Detecting Network Interference Without Endpoint Participation

Extended Abstract

Sadia Nourin Kevin Bock Nguyen Phong Hoang Dave Levin

Internet Censorship

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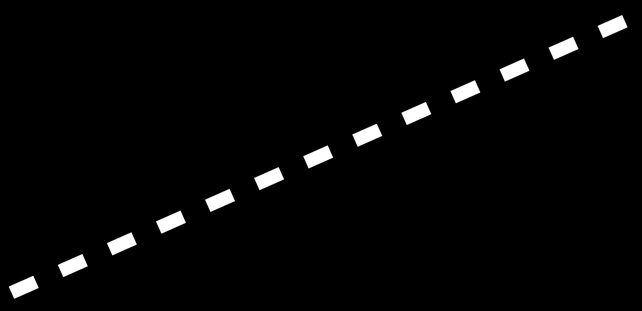

Blockpage

Internet Censorship

RST

Blockpage

Connection
Termination

Internet Censorship

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Connection Termination

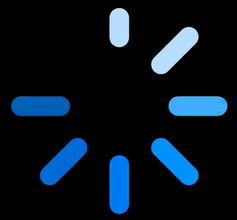
Throttling

Internet Censorship

Blockpage

RST

Connection Termination



Throttling

Packet Drop

Censorship Measurement

- ☐ twitter.com
- ☐ roxypalace.com
- ☑ facebook.com

What is being censored?

How do censors operate?

How does censorship change over time?

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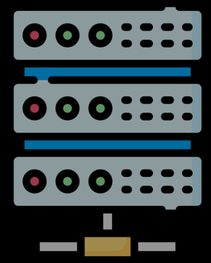
Volunteers

Remote Machines



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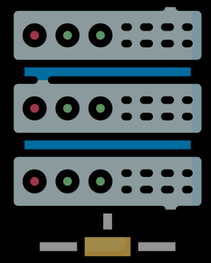

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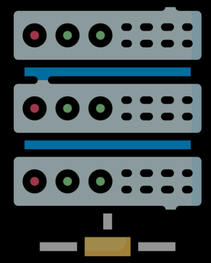

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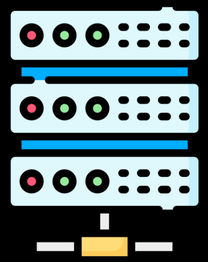

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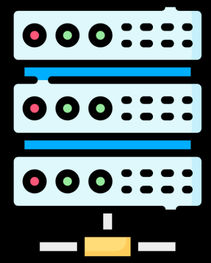

Censored Planet

ICLAB

Censorship Measurement

Works great in most countries!

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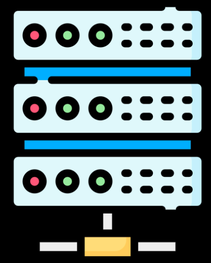

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Not great for countries with:

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Extremely Repressive Regimes

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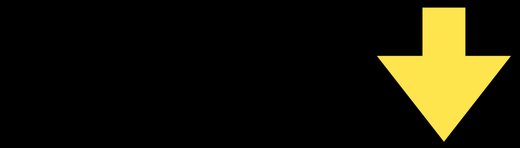

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Low Internet Penetration Rates

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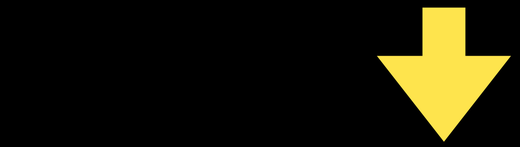

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Poor Internet Infrastructure

Censorship Measurement

We seek to build a new censorship measurement system

- Can longitudinally test millions of domains
- Without needing vantage points or endpoint participation
- Meant to complement NOT replace existing efforts — give insight into hard-to-reach networks or networks not reachable at all

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1. Background
2. High-Level Design
3. Preliminary Results

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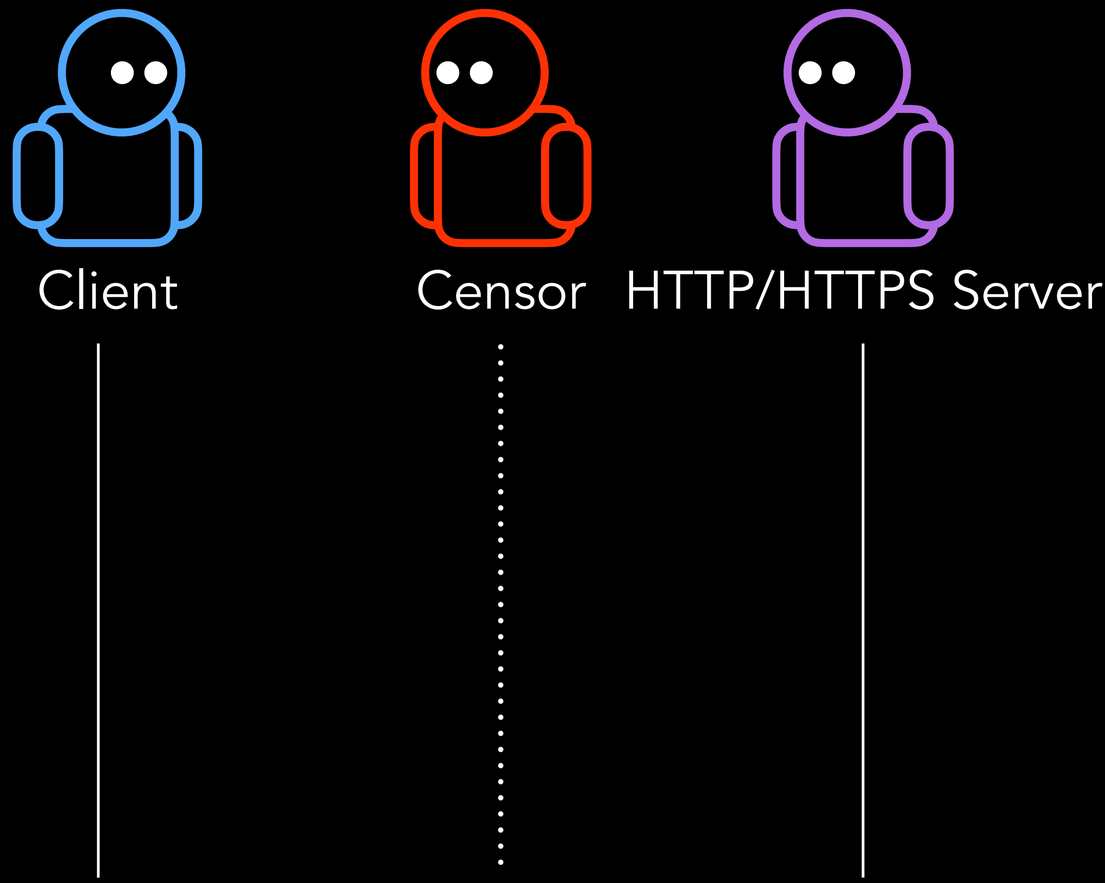
TCP Noncompliance



HTTP/HTTPS Censorship via TCP

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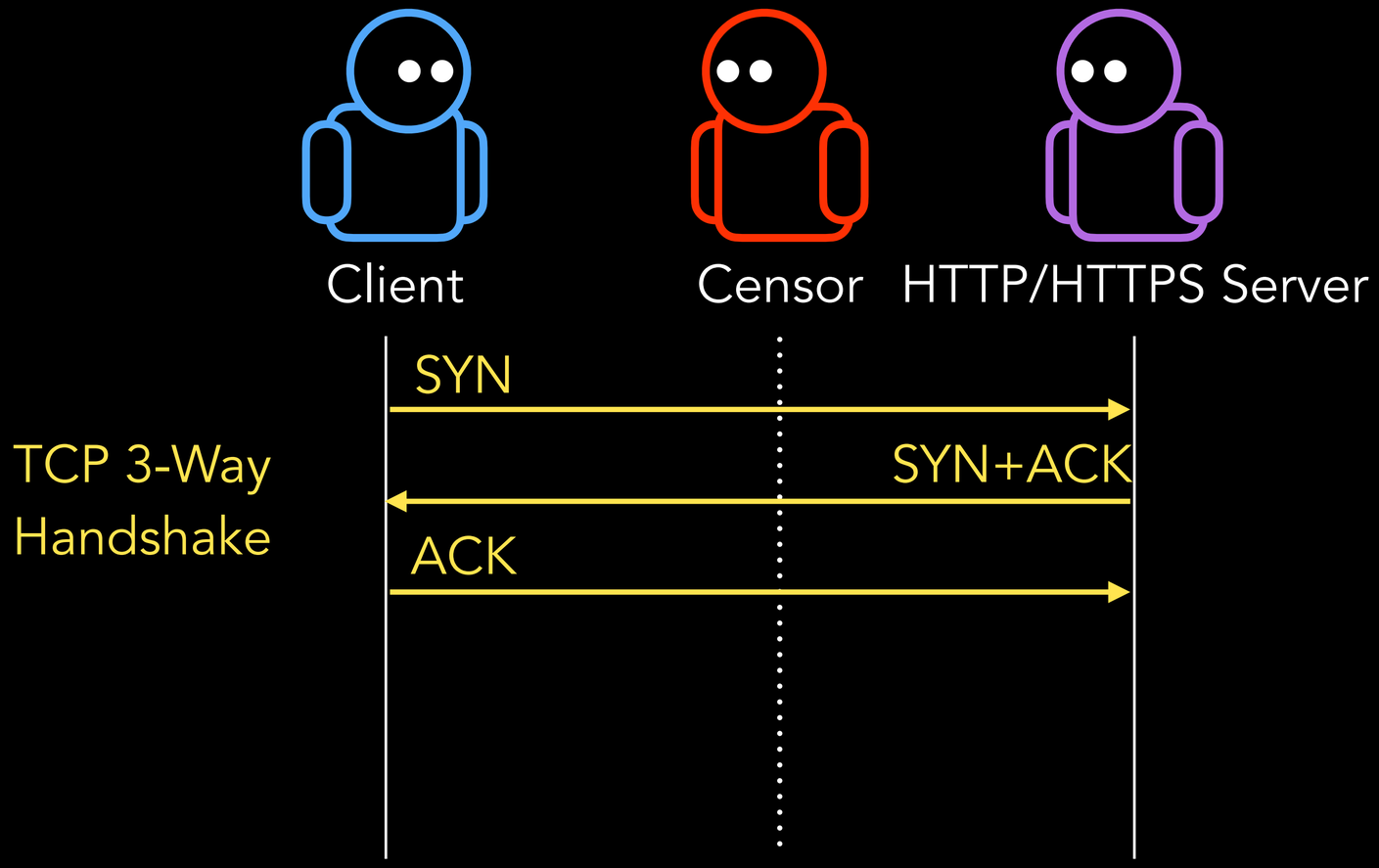

