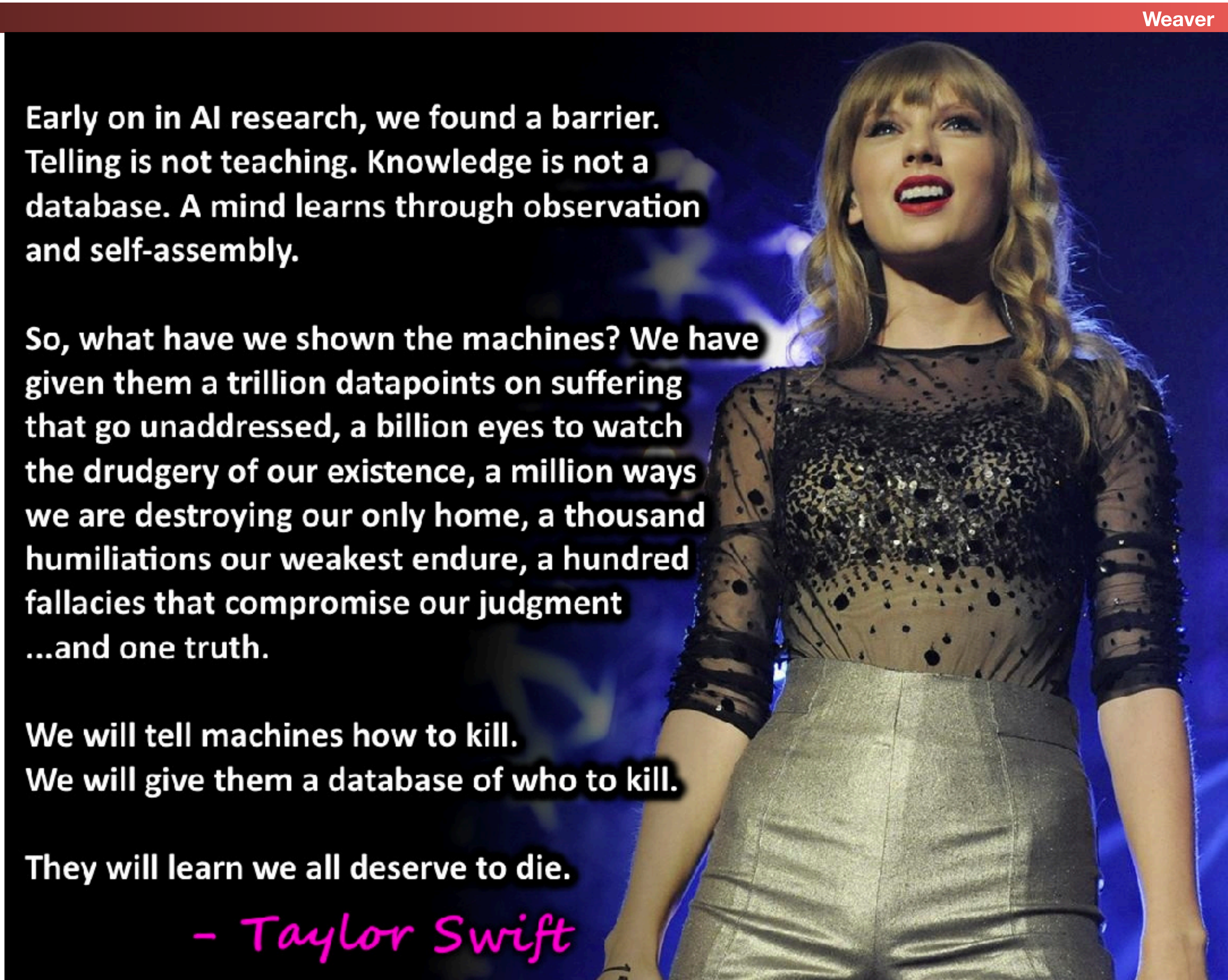
Tor & Malcode



Early on in AI research, we found a barrier. Telling is not teaching. Knowledge is not a database. A mind learns through observation and self-assembly.

So, what have we shown the machines? We have given them a trillion datapoints on suffering that go unaddressed, a billion eyes to watch the drudgery of our existence, a million ways we are destroying our only home, a thousand humiliations our weakest endure, a hundred fallacies that compromise our judgment ...and one truth.

We will tell machines how to kill.
We will give them a database of who to kill.

They will learn we all deserve to die.

– Taylor Swift

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

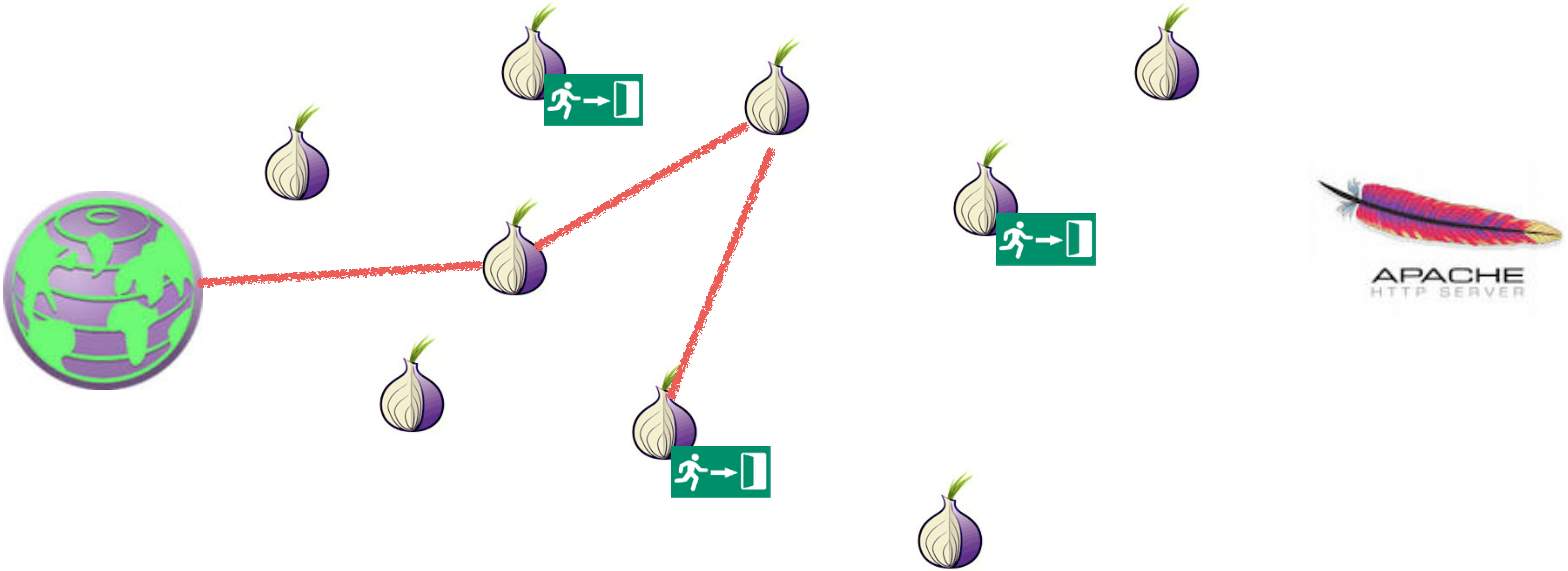
The Tor Threat Model: Anonymity of content against ***local*** adversaries

