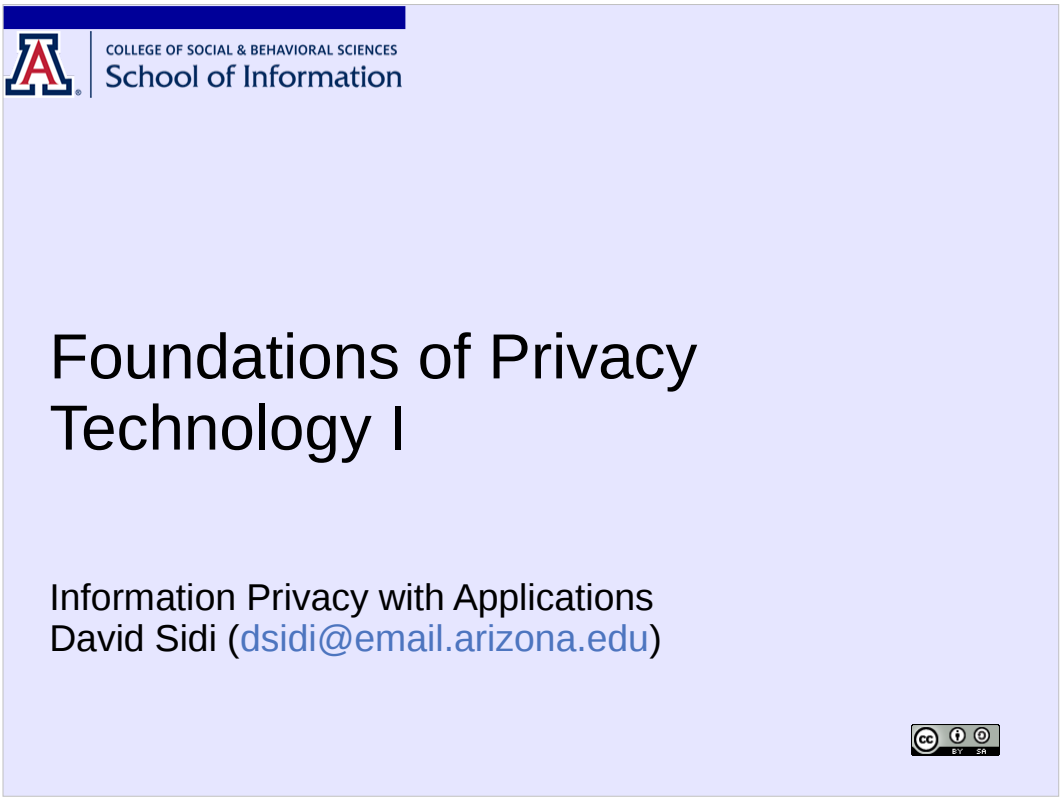


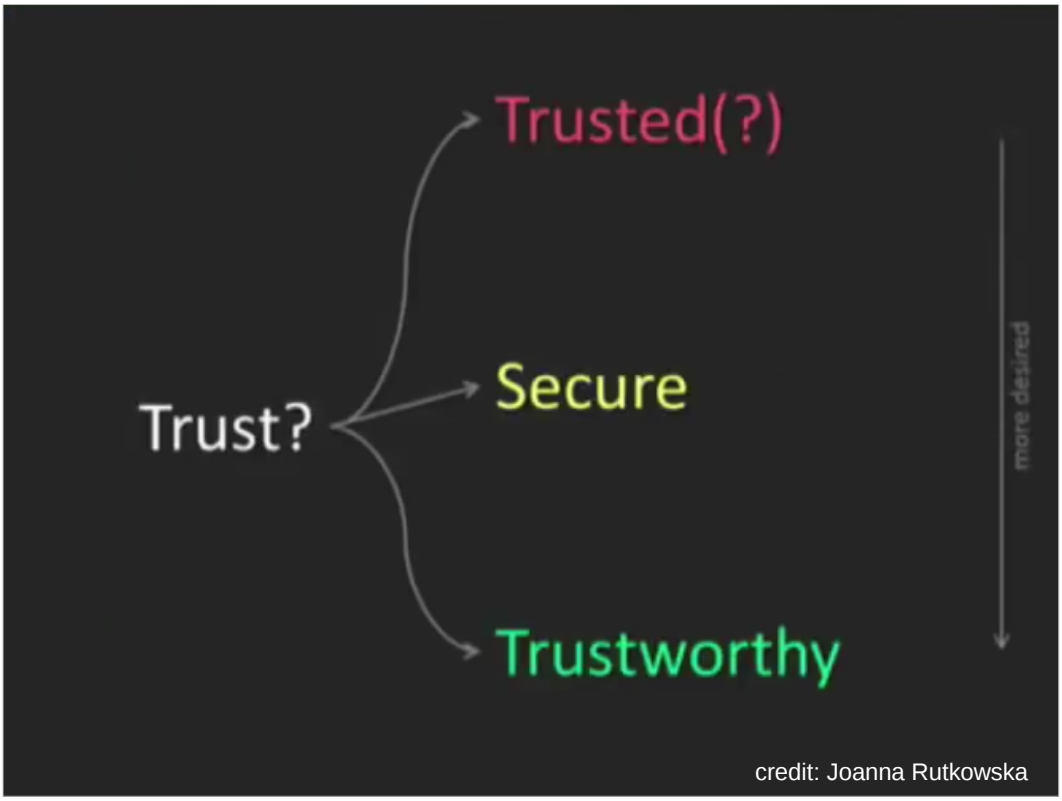
Le Métayer gives us an overview of PETs from a particular perspective, focused on one key aspect of these technologies, namely, the kind of trust they can provide. Weŕe going to talk about that perspective, and then go through the overview.

