Introduction
CS 239
Advanced Topics in Network Security
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Outline

- Subject of class
- Class topics and organization
- Reading material
- Class web page
- Grading
- Projects
- Office hours

Subject of Class

- Problems and solutions in network security
- Concentrating on unsolved problems and recent research
- Mostly on wide area infrastructure
- Not really on securing your LAN or individual machine
- Intended for students with serious research interest in network security

Class Organization

- Graduate level seminar class
- Concerning topics of ongoing research in network security
- Based around group discussions
  - Not formal lectures

A Typical Class

- Someone (usually one of you) will spend 15-20 minutes outlining a topic
- Remainder of class will be spent discussing it
- Whoever presented it should lead discussion
- Generally, everyone will lead a discussion at some point

Topics to Be Covered

- IP spoofing
- Routing security
- Secure DNS
- Security for ubiquitous networks
- DDoS defense
- Worm defense

More Topics

- Evaluating network defenses
- Handling spam
- Anonymization and privacy
- Security alert systems
- Phishing and pharming
- Legal and political issues related to these topics

Assigning Topics

- I'll take the first class (on IP spoofing)
- A few will have guest lecturers
- Each of you should volunteer to take one of the others
- To be decided at the end of second class
- First come, first served

Reading Material

- No textbook
- 2-4 papers for each class
  - Some selected by me
  - Some by class leader
- Papers will be made available on class web page
- In some cases, web pages may be used instead of papers

Class Web Page

- http://www.lasr.cs.ucla.edu/classes/239_3.spring06
- Will show class schedule
- And list papers for each class
  - With links to them
- Other useful information also there

Grading

- 20% midterm
- 40% class participation
- 40% project
- No final exam

Midterm Exam

- Essay questions based on material in first half of class
- Probably three questions
- Open notes
  - Including papers

Class Participation

- Covers both class you lead (15%) and participation in other classes (25%)
- Not graded on brilliance
- But on involvement and ability to contribute to discussion
- If you can't regularly attend this class, you won't do well in it

Leading a Class Discussion

- Should focus on:
  - Analysis of the problem
  - Critiques of existing solutions
  - Suggested improvements to those
    - Or new solution approaches
- Think of it as being part of a research team looking at this problem
- Goal is to spark a discussion
  - Not to spend two hours reviewing the papers that were assigned

Slides for Presentations

- Not required, but a good idea
- If possible, send them to me ahead of time
  - So I can post them on the web page
- I'll bring a projector to every class

Class Projects

- Half of your grade
- Group projects (2-4 people)
- On some topic involving network security
- Must be a research topic
  - Not just implementing known stuff

Project Proposals

- Project proposals due at end of 4th week of class (April 28)
- 1-page summary of what you want to do
- Can be submitted as hard copy or email
- Not graded, but required

Project Status Reports

- Due at end of 7th week of classes (May 19)
- 1-3 page summaries of the progress you've made to that date
  - Hint: there should be some
- Hard copy or email OK
- Not graded, but required

Project Presentation

- Last two class days reserved for project presentations
- In-class presentation of your project
  - Demo, if feasible
- Graded as part of project itself

Project Demonstration

- If not feasible to demo in class, arrange a separate demo with me
- Projects should (usually) produce something demonstrable
- Important that demo shows off something interesting about project
- Graded as part of project

Project Reports

- Written reports on project
- Due Monday of finals week (June 12)
- 15 pages is typical length
- Should:
  - Describe problem and approach
  - Cover difficulties and interesting points
  - Describe implementation
  - Show that you've learned something from it!

What Makes a Good Project?

