Applied Crypto: Signal & Tor

Project 2...

- Project 2 is now live, some observations
- This is a ***hard design*** project
  - The actual coding is straightforward but getting the design right is really, really, really hard
- You are ***not expected to get 100%***
  - This is part of the project's lesson: doing cryptographic systems right is really, really hard and you don't just lose 10%, but 100% on a mistake
- It is in go(lang) for several reasons:
  - Go gives really nice real world performance while being memory/typesafe
    - Especially for parallel programming
  - The learning curve is remarkably reasonable
  - It avoids the traps that other languages have on package/dependency management

Signal and Tor

- Signal is a messenger protocol and implementation
  - Signal (the company) is a 501(c)3 nonprofit
  - The protocol is also used by WhatsApp, Facebook Messenger, etc...
- Tor is an anonymity tool
  - Designed to provide anonymous but real-time network connectivity in the face of an ***aggressive but local adversary***
- Common (bad) information security advice is "Use Signal, Use Tor"
  - In reality, Signal is a great protocol, but some security compromises are annoying in the implementation, so for most, WhatsApp is about as good
  - While Tor is often not just a placebo but ***poison***!

End-To-End Messengers

- We love ***end to end*** cryptographic protocols...
- We love ***forward secrecy***...
  - If someone steals our private keys, they can't recover old messages
  - After all, we want things to stay secret even if our keys are compromised
- Forward secrecy is "easy" for online protocols
  - Just make sure to do a DHE/ECDHE key exchange, and throw away the session key when done
- Forward secrecy is ***much more annoying*** for an offline protocol
  - Alice wants to share data with Bob, but Bob is ***not online***
    - Like in project 2...
    - Or any messenger system!

Signal Requirements For Key Agreement

- Three parties: Alice, Bob, and a messenger server
  - The messenger server is like the file store in project 2, an ***untrusted*** entity
  - A ***separate*** mechanism is used to provide ***key transparency***
- Bob is ***offline***:
  - He has prearranged data stored on the messenger server
- Alice and Bob want to create an ephemeral (DH) key...
  - To use for then encrypting messages
- They need ***mutual authentication***
  - Assuming Alice and Bob have the correct public keys, ***only*** Alice and Bob could have agreed on a key
- They also need ***deniability***
  - Alice or Bob can't create a record ***proving*** the other side participated in creating the key:
    So no "Alice just signs her DH..." design

Extended Triple Diffie-Hellman

- Key idea:
  - Lets use multiple Diffie-Hellman exchanges combined into one
    - Some to perform mutual authentication
    - Some to generate an ephemeral key
    - Shove them ALL into a hash-based key derivation function
- They use elliptic curves, but the design would be the same for conventional DH, so we will use the former
  - We will use ***DH(A,B)*** as ***DH(g^a,g^b)*** where we know ***a*** but not ***b***.
    (So ***A*** is our private value, ***B*** is someone else's public value)
  - Also have ***Sign(K,M)*** for signing and ***KDF(KM)*** which derives a bunch of session keys for a hash-based key derivation function (e.g. ***PBKDF2*** with only a couple iterations)

Lots of Keys!

- All keys have both a public & private component
  - Private components always stay with Alice and Bob
  - Anything broadcast is always the public component
- Alice:
  - ***IK_A***: Alice's identity key: for both DH and signatures
  - ***EK_A***: Alice's ephemeral key: Created randomly just to talk to Bob.
- Bob:
  - ***IK_B***: Bob's identity key, long lived
  - ***SPK_B***: Bob's signed rekey, rotates ~weekly/monthly
    - Has corresponding signature ***Sign(IK_b, SPK_b)***
  - ***OPK_B***: Bob's one time use keys (One Time Prekey)
    - Can run out, but designed to increase security when available

Before We Start:
Bob to Server, Server to Alice

- Bob uploads:
  - $\boldsymbol{IK_B}$, $\boldsymbol{SPK_B}$, ***Sign(IK_B, SPK_B)***, {$\boldsymbol{OPK_B^1}$, $\boldsymbol{OPK_B^2}$, $\boldsymbol{OPK_B^3}$ ...}
- Now when Alice wants to talk to Bob...
- Gets from the server:
  - $\boldsymbol{IK_B}$, $\boldsymbol{SPK_B}$, ***Sign(IK_B, SPK_B)***, $\boldsymbol{OPK_B^?}$
  - Told which ***OPK*** it is or "There are no ***OPKs*** left"
    - ***OPKs*** are designed to prevent replay attacks:
      Bob will ***never*** allow any particular ***OPK*** to be used twice
- This is now the input into Alice's DH calculations

Alice now does a lot of DH...

- ***$DH1 = DK(IK_A, SPK_B)$***
  - Acts as authentication for Alice when Bob does the same
- ***$DH2 = DK(EK_A, IK_B)$***
  - Forces Bob to do mutual authentication
- ***$DH3 = DK(EK_A, SPK_B)$***
  - Adds in ephemeral ***EK_A*** to short lived ***SPK_B***
- ***$DH4 = DK(EK_A, OPK_B)$***
  - Adds in one-time used ***OPK_B***, if available
- ***$SK = HKDF(DH1 || DH2 || DH3 || DH4)$***
  - Skip DH4 if no one time pre-keys are available
- Now discard the private part of ***EK_A*** and the intermediate DH calculations

HKDF...

- Hash Based Key Derivation Function...
  - AKA how to use HMAC to create several keys starting from a single key
- Why? Different keys for different purposes
  - Encryption keys in different directions,
    separate MAC keys
- Very simple construction

```
hkdf(keydata, info, L):
  T = Out = ""
  for (i = 1; i <= ceiling(L/hashlen); ++i){
     T = HMAC(keydata, T || info || i);
     Out = Out || T
  }
  return Out[0:L-1]
```

Now Alice Sends To Bob

- ***IK_A***, ***EK_A***, which ***OPK*** used (if any), and ***$E(SK, M, IK_A \,||\, IK_B)$***
  - Using an AEAD encryption mode: ***Authenticated Encryption with Additional Data*** modes allow additional data to be protected by the MAC but sent in the clear: In this case ***IK_A*** and ***IK_B***
- Bob can do the same DH calculations to generate SK
  - Since Bob knows the private keys corresponding to the public values Alice used
  - If it fails to verify the AEAD data abort: How we know that ***IK_a*** and ***IK_b*** are sent honestly

Key Transparency

- For now, Alice and Bob are trusting the server to report ***IK_A*** and ***IK_B*** correctly
  - If the server lies, 🤷‍♂️
- Fortunately there is an answer:
  If Alice and Bob are ***ever*** together:
  - One person's phone displays ***$H(IK_A \| IK_B)$*** as a QR Code
  - Other person's phone verifies that it is the same
- Plus the voice channel...
  - Display "Two Words" on screen:
    $F(H(IK_A \| IK_B \| SK))$
  - Assumption is a MitM attacker can't fake a voice conversation quickly enough, so if each person says one of the words...