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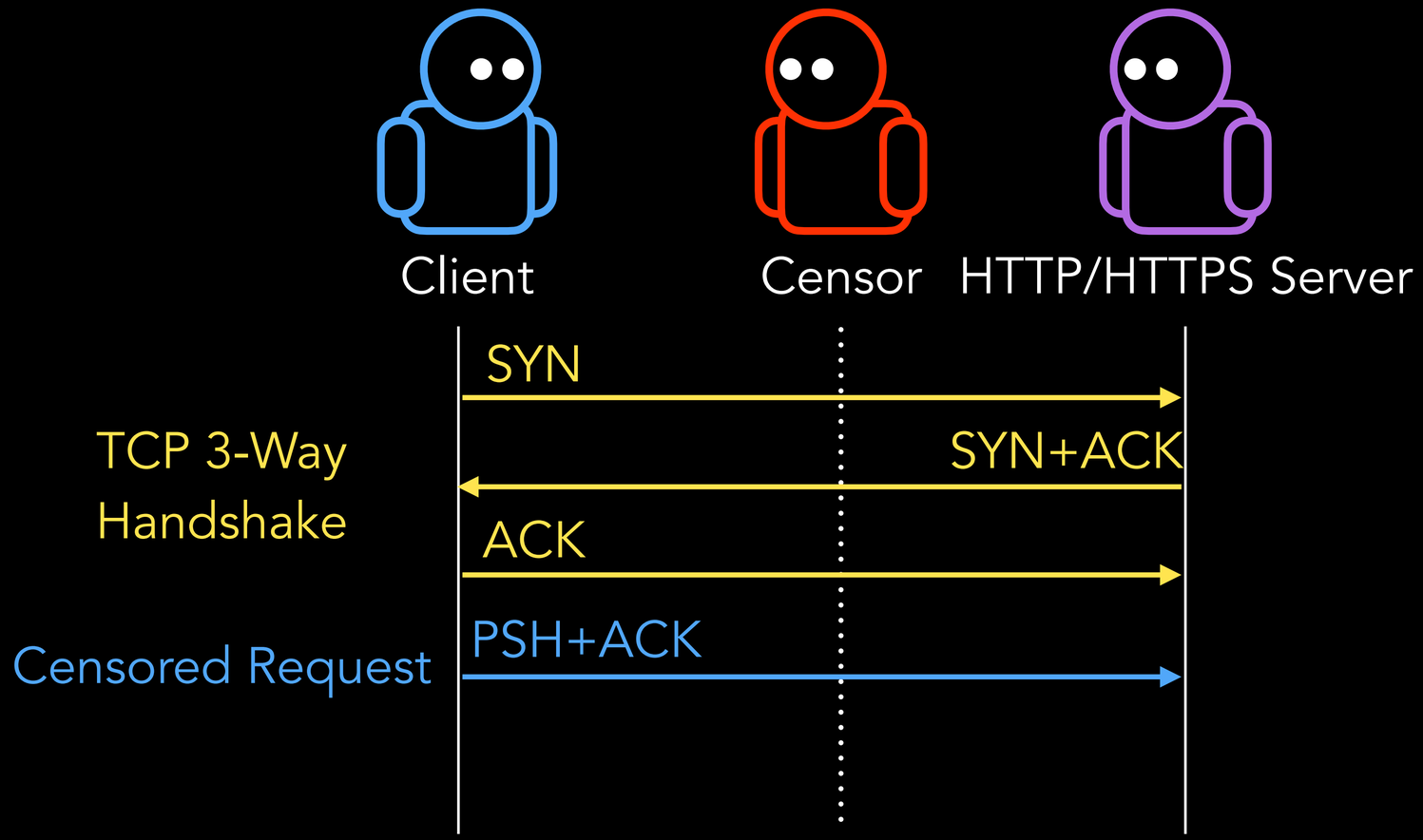

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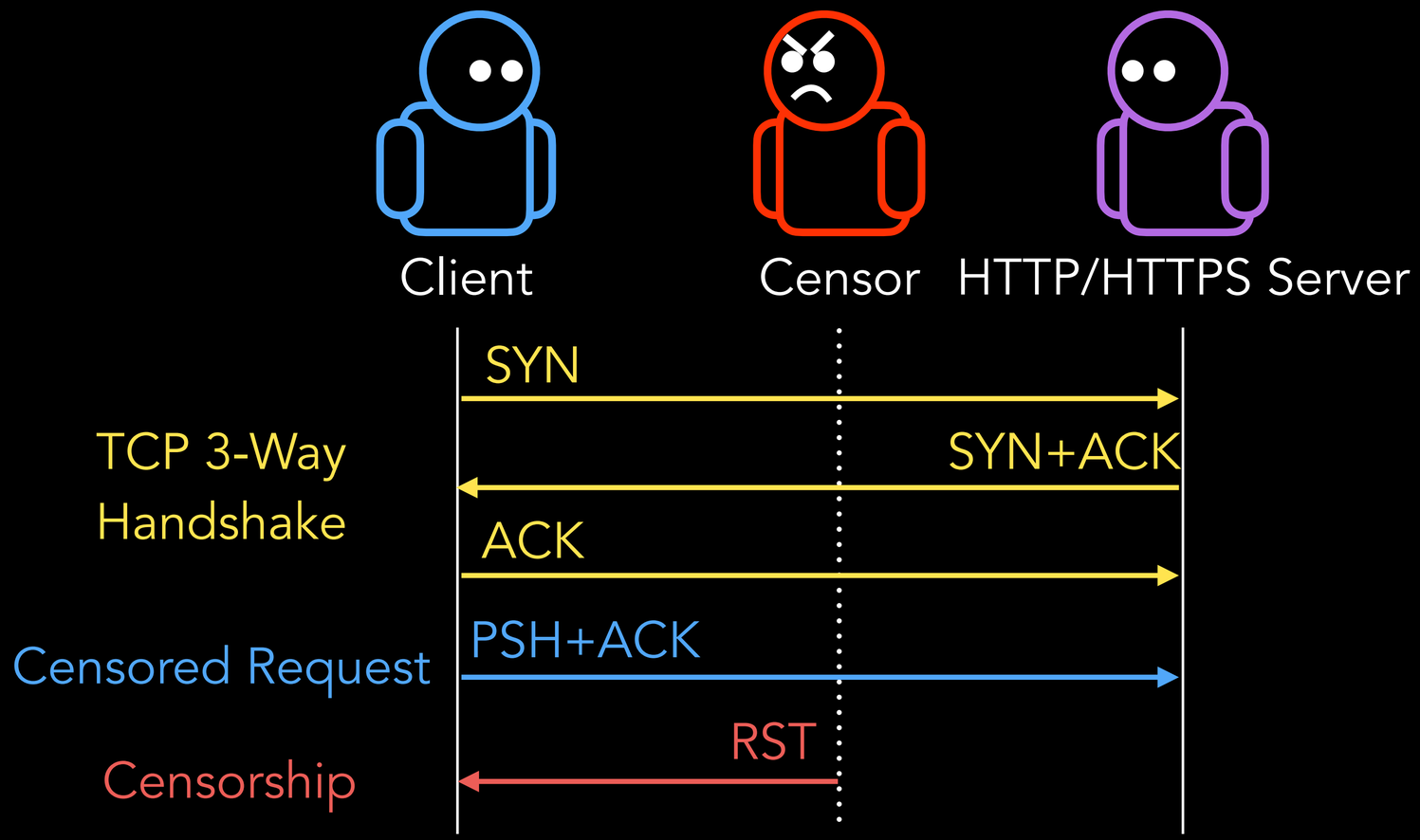

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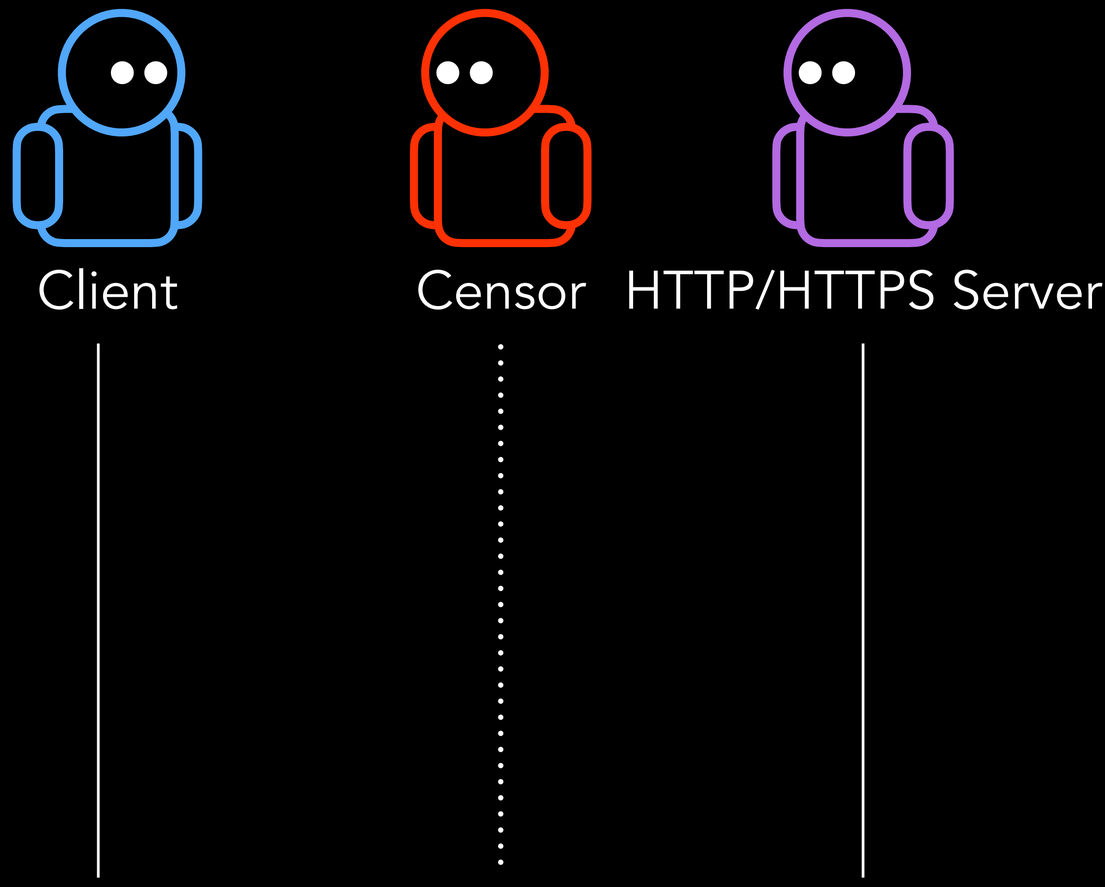

