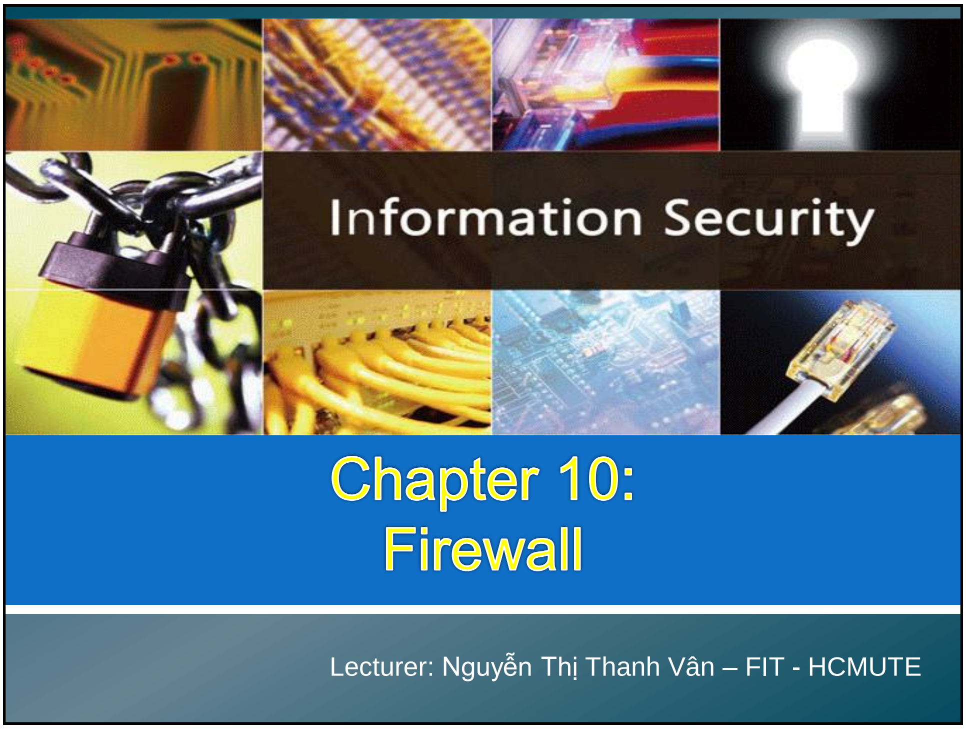
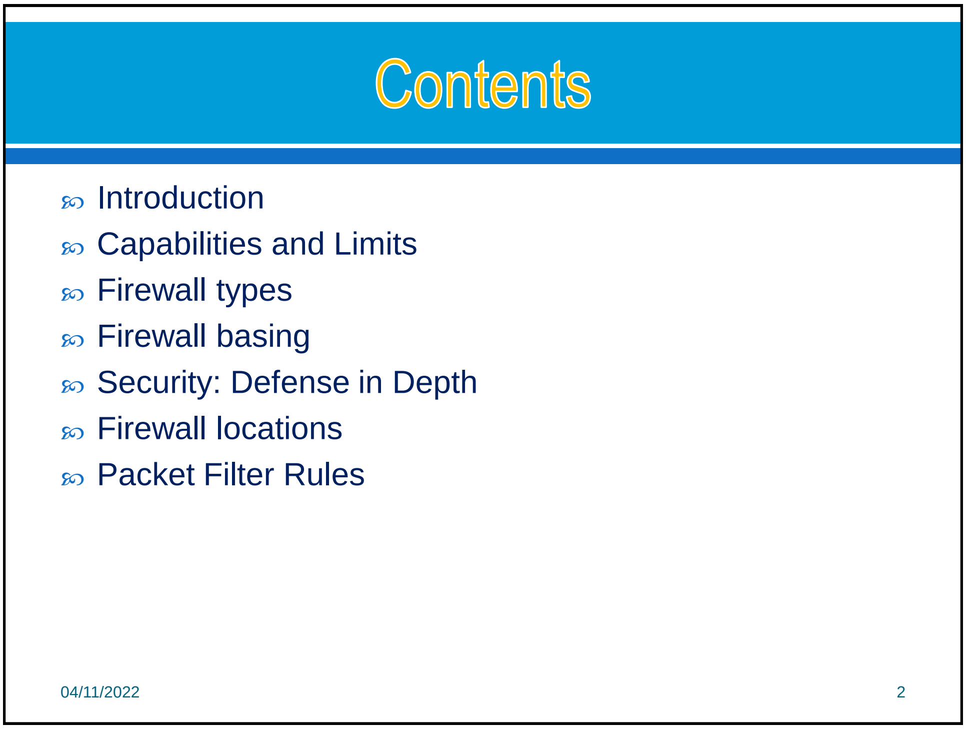


Information Security

Chapter 10: Firewall

Lecturer: Nguyễn Thị Thanh Vân – FIT - HCMUTE

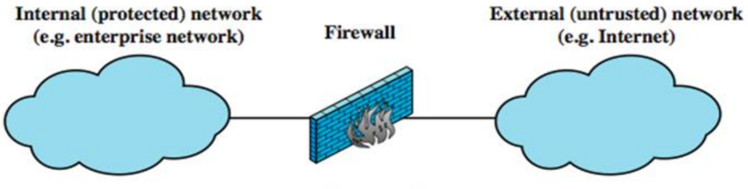


Contents

- Introduction
- Capabilities and Limits
- Firewall types
- Firewall basing
- Security: Defense in Depth
- Firewall locations
- Packet Filter Rules

Firewalls

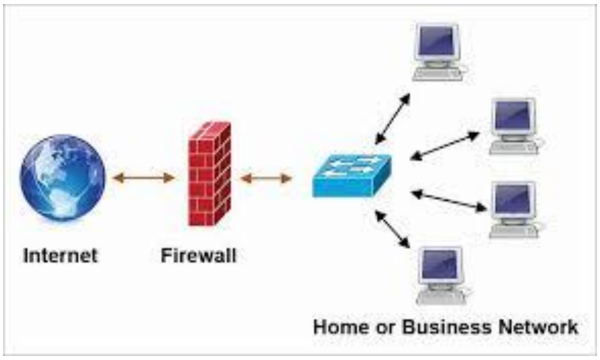
- Can be effective means of protecting LANs from threats
- internet connectivity essential
  - for organization and individuals
  - but creates a threat when the outside is enabled to reach with local network
- could secure workstations and servers
- also use firewall as perimeter defence
  - single block point to impose security


Internal (protected) network
(e.g. enterprise network)
Firewall
External (untrusted) network
(e.g. Internet)

(a) General model

Firewall

- Hardware



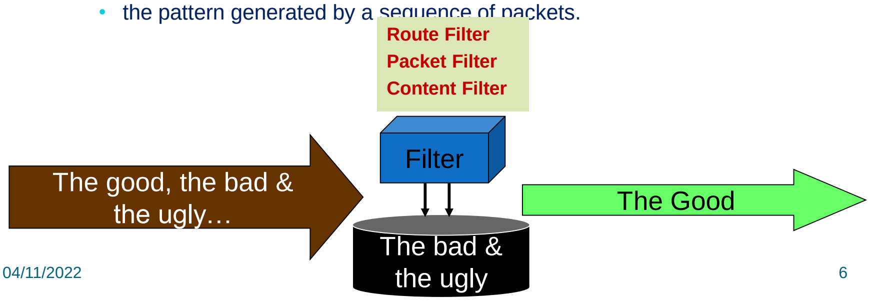
- Software
  - Copyright: ISA, TMG
  - Opensource: IPTable, Endien…

