# Intruders

- significant issue for networked systems is hostile or unwanted access
- either via network or local
- can identify classes of intruders:
  - masquerader
  - misfeasor
  - clandestine user
- varying levels of competence
  - key goal often is to acquire passwords

# Password Guessing

- one of the most common attacks
- attacker knows a login (from email/web page etc)
- then attempts to guess password for it
  - try default passwords shipped with systems
  - try all short passwords
  - then try by searching dictionaries of common words
  - intelligent searches try passwords associated with the user (variations on names, birthday, phone, common words/interests)
  - before exhaustively searching all possible passwords
- success depends on password chosen by user
- surveys show many users choose poorly

# Password Capture

- another attack involves **password capture**
  - watching over shoulder as password is entered
  - using a Trojan horse program to collect
  - monitoring an insecure network login (eg. telnet, FTP, web, email)
  - extracting recorded info after successful login (web history/cache, last number dialed etc)

# Intrusion Detection

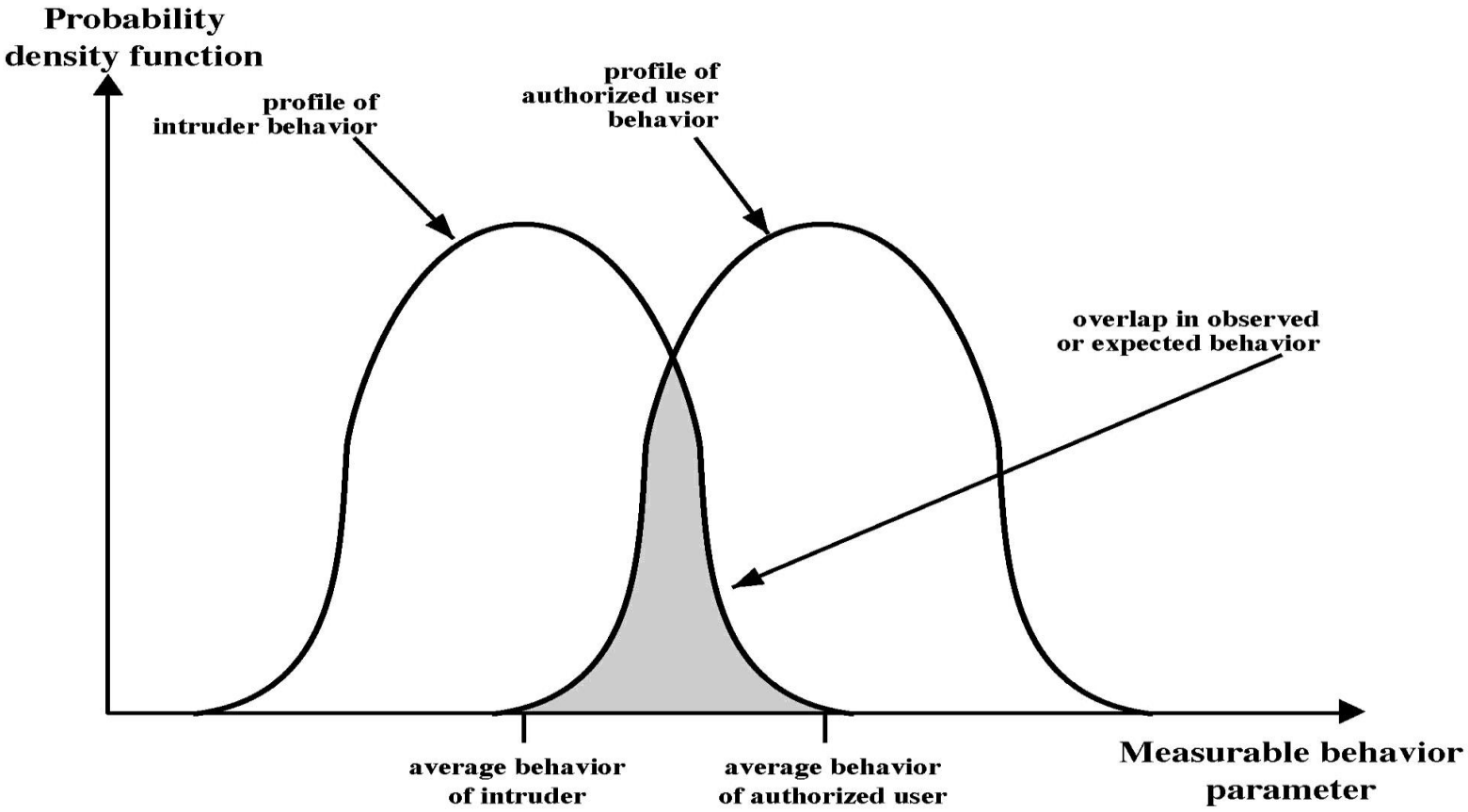



