

# **Introduction to The Tor Ecosystem:**

## Privacy, Anonymity, and Anti-censorship

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# About Me

- Core Developer at The Tor Project since early 2017. Team Lead of the Network Team since late 2019.
- Free Software developer since 2006.
- Worked with distributed systems in the Erlang programming language, WebKit-based mobile browsers, embedded development, and software development consulting.

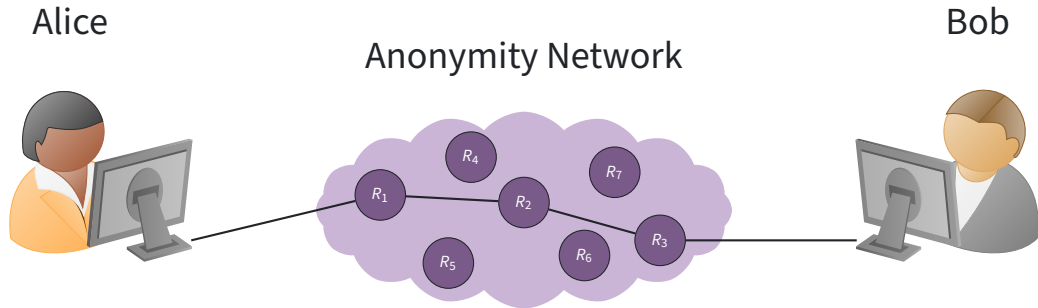


# What is Tor?

- Online anonymity, and censorship circumvention.
  - Free software.
  - Open network.
- Community of researchers, developers, users, and relay operators.
- U.S. 501(c)(3) non-profit organization.

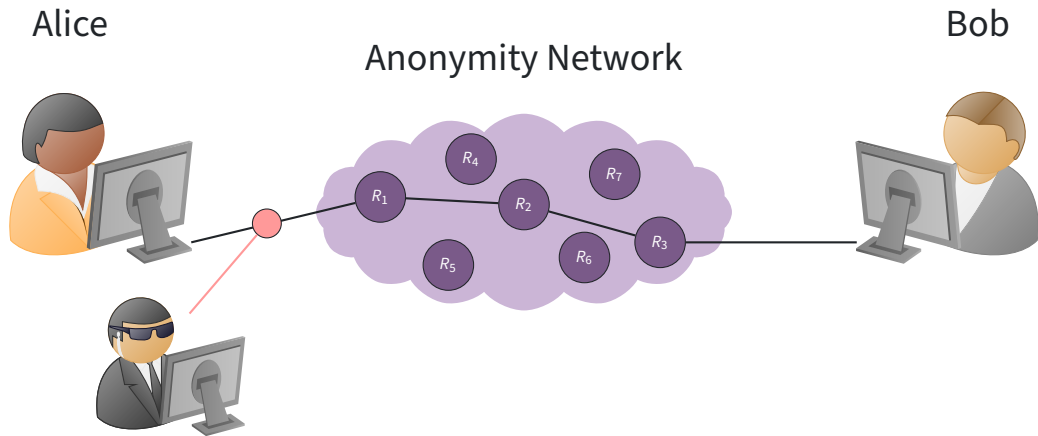


# Threat Model

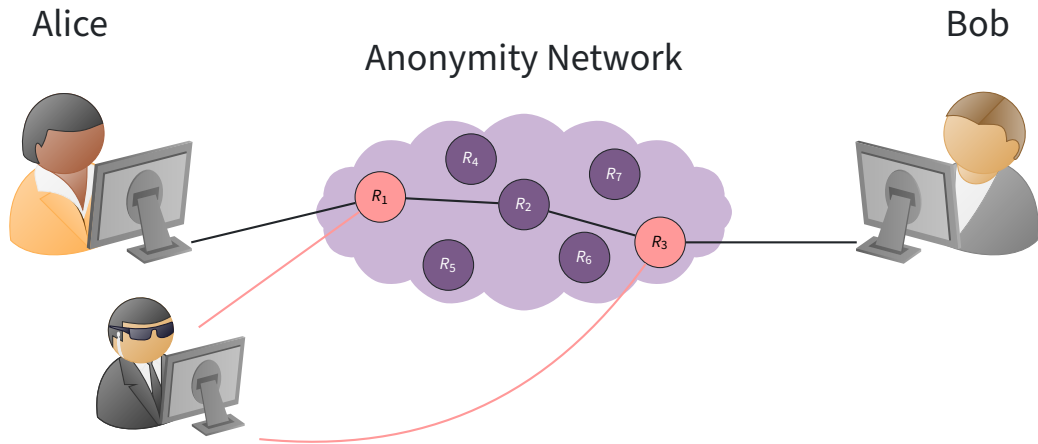


What can the attacker do?