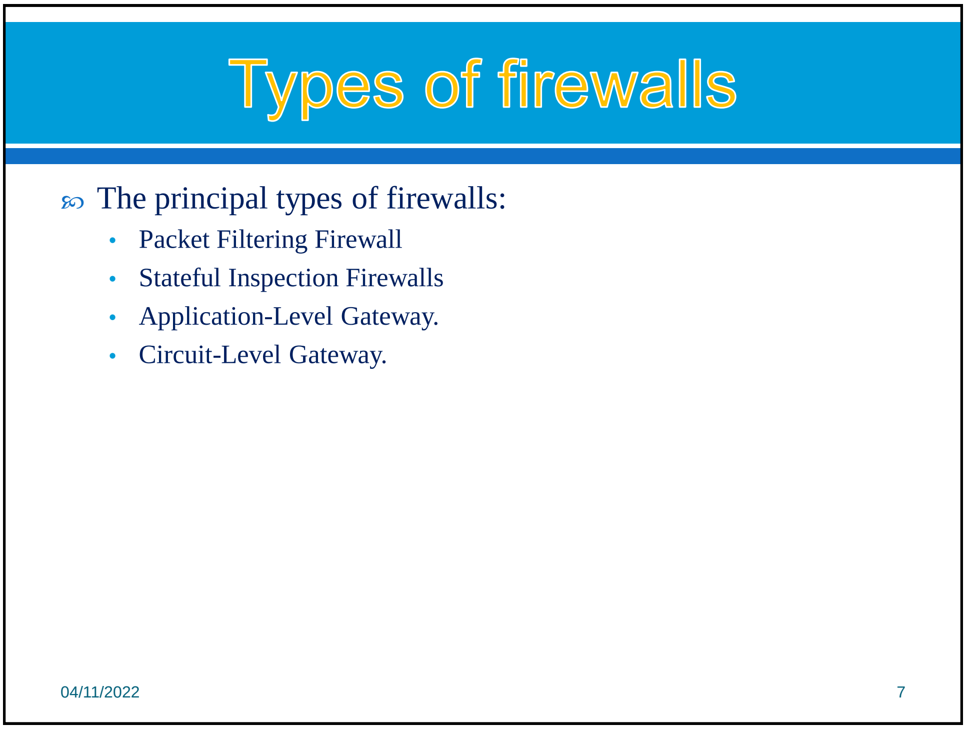
Firewall Capabilities & Limits

- capabilities:
  - defines a single choke point
  - provides a location for monitoring security events
  - convenient platform for some Internet functions such as NAT, usage monitoring, IPSEC VPNs
- limitations:
  - cannot protect against attacks bypassing firewall
  - may not protect fully against internal threats
  - improperly secure wireless LAN
  - laptop, PDA, portable storage device infected outside then used inside

Firewall operation

- as a positive filter:
  - allowing to pass only packets that meet specific criteria, or
- as a negative filter:
  - rejecting any packet that meets certain criteria.
- Depending on the type of firewall, it may examine:
  - one or more protocol headers in each packet,
  - the payload of each packet, or
  - the pattern generated by a sequence of packets.





Types of firewalls

- The principal types of firewalls:
  - Packet Filtering Firewall
  - Stateful Inspection Firewalls
  - Application-Level Gateway.
  - Circuit-Level Gateway.

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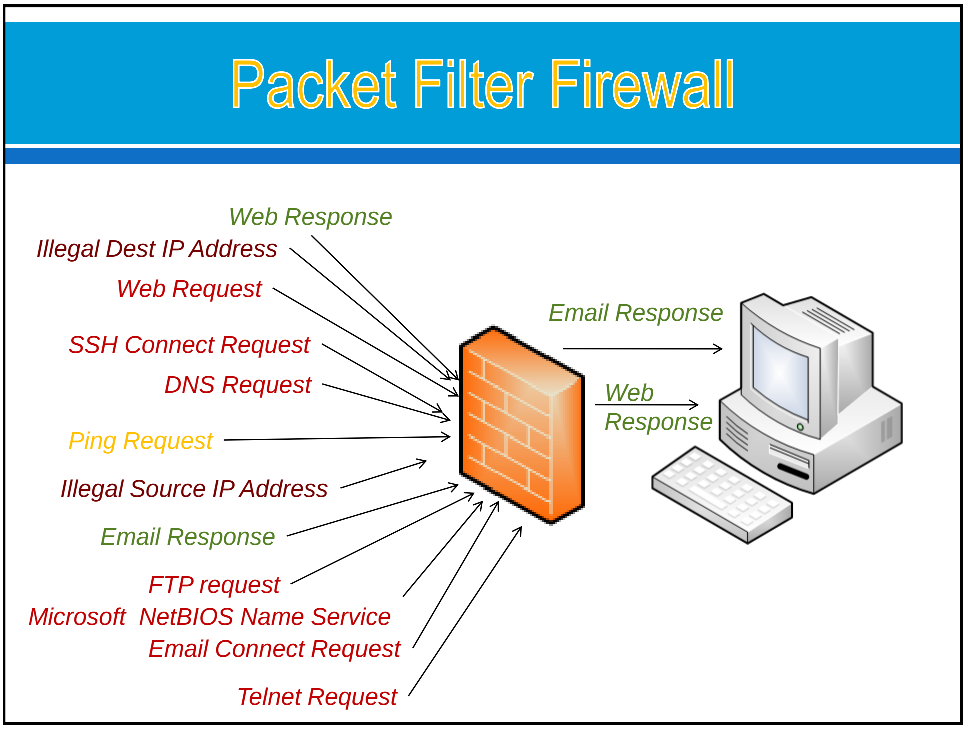


