Résistance des GNUs
2015 Edition

Christian Grothoff

Inria Rennes Bretagne Atlantique

24.3.2015

"Never doubt your ability to change the world." –Glenn Greenwald

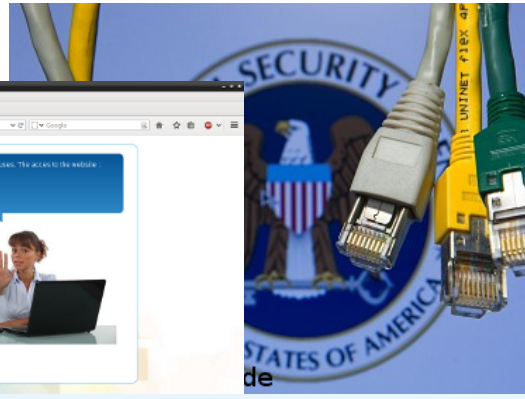
Where We Are

Where We Are


Source: csmoni


Source: gawand.org


Source: padresteve.com



Source: wikileaks.org

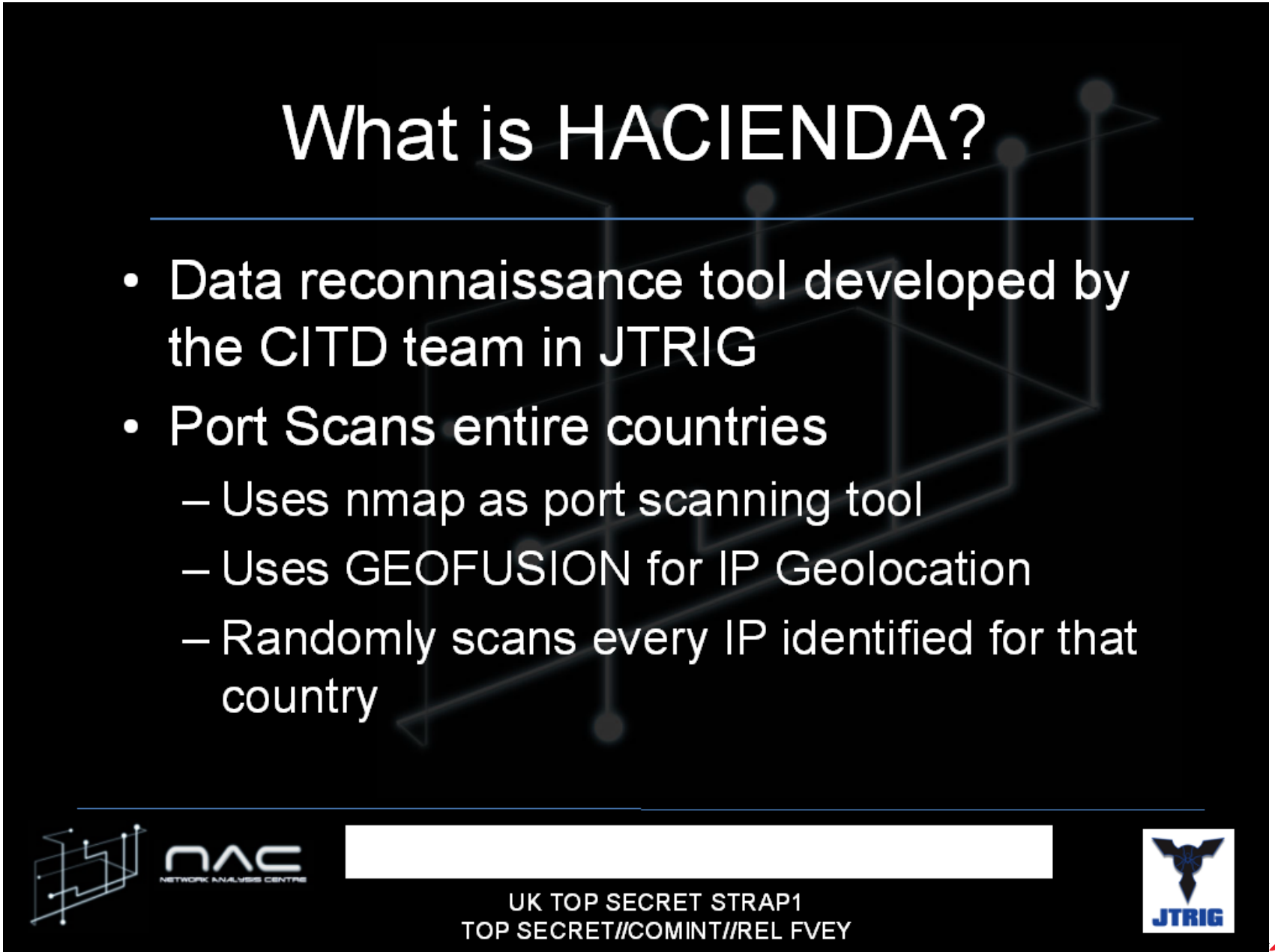
Source: wikicommons.org


Source: enturebeat.com

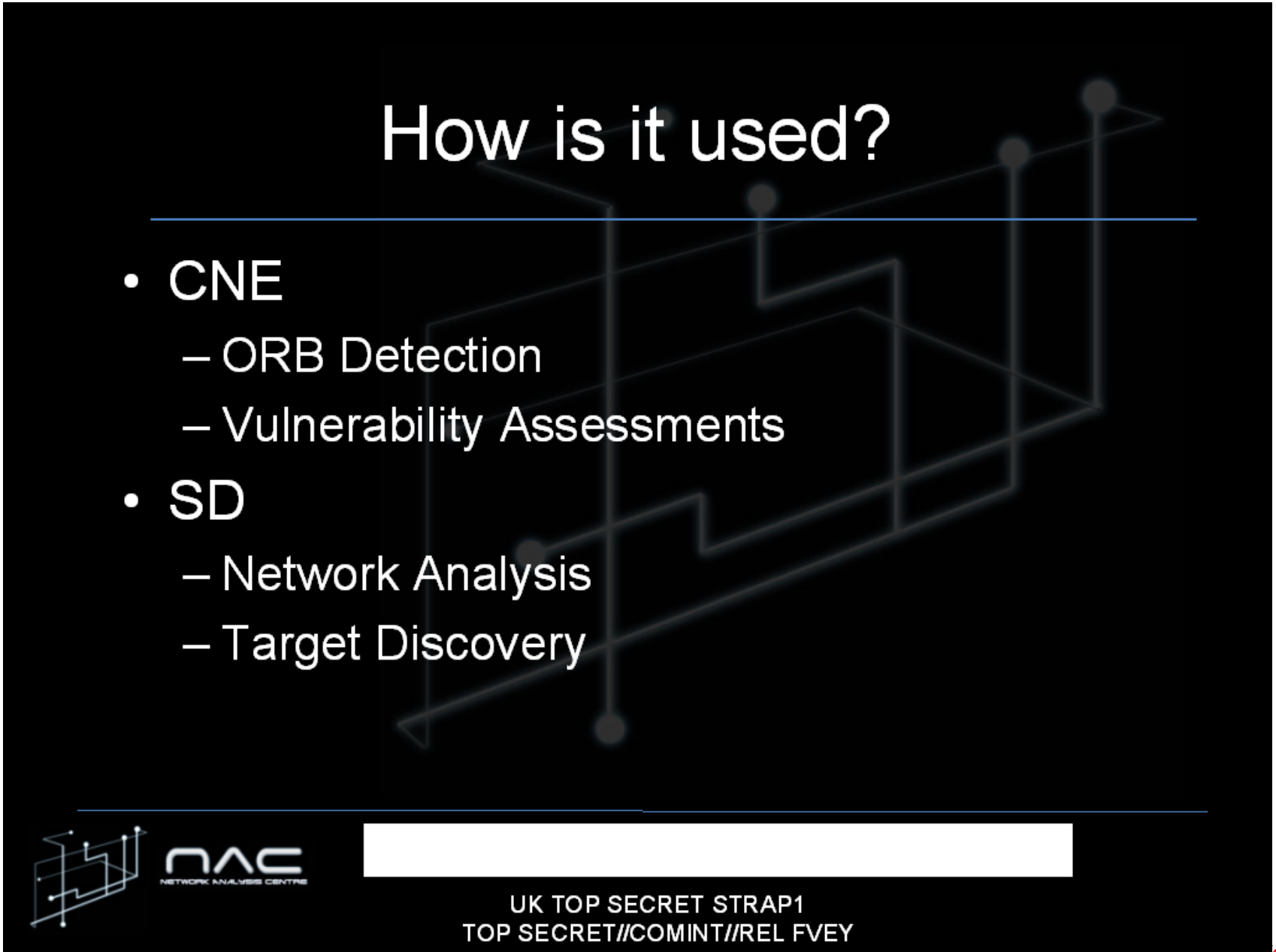
Dé centrali sé

informatiques mathématiques

Example 1: Collateral Damage



Example 1: Collateral Damage



Example 1: Collateral Damage

TOP SECRET//COMINT

Communications Security Establishment | Centre de la sécurité des télécommunications

LANDMARK

- CSEC's Operational Relay Box (ORB) covert infrastructure used to provide an additional level of non-attribution; subsequently used for exploits and exfiltration
- 2-3 times/year, 1 day focused effort to acquire as many new ORBs as possible in as many non 5-Eyes countries as possible

Canada

Why should you care?

If you are ...

- ... of any importance in the world, or
- ... a system or network administrator, or
- ... a security researcher, or
- ... in this room, or
- ... mistaken for any of the above,

Why should you care?

If you are ...

- ... of any importance in the world, or
- ... a system or network administrator, or
- ... a security researcher, or
- ... in this room, or
- ... mistaken for any of the above,

then you are probably a target.

So what if they listen to my calls?

- Kompromat — and you do not get to decide what is bad!
- Self-censorship
- Loss of business
- No privacy $\Rightarrow$ No free press $\Rightarrow$ No liberal democracy

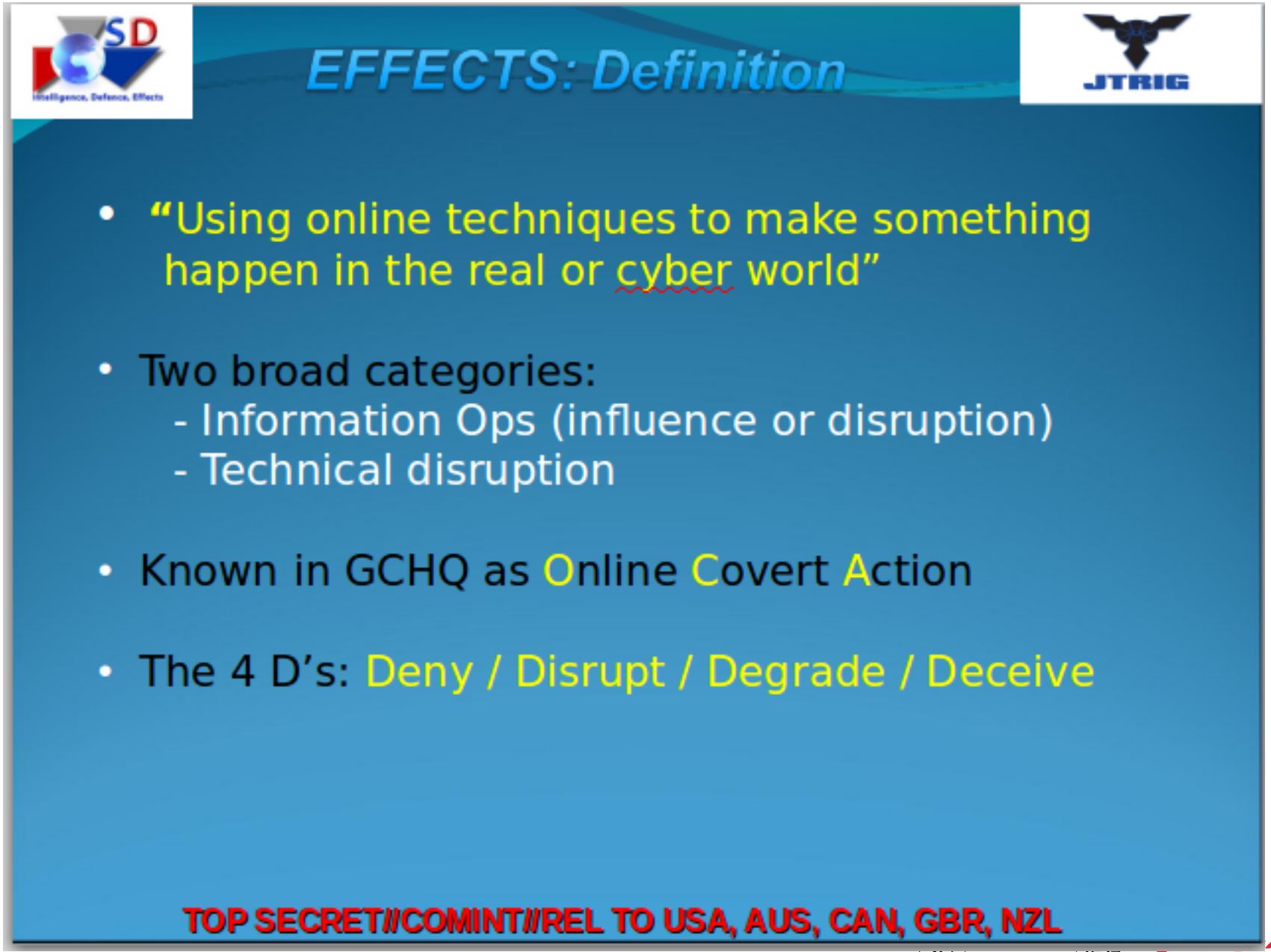
So what if they listen to my calls?

- Kompromat — and you do not get to decide what is bad!
- Self-censorship
- Loss of business
- No privacy $\Rightarrow$ No free press $\Rightarrow$ No liberal democracy
- Security services also get you drunk, encourage you to drive, arrest you for drunken driving and then ask you for your customer data.

