NC STATE UNIVERSITY Computer Science

CSC 474/574
Information Systems Security

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About Instructor

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About TA

- Srinath Anantharaju
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- Office hours:
  - TBD

Course Objectives

- Understanding of basic issues, concepts, principles, and mechanisms in information systems security.
  - Basic security concepts
  - Cryptography
  - Authentication
  - Access control
  - Distributed system security
  - Network security
- Be able to determine appropriate mechanisms for protecting information systems.

Course Styles

- Descriptive: what is out there.
- Critical: what is wrong with ...
- Both knowledge and skill oriented
  - Homework, projects, papers.
- Interactive: discussion and questions encouraged.
- Information sharing: home page and message board in http://wolfware.ncsu.edu.

Course Outline

- Basic Security Concepts
  - Confidentiality, integrity, availability
  - Security policies, security mechanisms, assurance
- Cryptography
  - Basic number theory
  - Secret key cryptosystems
  - Public key cryptosystems
  - Hash function
  - Key management

Course Outline (Cont'd)

- Identification and Authentication
  - Basic concepts of identification and authentication
  - Password authentication
  - Security handshake pitfalls

Course Outline (Cont'd)

- Access Control
  - Basic concepts of access control
  - Discretionary access control and mandatory access control
  - Lattice-based Models
  - Role based Access Control

Course Outline (Cont'd)

- Network and Distributed Systems
  - Issues in Network and Distributed Systems Security
  - Kerberos
  - IPsec
  - IPsec key management
  - IP trace back
  - SSL/TLS
  - Firewalls and Virtual Private Network
  - Secure Email
  - Related course: CSC 774 Network Security

Course Outline (Cont'd)

- Miscellaneous Topics
  - Malicious Software
  - Multi-Level Security
  - Evaluation of Secure Information Systems
  - Auditing and Intrusion Detection

Prerequisites

- CSC 401 (Data and Computer Communications Networks)
- Programming in Java
- Basic knowledge and skills in Discrete Mathematics

Textbook and Handouts

- Required texts
  - Charlie Kaufman, Radia Perlman, and Mike Speciner, *Network Security: Private Communication in a Public World, 2nd Edition*, Prentice Hall, ISBN: 0-13-046019-2.
  - Research papers listed on the course website.

On-line Resources

- WWW page: http://courses.ncsu.edu/csc574/lec/001
  - For course materials, e.g., lecture slides, homework files, papers, tools, etc.
  - Will be updated frequently. So check frequently.
- Message board: http://courses.ncsu.edu/csc574
  - For discussions, Q&As.

Grading

- CSC 474: Assignments 20%, midterm 40%, final 40%.
- CSC 574: Assignments 15%, project 15%, midterm 35%, final 35%.
- The final grades are computed according to the following rules:
  - **A+: >= 95%; A: >= 90% and < 95%; A-: >= 85% and < 90%;**
  - **B+: >= 80% and < 85%; B: >= 75% and < 80%;**
  - **B-: >= 70% and < 75%; C+: >= 66% and < 70%;**
  - **C: >= 63% and < 66%; C-: >= 60% and < 63%;**
  - **D+: >= 56% and < 60%; D: >= 53% and < 56%;**
  - **D-: >= 50% and < 53%;**
  - **F: < 50%.**

Policies on incomplete grades and late assignments

- Homework and project deadlines will be hard.
- Late homework will be accepted with a 10% reduction in grade for each class period they are late by.
- Once a homework assignment is discussed in class, submissions will no longer be accepted.
- All assignments must be turned in before the start of class on the due date.

Policies on absences and scheduling makeup work

- You may be excused from an exam only with a university approved condition, with proof. For example, if you cannot take an exam because of a sickness, we will need a doctor's note.
- Events such as going on a business trip or attending a brother's wedding are not an acceptable excuse for not taking an exam at its scheduled time and place.
- You will have one chance to take a makeup exam if your absence is excused. There will be no makeup for homework assignments.

