Anonymity and Anticensorship

EECS 388: Introduction to Computer Security
March 18, 2015

1

Why Privacy?

- Privacy is not equivalent to secrecy
- Necessary to ensure civil liberties:
  - Free speech, free association, autonomy, freedom from censorship and constant surveillance
- "Nothing to Hide Argument"
  - Dangers of constructing a Kafkaesque world
  - Optional reading: *'I've Got Nothing to Hide' and Other Misunderstandings of Privacy*, Daniel J. Solove

2

Nymity Spectrum

- Verinymity
  - credit card #s, driver's license, address
- Pseudonymity
  - pen names, many blogs
- Linkable anonymity
  - loyalty cards, prepaid mobile phone
- Unlinkable anonymity
  - paying in cash, Tor

3

Understanding Anonymity

- "without a name"
- Who wants it
- How to get it
- Threats to it

4

Anonymity

- Anonymity: Concealing your identity
- In the context of the Internet, we may want anonymous communications
  - **Communications where the identity of the source and/or destination are concealed**
- Not to be confused with confidentiality
  - Confidentiality is about contents, anonymity is about identities

5

Anonymity

- Internet anonymity is *hard**
  - Difficult if not impossible to achieve on your own
  - Right there in every packet is the source and destination IP address
  - * But it's easy for bad guys. Why?
- You generally need help
- State of the art technique: **Ask someone else to send it for you**
  - Ok, it's a bit more sophisticated than that…

6

Proxies

- Proxy: Intermediary that relays our traffic
- Trusted 3rd party, e.g. … hidemyass.com
  - You set up an encrypted VPN to their site
  - All of your traffic goes through them
- Why easy for bad guys? Compromised machines as proxies.

7

Alice wants to send a message M to Bob …

- Bob doesn't know M is from Alice, and
- Eve can't determine that Alice is indeed communicating with Bob.

- HMA accepts messages encrypted for it. Extracts destination and forwards.

8

Anonymity motivation

Surveillance under:

- The Patriot Act
  - Section 215
  - National Security Letters (NSLs)
- FISA Amendment Act

9

Image credit: ACLU

Surveillance under the PATRIOT Act

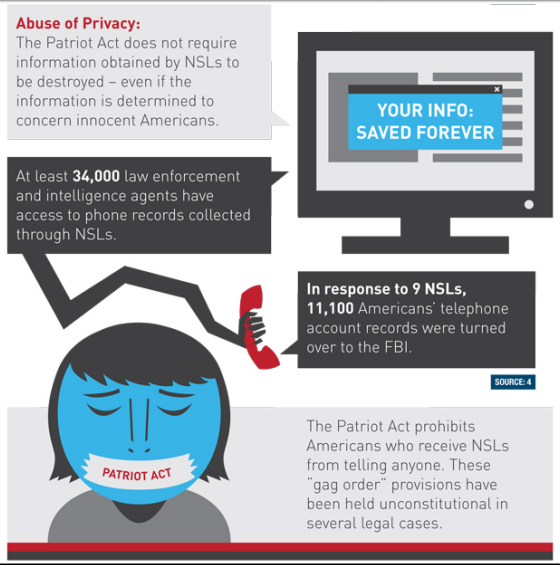


Image credit: ACLU

Surveillance under the PATRIOT Act

Image credit: ACLU

Surveillance under the PATRIOT Act

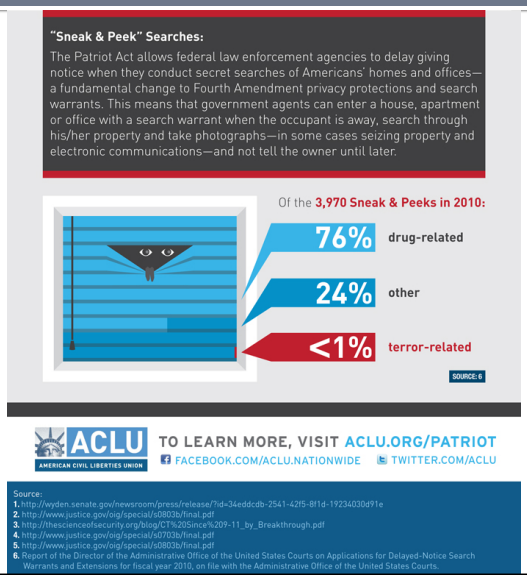


Image credit: ACLU

Google Transparency Report

National Security Letters (NSLs)

Reporting Period	National Security Letters	Users/Accounts
January to June 2014	0–999	0–999
July to December 2013	0–999	1000–1999
January to June 2013	0–999	0–999
July to December 2012	0–999	0–999
January to June 2012	0–999	1000–1999
July to December 2011	0–999	0–999
January to June 2011	0–999	0–999
July to December 2010	0–999	1000–1999
January to June 2010	0–999	1000–1999
July to December 2009	0–999	0–999
January to June 2009	0–999	0–999

Google Foreign Intelligence Surveillance Act (FISA) Requests

Non-content FISA requests

Reporting Period	Number of requests	Users/Accounts
January to June 2014	Data subject to six month reporting delay	
July to December 2013	0–999	0–999
January to June 2013	0–999	0–999
July to December 2012	0–999	0–999
January to June 2012	0–999	0–999
July to December 2011	0–999	0–999
January to June 2011	0–999	0–999
July to December 2010	0–999	0–999
January to June 2010	0–999	0–999
July to December 2009	0–999	0–999
January to June 2009	0–999	0–999