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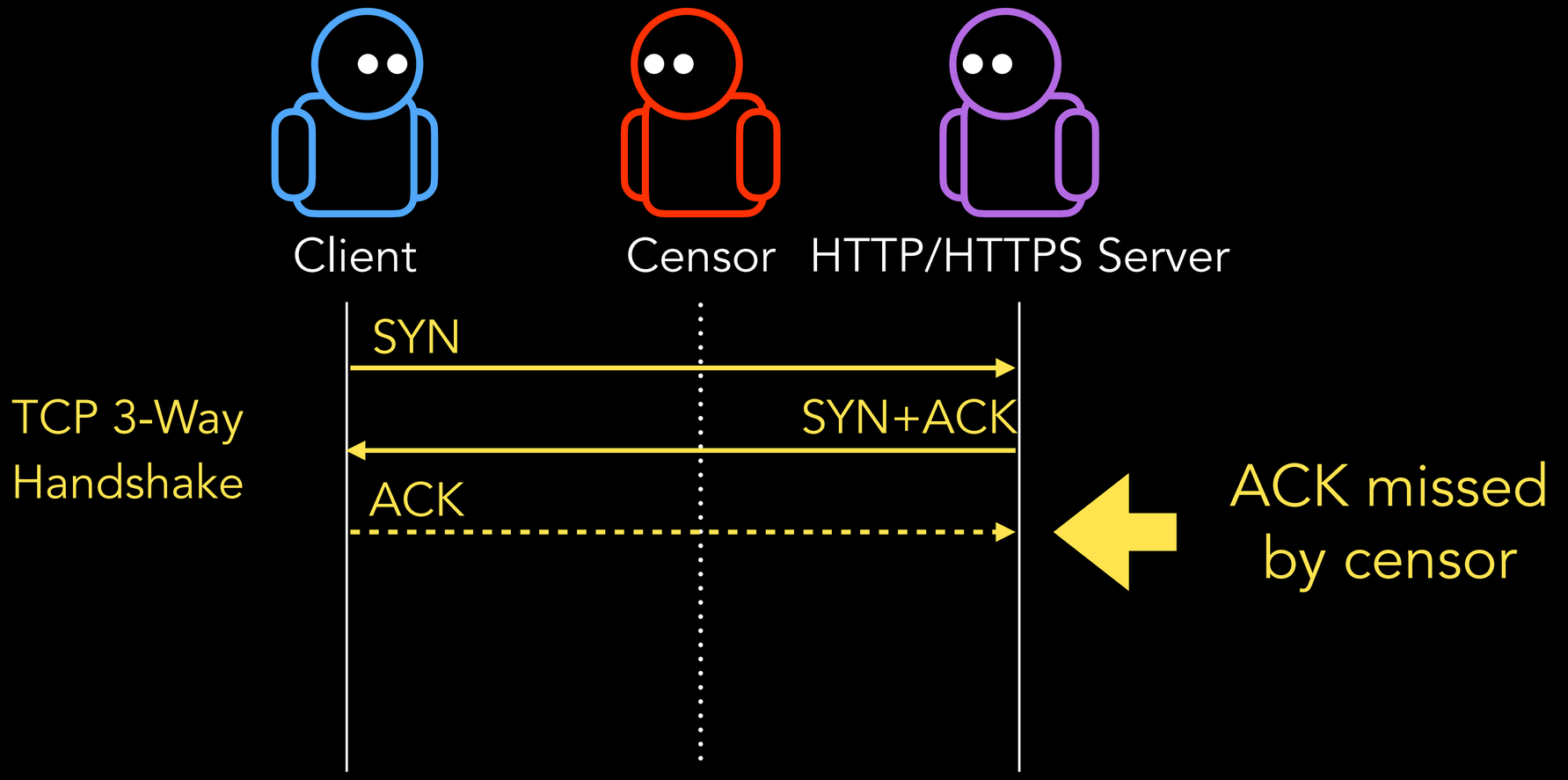

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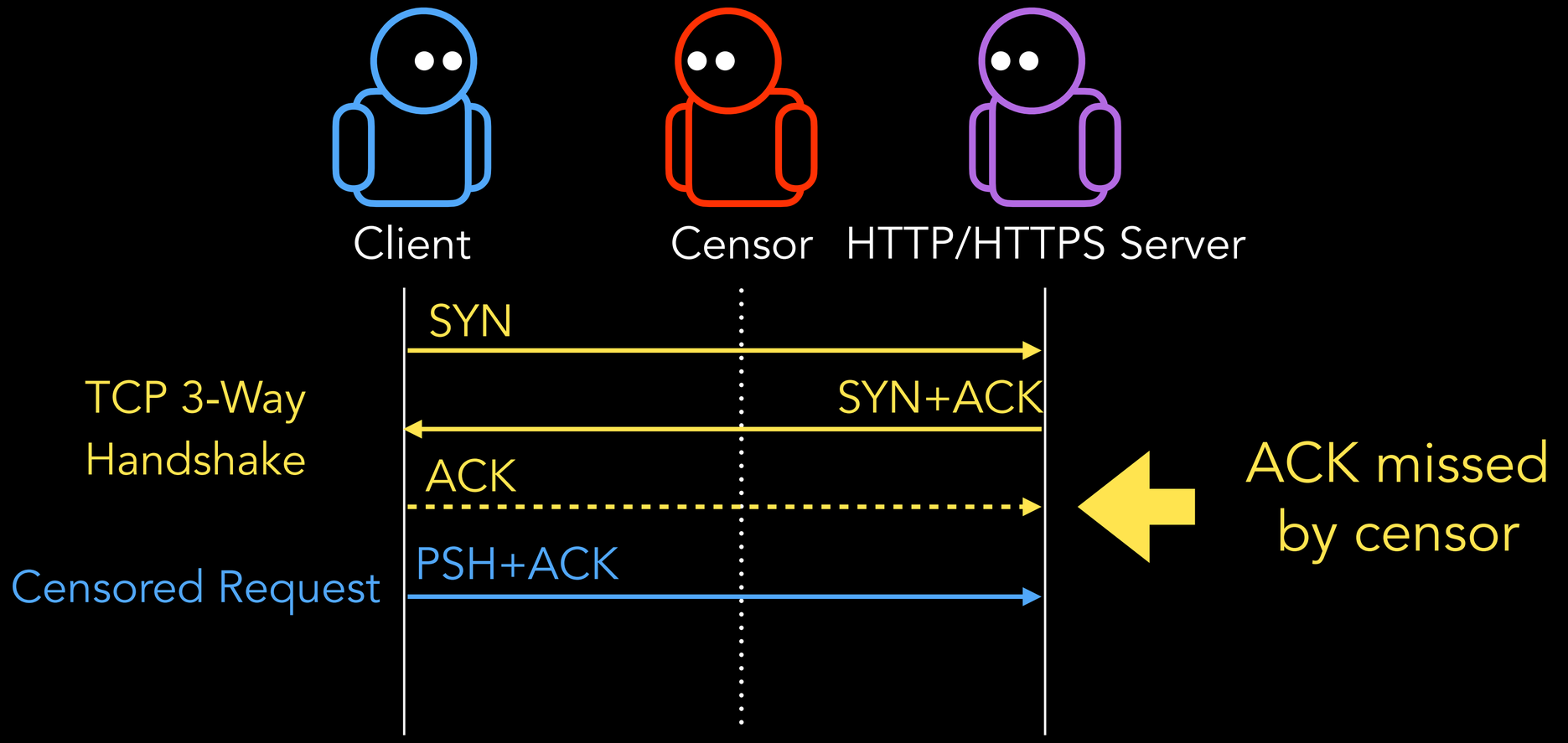

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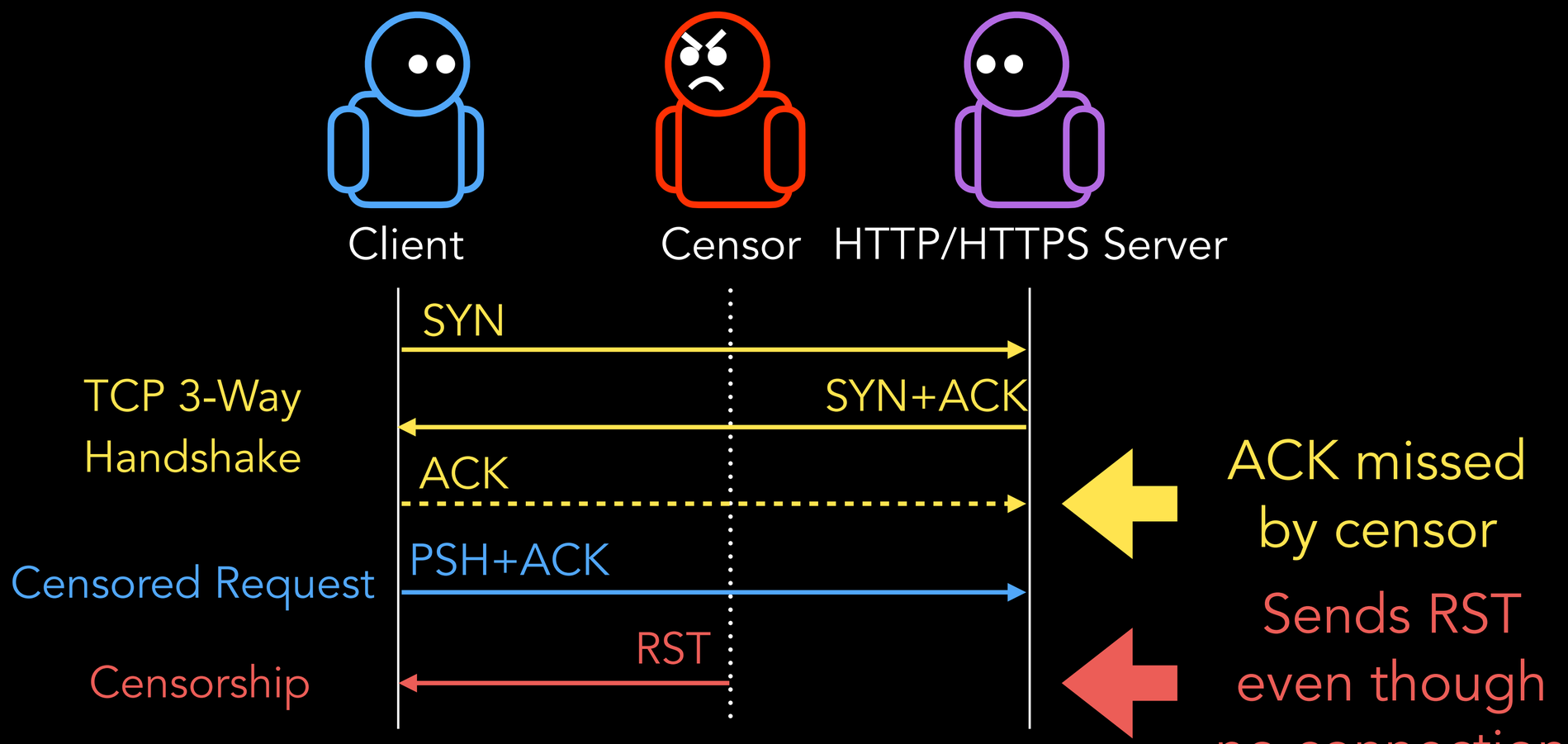