- Probably requires coding
  - Hardware OK, if you can do it
  - Theoretical work acceptable, but you'll need real results
- Probably requires testing and/or measurement
- Should be research
  - Original work no one else has already done
  - Based on a promising idea
  - Ideally, this should be capable of being converted to a publishable research paper

Office Hours

- MW 2-3
- In 3532F Boelter Hall
- I'm around a lot, so other times can be arranged by appointment
- But I'll be away April 17-28
  - Guest lecturers most of those days

Prerequisites

- Probably should have taken CS 218
- Should have taken my CS 239 on Computer Security
  - Or similar class elsewhere
- I'm not going to check on this
- But I'll assume you know this material
  - I won't be presenting reviews of this material

Kinds of Security Things You Should Know About

- IPsec
- Security protocols
- Key exchange, certificates, certification hierarchies
- Basics of security threats and mechanisms
- Use of cryptography for authentication, privacy, and other purposes
- Basics of firewalls and virus protection systems
- Basics of viruses and worms

Kinds of Networking Things You Should Know About

- TCP/IP
- Routing protocols
- How DNS works
- Multicast protocols
- Basic ad hoc networking
- Basics of wireless networks
- Basic design and architecture of the Internet

A Short Introduction

- What is this class really about?
- Protecting computer networks and the machines attached to them
- Focusing on the network threats
  - Bad things that can happen due to networking
  - Attacks on network components

What's In

- Security of routing protocols, DNS, multicast protocols, resource reservation protocols
- Network-wide attacks (DDoS, Worms)
- Security of specialized networks (sensor networks, ad hoc networks)
- Related topics (measurement issues, privacy, legal issues)

What's Out

- Cryptography (except as a tool)
- Securing LANs (firewalls, intrusion detection systems, etc.)
- Securing individual computers (e.g, hardening against buffer overflow attacks)
- Security policy issues
- Auditing, logging, formal methods, VPNs

Types of Networks Covered

- The Internet
- Ad hoc networks
- Sensor networks
- Ubiquitous environments
- Peer overlay networks

The Internet and Security

- The original Internet design did not consider security
- Not surprisingly, the resulting network has security problems
- What are the threats?
- How do we handle them?

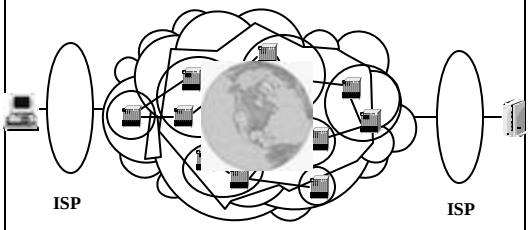
Does the Internet Need Security?

- Absolutely
- Successful network attacks every day
- Some network attacks have cut whole countries off from the network
- Some attacks have been made on the infrastructure that whole Internet relies on
- The value of what's done on the Internet keeps growing
- So the value of stopping it also grows

Example Problems

- Routing update security
- DNS security
- Router compromise
- IP spoofing
- Distributed denial of service attacks
- Worms

Internet Realities

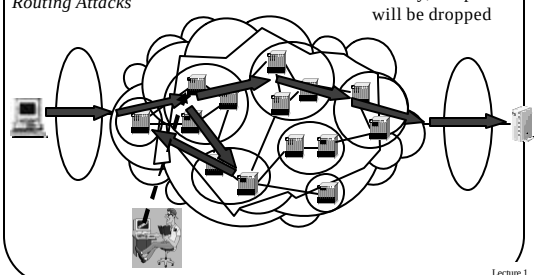


Autonomous Systems (ASs)
The scope is worldwide

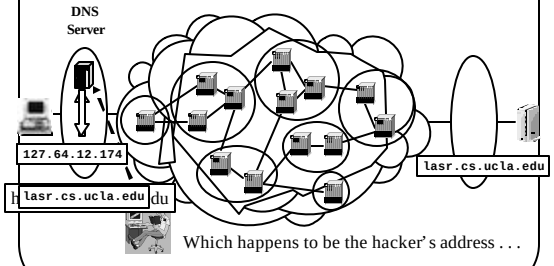
Illustrating Some Security Problems

Routing Attacks

Eventually, the packets will be dropped



DNS Security



Which happens to be the hacker's address . . .