**Figure 18.1 Profiles of Behavior of Intruders and Authorized Users**

# Approaches to Intrusion Detection

- statistical anomaly detection
  - threshold
  - profile based
- rule-based detection
  - Anomaly, based on previous usage pattern
  - penetration identification

# Audit Records

- fundamental tool for intrusion detection
- native audit records
  - part of all common multi-user O/S
- detection-specific audit records
  - created specifically to collect wanted info

# Statistical Anomaly Detection

- threshold detection
  - count occurrences of specific event over time
  - if exceed reasonable value assume intrusion
  - alone is a crude & ineffective detector
- profile based
  - characterize past behavior of users
  - detect significant deviations from this
  - profile usually multi-parameter

# Audit Record Analysis

- foundation of statistical approaches
- analyze records to get metrics over time
  - counter, gauge, interval timer, resource use
- use various tests on these to determine if current behavior is acceptable
  - mean & standard deviation, multivariate, markov process, time series, operational

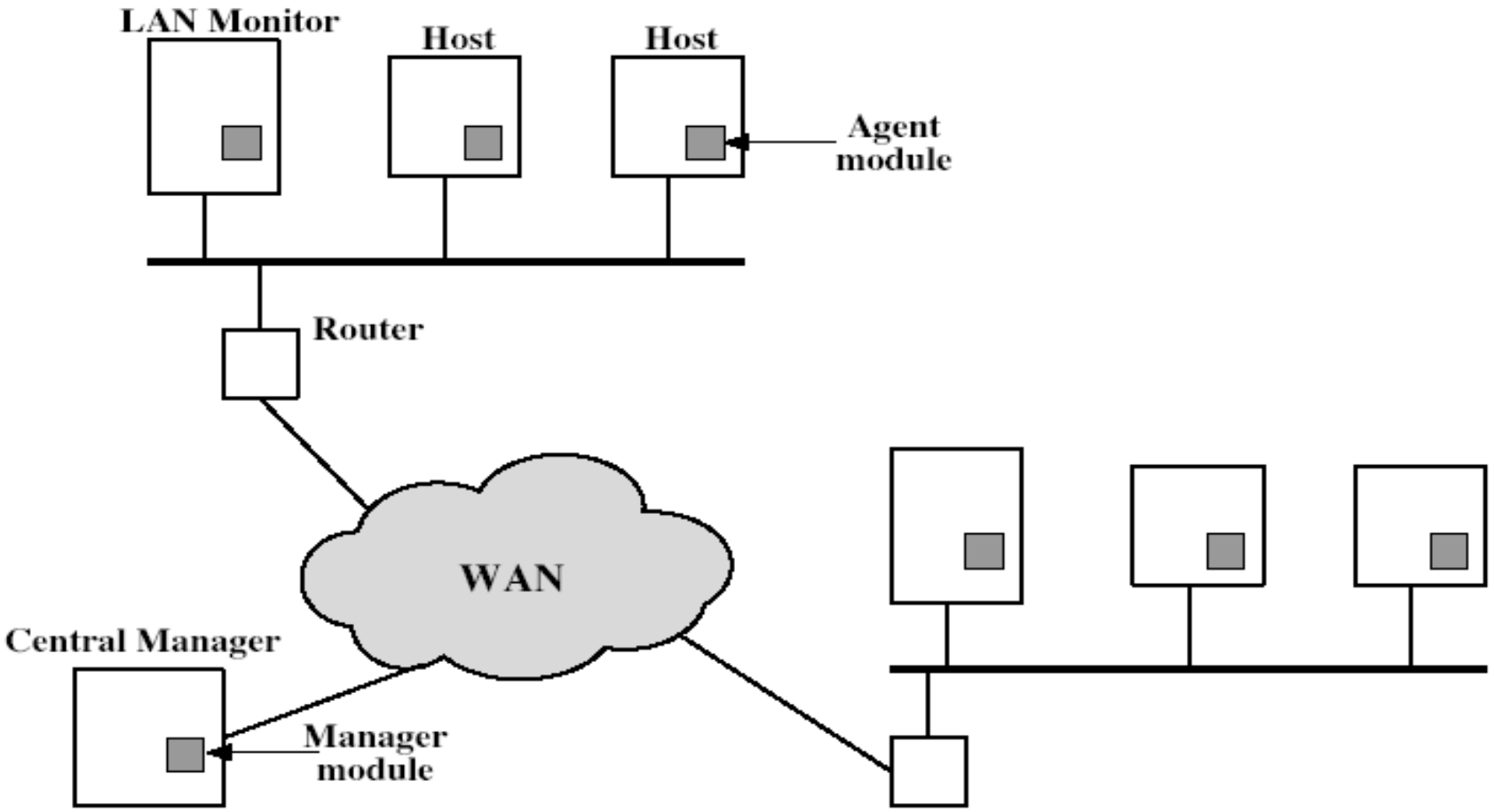
**Table 18.1 Measures That May Be Used for Intrusion Detection**

