Computer Security
CS 426
Lecture 36

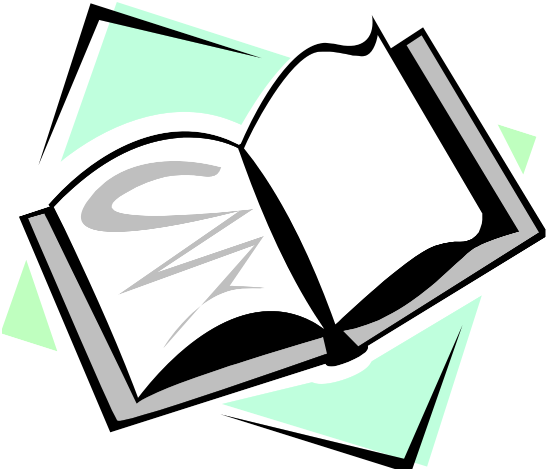
Perimeter Defense and Firewalls

Announcements

- There will be a quiz on Wed
- There will be a guest lecture on Friday, by Prof. Chris Clifton

Readings for This Lecture

- Readings
  - Perimeter Security Fundamentals



Elements of Perimeter Defense (Fortified Boundary)

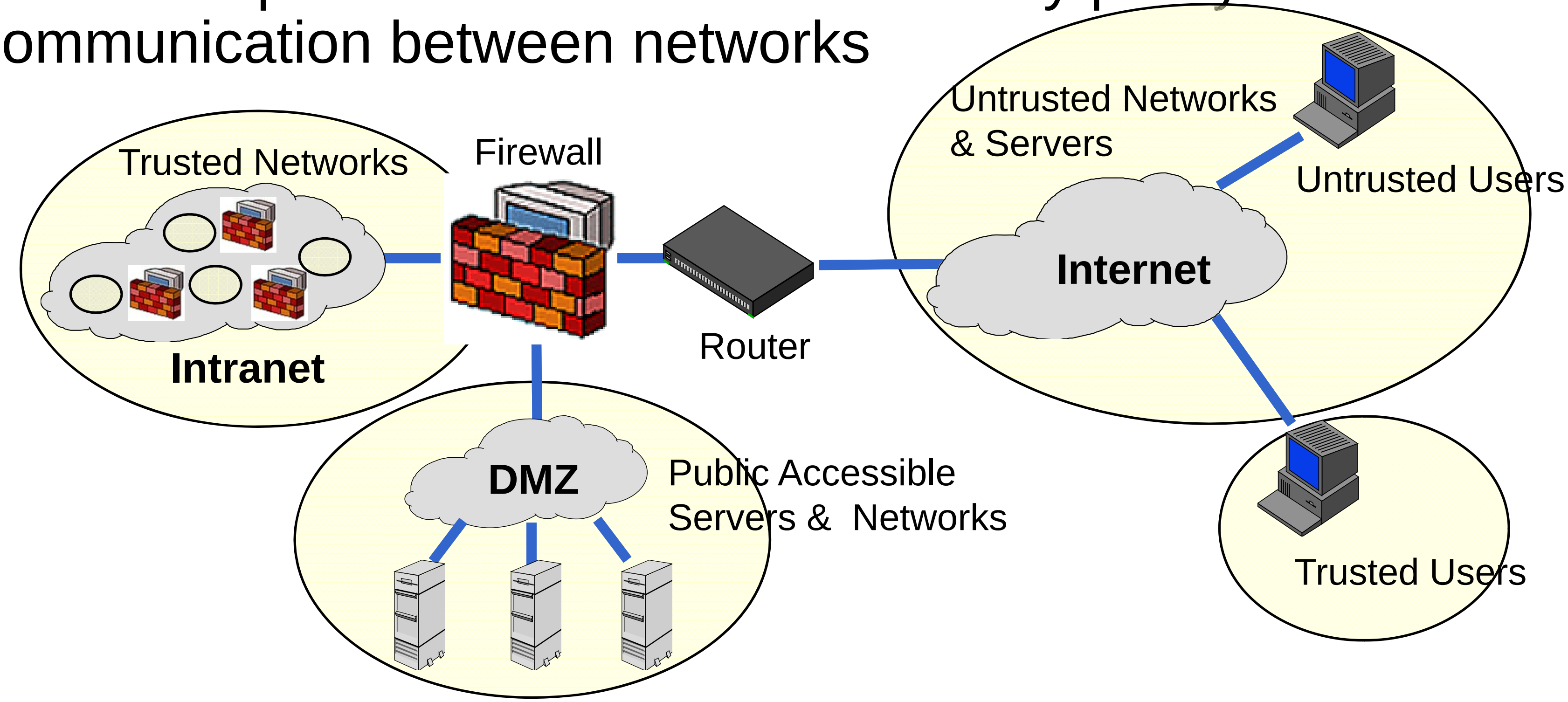
- Border Routers:
  - the last router you control before an untrusted network (such as Internet)
- Firewalls:
  - a chokepoint device that decide what traffic is to be allowed or denied
  - static packet filters, stateful firewalls, proxies
- Intrusion detection system
  - an alarm system that detects malicious events and alerts
  - network-based (NIDS) and host-based (HIDS)