Example 2: Zersetzung

Example 2: Zersetzung

Example 2: Zersetzung



Targets

- Labor movement
- Environmental groups
- Foreign governments
- Industrial competitors
- United Nations
- European Union

Example 3: Trusting Trust

[edit] (S//NF) Strawhorse: Attacking the MacOS and iOS Software Development Kit

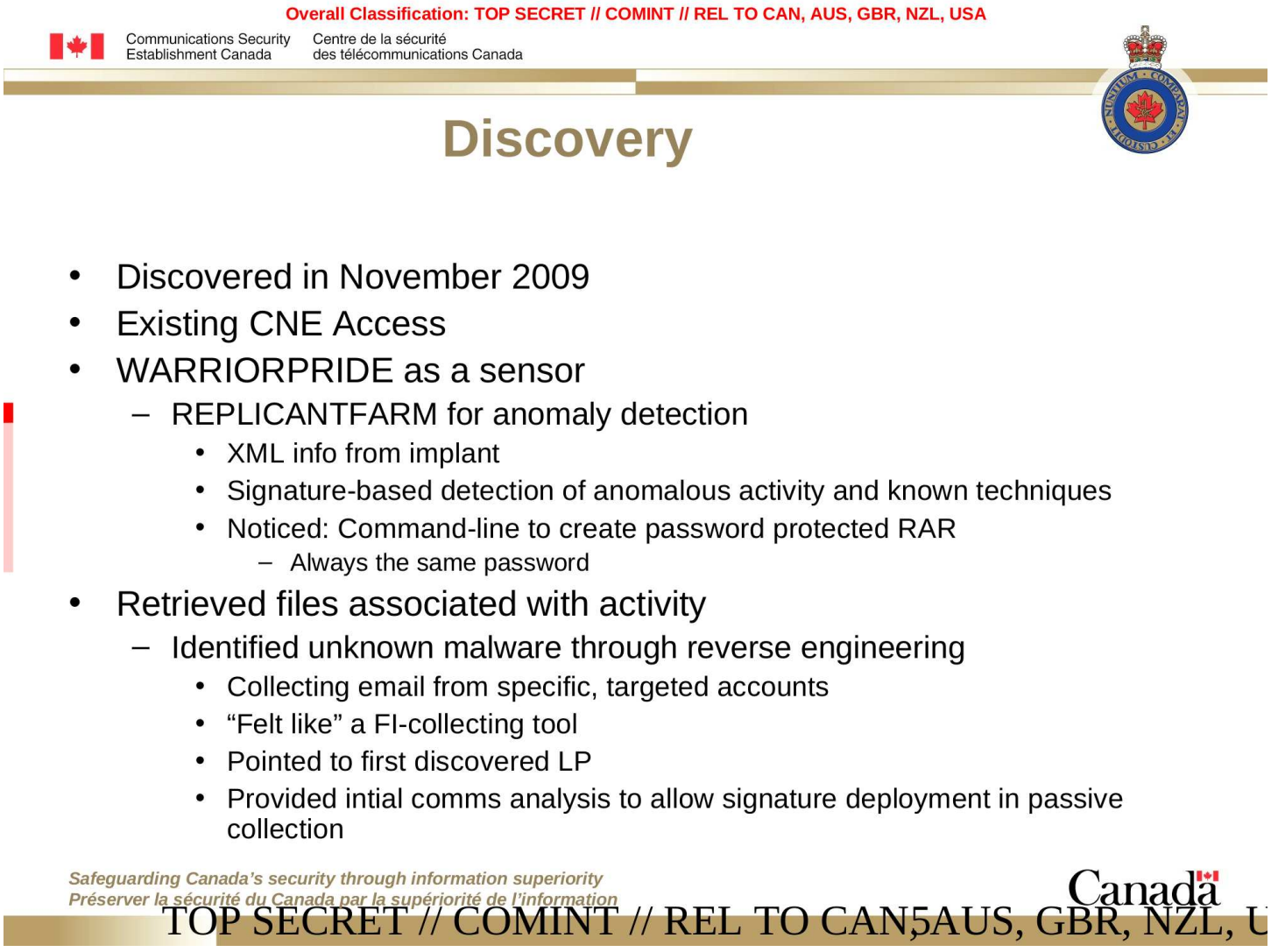
(S) Presenter: [redacted], Sandia National Laboratories

(S//NF) Ken Thompson's gcc attack (described in his 1984 Turing award acceptance speech) motivates the StrawMan work: what can be done of benefit to the US Intelligence Community (IC) if one can make an arbitrary modification to a system compiler or Software Development Kit (SDK)? A (whacked) SDK can provide a subtle injection vector onto standalone developer networks, or it can modify any binary compiled by that SDK. In the past, we have watermarked binaries for attribution, used binaries as an exfiltration mechanism, and inserted Trojans into compiled binaries.

(S//NF) In this talk, we discuss our explorations of the Xcode (4.1) SDK. Xcode is used to compile MacOS X applications and kernel extensions as well as iOS applications. We describe how we use (our whacked) Xcode to do the following things: -Entice all MacOS applications to create a remote backdoor on execution -Modify a dynamic dependency of securityd to load our own library - which rewrites securityd so that no prompt appears when exporting a developer's private key -Embed the developer's private key in all iOS applications -Force all iOS applications to send embedded data to a listening post -Convince all (new) kernel extensions to disable ASLR

(S//NF) We also describe how we modified both the MacOS X updater to install an extra kernel extension (a keylogger) and the Xcode installer to include our SDK whacks.

Example 4: Knowing your Enemies



Example 4: Knowing your Enemies

Victimology: Iran

- Iranian MFA
- Iran University of Science and Technology
- Atomic Energy Organization of Iran
- Data Communications of Iran
- Iranian Research Organization for Science Technology, Imam Hussein University
- Malek-E-Ashtar University

Example 4: Knowing your Enemies

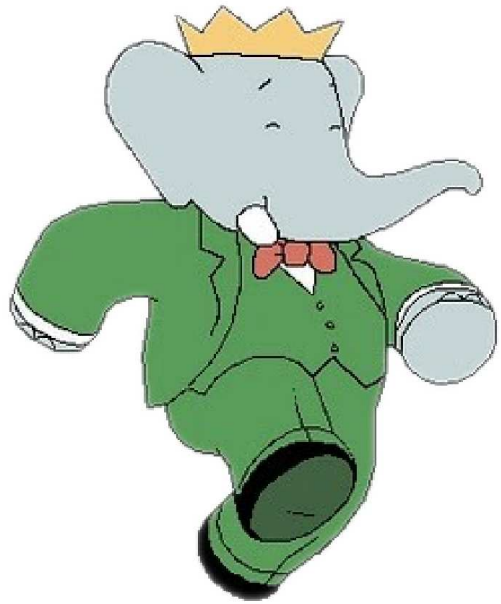
Victimology: Global

- Five Eyes
  - Possible targeting of a French-language Canadian media organization
- Europe
  - Greece
    - Possibly associated with European Financial Association
  - France
  - Norway
  - Spain
- Africa
  - Ivory Coast
  - Algeria

Example 4: Knowing your Enemies

Attribution: Binary Artifacts

- ntrass.exe
  - DLL Loader uploaded to a victim as part of tasking seen in collection
  - Internal Name: Babar
  - Developer username: titi
- Babar is a popular French children's television show
- Titi is a French diminutive for Thiery, or a colloquial term for a small person



Example 4: Knowing your Enemies

Attribution: Language

- ko used instead of kB – a quirk of the French technical community
- English used throughout C2 interface, BUT phrasing and word choice are not typical of a native English speaker
  - An attempt at obfuscation?
- Locale option of artifact within spear-phishing attack set to "fr_FR"

Example 4: Knowing your Enemies

Attribution: Intelligence Priorities

- Iranian science and technology
  - Notably, the Atomic Energy Organization of Iran
  - Nuclear research
- European supranational organizations
  - European Financial Association
- Former French colonies
  - Algeria, Ivory Coast
- French-speaking organizations/areas
  - French-language media organization
- Doesn't fit cybercrime profile

Example 5: Pwning your Enemies

Example 5: Pwning your Enemies

(TS//SI//REL) Is there "fifth party" collection? | Round Table

(TS//SI//REL) Yes. There was a project that I was working last year with regard to the South Korean CNE program. While we aren't super interested in SK (things changed a bit when they started targeting us a bit more), we were interested in North Korea and SK puts a lot of resources against them. At that point, our access to NK was next to nothing but we were able to make some inroads to the SK CNE program. We found a few instances where there were NK officials with SK implants on their boxes, so we got on the exfil points, and sucked back the data. Thats fourth party. (TS//SI//REL) However, some of the individuals that SK was targeting were also part of the NK CNE program. So I guess that would be the fifth party collect you were talking about. But once that started happening, we ramped up efforts to target NK ourselves (as you dont want to rely on an untrusted actor to do your work for you). But some of the work that was done there was able to help us gain access. (TS//SI//REL) I know of another instance (I will be more vague because I believe there are more compartments involved and parts are probably NF) where there was an actor we were going against. We realized there was another actor that was also going against them and having great success because of a 0 day they wrote. We got the 0 day out of passive and were able to re-purpose it. Big win. (TS//SI//REL) But they were all still referred to as fourth party.
answered 2 days ago
UNCLASSIFIED//FOUO
[redacted] (CIV-NSA)

Add A Comment | Show 1 Comment (1 new)

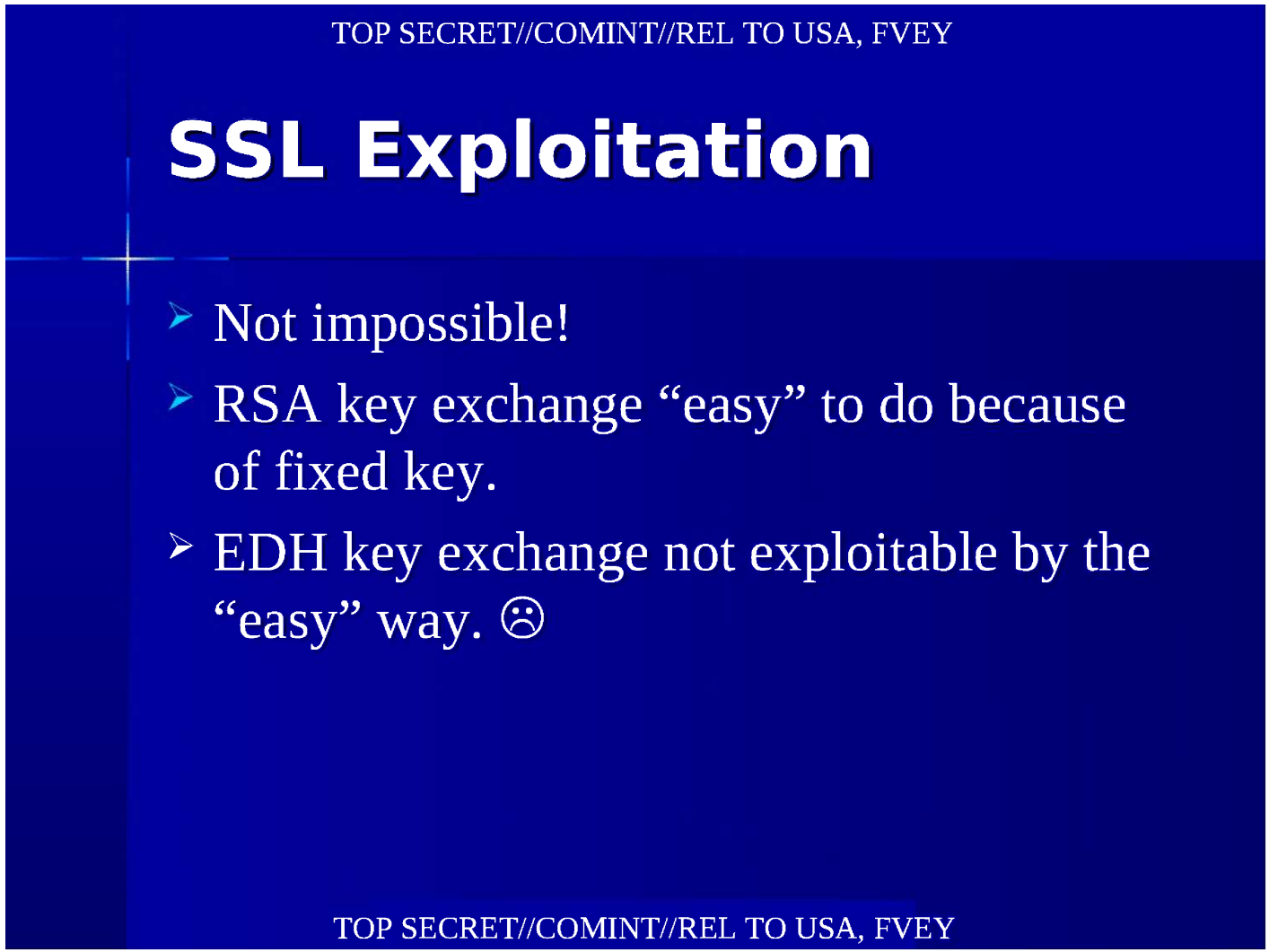
Example 6: Thank Security Standards

Acknowledgements

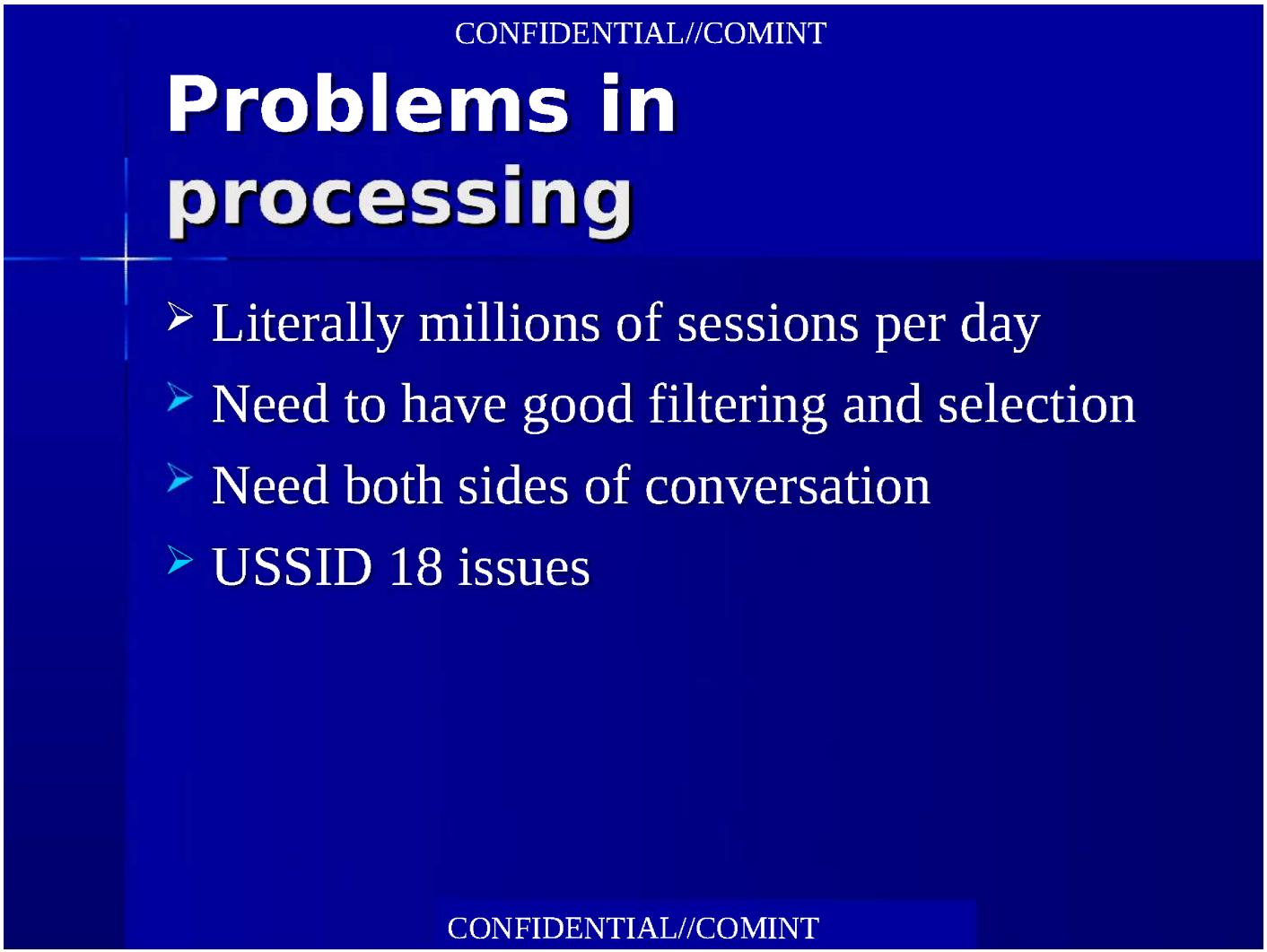
The National Institute of Standards and Technology (NIST) gratefully acknowledges and appreciates contributions by Mike Boyle and Mary Baish from NSA for assistance in the development of this Recommendation. NIST also thanks the many contributions by the public and private sectors.