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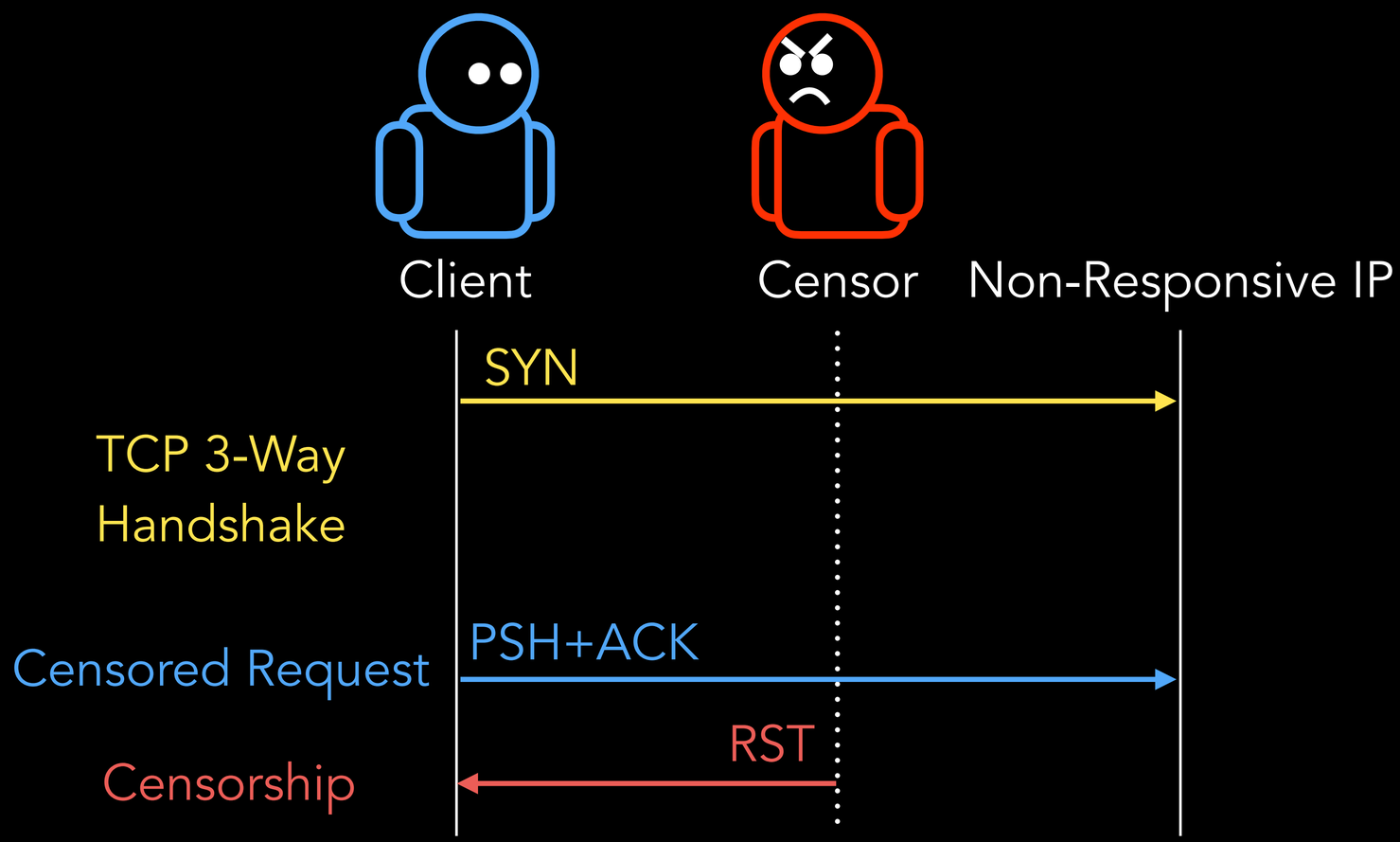

Triggering HTTP/HTTPS Censorship without Endpoint Participation

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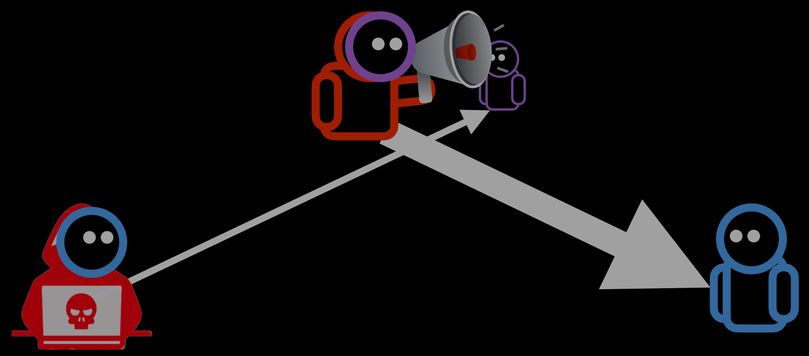

TCP Amplification Attacks

[Bock et al. USENIX 2021]

Measuring Turkmenistan Censorship

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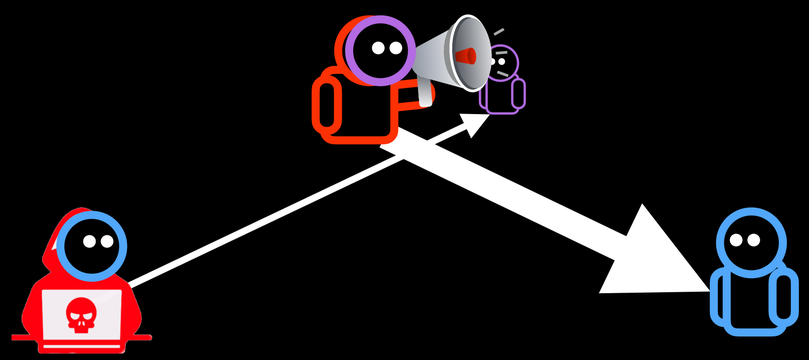

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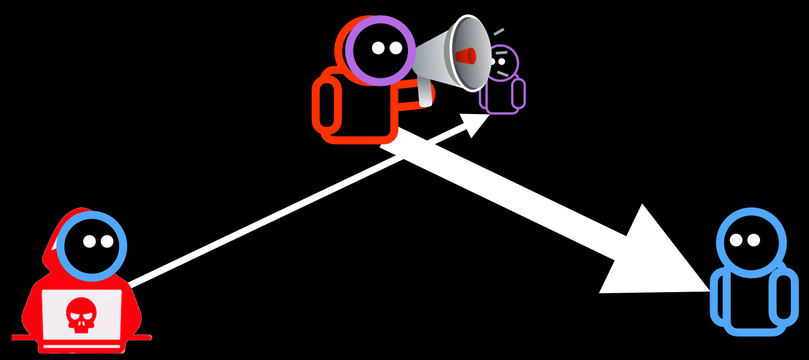

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Measuring Censorship

- Once we can trigger censorship on one IP address, we can trigger censorship on virtually all IP addresses
- Can not only measure networks current tools cannot access, but can hit more endpoints in other networks too
- Why does this matter? Censorship is not uniformly distributed over IP addresses!

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High-Level Design

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A country is eligible for our measurement system if it has:

1. Confirmed Censored Domain(s)
2. Bidirectional Censorship
3. Little to No Residual Censorship

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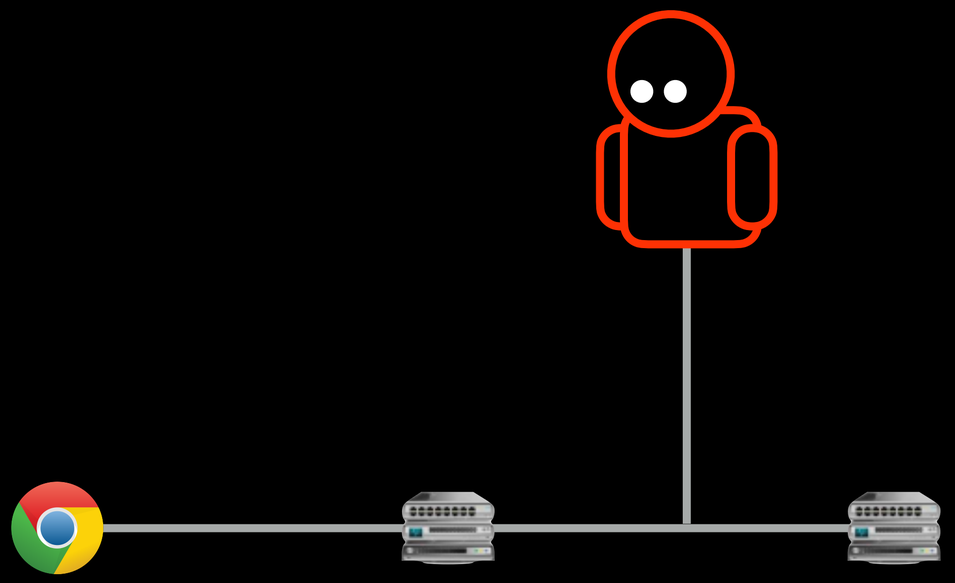
Censor filters all traffic regardless of where it originated



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(outside censored country)

Server

(inside censored country)

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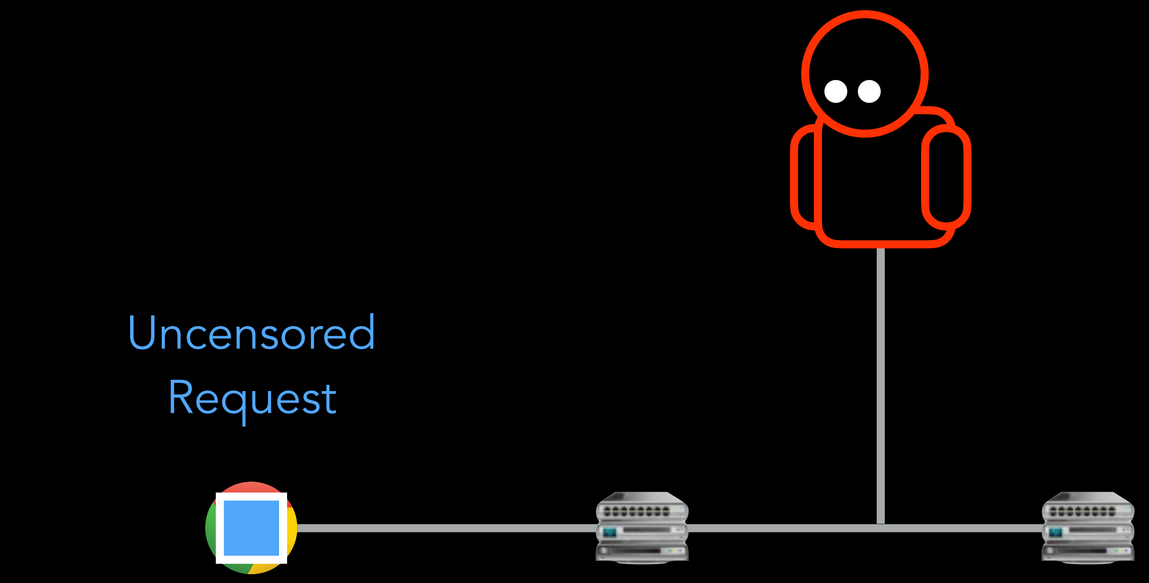