| Measure | Model | Type of Intrusion Detected |
|---|---|---|
| **Login and Session Activity** | | |
| Login frequency by day and time | Mean and standard deviation | Intruders may be likely to log in during off-hours. |
| Frequency of login at different locations | Mean and standard deviation | Intruders may log in from a location that a particular user rarely or never uses. |
| Time since last login | Operational | Break-in on a "dead" account. |
| Elapsed time per session | Mean and standard deviation | Significant deviations might indicate masquerader. |
| Quantity of output to location | Mean and standard deviation | Excessive amounts of data transmitted to remote locations could signify leakage of sensitive data. |
| Session resource utilization | Mean and standard deviation | Unusual processor or I/O levels could signal an intruder. |
| Password failures at login | Operational | Attempted break-in by password guessing. |
| Failures to login from specified terminals | Operational | Attempted break-in. |
| **Command or Program Execution Activity** | | |
| Execution frequency | Mean and standard deviation | May detect intruders, who are likely to use different commands, or a successful penetration by a legitimate user, who has gained access to privileged commands. |
| Program resource utilization | Mean and standard deviation | An abnormal value might suggest injection of a virus or Trojan horse, which performs side-effects that increase I/O or processor utilization. |
| Execution denials | Operational model | May detect penetration attempt by individual user who seeks higher privileges. |
| **File access activity** | | |
| Read, write, create, delete frequency | Mean and standard deviation | Abnormalities for read and write access for individual users may signify masquerading or browsing. |
| Records read, written | Mean and standard deviation | Abnormality could signify an attempt to obtain sensitive data by inference and aggregation. |
| Failure count for read, write, create, delete | Operational | May detect users who persistently attempt to access unauthorized files. |

# Base-Rate Fallacy

- practically an intrusion detection system needs to detect a substantial percentage of intrusions with few false alarms
  - if too few intrusions detected -> false security
  - if too many false alarms -> ignore / waste time
- this is very hard to do
- existing systems seem not to have a good record