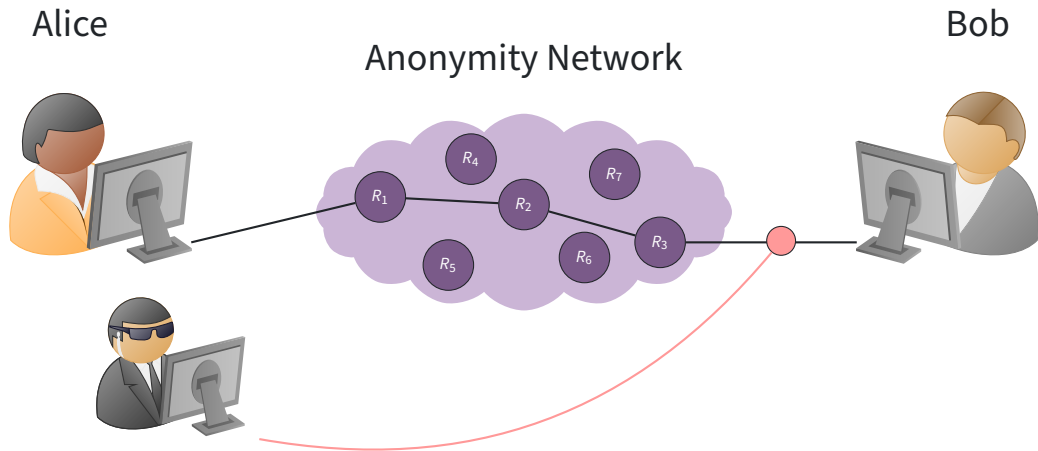
# Threat Model



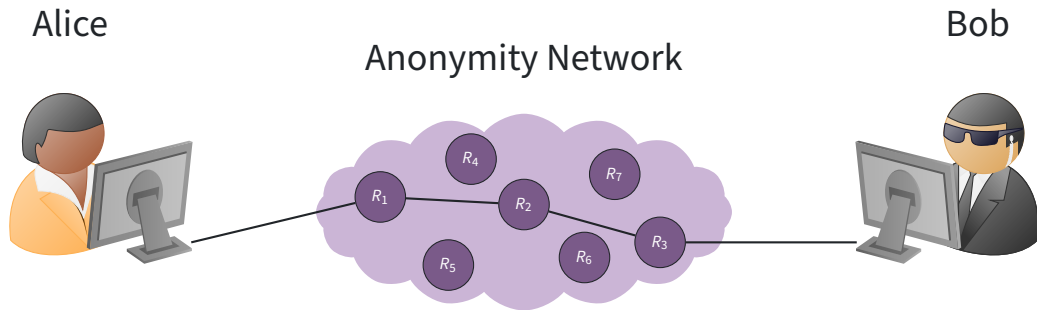
# Threat Model



# Threat Model

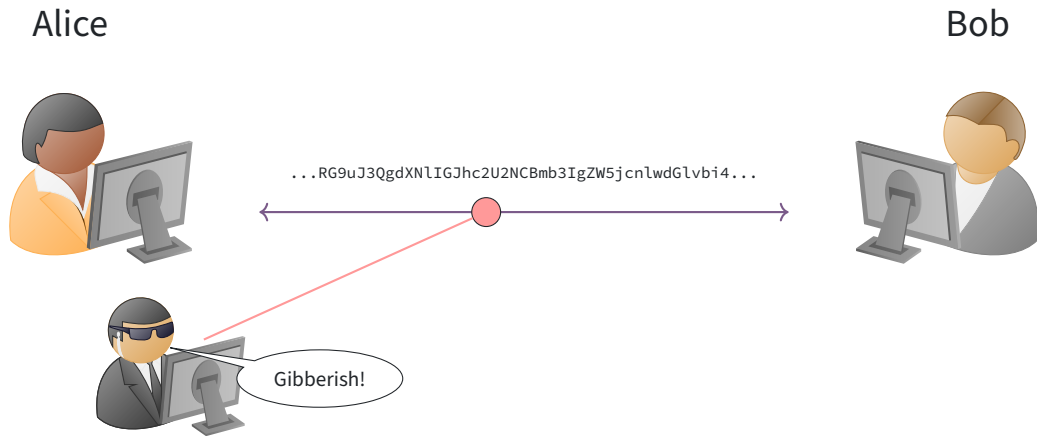


# Threat Model





# Anonymity isn't Encryption



Encryption just protects contents.

