

Network Security - ISA 656

Angelos Stavrou

January 28, 2008

Course Overview

What is this Course about?

Why Network Security?

Importance of network security

How to Think About Insecurity

Course Objectives

Administrivia

Network Security

Network (in)Security

Course Outline

Course Overview

What is this Course about?

Course Overview
What is this Course
about?

Why Network
Security?

Importance of
network security

How to Think About
Insecurity

Course Objectives

Administrivia

Network Security

Network (in)Security

Course Outline

- Network & Computer (in)security
- Network security — protect the network infrastructure, and secure the end-to-end communications
- Not entirely true — we also focus on security of networked applications

Why Network Security?

Course Overview

What is this Course about?

Why Network Security?

Importance of network security

How to Think About Insecurity

Course Objectives

Administrivia

Network Security

Network (in)Security

Course Outline

- Touches every aspect of network and system design and implementation
- Different mentality from other disciplines
 - ◆ “Does it work?” vs “Can it be broken?”
 - ◆ “Is the fix going to break something else?”
- Learn to think differently :-)

Importance of network security

Course Overview

What is this Course about?

Why Network Security?

Importance of network security

How to Think About Insecurity

Course Objectives

Administrivia

Network Security

Network (in)Security

Course Outline

- Increasingly large deployments of networked computers
- Sensitive information/resources are coming online
- Personal information
- Financial services
- Military operations
- Critical Infrastructure
- Enormous number of users, vast amount of money
- Cyber-attacks can cause significant economic damage

How to Think About Insecurity

- The bad guys don't follow the rules
- To understand how to secure a system, you have to understand what sort of attacks are possible
- Note that that is *not* the same as actually launching them...

[Course Overview](#)

[What is this Course about?](#)

[Why Network Security?](#)

[Importance of network security](#)

[How to Think About Insecurity](#)

[Course Objectives](#)

[Administrivia](#)

[Network Security](#)

[Network \(in\)Security](#)

[Course Outline](#)

Course Objectives

Course Overview

What is this Course about?

Why Network Security?

Importance of network security

How to Think About Insecurity

Course Objectives

Administrivia

Network Security

Network (in)Security

Course Outline

- Learn how to design secure networked systems
- Quantify the cost and tradeoffs of security
- Determine where to apply/use cryptography (Cryptography not a prerequisite!)
- Appreciate the role of correct software
- Prevent?/Mitigate/Limit the security threats that step bad software
- Get hands-on knowledge practicing on real systems in the lab!

Course Overview

Administrivia

Course Location and
Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of

Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

Administrivia

Course Location and Time

Course Overview

Administrivia

Course Location and Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of

Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

- Always check the page website for new material:
http://cs.gmu.edu/~astavrou/isa656_S08.html
- Time: Monday 7:20 pm - 10:00pm
- Room: Robinson Hall B, room B205
- Lab: We are waiting for a larger Lab.
- Lab Meeting: Scheduled the same time as the class, usually every third lecture (you will be notified in advance)

Course Structure

Course Overview

Administrivia

Course Location and
Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of

Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

- Lectures and Laboratory Sessions
- Approximately five homework assignments, all with programming and non-programming components
- Group Project or Midterm and a Final

Prerequisites

[Course Overview](#)

[Administrivia](#)

[Course Location and Time](#)

[Course Structure](#)

[Prerequisites](#)

[Readings](#)

[Grading](#)

[Office Hours & TAs](#)

[Grading Logistics](#)

[Contacting Me](#)

[Class & Lab](#)

[Lectures](#)

[Homeworks](#)

[Programming Assignments](#)

[Homework 0](#)

[Co-operation versus Dishonesty](#)

[The Ethics of Security](#)

[Responsibility](#)

[Practical Focus](#)

[The Security Lab](#)

[Network Security](#)

[Network \(in\)Security](#)

[Course Outline](#)

- CS 555, or General Networking:
 - ◆ Network layers
 - ◆ Basics of TCP/IP
 - ◆ Difference between IP, ICMP, TCP, and UDP
 - ◆ Port numbers and sequences numbers
 - ◆ Some understanding of the TCP flags
- ISA 562 or understanding of network protocols
- Understand how to use “make”, the compiler, etc.
- **Programming** in either C or Java

Readings

[Course Overview](#)

[Administrivia](#)

[Course Location and Time](#)