# Distributed Intrusion Detection - Architecture



# Honeypots

- decoy systems to lure attackers
  - away from accessing critical systems
  - to collect information of their activities
  - to encourage attacker to stay on system so administrator can respond
- are filled with fabricated information

# Password Management

- front-line defense against intruders
- users supply both:
  - login – determines privileges of that user
  - password – to identify them
- passwords often stored encrypted
  - Unix uses multiple DES (variant with salt)
  - more recent systems use hash function

# Managing Passwords

- need policies and good user education
- protect password file from general access
- Enforce rules for “good” passwords
- Change password periodically
- Run password –guessing program
- Monitor login failures
- Proactive Password Checking

# Chapter 19 – Malicious Software

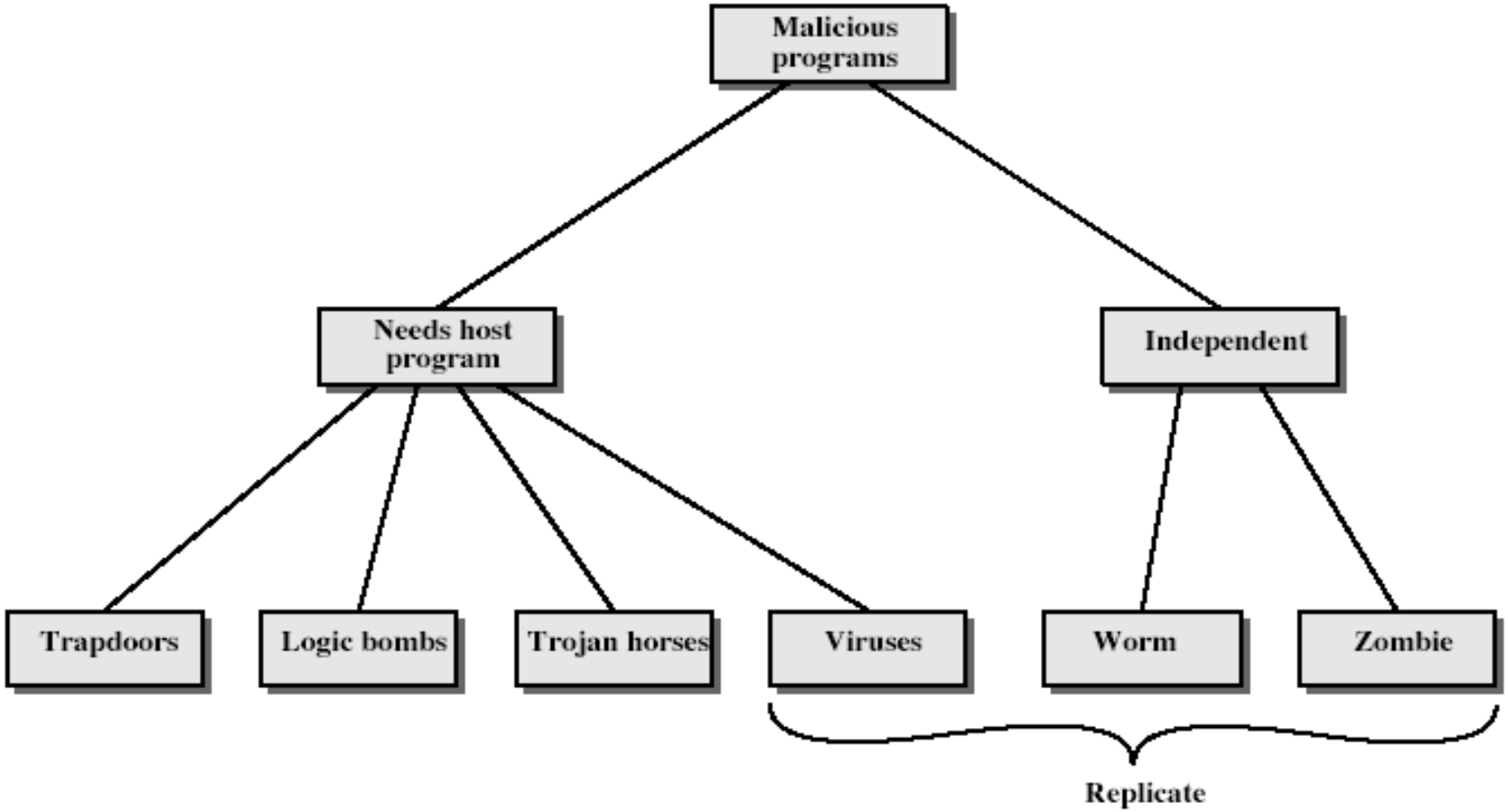
*What is the concept of defense: The parrying of a blow. What is its characteristic feature: Awaiting the blow.*