Packet Filter Firewall

Web Response

Illegal Dest IP Address

Web Request

SSH Connect Request

DNS Request

Ping Request

Illegal Source IP Address

Email Response

FTP request

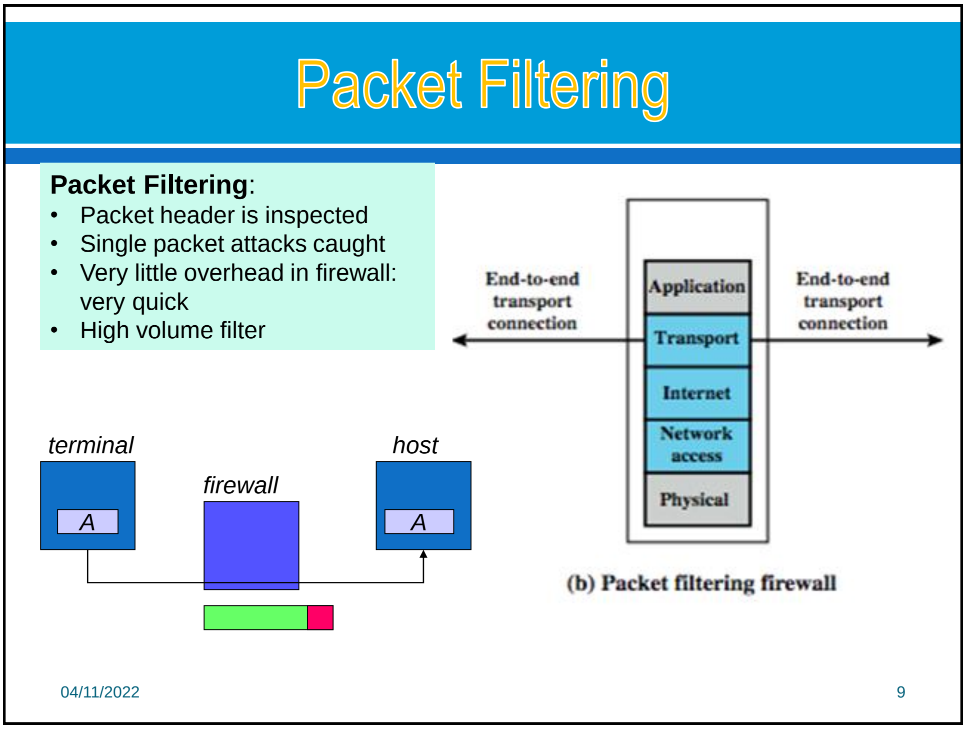
Microsoft NetBIOS Name Service

Email Connect Request

Telnet Request

Email Response

Web Response

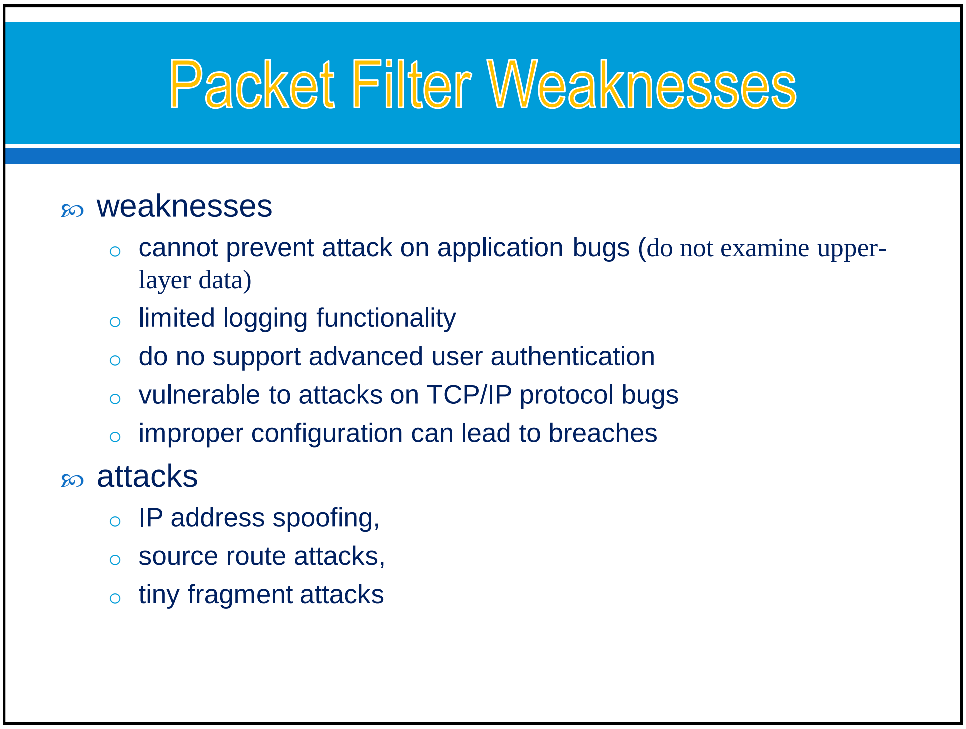


Packet Filtering

Packet Filtering:

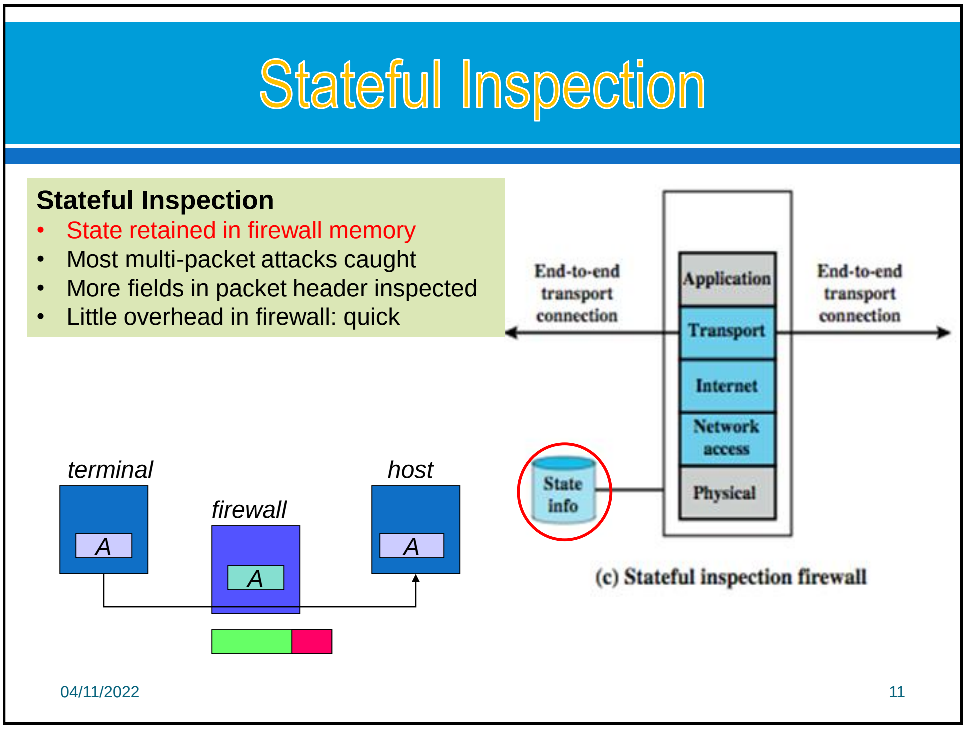
- Packet header is inspected
- Single packet attacks caught
- Very little overhead in firewall: very quick
- High volume filter

(b) Packet filtering firewall



Packet Filter Weaknesses

- weaknesses
  - cannot prevent attack on application bugs (do not examine upper-layer data)
  - limited logging functionality
  - do no support advanced user authentication
  - vulnerable to attacks on TCP/IP protocol bugs
  - improper configuration can lead to breaches
- attacks
  - IP address spoofing,
  - source route attacks,
  - tiny fragment attacks



Stateful Inspection

Stateful Inspection
- State retained in firewall memory
- Most multi-packet attacks caught
- More fields in packet header inspected
- Little overhead in firewall: quick

(c) Stateful inspection firewall

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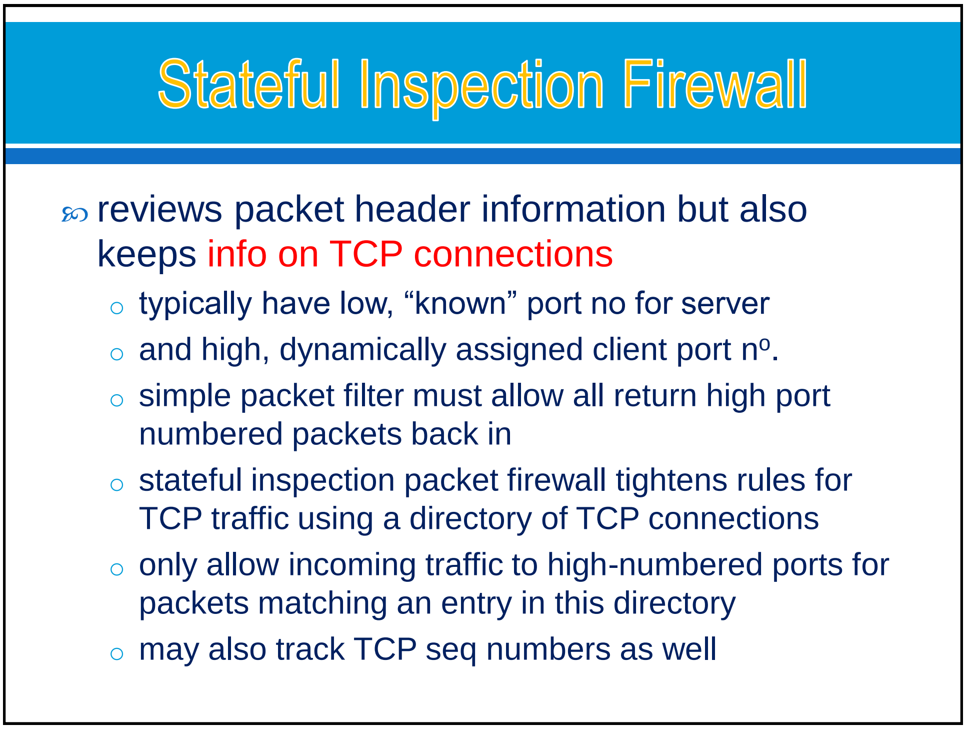
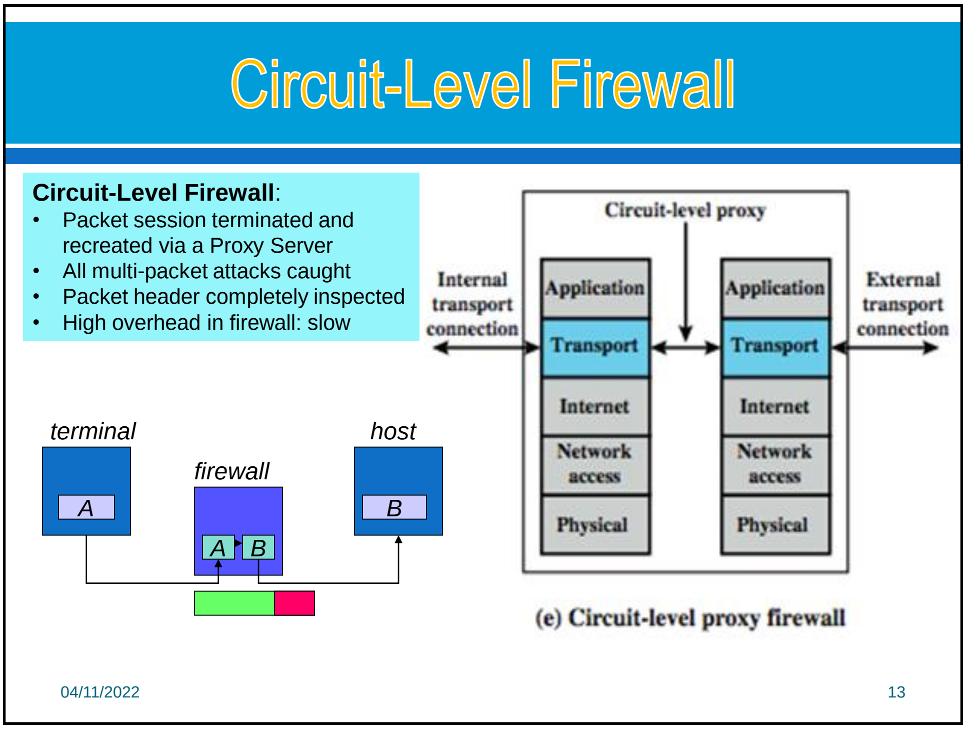


