Computers, Society, and the Law

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The Space Shuttle Challenger

- NASA wanted to launch the shuttle on a cold January day
- The crucial O-rings had never been tested at low temperatures, but some Thiokol engineers suspected a problem
  - Roger Boisjoly had warned of it six months earlier
- Allan McDonald, director of the solid rocket program at Thiokol, opposed the launch
- NASA: “My God, Thiokol, when do you want me to launch, next April?”

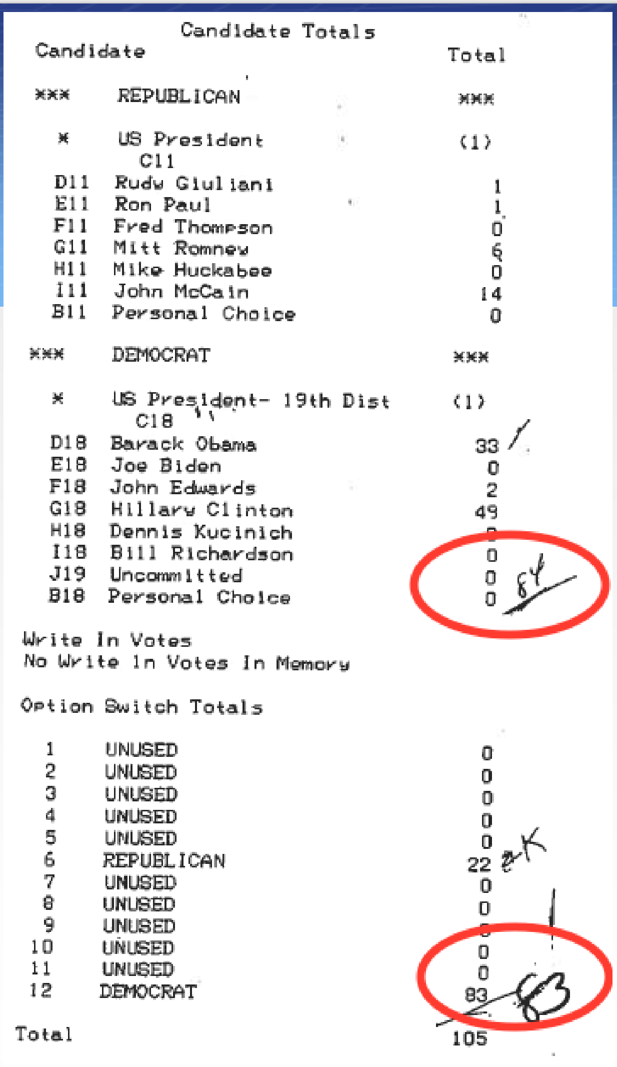
Engineers often know things that managers don’t know but need to

Some Cases are Easy

- Volkswagen and the “defeat device” software to fool emissions tests
- Prenda Law and its bogus copyright infringement lawsuits
  - A judge hearing one case referred the matter to the FBI…
- Viruses, ransomware, and the like

Voting Machines

- There’s long been interest in computerized (“DRE”—Direct Recording Electronic) voting machines and Internet voting
- Virtually all computer scientists oppose the idea: “Don’t use our technology!”
- But: “We bank online; why can’t we vote that way?”



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                  Candidate Totals
Candidate                                    Total

***     REPUBLICAN                            ***

  *     US President                          (1)
          C11
 D11    Rudy Giuliani                           1
 E11    Ron Paul                                1
 F11    Fred Thompson                           0
 G11    Mitt Romney                             6
 H11    Mike Huckabee                           0
 I11    John McCain                            14
 B11    Personal Choice                         0

***     DEMOCRAT                              ***

  *     US President- 19th Dist               (1)
          C18
 D18    Barack Obama                           33
 E18    Joe Biden                               0
 F18    John Edwards                            2
 G18    Hillary Clinton                        49
 H18    Dennis Kucinich                         0
 I18    Bill Richardson                         0
 J19    Uncommitted                             0  84
 B18    Personal Choice                         0

Write In Votes
No Write In Votes In Memory

Option Switch Totals

  1      UNUSED                                 0
  2      UNUSED                                 0
  3      UNUSED                                 0
  4      UNUSED                                 0
  5      UNUSED                                 0
  6      REPUBLICAN                            22  22
  7      UNUSED                                 0
  8      UNUSED                                 0
  9      UNUSED                                 0
 10      UNUSED                                 0
 11      UNUSED                                 0
 12      DEMOCRAT                              83  83