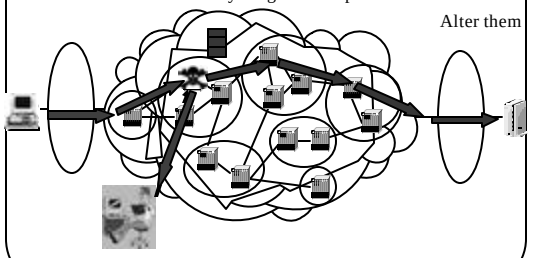
Router Compromise

Now the attacker can do anything with the packets

Drop them

Misroute them

Alter them

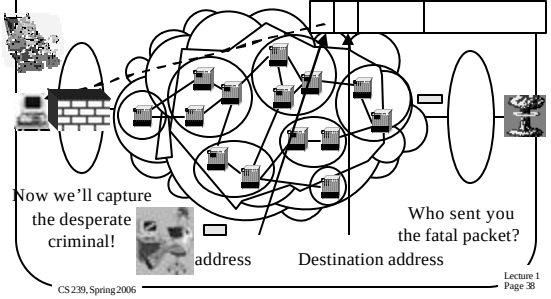


IP Spoofing

So has someone hacked Granny's machine?

No, somebody forged Granny's IP address

IP header IP payload

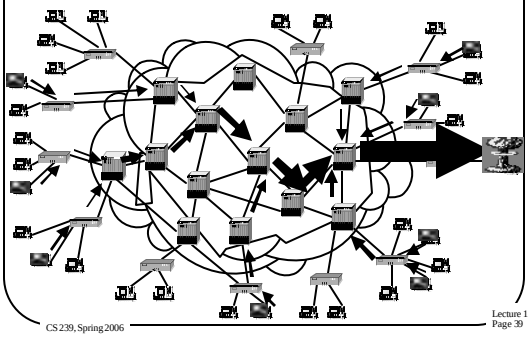


Now we'll capture the desperate criminal!

Who sent you the fatal packet?

address Destination address

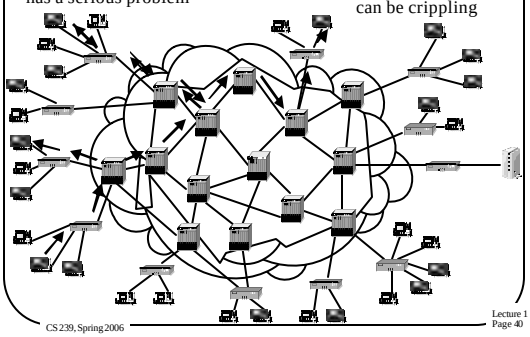
Distributed Denial of Service



Worms

Pretty soon the Internet has a serious problem

The infection traffic alone can be crippling



Internet Security Realities

1. No one is in charge
2. Different parties have different goals
3. Cooperation only likely when it's in each party's own interests
4. It's hard to change things
5. It's hard to get a global view of what's happening

The Security Implications

- Attackers can leverage lack of cooperation
- Attackers can hide behind complexity
- Hard to deploy new security solutions
- You can't count on other parties helping you
  - Even if they aren't attackers

Problems for Other Types of Networks

- Power-draining attacks in sensor networks
- Compromise of location privacy in ubiquitous environments
- Sybil attacks in peer networks
- Wormhole attacks in ad hoc networks

Characteristics of These Problems

- Basic problems with network behavior
- Assaults on networking infrastructure
- Leveraging failure of network to check for proper behavior
- Overloading network
- Attacking special requirements of particular network types

Realities for Other Types of Networks

- Many have inherent characteristics that mitigate against security
- Usually operating with limited resources
- Often necessary to support many different users
- Often necessary to handle unknown users
- What you're trying to protect might be different in nature than Internet cases

Implications of Those Realities

- Many existing security solutions don't work here
- Each special network type might be its own special case
- Generally can't rely on closed communities
- Must think in different ways related to the characteristics of this network