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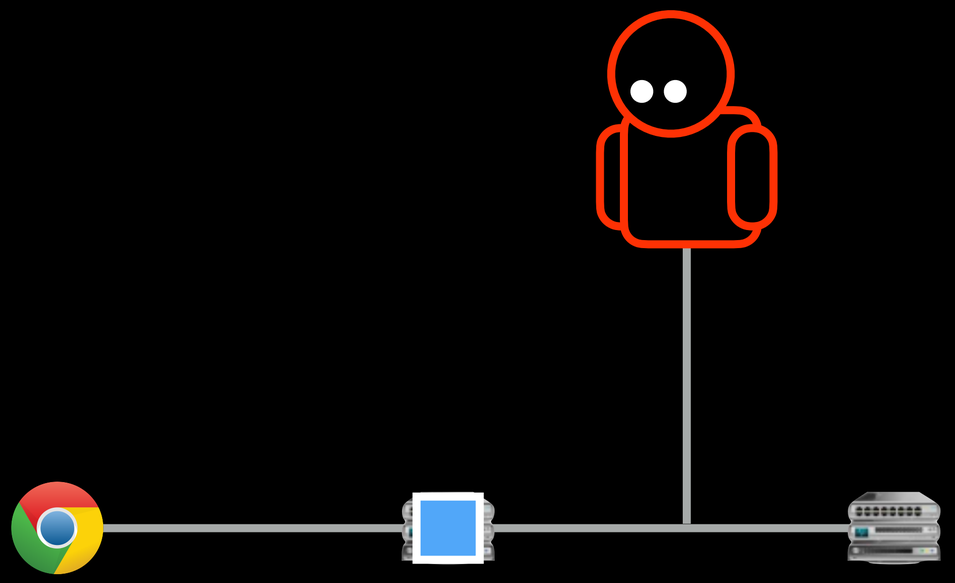

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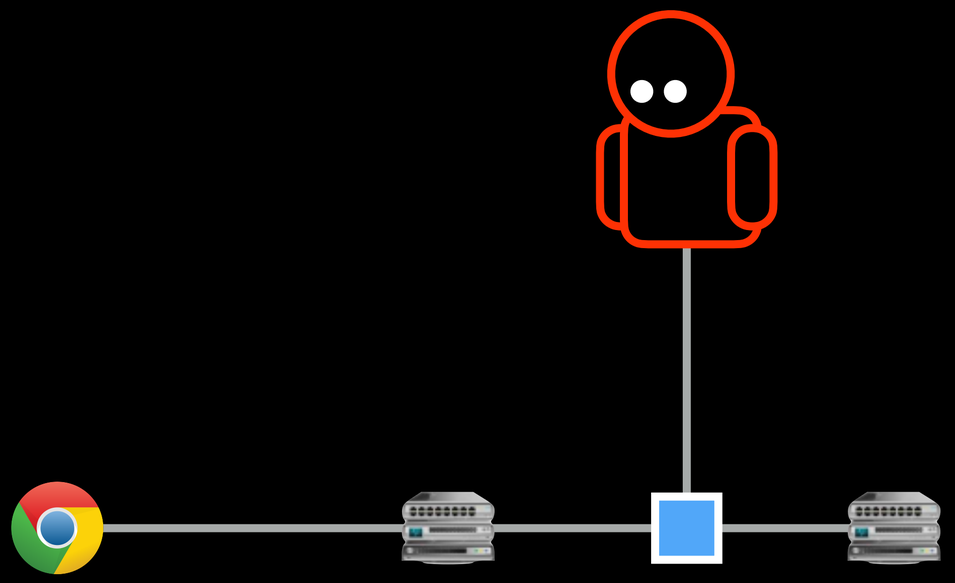

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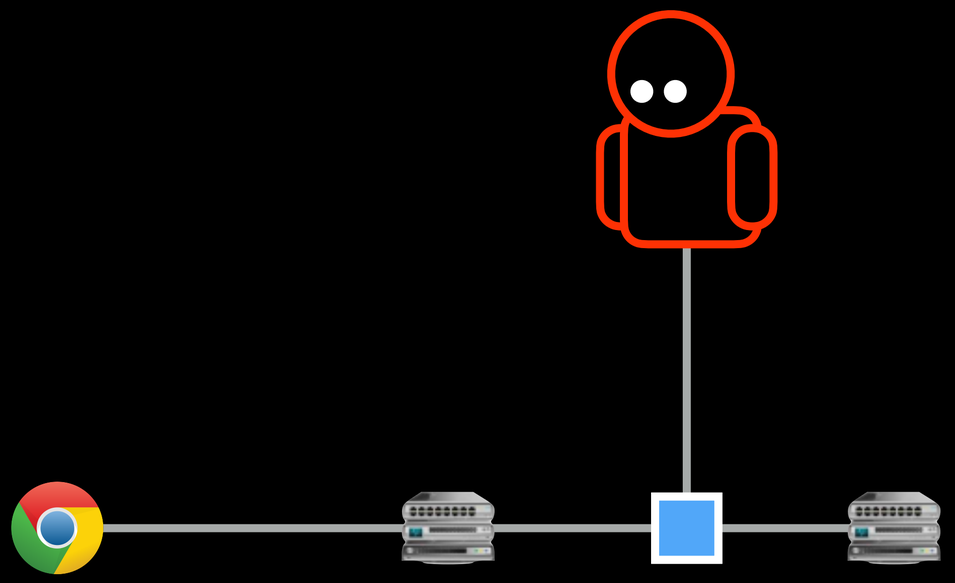

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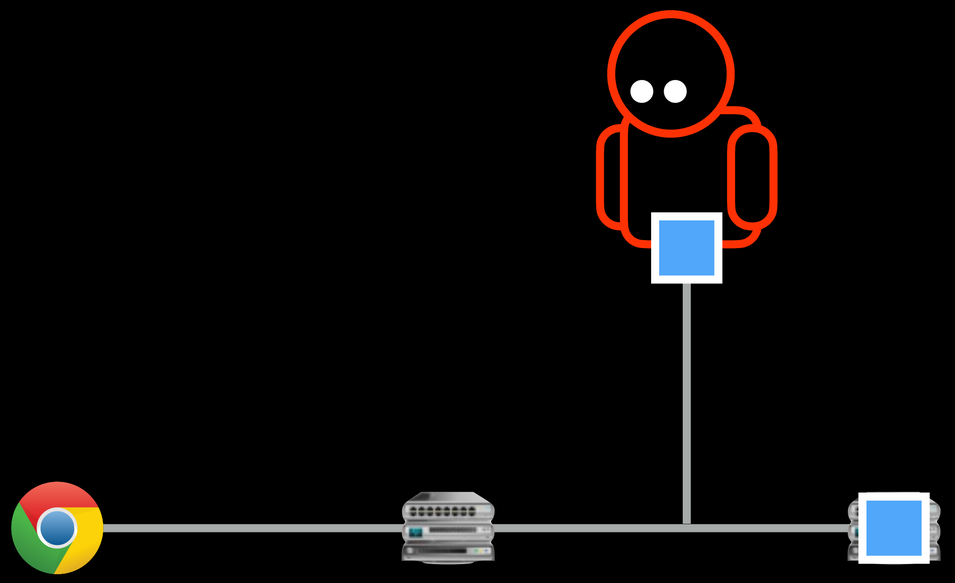

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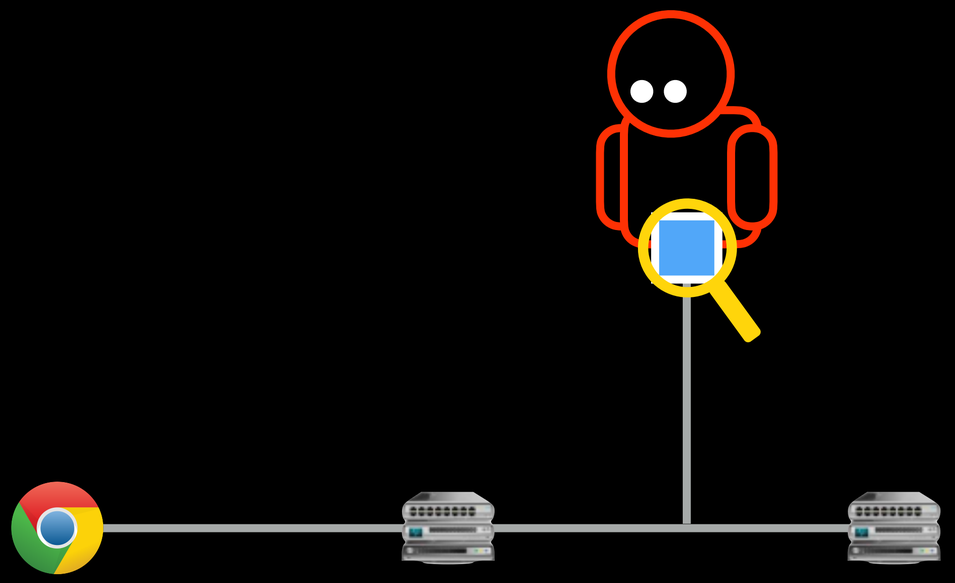

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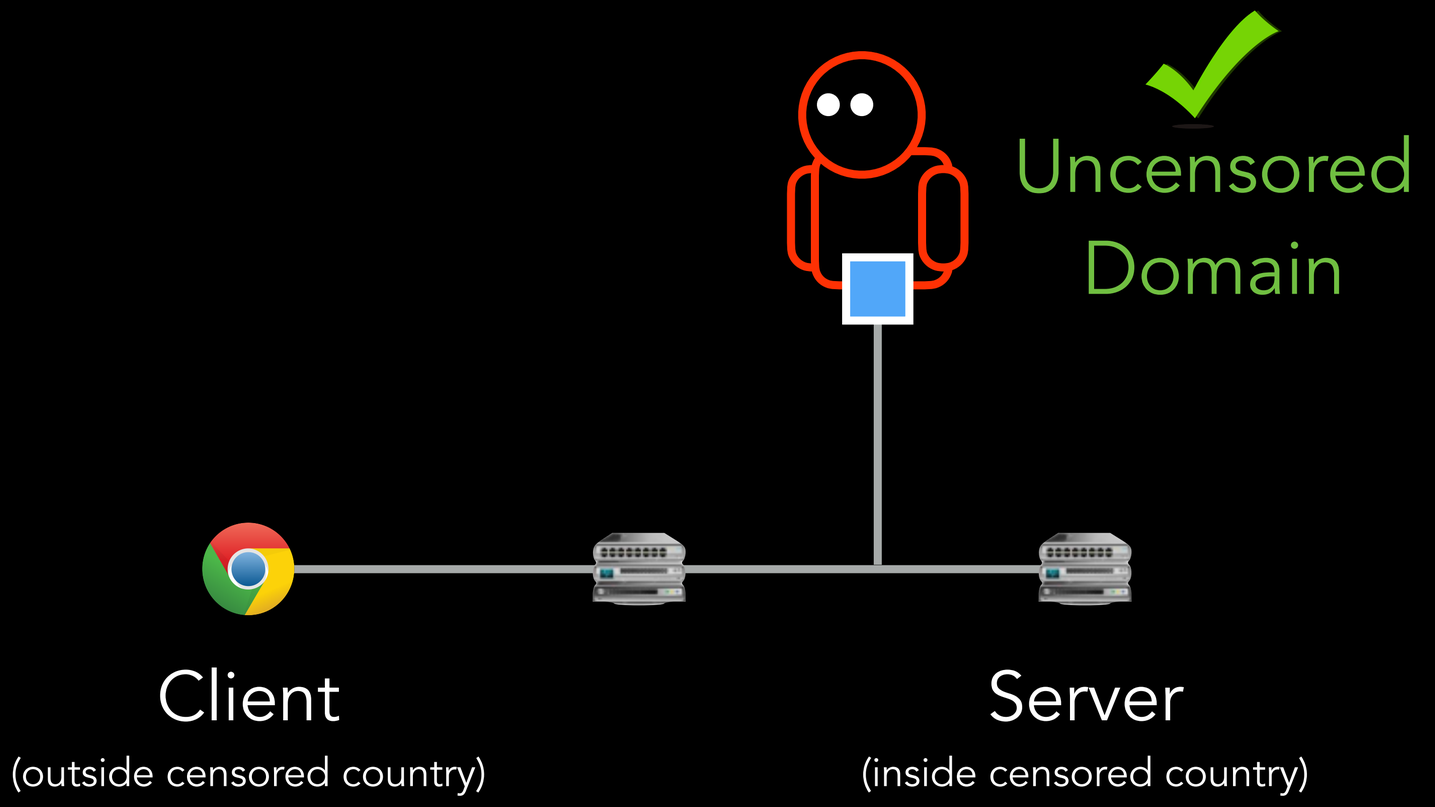