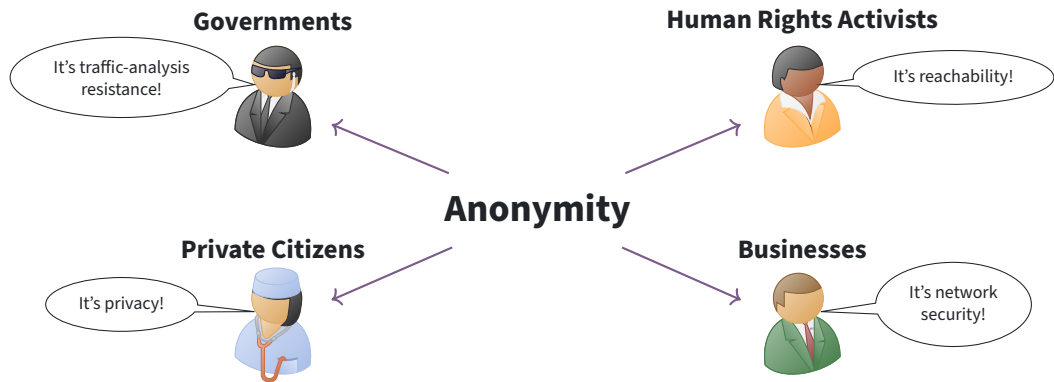
# Metadata



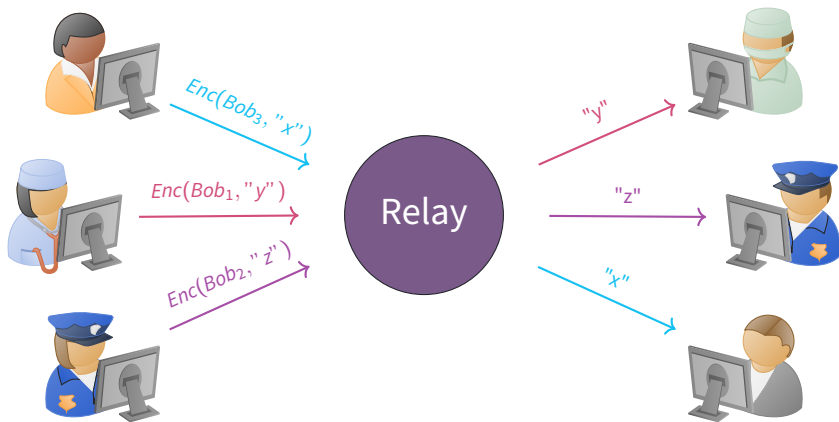
*"We Kill People Based on Metadata."*

*—Michael Hayden, former director of the NSA.*

# Different Purposes of Anonymity

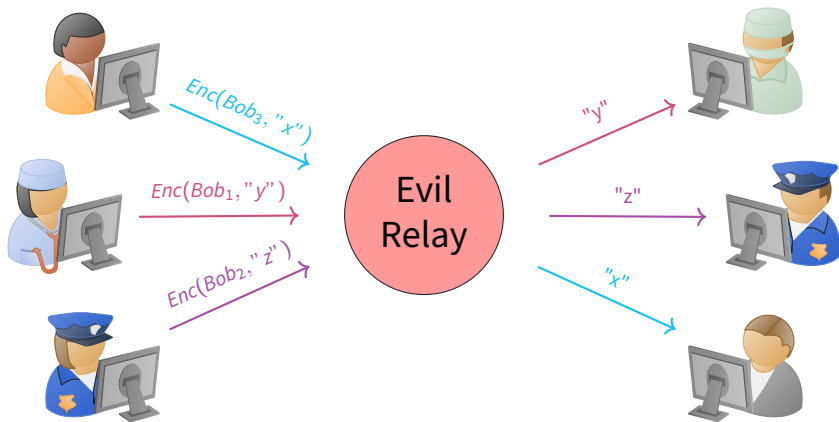


# A Simple Design

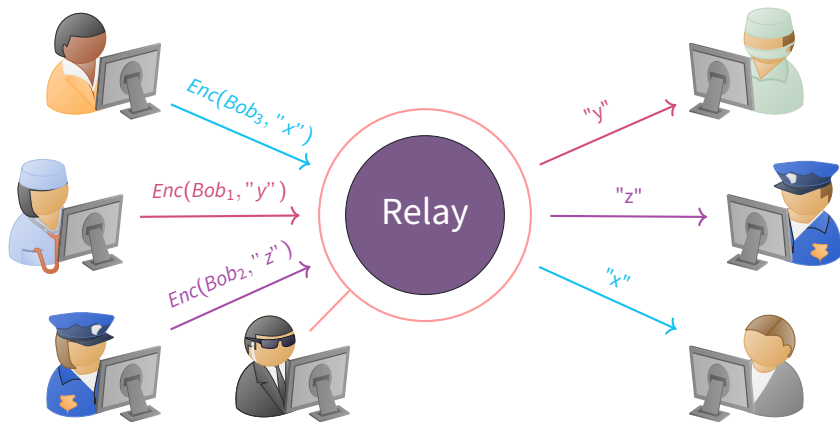


Equivalent to some commercial proxy providers.