**—*On War,* Carl Von Clausewitz**

# Viruses and Other Malicious Content

- computer viruses have got a lot of publicity
- one of a family of **malicious software**
- effects usually obvious
- have figured in news reports, fiction, movies (often exaggerated)
- getting more attention than deserve
- are a concern though

# Malicious Software



# Logic Bomb

- one of oldest types of malicious software
- code embedded in legitimate program
- activated when specified conditions met
  - eg presence/absence of some file
  - particular date/time
  - particular user
- when triggered typically damage system
  - modify/delete files/disks

# Trojan Horse

- program with hidden side-effects
- which is usually superficially attractive
  - eg game, s/w upgrade etc
- when run performs some additional tasks
  - allows attacker to indirectly gain access they do not have directly
- often used to propagate a virus/worm or install a backdoor
- or simply to destroy data

# Zombie

- program which secretly takes over another networked computer
- then uses it to indirectly launch attacks
- often used to launch distributed denial of service (DDoS) attacks
- exploits known flaws in network systems

# Viruses

- a piece of self-replicating code attached to some other code
  - cf biological virus
- both propagates itself & carries a payload
  - carries code to make copies of itself
  - as well as code to perform some covert task

# Virus Operation

- virus phases:
  - dormant – waiting on trigger event
  - propagation – replicating to programs/disks
  - triggering – by event to execute payload
  - execution – of payload

# Virus Structure

```
program V :=
    {goto main;
    1234567;
    subroutine infect-executable :=          {loop:
                    file := get-random-executable-file;
                    if (first-line-of-file = 1234567) then goto loop
                    else prepend V to file; }
    subroutine do-damage :=      {whatever damage is to be done}
    subroutine trigger-pulled :=  {return true if some condition holds}
    main: main-program :=        {infect-executable;
                                  if trigger-pulled then do-damage;
                                  goto next;}
    next:
}
```

# Macro Virus

- **macro code** attached to some **data file**
- interpreted by program using file
  - eg Word/Excel macros
  - esp. using auto command & command macros
- code is now platform independent
- is a major source of new viral infections

# Email Virus

- spread using email with attachment containing a macro virus
- triggered when user opens attachment
- or worse even when mail viewed by using scripting features in mail agent
- usually targeted at Microsoft Outlook mail agent & Word/Excel documents

# Worms

- replicating but not infecting program
- typically spreads over a network

# Worm Operation

- worm phases like those of viruses:
  - dormant
  - propagation
    - search for other systems to infect
    - establish connection to target remote system
    - replicate self onto remote system
  - triggering
  - execution

# Virus Countermeasures

- viral attacks exploit lack of integrity control on systems
- to defend need to add such controls
- typically by one or more of:
  - **prevention** - block virus infection mechanism
  - **detection** - of viruses in infected system
  - **reaction** - restoring system to clean state