Small mention of interesting things

- Google exposed user data with Google Plus, the n deleted logs to avoid regulators
- Bloomberg reports a supply chain attack on App le
- Tim Berners-Lee has launched his startup for So lid
- Office hours will be changed this week only; there will be a d2L announcement with the new time

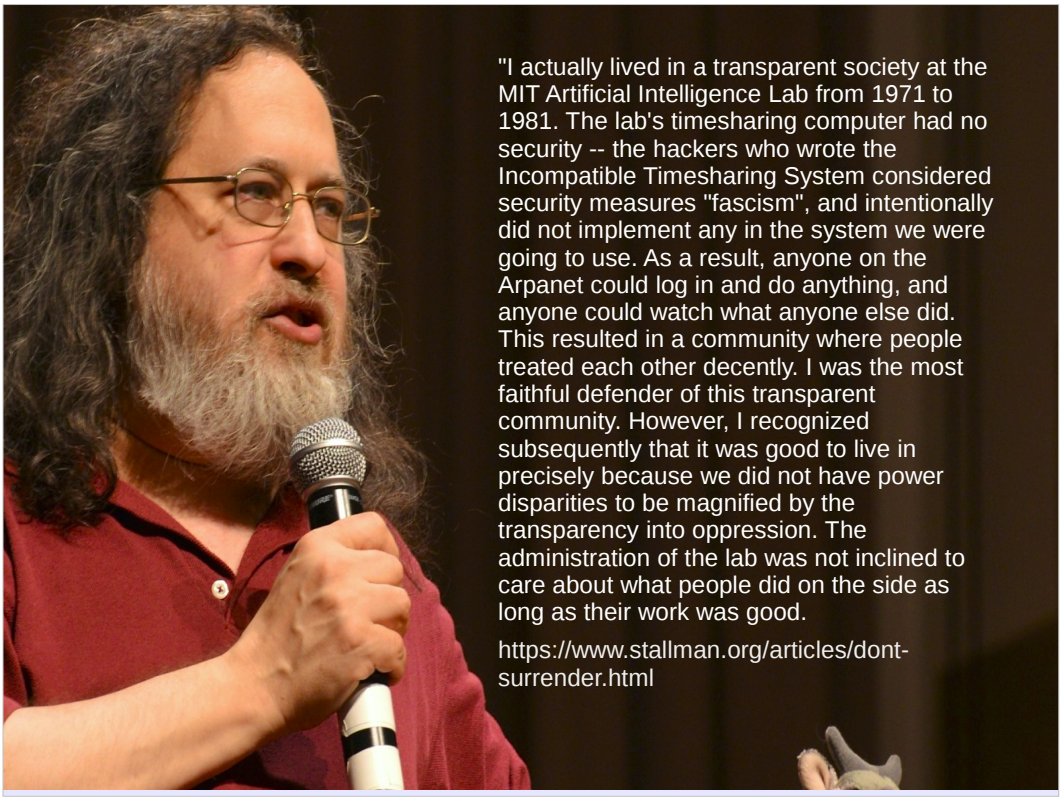
The U.S. Supreme Court has ruled that federal administrative agencies can invoke the All Writs Act to preserve the status quo when a party within the agency's jurisdiction is about to take action that will prevent or impair the agency from carrying out its functions.

Is an ideal privacy technology one that limits trust, as Le Métayer says? Consider the role of trustworthiness (5 minutes, post to question tool)



Connecting red and green. Which is better? trusting someone who is trustworthy, or not trusting someone trustworthy?

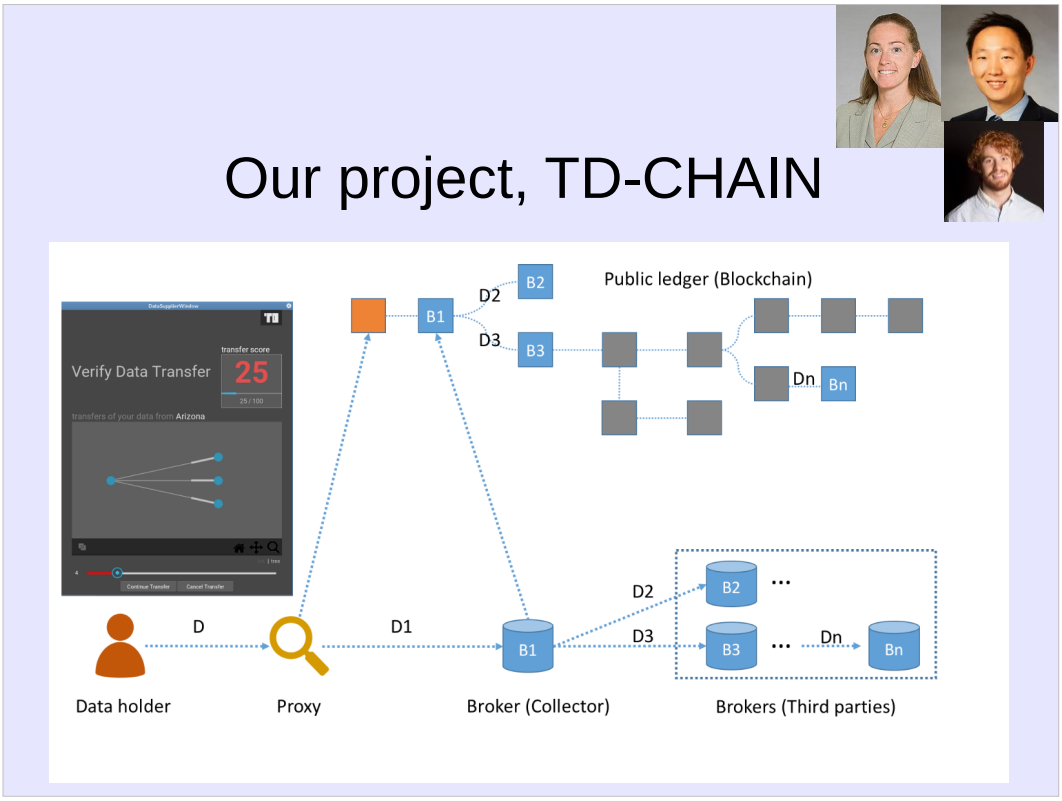
What are the benefits of trusting the trustworthy?



benefits of trust: less overhead / transaction costs (example: Richard Stallman's lab)

a bad example: SSL/TLS, VPNs, type-0 remailers. These don't support trusting based on evidence of trustworthiness; they just trust (and leave the rest to you).

question for the class: what are technologies that support reliably identifying the trustworthy, so that you can trust the right people? (reputation systems? review systems? honeypots?)



