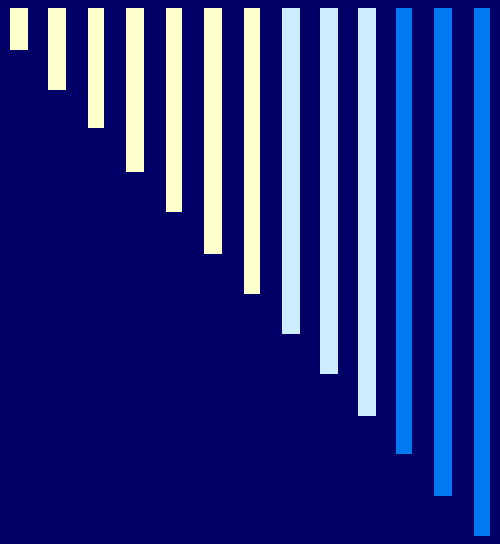


Course Overview

Anupam Datta

CMU
Fall 2007-08

Plan for Today

- Course logistics
- Overview of topics
- Basic cryptographic primitives

Course Staff

- Instructor: Anupam Datta
  - Office: CIC 2118
  - Email: danupam@cmu.edu
  - Office hours: Tue, Th 4:30-5:30PM

- TA: Joseph Slember
  - Office: CIC 2225B
  - Email: jslember@ece.cmu.edu
  - Office hours: Mon, Wed 2-3PM

Logistics

- Location: BH A51
- Days: Tuesday & Thursday
- Time: 10:30-11:50AM

- Web page: http://www.ece.cmu.edu/~ece739/
- Course blackboard (linked from web page)
- Course work:
  - Homework (20%), scribing (20%), class participation (10%), course project (50%)

Logistics

- Course Project:
  - Teams of 2-3 (form team by end of week)
  - 2 presentations (proposal, final)
  - Written report
  - Project suggestions online (or pick your own)
- Reading:
  - No textbook for the course
  - Research papers on which lectures are based
- Lab Space:
  - Use Linux machines in HH 1107 cluster for homework and projects

Logistics

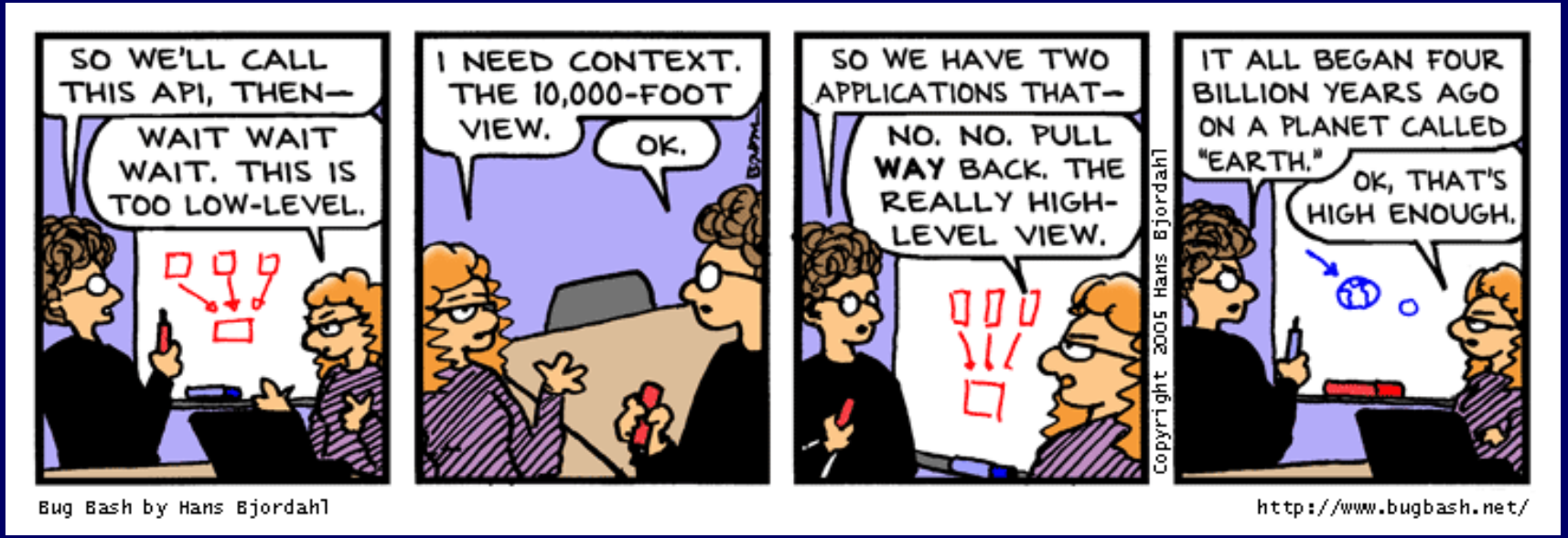
- Section:
  - Friday: 2-4PM
  - CIC Room 1301
- First few weeks of the course
- TA (s) will discuss and demo various security analysis tools
- Should be useful for projects
- First section this Friday