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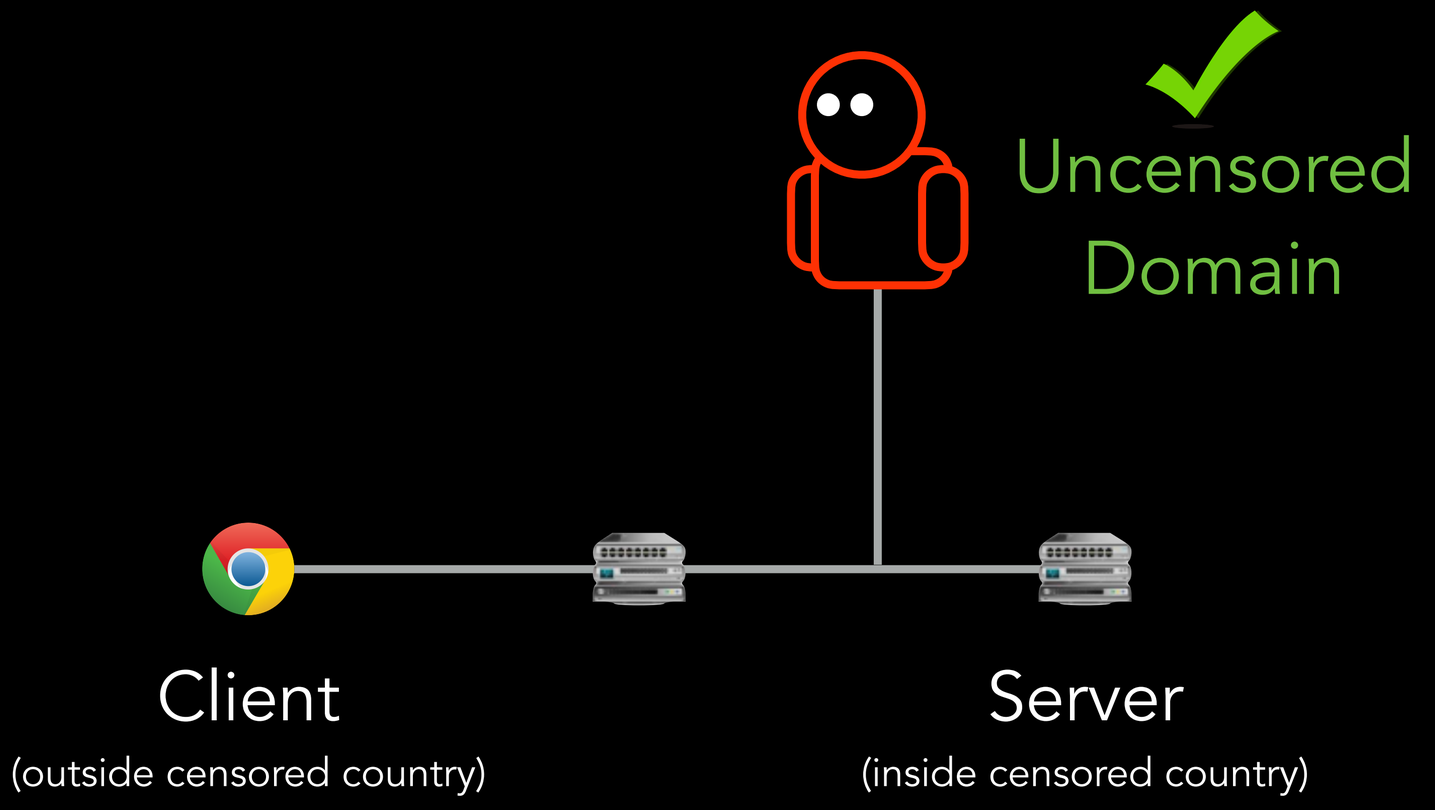

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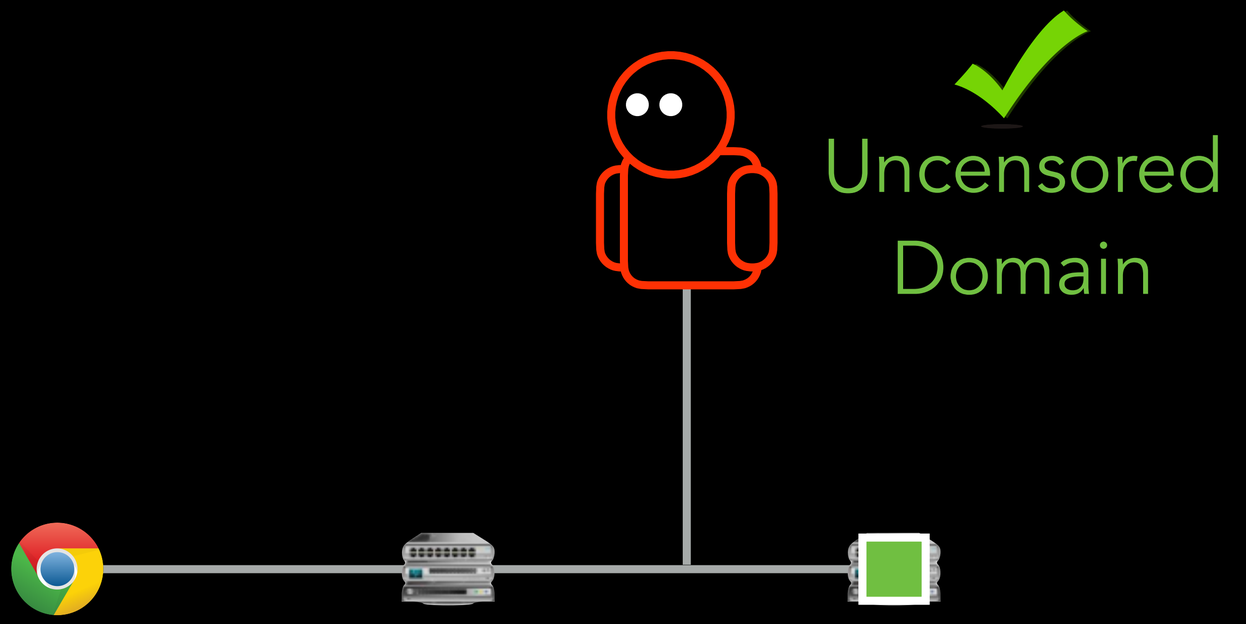

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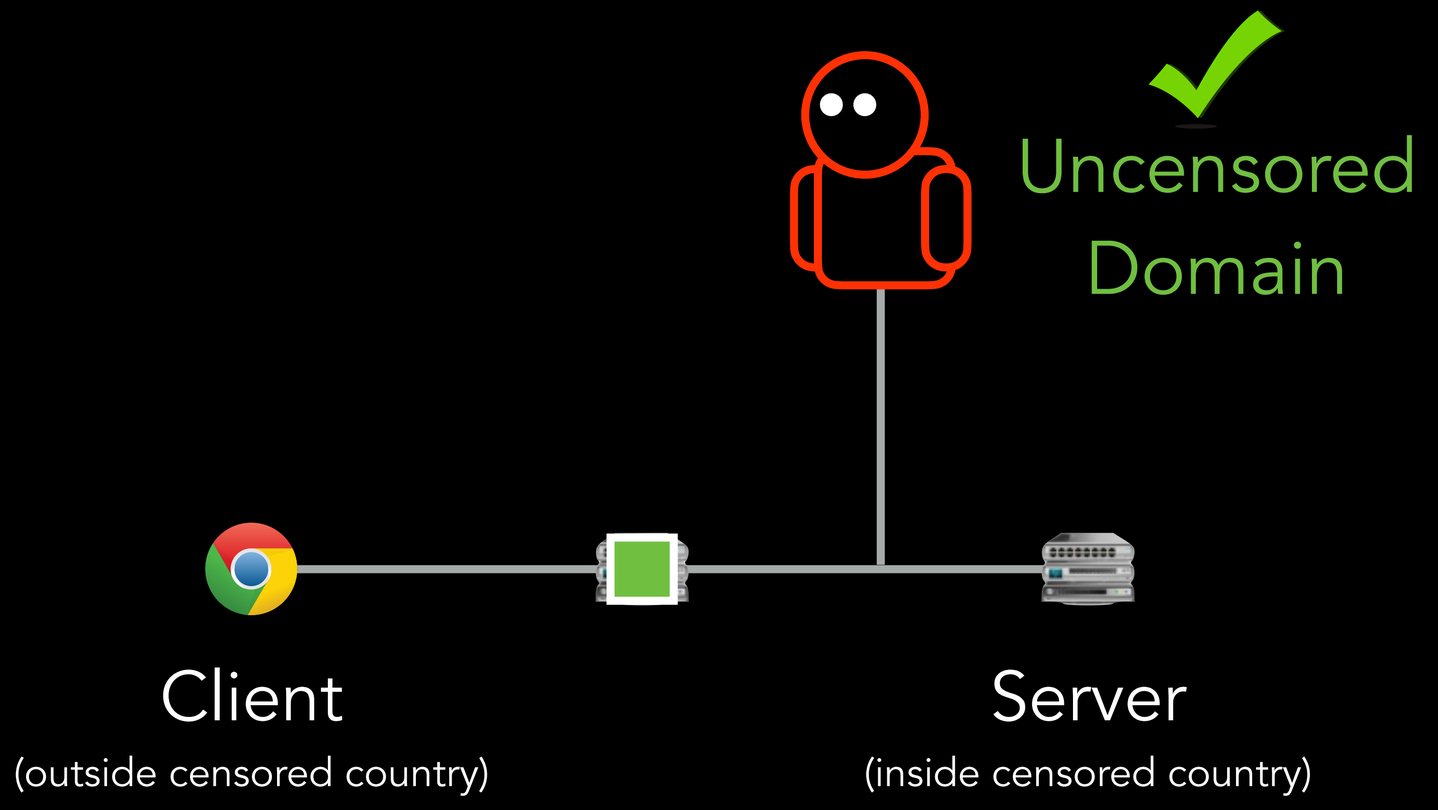