Here's one I worked on last year with people from CS and MIS

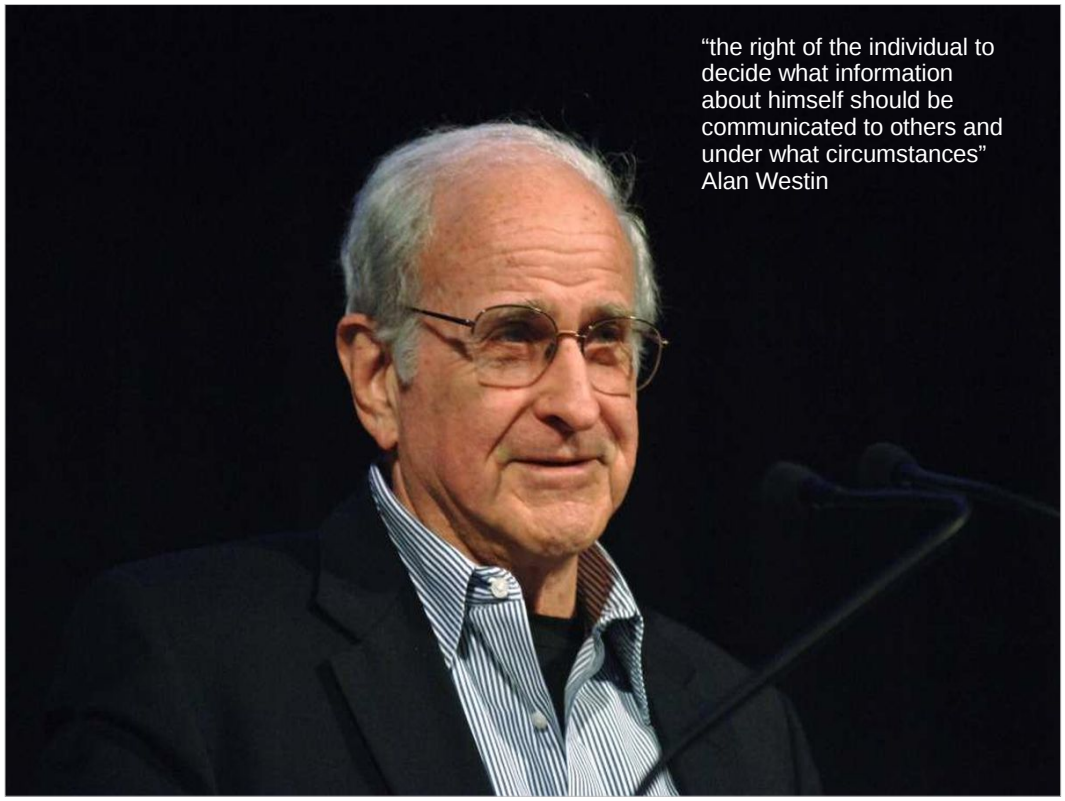
Two views organizing research on privacy

- Privacy as control
- Privacy as confidentiality
- ....(there are more, but we focus on the two above)

- What is the cost of disclosure?
- How can data be controlled by policy?
  - Policies set by data subject for controlling disclosure of their own information
  - Organizational data security policies and enforcement mechanisms for them
- Example of a policy set by a data subject?

Two views organizing research on privacy

- **Privacy as control**
- Privacy as confidentiality



- How can data be controlled **without** technology?
  - Policies set by data subject for controlling disclosure of their own information
  - Organizational data security policies
- Example of a policy set by a data subject?

A policy is just words

Rawat and Saxena (2008). “Practical Data Protection,” Journal of Craptology, 5.

Practical Data Protection

Sanjay Rawat *and Amitabh Saxena
<rawat, amitabh>@dit.unitn.it
Dept. of Information and Communication Technology
University of Trento
38050 Trento, Italy

April 23, 2008

Abstract

We present a very easy and practical method to send the information in a secure manner such that its disclosure to unintended recipient is not possible. Our method does not require the distribution of shared key at all. Our idea is inspired by the popularity of a very recent phenomenon of "Disclaimer Statement" in corporate emails.

2 Our Method

As mentioned above, our method is based on the a popular phenomenon of putting a "disclaimer" (a similar method was used for creating a very deadly virus [1]). This disclaimer is appended at the end of the mail. We propose that instead of putting the disclaimer at the end of the mail/message, it should be inserted at the very beginning of the mail. In this way, the receiver will first read the disclaimer and if he is not the intended recipient, he must not read that message and must delete that. These "MUST" properties are the characteristics of the disclaimer method and are well accepted in practice [5]. Following is an example of such a disclaimer:

> "*This message is being sent from University of Trento (Italy) and may contain information which is confidential. If you receive this message but you are not the intended recipient, stop reading a single line after this disclaimer onwards, advise the sender immediately by replying this e-mail and delete this message and any attachments without retaining a copy (don't forget to delete the mail from your "Sent Mails" folder). We appreciate your cooperation, otherwise you will be in big trouble.*"

