Cryptography and Network Security Chapter 19

Fourth Edition

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Chapter 19 – Malicious Software

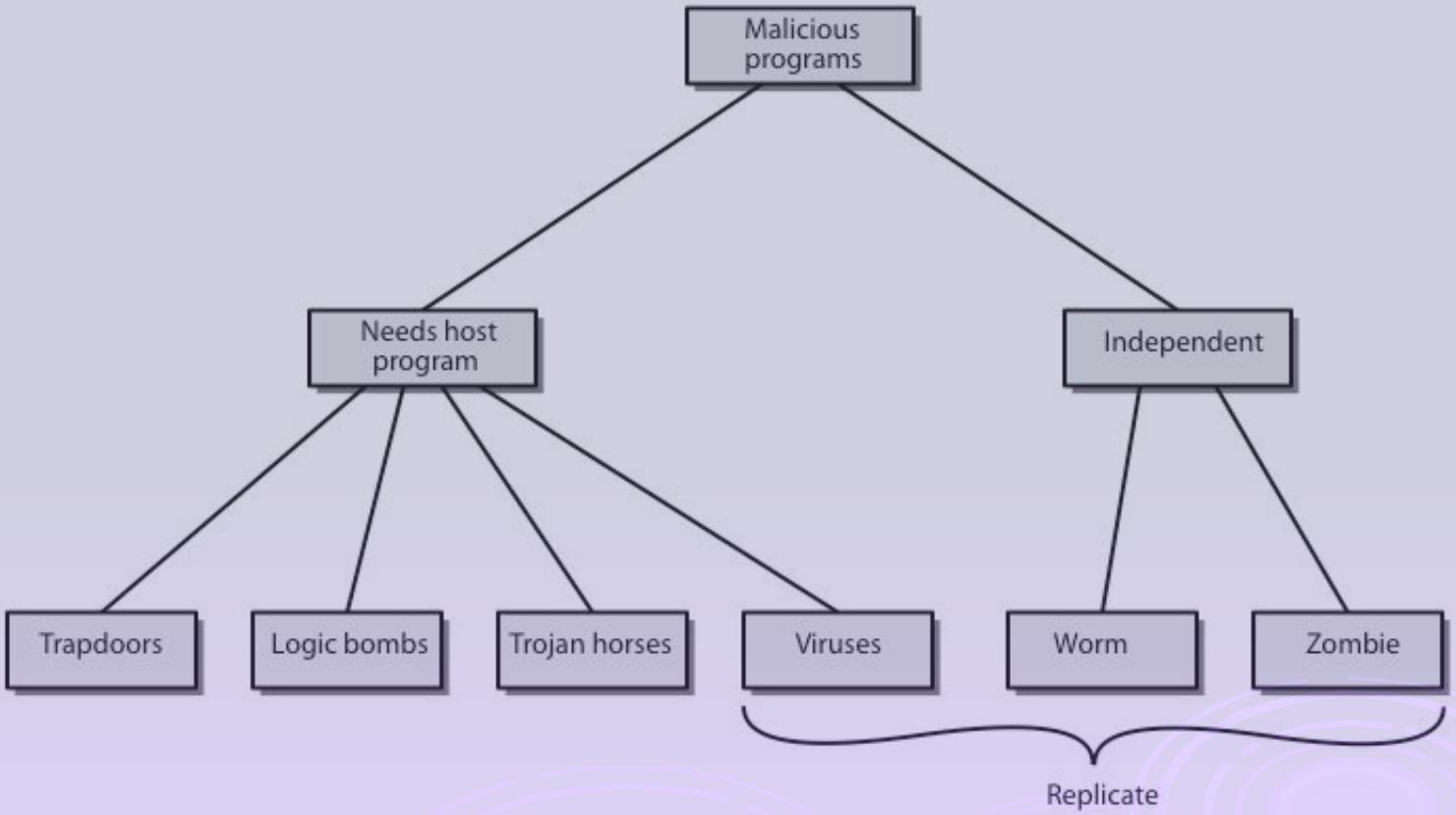
What is the concept of defense: The parrying of a blow. What is its characteristic feature: Awaiting the blow.