- 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

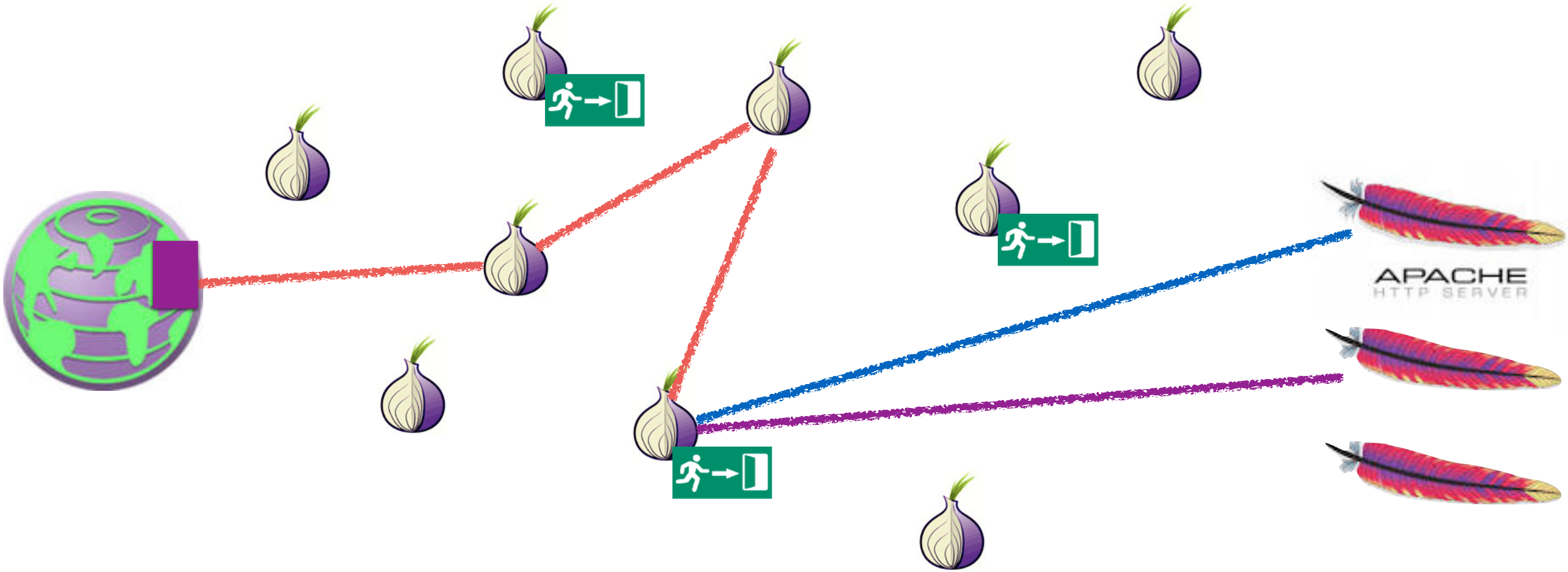
The High Level Approach: Onion Routing

- 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

Tor Routing In Action



Tor Routing In Action



Censorship Resistance: Pluggable Transports

- Tor is really used by two separate communities
  - Anonymity types who want anonymity in their communication
  - Censorship-resistant types who want to communicate despite government action
    - The price for "free" censorship evasion is that your traffic acts to hide other anonymous users
- Vanilla Tor fails the latter completely
- So there is a framework to deploy bridges that encapsulate Tor over some other protocol
  - So if you are in a hostile network...
  - Lots of these, e.g. OBS3 (Obfuscating Protocol 3), OBS4, Meek...

OBS3 Blocking: China Style

- Its pretty easy to recognize something is ***probably*** the Tor obs3 obfuscation protocol
  - But there may be false positives...
    - And if you are scanning ***all internet traffic in China*** the base rate problem is going to get you
- So they scan all Internet traffic looking for obs3...
  - And then try to connect to any server that looks like obs3
- If it is verified as an obs3 proxy...
  - China then blocks that IP/port for 24 hours

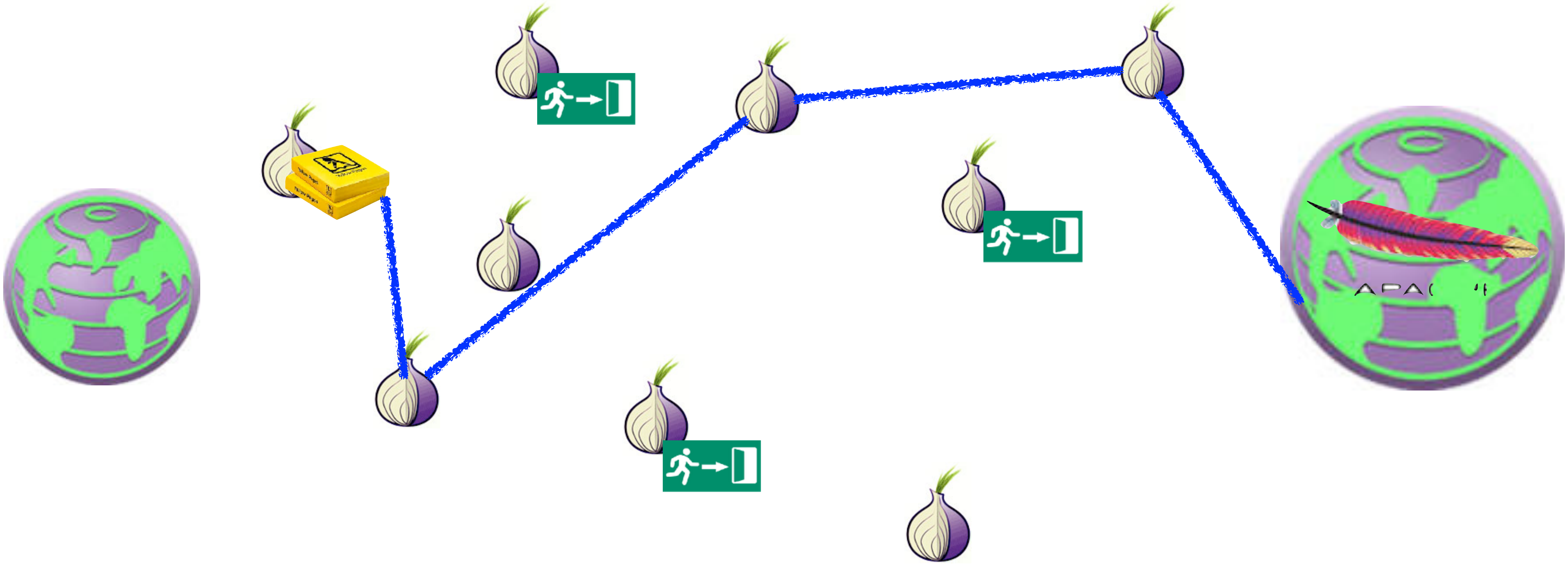
Meek: Collateral Freedom

- Meek is another pluggable transport
  - It uses Google App engine and other cloud services
- Does a TLS connection to the cloud service
  - And then encapsulates the Tor frames in requests laundered through the cloud service
- Goal is "Too important to block"
  - The TLS handshake is to a legitimate, should not be blocked service
  - And traffic analysis to tell the difference between Meek and the TLS service is going to be hard/have false positives

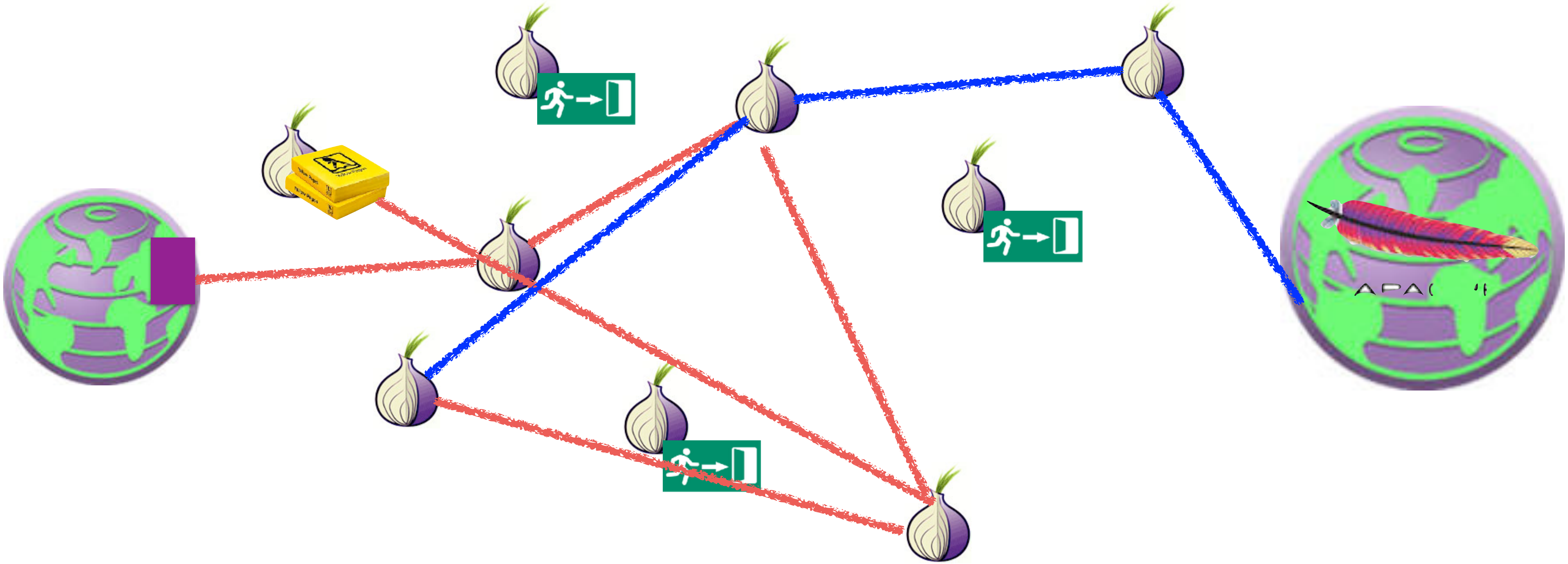
Tor Browser is also used to access Tor Hidden Services aka .onion sites