15

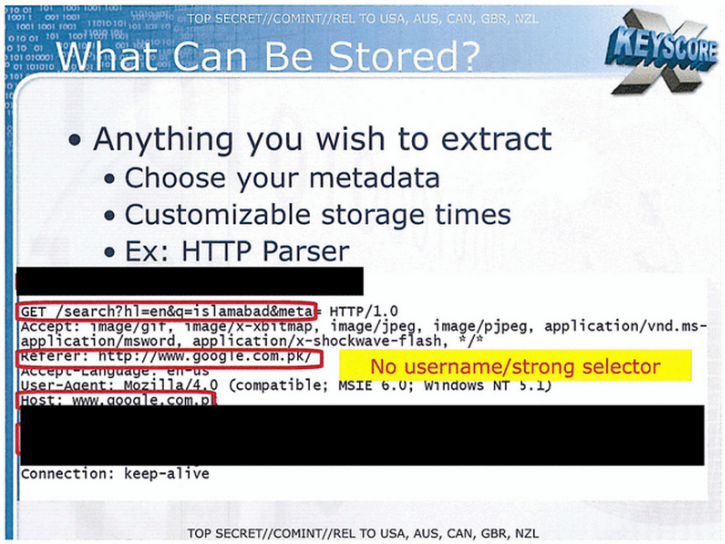
Google FISA Requests

Content requests

Reporting Period	Number of requests	Users/Accounts
January to June 2014	Data subject to six month reporting delay	
July to December 2013	0–999	15000–15999
January to June 2013	0–999	9000–9999
July to December 2012	0–999	12000–12999
January to June 2012	0–999	8000–8999
July to December 2011	0–999	9000–9999
January to June 2011	0–999	7000–7999
July to December 2010	0–999	5000–5999
January to June 2010	0–999	3000–3999
July to December 2009	0–999	3000–3999
January to June 2009	0–999	2000–2999

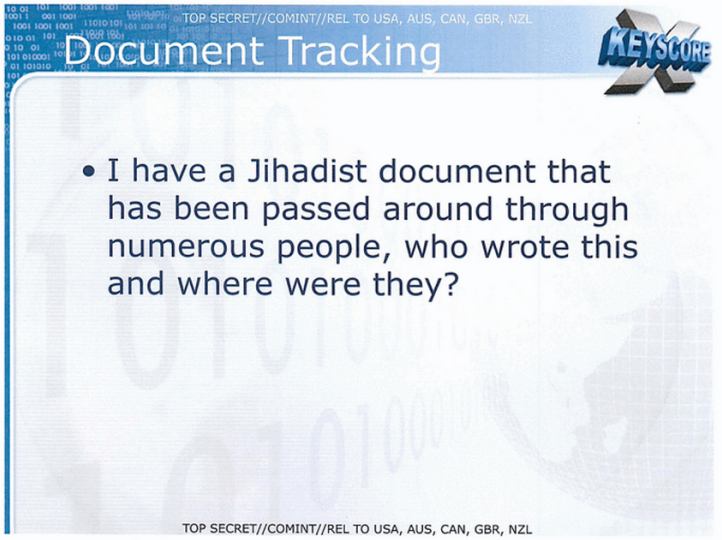
16

XKEYSCORE



17

XKEYSCORE



18

Technology as a defense

19

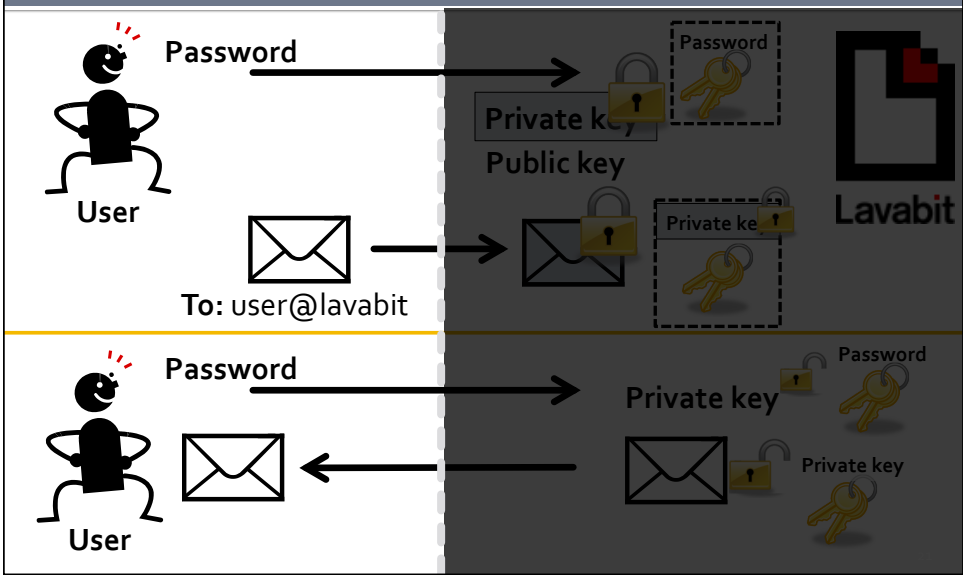
Poor example: Lavabit

Lavabit

My Fellow Users,

I have been forced to make a difficult decision: to become complicit in crimes against the American people or walk away from nearly ten years of hard work by shutting down Lavabit. After significant soul searching, I have decided to suspend operations. I wish that I could legally share with you the events that led to my decision. I cannot. I feel you deserve to know what's going on--the first amendment is supposed to guarantee me the freedom to speak out in situations like this. Unfortunately, Congress has passed laws that say otherwise. As things currently stand, I cannot share my experiences over the last six weeks, even though I have twice made the appropriate requests.