Stateful Inspection Firewall

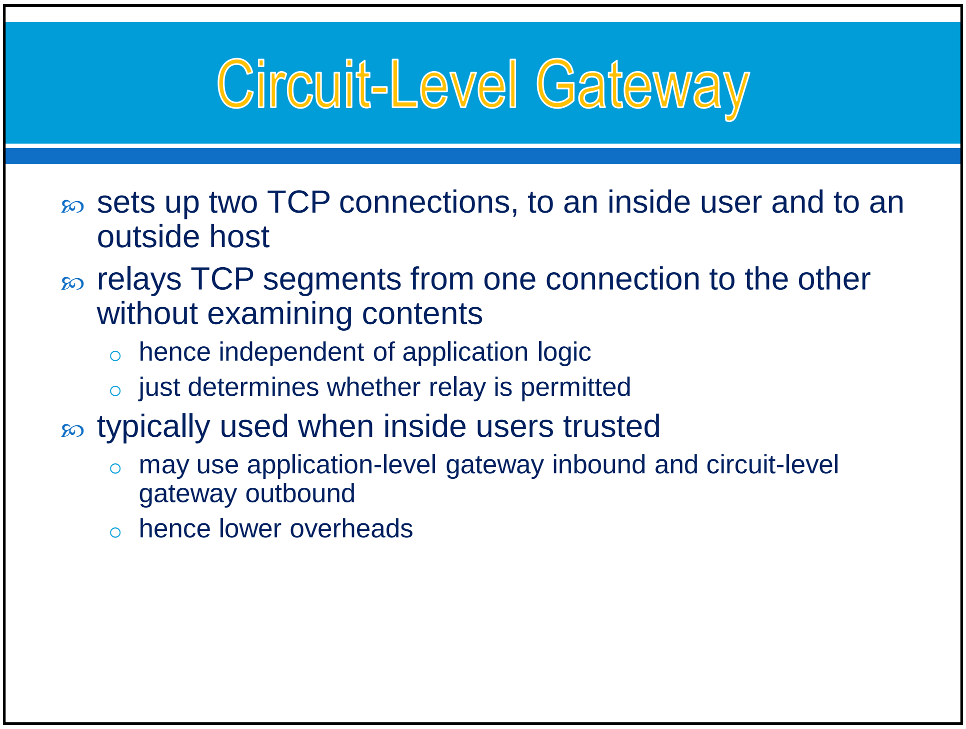
- reviews packet header information but also keeps info on TCP connections
  - typically have low, “known” port no for server
  - and high, dynamically assigned client port nº.
  - simple packet filter must allow all return high port numbered packets back in
  - stateful inspection packet firewall tightens rules for TCP traffic using a directory of TCP connections
  - only allow incoming traffic to high-numbered ports for packets matching an entry in this directory
  - may also track TCP seq numbers as well



Circuit-Level Firewall

Circuit-Level Firewall:
- Packet session terminated and recreated via a Proxy Server
- All multi-packet attacks caught
- Packet header completely inspected
- High overhead in firewall: slow

(e) Circuit-level proxy firewall



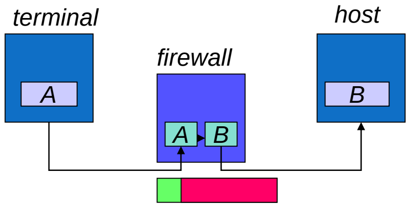
Circuit-Level Gateway

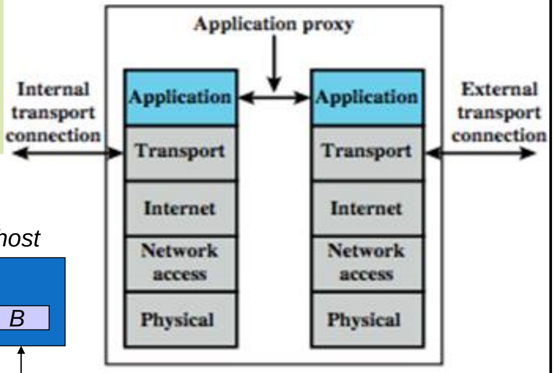
- sets up two TCP connections, to an inside user and to an outside host
- relays TCP segments from one connection to the other without examining contents
  - hence independent of application logic
  - just determines whether relay is permitted
- typically used when inside users trusted
  - may use application-level gateway inbound and circuit-level gateway outbound
  - hence lower overheads

Application-Level Firewall

Application-Level Firewall

- Packet session terminated and recreated
- via a Proxy Server
- Packet header completely inspected
- Most or all of application inspected
- Highest overhead: slow & low volume

