Computer Security
SEGC-00 - Overview

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Summary

This course is about computer security, both from the network view as well as the machine, its OS and applications’ point of view. Students shall demonstrate ability in research and programming and shall acquire both overall comprehension and specific abilities.

Lecture and Office Hours

Lectures: 3:19–21, 5:21–23; Room: 351 (IC3.5)
Office hours: 3:18, 5:20; Room: 26
full mailing list (professor + TAs + students):
segc@lasca.ic.unicamp.br
instructors list (professor + TAs): segc-staff@lasca.ic.unicamp.br
Topics

- Introduction
- Basic Knowledge
- Network Security
- Protocol Analysis
- Network Defenses

Planned, but probably only on a follow-up course:

- Machine Defenses
- Application Security
- Web Vulnerabilities
References

- Nakamura-deGeus - Segurança de Redes em Ambientes Cooperativos, Novatec, 2010 (“more or less” 3rd ed)
- Zwicky-Cooper-Chapman - Building Internet Firewalls, 2nd ed, 2000
- Davis-Bodmer-LeMasters - Hacking Exposed: Malware and Rootkits, 1st ed, 2009
Prerequisites

- Computer Networks, strong emphasis on TCP/IP
- C, Python, Assembly Programming
- Linux system level knowledge
- Autonomy to research methods/solutions
Evaluation

\( n \) written Exams: \( 2/4 \) of grade

\( p \) practical Experiments: \( 1/4 \)

\( k \) extra Assignments: \( 1/4 \)

Note: the extra assignments factor on the grade may vary in the 0–100\% range.

- Exams are individual: plagiarism not accepted
- Practical experiences in teams of 1–2 students
Introduction

- Failures and vulnerabilities, common practices and excuses, threats
- Vulnerabilities in general, risks, Internet history
- Increase of vulnerabilities and incidents, hacking history
- Classical incidents, parlance, ethics, policies (penetration testing)
Basic, assumed knowledge

- Unix services: rc scripts, Unix and TCP/IP sockets, xinetd, users/permissions
- Filesystems, suid, PAM, OTP, ACLs, capabilities
- Cryptography: basic functions, algorithms, secure communications, man-in-the-middle
  key management, certificates, PKI, OpenPGP
Network Security

- TCP/IP: protocols, addressing, CIDR, Ethernet, ARP, sniffing tools
  - IP routing, IP spoofing, hijacking, MITM, ARP spoofing
- IP: attacks, fragmentation, Ping of Death
- ICMP: ping, attacks, smurf, redirect, dest unreachable, time exceeded, traceroute
- UDP: header, spoofing, hijacking, NIS, NFS, portscan
- TCP: sequence, windows, flags, portscan, OS fingerprinting, spoofing/Mitnick
  - ISN, hijacking, hunt, ACK storm, SYN flooding/cookies, states
- IPSec: AH, ESP, modes, IKE, IPv6
- Wireless: link level, CSMC/CA, modes, associations, energy, WEP/WPA, attacks
  - sniffing, crypto attacks, DoS, injection, MITM, protections, 802.1x, wardriving
Protocol Analysis

- FTP: vulnerabilities, attacks/scan through bounce
- DNS: resolving, zone transfer, spoofing, hijacking, contamination, Kaminsky, Birthday
- Botnets: history, Drive-by downloads, architectures, evolution, uses
Network Defenses

- IDS, architectures, classification, abuse/anomaly, precision, IDMEF, NIDS/HIDS
- Sniffing: injection, evasion, dessynchronization, defragmentation
- TCP reassembly: alert and component correlation, normalization, pre-processing
  alert recombination, verification, attack sequence reconstruction
- packet filtering, secure channels, e-mail, VPN, https
Machine Defenses

- Software installation, backup, system accounting
- Event logging and monitoring, auditing, password scan
- File integrity, TCPWrapper, SELinux, VM
Application Security

- local and remote attacks, Unix processes, parameters, filesystems
- TOCTOU attacks, open files, assembly, memory addressing
- x86 registers, data sizes, signals, instructions, execution levels
  stack, frames, prologue/epilogue
- Object files: .COM, a.out, PE, ELF. process data structures, gdb
- Buffer overflows: stack, shell code, syscalls, execve, string, egg, overrun
- Advanced attacks: setjmp/longjmp, off-by-one, array/integer/heap overflow
  teardrop, return-to-libc, chunk management, memory allocation, unlink macro,
  double free, C++ Vtables, format string, locale
- Solutions to overflow: static/dynamic analysis, libc replacement, confining, StackGuard, StackShield, Propolice, Windows, PaX, Armor
Web Vulnerabilities

- Architecture, http, methods, status, headers, URI/URL/URN, authentication
- State, attached info, CGI, ASP, Servlets, PHP, Java Applets, ActiveX
- Scriptting languages, JavaScript, AJAX, XML, Mashups
- Authentication and authorization attacks, injection: PHP, HTML, SQL, XPath, LDAP
  XSS, reflection, solutions, CSRF/XSRF, HTTP attacks, scanners, crawling