Academic integrity

- The university, college, and department policies against academic dishonesty will be strictly enforced.
- You may obtain copies of the NCSU Code of Student Conduct from the Office of Student Conduct, or from the following URL.
- http://www.fis.ncsu.edu/ncsulegal/41.03-codeof.htm

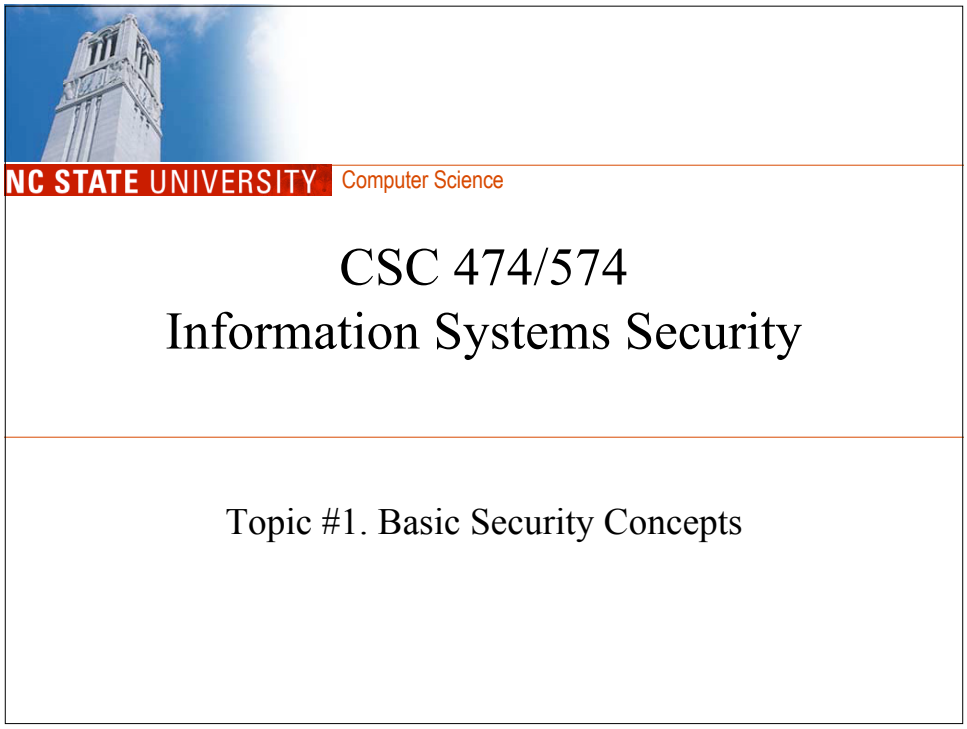
NC State policy on working with students with disabilities

- Reasonable accommodations will be made for students with verifiable disabilities.
  - Please schedule an appointment with the instructor.
- In order to take advantage of available accommodations, students must register with Disability Service for Students at 1900 Student Health Center, Campus Box 7509, 515-7653.
  - http://www.ncsu.edu/provost/offices/affirm_action/dss/
- For more information on NC State's policy on working with students with disabilities, please see
  - http://www.ncsu.edu/provost/hat/current/appendix/appen_k.html.

Course Project

- Can be (a combination of):
  - Design of new algorithms and protocols.
    - Or new attacks!
  - Analysis/evaluation of existing algorithms, protocols, and systems.
    - Vulnerabilities, efficiency, etc.
  - Implementation and experimentation.
- Small team - one to three persons.
- Proposal, work, and final demo/write-up.
- Suggested topics (see course website), but you can define your own.

Check the website for details!



Information Security Problems

- Public, private, and government networks have been penetrated by unauthorized users and rogue programs
- Increased volume of security breaches attributed Computer Emergency Response Team (CERT) reports a tremendous increase in cracking incidents
- Insider attacks

Information Security Concerns

- Distributed Denial of Service (DDOS) attacks
- Worm attacks (e.g., code red)
- Monitoring and capture of network traffic
  - User IDs, passwords, and other information are often stolen on Internet
- Exploitation of software bugs
- Unauthorized access to resources
  - Disclosure, modification, and destruction of resources
- Compromised system used as hostile attack facility
- Masquerade as authorized user or end system
- Data driven attacks
  - Importation of malicious or infected code
- E-Mail forgery