Total                                         105
```

(Photo by Ed Felten)

Computer Scientists and Voting Systems

- *We* know how buggy and insecure software can be
- *We* know that ATMs, etc., can have log files and (in some cases) we can "unwind" problematic transactions
- But—anonymity and result integrity are *extremely* important in voting
- (Rerunning elections is problematic. If last year's election were rerun a week later because of computer problems, what would the results have looked like?)

How do we communicate the software issues to legislators?

Encryption

- The FBI claims that they’re “going dark” because of increasing use of encryption
- They want some sort of “exceptional access” to let them get at the plaintext
- Most cryptologists think that this is dangerous, that cryptographic protocols and mechanisms are far too hard to get right
- Why?

Historical Example:
The World War II Enigma Machine

Photo: public domain

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The World War II Enigma Machine

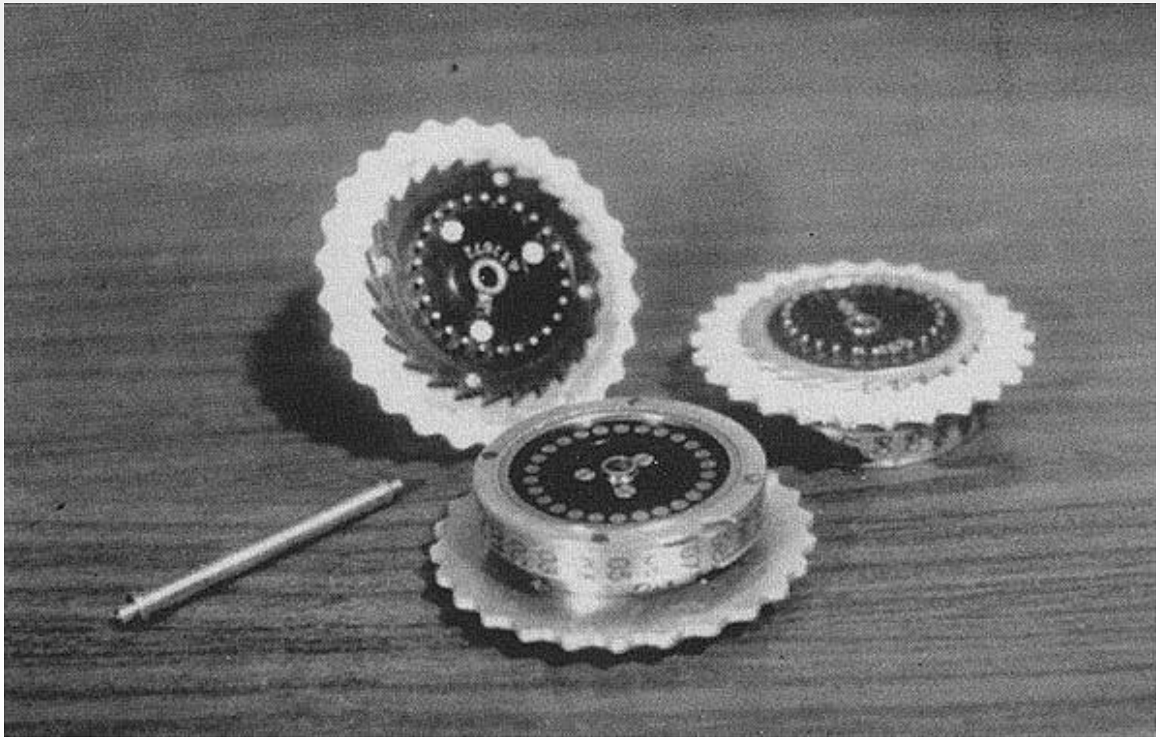


Photo: public domain

You select the proper rotors

Historical Example: The World War II Enigma Machine

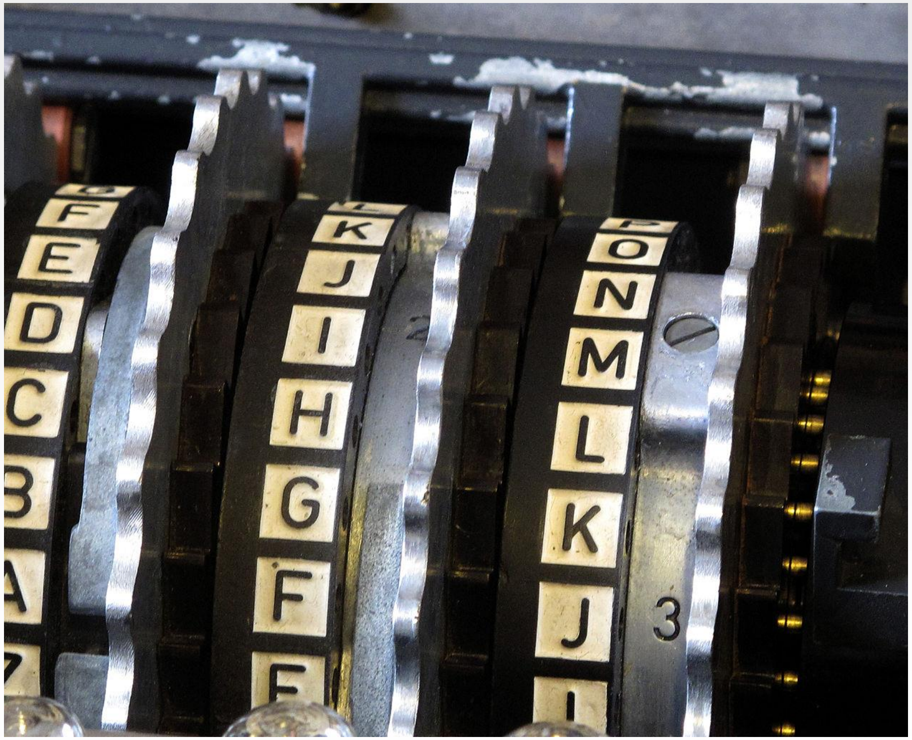


Photo: public domain

Adjust the rotors to their "ground setting"

Historical Example:
The World War II Enigma Machine

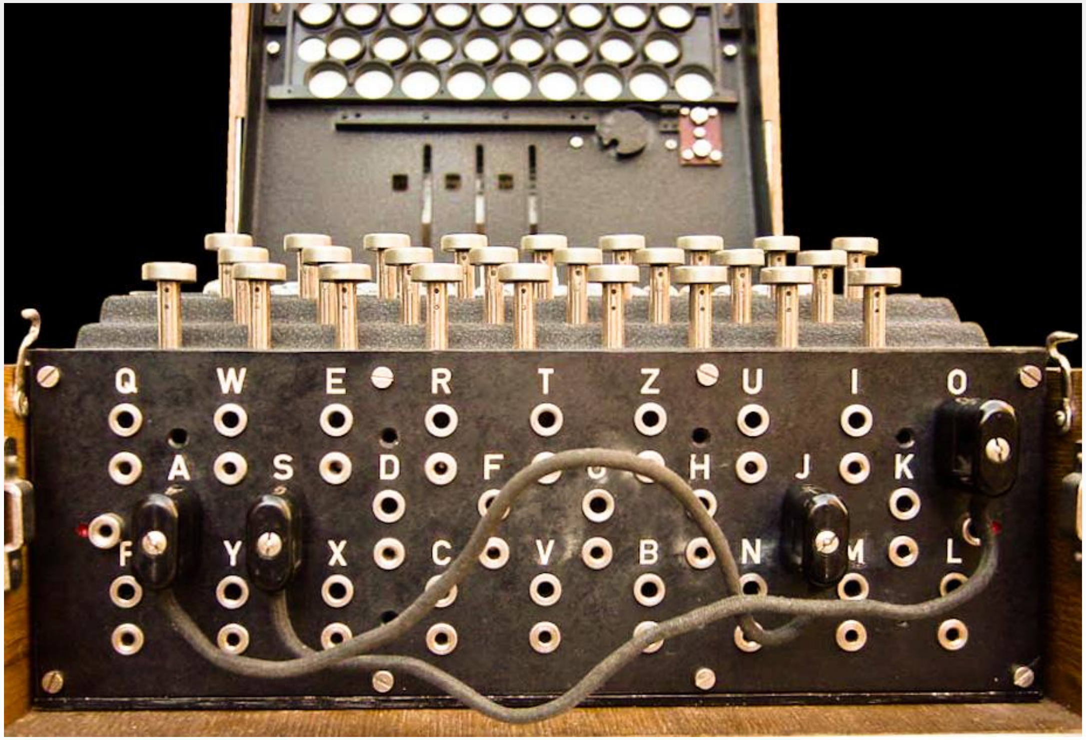


Photo: Bob Lord, via WikiMedia Commons

Set the plugboard

Historical Example: The World War II Enigma Machine

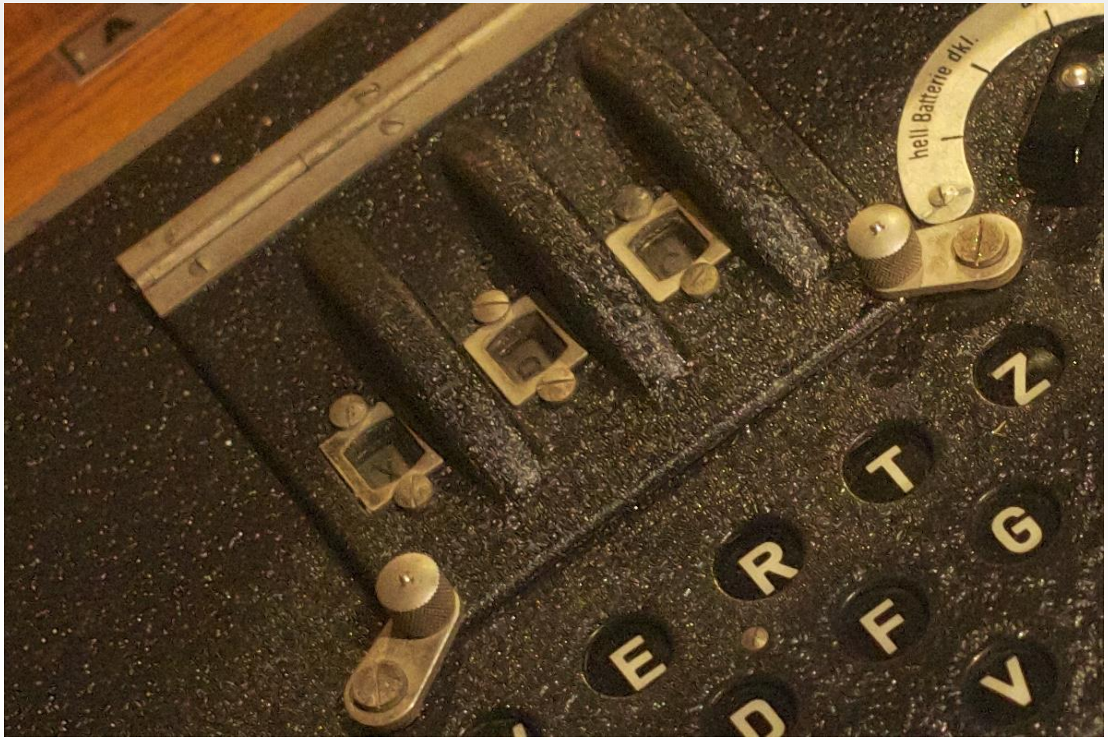


Photo: Paul Hudson, via Flickr

- Pick three random letters and encrypt them twice, and send those six letters as the start of the encrypted message