# A Simple Design

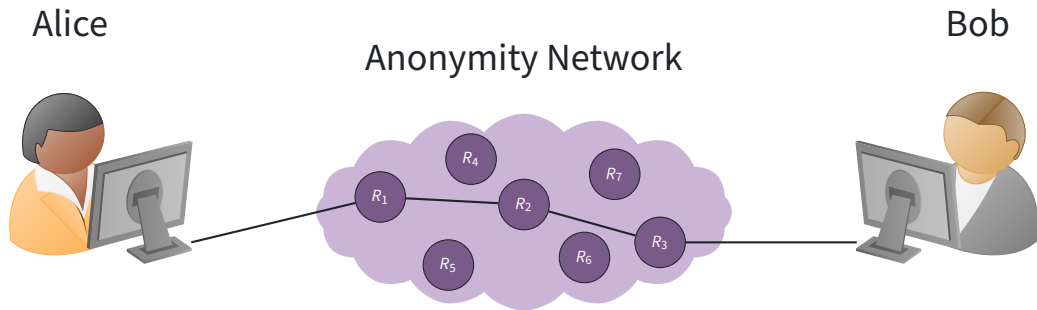


# A Simple Design



Timing analysis bridges all connections going through the relay.

# The Tor Design



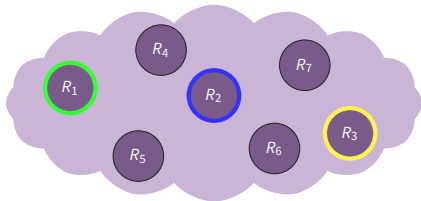
Add multiple relays so that no single relay can betray Alice.

# The Tor Design

Alice



Anonymity Network



Bob



Alice picks a path through the network:  $R_1$ ,  $R_2$ , and  $R_3$  before finally reaching Bob.

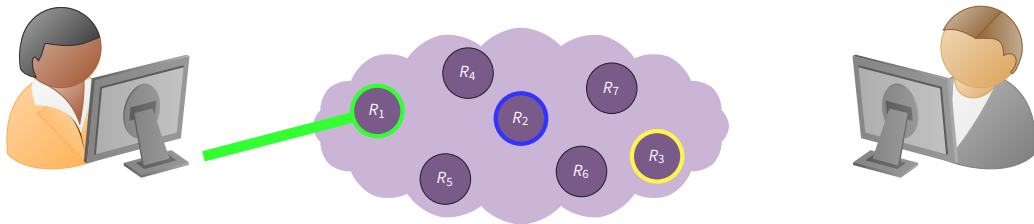


# The Tor Design

Alice

Anonymity Network

Bob



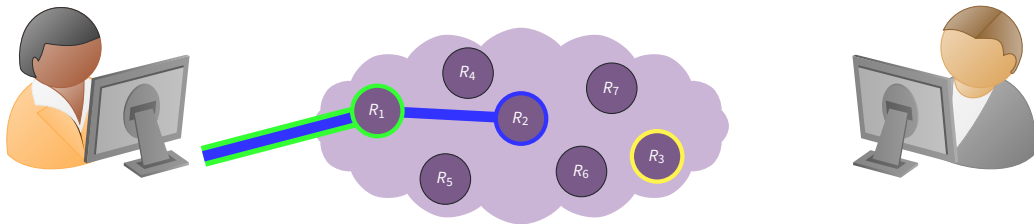
Alice makes a session key with  $R_1$ .

# The Tor Design

Alice

Anonymity Network

Bob



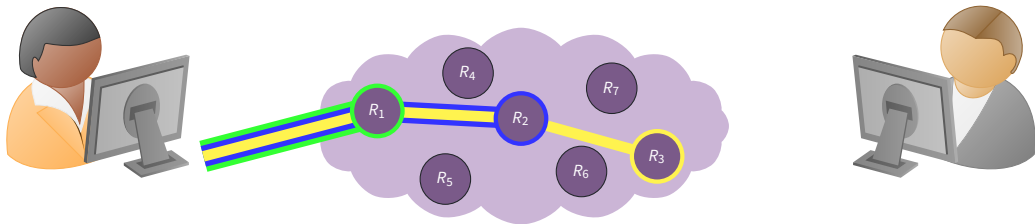
Alice asks  $R_1$  to extend to  $R_2$ .

# The Tor Design

Alice

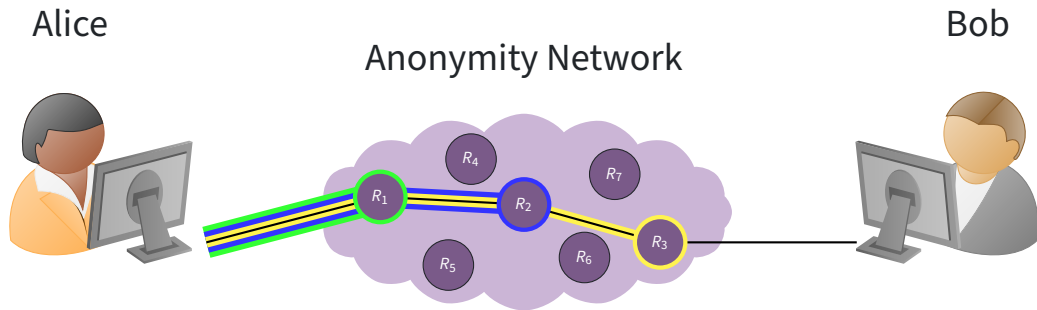
Bob

Anonymity Network



Alice asks  $R_2$  to extend to  $R_3$ .