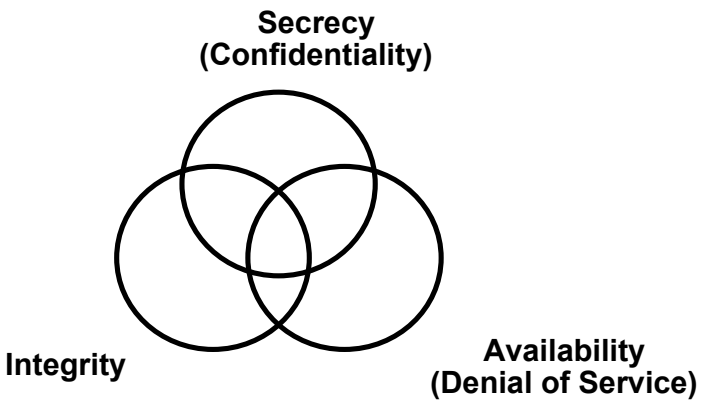
Contributing Factors

- Lack of awareness of threats and risks of information systems
  - Security measures are often not considered until an Enterprise has been penetrated by malicious users
- Wide-open network policies
  - Many Internet sites allow wide-open Internet access
- Vast majority of network traffic is unencrypted
  - Network traffic can be monitored and captured

Contributing Factors (Cont'd)

- Lack of security in TCP/IP protocol suite
  - Most TCP/IP protocols not built with security in mind
  - Work is actively progressing within the Internet Engineering Task Force (IETF)
- Complexity of security management and administration
- Exploitation of software (e.g., protocol implementation) bugs
  - Example: Sendmail bugs
- Cracker skills keep improving

Security Objectives



Security Objectives

- Secrecy — Prevent/detect/deter improper disclosure of information
- Integrity — Prevent/detect/deter improper modification of information
- Availability — Prevent/detect/deter improper denial of access to services provided by the system

- Note the use of improper rather than unauthorized
- Authorized users are accountable for their actions

Commercial Example

- Secrecy — An employee should not come to know the salary of his manager
- Integrity — An employee should not be able to modify the employee's own salary
- Availability — Paychecks should be printed on time as stipulated by law

Military Example

- Secrecy — The target coordinates of a missile should not be improperly disclosed
- Integrity — The target coordinates of a missile should not be improperly modified
- Availability — When the proper command is issued the missile should fire

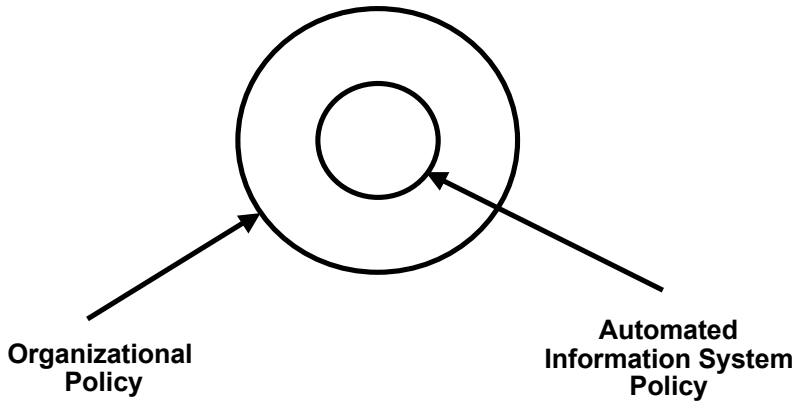
A Fourth Objective

- Securing computing resources — Prevent/detect/deter improper use of computing resources including
  - Hardware Resources
  - Software resources
  - Data resources
  - Network resources

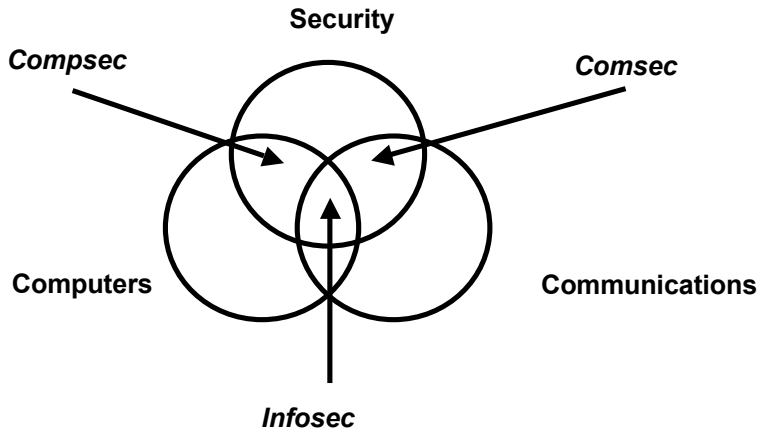
Achieving Security

- Security policy — What?
- Security mechanism — How?
- Security assurance — How well?