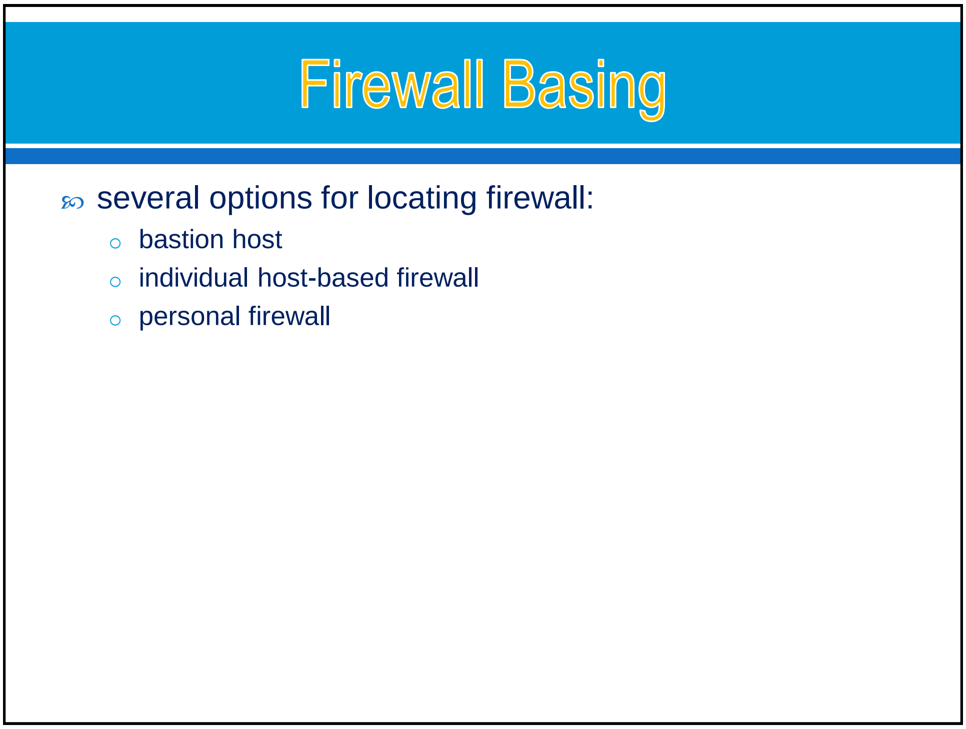




(d) Application proxy firewall

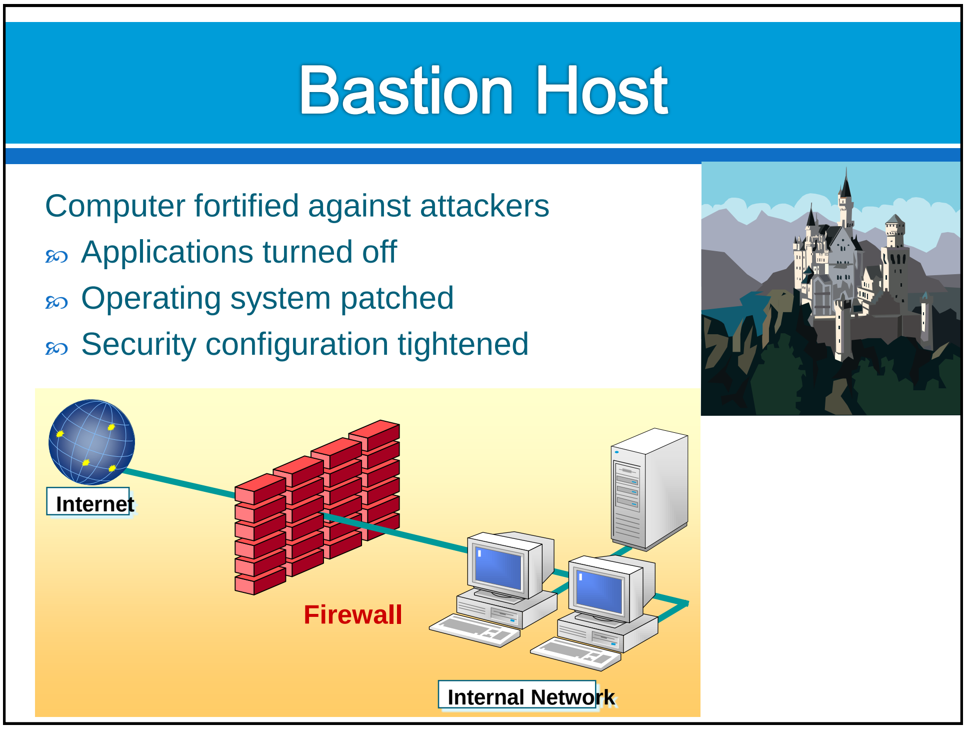
Application-Level Gateway

- acts as a relay of application-level traffic
  - user contacts gateway with remote host name
  - authenticates themselves
  - gateway contacts application on remote host and relays TCP segments between server and user
- must have proxy code for each application
  - may restrict application features supported
- more secure than packet filters
- but have higher overheads



Firewall Basing

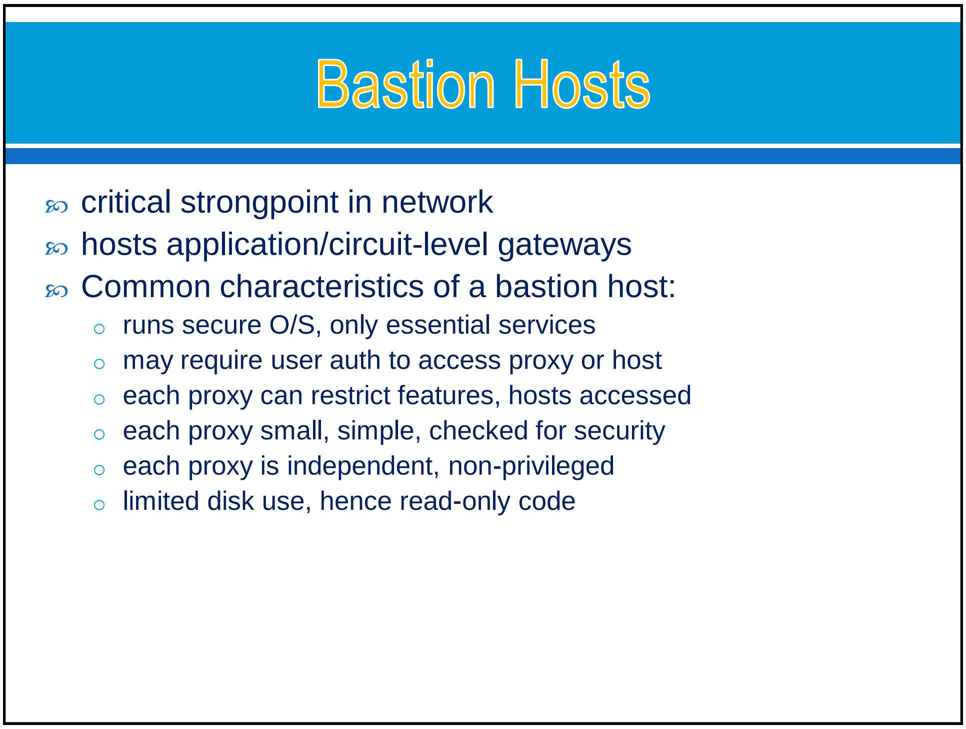
- several options for locating firewall:
  - bastion host
  - individual host-based firewall
  - personal firewall



Bastion Host

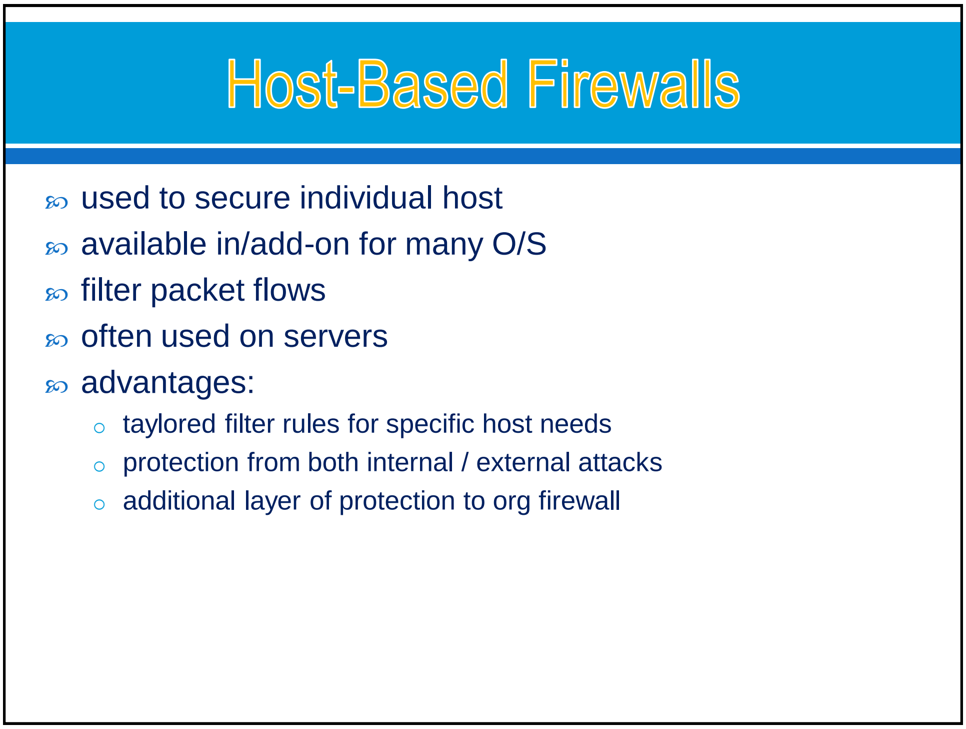
Computer fortified against attackers

- Applications turned off
- Operating system patched
- Security configuration tightened