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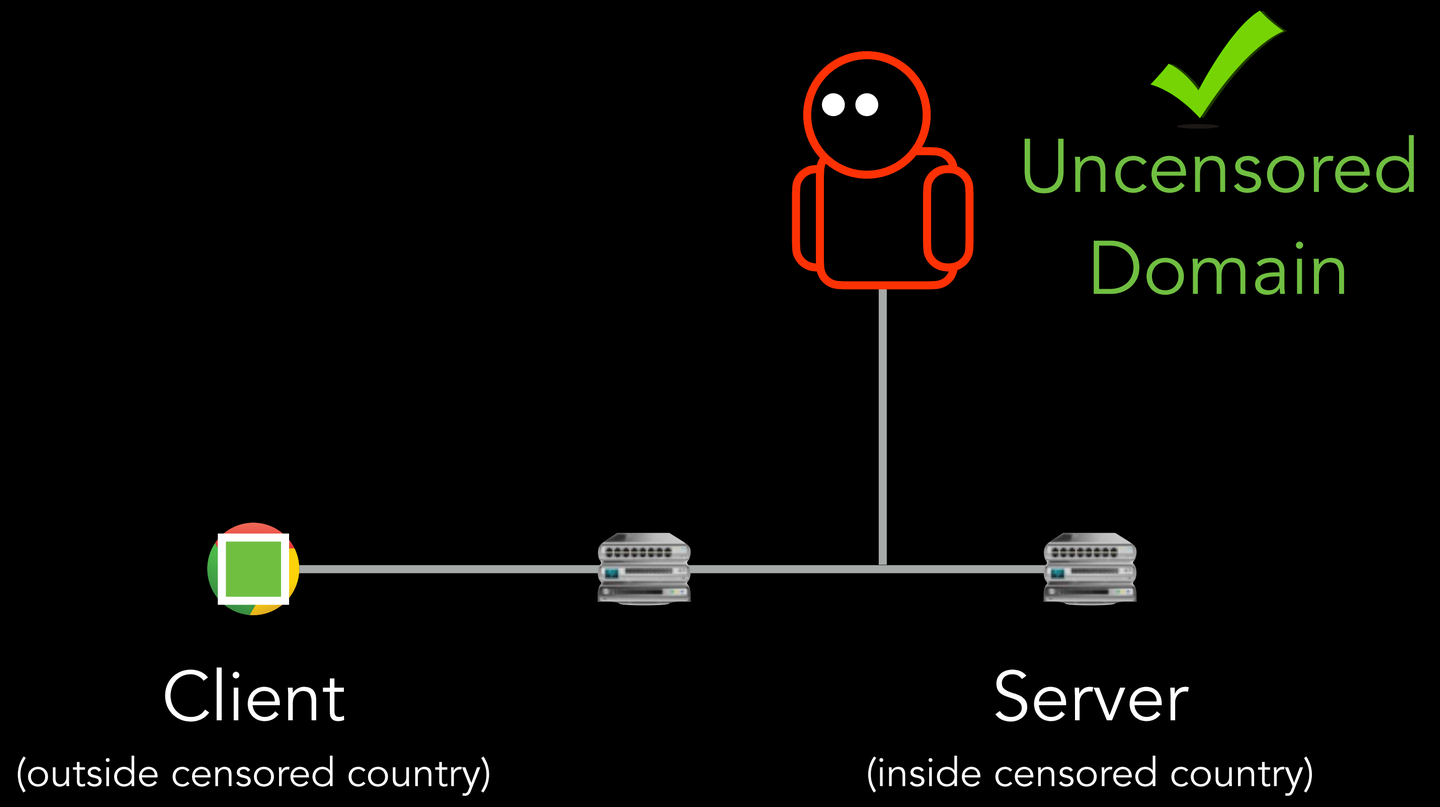

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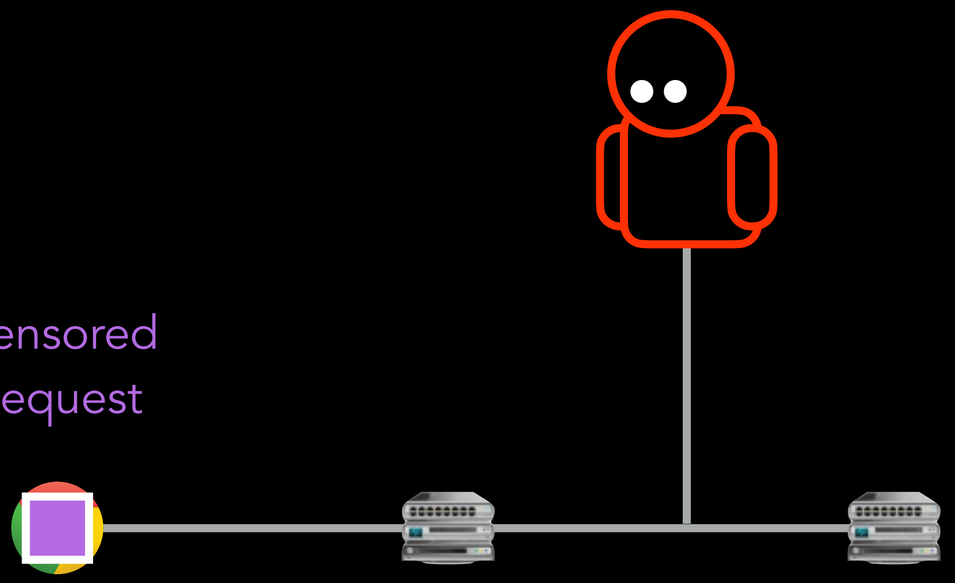

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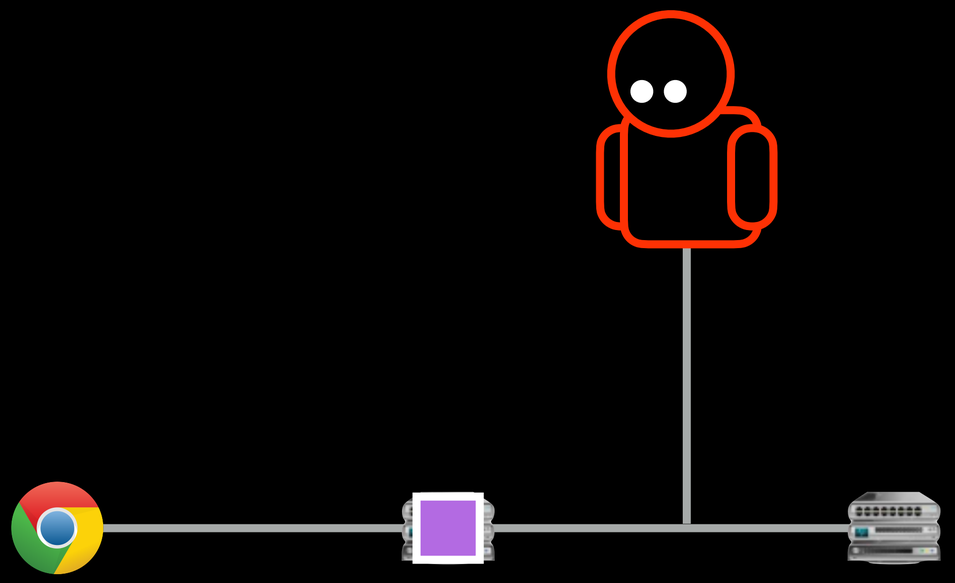

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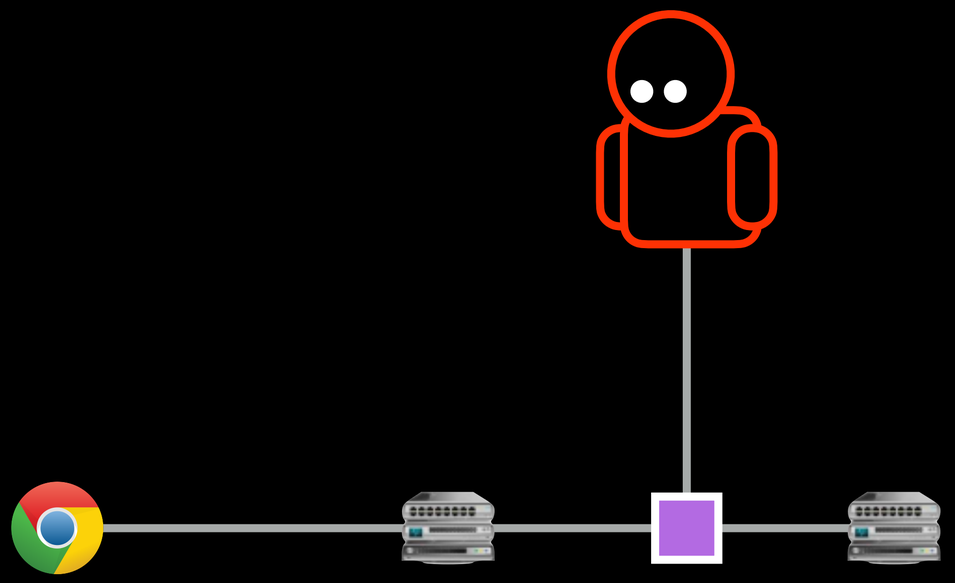

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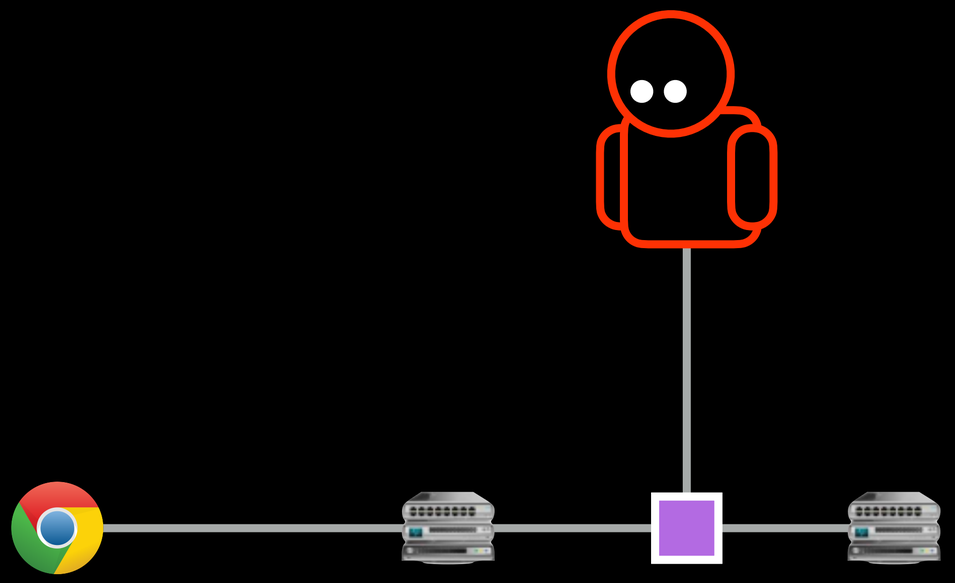

