Censorship-Resistant Architectures

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The Censorship Problem

Internet censorship is a problem in certain areas of the world. In some cases, censorship may be ubiquitous, e.g. government imposed censorship.

Users in these areas are

- unable to access restricted services
- are punished if they are observed accessing restricted services

Most existing services do not work against these powerful adversaries.

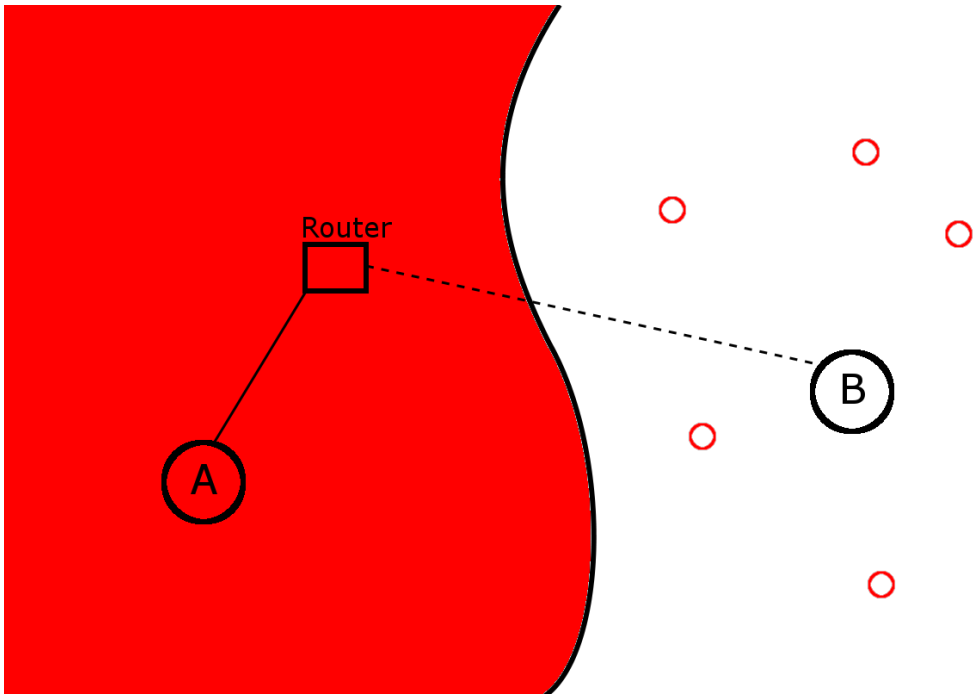
Existing Methods

Anonymity Services

Tor - Relay traffic through a series of anonymizing routers.
VPNs
Anonymizing proxy websites etc.

Very effective for their designed purposes
Less so against censorship

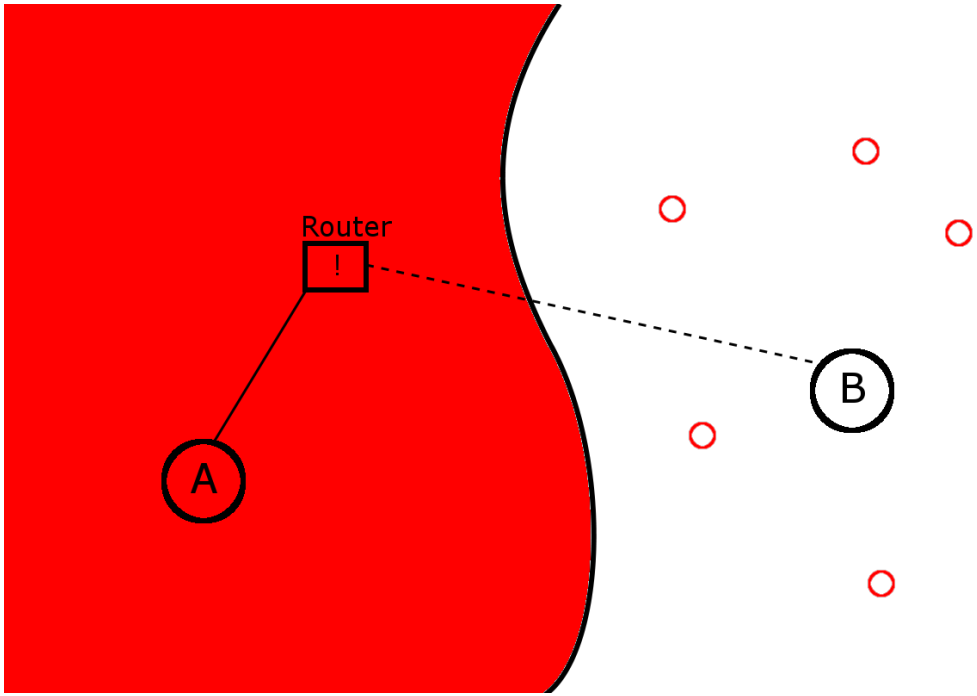
Attack Model



Powerful Adversary known to control large portion of ‘nearby’ network.