Lavabit



Encryption Tools: PGP

- GnuPG, free software
  - Pretty Good Privacy (PGP), Phil Zimmerman ('91)
  - Lets you hide email content via encryption
- Basic idea:
  - Hybrid encryption to conceal messages
  - Digital signatures on messages (hash-then-sign)

22

PGP cont'd

- Each user has:
  - A public encryption key, paired with a private decryption key
  - A private signature key, paired with a public verification key
- How does sending/receiving work?
- How do you find out someone's public key?

23

Sending and receiving

To send a message:

- Sign with your signature key
- Encrypt message and signature with recipient's public encryption key

To receive a message:

- Decrypt with your private key to get message and signature
- Use sender's public verification key to check sig

24

Fingerprints

- How do you obtain Bob's public key?
  - Get it from Bob's website? (☹)
  - Get it from Bob's website, verify using out-of-band communication
    - Keys are unwieldy -→ fingerprints
    - A fingerprint is a cryptographic hash of a key
  - What if you don't personally know Bob?
    - Web of Trust (WoT)

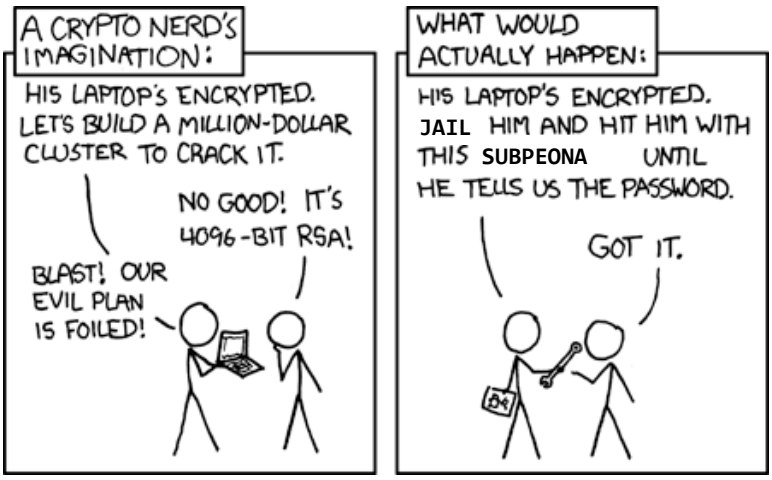
25

Drawbacks of (Just) Encryption I

- What if Bob's machine compromised?
  - His key material becomes known
  - Past messages can be decrypted and read
  - You also have sender's signature on messages sent, so you can prove identity of sender
- So…
  - PGP sends key material to decrypt content over public channel
  - Sender must trust recipient's ability and desire to keep her statements private

26

Drawbacks of (Just) Encryption II



27

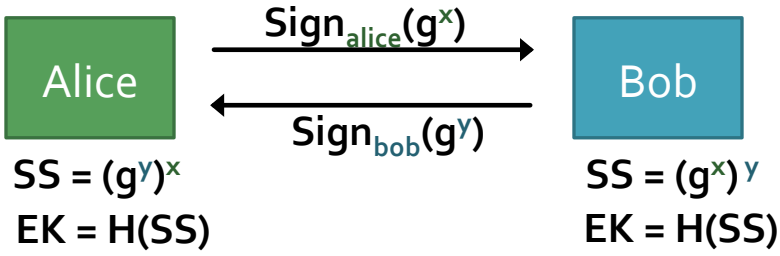
Desirable communication properties

- Forward secrecy:
  - Even if your key material is compromised, past messages should be safe
- Deniability: be able to deny having sent a message
- Mimic casual, off-the-record conversations
  - Deniable authentication: be confident of who you are talking to, but unable to prove to a third party what was said

28

Off-the-Record (OTR) Messaging

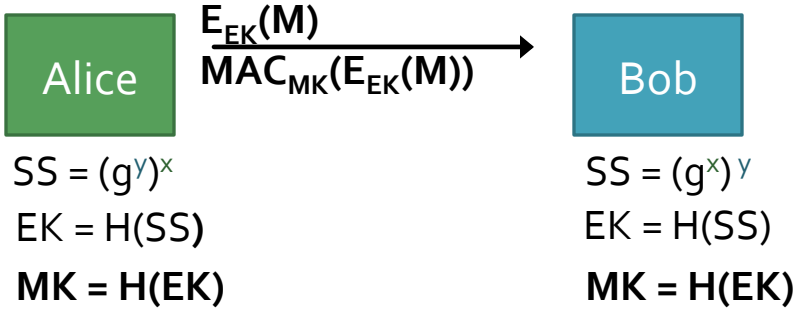
1. Use Authenticated Diffie-Hellman to establish a (short-lived) session key EK



29

OTR II

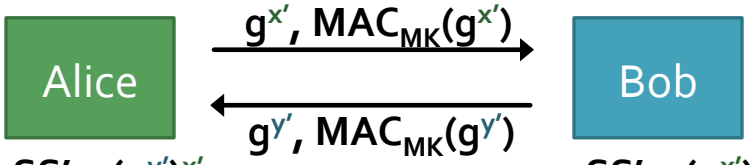
2. Then use secret-key encryption on message M
… And authenticate using a MAC