Considerations

- Authentication requires the out-of-channel methods
  - Otherwise no guarantees: Absent the out of channel the keyserver could be lying
- Replay attacks
  - Only if no OPK is available: Can be potentially bad
- Deniability
  - No cryptographic proofs available as to the sender/receiver!
  - So if Bob releases a message saying "Alice sent me X", Alice can go "Nope, never did" and Bob can't release anything proving that the message was created by Alice and not Bob:
    Both possess the cryptographic material necessary to create the message

And Then Ratchets...

- A "ratchet" is a one-way function for message keys
  - ***Ratchet(K_i)*** -> ***K_{i+1}***, ***MK_i***
  - But can't take ***K_{i+1}*** and ***MK_i*** to find ***K_i***
- A symmetric key ratchet is easy
  - We've seen these already:
    Any secure PRNG with rollback resistance is a ratchet
  - Can do it slightly more efficiently with HMAC:
    HMAC(K_i, 0x01) -> ***MK_i***
    HMAC(K_i, 0x02) -> ***K_{i+1}***
- Its OK to keep around the intermediate session keys
  - Thanks to HMAC we can't go backwards with them anyway:
    Needed for out of order messages

Signal adds in DH ratchets too...

- So for a few messages in a chain you use a symmetric key ratchet...
  - You gain forward secrecy by discarding the old internal state
- But occasionally you rekey with an additional DH
  - Used to add into the ratchet internal state: update $\boldsymbol{K_i}$ to $\boldsymbol{H(K_{i-1} \mathbin{||} DH)}$
- Acts to reset everything with even more randomness
  - So even if you compromise Bob's device at time ***T*** and steal all the keys...
  - You can't decrypt old messages that aren't on Bob's device:
    can't run the symmetric ratchet backwards
  - You can't decrypt subsequent messages once Bob & Alice use a DH ratchet

The Protocol is Great...
BUT!

- The app itself does some ehh thing in the usability/security tradeoff...
  - ***No mechanism to back-up messages***!
    If your phone is toast, your messages are gone!
  - ***No mechanism to migrate to a new phone***!
    If you upgrade to a new phone, your messages are gone!
  - ***Auto-notifies all those where you are in their contacts that they join***
- This is where WhatsApp has a huge competitive advantage
  - They allow backup of messages, message migration etc...

And A Particular Problem:
Naming/Identifying People...

- How does Alice identify Bob in a system?
  How does Bob register his keys for the first time?
  - Name? There are lots of people named Bob!
  - Email? Email addresses don't tend to be the most secure thing in the world...
- Signal's solution: phone #
  - Phone numbers are a lot harder to hijack than email addresses
- But this creates a problem:
  Not everyone wants to reveal their phone #

And Signal Makes It Worse...

- When you register your phone # with Signal...
- It broadcasts to everyone who has you in ***their*** contacts that you are now on Signal
  - And with no notice or control to you...
- You think this might be a problem?
  Because I think this is a problem...
  - Phone # is a lot more disruptive information in the hands of an abuser than an email address is...

Tor: The Onion Router Anonymous Websurfing

- Tor actually encompasses many different components
- The Tor network:
  - Provides a means for anonymous Internet connections with low(ish) latency by relaying connections through multiple Onion Router systems
- The Tor Browser bundle:
  - A copy of FireFox extended release with privacy optimizations, configured to only use the Tor network
- Tor Hidden Services:
  - Services only reachable though the Tor network
- Tor bridges with pluggable transports:
  - Systems to reach the Tor network using encapsulation to evade censorship
- Tor provides three separate capabilities in one package:
  - Client anonymity, censorship resistance, server anonymity

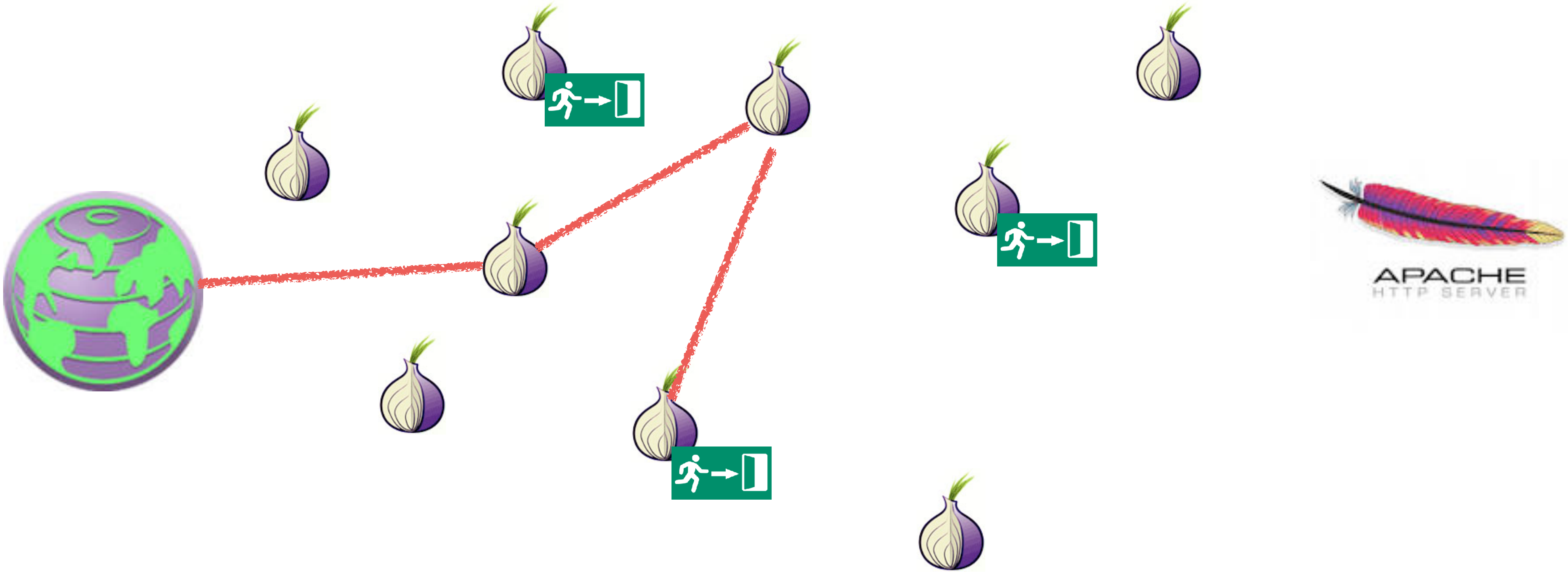
The Tor Threat Model:
Anonymity of content against ***local*** adversaries

- The goal is to enable users to connect to other systems "anonymously" but with low latency
  - The remote system should have no way of knowing the IP address originating traffic
  - The local network should have no way of knowing the remote IP address the local user is contacting
- Important what is excluded:
  The ***global*** adversary
  - Tor does not even attempt to counter someone who can see ***all*** network traffic:
    It is probably ***impossible*** to do so and be low latency & efficient