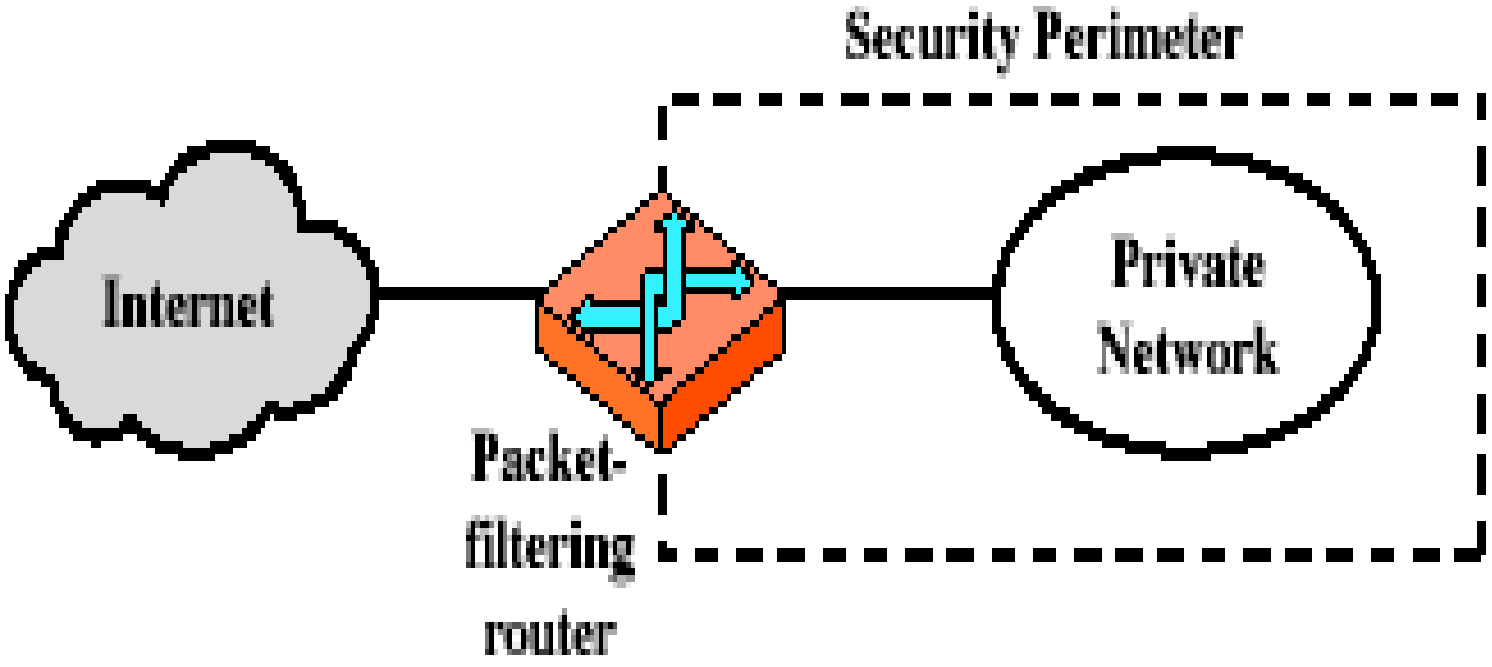
# Anti-Virus Software

- **first-generation**
  - scanner uses virus signature to identify virus
  - or change in length of programs
- **second-generation**
  - uses heuristic rules to spot viral infection
  - or uses program checksums to spot changes
- **third-generation**
  - memory-resident programs identify virus by actions
- **fourth-generation**
  - packages with a variety of antivirus techniques
  - eg scanning & activity traps, access-controls

# Advanced Anti-Virus Techniques

- generic decryption
  - use CPU simulator to check program signature & behavior before actually running it
- digital immune system (IBM)
  - general purpose emulation & virus detection
  - any virus entering org is captured, analyzed, detection/shielding created for it, removed

