UIVIT - V: Intruders, Viruses and Worms Intruders, categories: Trojans, Ransomware, Sp1'ware, Adware, etc. , Viruses and related threats**,** Firewalls: Stateful vs. Stateless Firewalls, Firewall Design Principles, Trusted Systems, Multilevel Security (MLS) and Mandatory Access Control (MAC), Intrusion Detection Systems.

FIREWALLS

A firewall is inserted between the premises network and the Internet to establish a controlled link and to erect an outer security wall or perimeter, forming a single chokepoint where security and audit can be imposed. A firewall:

1. Defines a single choke point that keeps unauthorized users out of the protected network, prohibits potentially vulnerable services from entering or leaving the network, and provides protection from various kinds of IP spoofing and routing attacks.

2. provides a location for monitoring security-related events

3. is a convenient platform for several Internet functions that are not security related, such as NAT and Internet usage audits or logs

4. A firewall can serve as the platform for IPSec to implement virtual private networks.

Design Goals of Firewalls

All traffic from inside to outside must pass through the firewall (physically blocking allaccess to the local network except via the firewall)

Only authorized traffic (defined by the local security police) will be allowed to pass

The firewall itself is immune to penetration (use of trusted system with a secureoperating system)

The four general techniques that firewalls use to control access and enforce the site security policies are:

- Service control: Determines the types of Internet services that can be accessed, inbound oroutbound
- Direction control: Determines the direction in which particular service requests areallowed to flow
- User control: Controls access to a service according to which user is attempting toaccess it
- Behavior control: Controls how particular services are used (e.g. filter e-mail)

The limitations of Firewalls are:

1. Cannot protect against attacks that bypass the firewall, eg PCs with dial-out capabilityto an ISP, or dial-in modem pool use.

2. do not protect against internal threats, eg disgruntled employee or one who cooperates withan attacker

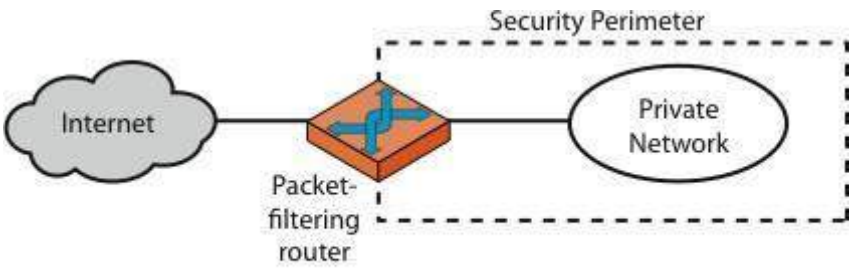
3. cannot protect against the transfer of virus-infected programs or files, given wide variety of O/S & applications supported

Types of Firewalls

Firewalls are generally classified as three types: packet filters, application-level gateways, & circuit-level gateways.

Packet-filtering Router

A packet-filtering router applies a set of rules to each incoming and outgoing IP packet to forward or discard the packet. Filtering rules are based on information contained in a network packet such as src & dest IP addresses, ports, transport protocol & interface.



(a) Packet-filtering router

If there is no match to any rule, then one of two default policies are applied:

- that which is not expressly permitted is prohibited (default action is discard packet),conservativepolicy
- that which is not expressly prohibited is permitted (default action is forward packet),permissive policy

The default discard policy is more conservative. Initially, everything is blocked, and services must be added on a case-by-case basis. This policy is more visible to users, who are more likely to see the firewall as a hindrance. The default forward policy increases ease of use for end users but provides reduced security; the security

administrator must, in essence, react to each new security threat as it becomes known. One advantage of a
packet-filtering router is its simplicity. Also, packet filters typically are transparent to users and are very fast.

The table gives some examples of packet-filtering rule sets. In each set, the rules are applied top to bottom.