[Course Structure](#)

[Prerequisites](#)

[Readings](#)

[Grading](#)

[Office Hours & TAs](#)

[Grading Logistics](#)

[Contacting Me](#)

[Class & Lab](#)

[Lectures](#)

[Homeworks](#)

[Programming Assignments](#)

[Assignments](#)

[Homework 0](#)

[Co-operation versus](#)

[Dishonesty](#)

[The Ethics of](#)

[Security](#)

[Responsibility](#)

[Practical Focus](#)

[The Security Lab](#)

[Network Security](#)

[Network \(in\)Security](#)

[Course Outline](#)

- Kaufman, Perlman, and Speciner. *Network Security: Private Communication in a Public World, Second Edition*, Prentice Hall PTR, 2002, ISBN 0130460192. **Required.**
- Cheswick, Bellovin, and Rubin. *Firewalls and Internet Security: Repelling the Wily Hacker, Second Edition*, Addison-Wesley Professional, 2003, ISBN 020163466X. (Recommended)
- Research papers and reference manuals (RFCs etc.) (Provided on the class web site)

Grading

Course Overview

Administrivia

Course Location and
Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of

Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

Midterm/Project 20%

Final 25%

Homeworks 50%

Class Participation 5%

In addition: extra credit assignments (why?)

Exams will be open book having part of the exam
in the lab.

Office Hours & TAs

Instructor: Angelos Stavrou <astavrou@gmu.edu>

Office: 441 Science & Technology II

Hours: Wednesday 5 - 7pm & by appointment

TA: Nour Wasif Aulabi <naulabi@gmu.edu>

Office: Adjunct office, Science & Technology II

Hours: Thursday 5 - 7pm & by appointment

Course Overview

Administrivia

Course Location and
Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of

Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

Grading Logistics

Course Overview

Administrivia

Course Location and
Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of

Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

- For grading issues, approach the TA within two weeks; if you don't receive a satisfactory answer, contact me.
- For issues relating to *this class*, email astavrou@gmu.edu...
- The TA should be your first contact point but you can also contact me with any questions or problems related to the class (or security in general) .

Contacting Me

[Course Overview](#)

[Administrivia](#)

[Course Location and Time](#)

[Course Structure](#)

[Prerequisites](#)

[Readings](#)

[Grading](#)

[Office Hours & TAs](#)

[Grading Logistics](#)

[Contacting Me](#)

[Class & Lab](#)

[Lectures](#)

[Homeworks](#)

[Programming Assignments](#)

[Homework 0](#)

[Co-operation versus](#)

[Dishonesty](#)

[The Ethics of](#)

[Security](#)

[Responsibility](#)

[Practical Focus](#)

[The Security Lab](#)

[Network Security](#)

[Network \(in\)Security](#)

[Course Outline](#)

- You don't need to be in trouble to talk with me...
- You can always arrange an appointment with me via email
- We will also have Q&A sessions outside the class hours
- But — I also travel to conferences...

Class & Lab Lectures

Course Overview

Administrivia

Course Location and
Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

**Class & Lab
Lectures**

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of
Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

- I will prepare slides for each class, and upload them on the web site ahead of time (usually 2-3 weeks)
- Well, occasionally they're uploaded shortly before class...
- For the Laboratory Sessions, you need to come prepared (read the material posted on the web) before the lab starts
- If you miss a class make sure that you read the lecture notes and come see us at our office hours

Homeworks

Course Overview

Administrivia

Course Location and
Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of

Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

- A lot of it...
- As noted, approximately five homework assignments
- Homeworks are designed for practice, teaching, and evaluation
- Homeworks must be submitted electronically by the start of class
- Homeworks received later that day lose 5%, the next day 10%, two days late 20%, three days late 30%; after that, zero credit
- Exceptions granted only for *unforeseeable* events. Workload, day job, etc., are quite foreseeable.