- performs traffic analysis
- participates in any communication system
- controls some peers outside of censored region

Adversary's Goals



The adversary wins if it

- discovers that Alice has been communicating with Bob
- is able to prevent Alice from communicating with Bob

1) Blocking off entire communication network/service

If a service:

- is dedicated to providing anonymity
- and can be identified by the adversary (e.g. entry IP addresses are published, differentiable traffic)

then the adversary can shutdown the entire network without repercussions

Solution

Build a general purpose communication system

- primary purpose is not censorship resistance
- provides cover traffic and encourages usage, e.g. in business.

2) Traffic Analysis

SkypeMorph: shape traffic as Skype traffic
FreeWave: encodes data stream as audio stream

Recent work shows that this may not be enough due to VBR encoding.

Solution

Avoid VBR encoding.
Ensure encoding schemes and traffic patterns are sufficiently similar among communication types
May imply inefficient traffic for data stream

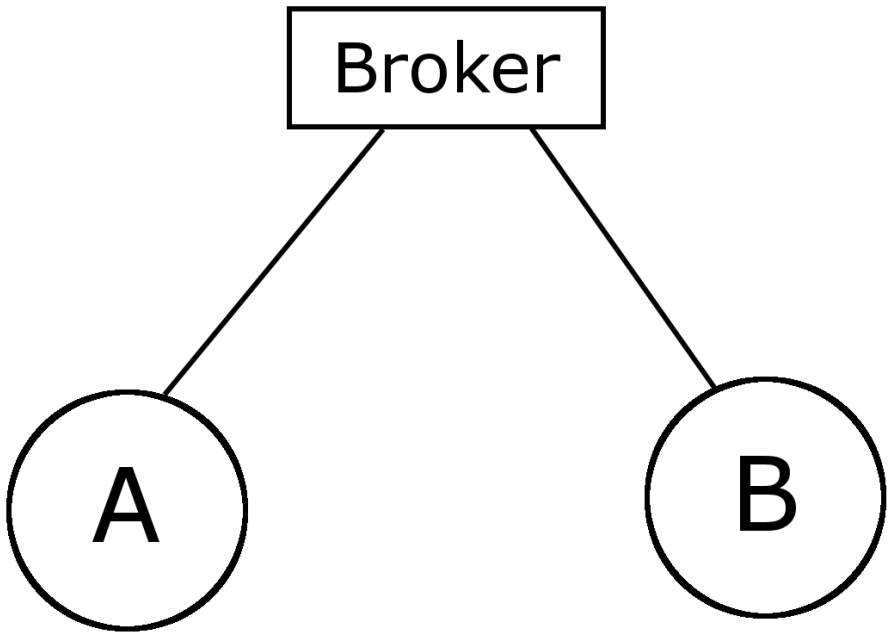
3) Public Addresses

Service's IP Addresses must be published for clients to access them.
Censor can also obtain and block these IP addresses.

Solution

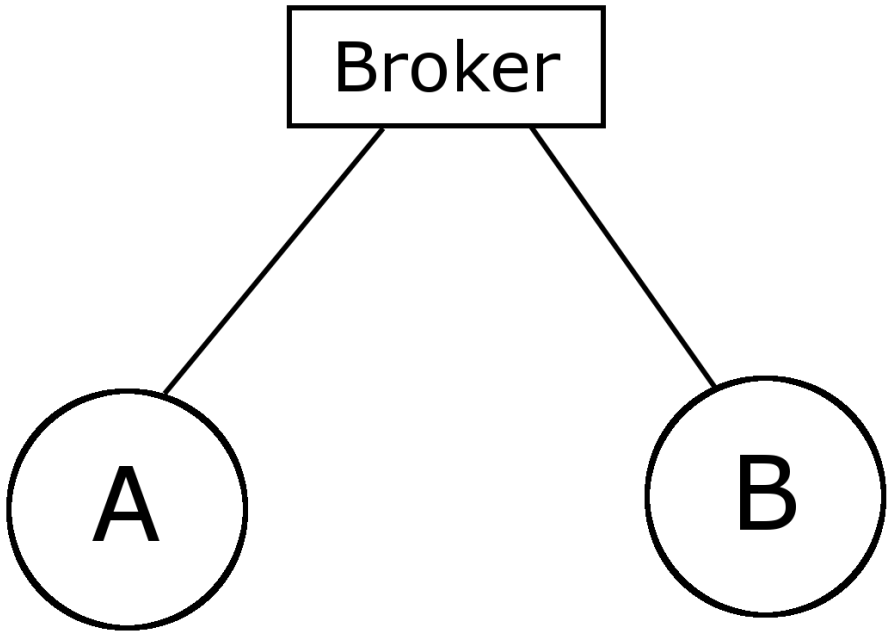
Use trusted third parties to relay traffic to published destination.
Same basic idea is used in Skype for reachability.

Approach #1 - Fully Centralized



Based on standard client/server model.
Broker controls network, users register with **B**roker

Approach #1 - Fully Centralized



Users are identified by usernames and broker does not reveal IP addresses. Broker disseminates public keys and binds keys to usernames.