30

Off-the-Record

3. Re-key using Diffie-Hellman



$SS' = (g^{y'})^{x'}$
$EK' = H(SS')$
$MK' = H(EK')$
$MK = H(EK)$

$SS' = (g^{x'})^{y'}$
$EK' = H(SS')$
$MK' = H(EK')$
$MK = H(EK)$

31

Off-the-Record

4. Publish old MK

$SS' = (g^{y'})^{x'}$
$EK' = H(SS')$
$MK' = H(EK')$
~~$MK = H(EK)$~~

$SS' = (g^{x'})^{y'}$
$EK' = H(SS')$
$MK' = H(EK')$
~~$MK = H(EK)$~~

32

Off-the-record Messaging (OTR)

- Note this is suited to interactive communication, not so much email
- But, OTR provides
  - message confidentiality
  - authentication
  - perfect forward secrecy
  - deniability

33

Using OTR

- Built in to Adium and Pidgin
- But beware **defaults**
  - Logging enabled by default
  - Etiquette dictates you should disable this, so does history (e.g., Chelsea Manning)
- ☺ optional exercise: create an account on jabber.ccc.de, install OTR and verify a buddy. You may also want to run it over Tor.

34

Anonymity for browsing?

You

Server

35

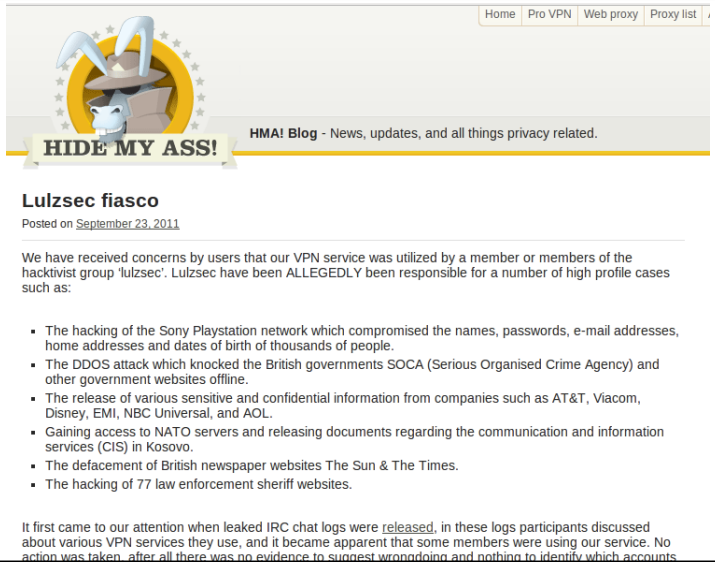
Naive approach …. VPNs

You

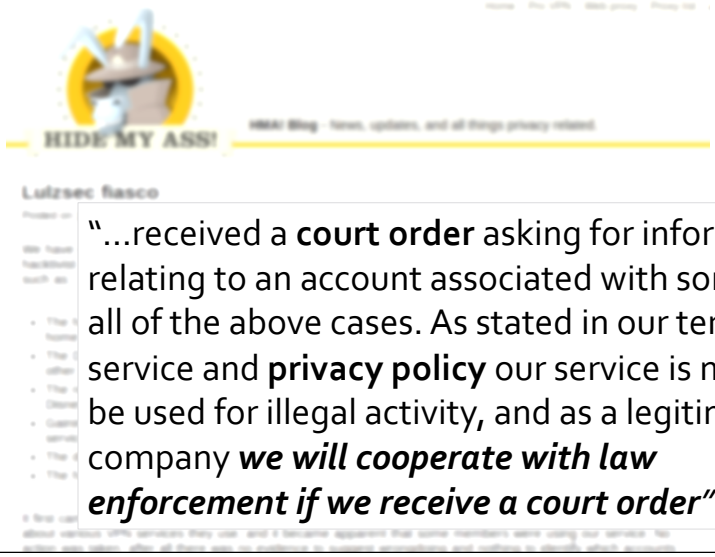
Server

36

VPNs


Home
Pro VPN
Web proxy
Proxy list
HIDE MY ASS!
HMA! Blog - News, updates, and all things privacy related.
Lulzsec fiasco
Posted on September 23, 2011
We have received concerns by users that our VPN service was utilized by a member or members of the hacktivist group 'lulzsec'. Lulzsec have been ALLEGEDLY been responsible for a number of high profile cases such as:
The hacking of the Sony Playstation network which compromised the names, passwords, e-mail addresses, home addresses and dates of birth of thousands of people.
The DDOS attack which knocked the British governments SOCA (Serious Organised Crime Agency) and other government websites offline.
The release of various sensitive and confidential information from companies such as AT&T, Viacom, Disney, EMI, NBC Universal, and AOL.
Gaining access to NATO servers and releasing documents regarding the communication and information services (CIS) in Kosovo.
The defacement of British newspaper websites The Sun & The Times.
The hacking of 77 law enforcement sheriff websites.
It first came to our attention when leaked IRC chat logs were released, in these logs participants discussed about various VPN services they use, and it became apparent that some members were using our service. No
37