—***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



Backdoor or Trapdoor

- secret entry point into a program
- allows those who know access bypassing usual security procedures
- have been commonly used by developers
- a threat when left in production programs allowing exploited by attackers
- very hard to block in O/S
- requires good s/w development & update

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, halt machine, etc

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
- details usually machine/OS specific
  - exploiting features/weaknesses

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 condition holds}
    main: main-program :=   {infect-executable;
                    if trigger-pulled then do-damage;
                    goto next;}
    next:
}
```

Types of Viruses

- can classify on basis of how they attack
- parasitic virus
- memory-resident virus
- boot sector virus
- stealth
- polymorphic virus
- metamorphic virus

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
- blur distinction between data and program files
- classic trade-off: "ease of use" vs "security”
- have improving security in Word etc
- are no longer dominant virus threat

Email Virus

- spread using email with attachment containing a macro virus
  - cf Melissa
- triggered when user opens attachment
- or worse even when mail viewed by using scripting features in mail agent
- hence propagate very quickly
- usually targeted at Microsoft Outlook mail agent & Word/Excel documents
- need better O/S & application security

Worms

- replicating but not infecting program
- typically spreads over a network
  - cf Morris Internet Worm in 1988
  - led to creation of CERTs
- using users distributed privileges or by exploiting system vulnerabilities
- widely used by hackers to create **zombie PC's**, subsequently used for further attacks, esp DoS
- major issue is lack of security of permanently connected systems, esp PC's

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

Morris Worm

- best known classic worm
- released by Robert Morris in 1988
- targeted Unix systems
- using several propagation techniques
  - simple password cracking of local pw file
  - exploit bug in finger daemon
  - exploit debug trapdoor in sendmail daemon
- if any attack succeeds then replicated self

Recent Worm Attacks

- new spate of attacks from mid-2001
- Code Red - used MS IIS bug
  - probes random IPs for systems running IIS
  - had trigger time for denial-of-service attack
  - 2nd wave infected 360000 servers in 14 hours
- Code Red 2 - installed backdoor
- Nimda - multiple infection mechanisms
- SQL Slammer - attacked MS SQL server
- Sobig.f - attacked open proxy servers
- Mydoom - mass email worm + backdoor

Worm Techology

- multiplatform
- multiexploit
- ultrafast spreading
- polymorphic
- metamorphic
- transport vehicles
- zero-day exploit

Virus Countermeasures

- best countermeasure is prevention
- but in general not possible
- hence need to do one or more of:
  - **detection** - of viruses in infected system
  - **identification** - of specific infecting virus
  - **removeal** - restoring system to clean state

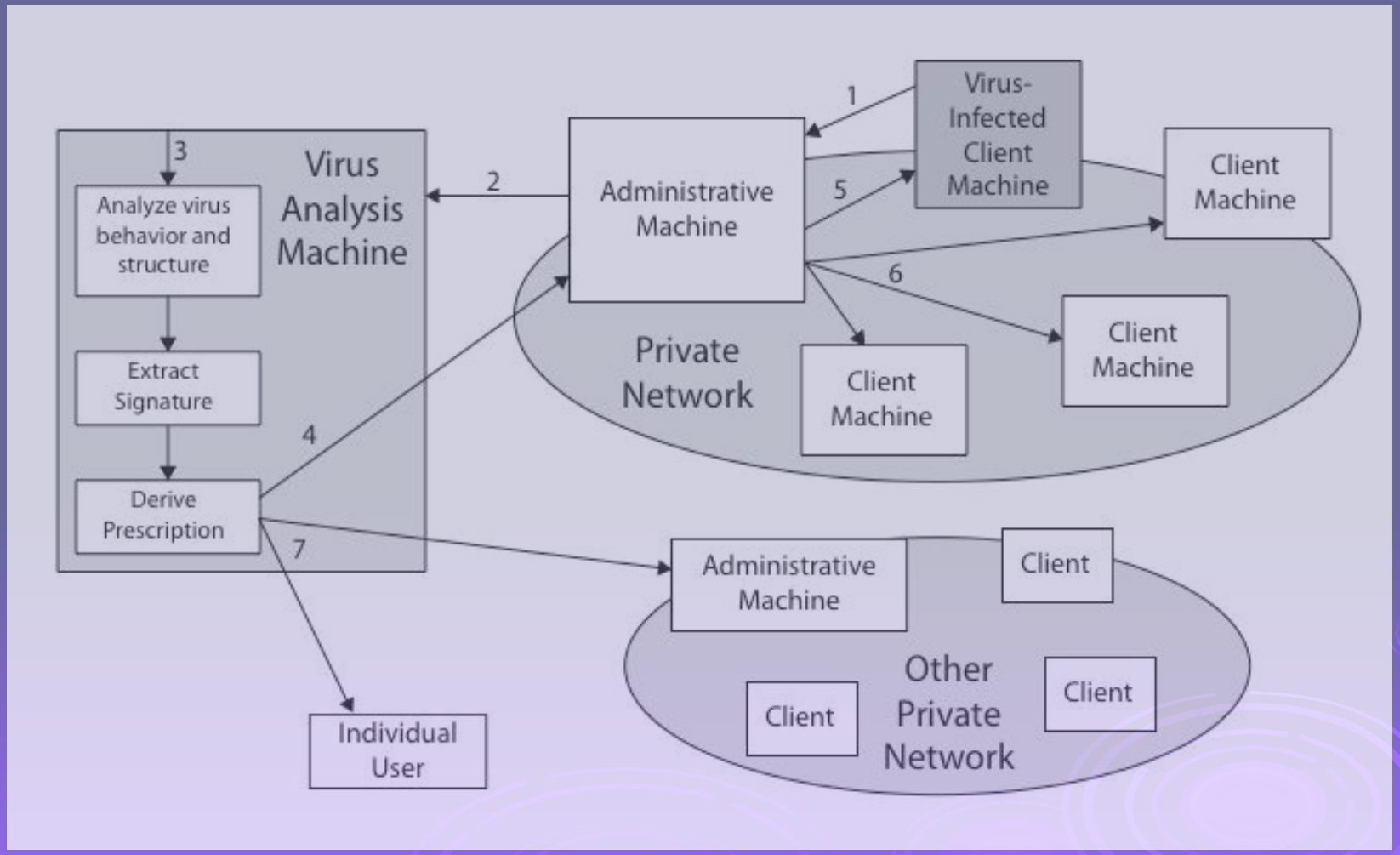
Anti-Virus Software

