Cryptography and Network Security Chapter 22

Fifth Edition
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Chapter 20 – Firewalls

The function of a strong position is to make the forces holding it practically unassailable
***—On War,* Carl Von Clausewitz**

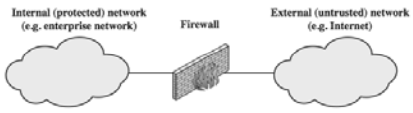
Introduction

- seen evolution of information systems
- now everyone want to be on the Internet
- and to interconnect networks
- has persistent security concerns
  - can't easily secure every system in org
- typically use a **Firewall**
- to provide **perimeter defence**
- as part of comprehensive security strategy

What is a Firewall?

- a **choke point** of control and monitoring
- interconnects networks with differing trust
- imposes restrictions on network services
  - only authorized traffic is allowed
- auditing and controlling access
  - can implement alarms for abnormal behavior
- provide NAT & usage monitoring
- implement VPNs using IPSec
- must be immune to penetration

What is a Firewall?



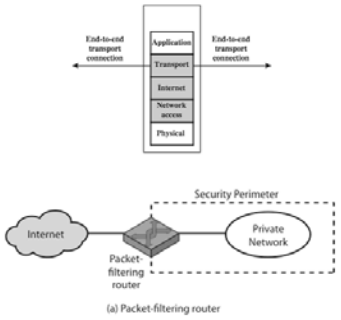
Firewall Limitations

- cannot protect from attacks bypassing it
  - eg sneaker net, utility modems, trusted organisations, trusted services (eg SSL/SSH)
- cannot protect against internal threats
  - eg disgruntled or colluding employees
- cannot protect against access via WLAN
  - if improperly secured against external use
- cannot protect against malware imported via laptop, PDA, storage infected outside

Firewalls – Packet Filters

- simplest, fastest firewall component
- foundation of any firewall system
- examine each IP packet (no context) and permit or deny according to rules
- hence restrict access to services (ports)
- possible default policies
  - that not expressly permitted is prohibited
  - that not expressly prohibited is permitted

Firewalls – Packet Filters



Firewalls – Packet Filters

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

Attacks on Packet Filters

- IP address spoofing
  - fake source address to be trusted
  - add filters on router to block
- source routing attacks
  - attacker sets a route other than default
  - block source routed packets
- tiny fragment attacks
  - split header info over several tiny packets
  - either discard or reassemble before check

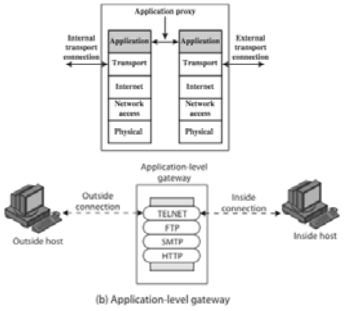
Firewalls – Stateful Packet Filters

- traditional packet filters do not examine higher layer context
  - ie matching return packets with outgoing flow
- stateful packet filters address this need
- they examine each IP packet in context
  - keep track of client-server sessions
  - check each packet validly belongs to one
- hence are better able to detect bogus packets out of context
- may even inspect limited application data

Firewalls - Application Level Gateway (or Proxy)

- have application specific gateway / proxy
- has full access to protocol
  - user requests service from proxy
  - proxy validates request as legal
  - then actions request and returns result to user
  - can log / audit traffic at application level
- need separate proxies for each service
  - some services naturally support proxying
  - others are more problematic

Firewalls - Application Level Gateway (or Proxy)

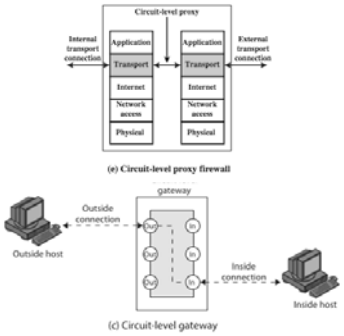


(b) Application-level gateway

Firewalls - Circuit Level Gateway

- relays two TCP connections
- imposes security by limiting which such connections are allowed
- once created usually relays traffic without examining contents
- typically used when trust internal users by allowing general outbound connections
- SOCKS is commonly used