Table 20.1 Packet-Filtering Examples

A

action	ourhost	port	theirhost	port	comment
block	*	*	SPIGOT	*	we don't trust these people
allow	OUR-GW	25	*	*	connection to our SMTP port

B

action	ourhost	port	theirhost	port	comment
block	*	*	*	*	default

C

action	ourhost	port	theirhost	port	comment
allow	*	*	*	25	connection to their SMTP port

D

action	src	port	dest	port	flags	comment
allow	{our hosts}	*	*	25		our packets to their SMTP port
allow	*	25	*	*	ACK	their replies

E

action	src	port	dest	port	flags	comment
allow	{our hosts}	*	*	*		our outgoing calls
allow	*	*	*	*	ACK	replies to our calls
allow	*	*	*	>1024		traffic to nonservers

A. Inbound mail is allowed to a gateway host only (port 25 is for SMTP incoming

B. explicit statement of the default policy

C. tries to specify that any inside host can send mail to the outside, but has problem thatanoutside machine could be configured to have some other application linked to port 25

D. properly implements mail sending rule, by checking ACK flag of a TCP segment is set

E. this rule set is one approach to handling FTP connections

Some of the attacks that can be made on packet-filtering routers & countermeasures are:

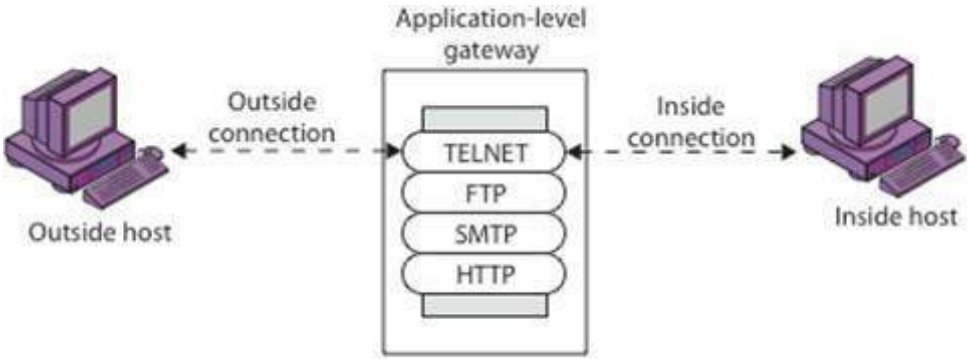
- **IP address spoofing**: where intruder transmits packets from the outside with internal host source IP addresses, need to filter & discard such packets
- **Source routing attacks**: where source specifies the route that a packet should take to bypass security measures, should discard all source routed packets
- **Tiny fragment attacks**: intruder uses the IP fragmentation option to create extremelysmall fragments and force the TCP header information into separate fragments to circumvent filtering rules needing full header info, can enforce minimum fragment size to include full header.

Stateful Packet Filters

A traditional packet filter makes filtering decisions on an individual packet basis and does not take into consideration any higher layer context. A stateful inspection packet filter tightens upthe rules for TCP traffic by creating a directory of outbound TCP connections, and will allow incoming traffic to high-numbered ports only for those packets that fit the profile of one of theentries in this directory. Hence, they are better able to detect bogus packets sent out of context.

APPLICATION-LEVEL GATEWAY

An application-level gateway (or proxy server), acts as a relay of application-level traffic. The user contacts the gateway using a TCP/IP application, such as Telnet or FTP, and the gateway asks the user for the name of the remote host to be accessed. When the user responds and provides a valid user ID and authentication information, the gateway contacts the application on the remote host and relays TCP segments containing the application data between the two endpoints. If the gateway does not implement the proxycode for a specific application, the service is not supported and cannot be forwarded across the firewall.