Bastion Hosts

- critical strongpoint in network
- hosts application/circuit-level gateways
- Common characteristics of a bastion host:
  - runs secure O/S, only essential services
  - may require user auth to access proxy or host
  - each proxy can restrict features, hosts accessed
  - each proxy small, simple, checked for security
  - each proxy is independent, non-privileged
  - limited disk use, hence read-only code



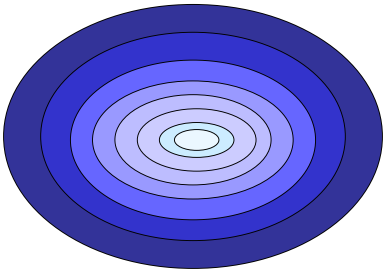
Host-Based Firewalls

- used to secure individual host
- available in/add-on for many O/S
- filter packet flows
- often used on servers
- advantages:
  - taylored filter rules for specific host needs
  - protection from both internal / external attacks
  - additional layer of protection to org firewall

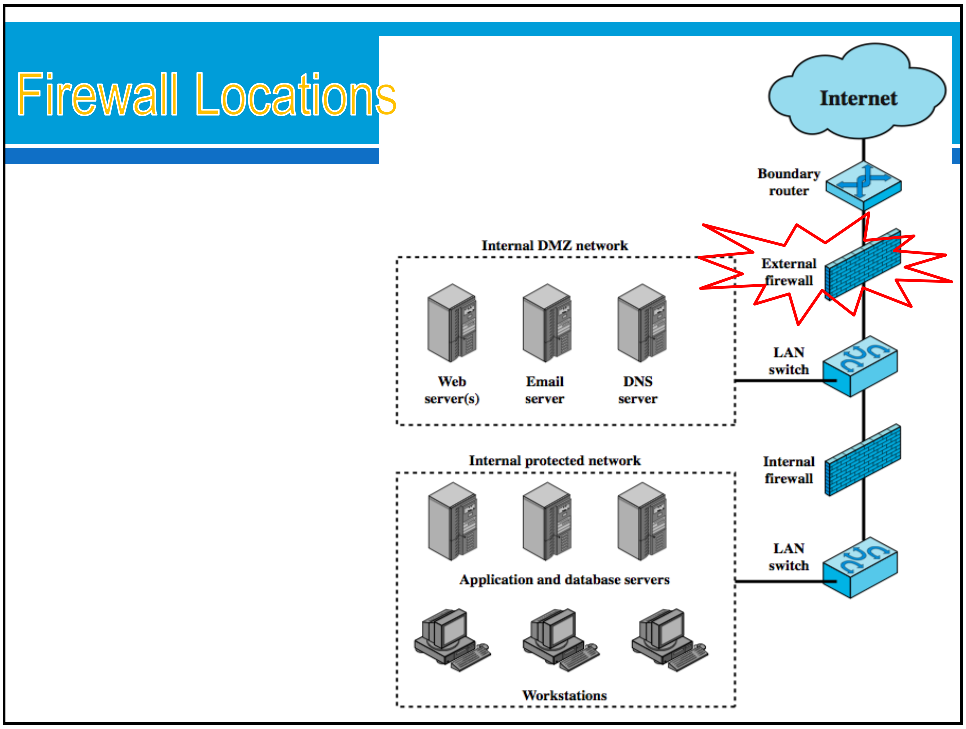
Personal Firewall

- controls traffic flow to/from PC/workstation
- for both home or corporate use
- may be software module on PC
- or in home cable/DSL router/gateway
- typically much less complex
- primary role to deny unauthorized access
- may also monitor outgoing traffic to detect/block worm/malware activity

Security: Defense in Depth



- Border Router
- Perimeter firewall
- Internal firewall
- Intrusion Detection System
- Policies & Procedures & Audits
- Authentication
- Access Controls



Firewall Locations

Internet

Boundary router

External firewall

Internal DMZ network

Web server(s)

Email server

DNS server

LAN switch

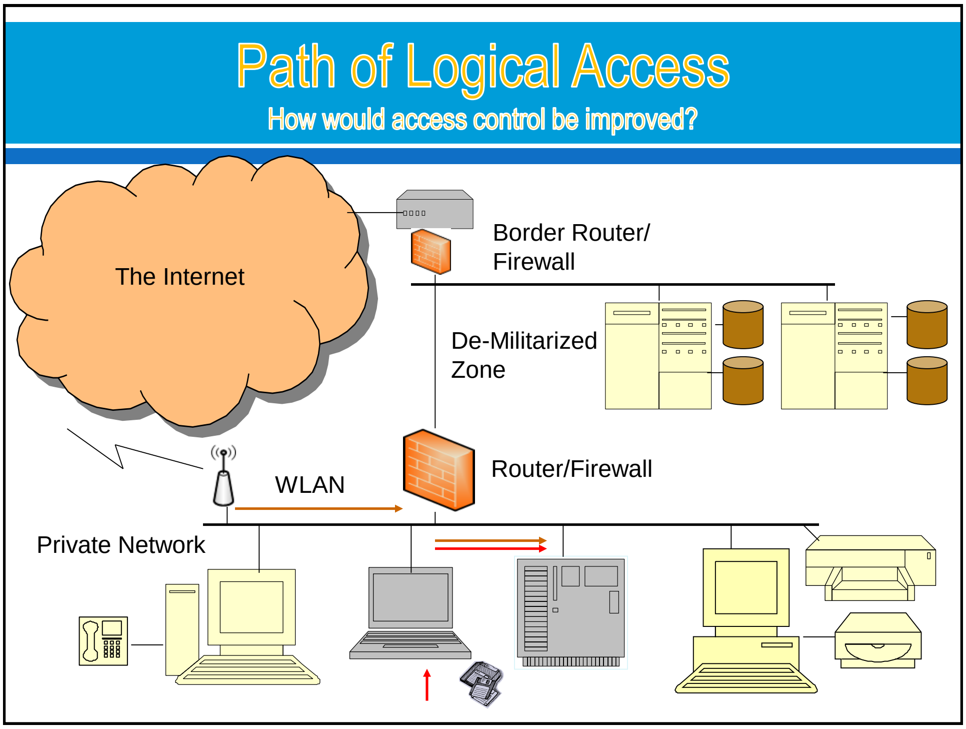
Internal firewall

Internal protected network

Application and database servers

Workstations

LAN switch



Path of Logical Access

How would access control be improved?