(From NIST standard SP 800-90A on DUAL-EC-DRBG.)

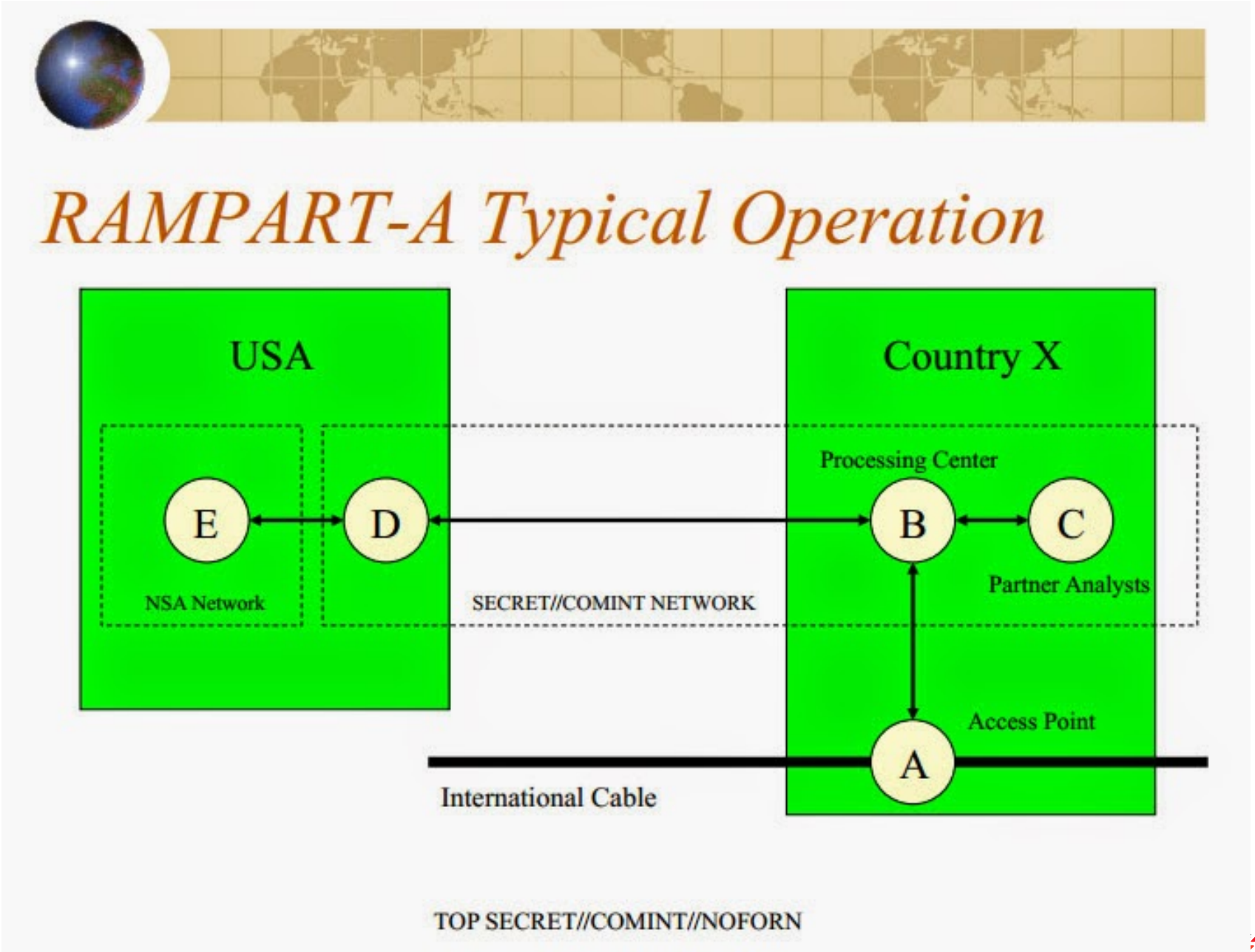
Example 6: Thank Security Standards



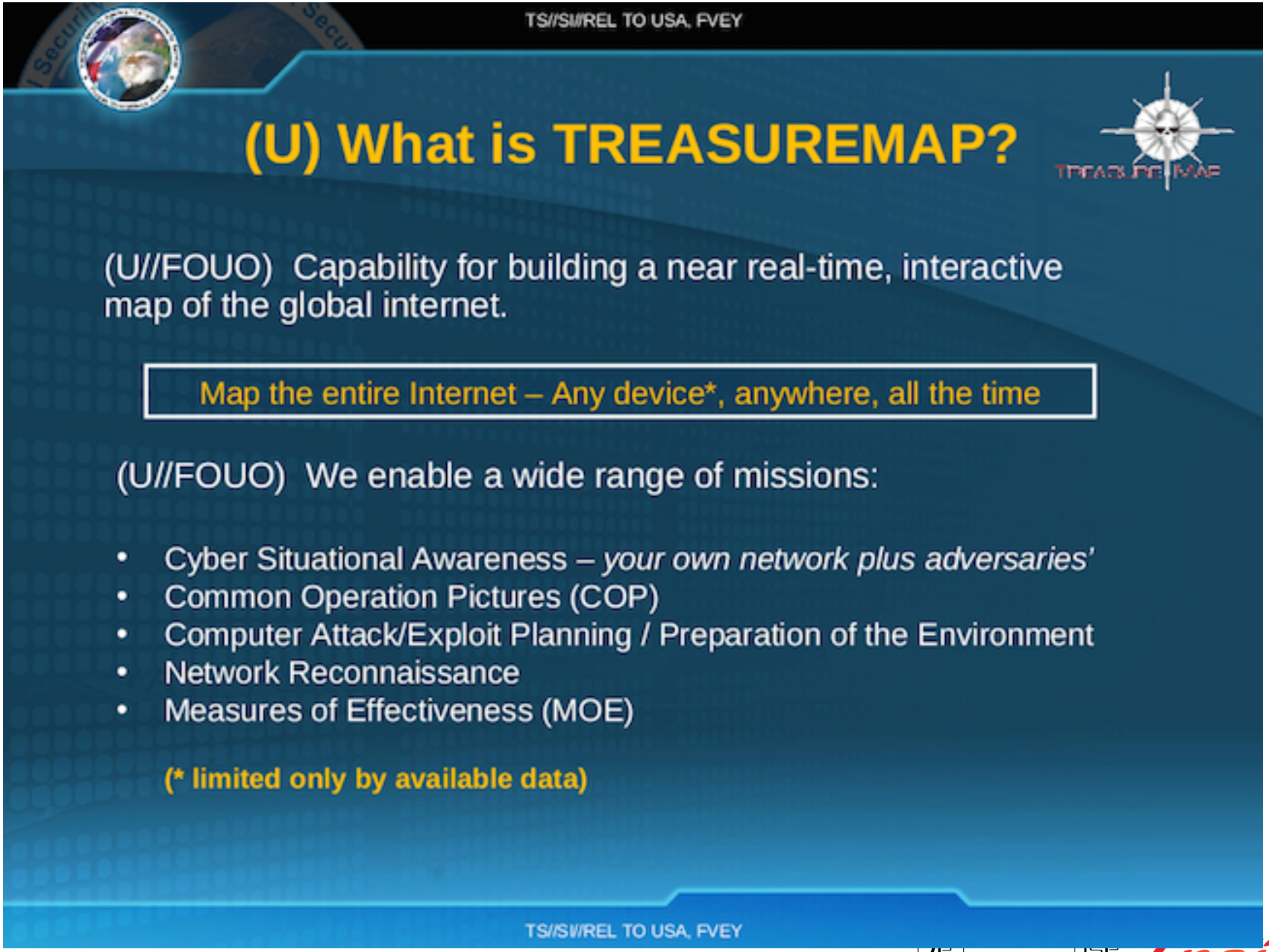
Example 6: Thank Security Standards



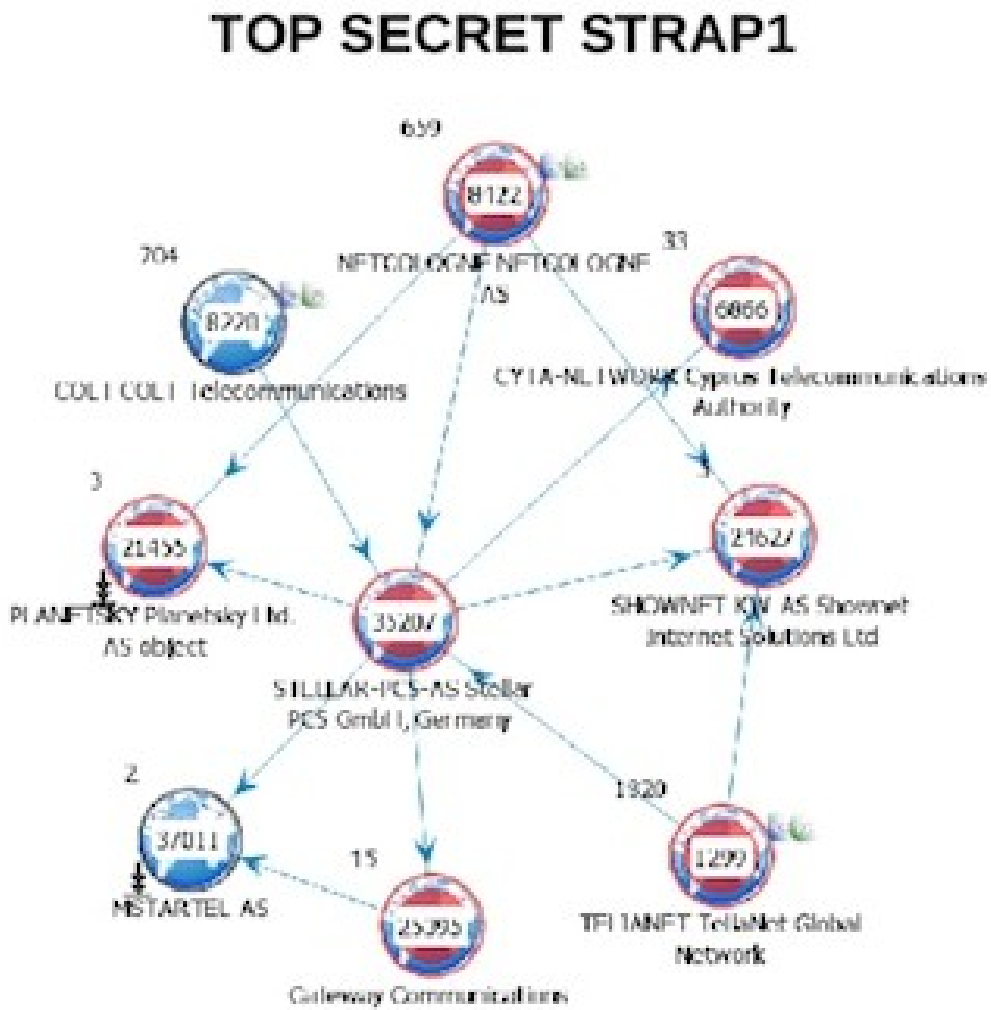
Example 7: Owning the Network



Example 7: Owning the Network



Example 7: Owning the Network



Generated via TeasureMap

The Internet is Broken

Administrators have power.

Power attracts Mexican drug cartels.

Adversary model: Mexican drug cartel

- They took your family, and will brutally kill them if you do not give them what they want.
- Under these circumstances, you must still not be able to assist, and the public system design must make that clear.
- Thus, the cartel has nothing to gain from abducting your family and will not bother with it.

System administrators are targets of such an adversary.

Political solutions?

Politicians are ...

- ... having Kompromat collected against them.
- ... generally not understanding the technology.
- ... limited in their influence to one country.
- ... unlikely to invest time in issues 2% of the population cares about.

Political solutions?

Politicians are ...

- ... having Kompromat collected against them.
- ... generally not understanding the technology.
- ... limited in their influence to one country.
- ... unlikely to invest time in issues 2% of the population cares about.

Politics could make it worse, but will not fix it!

Conclusion

- Cyberwar: Battle of the spy-agencies' bots
- Offensive and defensive goals of agencies conflict
- Our security services will **not** protect us

"World War III is a guerrilla information war with no division between military and civilian participation." –Marshall McLuhan

The Internet is Broken

- Network generally learns too much
- Insecure defaults and high system complexity (HTTP 2.0)
- Centralized Internet infrastructure requires administation:
  - Number resources (IANA)
  - Domain Name System (Root zone)
  - X.509 CAs (HTTPS certificates)
- Administrators have power, and power attracts Mexikan drug cartel

The Internet is Broken

- Network generally learns too much
- Insecure defaults and high system complexity (HTTP 2.0)
- Centralized Internet infrastructure requires administation:
  - Number resources (IANA)
  - Domain Name System (Root zone)
  - X.509 CAs (HTTPS certificates)
- Administrators have power, and power attracts Mexikan drug cartel
- Self-organizing systems aka P2P systems offer a way forward!

Our Vision (Simplified)

Internet

Google
DNS/X.509
TCP/UDP
IP/BGP
Ethernet
Phys. Layer

Our Vision (Simplified)

Internet

Google
DNS/X.509
TCP/UDP
IP/BGP
Ethernet
Phys. Layer

HTTPS/TCP/WLAN/...

Our Vision (Simplified)

Internet

Google
DNS/X.509
TCP/UDP
IP/BGP
Ethernet
Phys. Layer

CORE (OTR)
HTTPS/TCP/WLAN/...

Dé central isé

informatiques mathématiques

Our Vision (Simplified)

Internet

Google
DNS/X.509
TCP/UDP
IP/BGP
Ethernet
Phys. Layer

R^5N DHT
CORE (OTR)
HTTPS/TCP/WLAN/...

Our Vision (Simplified)

Internet

Google
DNS/X.509
TCP/UDP
IP/BGP
Ethernet
Phys. Layer

CADET (Axolotl+SCTP)
R^5N DHT
CORE (OTR)
HTTPS/TCP/WLAN/...