Perimeter (Fortified Boundary)

- Intrusion Prevention Systems
  - provide automatic defense without administrators' involvements
- Virtual Private Networks
  - protected network session formed across an unprotected channel such as Internet
    - hosts connected through VPN are part of borders
- De-militarized zones (DMZ)
  - small network providing public services (not protected by firewall)

What is a Firewall?

- Device that provides secure connectivity between networks (internal/external; varying levels of trust)
- Used to implement and enforce a security policy for communication between networks



Usage of Firewall

- Controlling inbound communications
  - Prevent vulnerable programs from being exploited

- Controlling outbound communications is generally harder

Common Acceptable Outbound Connections

- SMTP to any address from SMTP mail gateway(s);
- DNS to any address from an internal DNS server to resolve external host names;
- HTTP and HTTPS from an internal proxy server for users to browse web sites;
- NTP to specific time server adds from internal time server(s);
- Any ports required by AV, spam filtering, web filtering or patch management software to appropriate vendor address(es) to pull down updates; and
- Anything else where the business case is documented and signed off by appropriate management.

Routing Filtering

- A router can ensure that source IP address of a packet belongs to the network it is coming from
  - known as network ingress filtering [RFC 2827]
- Example
  - No outbound traffic bears a source IP address not assigned to your network.
  - No outbound traffic bears a private (non-routable) IP address.
  - No inbound traffic bears a source IP address assigned to your network.
  - No inbound traffic bears a private (non-routable) IP address.

Defense in Depth

- Perimeter
  - static packet filter
  - stateful firewall
  - proxy firewall
  - IDS and IPS
  - VPN device
- Internal network
  - Ingress and egress filtering
  - Internal firewalls
  - IDS sensors

Defense in Depth

- Individual Hosts
  - host-centric firewalls
  - anti-virus software
  - configuration management
  - audit
- The human factor

- Why defense in depth, or perimeter defense is not enough?

Why perimeter defense not enough?

- Wireless access points and/or modem connection.
- Network ports accessible to attacker who have physical access
- Laptops of employees and/or consultants that are also connected to other networks
- Compromised end hosts through allowed network communications, e.g., drive-by downloads, malicious email attachments, weak passwords

Types of Firewalls

- Network-based vs. host-based (Personal)
- Hardware vs. Software
- Network layer vs. application layer

Stateless Packet Filters

- Inspecting the "packets"
- Use rules to determine
  - Whether to allow a packet through, drop it, or reject it.
  - use only info in packet (no state kept)
    - source IP, destination IP, source port number, destination port number, TCP or UDP
- Example:
  - no inbound connection to low port
  - outgoing web/mail traffic must go through proxies

More about networking: port numbering

- TCP connection
  - Server port uses number less than 1024
  - Client port uses number between 1024 and 16383
- Permanent assignment
  - Ports <1024 assigned permanently
    - 20,21 for FTP 23 for Telnet
    - 25 for server SMTP 80 for HTTP
- Variable use
  - Ports >1024 must be available for client to make connection

Stateful Firewall

- Why need stateful: a stateless firewall doesn’t know whether a packet belong to an accesptable connection

- Packet decision made in the context of a connection
- If packet is a new connection, check against security policy
- If packet is part of an existing connection, match it up in the state table & update table
  - can be viewed as packet filtering with rules dynamically updated

Proxy Firewalls (Application Layer Firewalls)

- Relay for connections
- Client ↔ Proxy ↔ Server
- Understands specific applications
  - Limited proxies available
  - Proxy ‘impersonates’ both sides of connection
- Resource intensive
  - process per connection
- HTTP proxies may cache web pages

Personal Firewalls

- Running on one PC, controlling network access
  - Windows firewall, iptables (Linux), ZoneAlarm, etc.
- Typically determines network access based on application programs
- Typically block most incoming traffic, harder to define policies for outgoing traffic
- Can be bypassed/disabled if host is compromised

Coming Attractions …

- Network Intrusion Detection and Prevention