The Internet

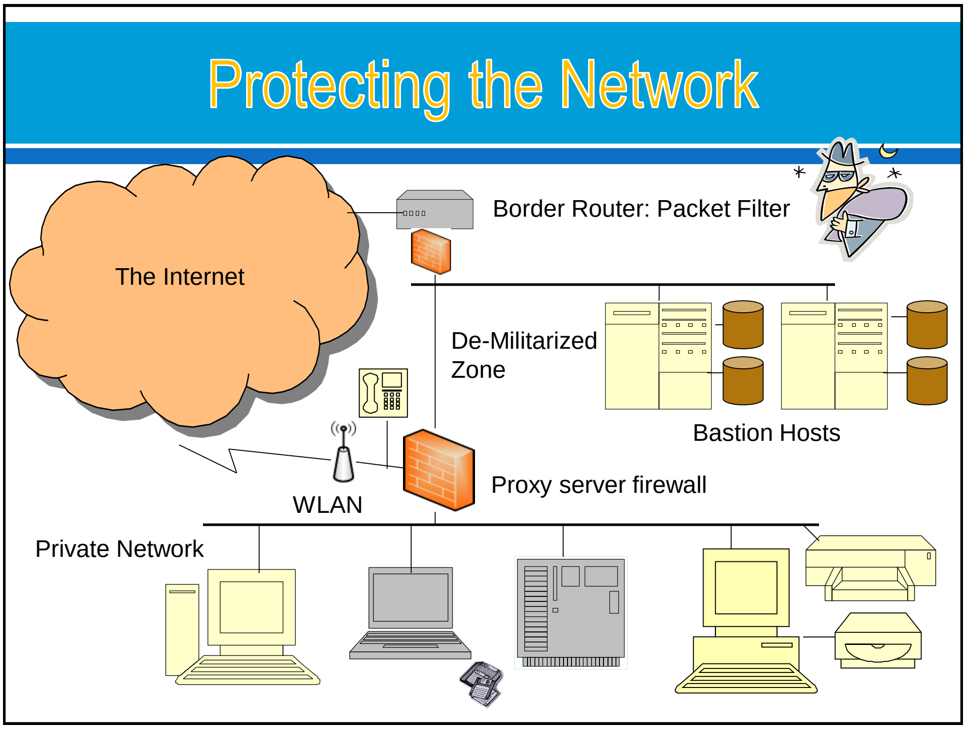
Border Router/ Firewall

De-Militarized Zone

WLAN

Router/Firewall

Private Network



Protecting the Network

Border Router: Packet Filter

The Internet

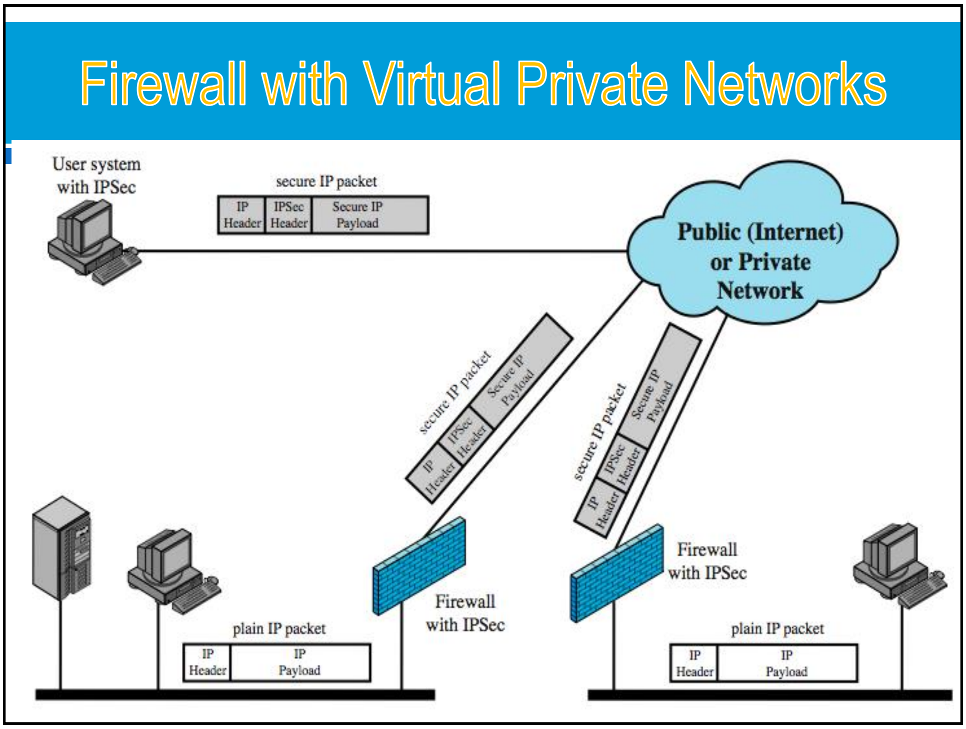
De-Militarized Zone

Bastion Hosts

WLAN

Proxy server firewall

Private Network



Firewall with Virtual Private Networks

User system with IPSec

secure IP packet

IP Header | IPSec Header | Secure IP Payload

Public (Internet) or Private Network

secure IP packet

IP Header | IPSec Header | Secure IP Payload

secure IP packet

IP Header | IPSec Header | Secure IP Payload

Firewall with IPSec

Firewall with IPSec

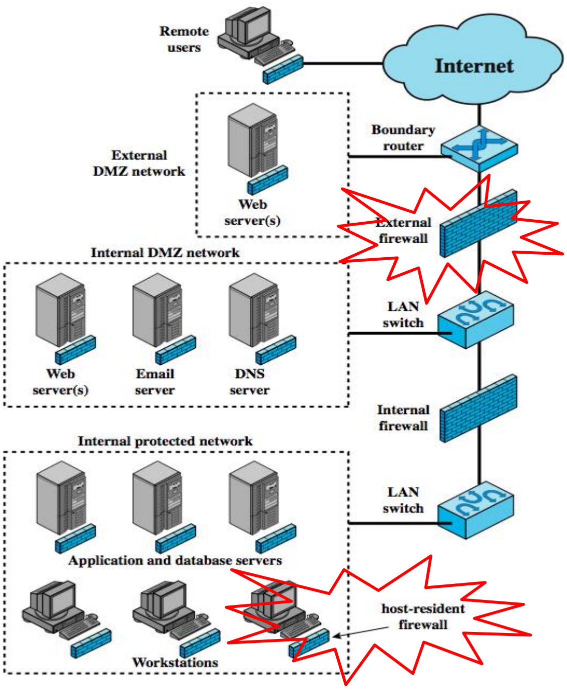
plain IP packet

IP Header | IP Payload

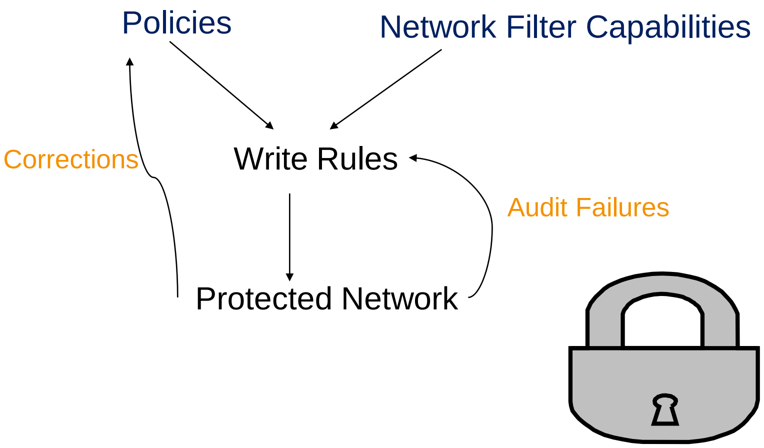
plain IP packet

IP Header | IP Payload

Distributed Firewalls



Firewall policy - Writing Rules


Policies

Network Filter Capabilities

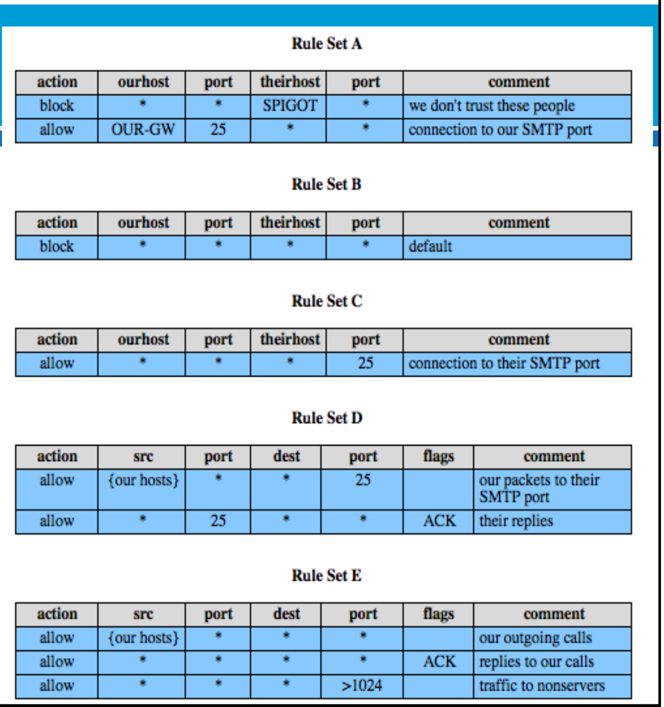
Corrections

Write Rules