Our Vision (Simplified)

Internet

Google
DNS/X.509
TCP/UDP
IP/BGP
Ethernet
Phys. Layer

GNU Name System
CADET (Axolotl+SCTP)
R^5N DHT
CORE (OTR)
HTTPS/TCP/WLAN/...

Our Vision (Simplified)

Internet

Google
DNS/X.509
TCP/UDP
IP/BGP
Ethernet
Phys. Layer

Applications
GNU Name System
CADET (Axolotl+SCTP)
R^5N DHT
CORE (OTR)
HTTPS/TCP/WLAN/...

Our Vision (Simplified)

Internet

Google
DNS/X.509
TCP/UDP
IP/BGP
Ethernet
Phys. Layer

GNUnet

Applications
GNU Name System
CADET (Axolotl+SCTP)
R^5N DHT
CORE (OTR)
HTTPS/TCP/WLAN/...

Applications (being) built using GNUnet

- Anonymous and non-anonymous file-sharing
- IPv6–IPv4 protocol translator and tunnel
- GNU Name System: censorship-resistant replacement for DNS
- Conversation: secure, decentralised VoIP
- SecuShare, a social networking application
- Taler: Taxable Anonymous Libre Electronic Reserves
- ...

GNUnet 0.10.x Release Status[1]

- GNUnet 0.10.x is an alpha release
- GNUnet 0.10.x works on GNU/Linux, OS X, W32, likely Solaris
- GNUnet 0.10.x has known bugs (see `https://gnunet.org/bugs/`)
- GNUnet 0.10.x lacks documentation
- GNUnet 0.10.x is non-trivial to install
- GNUnet 0.10.x has a somewhat steep learning curve

We hope to release 0.10.x+1 with fewer bugs, better documentation, ...

[1] $x = 2$ expected any day now.

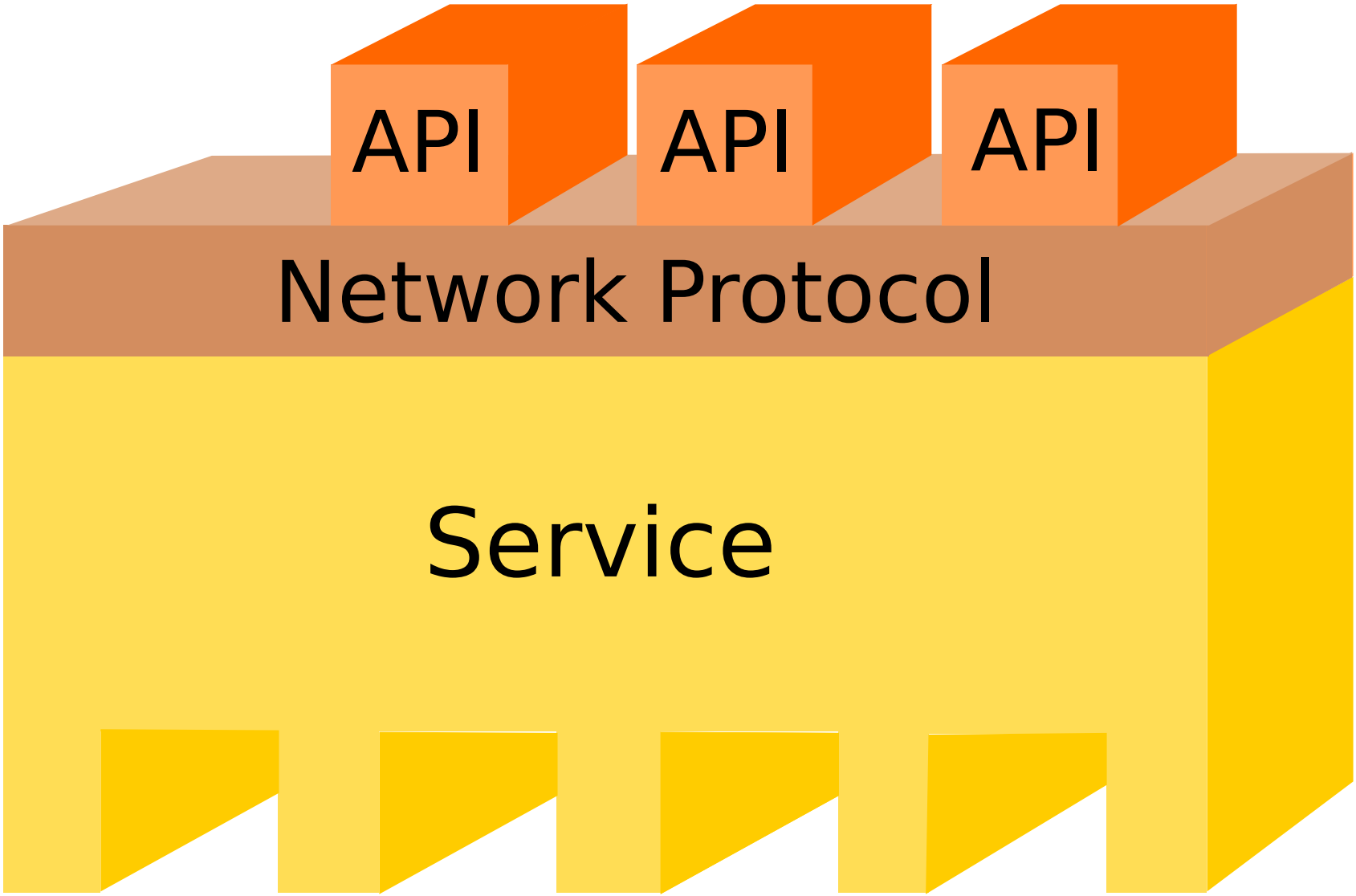
GNUnet Architecture: Goals

- Security
- Extensibility
- Portability
- Performance
- Usability

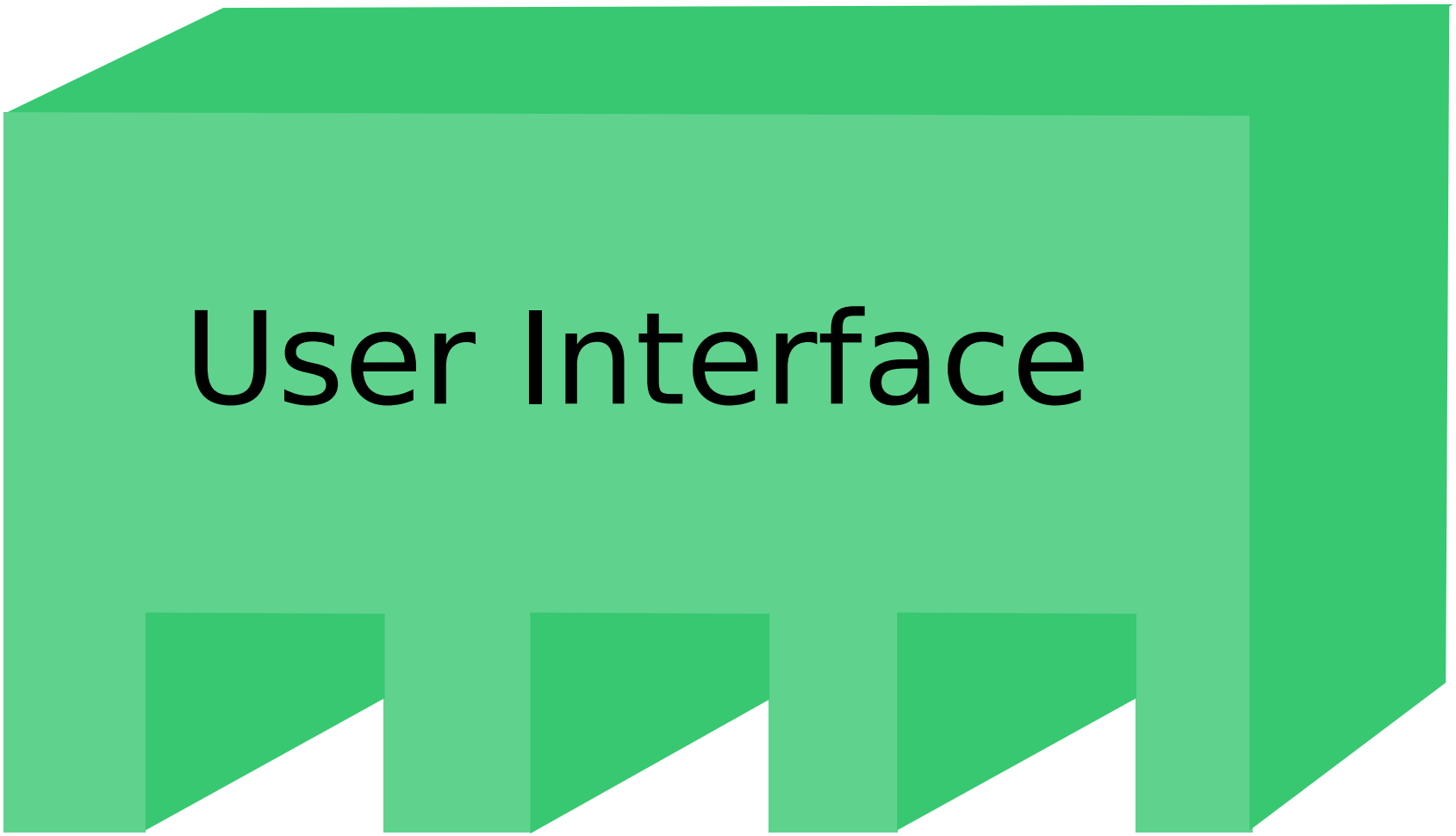
Architecture against Insanity

Problem	**Solution**
Deadlocks, races	Use event loop, forbid threads
Memory corruption	Multi-process, static analysis
Uninitialized data	Wrappers around std. C functions
Memory leaks	Multi-process, dynamic analysis
Arithmetic issues	ARM, static analysis

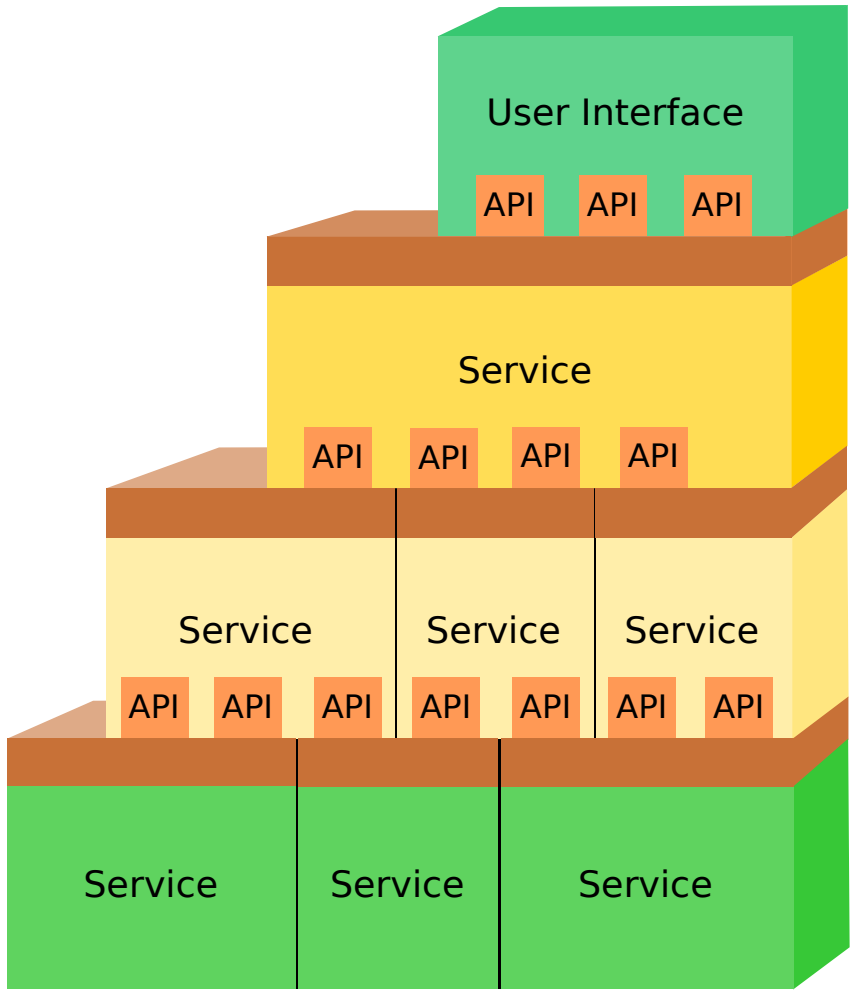
Multi-Process: A Service



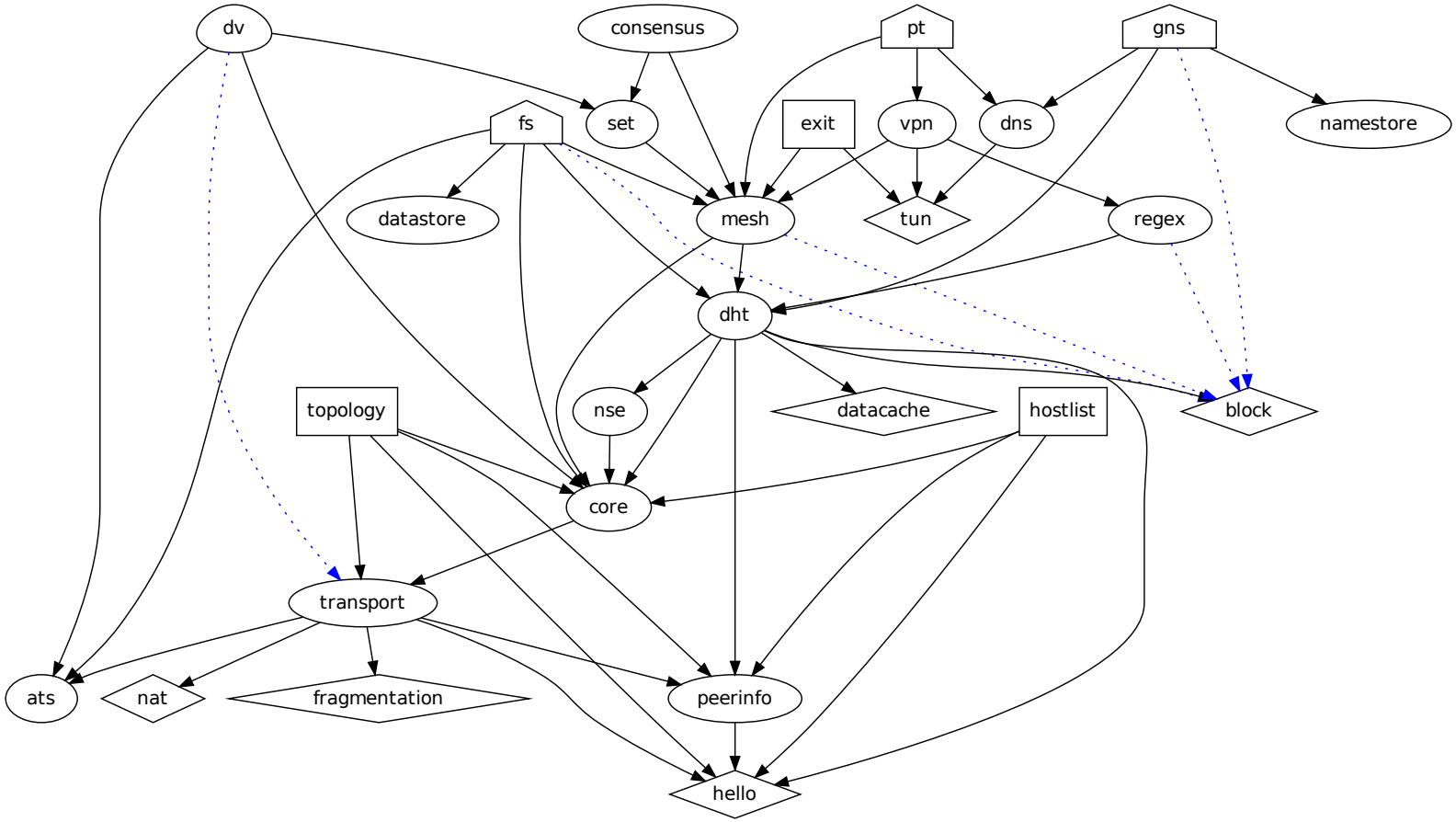
Multi-Process: A Daemon



Multi-Process: A GNUnet Peer



A real peer: Dependencies



A GNUnet Service is a Process

- If all subsystems are used, GNUnet would currently use ≈ 40 processes (services and daemons)
- user interfaces increase this number further
- systemd-like `gnunet-service-arm` starts them
- services are manipulated using the respective command-line tool