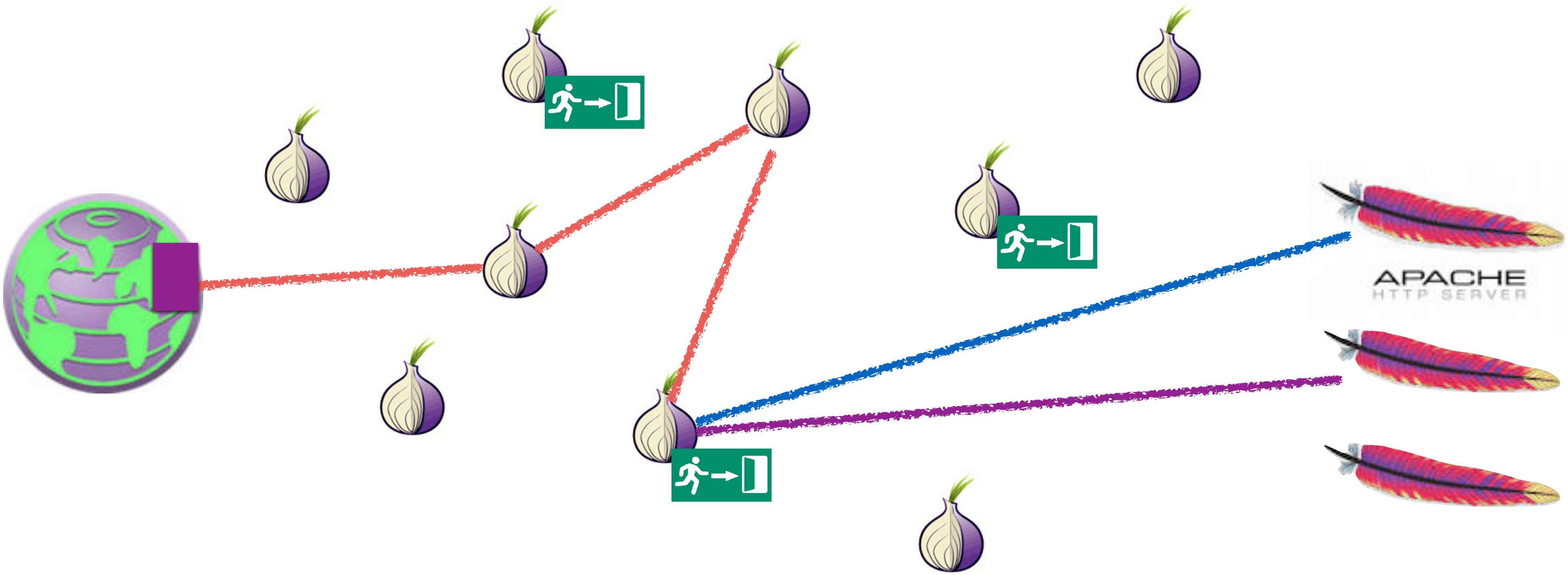
The High Level Approach: Onion Routing

- The Tor network consists of thousands of independent Tor nodes, or "Onion Routers"
  - Each node has a distinct public key and communicates with other nodes over TLS connections
- A Tor circuit encrypts the data in a series of layers
  - Each hop away from the client removes a layer of encryption
  - Each hop towards the client adds a layer of encryption
- During circuit establishment, the client establishes a session key with the first hop…
  - And then with the second hop through the first hop
- The client has a ***global*** view of the Tor Network:
  The directory servers provide a list of all Tor relays and ***their public keys***

Tor Routing In Action



Tor Routing In Action



Creating the Circuit Layers…

- The client starts out by using an authenticated DHE key exchange with the first node…
  - OR1 creates $\boldsymbol{g^a}$, signs it with its private key, sends $\boldsymbol{g^a}$, **Sign**($\boldsymbol{K_{priv\_or1}}$, $\boldsymbol{g^a}$) to client
    Client creates $\boldsymbol{g^b}$, sends it to OR1
    Client does **Verify**($\boldsymbol{K_{pub\_or1}}$, $\boldsymbol{g^a}$)
  - Creating a session key $\boldsymbol{K_{OR1}}$ as $\boldsymbol{H}$($\boldsymbol{g^{ab}}$)
    - This first hop is commonly referred to as the “guard node”
- It then tells OR1 to extend this circuit to OR2
  - Through that, creating a session key for the client to talk to OR2 that OR1 ***does not know***
  - And OR2 doesn't know what the client is, just that it is somebody talking to OR1 requesting to extend the connection...
- It then tells OR2 to extend to OR3…
  - And OR1 won’t know where the client is extending the circuit to, only OR2 will

Unwrapping the Onion

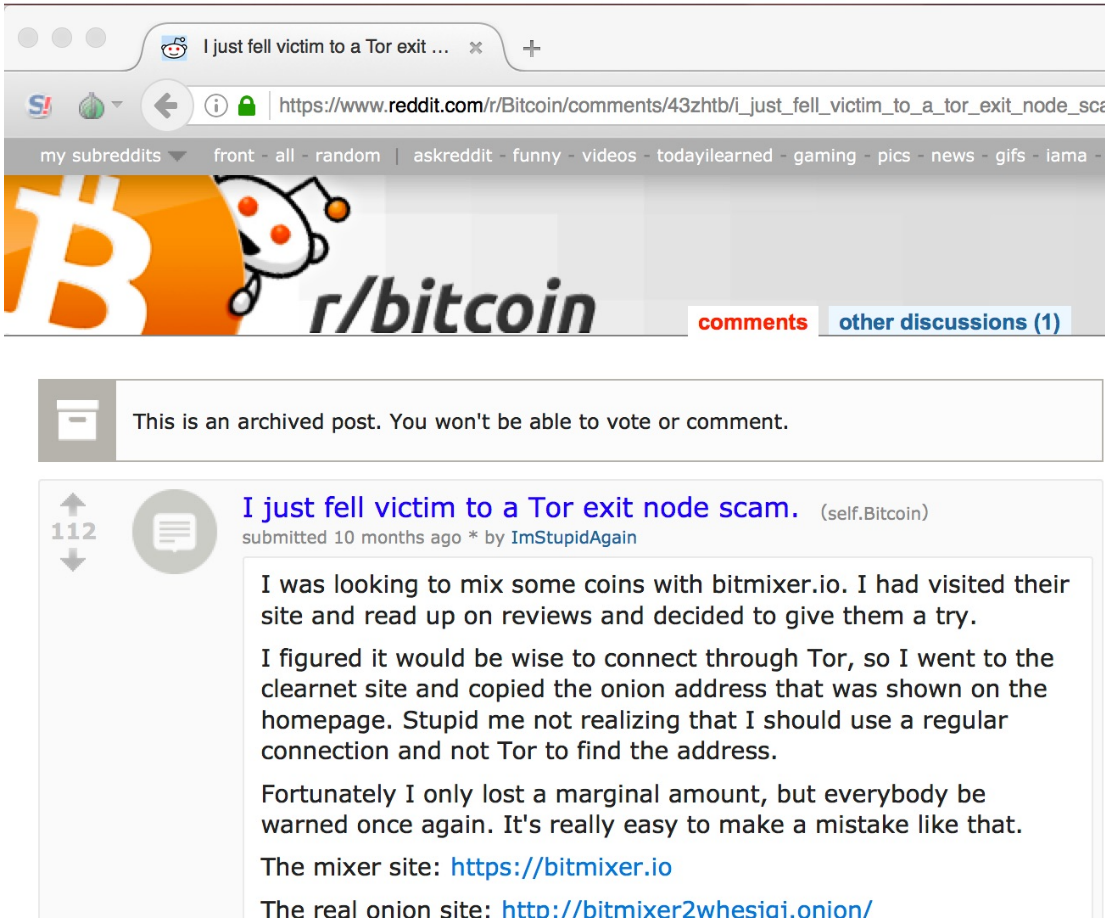
- Now the client sends some data…
  - E($\boldsymbol{K}_{or1}$,E($\boldsymbol{K}_{or2}$,E($\boldsymbol{K}_{or3}$, Data)))
- OR1 decrypts it and passes on to OR2
  - E($\boldsymbol{K}_{or2}$, E($\boldsymbol{K}_{or3}$, Data))
- OR2 then passes it on…
- Generally go through at least 3 hops…
  - Why 3? So that OR1 can't call up OR2 and link everything trivially
- Messages are a fixed-sized payload

