts to communicate with any of these ranges through the Internet result in ICMP "network unreachable" errors.

An organization implementing NAT uses one of the preceding ranges for their internal network addressing. The external interface of the firewall is assigned a normal routable IP address. When the firewall transmits a packet from the internal network to the Internet, it actually creates a new packet destined for the same address but originating from the external address(es) of the firewall. This packet is then transmitted to the destination. The firewall keeps a table of current communications so that when the return communications reach the firewall, they are taken and placed into a new packet destined for the internal computer and transmitted internally.

The NAT process affords a substantial degree of security. Since all direct communications are prevented (as long as the systems are properly configured), an external attacker is forced to compromise the firewall or find a means of passing his communications through it successfully rather than attacking the internal host directly. Given the firewall protection module and hardening, this is a relatively significant challenge.

Not inconsequentially, NAT prolongs the life expectancy of IPv4 on the Internet. Were it not for address translation, the supply of Internet addresses would have been exhausted long ago. Using NAT, a company with hundreds of internal computers can communicate fully with the Internet using only a handful of routable addresses.

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