Prerequisites

- An introductory course in computer security such as 18-487 or 18-730 is recommended, but not required.
- Some background in logic, programming languages, verification is recommended, but not required.

- Quick class poll

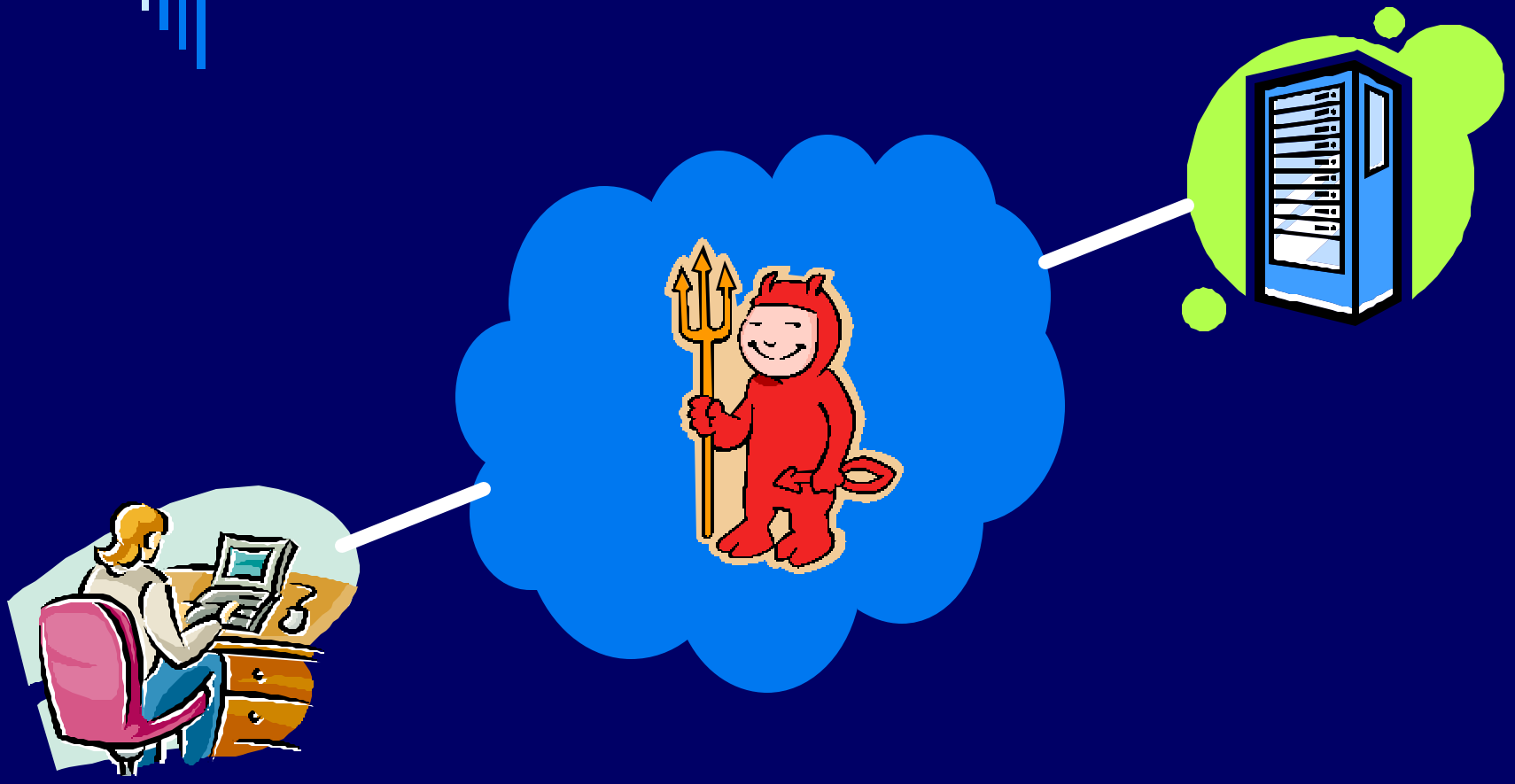
10,000-foot View



Four broad topics

1. Security Protocols 