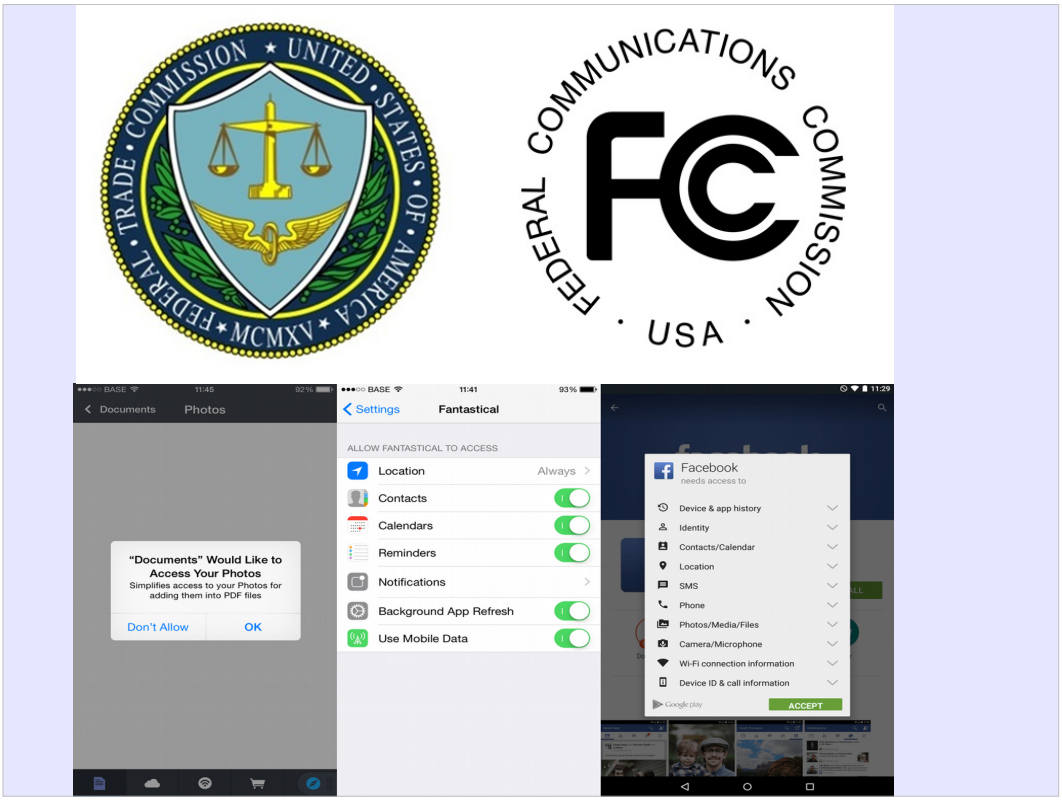
We can see that the above disclaimer provides very tight confidentiality. Our method is well protected by the law [7, 8] and is highly flexible in the sense that you can design very creative disclaimers based on your security requirements and level. Few disclaimers are available online [6][1]. Furthermore, the disclaimers can be inserted via the outgoing mail server so that individuals don't have to worry about that.

As a fine tuning parameter, we advise you not to mention the subject of the message in the "Subject" field as it may give an adversary some information leakage to do further cryptanalysis. Instead, write the Subject after the disclaimer, as a part of message body.

Finally, to counter the powerful cryptanalysis method of Knudsen and Mirza [3], we recommend that the very first line of the disclaimer must be "*Do not remove this disclaimer.*" This makes our method resistant to "deletion cryptanalysis."

> “This email message is for the sole use of the intended recipient(s) and may contain information that is sensitive, proprietary, and/or privileged. Any unauthorized review, use, disclosure or distribution is prohibited. If you are not the intended recipient, please contact the sender by reply email and destroy all copies of the original message.”

Here’s an example of a disclaimer from RAND. I pointed out to them the “groundbreaking research” on these (in the course of a back-and-forth about something else) and attached the “Craptology” paper, but they never replied. I don’t think they got the joke.



So, there is a role for technology in enforcement of policies aimed at controlling information that has gotten into a third-party's hands. This is sometimes forgotten by people thinking about policies as part of organizations of people like the FTC and FCC. Diaz and Gurses, who we will read next time, do this, for example.

But there are plenty of examples of PETs used for "privacy as control": take permissions on android phones, for example

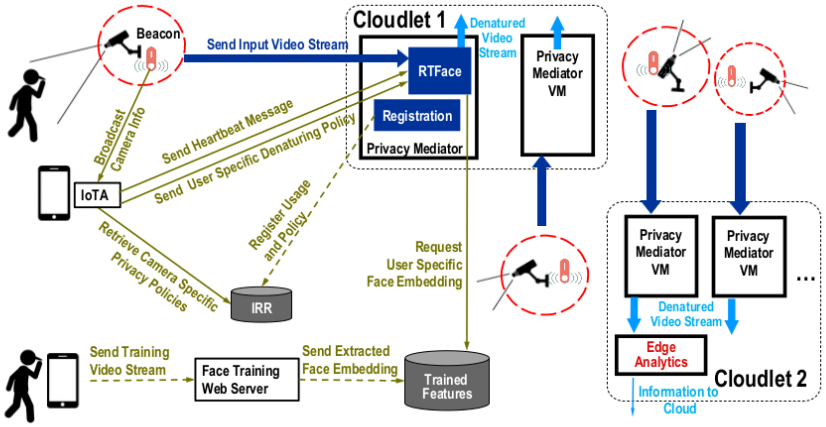


Figure 16: Scalable Privacy Mediation Architecture

Here’s another example (walk through)