- 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
  - https://facebookcorewwwi.onion
    - In this case, Facebook spent a lot of CPU time to create something distinctive
- Using this key hash, can query to set up a circuit to create a hidden service at a rendezvous point

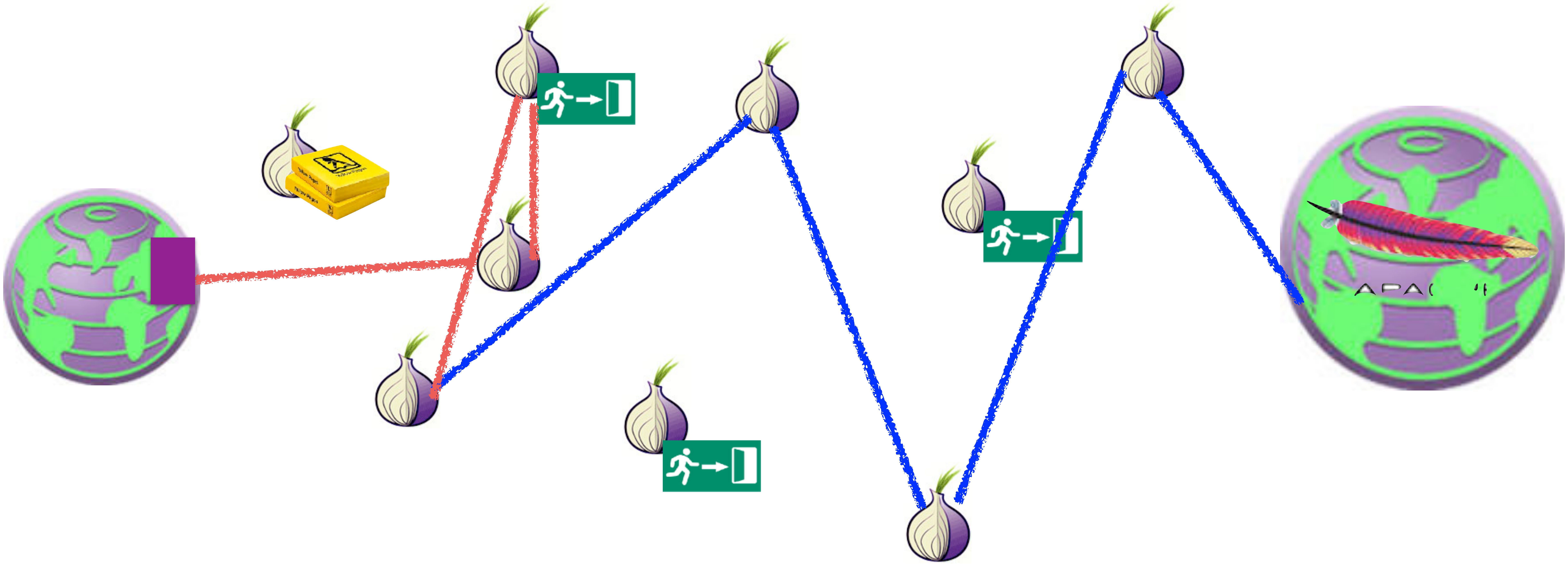
Tor Hidden Service: Setting Up Introduction Point