Programming Assignments

[Course Overview](#)

[Administrivia](#)

[Course Location and Time](#)

[Course Structure](#)

[Prerequisites](#)

[Readings](#)

[Grading](#)

[Office Hours & TAs](#)

[Grading Logistics](#)

[Contacting Me](#)

[Class & Lab](#)

[Lectures](#)

[Homeworks](#)

[Programming Assignments](#)

[Homework 0](#)

[Co-operation versus Dishonesty](#)

[The Ethics of Security](#)

[Responsibility](#)

[Practical Focus](#)

[The Security Lab](#)

[Network Security](#)

[Network \(in\)Security](#)

[Course Outline](#)

- All programming assignments *must* be done in C or Java
- Assignments will involve socket programming and use of cryptographic libraries — see HW0
- *All* inputs must be checked for validity and proper values and lengths — bugs are *the* major source of security problems

Homework 0

- Simple socket exercise (will be posted online)
- Not collected, not graded, completely optional
- But — it will be a useful base for another assignment
- It's also a refresher exercise for you on socket programming

Course Overview

Administrivia

Course Location and Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of

Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

Co-operation versus Dishonesty

Course Overview

Administrivia

Course Location and
Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus
Dishonesty

The Ethics of

Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

- Discussing homework with others is encouraged
- All programs and written material *must* be individual work unless otherwise instructed
- Looking or Copying other people's work is not allowed
- Zero tolerance for cheating or "outsourced homework"
- See the University academic honesty policy:
<http://www.gmu.edu/catalog/apolicies/#Anchor12>.
You are responsible for following it
- **ALWAYS** reference your source of information

The Ethics of Security

Course Overview

Administrivia

Course Location and
Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of
Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

- Taking a computer security class is *not* an excuse for hacking
- “Hacking” is any form of unauthorized access, including exceeding authorized permissions
- The fact that a file or computer is not properly protected is no excuse for unauthorized access
- *If* the owner of a resource invites you to attack it, such use is authorized
- No, I’m not joking

Responsibility

- You're all adults
- You're all responsible for your own actions
- Ask the TA or me if you are in doubt!

Course Overview

Administrivia

Course Location and Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of

Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

Practical Focus

- This is not a pure academic-style OS course
- You'll be experimenting with real security holes
- A lot of (in)security is about doing the unexpected
- The ability to “think sideways” is a big advantage

Course Overview

Administrivia

Course Location and Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of

Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

The Security Lab

Course Overview

Administrivia

Course Location and
Time

Course Structure

Prerequisites

Readings

Grading

Office Hours & TAs

Grading Logistics

Contacting Me

Class & Lab

Lectures

Homeworks

Programming

Assignments

Homework 0

Co-operation versus

Dishonesty

The Ethics of

Security

Responsibility

Practical Focus

The Security Lab

Network Security

Network (in)Security

Course Outline

- We would like you to bring with you a USB key of at least 512MB
- As an alternative, you can bring your own laptop
- No food or drink in the Security lab

Course Overview

Administrivia

Network Security

Goals

Differences from
systems security

Network Security: A
layered approach

Security-aware
System Design

Type of security
mechanisms

Reactive
mechanisms -
problems

Failures of security
mechanisms

More failures . . .

Network (in)Security

Course Outline

Network Security

Goals

- Usual security trinity: confidentiality, integrity, availability
- Must ensure these in two domains: over-the-wire *and* on the host (for network-connected applications)
- Strategies are very different!

[Course Overview](#)

[Administrivia](#)

[Network Security](#)

[Goals](#)

Differences from systems security

Network Security: A layered approach

Security-aware System Design

Type of security mechanisms

Reactive mechanisms - problems

Failures of security mechanisms

More failures . . .

[Network \(in\)Security](#)

[Course Outline](#)

Differences from systems security

Course Overview

Administrivia

Network Security

Goals

Differences from
systems security

Network Security: A
layered approach

Security-aware
System Design

Type of security
mechanisms

Reactive
mechanisms -
problems

Failures of security
mechanisms

More failures . . .

Network (in)Security

Course Outline

- Attacks can come from anywhere, at any time
- Highly automated (scripts)
- Physical security measures are inadequate
- Wide variety of applications, services, protocols
Complexity
- Different constraints, assumptions, goals
- No single "authority" / administrator
- Somehow at odds with concept of networking

Network Security: A layered approach

[Course Overview](#)

[Administrivia](#)

[Network Security](#)