VPNs


HIDE MY ASS!
Lulzsec fiasco
"...received a court order asking for information relating to an account associated with some or all of the above cases. As stated in our terms of service and privacy policy our service is not to be used for illegal activity, and as a legitimate company we will cooperate with law enforcement if we receive a court order"
38

Better approach: Tor

- Low-latency anonymous communication system
- Hide metadata
  - who is communicating with whom?
  - e.g., just sending an encrypted message to The Intercept may get you in trouble
- Hide existence of communication
  - any encrypted message may get you in trouble

39

Tor overview

- Works at the transport layer
- Allows you to make TCP connections without revealing your IP address
- Popular for web connections
- Tor network made up of volunteer-run nodes, or onion routers, located all over the world

Basic idea: Alice wants to connect to a web server without revealing her IP address

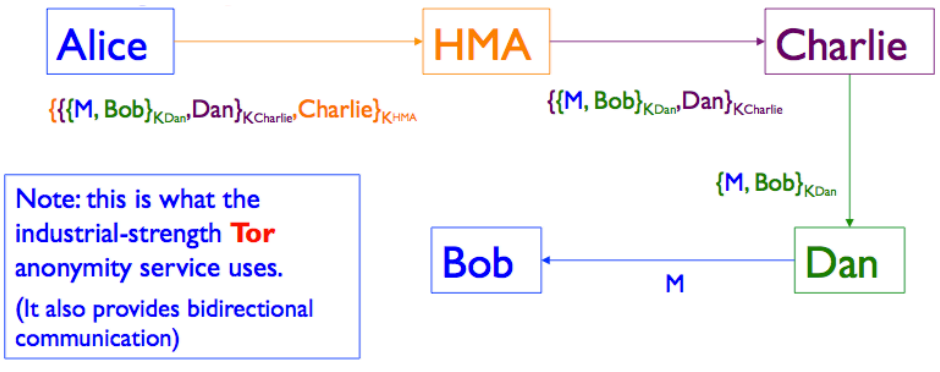
40

Onion Routing

- This approach generalizes to an arbitrary number of intermediaries ("mixes")
- Alice ultimately wants to talk to Bob, with the help of HMA, Dan, and Charlie
- **As long as any of the mixes is honest, no one can link Alice with Bob**

41

Onion Routing



Note: this is what the industrial-strength **Tor** anonymity service uses.

(It also provides bidirectional communication)

Key concept: No one relay knows both you and the destination!

Tor

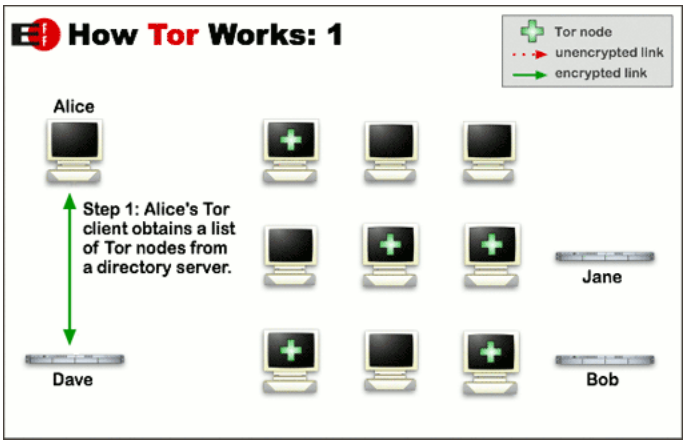


Image credit: Tor Project

Tor

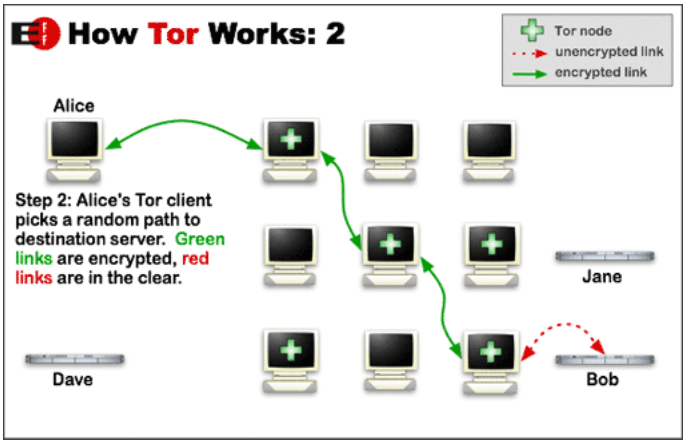


Image credit: Tor Project

Tor

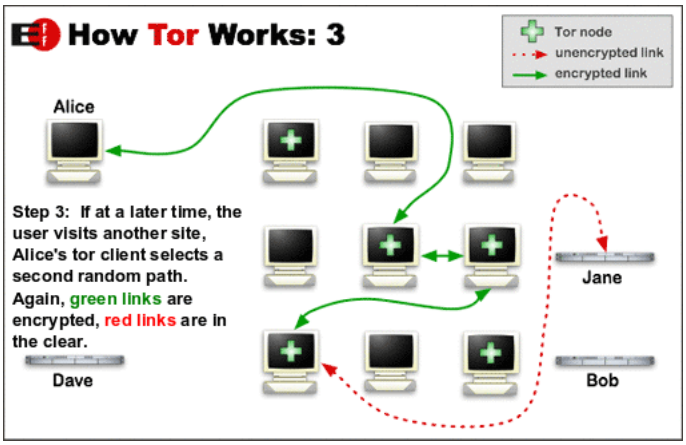


Image credit: Tor Project

Trust in Tor

- Entry node: knows Alice is using Tor, and identity of middle node, but not destination
- Exit node: knows some Tor user is connecting to destination, but doesn't know which user
- Destination: knows a Tor user is connecting to it via the exit node