The Tor Browser…

- Surfing “anonymously” doesn’t simply depend on hiding your connection…
- But also configuring the browser to make sure it resists tracking
  - No persistent cookies or other data stores
  - ***No deviations from other people*** running the same browser
- Anonymity ***only works in a crowd***…
  - So it really tries to make it all the same
- But by default it makes it easy to say “this person is using Tor”

But You Are Relying On Honest Exit Nodes…

- The exit node, where your traffic goes to the general Internet, is a man-in-the-middle…
  - Who can see and modify all non-encrypted traffic
  - The exit node also does the DNS lookups
- Exit nodes have not always been honest…


I just fell victim to a Tor exit …
https://www.reddit.com/r/Bitcoin/comments/43zhtb/i_just_fell_victim_to_a_tor_exit_node_sca
my subreddits
front - all - random | askreddit - funny - videos - todayilearned - gaming - pics - news - gifs - iama -
r/bitcoin
comments
other discussions (1)
112

This is an archived post. You won't be able to vote or comment.

I just fell victim to a Tor exit node scam. (self.Bitcoin)

submitted 10 months ago * by ImStupidAgain

I was looking to mix some coins with bitmixer.io. I had visited their site and read up on reviews and decided to give them a try.

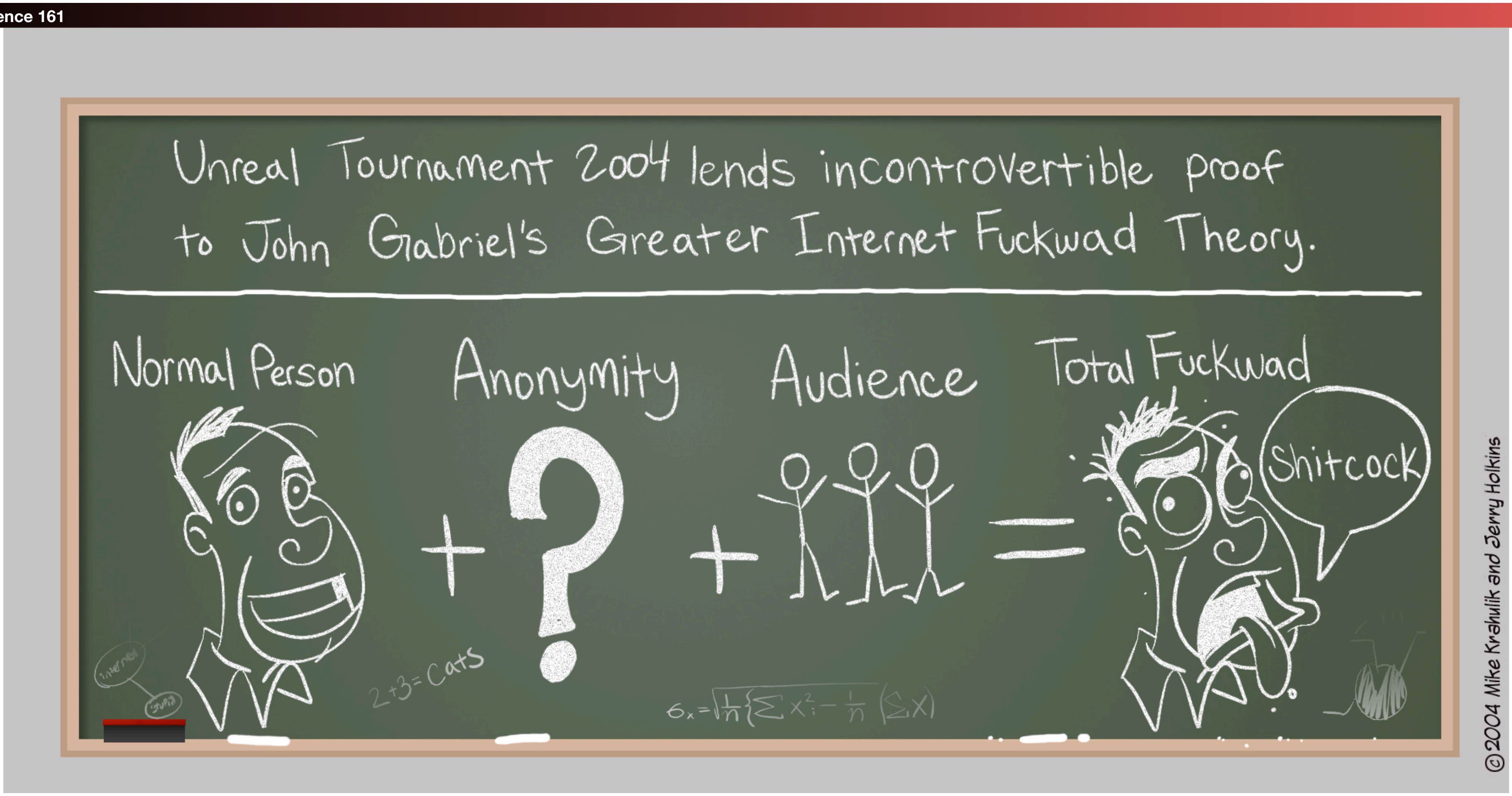
I figured it would be wise to connect through Tor, so I went to the clearnet site and copied the onion address that was shown on the homepage. Stupid me not realizing that I should use a regular connection and not Tor to find the address.

Fortunately I only lost a marginal amount, but everybody be warned once again. It's really easy to make a mistake like that.