Goals

Differences from systems security

Network Security: A layered approach

Security-aware System Design

Type of security mechanisms

Reactive mechanisms - problems

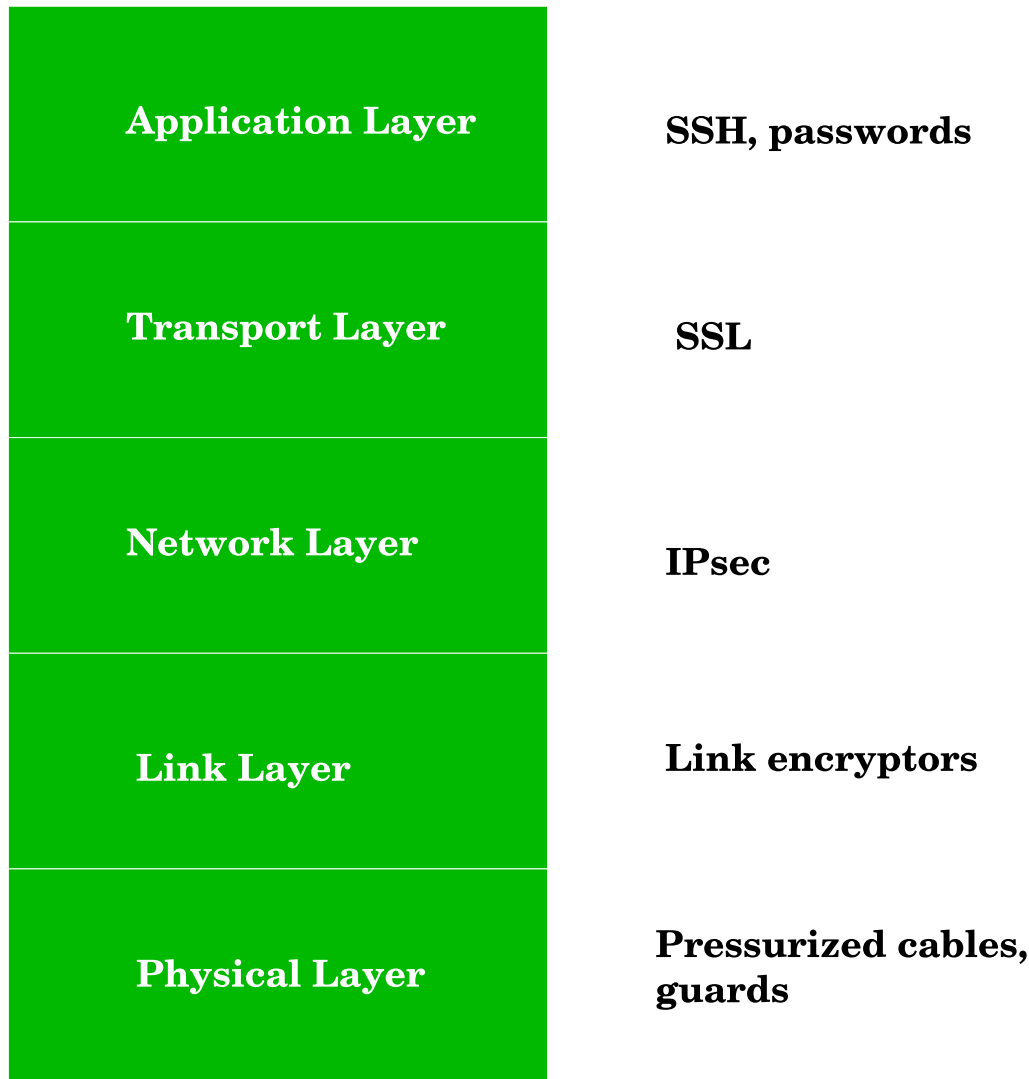
Failures of security mechanisms

More failures . . .

[Network \(in\)Security](#)

[Course Outline](#)

Network Stack



Security-aware System Design

Course Overview

Administrivia

Network Security

Goals

Differences from
systems security

Network Security:A
layered approach

Security-aware
System Design

Type of security
mechanisms

Reactive
mechanisms -

problems

Failures of security
mechanisms

More failures . . .

Network (in)Security

Course Outline

- Cost/benefit tradeoffs
- Threat model
- Trust model
- Available mechanisms
- Security is not only cryptography
- Security often conflicts with other goals:
Fault tolerance, debugging & monitoring,
sharing, etc.

