

Course Overview

CS 438: Spring 2014

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<http://courses.engr.illinois.edu/cs438/>

Target: Hacking hit 70 million customers

CNNMoney

NEW YORK (CNNMoney)

The data breach at Target was significantly broader than originally reported: The company said Friday that 70 million customers had information such as their name, address, phone number and e-mail address hacked in the breach.

Target said the personal data stolen could affect its past shoppers -- not just those who have visited the store recently.

Customers who shopped in the weeks following Thanksgiving may have had credit or debit card information stolen, with as many as 40 million people affected. Some of those people may also be included in the 70-million group revealed Friday.

Target said it would try to reach customers for whom it has e-mail addresses to inform them of the breach. It cautioned that it would not ask customers to provide any personal information and warned customers not to respond to any e-mail claiming to be from Target.

"I know that it is frustrating for our guests to learn that this information was taken and we are truly sorry they are having to endure this," said Target CEO Gregg Steinhafel.

Customers will not be liable for the cost of any fraudulent charges. Target is also offering one year of free credit monitoring and identity theft protection to all customers who

FCC blasts Verizon for 911 outages

The FCC and largest of 2012. A generator thousands Still, the F Unfortuna two days t reliability t lasted for June 30. "The failu service to network m been prev engineeri

TRANSPORT ► AIRLINES

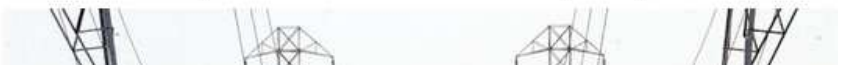
United's global systems fail major flight delays

The airline described the problems as a "network outage." The extent of the ou was down for roughly two hours, to its airline to rely on hand-written boarding Pictures shared by users on Twitter showed lines wrapped around the inside of Washington Dulles and Chicago-O'Hare airports.

Systems returned to relative normality

'Military-Style' Raid on California Power Station Spooks U.S.

BY SHANE HARRIS | DECEMBER 27, 2013 - 01:50 PM



TECHSPOT

TECHSP

National broadband outage caused by router bug

A vast number of Time Warner Cable customers arose from bed this Monday morning to discover that their Internet connections were down. Other ISPs have been affected as well, but TWC customers are clearly the loudest.

Time Warner He

Trio of Cisco flaws may threaten network

By Joris Evers
Staff Writer, CNET News

Related Stories

Cisco squashes 'critical' Net

Three security holes in the software that runs C routers and switches could let miscreants disru networks, including the Internet.

Bloomberg Our Company | Professional | Anywh

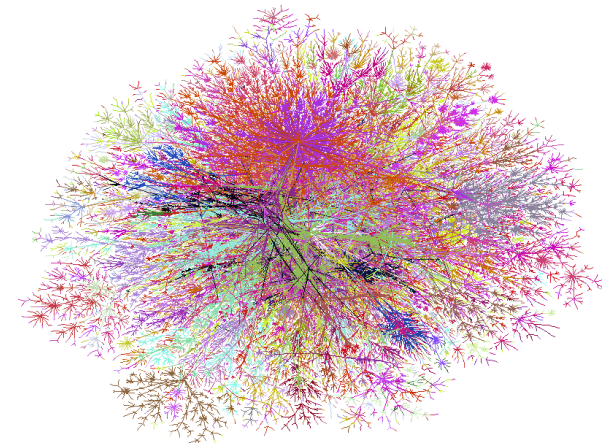
Power-Grid Cyber Attack Seen Millions in Dark for Months

By Brian Wingfield - Jan 31, 2012 11:00 PM CT

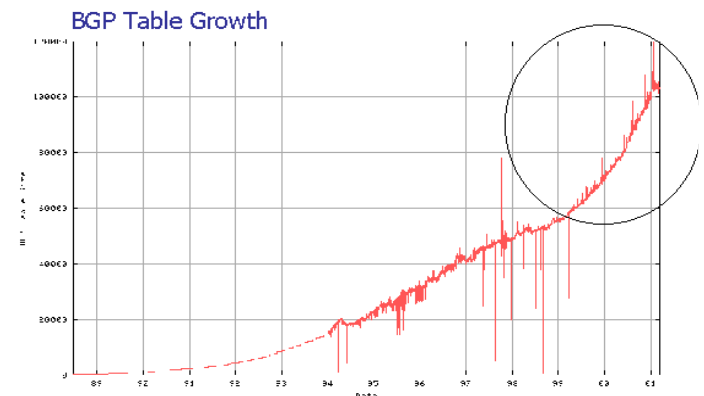
A blackout that swept parts of North America in August 2003. leavin