Important to note that Tor does not provide encryption between exit and destination! (e.g., use HTTPS)

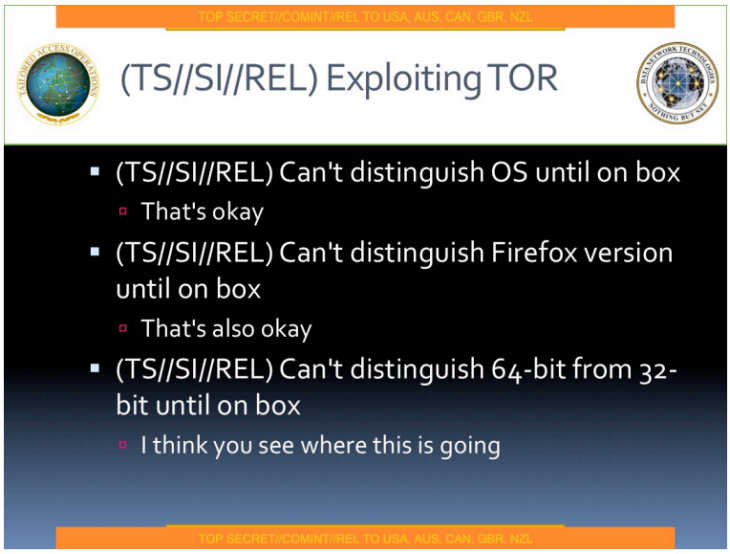
46

How to get Tor

- Tor Browser bundle available (built on modified version of firefox)
- ☺ optional exercise: download and use it!
- https://www.torproject.org/
- …or volunteer to be a part of the Tor network.

47

Egotistical Giraffe



48

Onion Routing Issues/Attacks?

- Performance: message bounces around a lot
- Attack: rubber-hose cryptanalysis of mix operators
  - Defense: use mix servers in different countries
- Attack: adversary operates all of the mixes
  - Defense: have lots of mix servers (Tor today: ~2,000)
- Attack: adversary observes when Alice sends and when Bob receives, links the two together
- A side channel attack – exploits timing information
  - Defenses: pad messages, introduce significant delays
    - Tor does the former, but notes that it's not enough for defense

49

Onion Routing Issues, cont.

- Issue: **traffic leakage**
- Suppose all of your HTTP/HTTPS traffic goes through Tor, but the rest of your traffic doesn't
- How might the operator of sensitive.com
- deanonymize your web session to their server?

50

The traffic leakage problem

- Answer: they inspect the logs of their DNS server to see who looked up sensitive.com just before your connection to their web server arrived
- **Hard,** general problem: anonymity often at risk when adversary can correlate separate sources of information