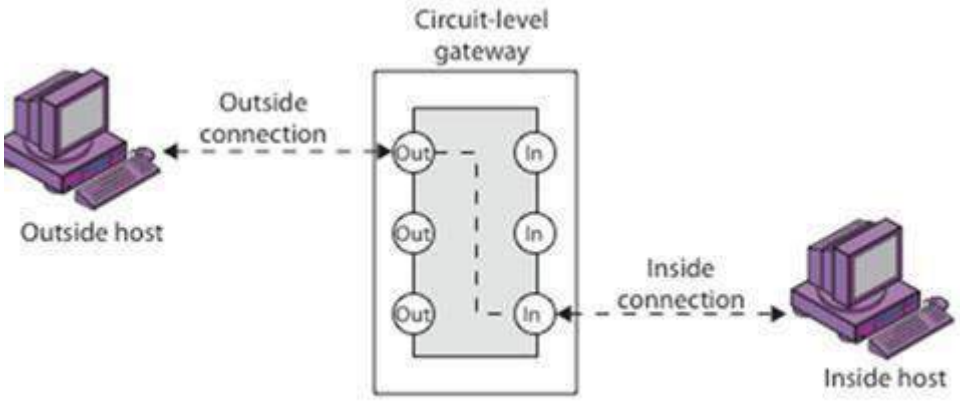
(b) Application-level gateway

Application-level gateways tend to be more secure than packet filters. Rather than trying to deal with the numerous possible combinations that are to be allowed and forbidden atthe TCPand IP level, the application-level gateway need only scrutinize a few allowable applications. In addition, it is easy to log and audit all incoming traffic at the application level. A prime disadvantage of this type of gateway is the additional processing overheadon each connection.In effect, there are two spliced connections between the end users, with the gateway at the splice point, and the gateway must examine and forward all trafficin both directions.

CIRCUIT LEVEL GATEWAY

A circuit-level gateway relays two TCP connections, one between itself and an inside TCP user, and the other between itself and a TCP user on an outside host. Once the two connections are established, it relays TCP data from one connection to the other without examining its contents. The security function consists of determining which connections will be allowed. It is typically used when internal users are trusted to decide what external servicesto access.

One of the most common circuit-level gateways is SOCKS, defined in RFC 1928. It consists of a SOCKS server on the firewall, and a SOCKS library & SOCKS-aware applications on internal clients. The protocol described here is designed to provide a framework for client-server applications in both the TCP and UDP domains to conveniently and securely use the services of a network firewall. The protocol is conceptually a "shim- layer" between the application layer and the transport layer, and as such does not provide network-layer gateway services, such as forwarding of ICMP messages.



(c) Circuit-level gateway

Bastion Host

A bastion host is a critical strong point in the network's security, serving as a platformfor an application-level or circuit-level gateway, or for external services. It is thus potentially exposed to "hostile" elements and must be secured to withstand this. Commoncharacteristics ofa bastion host include that it:

- executes a secure version of its O/S, making it a trusted system
- has only essential services installed on the bastion host
- may require additional authentication before a user is allowed access to

the proxyservices

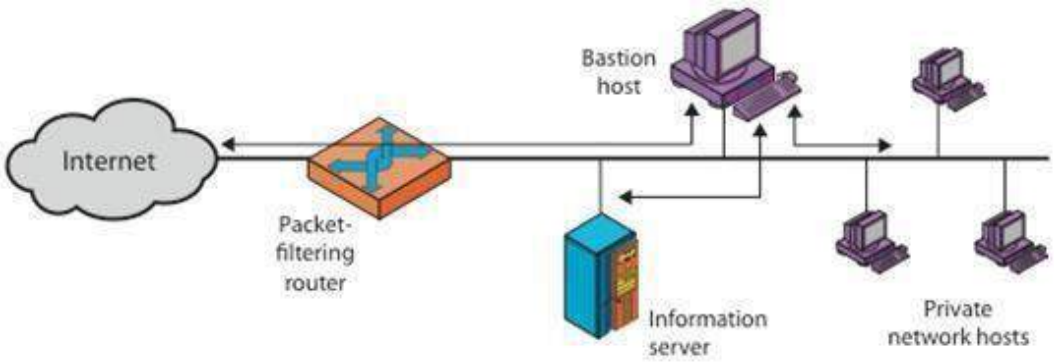
- is configured to support only a subset of the standard application's command set, withaccess only to specific hosts
- maintains detailed audit information by logging all traffic
- has each proxy module a very small software package specifically designed fornetwork security
- has each proxy independent of other proxies on the bastion host
- have a proxy performs no disk access other than to read its initial configurationfile
- have each proxy run as a non-privileged user in a private and secured directory
- A bastion host may have two or more network interfaces (or ports), and must be trusted to enforce trusted separation between these network connections, relaying traffic only according to policy.