# The Tor Design



Alice finally asks  $R_3$  to connect to Bob.

# The Tor Network

- An open network – everybody can join!
- Between 6000 and 8000 relay nodes.
- Kindly hosted by various individuals, companies, and non-profit organisations.
- 9 Directory Authority nodes and 1 Bridge Authority node.

**I live in Iran and I have been using Tor for censorship circumvention.** During political unrest while the government tightens grip on other censorship circumvention alternatives, **Tor with obfuscation plugins remains the only solution.**

Tor changed my personal life in many ways. **It made it possible to access information on Youtube, Twitter, Blogger and countless other sites.** I am grateful of Tor project, people working on it as well as people running Tor nodes.

—Anonymous Tor User.

يالله بالستر...!

تصفح بأمان!

عزيزي، هذا الموقع غير متاح في دولة الإمارات العربية المتحدة.

تتشكل شبكة الإنترنت وسيلة للتواصل والمعرفة وخدمة متطلبات حياتنا اليومية. وقد تم حجب الموقع الذي ترغب بدخوله لاشتماله محتوى مرع لحد "فئات المحتويات المحظورة" حسب تصنيف "السياسة التنظيمية لإدارة النفاذ للإنترنت" لهيئة تنظيم الاتصالات بدولة الإمارات العربية المتحدة.

إذا كانت لديك وجهة نظر مختلفة، الرجاء انقر [هنا](#).

Surf Safely!

This website is not accessible in the UAE.

The Internet is a powerful medium for communication, sharing and serving our daily learning needs. However, the site you are trying to access contains content that is prohibited under the 'Internet Access Management Regulatory Policy' of the Telecommunications Regulatory Authority of the United Arab Emirates.

If you believe the website you are trying to access does not contain any such content, please [click here](#).

خطراً!

تصفح بأمان!

عزيزي، هذا الموقع غير متاح في دولة الإمارات العربية المتحدة.  
تشكل شبكة الإنترنت وسيلة للتواصل والمعرفة وخدمة متطلبات حياتنا اليومية. وقد تم حجب الموقع الذي ترغب بدخوله لاشتماله محتوى مرع لحد "فئات المحتويات المحظورة" حسب تصنيف "السياسة التنظيمية لإدارة النفاذ للإنترنت" لهيئة تنظيم الاتصالات بدولة الإمارات العربية المتحدة.

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Access Denied

Your request was denied because of its content categorization: "Computers/Internet/Proxy Avoidance"

عزيزي العميل : تم حجب هذا الموقع بناء على القوانين

بأن هناك خطأ يرجى إرسال رسالة على البريد الإلكتروني [unblock.kw@kw.zain.com](mailto:unblock.kw@kw.zain.com) مع ذكر عنوان الموقع الذي تم حجب.

Dear Customer: This site has been blocked for categorizing this site, please



If you believe the requested page should Not be blocked please [click here](#).

هذا الموقع محظور  
This site is blocked

الوصول إلى هذا الموقع غير مسموح به حالياً لأنه مصنف ضمن فئات المحتويات المحظورة بموجب أحكام السياسة التنظيمية لإدارة النفاذ إلى الإنترنت في دولة الإمارات العربية المتحدة

Access to this site is currently blocked. The site falls under the Prohibited Content Categories of the UAE's Internet Access Management Policy.

إذا كنت ترغب في إعادة النظر في تصنيف هذا الموقع، يرجى التفضل بتعبئة استمارة الملاحظات

If you would like the classification on this site to be reviewed, please fill in and submit the Feedback Form

<http://torproject.org/>

Dear User,

Sorry, the requested page is unavailable.

If you believe the requested page should not be blocked please [click here](#).

For more information about internet service in Saudi Arabia, please click here: [www.internet.gov.sa](http://www.internet.gov.sa)

خدمة الإنترنت في المملكة العربية السعودية  
الموقع الإلكتروني: [www.internet.gov.sa](http://www.internet.gov.sa)



## Du var på vej ind på en ulovlig hjemmeside

Vi vil meget gerne hjælpe dig med at finde den film eller serie, du søger.

Søg med FilmFinder →

Hvis du er på udkig efter musik, bøger eller møbler

Gå til  SHARE WITH CARE →



SHARE  
WITH  
CARE

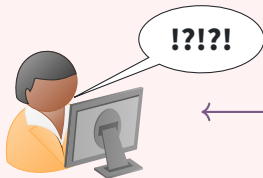
Hjemmesiden er blevet blokeret, fordi den er dømt ulovlig ved en dansk domstol. Brug Share With Care til at finde det, du leder efter, lovligt. På den måde passer du både på dig selv og på kulturen. **Læs mere om Share With Care**



# Introduction to Censorship

**Censored Region**

Alice



Bob



Alice is unable to reach Bob.