Firewalls - Circuit Level Gateway



(e) Circuit-level proxy firewall

(c) Circuit-level gateway

Bastion Host

- highly secure host system
- runs circuit / application level gateways
- or provides externally accessible services
- potentially exposed to "hostile" elements
- hence is secured to withstand this
  - hardened O/S, essential services, extra auth
  - proxies small, secure, independent, non-privileged
- may support 2 or more net connections
- may be trusted to enforce policy of trusted separation between these net connections

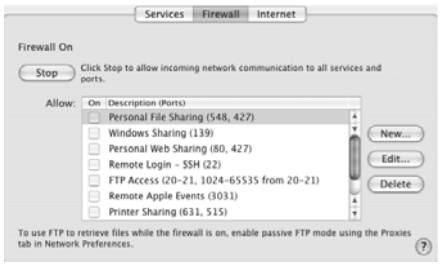
Host-Based Firewalls

- s/w module used to secure individual host
  - available in many operating systems
  - or can be provided as an add-on package
- often used on servers
- advantages:
  - can tailor filtering rules to host environment
  - protection is provided independent of topology
  - provides an additional layer of protection

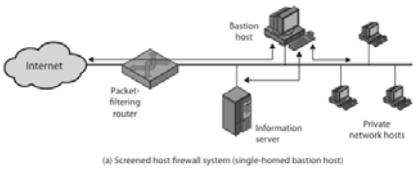
Personal Firewalls

- controls traffic between PC/workstation and Internet or enterprise network
- a software module on personal computer
- or in home/office DSL/cable/ISP router
- typically much less complex than other firewall types
- primary role to deny unauthorized remote access to the computer
- and monitor outgoing activity for malware

Personal Firewalls

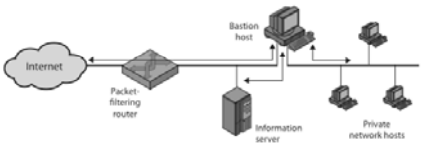


Firewall Configurations



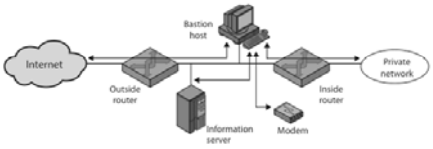
(a) Screened host firewall system (single-homed bastion host)

Firewall Configurations



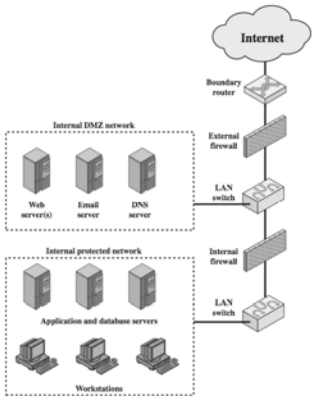
(b) Screened host firewall system (dual-homed bastion host)

Firewall Configurations

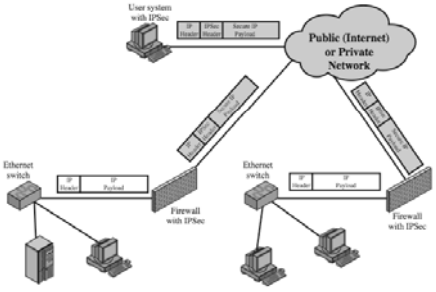


(c) Screened-subnet firewall system

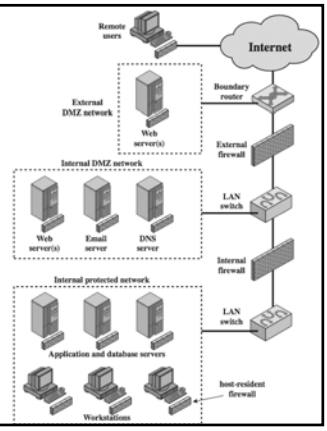
DMZ Networks



Virtual Private Networks



Distributed Firewalls



Summary of Firewall Locations and Topologies

- host-resident firewall
- screening router
- single bastion inline
- single bastion T
- double bastion inline
- double bastion T
- distributed firewall configuration

Summary

- have considered:
  - firewalls
  - types of firewalls
    - packet-filter, stateful inspection, application proxy, circuit-level
  - basing
    - bastion, host, personal
  - location and configurations
    - DMZ, VPN, distributed, topologies