51

Tor Hidden Services: Overview

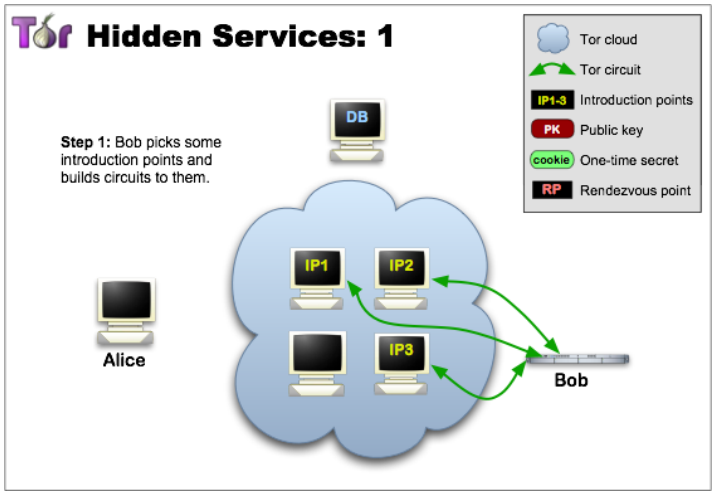


Image credit: Tor Project

Tor Hidden Services

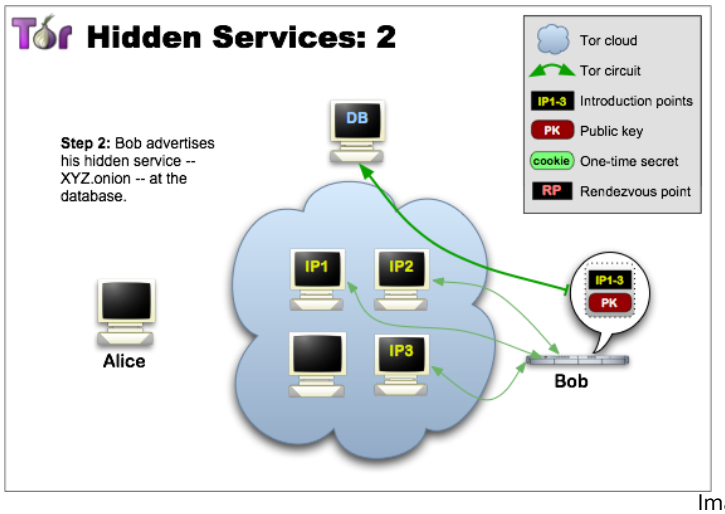


Image credit: Tor Project

Tor Hidden Services

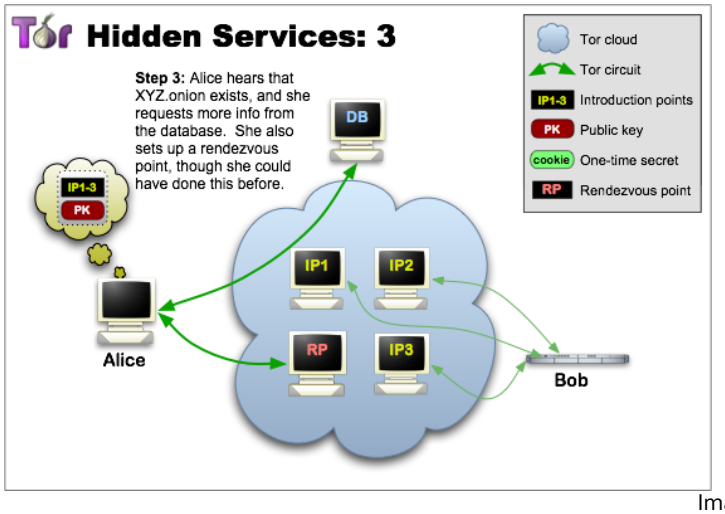


Image credit: Tor Project

Tor Hidden Services

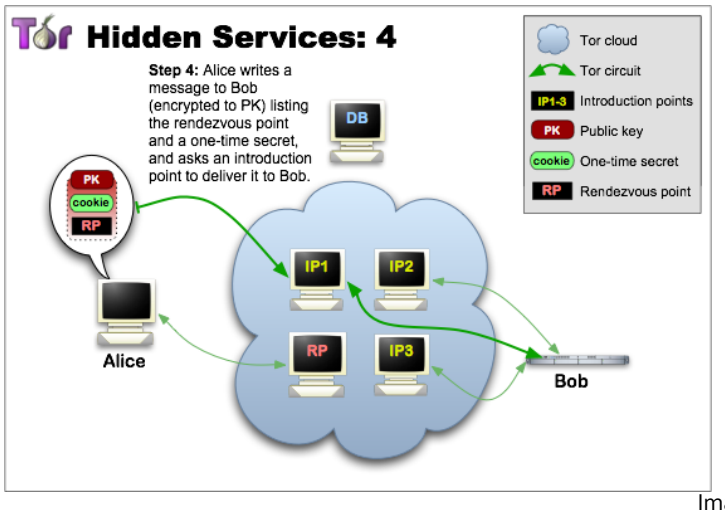


Image credit: Tor Project

Tor Hidden Services

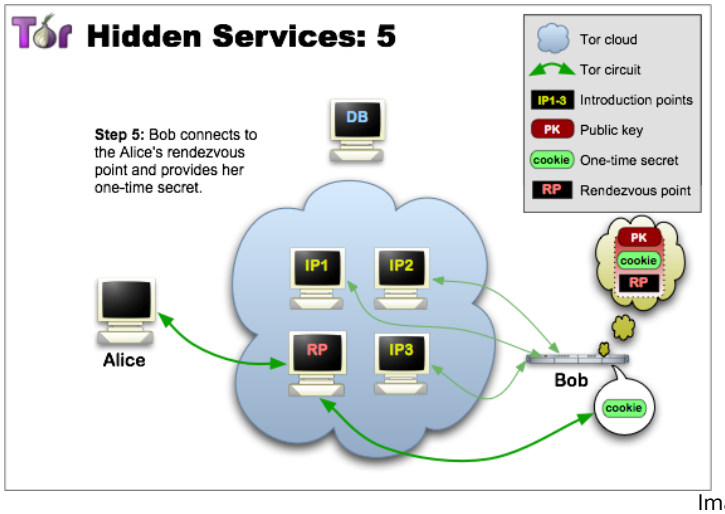


Image credit: Tor Project

Tor Hidden Services

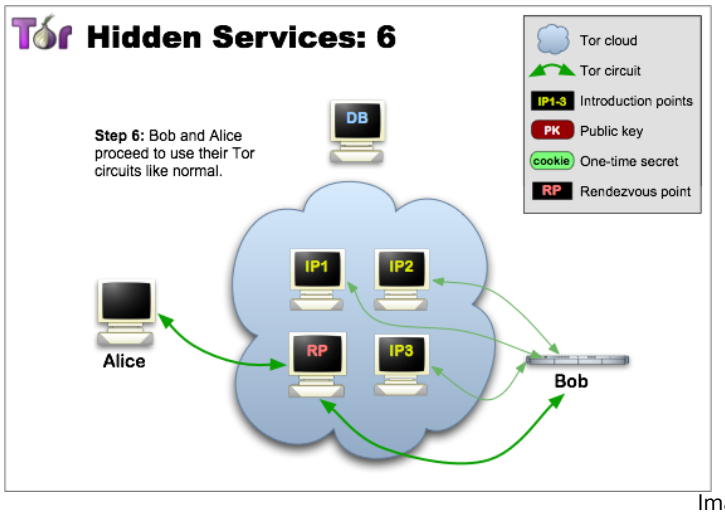
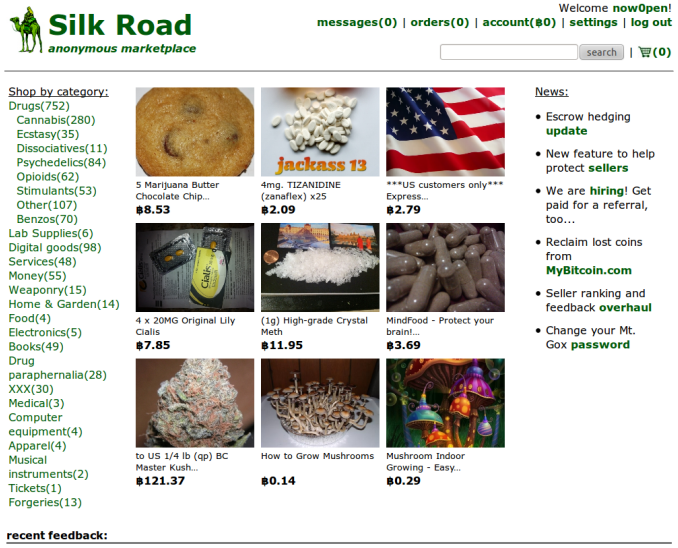