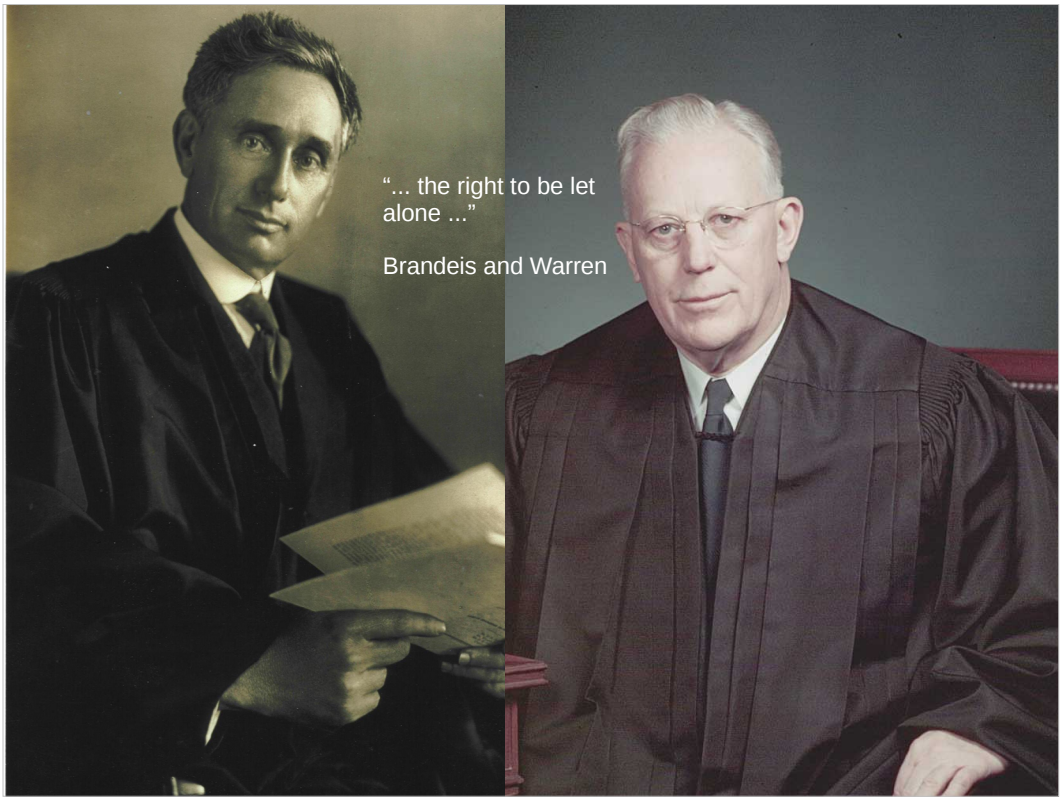
Two views organizing research on privacy

- **Privacy as control**
- Privacy as confidentiality

Now let’s think about the other paradigm we mentioned: privacy as confidentiality

Two views organizing research on privacy

- Privacy as control
- **Privacy as confidentiality**



The idea is captured in the famous understanding of privacy as a right "to be left alone."

According to this vision, everyone might be untrustworthy, so trust should be minimized.

> "A different family of privacy technologies considers however that placing such high levels of trust in organizations should be avoided whenever possible, as they leave individuals vulnerable to incompetent or malicious organizations." (Diaz et al. 2, our next reading)

UCL

Two families of privacy technologies

Soft Privacy Technologies

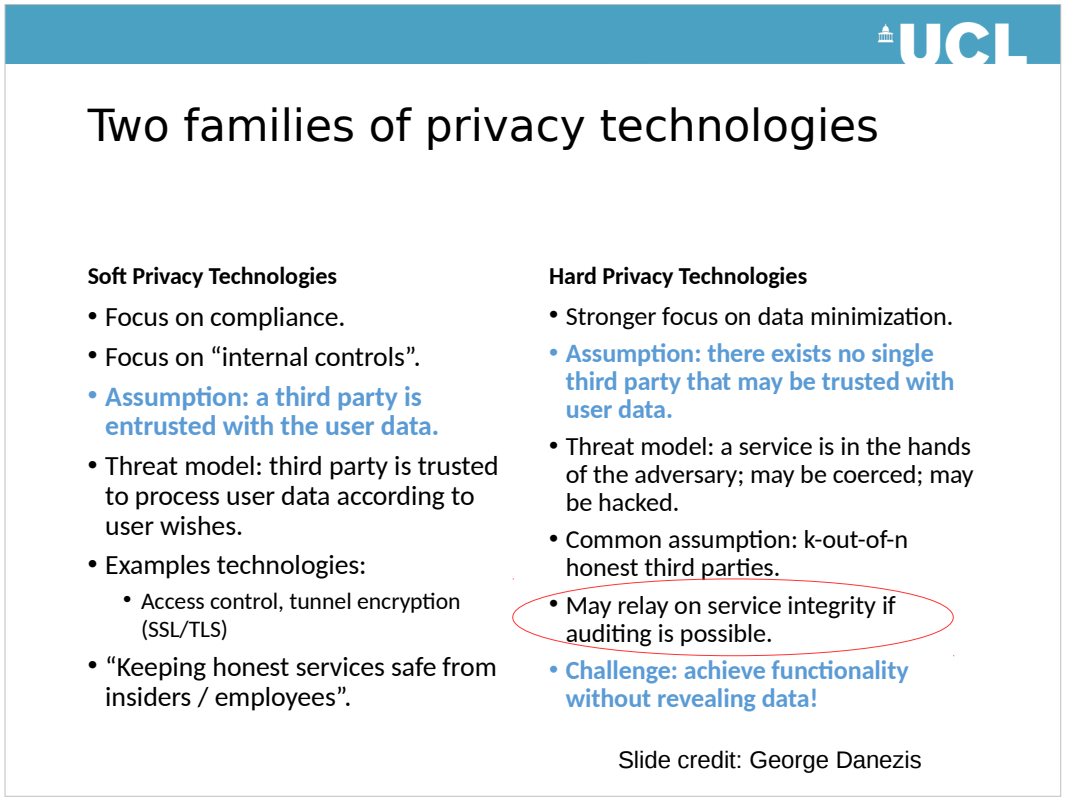
- Focus on compliance.
- Focus on "internal controls".
- **Assumption: a third party is entrusted with the user data.**
- Threat model: third party is trusted to process user data according to user wishes.
- Examples technologies:
  - Access control, tunnel encryption (SSL/TLS)
- "Keeping honest services safe from insiders / employees".