Building Networks is Challenging

- *Networks are large and complex*
- Tremendous scale
 - **2.4 Billion** users (34% of world population)
 - **1 Trillion** objects
 - **2 Million** routers, **20,000** ISPs
 - Routers that switch **10TB/second**
- Incessant rapid growth
- Run by parties with competing interests



BGP Table Growth – 12 year history



Building Networks is Challenging

- *Networks are hard to change*
- Complex intertwinings, dependencies across protocols/systems, networks
- But you cannot reboot the Internet
- Akin to changing engine of a plane while you are flying it

Building Networks is Challenging

- *Networks are under continuous attack*
- As network population grows in size so does number of
 - Vandals
 - Crazyies
- Size makes it attractive target to crooks, spies, and militaries
 - Network crime is a \$114B industry
- Continuous flood of DoS, sniffing, compromise, phishing, extortion,...

Building Networks is Challenging

- Networks are big, complex
- Distributed over global scales
- Undergoing continuous failure
- Run by parties with competing interests
- Under continuous attack
- Hard to introduce fixes, changes
- Incessant rapid growth

Networks are Important

- Networks are changing...
- *The way we do business*

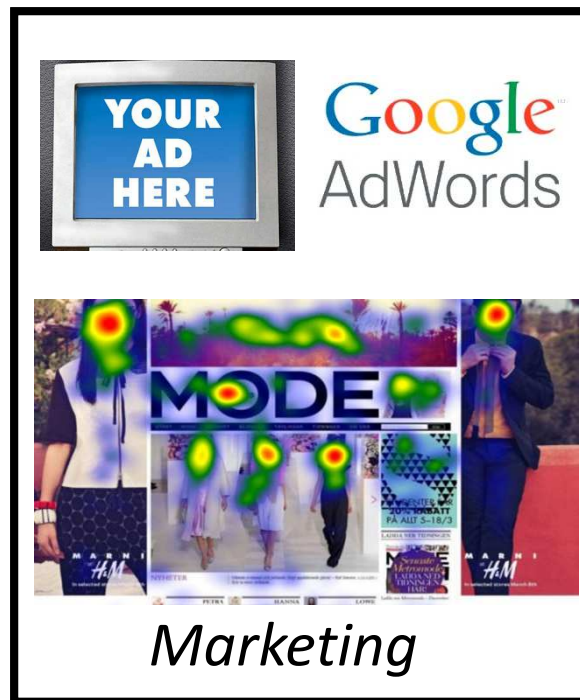


ebay™

a

E-Commerce

This panel illustrates E-Commerce. It features the eBay logo at the top left and the Amazon logo at the top right. In the center, a white 3D figure is pushing a shopping cart. The text 'E-Commerce' is written at the bottom.



YOUR AD HERE

Google AdWords

MODE

Marketing

This panel illustrates Marketing. It features a sign that says 'YOUR AD HERE' at the top left and the Google AdWords logo at the top right. In the center, there is a collage of fashion-related images with heatmaps overlaid, and the word 'MODE' is prominently displayed. The text 'Marketing' is written at the bottom.



iCloud

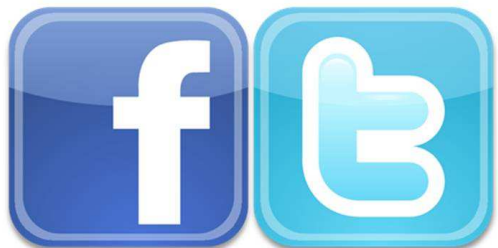
Azure

Cloud Computing

This panel illustrates Cloud Computing. It features the iCloud logo at the top left and the Azure logo at the top right. In the center, there is a blue cloud icon with three curved lines below it representing connectivity. The text 'Cloud Computing' is written at the bottom.