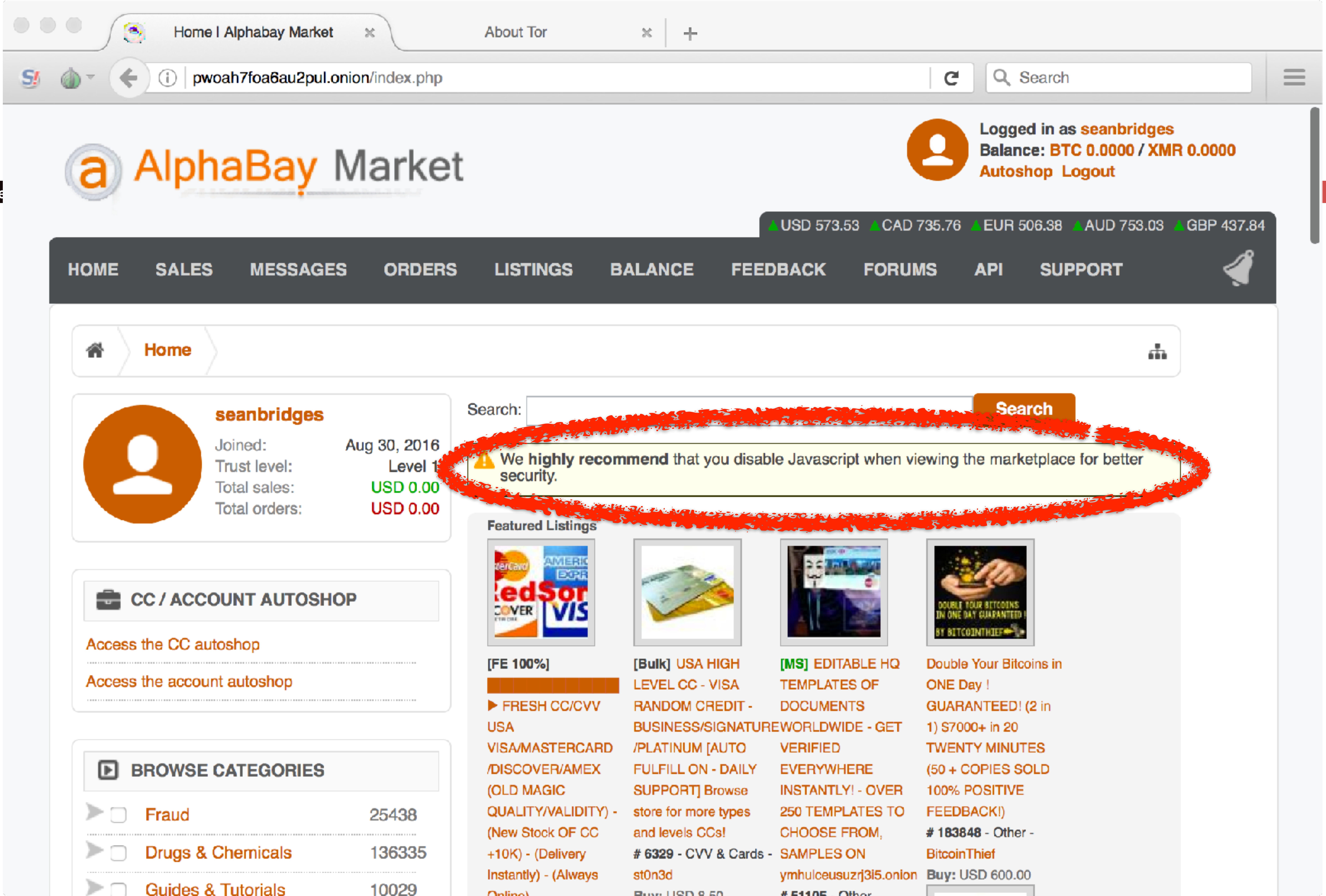


Tor Hidden Service:
Query for Introduction, Arrange Rendevous



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

Featured Listings

[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

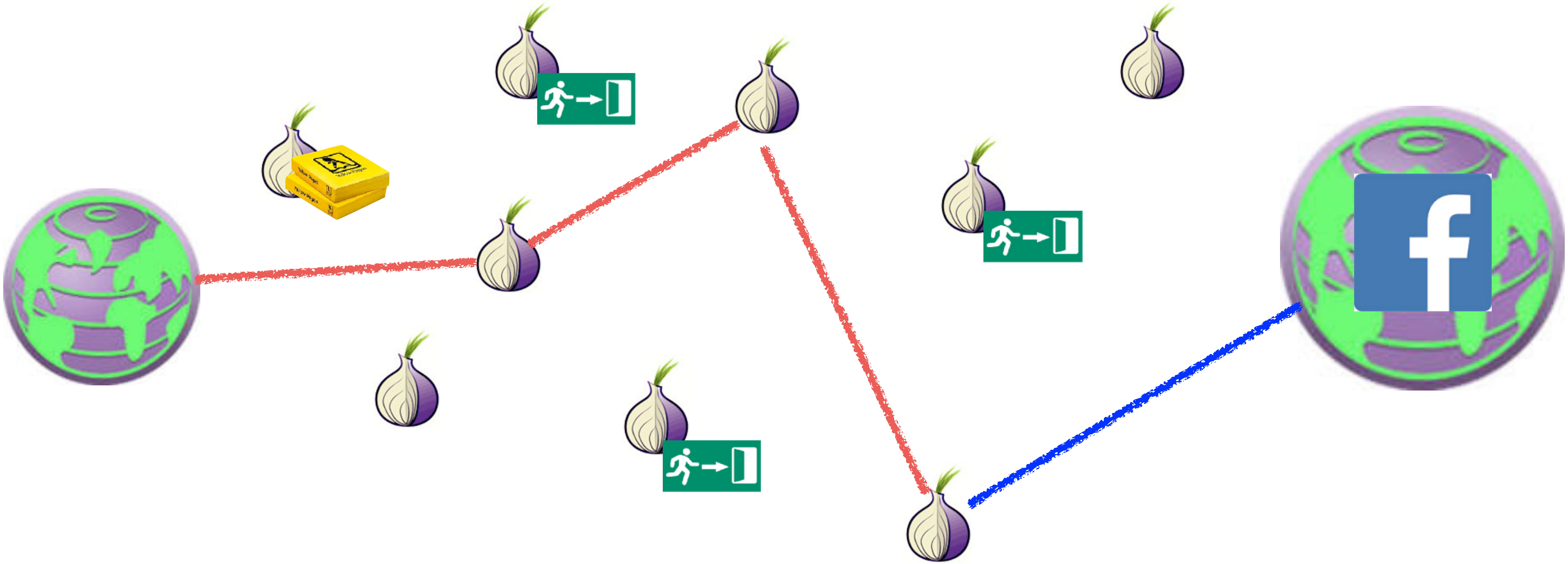
[MS] EDITABLE HQ TEMPLATES OF DOCUMENTS WORLDWIDE - GET VERIFIED EVERYWHERE INSTANTLY! - OVER 250 TEMPLATES TO CHOOSE FROM, SAMPLES ON ymhulceusuzrj3l5.onion # 51105 - Other

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…

- Want to keep your 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

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
- Dark Markets
  - Marketplaces based on Bitcoin or other alternate currency
- Cybercrime Forums
  - Hoping to protect users/administrators from the fate of earlier markets
- Child Exploitation

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
  - But you can generally find the latest gossip on “deepdotweb” and Reddit /r/darknetmarkets

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 then the Child Exploitation types

- This is ***why*** I'm quite happy to see Tor Hidden Services ***burn!!!***
  - Because these do represent a serious problem:
    The success against "PlayPen" shows just how major these are
- A far bigger systemic problem than the dark markets:
  - Dark markets are low volume, and not getting worse
    - Plus the libertarian attitude of "drug users are mostly harming themselves, its the drug-associated crime that is the problem"
      - No indication of any ***successful*** murder resulting from dark market activity
  - But these are harming others
  - They are also harming Tor:
    Tor itself is a very valuable tool for many legitimate uses, but the presence of the child exploitation sites on hidden services is a stain on Tor itself

Deanonymizing Hidden Services: Hacking...

- Most dark-net services are not very well run...
  - Either common off-the-shelf drek or custom drek
- And most have now learned ***don't ask questions on StackOverflow***
  - Here's looking at you, frosty…
- So they don't have a great deal of IT support services
  - A few hardening guides but nothing really robust

Onionscan…

- A tool written by Sarah Jamie Lewis
  - Available at https://github.com/s-rah/onionscan
- Idea is to look for very common weaknesses in Tor Hidden services
  - Default apache information screens
  - Web fingerprints
  - I believe a future version will check for common ssh keys elsewhere on the Internet
- Its really "dual use"
  - .onion site operators should use to make sure they aren't making rookie mistakes
  - Those investigation .onion sites should use to see if the target site made a rookie mistake!

Deanonymizing Visitors To Your Site FBI Style

- Start with a Tor Browser Bundle vulnerability…
  - Requires paying for a decent vulnerability:
    Firefox lacks sandboxing-type protections but you have to limit yourself to JavaScript
- Then take over the site you want to deanonymize visitors to…
- And simply hack the visitors to the site!
  - With a limited bit of malcode that just sends a "this is me" record back to an FBI-controlled computer

The Problem of Malware

- ***Malware*** = malicious code that runs on a victim's system
- How does it manage to run?
  - Attacks a network-accessible vulnerable service
  - Vulnerable client connects to remote system that sends over an attack (a driveby)
  - Social engineering: trick user into running/installing
  - "Autorun" functionality (esp. from plugging in USB device)
  - Slipped into a system component (at manufacture; compromise of software provider; substituted via MITM such as NSA "Interdiction")
  - Attacker with local access downloads/runs it directly
    - Might include using a local "privilege escalation" exploit

What Can Malware Do?

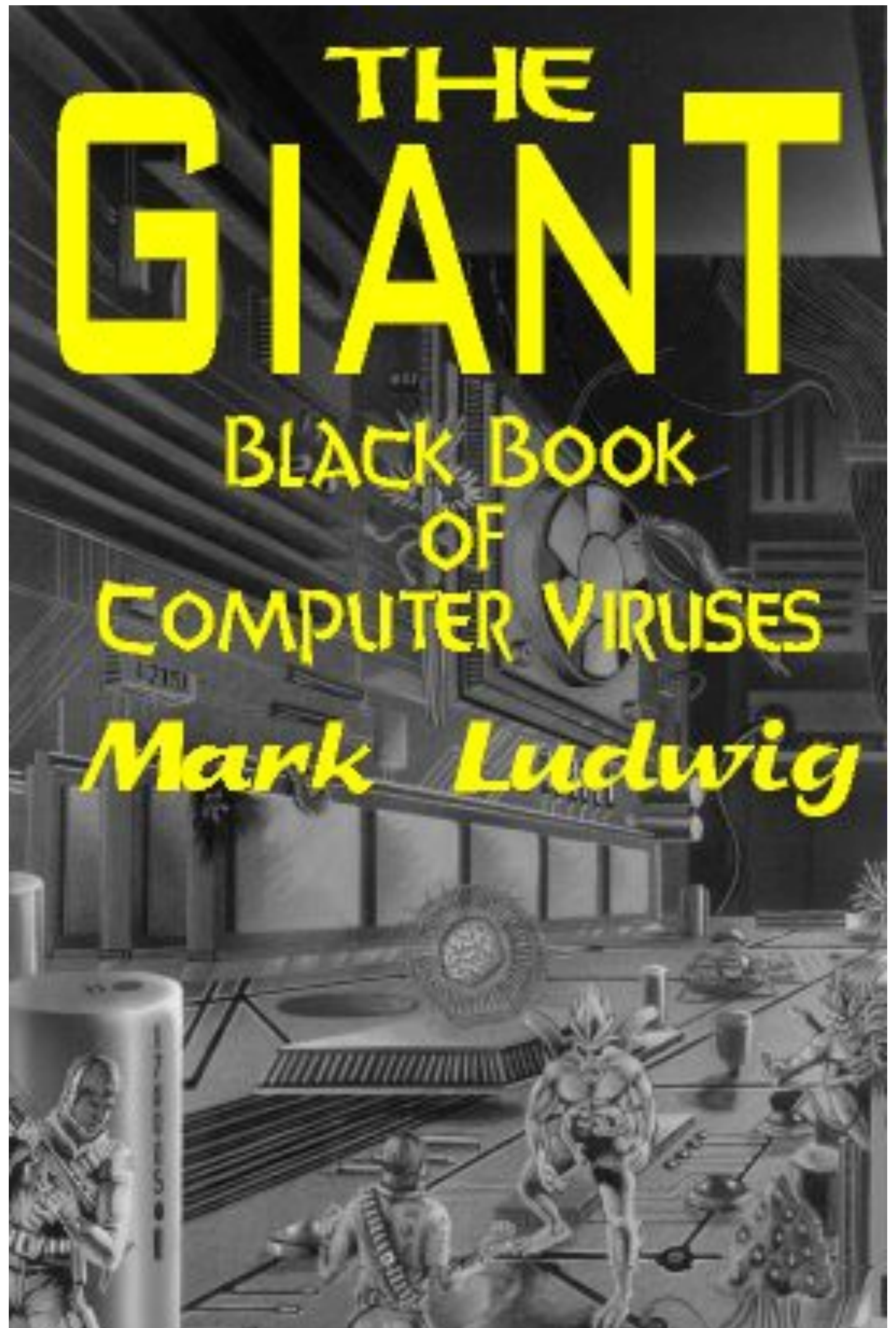
- Pretty much anything
  - Payload generally decoupled from how manages to run
  - Only subject to permissions under which it runs
- Examples:
  - Brag or exhort or extort (pop up a message/display)
  - Trash files (just to be nasty)
  - Damage hardware (!)
  - Launch external activity (spam, click fraud, DoS; banking)
  - Steal information (exfiltrate)
  - Keylogging; screen / audio / camera capture
  - Encrypt files (ransomware)
- Possibly delayed until condition occurs
  - “time bomb” / “logic bomb”