Type of security mechanisms

[Course Overview](#)

[Administrivia](#)

[Network Security](#)

[Goals](#)

[Differences from
systems security](#)

[Network Security: A
layered approach](#)

[Security-aware
System Design](#)

[Type of security
mechanisms](#)

[Reactive
mechanisms -
problems](#)

[Failures of security
mechanisms](#)

[More failures . . .](#)

[Network \(in\)Security](#)

[Course Outline](#)

- Pro-active try to keep the bad guys out
 - ◆ Passwords
 - ◆ Smartcards
 - ◆ Encrypted login protocols
 - ◆ Armed Marines
 - ◆ Reactive mechanisms try to detect and contain an attack
 - ◆ Intrusion detection
 - ◆ DoS push-back
 - ◆ Flood the enemy
 - ◆ Attack using physical forces

Reactive mechanisms - problems

- No "strike-back" mechanisms widely in use
- Air Force Caller-ID program
- RIAA anti-P2P work
- It involves legal, moral, and practical issues

Course Overview

Administrivia

Network Security

Goals

Differences from
systems security

Network Security:A
layered approach

Security-aware
System Design

Type of security
mechanisms

Reactive
mechanisms -
problems

Failures of security
mechanisms

More failures . . .

Network (in)Security

Course Outline

Failures of security mechanisms

[Course Overview](#)

[Administrivia](#)

[Network Security](#)

Goals

Differences from
systems security

Network Security: A
layered approach

Security-aware
System Design

Type of security
mechanisms

Reactive
mechanisms -
problems

Failures of security
mechanisms

More failures . . .

[Network \(in\)Security](#)

[Course Outline](#)

- Failures of security mechanisms
- Failure to understand the threat model
- Failure to understand what a mechanism protects against
- No (or wrong) mechanism/tool used
- Bad design
- Implementation fault
- Mis-configuration

More failures . . .

- Bad user interface
- Complexity (inherent in "systems")
- Emergent properties vs. bugs
- Theory vs. practical implementation

Course Overview

Administrivia

Network Security

Goals

Differences from
systems security

Network Security:A
layered approach

Security-aware
System Design

Type of security
mechanisms

Reactive
mechanisms -
problems

Failures of security
mechanisms

More failures . . .

Network (in)Security

Course Outline

Course Overview

Administrivia

Network Security

Network (in)Security

Dichotomy

Anarchic Networks
Observations about
Networks

Benign Failures

Trust Nothing

Unproductive
Attitudes

Better Attitudes
Network Security

Tools

Protocol Design

Buggy Software

Course Outline

Network (in)Security

Dichotomy

- The host is (or can be) well-controlled
- There are well-developed authentication and authorization models
- There is a strong notion of “privileged” state, as well as what programs can use it
- None of that is true for the network

Course Overview

Administrivia

Network Security

Network (in)Security

Dichotomy

Anarchic Networks
Observations about
Networks

Benign Failures

Trust Nothing

Unproductive

Attitudes

Better Attitudes

Network Security

Tools

Protocol Design

Buggy Software

Course Outline

Anarchic Networks

Course Overview

Administrivia

Network Security

Network (in)Security
Dichotomy

Anarchic Networks

Observations about
Networks

Benign Failures

Trust Nothing

Unproductive
Attitudes

Better Attitudes

Network Security
Tools

Protocol Design

Buggy Software

Course Outline

- More or less anyone can (and does) connect to the network
- Connectivity can only be controlled in very small, well-regulated environments, and maybe not even then
- Different operating systems have different — or no — notions of userIDs and privileges
- As a consequence, notions of privilege are lacking

Observations about Networks

1. Networks interconnect
2. Networks *always* interconnect
3. Interconnections happen at the edges, not the center

Course Overview

Administrivia

Network Security

Network (in)Security

Dichotomy

Anarchic Networks

Observations about
Networks

Benign Failures

Trust Nothing

Unproductive

Attitudes

Better Attitudes

Network Security

Tools

Protocol Design

Buggy Software

Course Outline

Benign Failures

[Course Overview](#)

[Administrivia](#)

[Network Security](#)

[Network \(in\)Security
Dichotomy](#)

[Anarchic Networks
Observations about
Networks](#)

[Benign Failures](#)

[Trust Nothing](#)

[Unproductive
Attitudes](#)

[Better Attitudes
Network Security
Tools](#)

[Protocol Design](#)

[Buggy Software](#)

[Course Outline](#)