- Reset the rotors to those three letters

What Could Go Wrong?

- Sending the same, simple message every day was a fatal flaw
- Picking non-random letters was a fatal flaw
- Sending a message consisting of nothing but the letter "L" was a fatal flaw
- Encrypting the three letters *twice* was a fatal flaw

The Three Letters

- Imagine that “XJM” was encrypted to “AMRDTJ”
- The cryptanalysts realized that A and D represented the same letter, M and T were the same, and R and J were the same
- This gave away valuable clues to the rotor wiring and the rotor order!

Cryptography is hard…

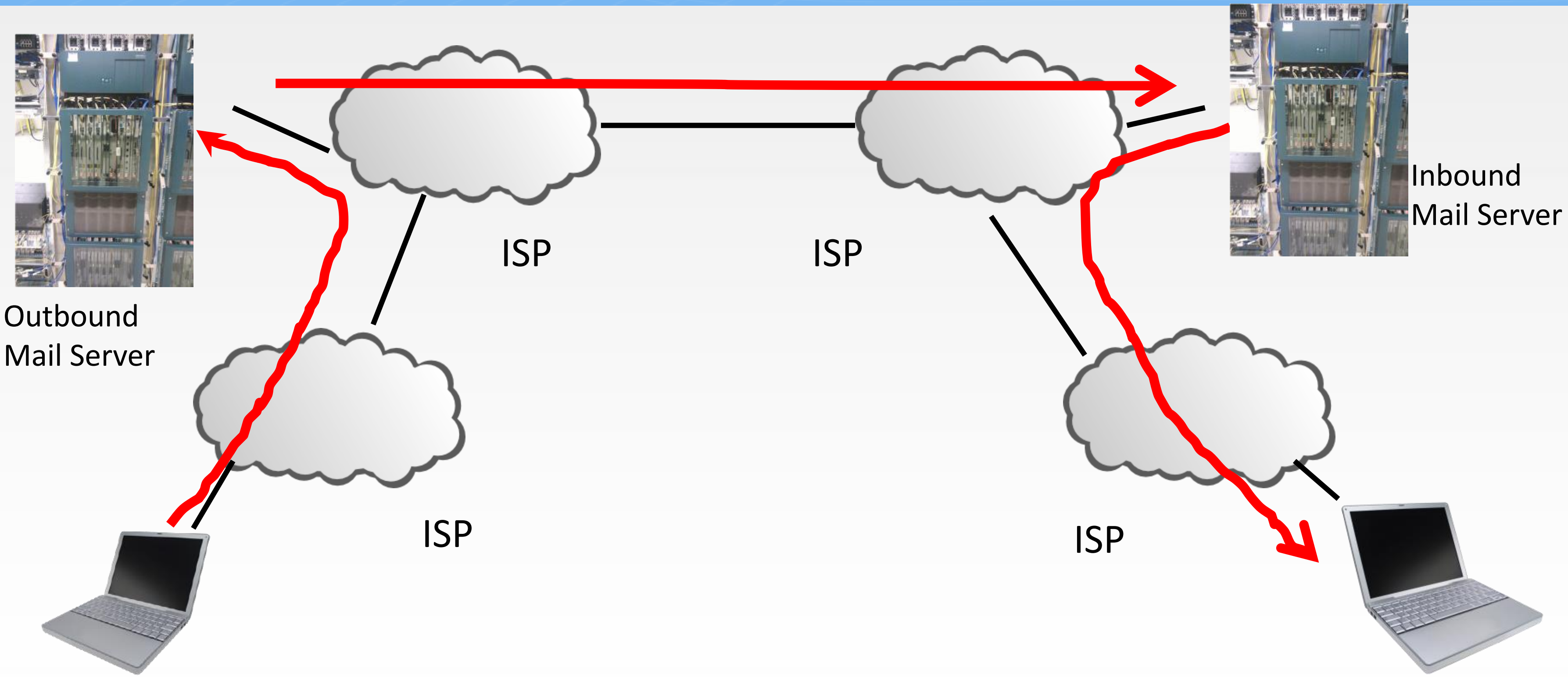
Legal Issues

- Sometimes, there are legal issues involving computer technology
  - Today, almost everything involves computer technology…
- Most legislators and judges know nothing of computers
- How can they reach the right answer?
- We may know the answers—but we have to learn to speak *their* language: the law

Example: Wiretap Law and the Internet

- Under US law, phone and email conversations are strongly protected—police need a search warrant based on “probable cause” to obtain them
- However, information that is voluntarily given to a “third party” is only weakly protected; it can be obtained if it is “likely to be relevant” to an ongoing criminal investigation
- Phone numbers are third-party data, obtained by a “pen register” or “trap-and-trace device”
- What about email addresses?

Sending Email



Email (Simplified)

- Mail goes from a sender’s device to an “outbound mail server”
- From there, it is sent to the recipient’s “inbound mail server”
- The recipient downloads it from that machine
- The mail servers are generally ISP- or enterprise-operated

Sending Myself Email