2. Distributed Access Control
3. Privacy
4. Language-based Security

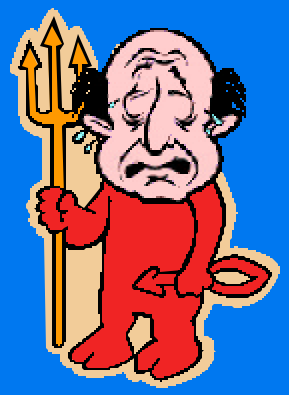
Web Purchase

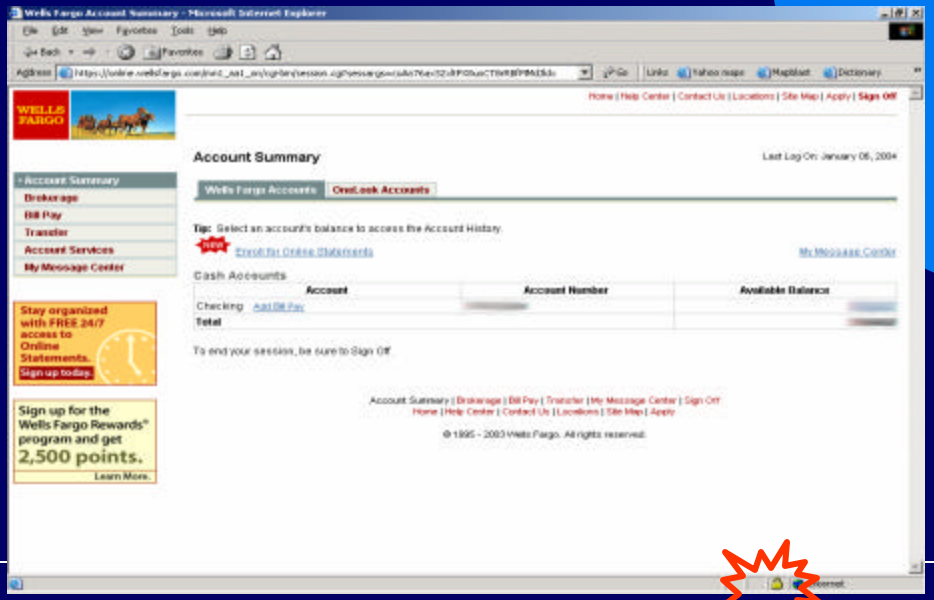


Secure communication using SSL/TLS

SSL uses cryptography:

•Public and symmetric key encryption, digital signatures, hash functions, message authentication codes