Requirements and assumptions

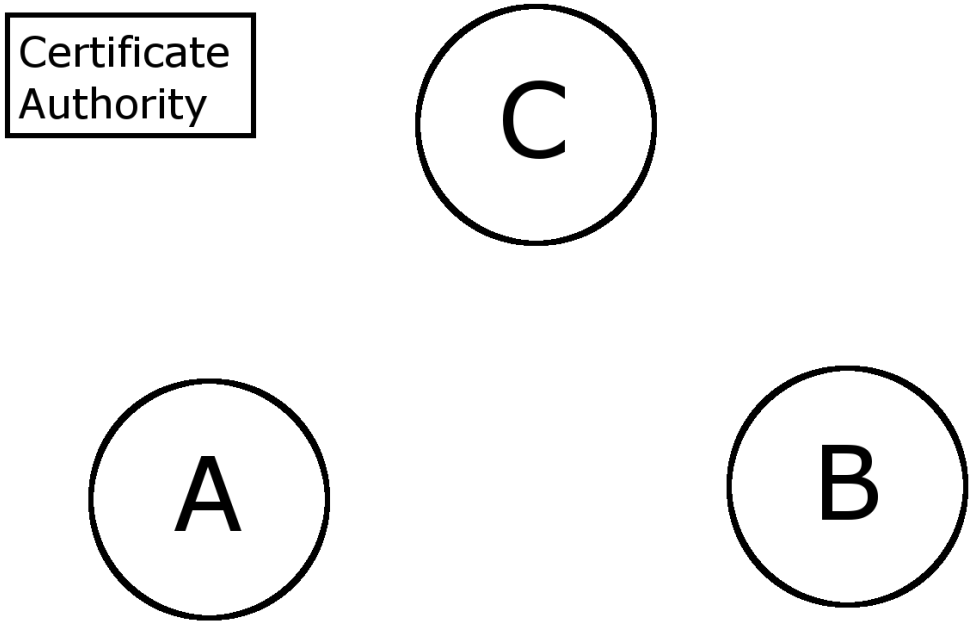
Broker

- Does not collude with Adversary
- Is outside of Adversary's influence
- Does not necessarily reveal Alice's identity to Bob

Use Cases

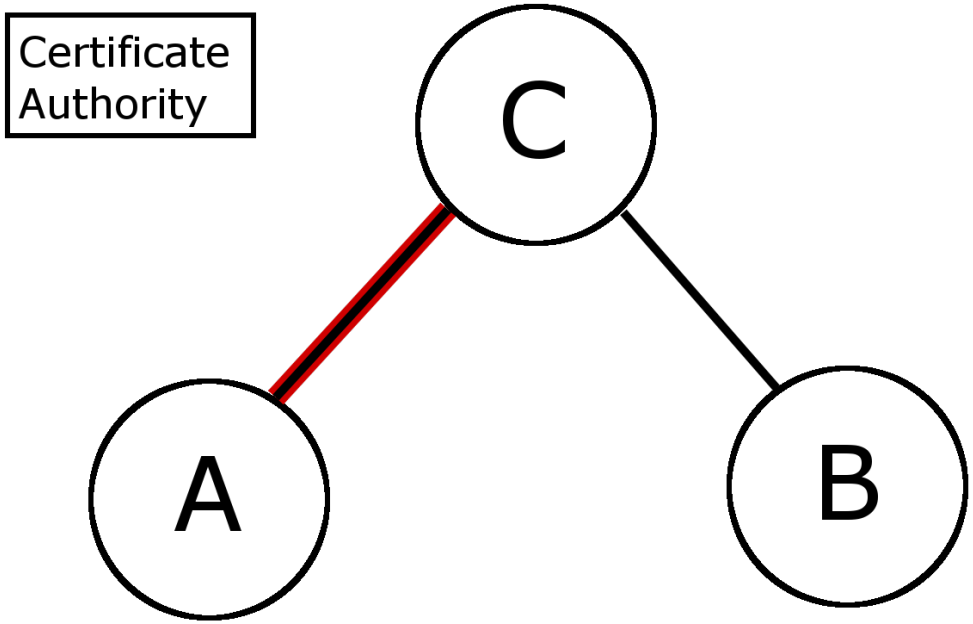
More useful for multi-party communication, e.g. Google hangouts

Approach # 2 - Distributed



Users create certificates - <username, public key, timestamp> signed by a known and trusted root certificate authority.

Approach # 2 - Distributed



Alice contacts Charlie, a known and trusted friend.
Charlie acts as a relay between Alice and Bob

Requirements and assumptions

Intermediary (Charlie)

- Does not collude with Adversary
- Is outside of Adversary's influence
- Does not reveal Alice's identity to Bob

Communication Network

- Allows for one way authentication (protect Alice's identity)
- Has indirection capabilities built in and available on demand

In Conclusion ...

Most existing systems are ineffective against a country level adversary. Use described architectures and techniques to build a general purpose censorship resistant network.