$\Rightarrow$ `gnunet-arm -s` starts GNUnet

A peak at the technology

- GNU Name System: censorship-resistant replacement for DNS
- GNU Taler: Taxable Anonymous Libre Electronic Reserves

The GNU Name System (GNS)

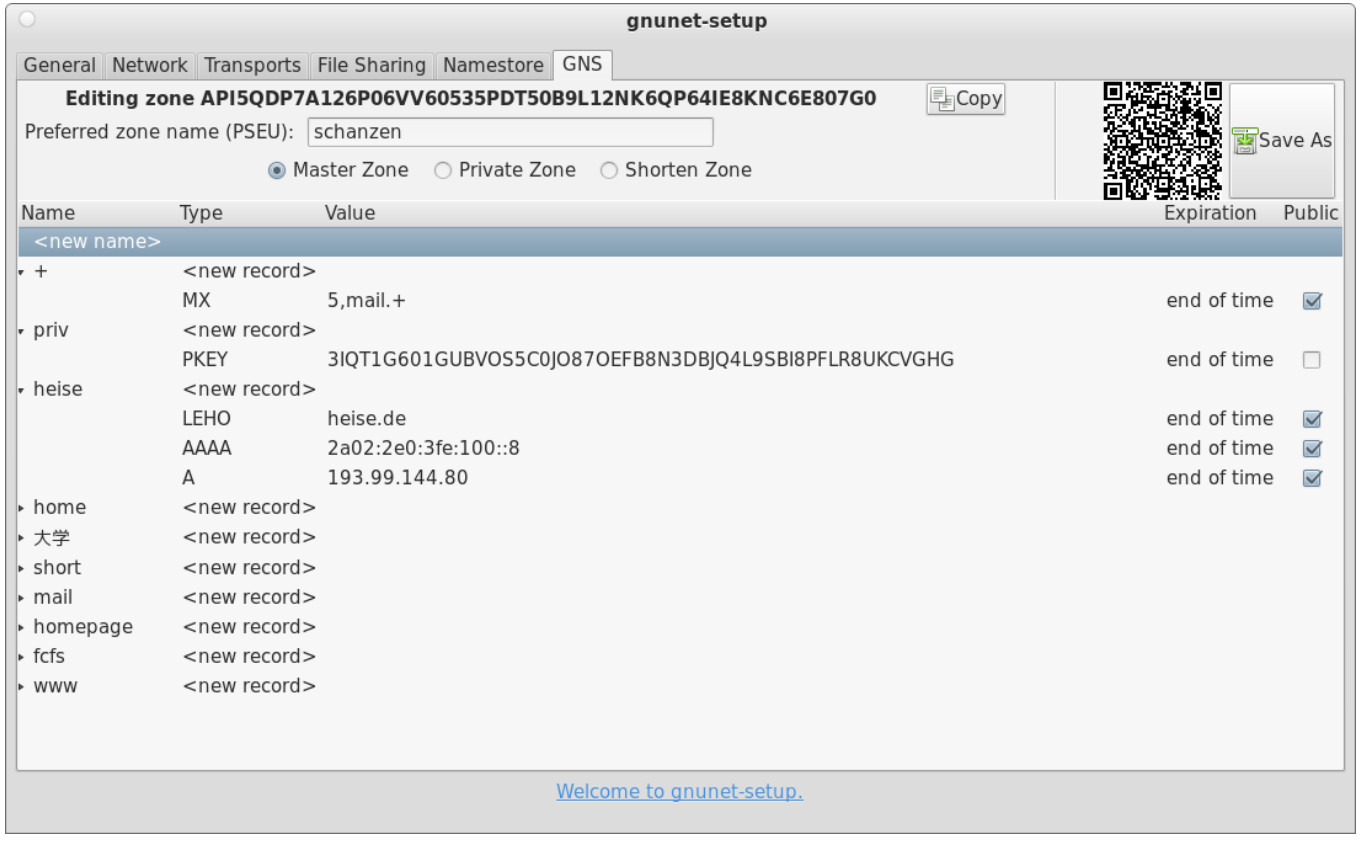
Properties of GNS

- Decentralized name system with secure memorable names
- Delegation used to achieve transitivity
- Also supports globally unique, secure identifiers
- Achieves query and response privacy
- Provides alternative public key infrastructure
- Interoperable with DNS

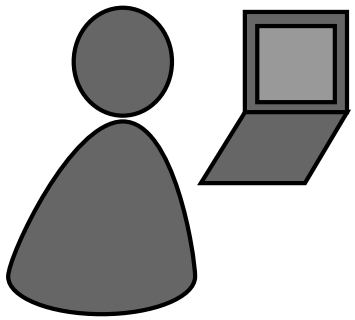
Uses for GNS in GNUnet

- Identify IP services hosted in the P2P network
- Identities in social networking applications

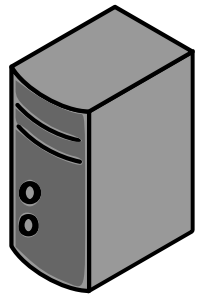
Zone management: like in DNS



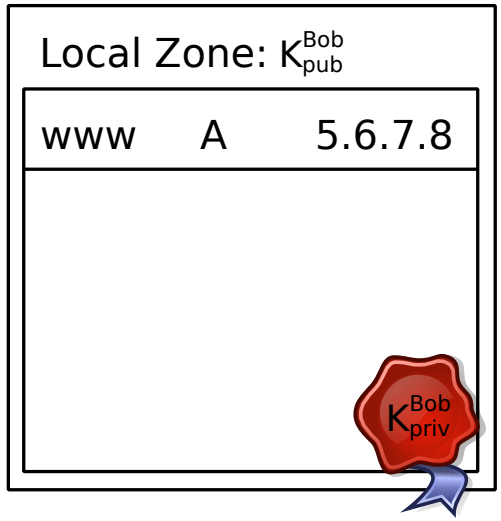
Name resolution in GNS



Bob



Bob's webserver

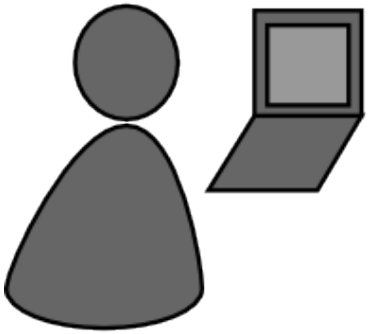


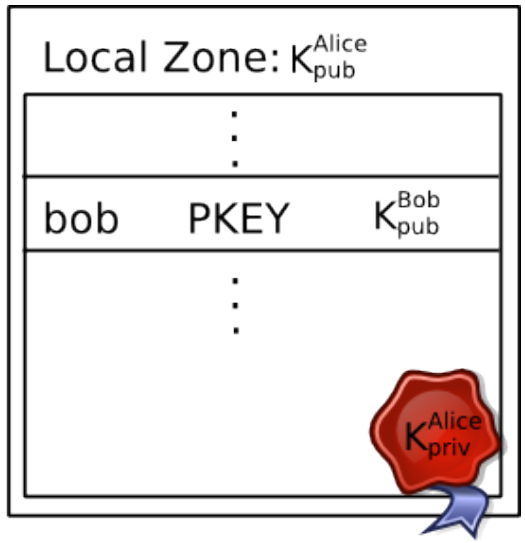
- Bob can locally reach his webserver via **www.gnu**

Secure introduction

- Bob gives his public key to his **friends**, possibly via QR code

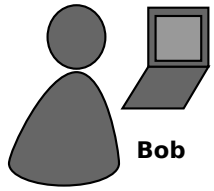
Delegation

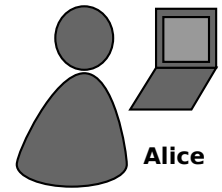


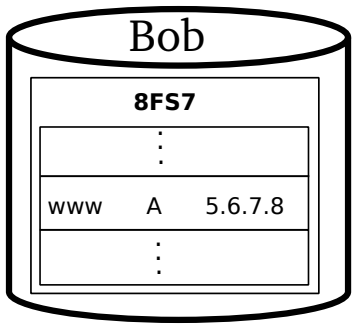


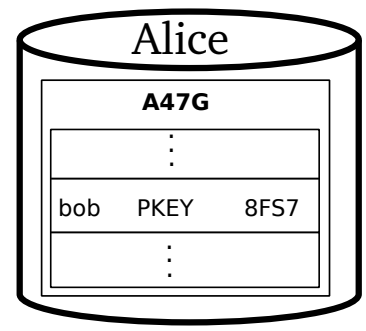
- Alice learns Bob's public key
- Alice creates delegation to zone K^{Bob}_{pub} under label **bob**
- Alice can reach Bob's webserver via **www.bob.gnu**