Provides

•Secrecy

•Authentication

•Data integrity

802.11i Wireless Authentication

802.11 Association

EAP/802.1X/RADIUS Authentication

MSK

4-Way Handshake

Group Key Handshake

Data Communication

Widely used in wireless LANs

Will discuss a number of industrial protocols

Security Protocol Analysis

- The Problem: Is a given network *protocol secure*?
- First define:
  - Model of protocol
  - Model of attacker
  - Security properties
    - Secrecy, confidentiality
    - Authentication, integrity
    - Denial of service

Methods

- Bug finding
  - Automated model-checking techniques
  - Finite number of sessions
- Security proofs
  - *Absence* of bugs
  - Unbounded number of sessions
  - Many approaches
    - Will cover: Paulson's Inductive Method, Protocol Logics, Process Calculi

Modeling Cryptography

- Symbolic Model
  - “Perfect crypto”: No attacker can break,

    e.g. can decrypt encrypted message iff has decryption key
  - Proof technique: Induction
- Complexity-theoretic Model
  - Primitives secure with high probability against probabilistic polynomial time attackers
  - Proof technique: Reduction
- Will cover recent work combining methods

Modular Analysis

- Goal: Prove security properties of complex protocols by combining proofs of their components
- Will cover:
  - Composition theorems of PCL
  - IEEE 802.11i case study

Attacks on Industry Standards

- IKE [Meadows; 1999]
  - Reflection attack; fix adopted by IETF WG
- IEEE 802.11i [He, Mitchell; 2004]
  - DoS attack; fix adopted by IEEE WG
- GDOI [Meadows, Pavlovic; 2004]
  - Composition attack; fix adopted by IETF WG
- Kerberos V5 [Scedrov et al; 2005]
  - Identity misbinding attack; fix adopted by IETF WG; Windows update released by Microsoft

Identified using logical methods

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Distributed Authorization

- Goal:

  Flexible and scalable access control in large-scale, open, distributed, decentralized systems

Example: Grey

Jon

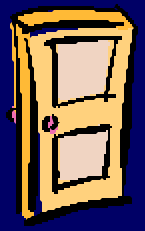
Mike

Kevin

Jason

Scott

I authorize access



Mike's Office, D208

Example: Grey

Jon

Mike

Kevin

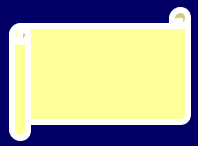
Jason

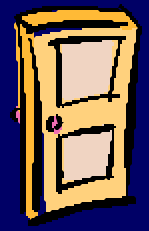
Scott

I want access.
-Scott

I allow Scott to enter.
-Mike

Demonstrate that Mike authorizes access





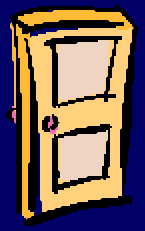
Mike's Office, D208

Example: Grey

Jon

I want access.
-Scott

Deny all access to Mike.
I delegate to Mike.
authorize Jason
Jason access



Mike's Office, D208

Mike

I delegate to Jason.
-Mike

Kevin

Jason

Scott

EPub

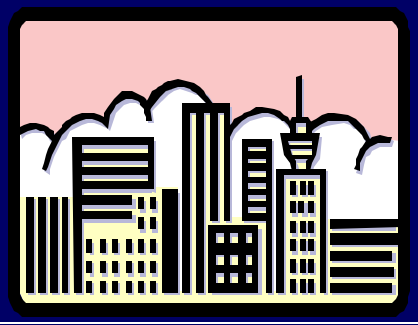
Alice

Grants access to university students

Trusts universities to certify students

Trusts ABU to certify universities

Alice is a student



StateU is a university

ABU

StateU

Characteristics of Distributed Authorization

- No central administration, each service makes its own decision
- No relationship between a service and a user prior to a request
  - knowing a user's name may not help
  - must rely on information from third-party to make authorization decision (delegation)
- Authorization information is distributed
- Communication channels may be insecure