Firewall Configurations

In addition to the use of a simple configuration consisting of a single system, more complex configurations are possible and indeed more common. There are three common firewall configurations.

The following figure shows the "**screened host firewall, single-homed bastion configuration**", where the firewall consists of two systems:

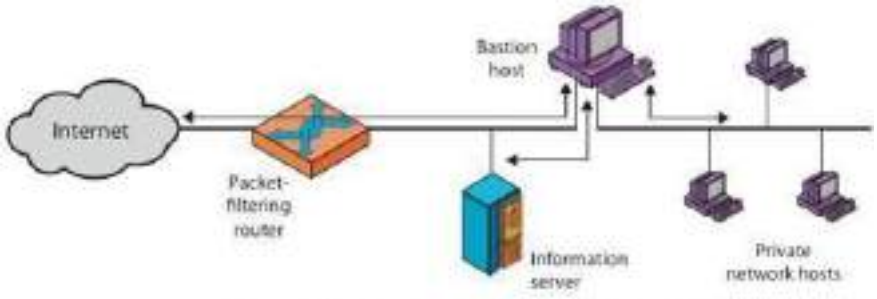
• a packet-filtering router - allows Internet packets to/from bastion only
• a bastion host - performs authentication and proxy functions



(a) Screened host firewall system (single-homed bastion host)

This configuration has greater security, as it implements both packet-level & application- levelfiltering, forces an intruder to generally penetrate two separate systems to compromise internal security, & also affords flexibility in providing direct Internet access to specific internal servers (eg web) if desired.

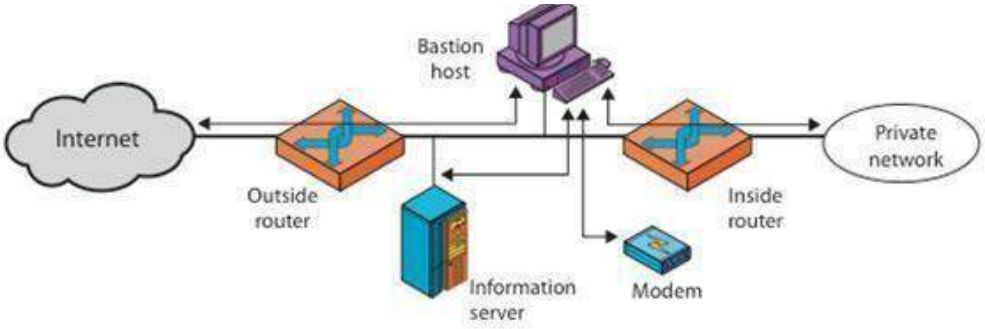
The next configuration illustrates the "**screened host firewall, dual-homed bastion configuration**" which physically separates the external and internal networks, ensuring two systems must be compromised to breach security. The advantages of dual layers of security are also present here.



(b) Screened host firewall system (dual-homed bastion host)

Again, an information server or other hosts can be allowed direct communication with the router if this is in accord with the security policy, but are now separated from the internal network.

The third configurations illustrated below shows the "**screened subnet firewall configuration**", being the most secure shown.



(c) Screened-subnet firewall system

It has two packet-filtering routers, one between the bastion host and the Internet and theother between the bastion host and the internal network, creating an isolated sub-network. This may consist of simply the bastion host but may also include one or more information servers and modems for dial-in capability. Typically, both the Internet and the internal network have access to hosts on the screened subnet, but traffic across the screened subnet is blocked. This configuration offers several advantages:

• There are now three levels of defense to thwart intruders

• The outside router advertises only the existence of the screened subnet to the

Internet; therefore the internal network is invisible to the Internet

• Similarly, the inside router advertises only the existence of the screened subnet to the internal network; hence systems on the inside network cannot construct direct routes to the Internet