Name resolution

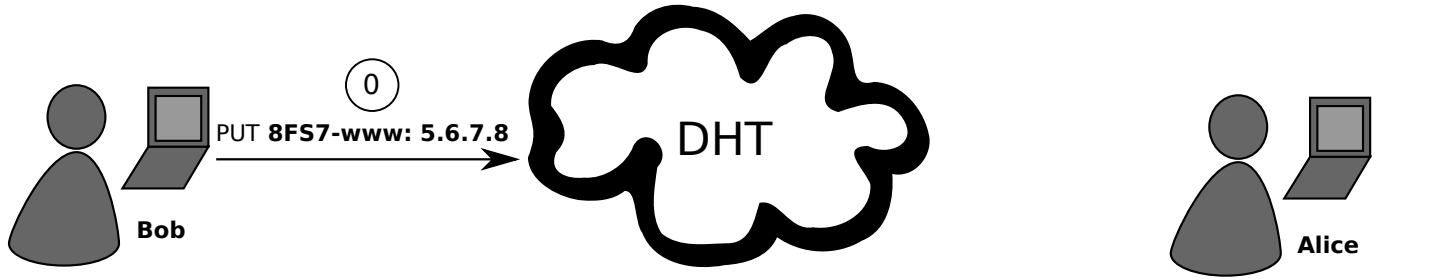




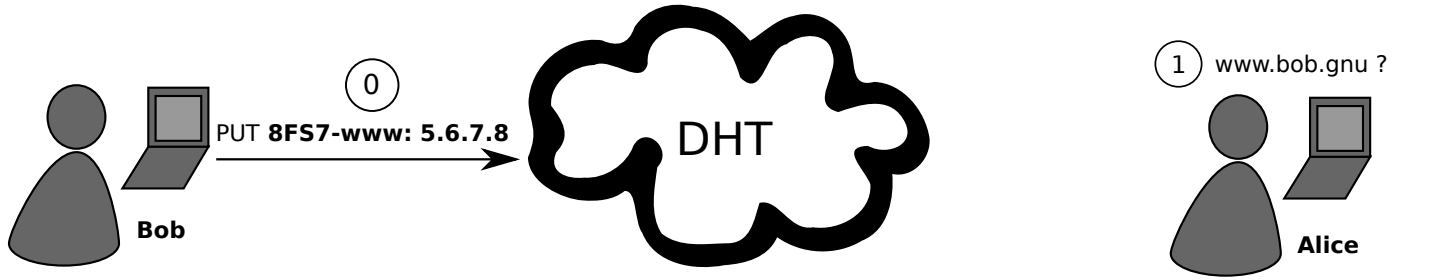


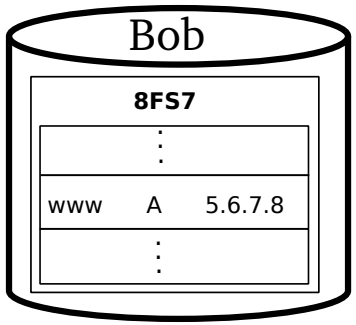


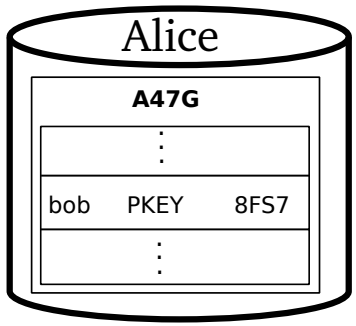
Name resolution



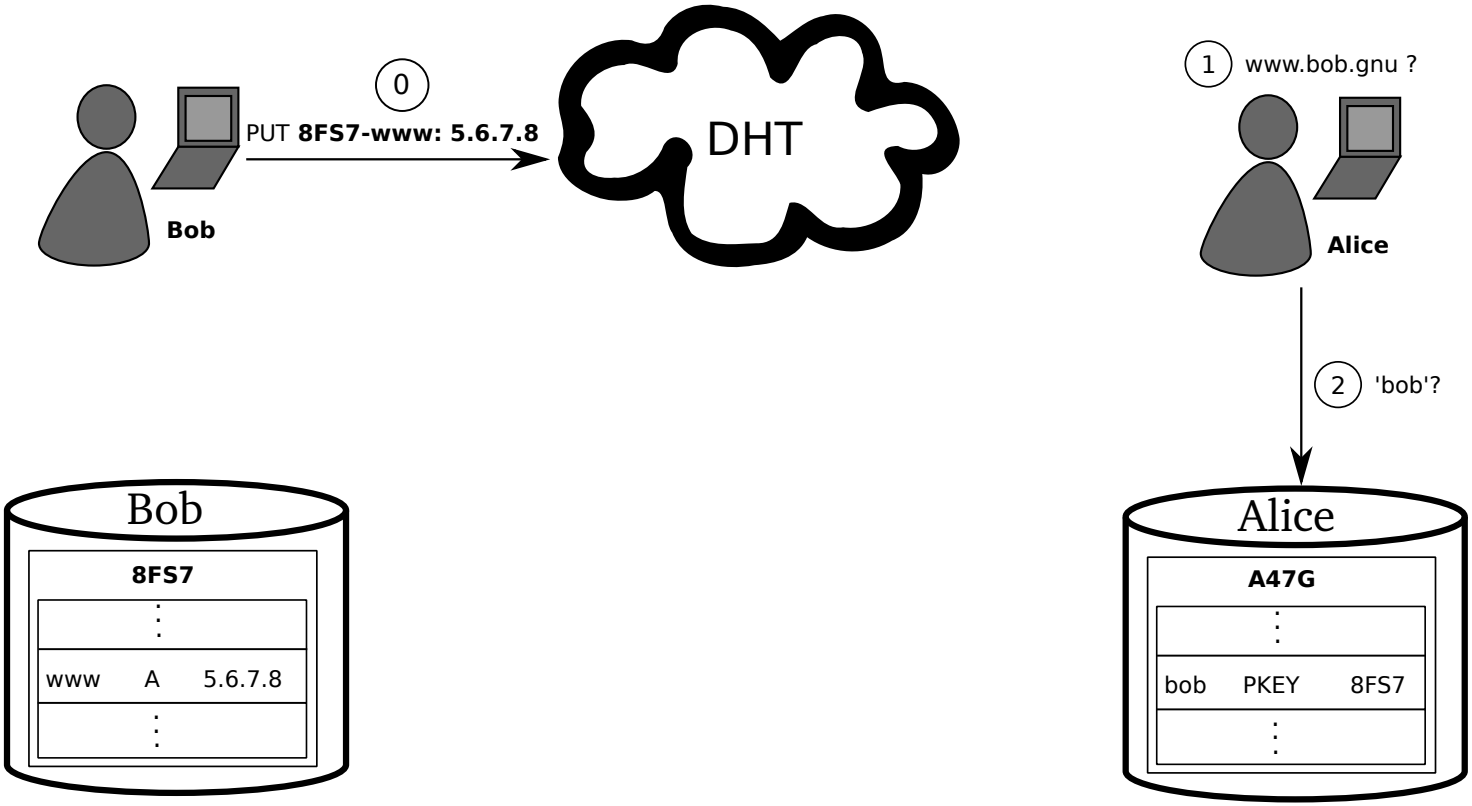
Name resolution



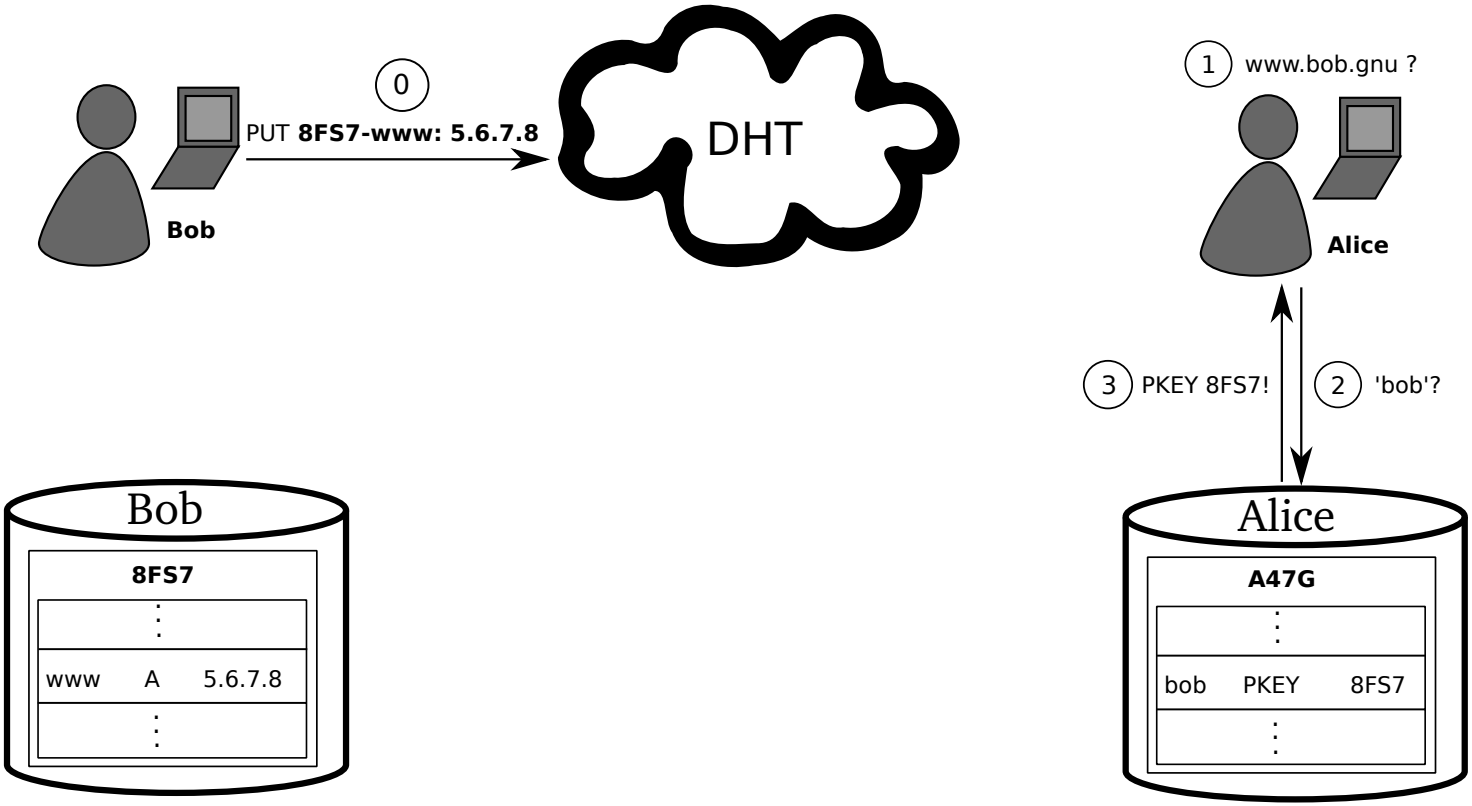




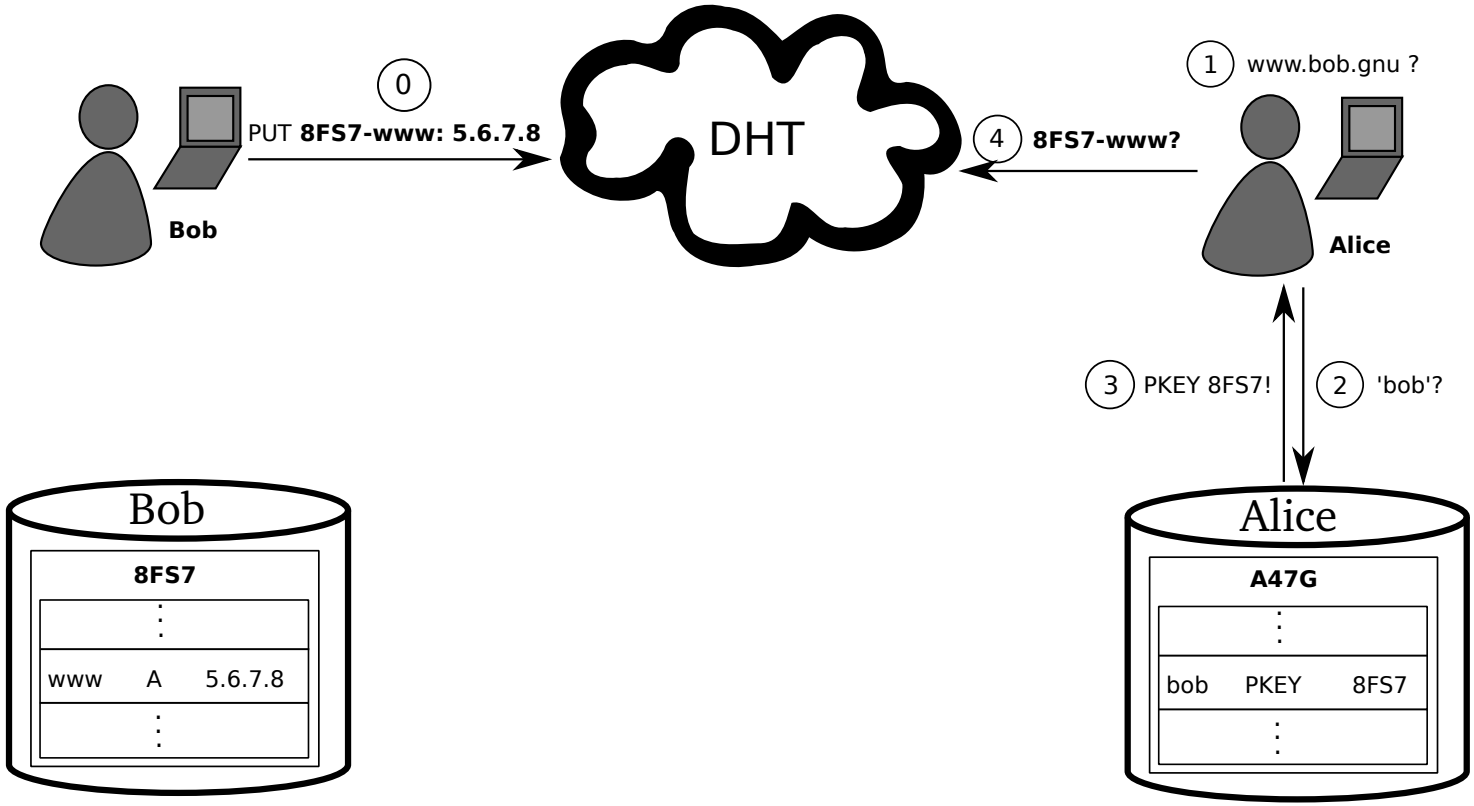
Name resolution



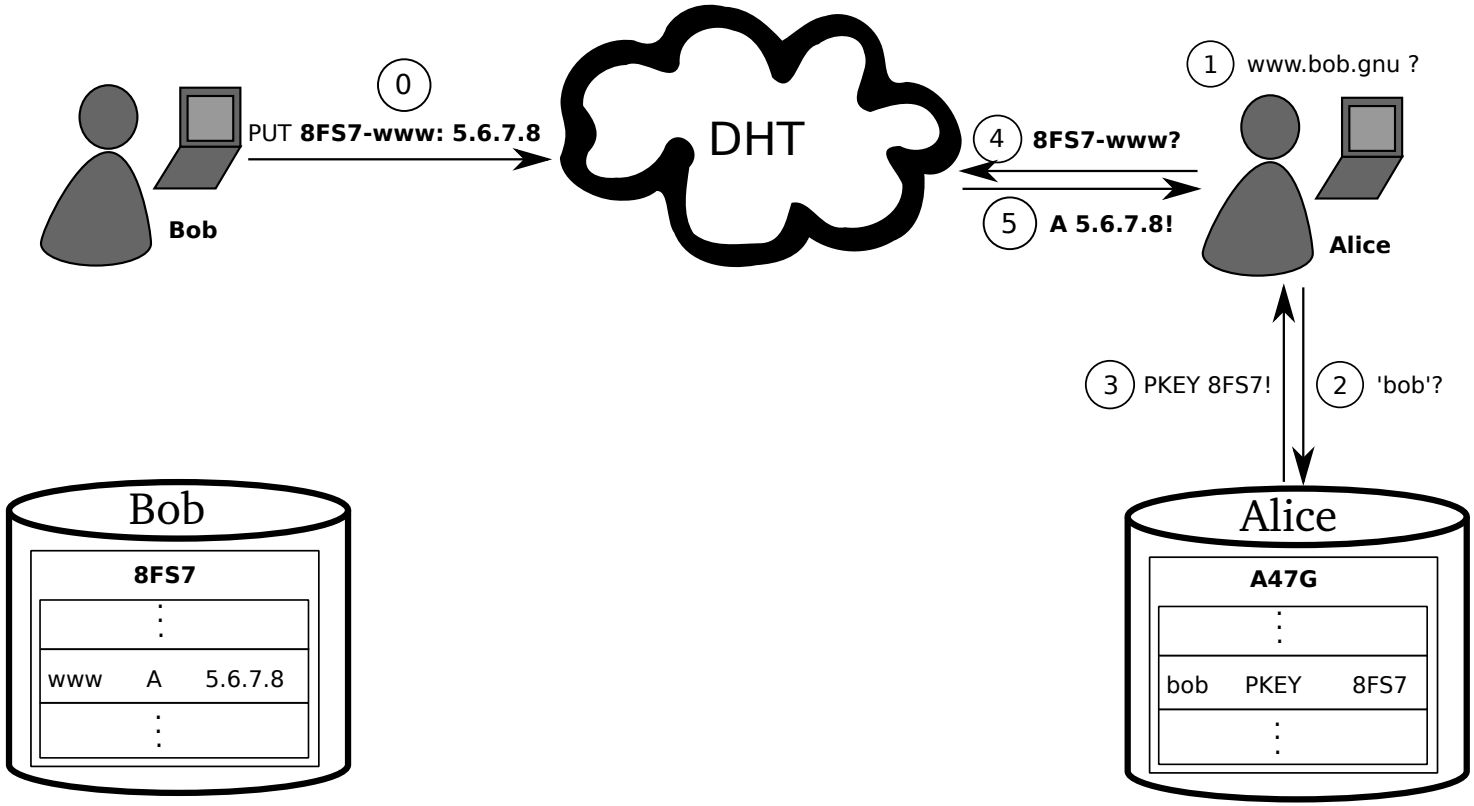
Name resolution



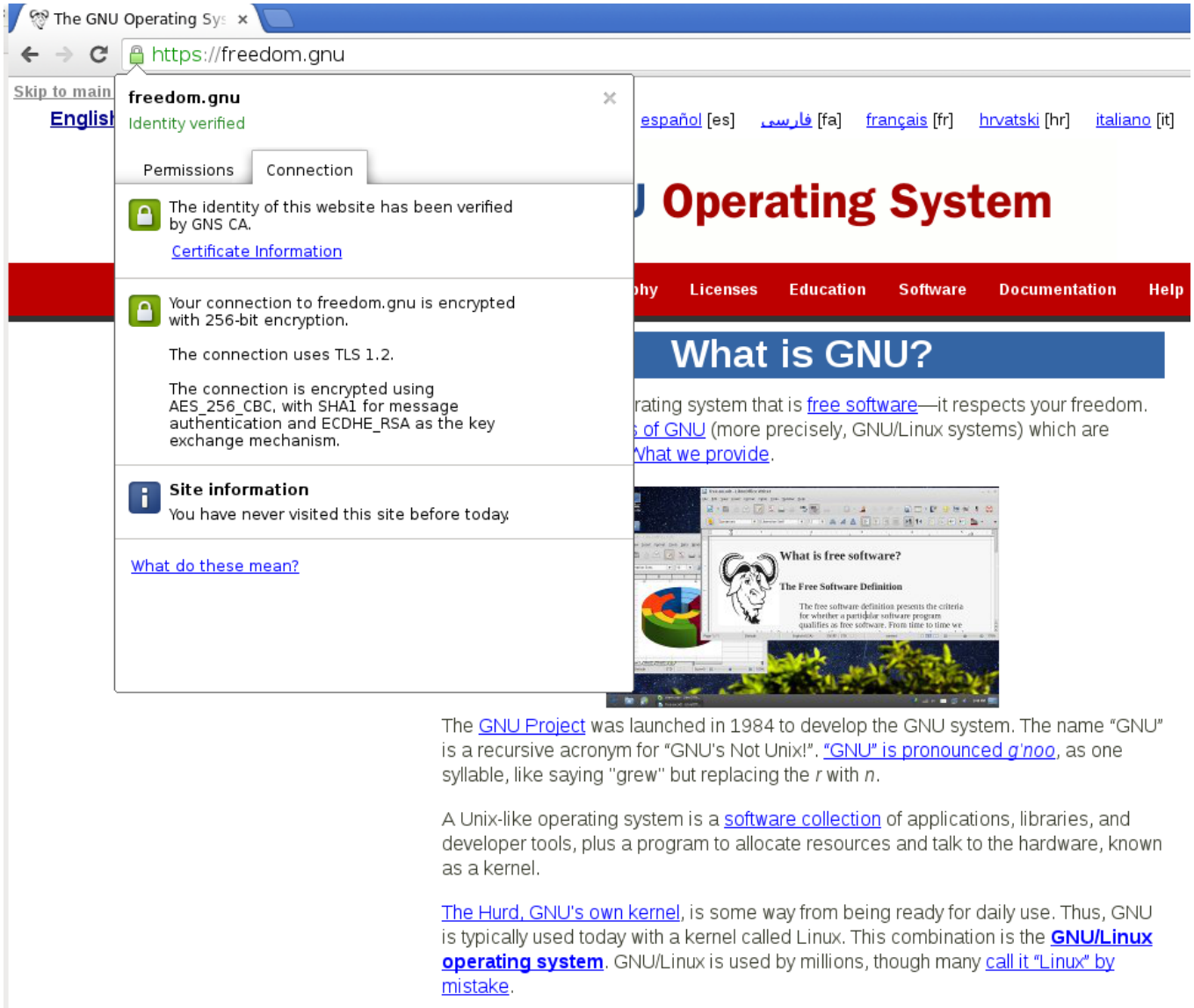
Name resolution



Name resolution



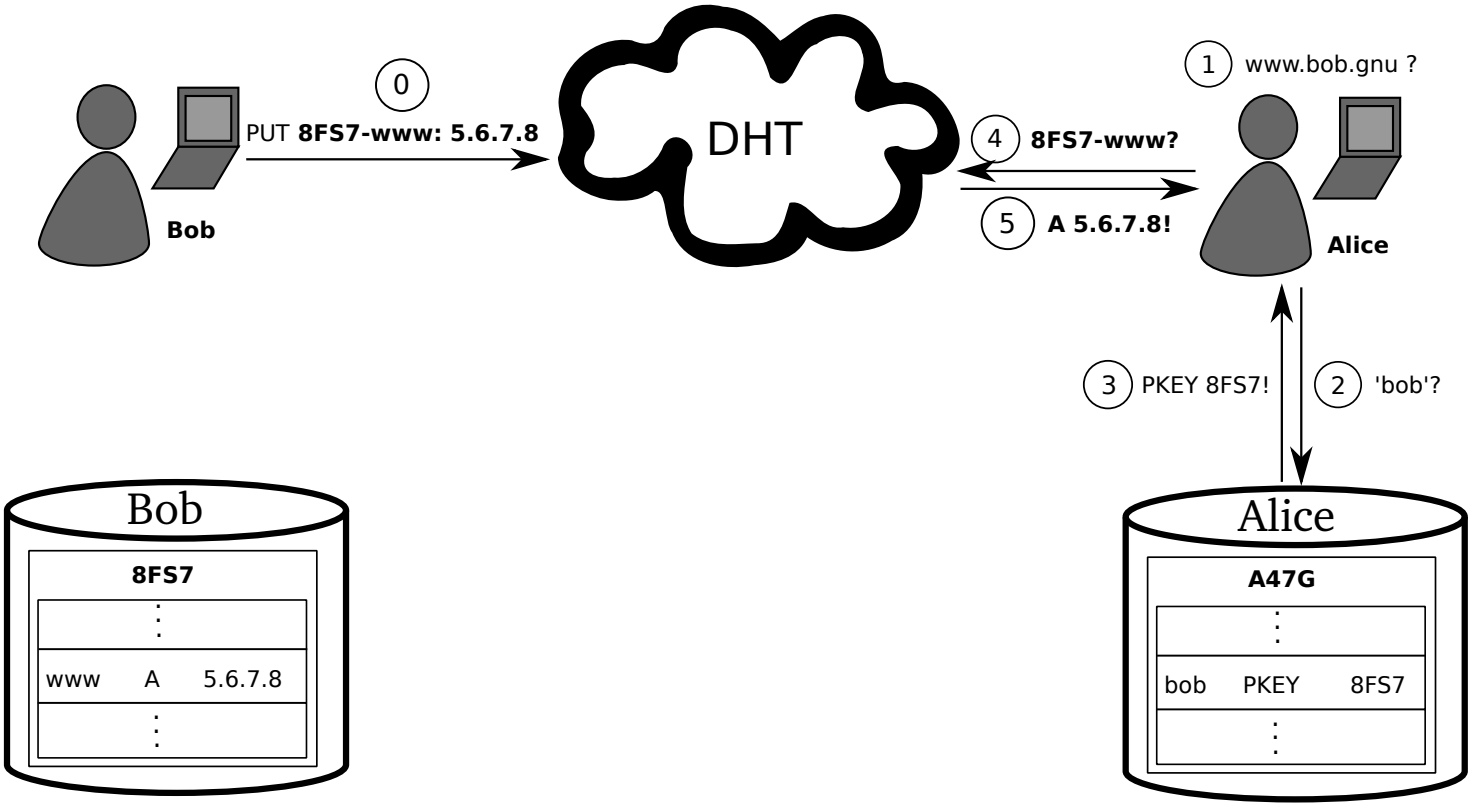
GNS as PKI (via DANE/TLSA)



Dé central isé

informatiques mathématiques

Privacy issue: DHT



Query privacy: terminology

G	generator in ECC curve, a point
n	size of ECC group, $n := \|G\|$, n prime
x	private ECC key of zone ($x \in \mathbb{Z}_n$)
P	public key of zone, a point $P := xG$
l	label for record in a zone ($l \in \mathbb{Z}_n$)
$R_{P,l}$	set of records for label l in zone P
$q_{P,l}$	query hash (hash code for DHT lookup)
$B_{P,l}$	block with encrypted information for label l in zone P published in the DHT under $q_{P,l}$

Query privacy: cryptography

Publishing records $R_{P,I}$ as $B_{P,I}$ under key $q_{P,I}$

$$h := H(I, P) \tag{1}$$
$$d := h \cdot x \mod n \tag{2}$$
$$B_{P,I} := S_d(E_{HKDF(I,P)}(R_{P,I})), dG \tag{3}$$
$$q_{P,I} := H(dG) \tag{4}$$

Query privacy: cryptography

Publishing records $R_{P,l}$ as $B_{P,l}$ under key $q_{P,l}$

$$h := H(l, P) \tag{1}$$
$$d := h \cdot x \mod n \tag{2}$$
$$B_{P,l} := S_d(E_{HKDF(l,P)}(R_{P,l})), dG \tag{3}$$
$$q_{P,l} := H(dG) \tag{4}$$

Searching for records under label l in zone P

$$h := H(l, P) \tag{5}$$
$$q_{P,l} := H(hP) = H(hxG) = H(dG) \Rightarrow \texttt{obtain } B_{P,l} \tag{6}$$
$$R_{P,l} = D_{HKDF(l,P)}(B_{P,l}) \tag{7}$$

The ".zkey" zone

- ".zkey" is another pTLD, in addition to ".gnu"
- In "LABEL.zkey", the "LABEL" is a public key of a zone