Audit Failures

Protected Network

Packet Filter Rules



Rule Set A

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

Rule Set B

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

Rule Set C

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

Rule Set D

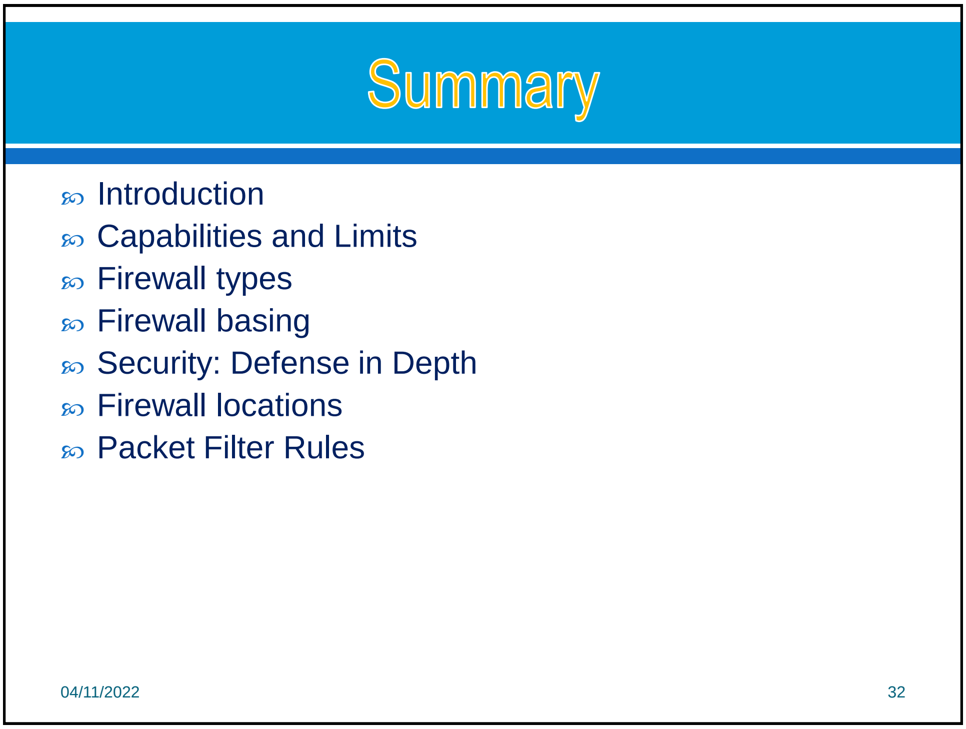
action	src	port	dest	port	flags	comment
allow	{our hosts}	*	*	25		our packets to their SMTP port
allow	*	25	*	*	ACK	their replies

Rule Set 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

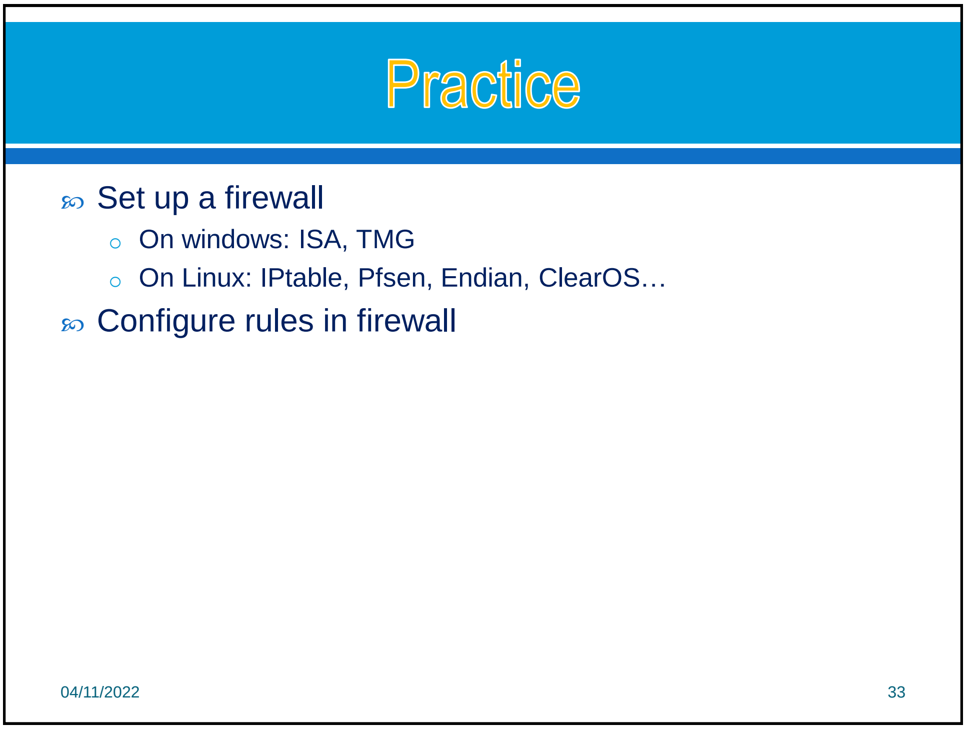
Firewall software

- Windows: ISA, TMG
- Open source: windows,linux
  - Iptable
  - Pfsense
  - Endien
  - ….



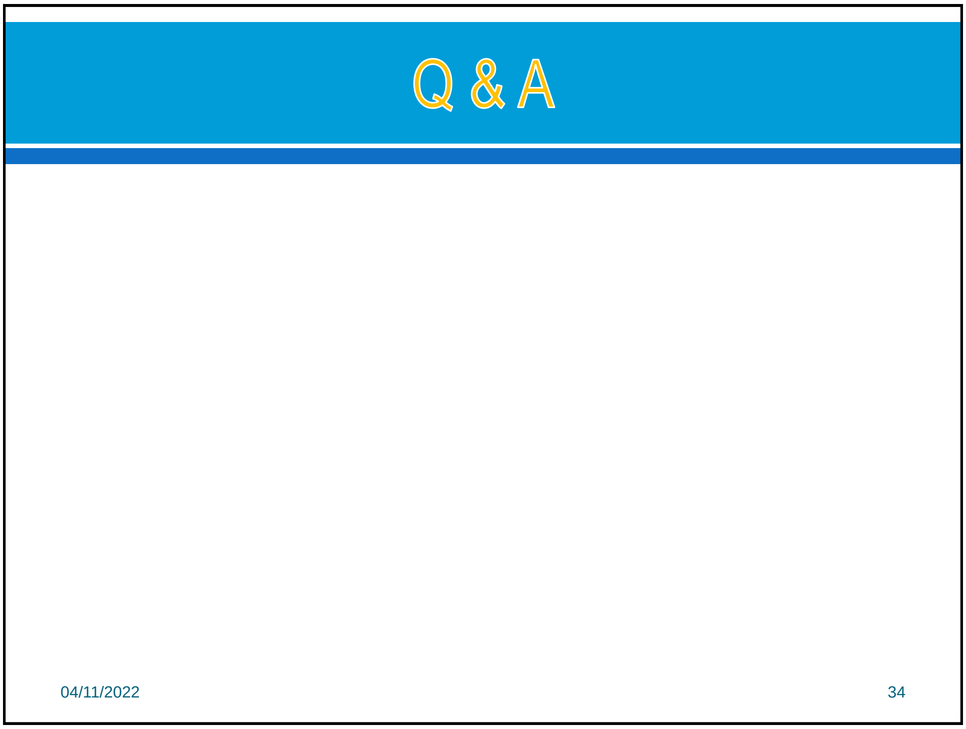
Summary

- Introduction
- Capabilities and Limits
- Firewall types
- Firewall basing
- Security: Defense in Depth
- Firewall locations
- Packet Filter Rules



Practice

- Set up a firewall
  - On windows: ISA, TMG
  - On Linux: IPtable, Pfsen, Endian, ClearOS…
- Configure rules in firewall



Q & A