Hard Privacy Technologies

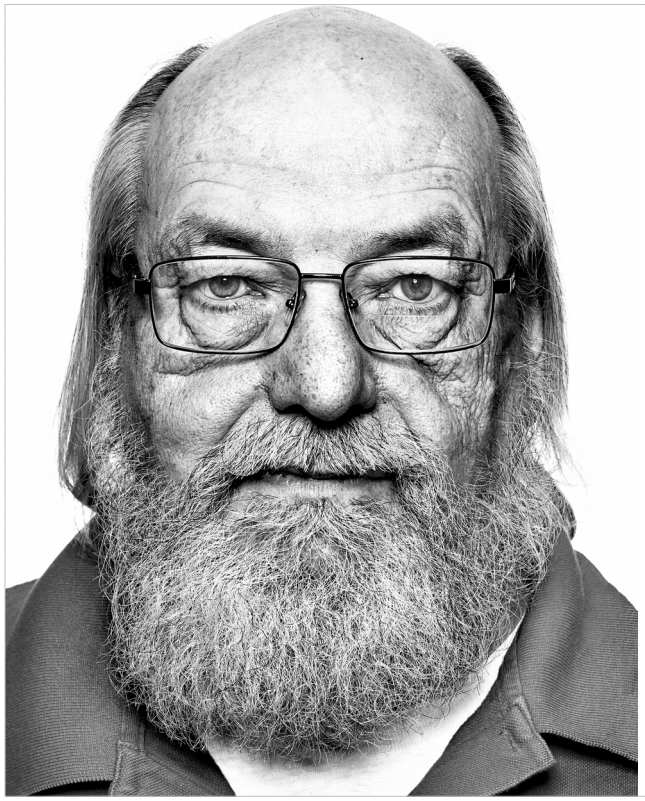
- Stronger focus on data minimization.
- **Assumption: there exists no single third party that may be trusted with user data.**
- Threat model: a service is in the hands of the adversary; may be coerced; may be hacked.
- Common assumption: k-out-of-n honest third parties.
- May relay on service integrity if auditing is possible.
- **Challenge: achieve functionality without revealing data!**

Slide credit: George Danezis

walk through (notice bad examples of soft privacy technology)



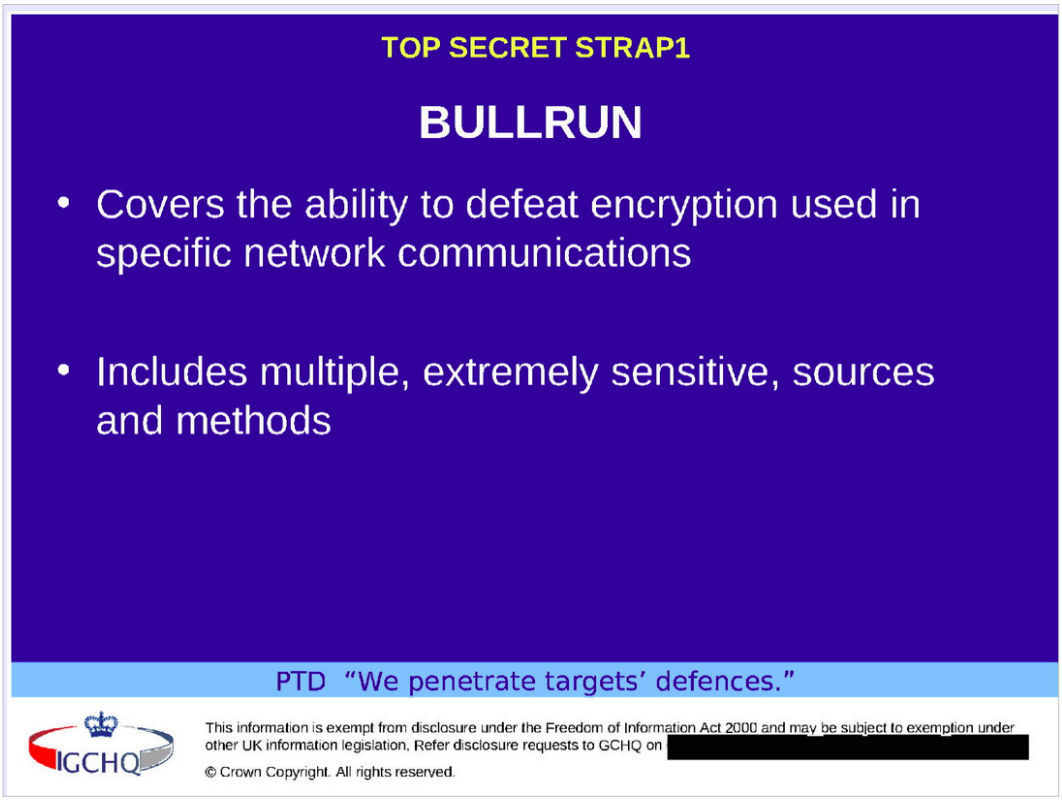
- Trust as field-verifiability (recall Ross Anderson on a UK military view of trust)
- Also, note that technology depends on lots of things. And the lesson of "Reflections on Trusting Trust" was that audit is not a panacea
- There is a role for both of these technologies, it's not just that Soft technologies paper over bad design in a way that hard privacy technologies don't



The moral is obvious. You can't trust code that you did not totally create yourself. (Especially code from companies that employ people like me). No amount of source-level verification or scrutiny will protect you from using untrusted code.

Ken Thompson, ACM Turing Award Speech, “Reflections on Trusting Trust”

This is a tricky problem. It eludes in principle the approach to auditing the security or privacy properties of software by examining it’s source code.



- A nice example of these dependencies and the difficulty of audit is the BULLRUN program
- This is especially important since cryptography is so central to hard privacy technologies, which emphasize confidentiality
- Question for class: What are the **really** hard, "adamantine" technologies that address the case where even the creator of the technology cannot be trusted?

- Laptop Lens Covers
- Direct Introspection Device
- Decoy based encryption
- ...
- Key shared property: "directly field verifiable"
- none of these is forever, of course...