# Introduction to Censorship

**Censored Region**

Alice



Bob



Alice can reach Bob, but their connection is throttled.

# Introduction to Censorship

**Censored Region**

Alice



Bob



Alice can reach Bob because the censor thinks Bob is fine.

# Anti-censorship Strategies

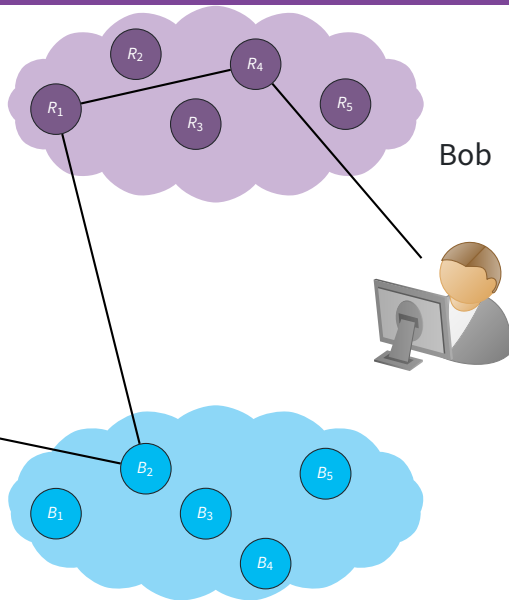
1. Censors will apply censorship to **all** relays in the network and effectively block access to the Tor network.
2. Censors will apply censorship to **known** bridges.

**Solution:** We make it difficult to find and block bridges and we make it difficult to learn if a given connection is between a Tor user and an entry-point into the Tor network.

# Bridges

**Censored Region**

Alice



Bob

# Bridges

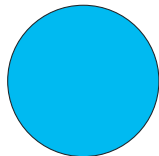
**Censored Region**

Alice



Tor Protocol

Bridge



# Bridges and Pluggable Transports

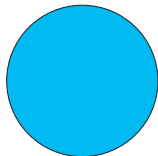
**Censored Region**

Alice



PT Client

Bridge



PT Server

Obfuscated Protocol



# Pluggable Transports

- Allows people to easily build, experiment, and deploy their own obfuscation technology without having to modify the Tor source code itself.
- The specification for Pluggable Transports is open and allows other vendors to implement support for PTs in their own products.
- Allows people to experiment with different transports for Tor that might not be doing any anti-censorship related obfuscation.