- On top of all that, most network failures are benign
- You have to program allowing for such failures: data corruption, timeouts, dead hosts, routing problems, etc.
- Rule of thumb: anything that can happen by accident can happen by malice — only more so

Trust Nothing

- A host can trust *nothing* that comes over the wire
- Any desired protections have to be supplied explicitly
- Perhaps there's a middle-ware layer supplying the protection — but such middle-ware is based on the same principles

[Course Overview](#)

[Administrivia](#)

[Network Security](#)

[Network \(in\)Security](#)

[Dichotomy](#)

[Anarchic Networks](#)
[Observations about](#)
[Networks](#)

[Benign Failures](#)

[Trust Nothing](#)

[Unproductive](#)
[Attitudes](#)

[Better Attitudes](#)
[Network Security](#)
[Tools](#)

[Protocol Design](#)

[Buggy Software](#)

[Course Outline](#)

Unproductive Attitudes

- “Why would anyone ever do *that*?”
- “That attack is too complicated”
- “No one knows how this system works, so they can’t attack it”

Course Overview

Administrivia

Network Security

Network (in)Security

Dichotomy

Anarchic Networks

Observations about
Networks

Benign Failures

Trust Nothing

Unproductive
Attitudes

Better Attitudes

Network Security

Tools

Protocol Design

Buggy Software

Course Outline

Better Attitudes

- “Programming Satan’s Computer”
(Ross Anderson)
- “Assume that serial number 1 of any device is delivered to the enemy
- “You hand your packets to the enemy to deliver; you receive all incoming packets from the enemy

Course Overview

Administrivia

Network Security

Network (in)Security
Dichotomy

Anarchic Networks
Observations about
Networks

Benign Failures

Trust Nothing

Unproductive
Attitudes

Better Attitudes

Network Security
Tools

Protocol Design

Buggy Software

Course Outline

Network Security Tools

Course Overview

Administrivia

Network Security

Network (in)Security

Dichotomy

Anarchic Networks
Observations about
Networks

Benign Failures

Trust Nothing

Unproductive
Attitudes

Better Attitudes

Network Security
Tools

Protocol Design

Buggy Software

Course Outline

- Network-based access control (firewalls and more)
- Monitoring
- Cryptography
- Paranoid design

Protocol Design

Course Overview

Administrivia

Network Security

Network (in)Security

Dichotomy

Anarchic Networks
Observations about
Networks

Benign Failures

Trust Nothing

Unproductive
Attitudes

Better Attitudes
Network Security
Tools

Protocol Design

Buggy Software

Course Outline

- Leave room for crypto and authentication
- Make sure all sensitive fields are protected
- Make authentication bilateral
- Figure out the proper authorization
- Defend against eavesdropping, modification, deletion, replay, and combinations thereof

Buggy Software

- Most network security holes are due to buggy code
- A buggy network-connected program is an insecure one
- Correct coding counts for a lot

[Course Overview](#)

[Administrivia](#)

[Network Security](#)

[Network \(in\)Security
Dichotomy](#)

[Anarchic Networks
Observations about
Networks](#)

[Benign Failures](#)

[Trust Nothing](#)

[Unproductive
Attitudes](#)

[Better Attitudes](#)

[Network Security](#)

[Tools](#)

[Protocol Design](#)

[Buggy Software](#)

[Course Outline](#)

Course Overview

Administrivia

Network Security

Network (in)Security

Course Outline

Network Availability

Authentication &
Secure Protocols

Applications

Course Outline

Network Availability

Course Overview

Administrivia

Network Security

Network (in)Security

Course Outline

Network Availability

Authentication &
Secure Protocols

Applications

- Attacks and threats
- Firewalls & VPNs
- Intrusion Detection
- Network scans
- Worms
- Denial of service
- Network infrastructure Design

Authentication & Secure Protocols

[Course Overview](#)

[Administrivia](#)

[Network Security](#)

[Network \(in\)Security](#)

[Course Outline](#)

[Network Availability](#)

[Authentication &
Secure Protocols](#)

[Applications](#)

- Cryptography overview
- Network authentication and key management
- Kerberos
- SSL
- IPsec
- Protocol design

Applications

Course Overview

Administrivia

Network Security

Network (in)Security

Course Outline

Network Availability

Authentication &
Secure Protocols

Applications

- Web security
- Email security and phishing
- Voice over IP (VoIP) security
- Network storage
- Trust Management