Edward Snowden and bunnie Huang

Figure 1: Top Secret slides extracted from the Snowden Archive illustrating one intelligence agency's perspective on metadata and location services offered by a major US brand [9]

Let's check out the introspection engine: video at 38:39 - 41:53

Technologies of confidentiality

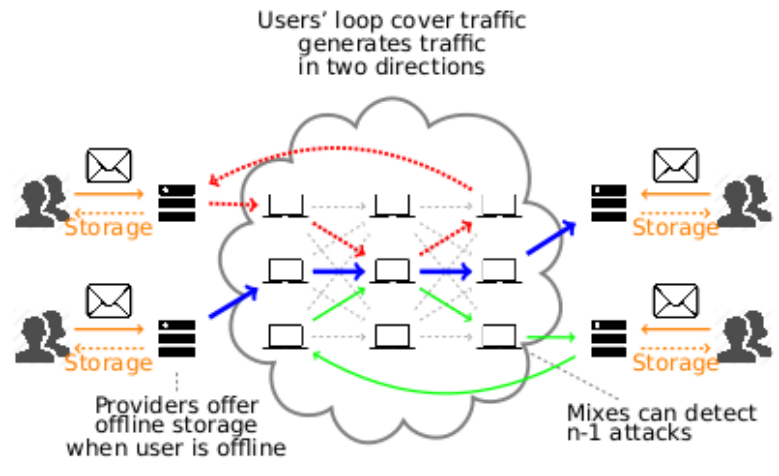
- Anonymous authentication protocols
- Anonymous communication networks
- Private Information Retrieval
- ... all require judicious use of modern cryptography

Anonymous authentication protocols

- Selective disclosure credentials

  “The new certificates function in much the same way as cash, stamps, cinema tickets, subway tokens, and so on: anyone can establish the validity of these certificates and the data they overtly specify, but no more than just that. A “demographic” certificate, for instance, can specify its holder’s age, income, marital status, and residence, all digitally tied together in an unforgeable manner.” (Brand,xix)

In anonymous authentication protocols [4,6], the user first obtains a credential from an issuer (e.g., the government) certifying a set of attributes. Later, the user is able to selectively prove properties on these attributes to a verifying party (e.g., a vendor). The main property of these protocols is that a statement on the attributes can be proven without revealing any additional information besides the statement itself.



Anonymous communication networks, including mixnets, and low-latency networks like tor.

This is a new mixnet called Loopix, which a student is studying with me at the moment

Private Information Retrieval (PIR)

- Access database records, but don’t reveal to the database server which ones
- Simplest case?

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  - (Hint: it requires transmitting a lot of data)

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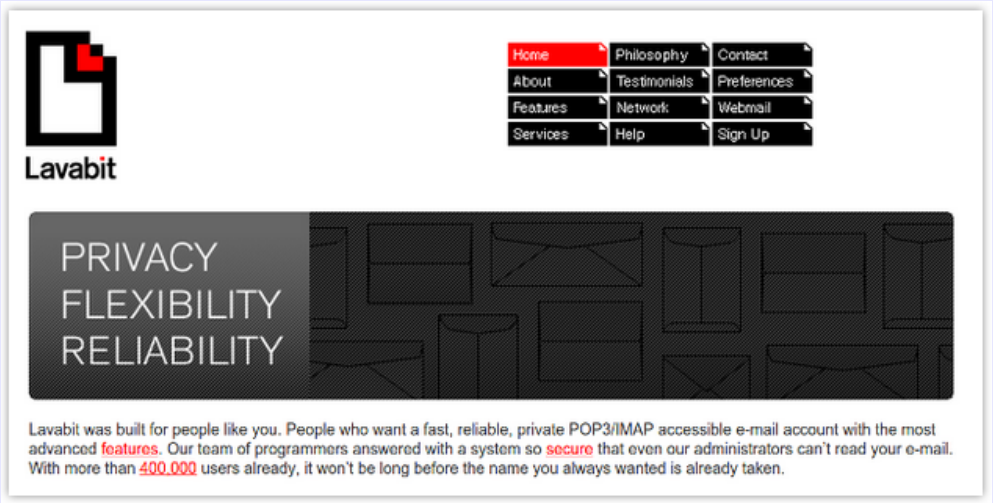
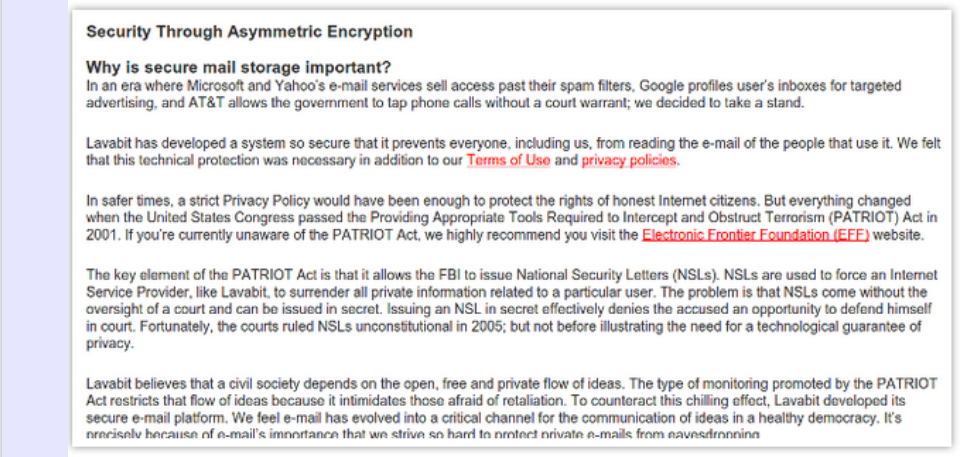
- Access database records, but don’t reveal to the database server which ones
- Simplest case?
  - (Hint: it requires transmitting a lot of data)
  - (Hint: it requires transmitting the max possible amount of data for that database)

Recap

- Privacy as control: a matter of policy, which **controls data use**. Does not necessarily try to minimize trust in a third party; may try to provide evidence of trustworthiness of trusted systems
- Privacy as confidentiality: **minimizes disclosure**. Tries to minimize trust in third parties

Example: Privacy as control or privacy as confidentiality?