We will cover

- Access control logics
  - Lampson et al “speaks-for” logic
  - Proof Carrying Authorization and the Grey System
  - Constructive Authorization Logic
- Trust Management
  - SPKI/SDSI
  - RT

Four broad topics

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Privacy

- An increasingly important concern for individuals and enterprises

Privacy

- Scenarios:
  - Enterprises collect personal information – email and postal addresses – in many cases through web sites
  - Organizations such as hospitals and financial institutions hold sensitive personal information
- Fundamental questions:
  - Policy: Under what conditions is the collected information used and distributed?
  - Enforcement: Do organizational processes actually enforce the stated policy?
- Privacy Laws:
  - HIPAA, GLBA, COPPA

Privacy Policy Languages

- P3P
  - Privacy policy specification for web sites.
- E-P3P/EPAL
  - Enterprise privacy policy specification and enforcement
- Contextual Integrity and LPU
  - Philosophical theory of privacy
  - Formalization in temporal logic (specification and enforcement)
  - Expressing privacy laws, e.g. HIPAA, GLBA, COPPA

Similarities with and differences from access control

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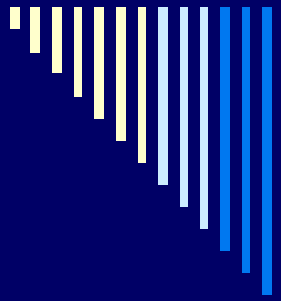


Type Systems for Security

- Focus on the use of type systems to improve software security
- Two representative projects
  - Jif: Enforcing information flow security properties (*non-interference* and variants)
  - Cyclone: Memory safe dialect of C, i.e. no *buffer overflow attacks*, *format string vulnerabilities* etc (or Ccured)

What is a type system?

"Now! *That* should clear up a few things around here!"

From “what” to “why”?

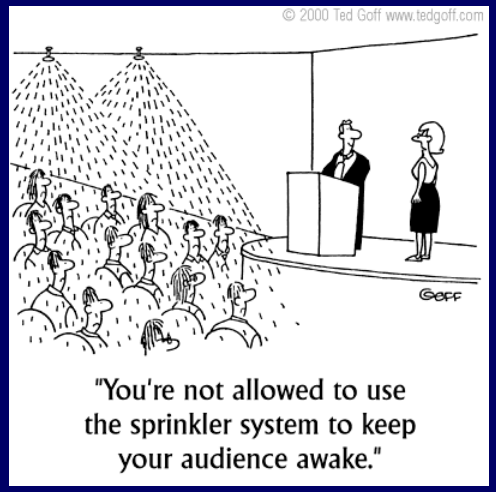
Why study foundations of security?

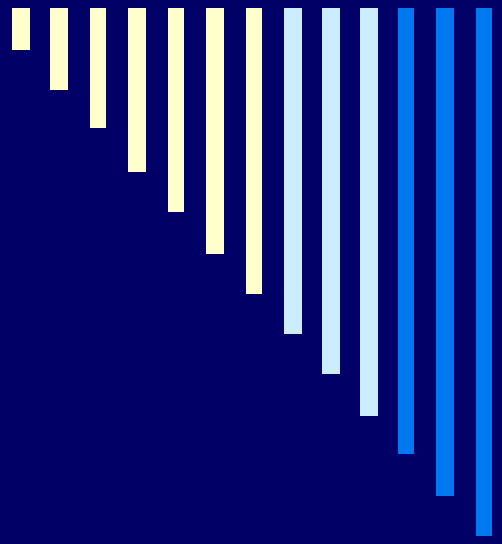
Our discipline of computer science seems to be one in which theory and practice are more intimately related than in any other field.....you can’t get very far in practical work without abstract theories that permit you to think at a higher level, and at the same time theoretical work becomes dead if it doesn’t receive fresh inspiration from practical problems in the “real world”.

D. E. Knuth

A Cautionary Word

- This is a theory heavy course!
- Litmus test on attitude toward theory





The End

Let’s get started…