# Snowflake

## Censored Region

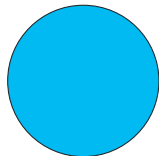
Alice



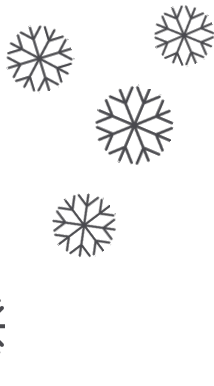
Snowflake PT Client

Snowflake Broker

Bridge



Snowflake PT Server



# Snowflake

## Censored Region

Alice

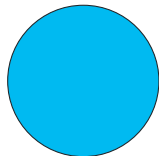


Snowflake PT Client

Snowflake Broker

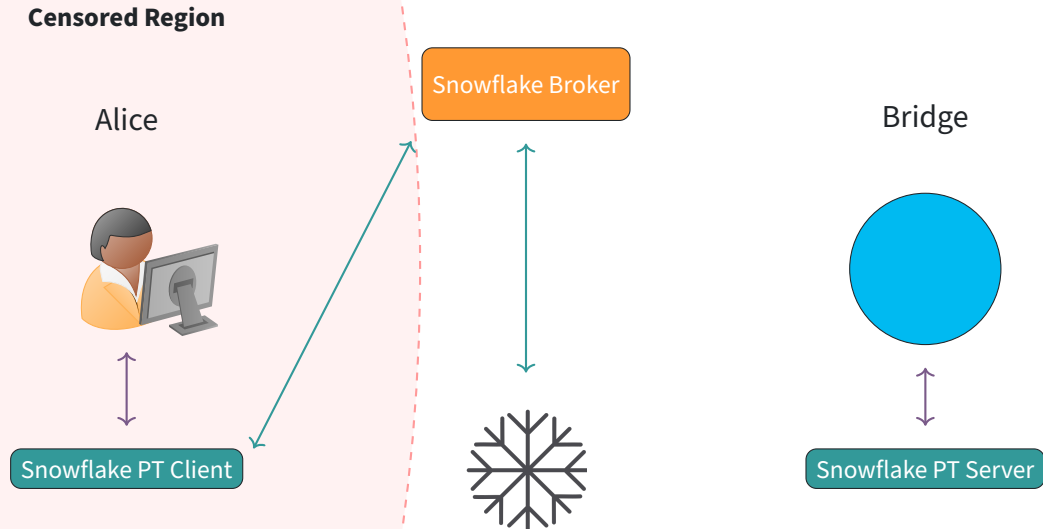


Bridge



Snowflake PT Server

# Snowflake



# Snowflake

## Censored Region

Alice

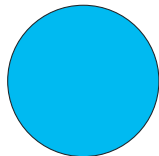


Snowflake PT Client

Snowflake Broker

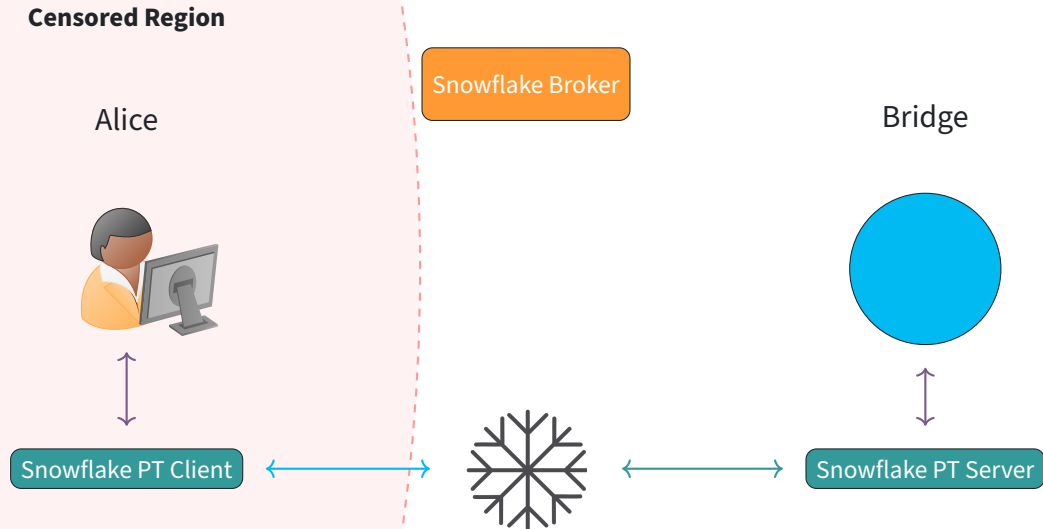


Bridge

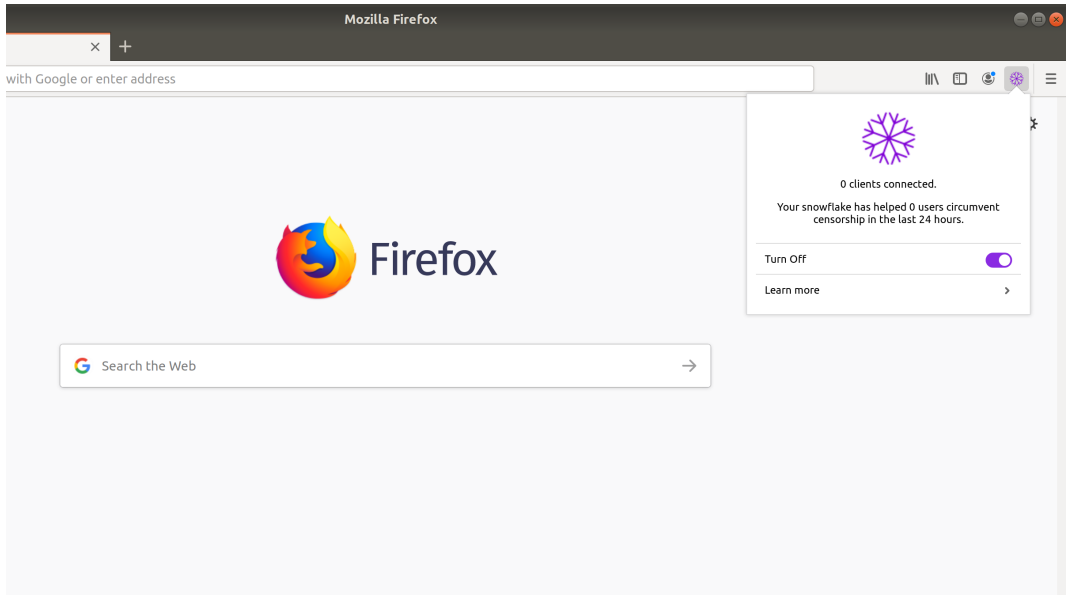


Snowflake PT Server

# Snowflake



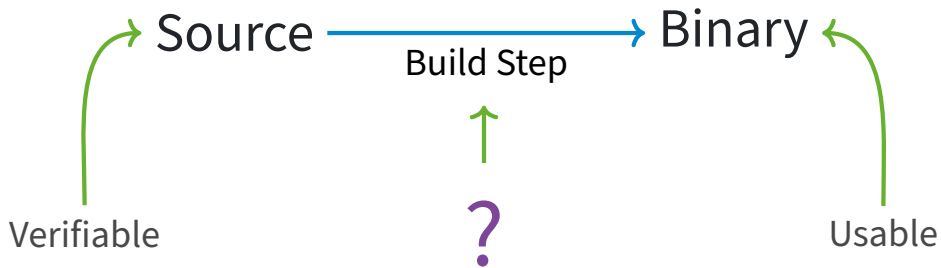
# Snowflake



# Reproducible Builds

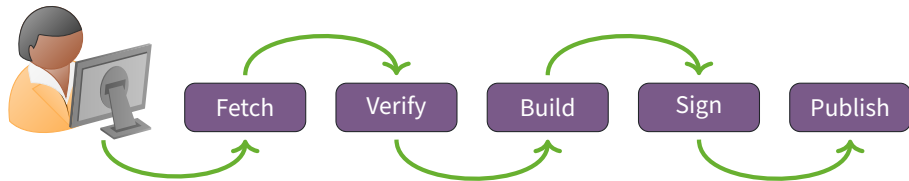


# Reproducible Builds

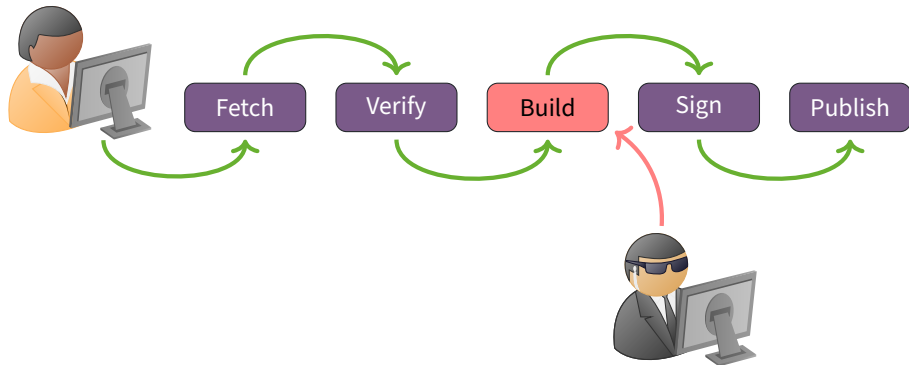




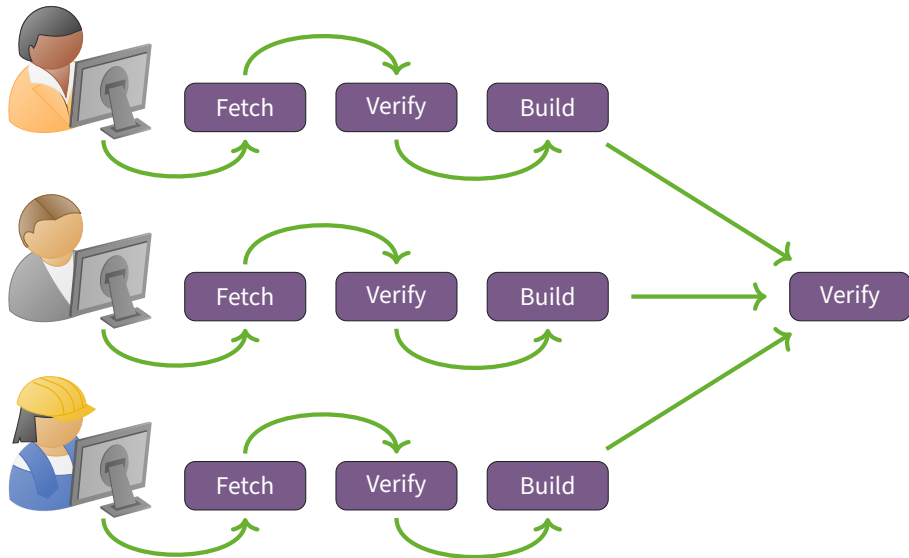
# Build Process



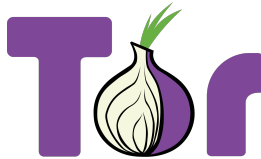
# Build Process



# Build Process



# Reproducible Builds



# Reproducible Builds Problems

Common problems includes:

- Timestamps as part of the build process.
- Usernames.
- Locale settings.
- Host settings (such as hostname and IP).

# Tor is not foolproof

- Browser metadata fingerprinting.
- Browser exploits.
- Traffic analysis.
- Operational security mistakes.

# How can you help?

- Find, and maybe fix, bugs in Arti.
- Run a Tor relay or a bridge!
- Teach others about Tor and privacy in general.
- Work on some of the many open research projects.



# Questions?

✉ ahf@torproject.org

- ahf @ Funding the Commons  
Discord

🔑 OpenPGP:  
1C1B C007 A9F6 07AA 8152  
C040 BEA7 B180 B149 1921

🐙 @ahf@mastodon.social

🦋 @ahf.me





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