The mixer site: https://bitmixer.io

The real onion site: http://bitmixer2whesjgj.onion/

Anonymity Invites Abuse…
(Stolen from Penny Arcade)


Unreal Tournament 2004 lends incontrovertible proof to John Gabriel's Greater Internet Fuckwad Theory.
Normal Person
+
Anonymity
+
Audience
=
Total Fuckwad
Shitcock
Internet
Stupid
2+3=Cats
$\sigma_x=\sqrt{\frac{1}{n}\{\Sigma x_i^2-\frac{1}{n}(\Sigma x)}$

© 2004 Mike Krahulik and Jerry Holkins

This Makes Using Tor Browser Painful…

And Also Makes Running Exit Nodes Painful…

- If you want to receive abuse complaints…
  - Run a Tor Exit Node
- Assuming your ISP even allows it…
  - Since they don't like complaints either
- Serves as a large limit on Tor in practice:
  - Internal bandwidth is plentiful, but exit node bandwidth is restricted
- Know a colleague who ran an exit node for research...
  - And got a ***visit from the FBI***!

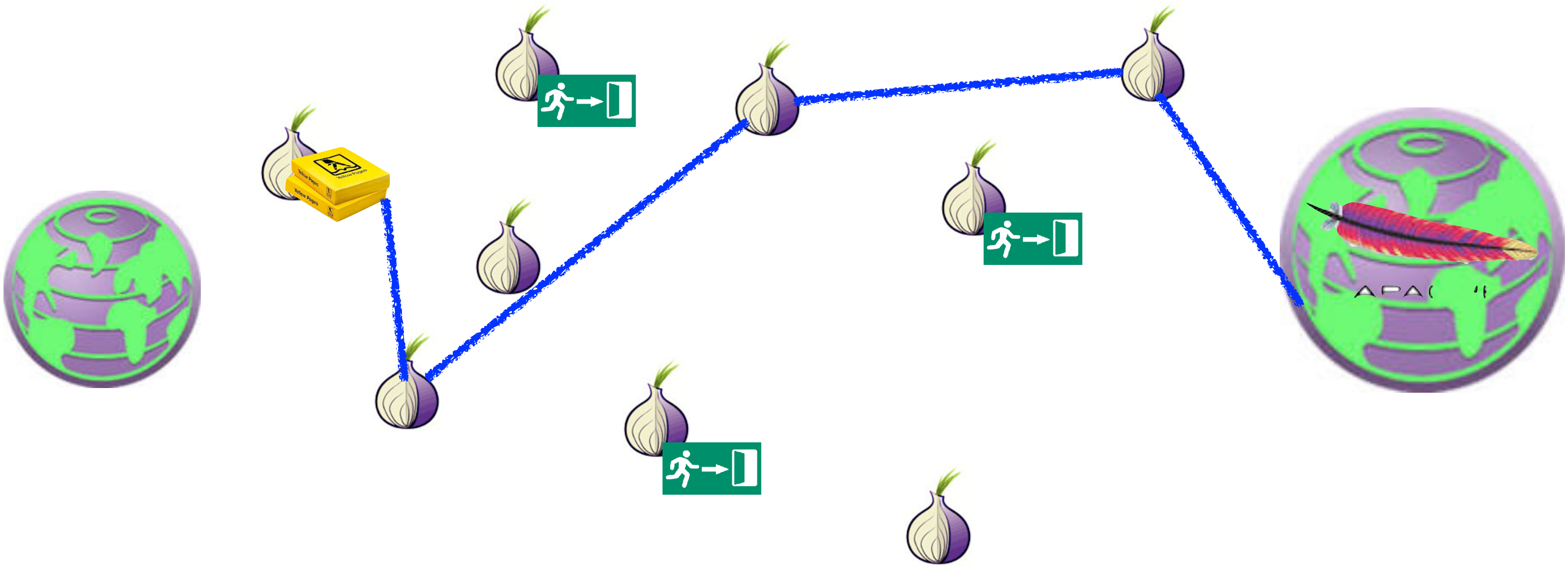
Censorship Evasion...

- Tor is actually really ***bad*** for evading censorship
  - It is trivial to tell that someone on the network is running Tor
- There are ***optional*** pluggable transports that attempt to hide the traffic
  - The problem is you have to learn about these...
    Yet if the censor does, it won't work!
- And then the user has all the bad of Tor...
  - Fate sharing with the exit nodes
  - Significantly worse latency
  - Oh, and Tor Browser's not saving history is not necessarily nice!
- Only good thing is it is "free"
  - Tor project gets paid largely for counter-censorship
  - Users are "paying" by providing traffic for those who want anonymity to hide in

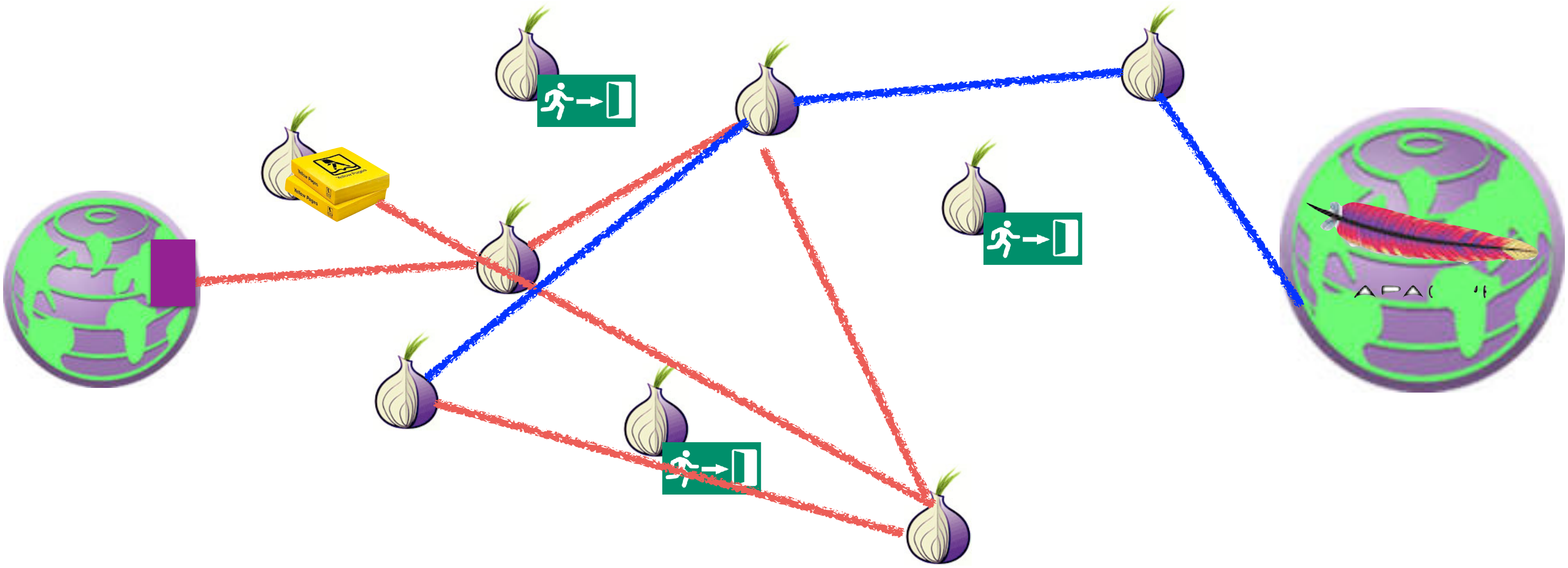
Tor Browser is also used to access Tor Hidden Services aka .onion sites