Security Policy



Compusec + Comsec = Infosec



Security Mechanism

- Prevention — Access control
- Detection — Auditing and intrusion detection
- Tolerance — Practicality

Good prevention and detection both require good authentication as a foundation

Security Mechanism

- Security mechanisms implement functions that help *prevent*, *detect*, and *respond* to security attacks
- Prevention is more fundamental
  - Detection seeks to prevent by threat of punitive action
  - Detection requires that the audit trail be protected from alteration
- Sometime detection is the only option, e.g.,
  - Accountability in proper use of authorized privileges
  - Modification of messages in a network
- Security functions are typically made available to users as a set of *security services* through APIs or integrated interfaces
- Cryptography underlies (almost) all security mechanisms

Security Services

- Confidentiality: protection of any information from being exposed to unintended entities.
  - Information content.
  - Parties involved.
  - Where they are, how they communicate, how often, etc.
- Authentication: assurance that an entity of concern or the origin of a communication is authentic - it's what it claims to be or from
- Integrity: assurance that the information has not been tampered with

Security Services - Cont'd

- Non-repudiation: offer of evidence that a party is indeed the sender or a receiver of certain information
- Access control: facilities to determine and enforce who is allowed access to what resources, hosts, software, network connections
- Monitor & response: facilities for monitoring security attacks, generating indications, surviving (tolerating) and recovering from attacks

Security Services - Cont'd

- Security management: facilities for coordinating users' service requirements and mechanism implementations throughout the enterprise network and across the internet
  - Trust model
  - Trust communication protocol
  - Trust management infrastructure

Security Assurance

- How well your security mechanisms guarantee your security policy
- Everyone wants high assurance
- High assurance implies high cost
  - May not be possible
- Trade-off is needed.

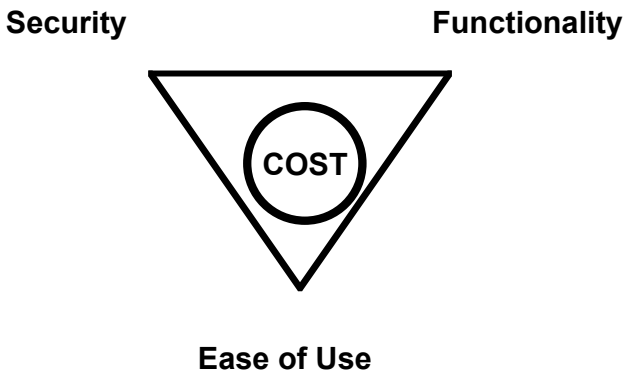
Security by Obscurity

- Security by obscurity says that if we hide the inner workings of a system it will be secure
- It is a bad idea
- Less and less applicable in the emerging world of vendor-independent open standards
- Less and less applicable in a world of widespread computer knowledge and expertise

Security by Legislation

- Security by legislation says that if we instruct our users on how to behave we can secure our systems
- It is a bad idea
- For example
  - Users should not share passwords
  - Users should not write down passwords
  - Users should not type in their password when someone is looking over their shoulder
- User awareness and cooperation is important, but cannot be the principal focus for achieving security

Security Tradeoffs



Threat-Vulnerability-Risk

- Threats — Possible attacks on the system
- Vulnerabilities — Weaknesses that may be exploited to cause loss or harm
- Risk — A measure of the possibility of security breaches and severity of the ensuing damage
- Requires assessment of threats and vulnerabilities

Risk Management

- Risk analysis
  - Mathematical formulae and computer models can be developed, but the underlying parameters are difficult to estimate.
- Risk reduction
- Risk acceptance
  - Certification
    - Technical evaluation of a system's security features with respect to how well they meet a set of specified security requirements
  - Accreditation
    - The management action of approving an automated system, perhaps with prescribed administrative safeguards, for use in a particular environment