```
220 machshav.com ESMTP Exim 4.82 Tue, 11 Mar 2014 19:43:03 +0000
HELO eloi.cs.columbia.edu
250 machshav.com Hello eloi.cs.columbia.edu [2001:18d8:ffff:16:12dd:b1ff:feef:8868]
MAIL FROM:<smb@eloi.cs.columbia.edu>
250 OK
RCPT TO:<smb@machshav.com>
250 Accepted
DATA
354 Enter message, ending with "." on a line by itself
From: Barack Obama <president@whitehouse.gov>
To: <smb2132@columbia.edu>
Subject: Test

This is a test
.
250 OK id=1WNSaS-0001z5-1d
QUIT
221 machshav.com closing connection
```

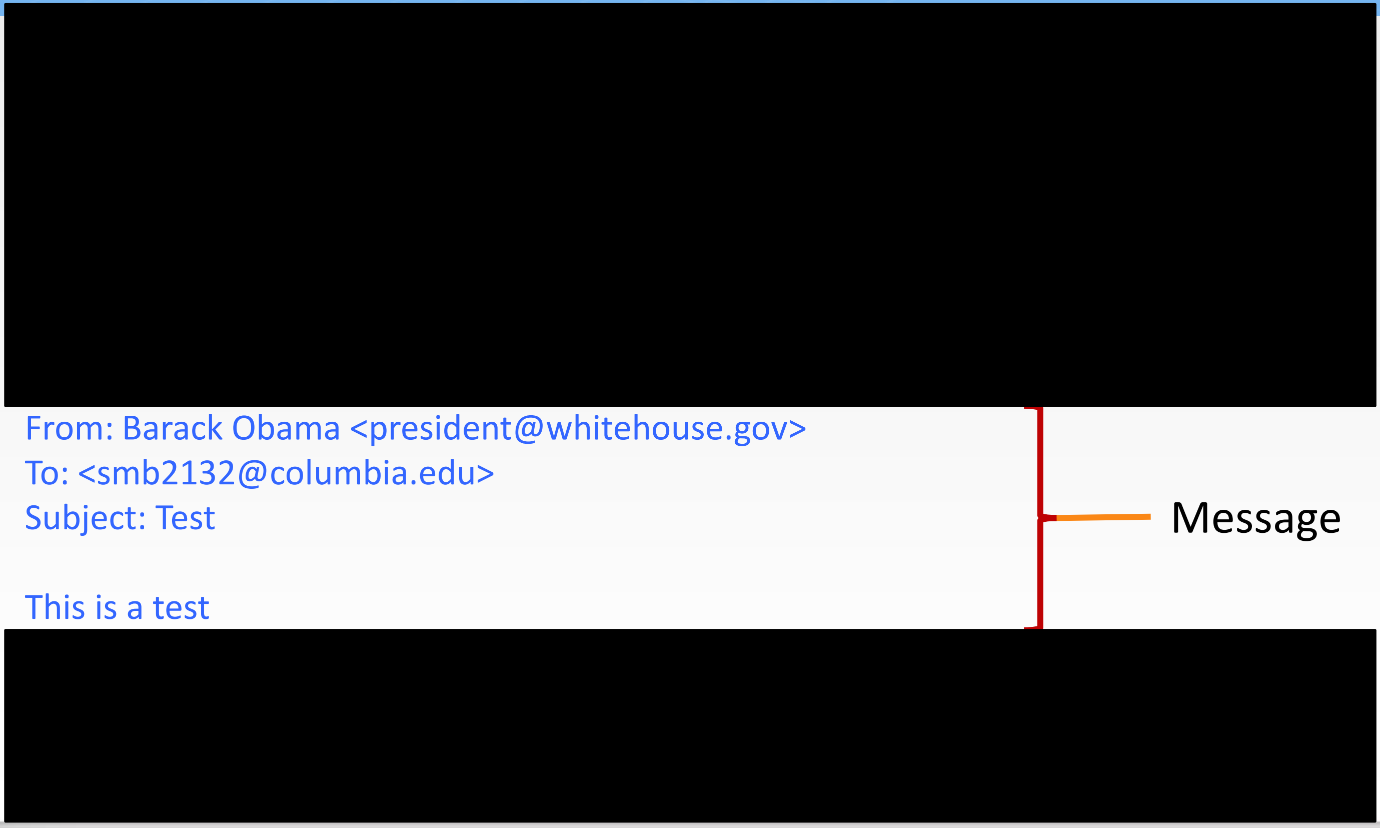
Message

Conversation With A Third Party