- Services that ***only*** exist in the Tor network
  - So the service, not just the client, has possible anonymity protection
  - The “Dark Web”
- A ***hash*** of the hidden service's public key
  - http://pwoah7foa6au2pul.onion
    - AlphaBay, one of many dark markets, now deceased
  - https://facebookcorewwwi.onion
    - In this case, Facebook spent a lot of CPU time to create something distinctive
      (Also a proof of work that Facebook spent a huge amount of time generating private keys to find one where the public key's hash started with "Facebook" and the rest sort of made sense)
- Using this key hash, can query to set up a circuit to create a hidden service at a rendezvous point
  - And because it is the hash of the key we have end-to-end security when we finally create a final connection

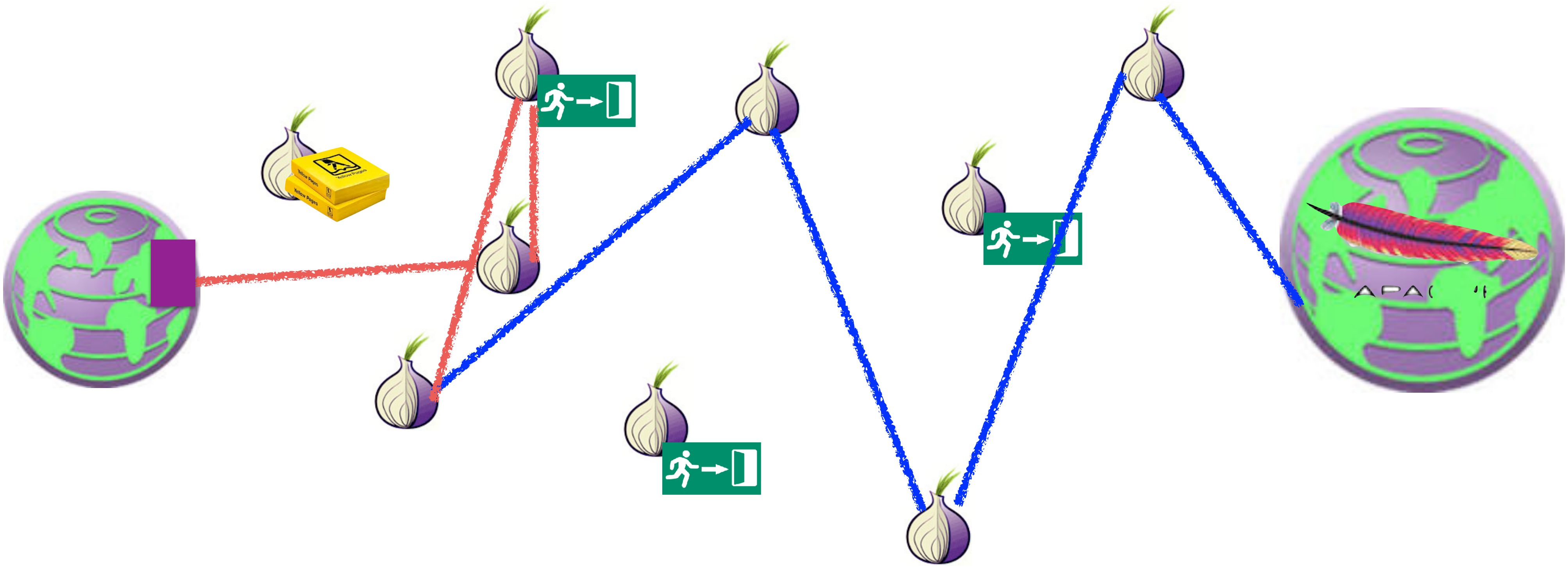
Tor Hidden Service:
Setting Up Introduction Point