Networks are Important

- Networks are changing...
- *The way we have relationships*



Social Networking



Virtual Worlds



23andMe



eHarmony®

Matchmaking

Networks are Important

- Networks are changing...
- *The way we interact*



Networks are Important

- Networks are changing...
- *The way we learn*




CENTER FOR INNOVATION IN
Teaching & Learning

coursera

KHAN
ACADEMY

Online Learning



ipl.org
The Internet Public Library

WIKIPEDIA
The Free Encyclopedia

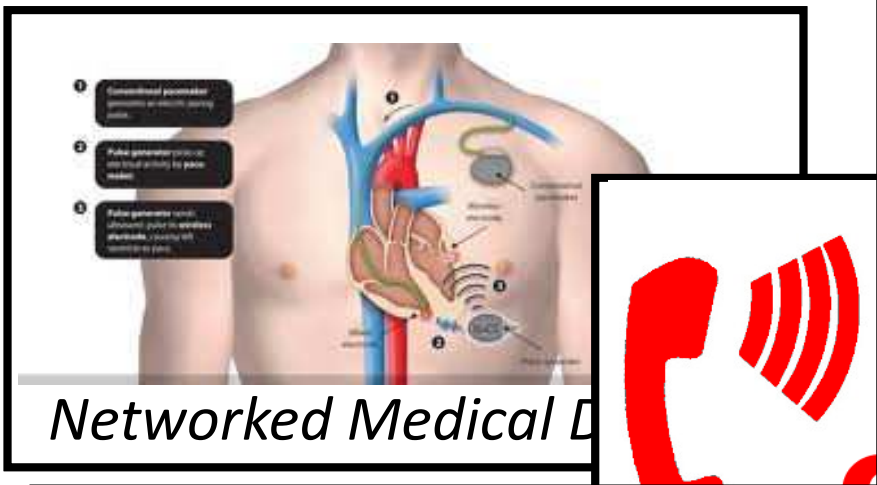
Online Content



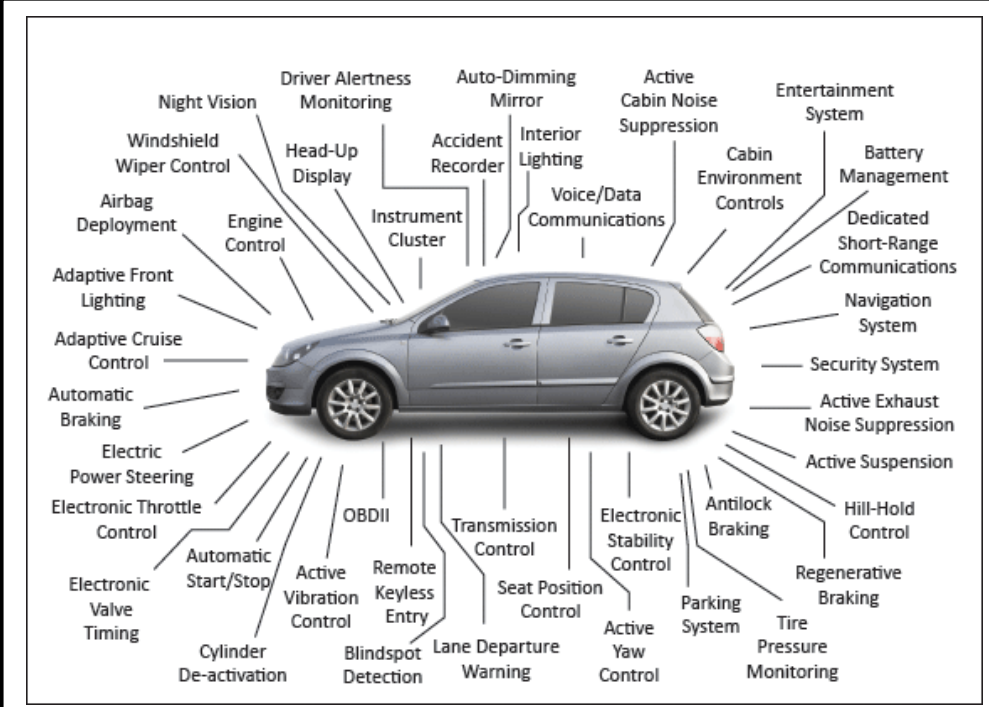
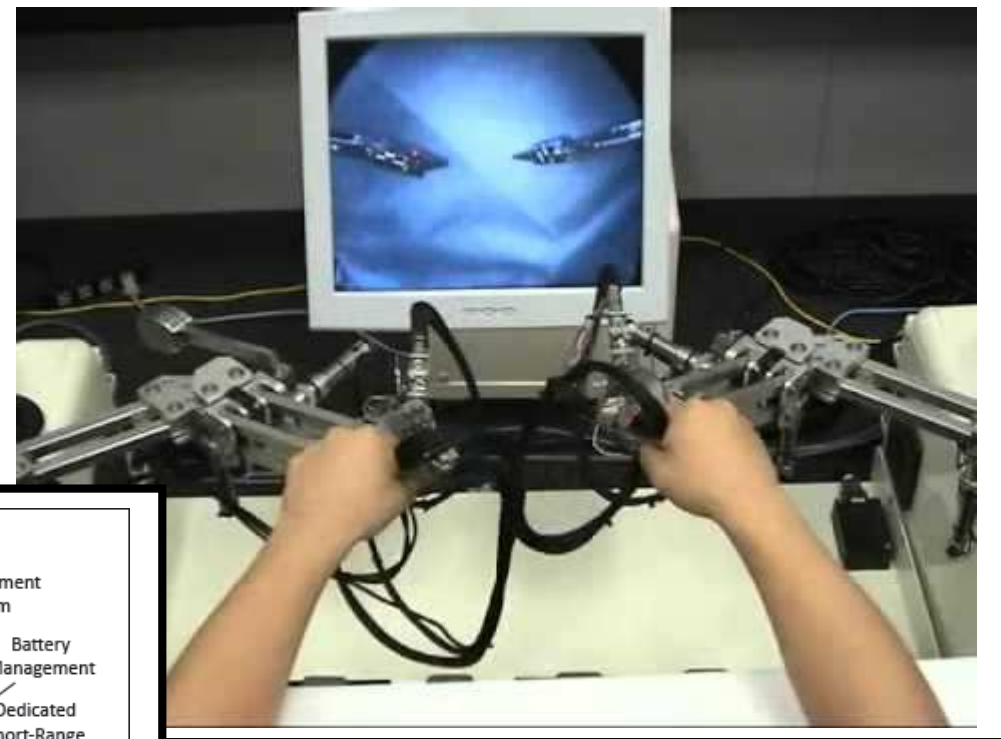
Google Maps