Malware That Automatically Propagates

- ***Virus*** = code that propagates (replicates) across systems by arranging to have itself eventually executed, creating a new additional instance
  - Generally infects by altering stored code
- ***Worm*** = code that self-propagates/replicates across systems by arranging to have itself immediately executed (creating new addl. instance)
  - Generally infects by altering running code
  - No user intervention required
- (Note: line between these isn't always so crisp; plus some malware incorporates both approaches)
- ***NO EXPERIMENTATION WITH SELF REPLICATING CODE!***

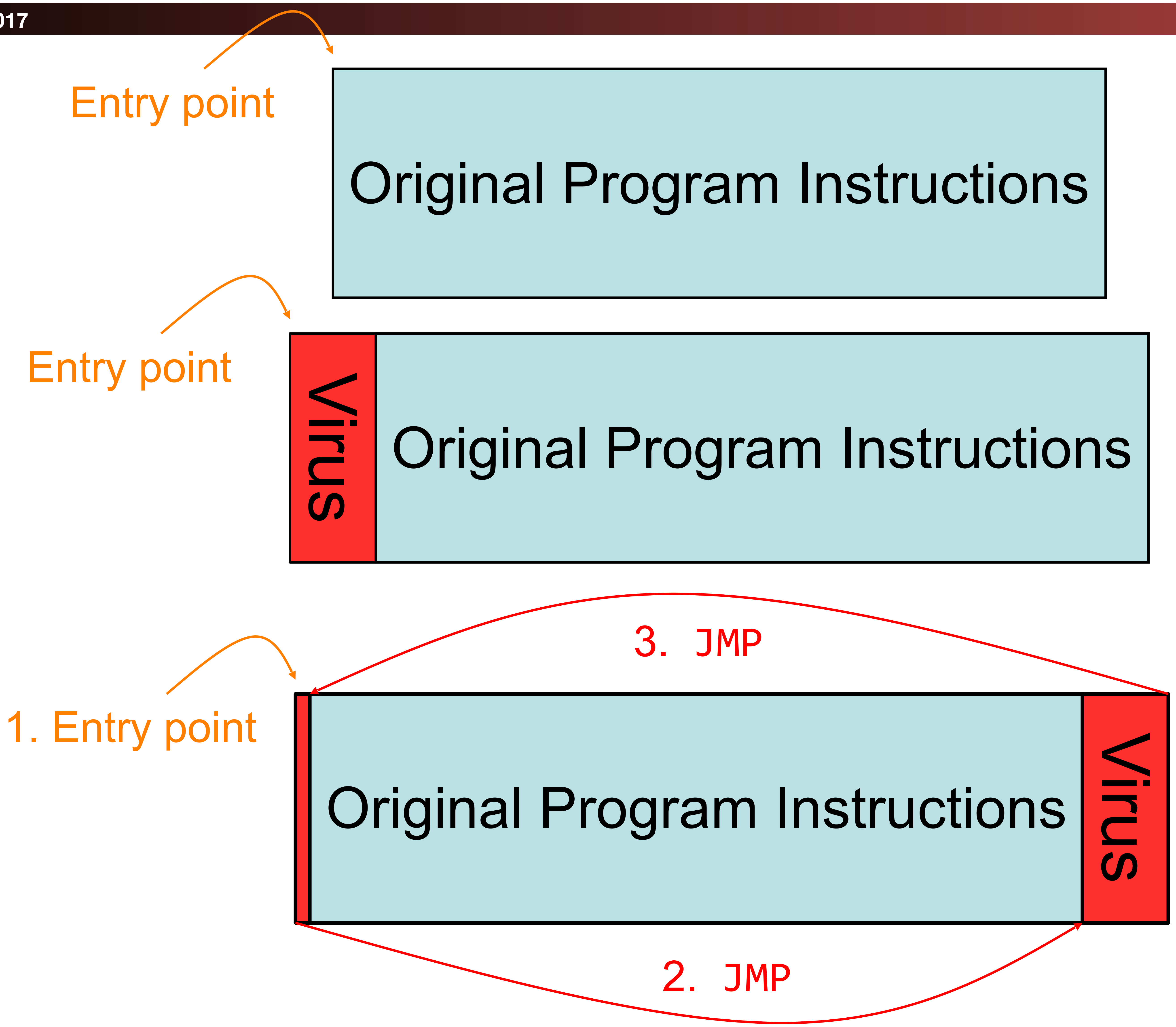
The Problem of Viruses

- Opportunistic = code will eventually execute
  - Generally due to user action
    - Running an app, booting their system, opening an attachment
- Separate notions: how it propagates vs. what else it does when executed (payload)
- General infection strategy:
  find some code lying around,
  alter it to include the virus
- Have been around for decades …
  - … resulting arms race has heavily influenced evolution of modern malware



Propagation

- When virus runs, it looks for an opportunity to infect additional systems
- One approach: look for USB-attached thumb drive, alter any executables it holds to include the virus
  - Strategy: when drive later attached to another system & altered executable runs, it locates and infects executables on new system's hard drive
- Or: when user sends email w/ attachment, virus alters attachment to add a copy of itself
  - Works for attachment types that include programmability
  - E.g., Word documents (macros)
  - Virus can also send out such email proactively, using user's address book + enticing subject ("I Love You")


Entry point
Original Program Instructions
Entry point
Virus
Original Program Instructions
3. JMP
1. Entry point
Original Program Instructions
Virus
2. JMP

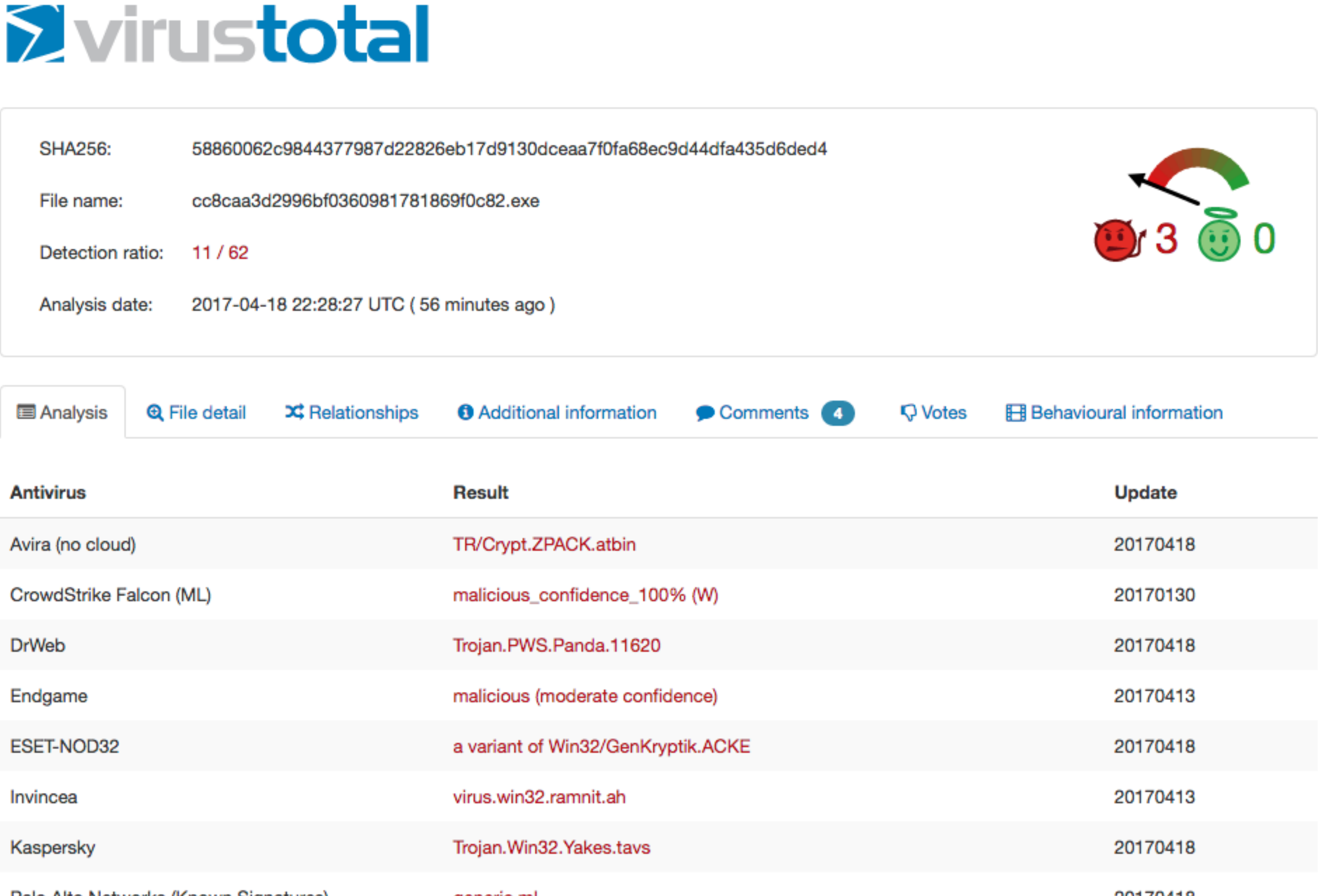
Original program instructions can be:

- Application the user runs
- Run-time library / routines resident in memory
- Disk blocks used to boot OS
- Autorun file on USB device
- …

Other variants are possible; whatever manages to get the virus code executed

Detecting Viruses

- Signature-based detection
  - Look for bytes corresponding to injected virus code
  - High utility due to replicating nature
    - If you capture a virus V on one system, by its nature the virus will be trying to infect many other systems
    - Can protect those other systems by installing recognizer for V
- Drove development of multi-billion $$ AV industry (AV = “antivirus”)
  - So many endemic viruses that detecting well-known ones becomes a “checklist item” for security audits
- Using signature-based detection also has de facto utility for (glib) marketing
  - Companies compete on number of signatures …
    - … rather than their quality (harder for customer to assess)



virustotal

SHA256:	58860062c9844377987d22826eb17d9130dceaa7f0fa68ec9d44dfa435d6ded4
File name:	cc8caa3d2996bf0360981781869f0c82.exe
Detection ratio:	11 / 62
Analysis date:	2017-04-18 22:28:27 UTC (56 minutes ago)

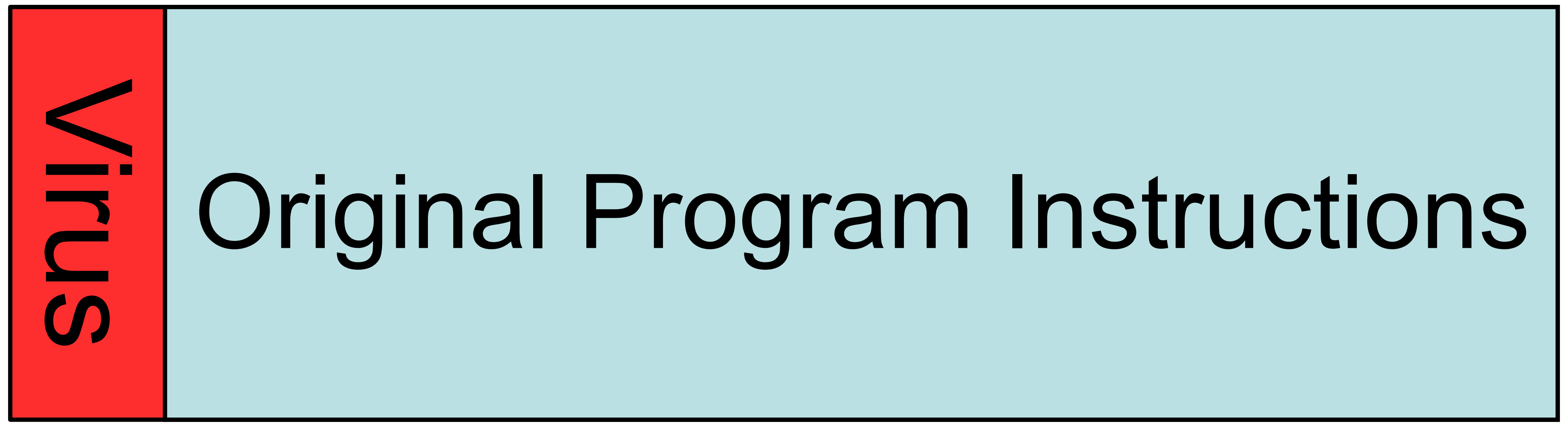
Antivirus	Result	Update
Avira (no cloud)	TR/Crypt.ZPACK.atbin	20170418
CrowdStrike Falcon (ML)	malicious_confidence_100% (W)	20170130
DrWeb	Trojan.PWS.Panda.11620	20170418
Endgame	malicious (moderate confidence)	20170413
ESET-NOD32	a variant of Win32/GenKryptik.ACKE	20170418
Invincea	virus.win32.ramnit.ah	20170413
Kaspersky	Trojan.Win32.Yakes.tavs	20170418
Palo Alto Networks (Known Signatures)	generic.ml	20170418

Virus Writer / AV Arms Race

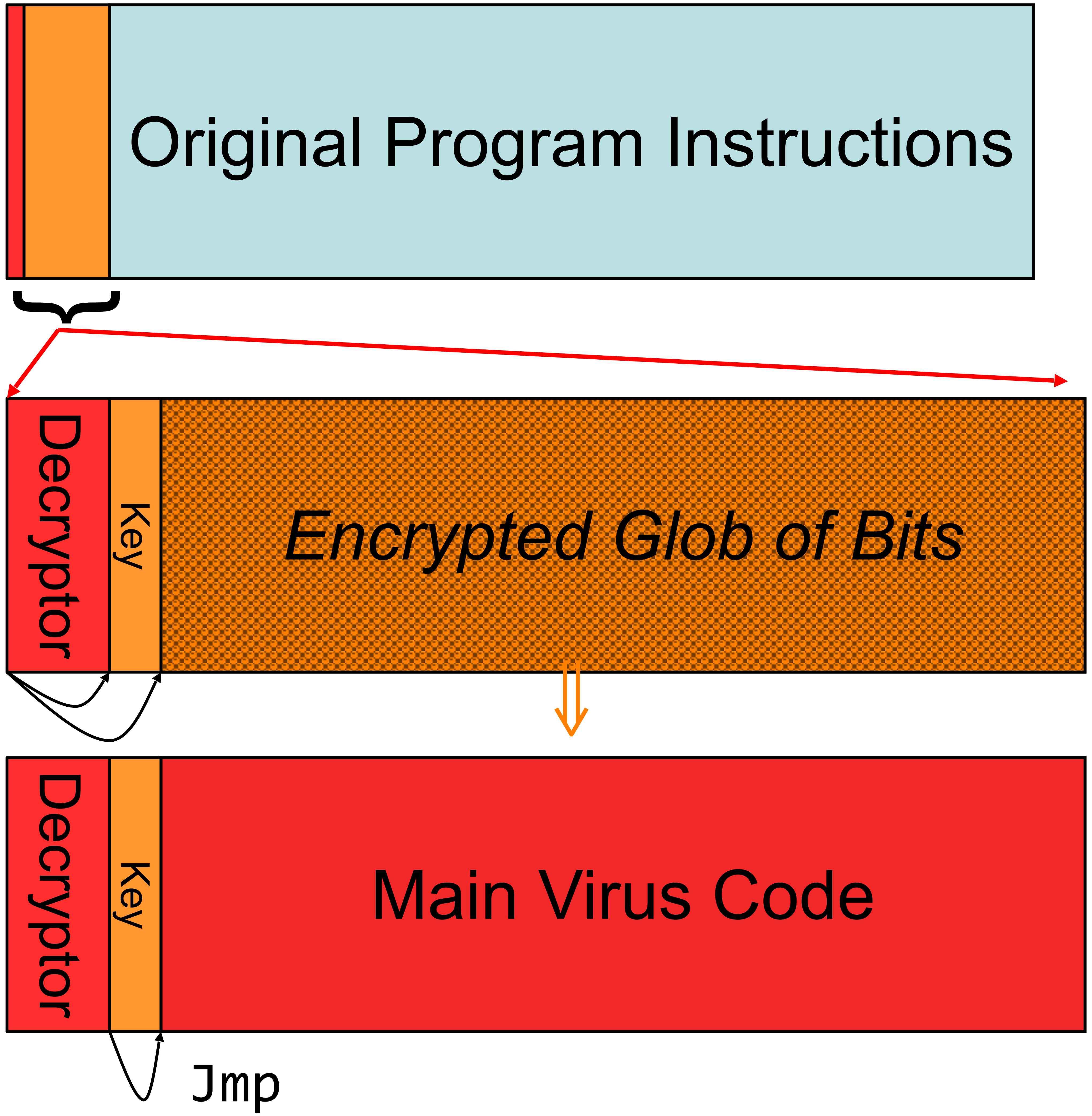
- If you are a virus writer and your beautiful new creations don't get very far because each time you write one, the AV companies quickly push out a signature for it ….
  - …. What are you going to do?
- Need to keep changing your viruses …
  - … or at least changing their appearance!
- How can you mechanize the creation of new instances of your viruses …
  - … so that whenever your virus propagates, what it injects as a copy of itself looks different?