# Firewalls – Packet Filters




(a) Packet-filtering router

# 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 |

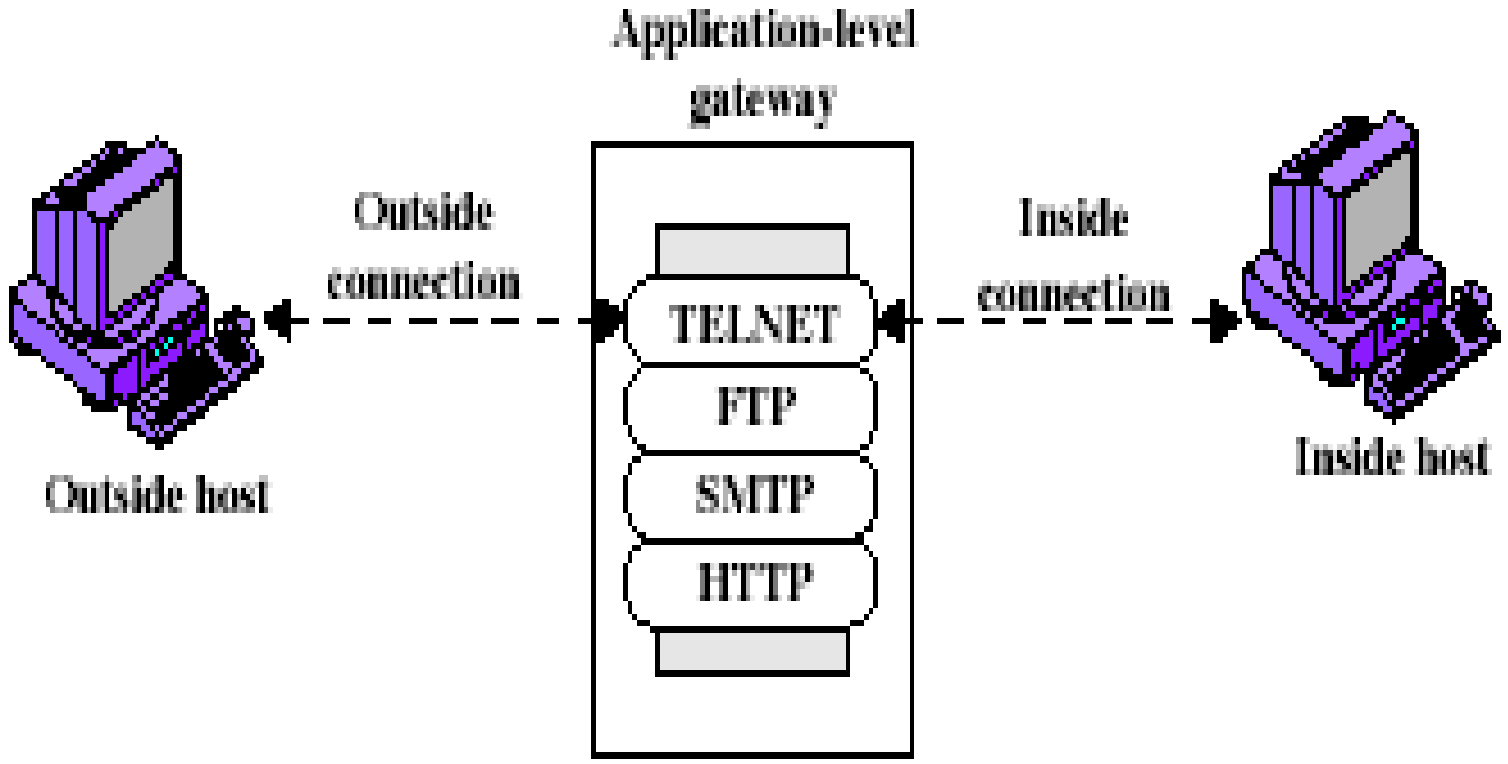
E

| 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

# Firewalls - Application Level Gateway (or Proxy)

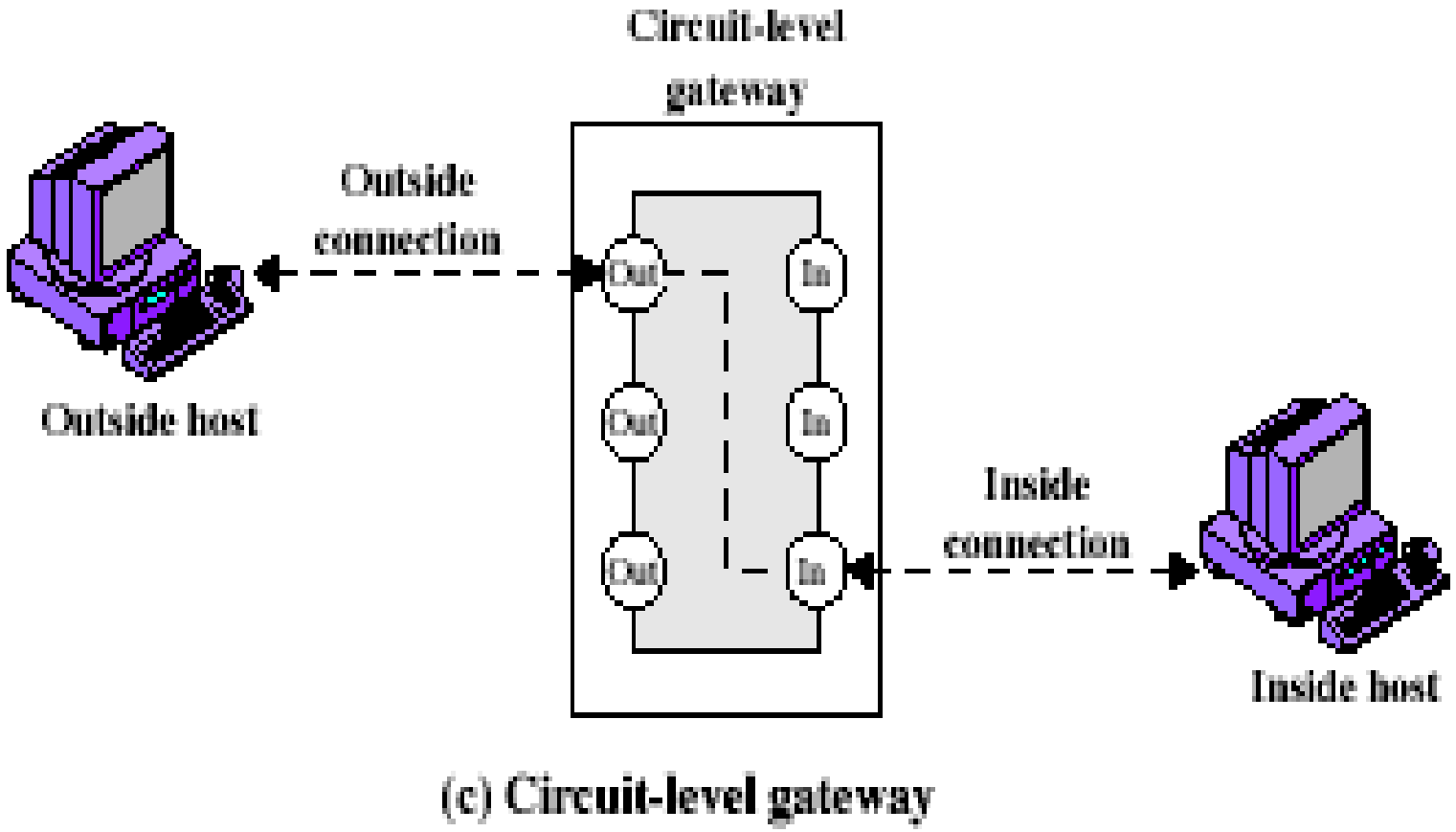



(b) Application-level gateway

# Firewalls - Application Level Gateway (or Proxy)

- use an 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
- need separate proxies for each service
  - some services naturally support proxying
  - others are more problematic
  - custom services generally not supported

# Firewalls - Circuit Level Gateway




(c) Circuit-level gateway