- **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 crypto hash of program 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
- arms race continues

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

Digital Immune System



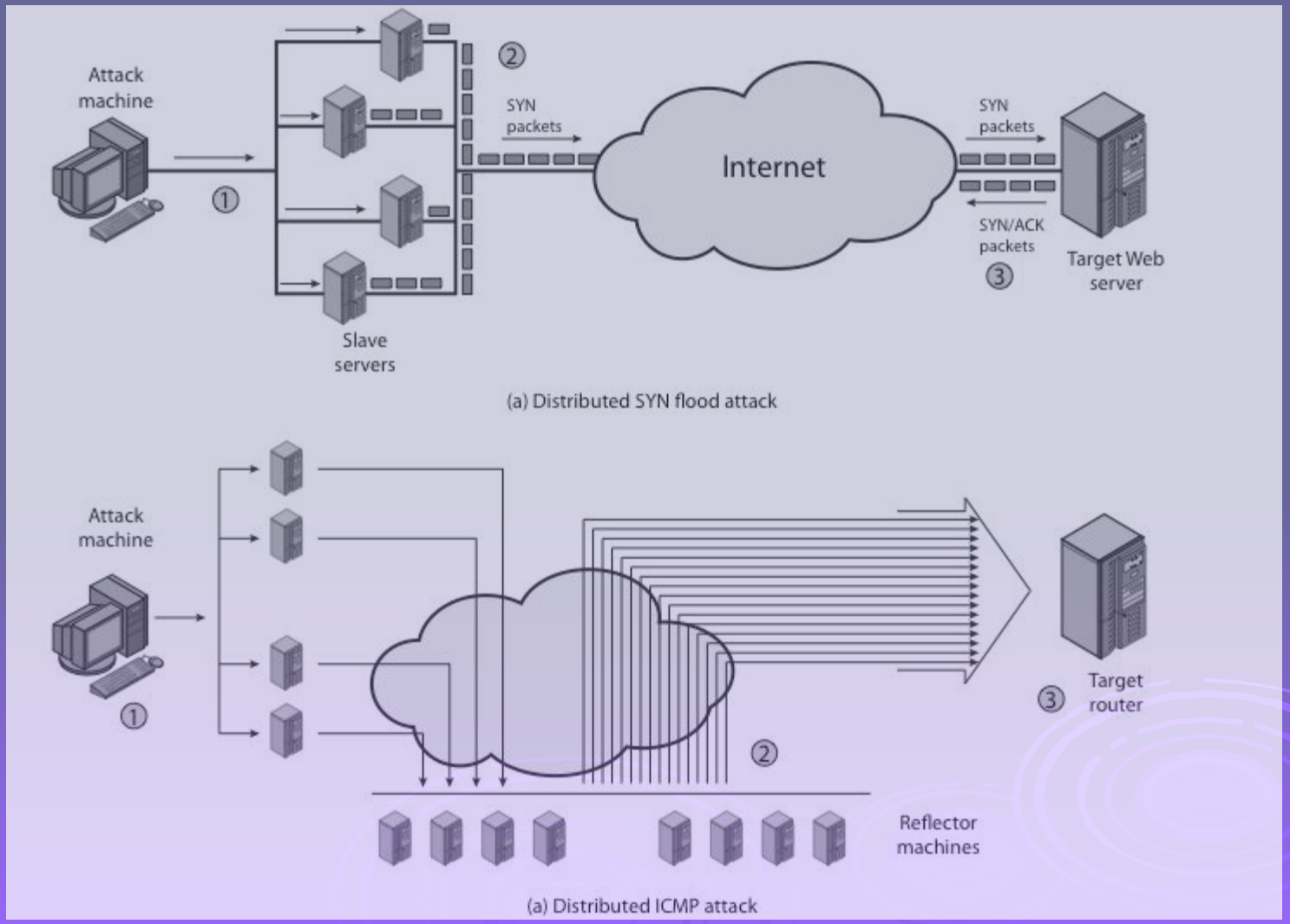
Behavior-Blocking Software

- integrated with host O/S
- monitors program behavior in real-time
  - eg file access, disk format, executable mods, system settings changes, network access
- for possibly malicious actions
  - if detected can block, terminate, or seek ok
- has advantage over scanners
- but malicious code runs before detection

Distributed Denial of Service Attacks (DDoS)

- Distributed Denial of Service (DDoS) attacks form a significant security threat
- making networked systems unavailable
- by flooding with useless traffic
- using large numbers of “zombies”
- growing sophistication of attacks
- defense technologies struggling to cope

Distributed Denial of Service Attacks (DDoS)



Contructing the DDoS Attack Network

- must infect large number of zombies
- needs:

1. software to implement the DDoS attack
2. an unpatched vulnerability on many systems
3. scanning strategy to find vulnerable systems
   - random, hit-list, topological, local subnet

DDoS Countermeasures

- three broad lines of defense:
  1. attack prevention & preemption (before)
  2. attack detection & filtering (during)
  3. attack source traceback & ident (after)
- huge range of attack possibilities
- hence evolving countermeasures

Summary

- have considered:
  - various malicious programs
  - trapdoor, logic bomb, trojan horse, zombie
  - viruses
  - worms
  - countermeasures
  - distributed denial of service attacks