Google™
YAHOO!®
bing™

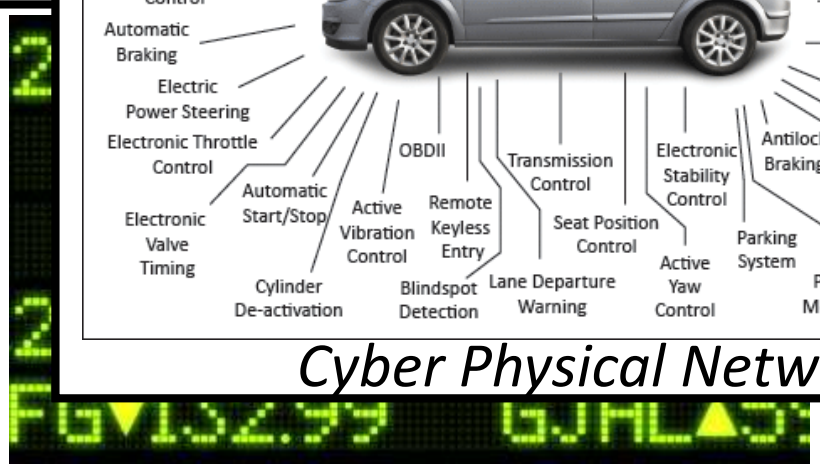
Search Engines



Networked Medical Devices



Cyber Physical Networks



Finance/trading Networks



Critical Infrastructures

This class

- Goal: teach tools and techniques to build, operate, manage, and deploy application services for modern computer network
- This class is a first step towards exciting careers
 - An operator of a large ISP network
 - Architect at a major network device manufacturer
 - Designer of a next-generation Internet protocol
 - Founder of the next hot network tech startup
 - Builder of a major datacenter network
 - And much more!...

This class

- Key concepts:
 - History and overall “architecture” of the Internet
 - Routing and addressing
 - Data packetization and transport
 - Network services
 - Security
 - Network application programming
 - Recent trends (datacenters, SDN, ...)

The Team



Instructor: Matthew Caesar



- CS Faculty at Univ. Illinois
- PhD from UC Berkeley, 2007
- Over 10+ years experience working in computer networks/systems
- NSF CAREER Award, AT&T VURI award, PI in DARPA MRC and CSSG programs, over 50 academic pubs
- I like to build things that people use
 - Industrial experience at AT&T Labs, Microsoft Research, HP, Nokia DSL; helped found two startups on core networking/security systems; partnerships/tech transfer with Cisco, AT&T, Microsoft

TA: Siting Chang



- Brings expertise in data traffic (monitoring, prediction), vehicle networks
- BE+MS in transportation engineering; PhD student at UIUC
- Research on Sustainable and Resilient Infrastructure systems
- Illinois Traffic Engineering Student Chapter Host

TA: Fred Douglas



- Brings expertise in network theory and data center networking
- BA (Math+CS, Case Western), PhD student at UIUC
- Awards: 1st place MAA math competition, NSF REU
- Currently building proposed technical infrastructure to power HP's cloud computing offerings
- Previous focus "secure multi-party computation"

TA: Lingyu (Ivory) Xu



- Brings expertise in network security, privacy, and mobile devices
- MS student at UIUC, BE in CS from Beijing Univ.
- Developed several real-world security solutions:
 - cross-site scripting
 - vulnerability detection tool,
 - privacy platform for Android OS,
 - time-interleaved allocation alg for data centers

How can we build
networks?