```
220 machshav.com ESMTP Exim 4.82 Tue, 11 Mar 2014 19:43:03 +0000
HELO eloi.cs.columbia.edu
250 machshav.com Hello eloi.cs.columbia.edu [2001:18d8:ffff:16:12dd:b1ff:feef:8868]
MAIL FROM:<smb@eloi.cs.columbia.edu>
250 OK
RCPT TO:<smb@machshav.com>
250 Accepted
DATA
354 Enter message, ending with "." on a line by itself
[redacted]
.
250 OK id=1WNSaS-0001z5-1d
QUIT
221 machshav.com closing connection
```

Message

What the Recipient Sees



[redacted]

From: Barack Obama <president@whitehouse.gov>
To: <smb2132@columbia.edu>
Subject: Test

This is a test

[redacted]

Message

Courts Have Gotten This Wrong

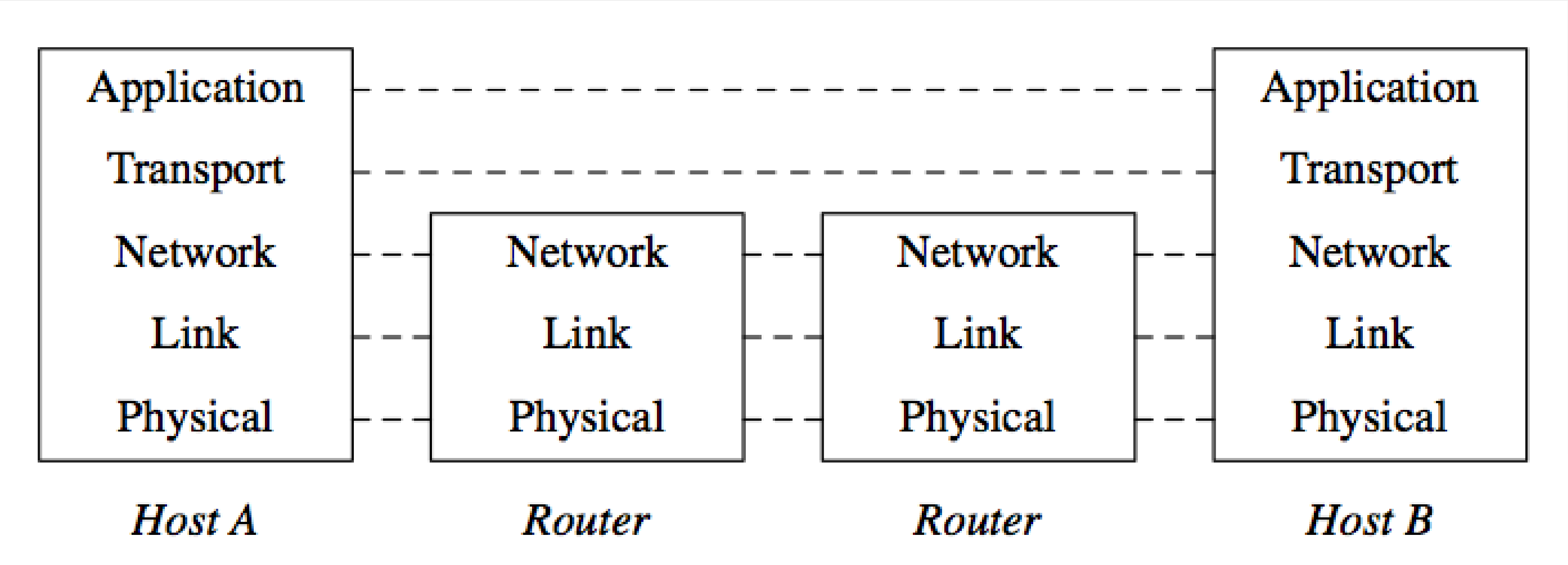
> ‘ That portion of the “header” which contains the information placed in the header which reveals the e-mail addresses of the persons to whom the e-mail is sent, from whom the e-mail is sent and the e-mail address(es) of any person(s) “cc’d” on the e-mail would certainly be obtainable using a pen register and/or a trap and trace device.’

(In re Application of United States, 396 F. Supp. 2d 45)

- But the “header” isn’t third-party data; it’s content, which cannot be obtained with a pen/trap order
- If you think that’s hard to explain to a judge, what about TCP port numbers?

Paper: http://jolt.law.harvard.edu/assets/articlePDFs/v30/30HarvJLTech1.pdf

The Internet:
A Layered Architecture



Is a Search Warrant Needed to Track Someone’s Location via their Cell Phone?

- Law enforcement: “No, you’re in public, and you’ve given your location to the phone company”
- But—the Fourth Amendment bars “unreasonable” searches
- Legal academics: if you track someone for too long, you can build up a very full picture of their life, which *is* unreasonable (called “mosaic theory”)
- Rejoinder: How long is “too long”? How will police know when they need a warrant?