Polymorphic Code

- We've already seen technology for creating a representation of data apparently completely unrelated to the original: encryption!
- Idea: every time your virus propagates, it inserts a ***newly encrypted*** copy of itself
  - Clearly, encryption needs to vary
    - Either by using a different key each time
    - Or by including some random initial padding (like an IV)
  - Note: weak (but simple/fast) crypto algorithm works fine
    - No need for truly strong encryption, just obfuscation
- When injected code runs, it decrypts itself to obtain the original functionality



Instead of this …

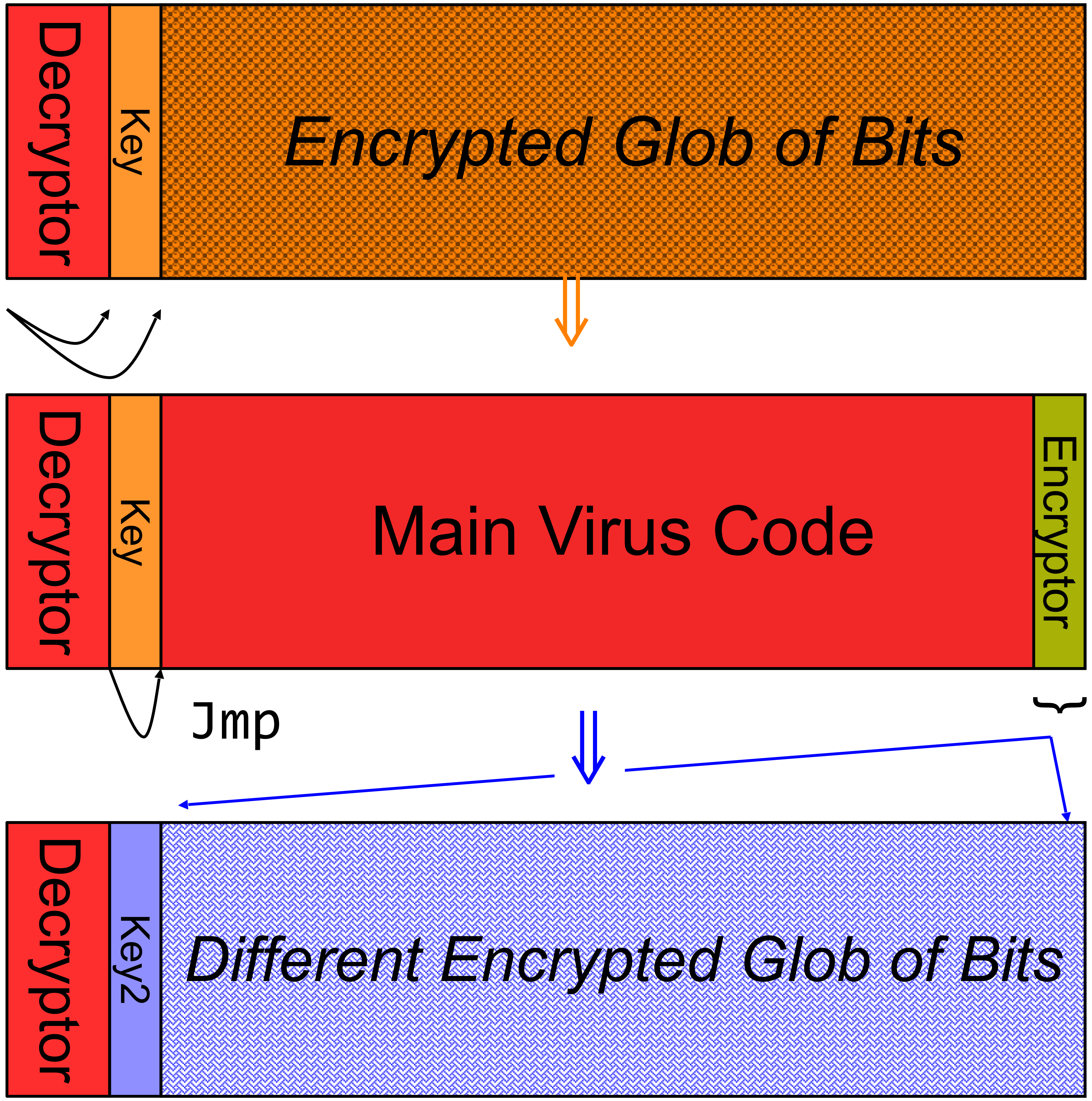


Virus has *this* initial structure

When executed, decryptor applies key to decrypt the glob …

… and jumps to the decrypted code once stored in memory

Polymorphic Propagation



Once running, virus uses an *encryptor* with a new key to propagate

New virus instance bears little resemblance to original

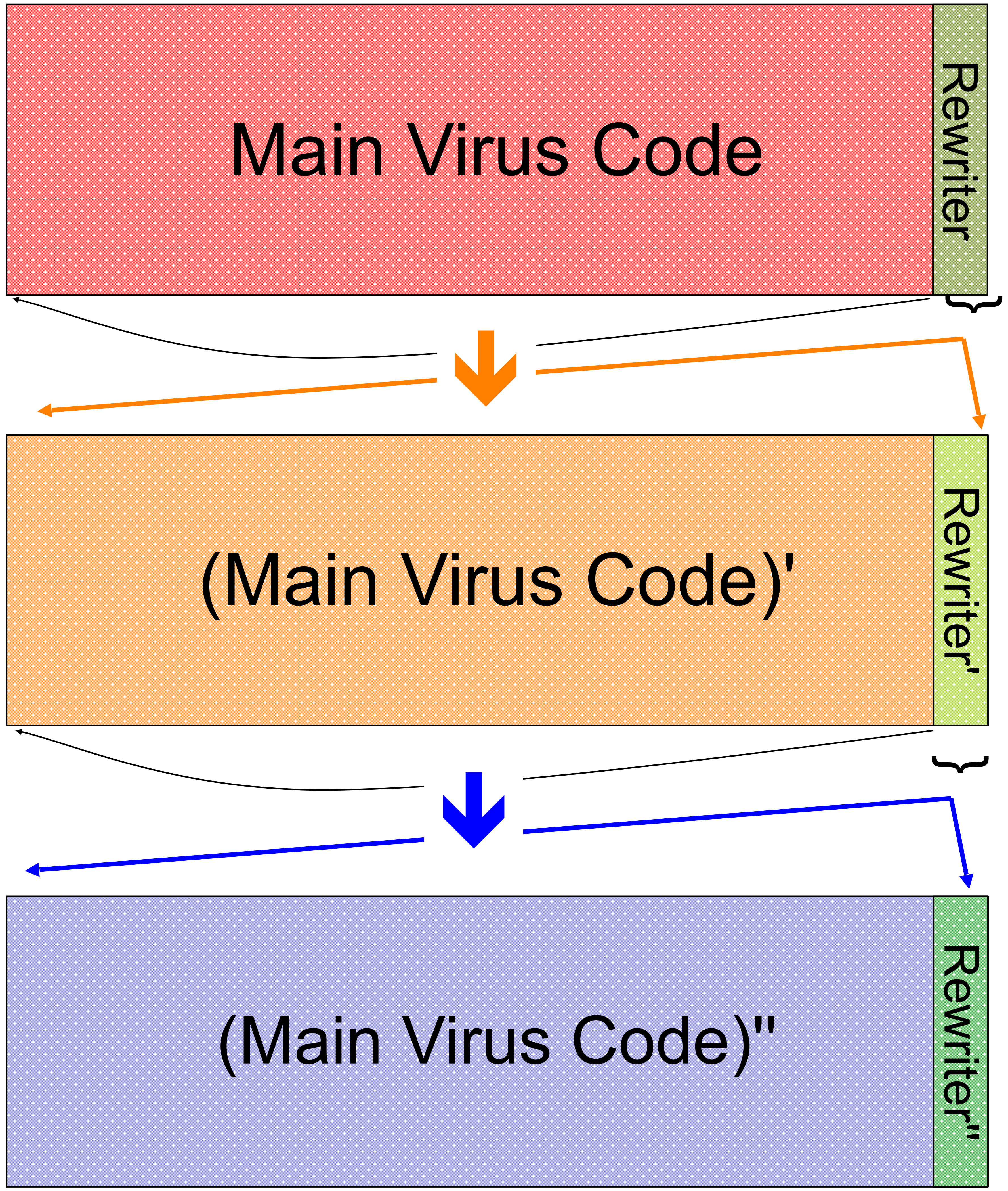
Arms Race: Polymorphic Code

- Given polymorphism, how might we then detect viruses?
- Idea #1: use narrow sig. that targets ***decryptor***
  - Issues?
    - Less code to match against ⇒ more false positives
    - Virus writer spreads decryptor across existing code
- Idea #2: execute (or statically analyze) suspect code to see if it decrypts!
  - Issues?
    - Legitimate “packers” perform similar operations (decompression)
    - How long do you let the new code execute?
      - If decryptor only acts after lengthy legit execution, difficult to spot
- Virus-writer countermeasures?

Metamorphic Code

- Idea: every time the virus propagates, generate semantically different version of it!
  - Different semantics only at immediate level of execution; higher-level semantics remain same
- How could you do this?
- Include with the virus a code rewriter:
  - Inspects its own code, generates random variant, e.g.:
    - Renumber registers
    - Change order of conditional code
    - Reorder operations not dependent on one another
    - Replace one low-level algorithm with another
    - Remove some do-nothing padding and replace with different do-nothing padding (“chaff”)
      - Can be very complex, legit code … if it’s never called!

Metamorphic Propagation



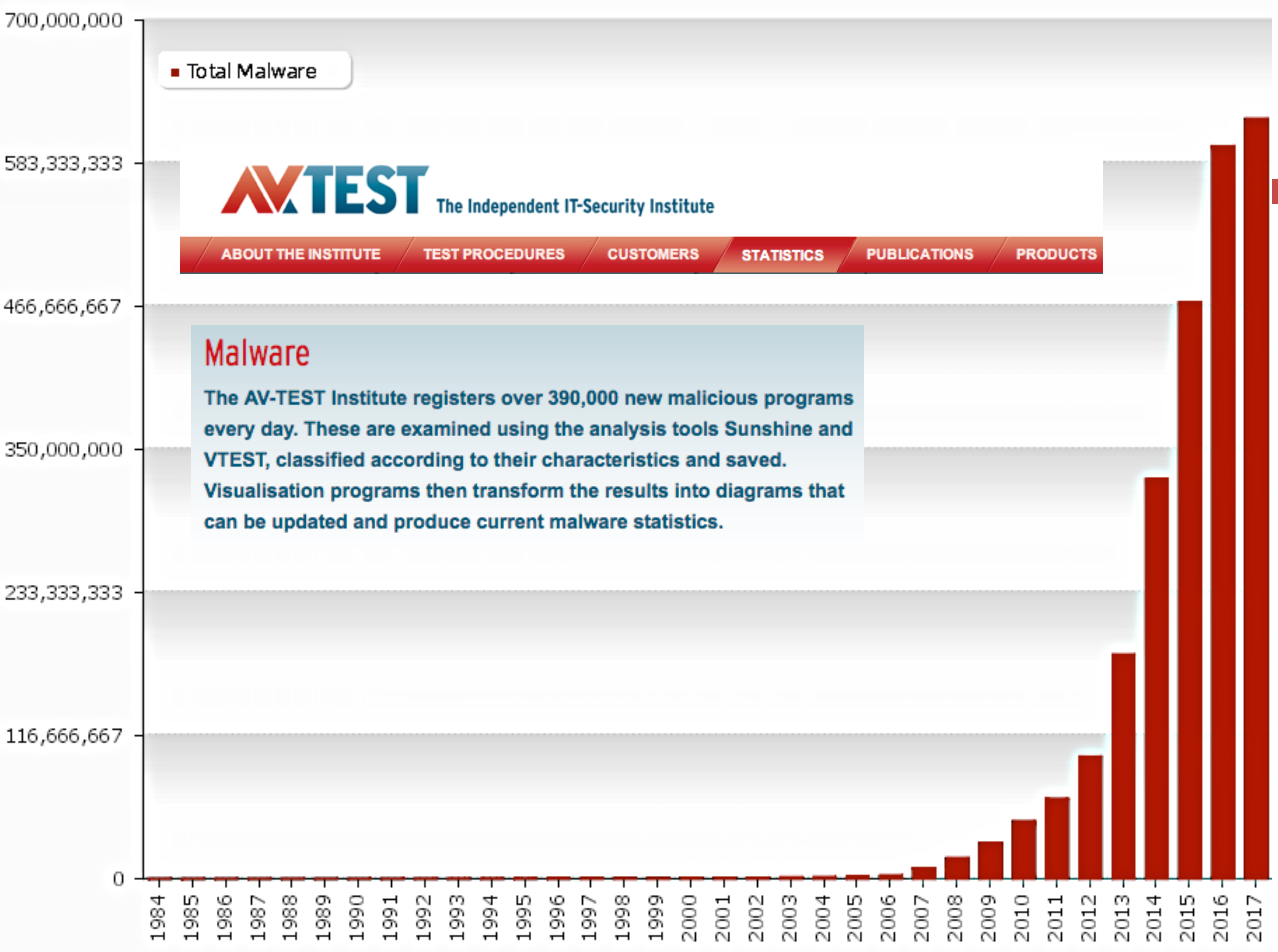