Lavabit
Home
Philosophy
Contact
About
Testimonials
Preferences
Features
Network
Webmail
Services
Help
Sign Up
PRIVACY
FLEXIBILITY
RELIABILITY
Lavabit was built for people like you. People who want a fast, reliable, private POP3/IMAP accessible e-mail account with the most advanced features. Our team of programmers answered with a system so secure that even our administrators can't read your e-mail. With more than 400,000 users already, it won't be long before the name you always wanted is already taken.



Security Through Asymmetric Encryption

Why is secure mail storage important?
In an era where Microsoft and Yahoo's e-mail services sell access past their spam filters, Google profiles user's inboxes for targeted advertising, and AT&T allows the government to tap phone calls without a court warrant; we decided to take a stand.

Lavabit has developed a system so secure that it prevents everyone, including us, from reading the e-mail of the people that use it. We felt that this technical protection was necessary in addition to our Terms of Use and privacy policies.

In safer times, a strict Privacy Policy would have been enough to protect the rights of honest Internet citizens. But everything changed when the United States Congress passed the Providing Appropriate Tools Required to Intercept and Obstruct Terrorism (PATRIOT) Act in 2001. If you're currently unaware of the PATRIOT Act, we highly recommend you visit the Electronic Frontier Foundation (EFF) website.

The key element of the PATRIOT Act is that it allows the FBI to issue National Security Letters (NSLs). NSLs are used to force an Internet Service Provider, like Lavabit, to surrender all private information related to a particular user. The problem is that NSLs come without the oversight of a court and can be issued in secret. Issuing an NSL in secret effectively denies the accused an opportunity to defend himself in court. Fortunately, the courts ruled NSLs unconstitutional in 2005; but not before illustrating the need for a technological guarantee of privacy.

Lavabit believes that a civil society depends on the open, free and private flow of ideas. The type of monitoring promoted by the PATRIOT Act restricts that flow of ideas because it intimidates those afraid of retaliation. To counteract this chilling effect, Lavabit developed its secure e-mail platform. We feel e-mail has evolved into a critical channel for the communication of ideas in a healthy democracy. It's precisely because of e-mail's importance that we strive so hard to protect private e-mails from eavesdropping.

- Unlike the design of most secure servers, which are ciphertext in and ciphertext out, this is the inverse: plaintext in and plaintext out. The server stores your password for authentication, uses that same password for an encryption key, and promises not to look at either the incoming plaintext, the password itself, or the outgoing plaintext.
-
- The ciphertext, key, and password are all stored on the server using a mechanism that is solely within the server's control and which the client has no ability to verify. There is no way to ever prove or disprove whether any encryption was ever happening at all, and whether it was or not makes little difference."

“[...] the system consisted of four basic steps:

- At account creation time, the user selected a login passphrase and transmitted it to the server.
- The server generated a keypair for that user, encrypted the private key with the login passphrase the user had selected, and stored it on the server.
- For every incoming email the user received, the server would encrypt it with the user’s public key, and store it on the server.
- When the user wanted to retrieve an email, they would transmit their password to the server, which would avert its eyes from the plaintext encryption password it had just received, use it to decrypt the private key (averting its eyes), use the private key to decrypt the email (again averting its eyes), and transmit the plaintext email to the user (averting its eyes one last time). ...”

- Unlike the design of most secure servers, which are ciphertext in and ciphertext out, this is the inverse: plaintext in and plaintext out. The server stores your password for authentication, uses that same password for an encryption key, and promises not to look at either the incoming plaintext, the password itself, or the outgoing plaintext.
-
- The ciphertext, key, and password are all stored on the server using a mechanism that is solely within the server’s control and which the client has no ability to verify. There is no way to ever prove or disprove whether any encryption was ever happening at all, and whether it was or not makes little difference.”


“Even though they advertised that they ‘can’t’ read your email, what they meant was that they would choose not to.”
Moxie Marlinspike
https://moxie.org/blog/lavabit-critique/

End-to-End Encryption

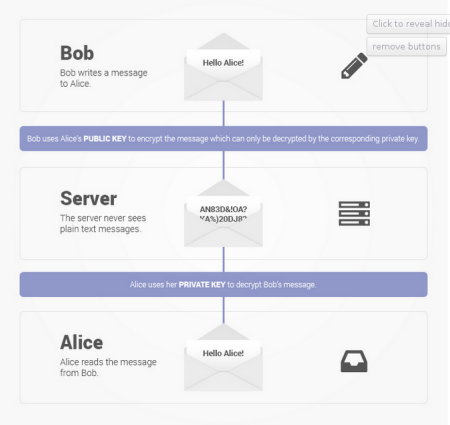
Messages are encrypted at all times

Messages are stored on ProtonMail servers in encrypted format. They are also transmitted in encrypted format between our servers and user devices. Messages between ProtonMail users are also transmitted in encrypted form within our secure server network. Because data is encrypted at all steps, the risk of message interception is largely eliminated.

Zero Access to User Data

Your encrypted data is not accessible to us

ProtonMail's zero access architecture means that your data is encrypted in a way that makes it inaccessible to us. Data is encrypted on the client side using an encryption key that we do not have access to. This means we don't have the technical ability to decrypt your messages, and as a result, we are unable to hand your data over to third parties. With ProtonMail, privacy isn't just a promise, it is mathematically ensured. For this reason, we are also unable to do data recovery. If you forget your password, we cannot recover your data.



End-to-end encryption means that no one but the intended recipient can read the message


D.C.'09

the openssl command

- One nice way to view certificate information (which we will be talking about soon)
- man openssl
- man x509
- verifying the fingerprint for a self-signed TLS certificate

openssl x509 -fingerprint -in ./cert.pem -noout

you can get much more information about certificates with openssl x509 ... . Worth investigating a bit.