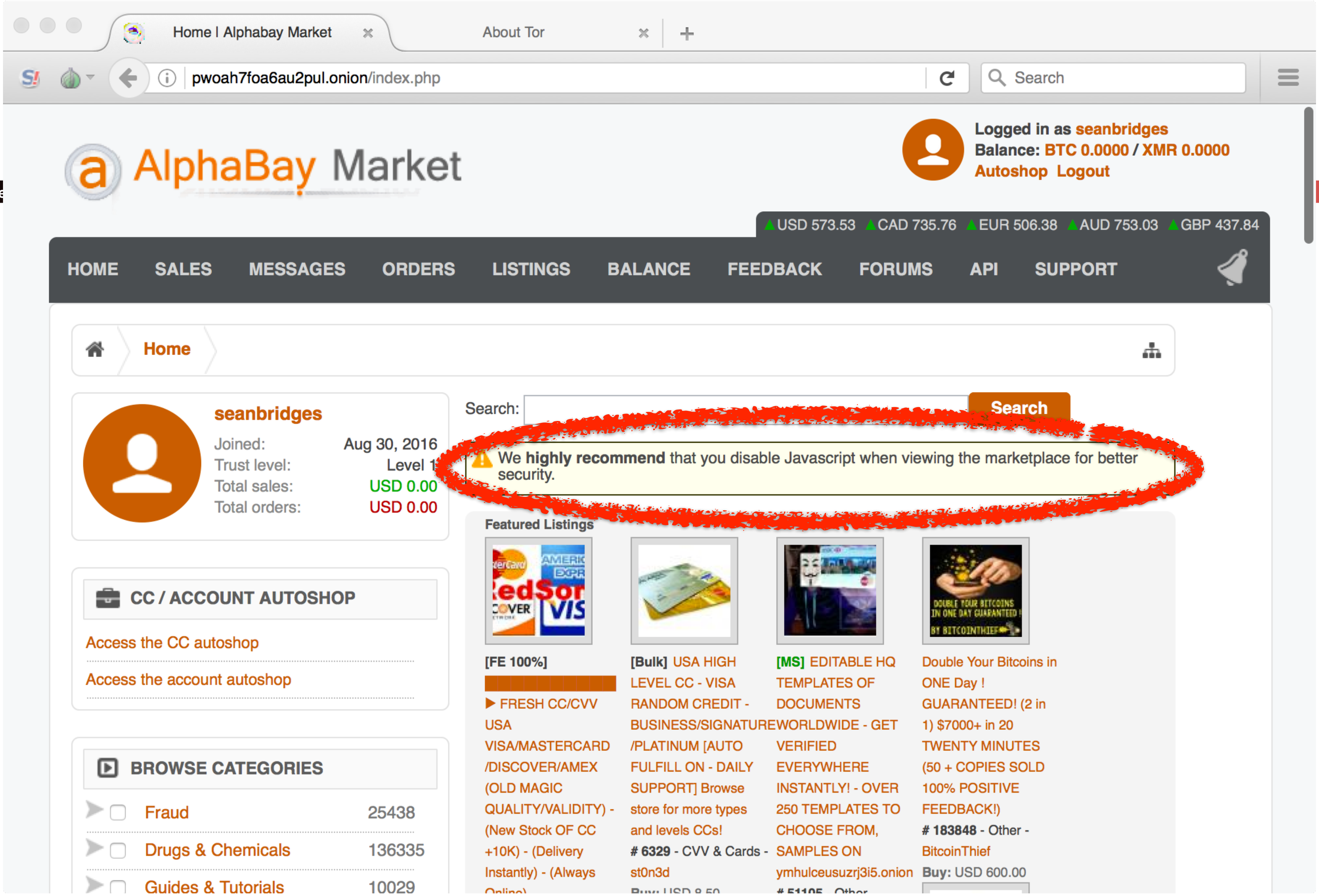


Tor Hidden Service:
Query for Introduction, Arrange Rendevous



Tor Hidden Service:
Rendevous and Data





Home | Alphabay Market

About Tor

pwoah7foa6au2pul.onion/index.php

Search

AlphaBay Market

Logged in as seanbridges
Balance: BTC 0.0000 / XMR 0.0000
Autoshop Logout

▲USD 573.53 ▲CAD 735.76 ▲EUR 506.38 ▲AUD 753.03 ▲GBP 437.84

HOME SALES MESSAGES ORDERS LISTINGS BALANCE FEEDBACK FORUMS API SUPPORT

Home

seanbridges

Joined:	Aug 30, 2016
Trust level:	Level 1
Total sales:	USD 0.00
Total orders:	USD 0.00

Search: Search

⚠ We **highly recommend** that you disable Javascript when viewing the marketplace for better security.

CC / ACCOUNT AUTOSHOP

Access the CC autoshop

Access the account autoshop

BROWSE CATEGORIES

□ Fraud	25438
□ Drugs & Chemicals	136335
□ Guides & Tutorials	10029

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[FE 100%] ▶ FRESH CC/CVV USA VISA/MASTERCARD /DISCOVER/AMEX (OLD MAGIC QUALITY/VALIDITY) - (New Stock OF CC +10K) - (Delivery Instantly) - (Always Online)

[Bulk] USA HIGH LEVEL CC - VISA RANDOM CREDIT - BUSINESS/SIGNATURE /PLATINUM [AUTO FULFILL ON - DAILY SUPPORT] Browse store for more types and levels CCs! # 6329 - CVV & Cards - st0n3d Buy: USD 8.50

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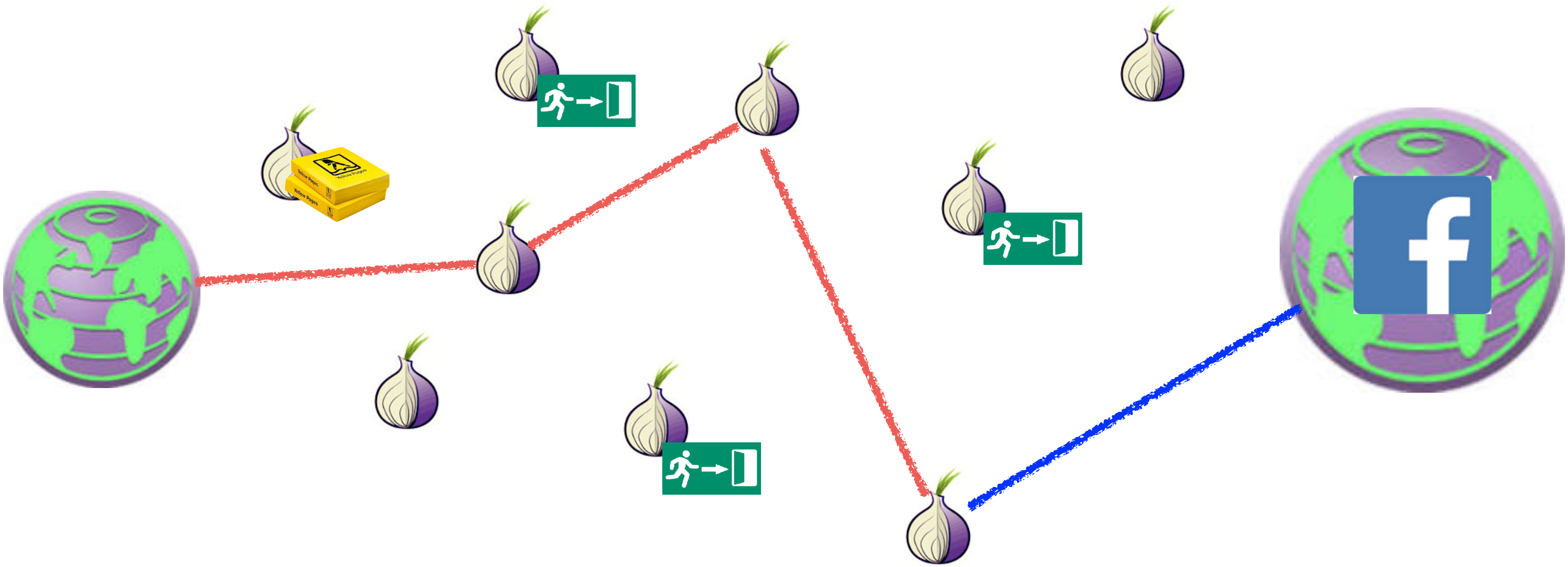
Double Your Bitcoins in ONE Day ! GUARANTEED! (2 in 1) $7000+ in 20 TWENTY MINUTES (50 + COPIES SOLD 100% POSITIVE FEEDBACK!) # 183848 - Other - BitcoinThief Buy: USD 600.00

Remarks…

- A hidden service wants to keep the guard node constant for a long period of time…
  - Since the creation of new circuits is far easier to notice than any other activity
- Want to use a different node for the rendezvous point and introduction
  - Don't want the rendezvous point to know who you are connecting to
- These are ***slow!***
  - Going through 6+ hops in the Tor network!

Non-Hidden Tor Hidden Service: Connect Directly to Rendezvous



Non-Hidden Hidden Services Improve Performance

- No longer rely on exit nodes being honest
  - No longer rely on exit node bandwidth either
- Reduces the number of hops to be the same as a not hidden service
- Result: Huge performance win!
  - Not slow like a hidden service
  - Not limited by exit node bandwidth
  - Facebook does this
- Any ***legitimate*** site offering a Tor hidden service should use this technique
  - Since legitimate sites don't need to hide!

Real use for ***true hidden*** hidden services

- "Non-arbitrageable criminal activity"
  - Some crime which is universally attacked and targeted
    - So can't use "bulletproof hosting", CDNs like CloudFlare, or suitable "foreign" machine rooms:
      And since CloudFlare will service the anti-Semitic shitheads like gab.ai and took forever to get rid of the actual nazis of Stormfront and the murderous shits of 8chan...
- Dark Markets
  - Marketplaces based on Bitcoin or other alternate currency
- Cybercrime Forums
  - Hoping to protect users/administrators from the fate of earlier markets
- And worse...