Image credit: Tor Project

SilkRoad Marketplace



58

SilkRoad Marketplace

59

Metadata

- If
- When
- How much
- Who
- What

60

Metadata

- If
- When
- How much
- Who
- ~~What~~ ← TLS/PGP

61

Metadata

- If
- When
- How much
- ~~Who~~ ← 
- ~~What~~ ← TLS/PGP

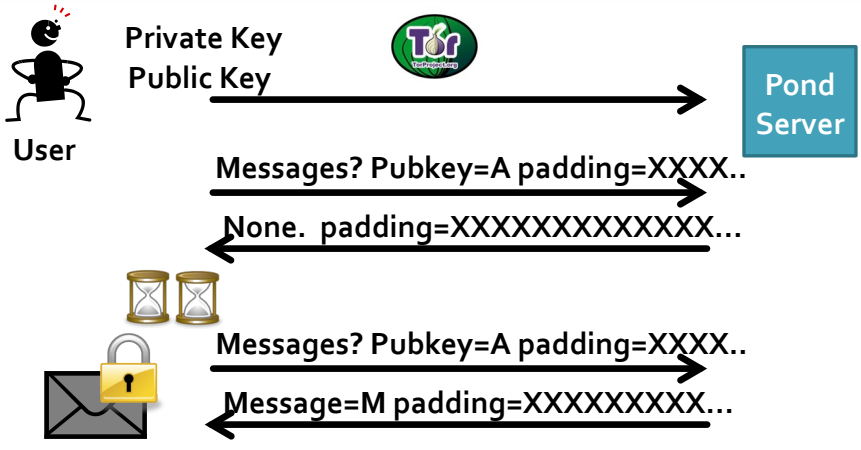
62

Pond

- "Pond is not email. Pond is a forward secure, asychronous messaging system for the discerning"
- Seeks to protect against leaking traffic info against all but a global passive adversary
  - forward secure
  - no spam
  - messages expire automatically after a week

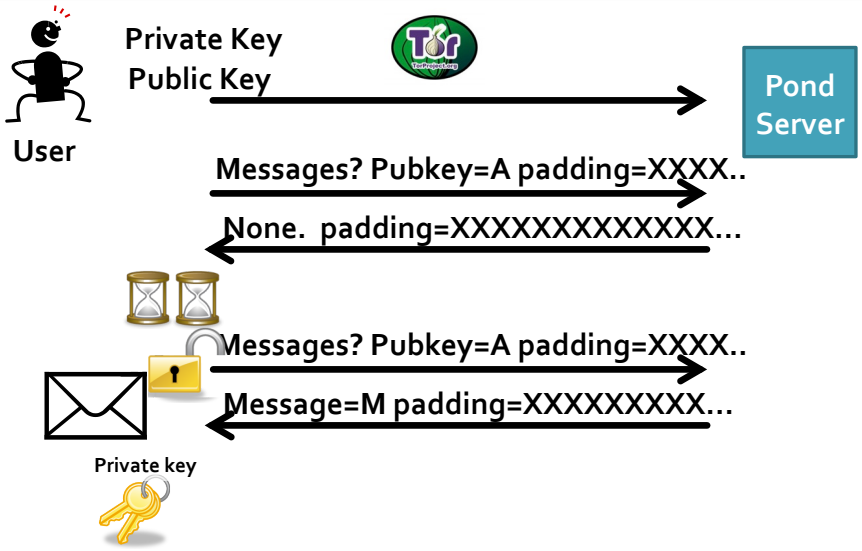
63

Pond



64

Pond



65

Metadata summary

- If
- ~~When~~ ← Pond
- ~~How much~~ ←
- ~~Who~~ ←
- ~~What~~ ← TLS/PGP

66

Extra…

Optional exercises. Play with the following:

- Tor Browser bundle
- GnuPG
- OTR on pidgin (or adium)
- Pond …
  - highly recommend using the CLI for pond
  - make a contact over Pond using a human memorable secret, as in the PANDA protocol…

67

Other Tools

From WhisperSystems
https://whispersystems.org/)

For Android: RedPhone, TextSecure

For iOS: Signal
(compatible with RedPhone, a texting app is on the way)

68