- "alice.bob.*KEY*.zkey" is perfectly legal

$\Rightarrow$ Globally unique identifiers

Key revocation

- Revocation message signed with private key (ECDSA)
- Flooded on all links in P2P overlay, stored forever
- Efficient set reconciliation used when peers connect
- Expensive proof-of-work used to limit DoS-potential
- Proof-of-work can be calculated ahead of time
- Revocation messages can be stored off-line if desired

Fun GNS record types

- BOX: store TLSA records *with* A/AAAA record
- VPN: TCP/IP services hosted in GNUnet
- PHONE: have a conversation
- CERT: store your GPG public key (WiP)
- TOR: store your hidden service descriptor (WiP)

Summary

- Interoperable with DNS
- Delegation allows using zones of other users
- Trust paths explicit, trust agility
- Simplified key exchange compared to Web-of-Trust
- Privacy-enhanced queries, censorship-resistant
- Reliable revocation

GNU Taler

Modern economies need a currency.

Dé central isé

informatiques mathématiques

Motivation

Modern economies need a currency online.

Dé central isé

informatiques mathématiques

SWIFT?

SWIFT/Mastercard/Visa are too transparent.

Dé central isé

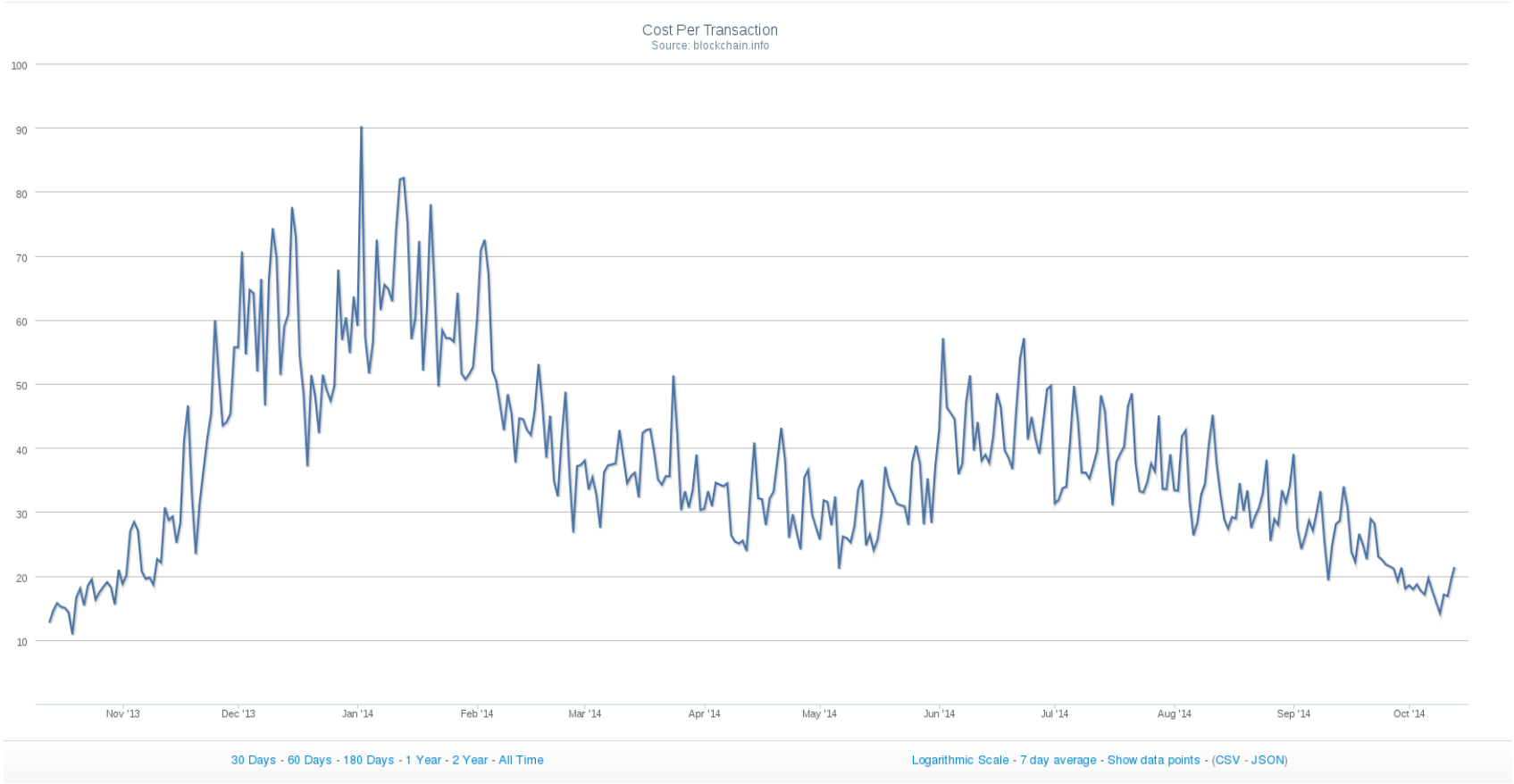
informatiques mathématiques

?

Dé central isé

informatiques mathématiques

?



Dé central isé

informatiques mathématiques

- All BitCoin transactions are public
- BitCoin does not come with privacy guarantees

  $\Rightarrow$ BitCoin was enhanced with “laundering” services

  $\Rightarrow$ ZeroCoin and successors offer full anonymity

₿?

- All BitCoin transactions are public
- BitCoin does not come with privacy guarantees

  $\Rightarrow$ BitCoin was enhanced with "laundering" services

  $\Rightarrow$ ZeroCoin and successors offer full anonymity

Is society ready for an anarchistic economy?

Let's make cash **digital** and **socially responsible**.