The Dark Market Concept

- Four innovations:
- A censorship-resistant payment (Bitcoin)
    - Needed because illegal goods are not supported by Paypal etc
        - Bitcoin/cryptocurrency is the ***only game in town*** for US/Western Europe after the Feds smacked down Liberty Reserve and eGold
- An eBay-style ratings system with mandatory feedback
    - Vendors gain positive reputation through continued transactions
- An escrow service to handle disputes
    - Result is the user (should) only need to trust the market, not the vendors
- Accessable ***only*** as a Tor hidden service
    - Hiding the market from law enforcement

The Dark Markets: History

- All pretty much follow the template of the original “Silk Road”
  - Founded in 2011, Ross Ulbricht busted in October 2013
- The original Silk Road actually (mostly) lived up to its libertarian ideals
  - Including the libertarian ideal that if someone rips you off you should be able to call up the Hell’s Angels and put a hit on them
    - And the libertarian idea if someone is foolish enough to THINK you are a member of the Hell’s Angels you can rip them off for a large fortune for a fake hit
- Since then, markets come and go...
  - And even information about them is harder:
    Reddit no longer supports them, deepdotweb got busted...
    Leaving "Dread": Reddit as a Tor Hidden Service

The Dark Markets:
Not So Big, and ***Not Growing!***

- Kyle Soska and Nicolas Christin of CMU have crawled the dark markets for years
  - These markets ***deliberately*** leak sales rate information from mandatory reviews
- So simply crawl the markets, see the prices, see the volume, voila…
- Takeaways:
  - Market size has been relatively steady for years, about $300-500k a day sales
    - Latest peak got close to $1M a day
  - Dominated by Pot, MDMA, and stimulants, with secondary significance with opioids and psychedelics
  - A few sellers and a few markets dominate the revenue: A fair bit of “Winner take all”
    - But knock down any “winner” and another one takes its place

The Scams…

- You need a reputation for honesty to be a good crook
  - But you can burn that reputation for short-term profit
- The “Exit Scam” (e.g. pioneered by Tony76 on Silk Road)
  - Built up a positive reputation
  - Then have a big 4/20 sale
  - Require buyers to “Finalize Early”
    - Bypass escrow because of “problems”
  - Take the money and run!
- Can also do this on an entire ***market*** basis
  - The “Sheep Marketplace” being the most famous

And Now A Content Warning...

- The rest of the lecture is going to talk about the Elephant in the Room with Tor...
  Tor hidden services facilitate child abuse on an industrial scale
  - And the Tor project ***DOES NOT CARE***!
- I will be talking about actual cases and the scope of the problem
  - I studied these cases because they touched on significant policy issues surrounding searches and government hacking
- This will not be on the test beyond the following:
  "Yes, Nick does hate Tor with the fires of a thousand suns"
  and this is why...
  - And for the love of everything do not ever build something that has proved as loathsome as Tor

February 2, 2020,
Sunrise, Florida

- A team of FBI agents in the Violent Crimes Against Children division, including special agents Daniel Alfin and Laura Schwartzenberger, attempted to serve a search warrant as part of a CSAM (Child Sexual Abuse Material) investigation
    - Agents Alfin and Schwartzenberger were murdered by the suspect and three other agents injured
- I knew Dan professionally from his previous work involving CSAM and Tor...

The "Playpen" Investigation

- In 2015 the FBI managed to identify and capture the server hosting the "Playpen" child exploitation site:
  Daniel Alfin was one of the lead investigators
- Playpen operated as a hidden service image board for posting CSAM
  - 250,000+ registered users, 20,000+ images
  - This represents thousands of abused children!
- But the site operator's are not the only problem...
  The site users are a problem
  - A significant number are "hands-on" abusers:
    Both because of their predilections and because creating new "content" is currency in these communities

To Deanonymize the Users...

- The FBI took over Playpen and ran the site for 2 weeks
- During those two weeks...
  - Disabled posting of new content, but continued to serve old content...
  - And added a post-login bonus: A zero-day attack on the Tor Browser Bundle
- Exploit payload: "phone home"
  - Not a general purpose shellcode, instead collect Ethernet Addresses, current user, and similar identifying information and contact an FBI server
- FBI calls this a NIT: "Network Investigation Technique"
- They had a warrant:
  - It described with particularity what it would search for, how it would work conceptually, etc...

Significant Impact

- 25 producers prosecuted, 350 arrests in the US alone
- Nearly 300 children identified or rescued from abusive situations worldwide, over 50 in the US
- But also two significant controversies:
- Was the warrant actually valid?
  - Answer ended up being "No, but 'good faith'....":
    At the time there was no way to write a warrant that says "I want to search these computers, but we don't know where they are!"
- What should defendants be able to examine with regard to the exploit?
  - Answer largely ended up being "No, not actually relevant"
  - An in the weeds discussion by Susan Hennesey and myself is available here:
    https://www.lawfareblog.com/judicial-framework-evaluating-network-investigative-techniques

The Problem: These are communities of abusers

- There have been others both before and since
  - Before Playpen there was "Freedom Hosting": hosted close to 50 CSAM sites.
    If you want to be nauseated read the Freedom Hosting NIT warrant application
    - But "Freedom Hosting" they simply replaced the content with a "doing maintenance" page where the NIT was quickly spotted
  - In 2017 an FBI style NIT was deployed on "GiftBox" (probably by the French):
    But it was captured by a site user and posted to Reddit...
  - In 2018 "Welcome to Video" was busted: Pay for CSAM with Bitcoin!
    Again, if you want to vomit read the indictments
- Communities create dangerous cycles of normalization
  - And larger communities are more dangerous:
    See more mild versions that happened on Reddit with TheDonald, jailbait, creepshots, etc...
    - Self reinforcement behavior: "Its normal because others in the community do it" and the community becomes self justifying
    - See the "Jailbait" analysis in ***Twitter and Tear Gas***
  - Drives to extremes: Over the past decade, the age of CSAM victims has basically gotten younger... To the point where average age really can't get much lower

The Problem #2:
The Tor Project ***JUST DOES NOT CARE!***

- They treat this as "collateral damage" with a series of excuses.
  Here are actual justifications by Roger Dingledine (Founder):
- "But hidden services are in their infancy"
  - And in the same presentation talk about it being a 10 year old idea...
- "But hidden services are end-to-end authenticated"
  - Yeah, there is this thing call TLS...
- "But hidden services work through NATs"
  - Yeah, there is this thing called uPNP: You ask the NAT to allow inbound connections
  - Oh, or just use EC2...
- "But dissidents..."
  - Well, running Tor is very noticeable...
  - Plus you can "arbitrage host": Want to piss off China? Host in the US. Piss off the US? Host in Russia...
- "But Facebook/SecureDrop/Etc... has an onion service"
  - Uh, they don't actually need to be hidden! And work better when they aren't!

And A Different Problem: Grooming

- I never encountered Agent Schwartzenberger, but this was her specialty...
  people who use electronic chat to groom child victims for exploitation
- In unencrypted chats, the chat-provider can ***theoretically*** try to detect this behavior
  - A case where classic Machine Learning tends to work pretty well if the results are human-reviewed for false-positives
- The problem grows even harder when dealing with encrypted chats
  - Since there is no longer a central server that can try to detect the behavior...
  - And the developers would probably resist adding an AI-snitch to the client