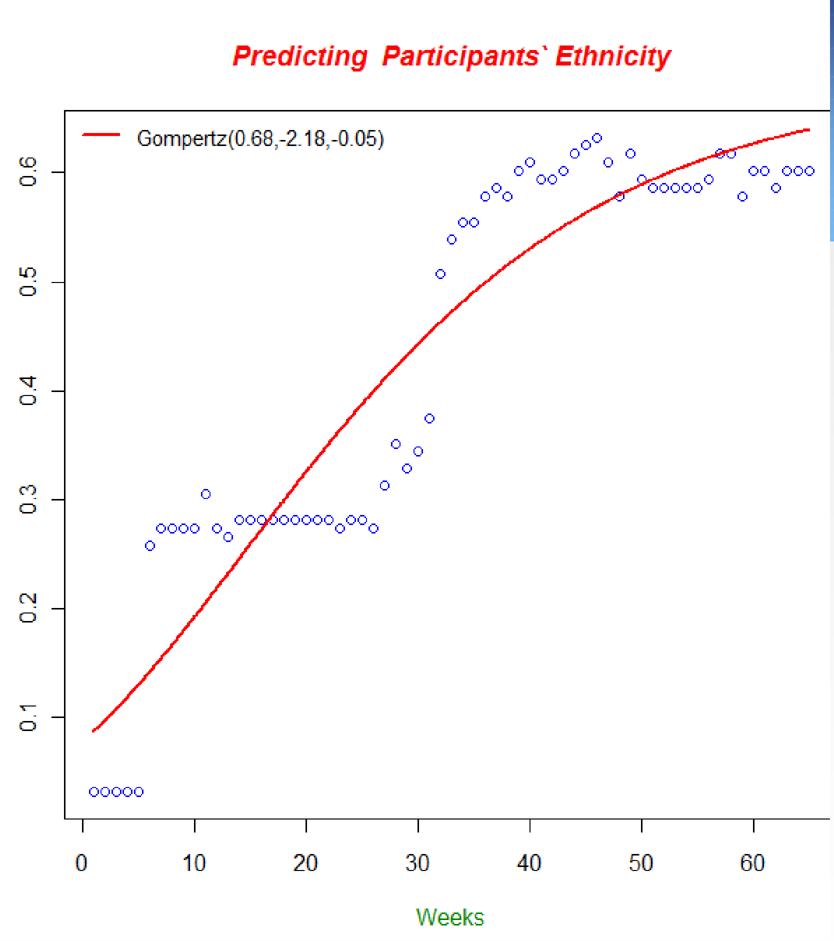
Can Big Data Provide an Answer?

- Use machine learning to make predictions based on location data
- When predictions are accurate enough, a mosaic exists
- In other words, use computer science to answer the question

Machine Learning and Mosaic Theory

- The technical literature supports the basic premise: with enough points, the whole *is* greater than the sum of its parts

- Note the jump in accuracy at 5 weeks and 28 weeks



(Graph from Altshuler et al.)

One Week is the limit

- Experiments show that week-to-week movements are very predictable (Sadilek & Krumm)
- Weekend movements are *more* predictable, though of course different than weekday movement
- With seven days of observation, you have a very good picture of someone’s life

Where Are We?

- From a technical perspective, mosaic theory is correct: you really can build a very full picture of someone with enough data points
- The limit should be about one week
- But—movements are still in public
- But—there are other legal issues that might arise in specific cases, such as the third party doctrine

Results

- The science alone isn’t enough
- Fundamentally, this is a legal question, not a technical one. We can supply facts but the courts determine the law. Getting the right answer requires both kinds of input, legal and technical.

Paper: http://lawandlibertyblog.com/s/Hutchins.pdf

What Do We Do?

- First and foremost: *decide* to be involved
  - Be aware of societal issues
  - Make ethical choices about career paths and on-the-job behavior
- Learn the language of law and policy
  - You don’t have to be a lawyer—I’m not—but you do need to understand how to talk to policymakers
- Get involved—spend time in Trenton or Washington
- If you don’t speak, they can’t listen, even if they want to