There's a lot we don't know about how to build networks

- No consensus on what constitutes the “correct” or “best” network design
- No consensus on “top problems”
- No consensus on the right prioritization of goals
- Not even a well-developed theory to draw from

What we do know

- The early Internet pioneers came up with a solution that was successful beyond all imagining
- Several enduring **architectural principles and practices** emerged from their work

Some key principles

- Statistical multiplexing [lecture 2]
- Packets [lecture 2]
- The network is “application neutral” [lecture 3]
- Best effort service [lecture 3]
- A layered protocol architecture [lectures: all]
- A “narrow API” at the network layer [lecture 8]
- The “end to end” design principle [lecture 8]
- Decentralization [lecture: 2, 3, 6, 8, 9, 21]

What we do know

- The early Internet pioneers came up with a solution that was successful beyond all imagining
- Several enduring **architectural principles and practices** emerged from their work
- But it is just one design
- And numerous cracks have emerged over time
 - want to diagnose problems but IP hides federation
 - want to block unwanted traffic but the network doesn't authenticate
 - can't optimize for different applications or customers
 - complex and buggy protocols
 - upgrading protocols is deeply painful

What we do know

- The early Internet pioneers came up with a solution that was successful beyond all imagining
- Several enduring **architectural principles and practices** emerged from their work
- But it is just one design
- And numerous cracks have emerged over time
- As have new requirements
 - **Mobility, reliability, data centers, sensors, ...**

Hence, networking today is still debating the big questions...

- Packets → “circuits”
- Statistical multiplexing → “reservations”
- Protocol layers
- A “narrow waist” at the network layer → multi-service
- Best-effort service
- The “end to end” design principle → “middleboxes”
- Decentralization → “centralize”

Backing up a level

- The Intro
the des

- What
- What
- How
- Who
- What
- What



reason through

ts?
ons?

- In short, a lesson in how to architect a system

Network “Architecture”

- More about thinking rigorously than doing rigorous math
- More about understanding tradeoffs than running benchmarks
- More about practicality than optimality

What CS 438 Will Teach You

- How the Internet works
- **Why** it works the way it does
- How to **think** through a complicated (networking) design problem

Administrative Details

Prerequisites

- Operating Systems Concepts
 - CS 241 or equivalent
- C or C++ Programming
 - Preferably Unix
- Probability and Statistics

Grading Policy

7 Homeworks	15%
3 MPs	35% (10+10+15)
Midterm exam	25%
“High-level” exam	2% (extra credit)
Final exam	25%

Homework and Projects

- Homework: Due Wednesdays at start of class.
- Projects: Due Fridays at 9:00pm.
 - 2% off per hour late
 - MP1 is solo
 - MP2 and MP3 are 2 person teams
 - TAs will handle all project-related questions

Academic Honesty

- Your work in this class must be your own.
- All infractions reported to the department
- If students are found to have collaborated excessively or to have blatantly cheated (e.g., by copying or sharing answers during an examination or sharing code for the project), all involved will at a minimum receive grades of 0 for the first infraction.
 - We will run a similarity-checking system on code and binaries
- Further infractions will result in failure in the course and/or recommendation for dismissal from the university.

Graduate Students

- Graduate students MAY take an extra one hour project in conjunction with this class
- Undergraduates may not take this project course
 - However, if you are interested in networking research, please contact me or another faculty here at UIUC

Class Communications

- Web site: <http://courses.engr.illinois.edu/cs438>
 - Assignments, lecture slides, announcements
- Use your instructional account to hand in homework and projects
- Email list:
 - Make sure you are on cs438-sp14@illinois.edu
- Use [Piazza](#) for all other intra-class communication
 - You should all be signed up by now
- Cc our staff (cs438-staff@illinois.edu) on any non-private emails sent directly to me (caesar@illinois.edu)

Class Participation

- Ask and answer questions!!
 - it helps you understand
 - it helps others understand
 - it helps you stay awake
 - it helps me stay awake
 - it's just more fun for all of us
- Sit towards the front
- Limit electronic access for < 90 minutes

Thanks to

- Slide decks include content developed at UC Berkeley (Scott Shenker, Ion Stoica, Sylvia Ratnasamy), Princeton University (Jennifer Rexford), University of Massachusetts (Jim Kurose), Stanford (Nick McKeown), and others

Any questions?