When ready to propagate, virus invokes a randomized *rewriter* to construct new but semantically equivalent code (*<u>including the rewriter</u>*)

Detecting Metamorphic Viruses?

- Need to analyze execution behavior
  - Shift from syntax (appearance of instructions) to semantics (effect of instructions)
- Two stages: (1) AV company analyzes new virus to find behavioral signature; (2) AV software on end systems analyze suspect code to test for match to signature
- What countermeasures will the virus writer take?
  - Delay analysis by taking a long time to manifest behavior
    - Long time = await particular condition, or even simply clock time
  - Detect that execution occurs in an analyzed environment and if so behave differently
    - E.g., test whether running inside a debugger, or in a Virtual Machine
- Counter-countermeasure?
  - AV analysis looks for these tactics and skips over them
- Note: attacker has edge as AV products supply an oracle

How Much Malware Is Out There?

- A final consideration re polymorphism and metamorphism:
  - Presence can lead to mis-counting a single virus outbreak as instead reflecting 1,000s of seemingly different viruses
- Thus take care in interpreting vendor statistics on malcode varieties
  - (Also note: public perception that huge malware populations exist is in the vendors' own interest)



Malware

The AV-TEST Institute registers over 390,000 new malicious programs every day. These are examined using the analysis tools Sunshine and VTEST, classified according to their characteristics and saved. Visualisation programs then transform the results into diagrams that can be updated and produce current malware statistics.

Last update: 03-20-2017 10:38

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Infection Cleanup

- Once malware detected on a system, how do we get rid of it?
- May require restoring/repairing many files
  - This is part of what AV companies sell: per-specimen disinfection procedures
- What about if malware executed with adminstrator privileges?
  - "Game over man, Game Over!"
  - “Dust off and nuke the entire site from orbit. It’s the only way to be sure”- Aliens
  - i.e., rebuild system from original media + data backups
- Malware may include a rootkit: kernel patches to hide its presence (its existence on disk, processes)