Dé central isé

informatiques mathématiques

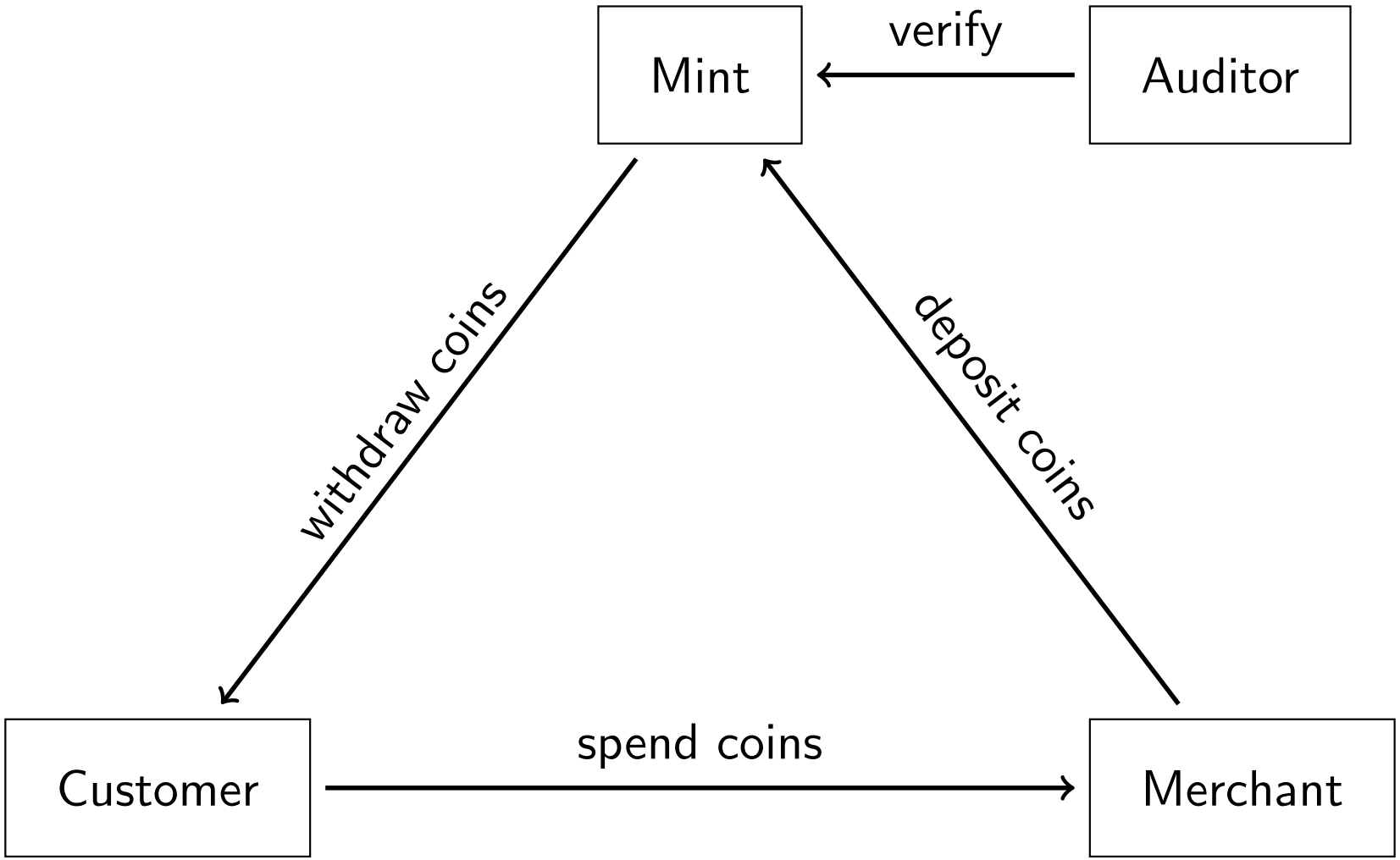
Let's make cash **digital** and **socially responsible**.

Taxable, Anonymous, Libre, Practical, Resource Friendly

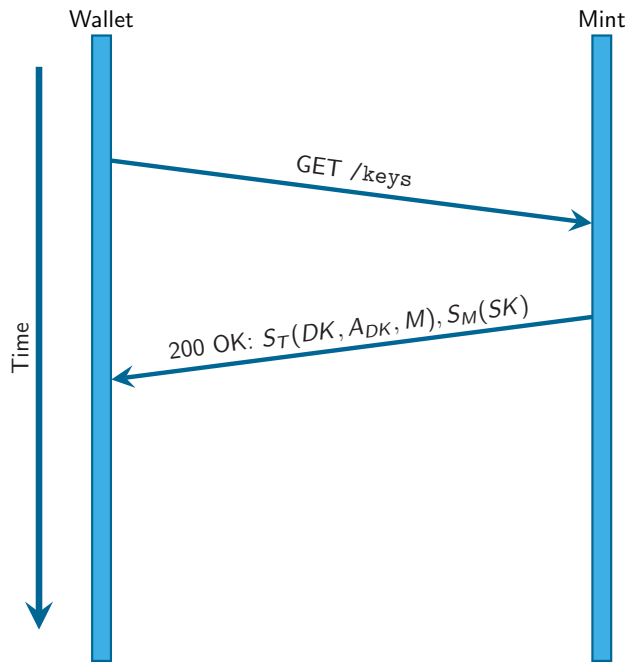
Dé central isé

informatiques mathématiques

Architecture of GNU Taler

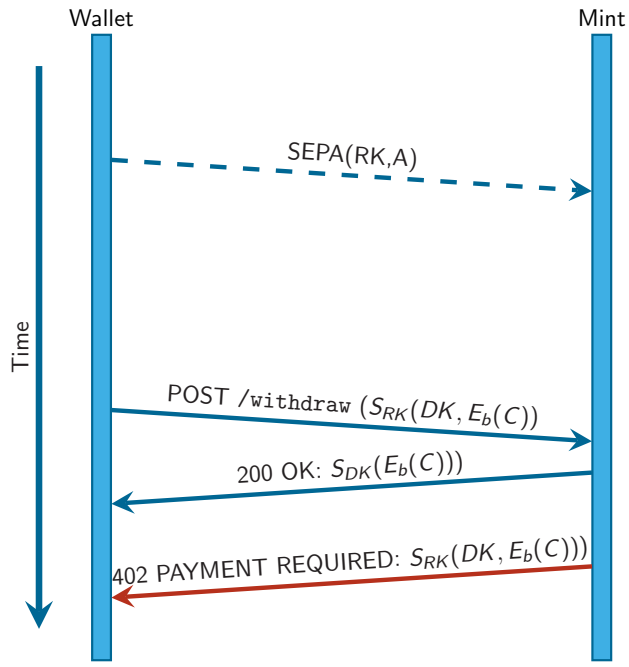


Taler /keys



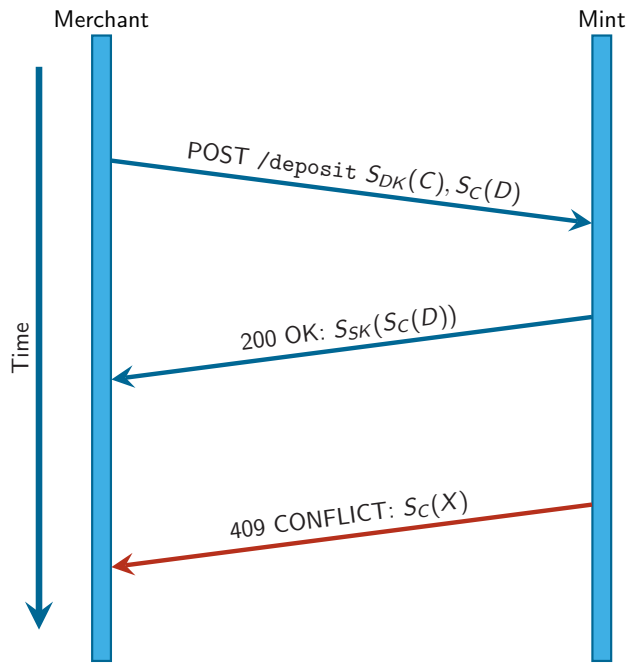
T	Financial regulator key
DK	RSA public key ("denomination key")
A_{DK}	Value of coins signed by DK
M	Offline master key of mint
SK	Online signing key of mint

Taler `/withdraw/sign`



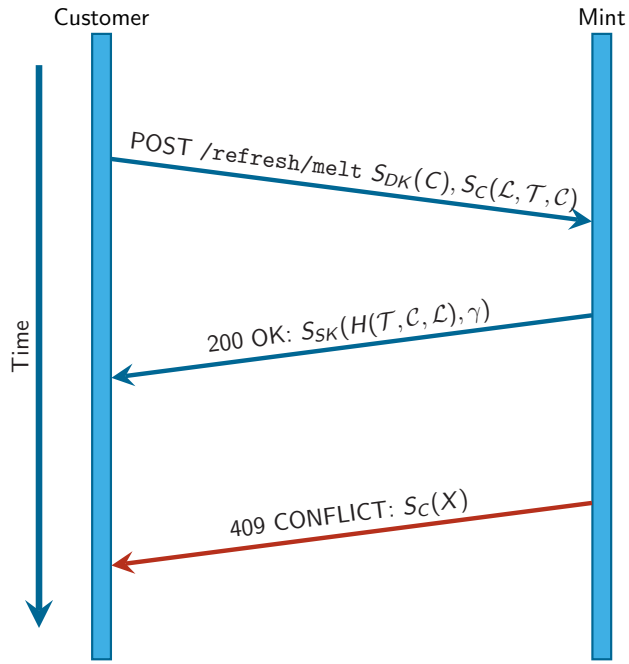
RK	Reserve key
A	Some amount, $A \geq A_{DK}$
b	Blinding factor
$E_b()$	RSA blinding
C	Coin key
$S_{DK}()$	(Blind) signature

Taler /deposit



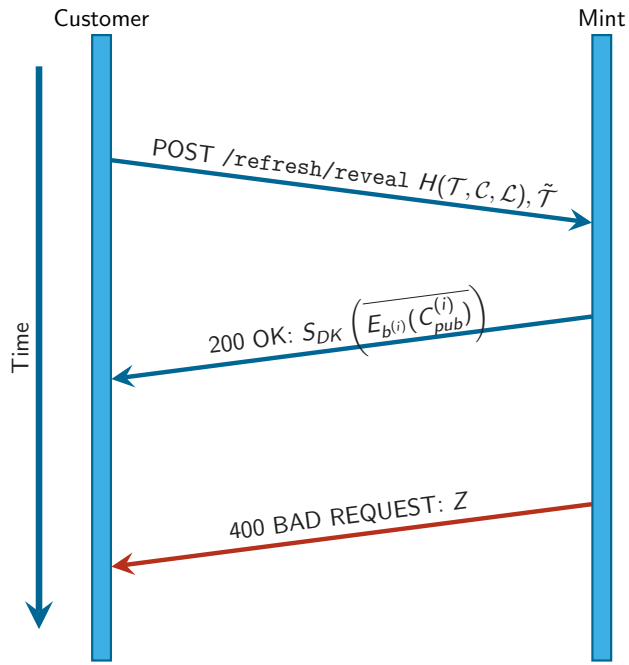
DK	Denomination key
$S_{DK}()$	RSA signature using DK
C	Coin key
$S_C()$	EdDSA signature using C
D	Deposit details
SK	Signing key
$S_{SK}()$	EdDSA signature using SK
X	Conficting deposit details

Taler /refresh/melt



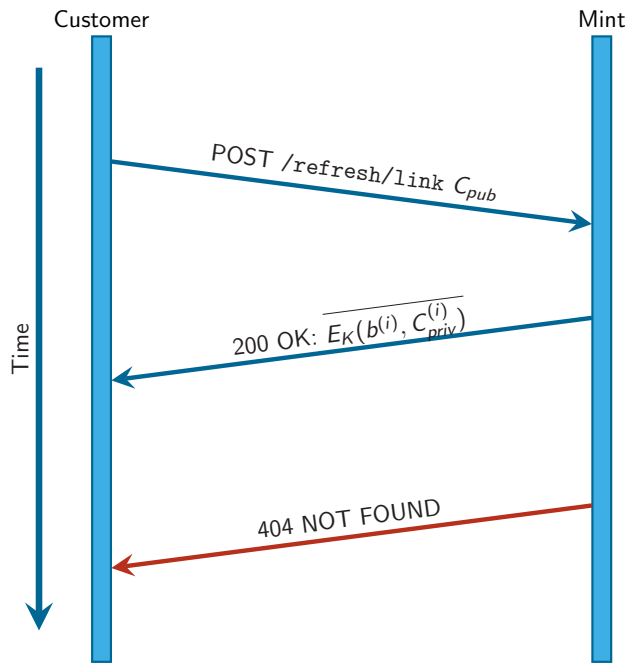
κ	System-wide security parameter
K	$:= ECDHE(T, C)$
$E_K()$	Symmetric encryption using key K
$DK^{(i)}$	List of denomination keys
$C^{(i)}$	List of coin keys
$b^{(i)}$	List of blinding factors
$E_{b^{(i)}}()$	Blinding with respective $b^{(i)}$
$\mathcal{T}$	$[T_{pub}]_\kappa$
$\mathcal{L}$	$[E_K(b^{(i)}, C^{(i)}_{priv})]_\kappa$
$\mathcal{C}$	$[E_{b^{(i)}}(C^{(i)}_{pub}), DK^{(i)}]_\kappa$
γ	Random value in $[0, \kappa)$

Taler /refresh/reveal



$\tilde{\mathcal{T}}$	$[T_{priv}]_{\kappa \setminus \gamma}$
$\overline{E_{b(i)}(C^{(i)})}$	Blinded coins from $\mathcal{C}$ at γ
Z	Cut-and-choose missmatch information

Taler /refresh/link



$\overline{E_K(b^{(i)}, C_{priv}^{(i)})}$ Linkage data $\mathcal{L}$ at γ

Summary

- GNUnet: A future Internet for liberal societies
- GNU Taler: A payment system focused on ethics

How can you help?

- Anonymity: protect yourself (use Tor, Pond, etc.)
- Baseline: encrypt your harddrive, encrypt your e-mail
- Coding: bugfixes, GUI design (it's just XML!), new ideas
- Documentation: improvements, translations

How can you help?

- Anonymity: protect yourself (use Tor, Pond, etc.)
- Baseline: encrypt your harddrive, encrypt your e-mail
- Coding: bugfixes, GUI design (it's just XML!), new ideas
- Documentation: improvements, translations
- Égalité: run a peer, not a server
- Fraternité: share resources and knowledge
- Liberté: write free software

Conclusion

- Decentralization is necessary
- Decentralization creates challenges for research:
  - Privacy-enhancing network protocol design
  - Secure software implementations
  - Software engineering and system architecture
  - Programming languages and tool support

Conclusion

- Decentralization is necessary
- Decentralization creates challenges for research:
  - Privacy-enhancing network protocol design
  - Secure software implementations
  - Software engineering and system architecture
  - Programming languages and tool support

We must decentralize or accept authocracy and planetary collapse.

Décentralisé

informatiques mathématiques

Conclusion

- This is **not** about the NSA
- Chinese, French, German, Russian agencies do the same

Conclusion

- This is **not** about the NSA
- Chinese, French, German, Russian agencies do the same
- It is about governments against their citizens
- It is about rich against poor

Do you have any questions?

References:

- Nathan Evans and Christian Grothoff. *R^5N. Randomized Recursive Routing for Restricted-Route Networks*. **5th International Conference on Network and System Security**, 2011.
- M. Schanzenbach *Design and Implementation of a Censorship Resistant and Fully Decentralized Name System*. **Master's Thesis (TUM)**, 2012.
- Christian Grothoff, Bart Polot and Carlo von Loesch. *The Internet is broken: Idealistic Ideas for Building a GNU Network*. **W3C/IAB Workshop on Strengthening the Internet Against Pervasive Monitoring (STRINT)**, 2014.
- Matthias Wachs, Martin Schanzenbach and Christian Grothoff. *A Censorship-Resistant, Privacy-Enhancing and Fully Decentralized Name System*. **13th International Conference on Cryptology and Network Security**, 2014.

"Totalitarianism is man's escape from the fearful realities of life into the virtual womb of the leader. (...) The mystic center is in control of everything; man need no longer assume responsibility for his own life. The order and logic of the prenatal world reign. There is peace and silence, the peace of utter submission."
–Joost A. Merloo, Rape of the Mind (1956)