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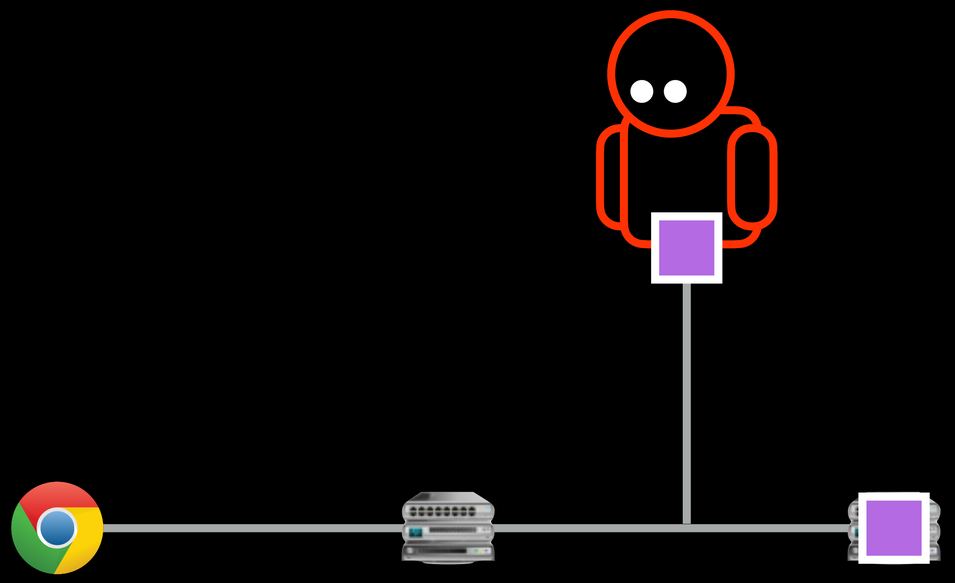

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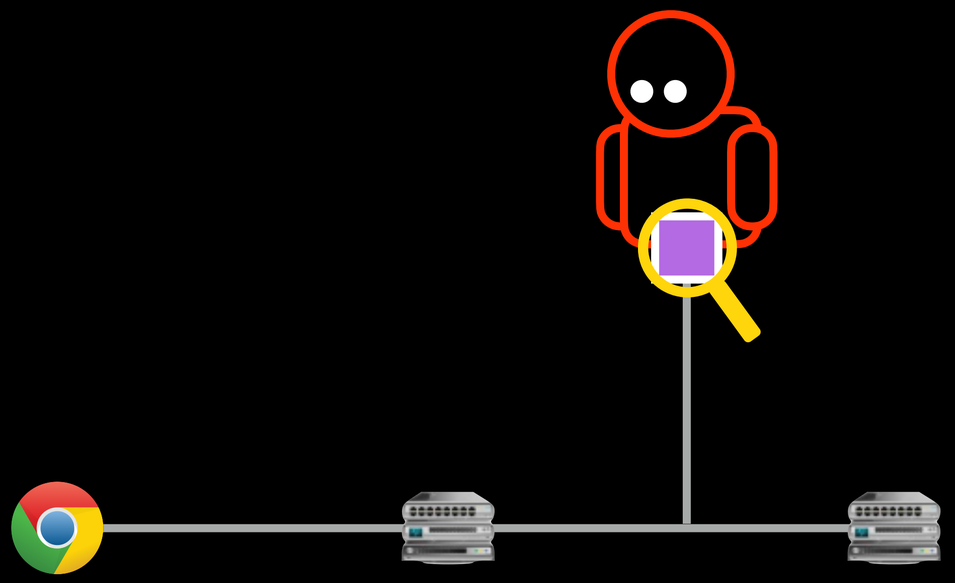

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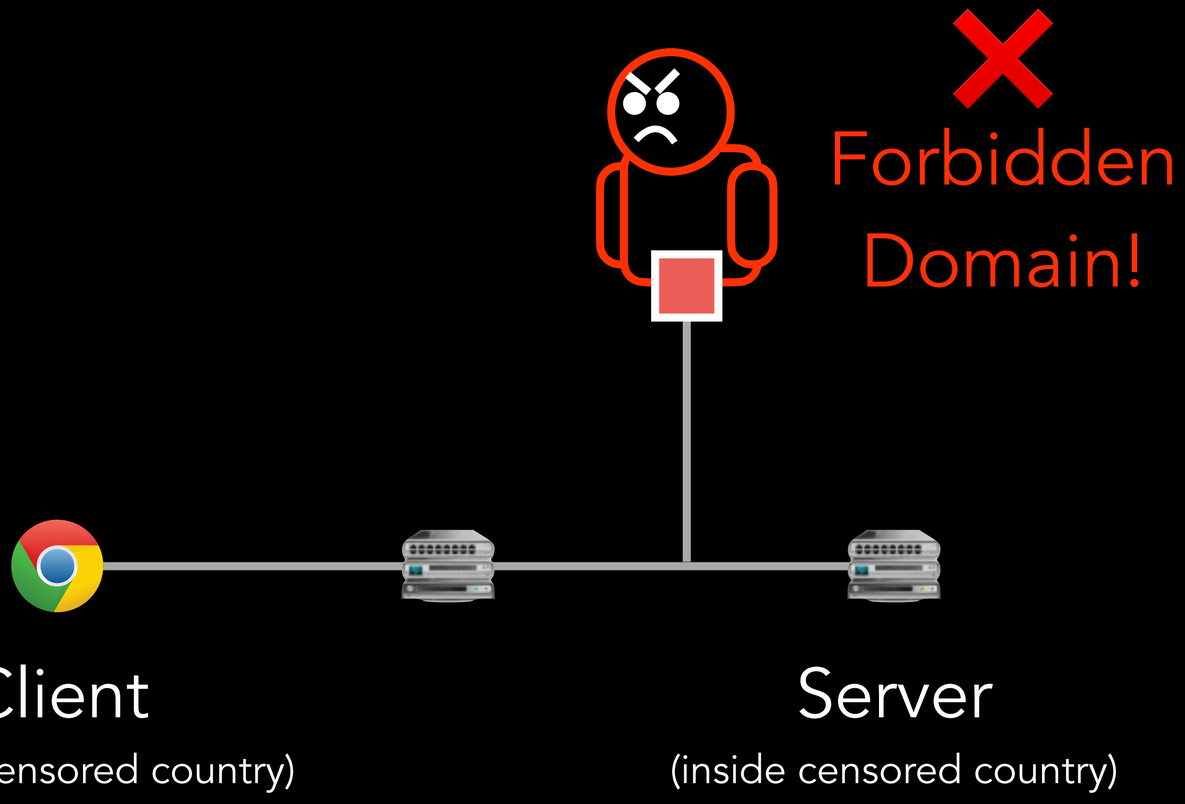

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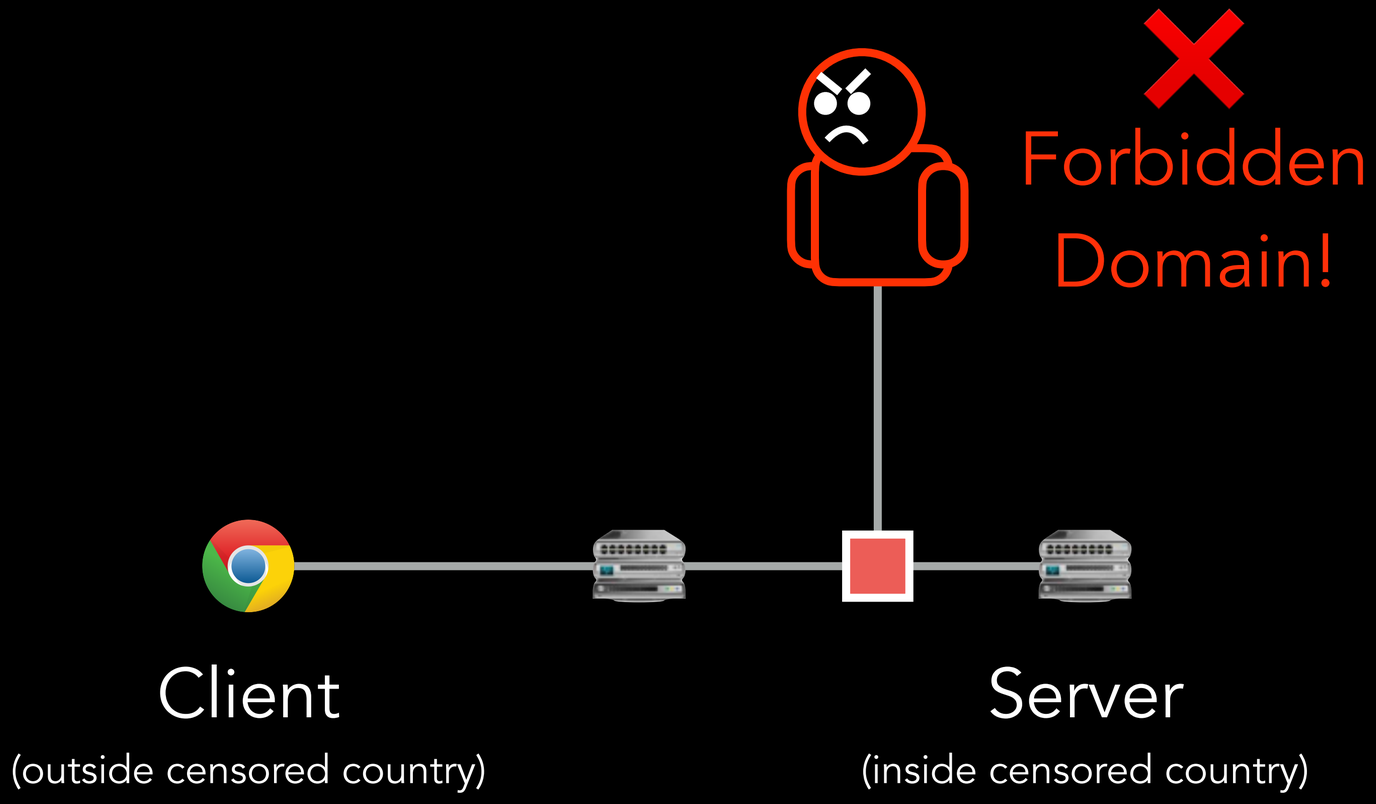

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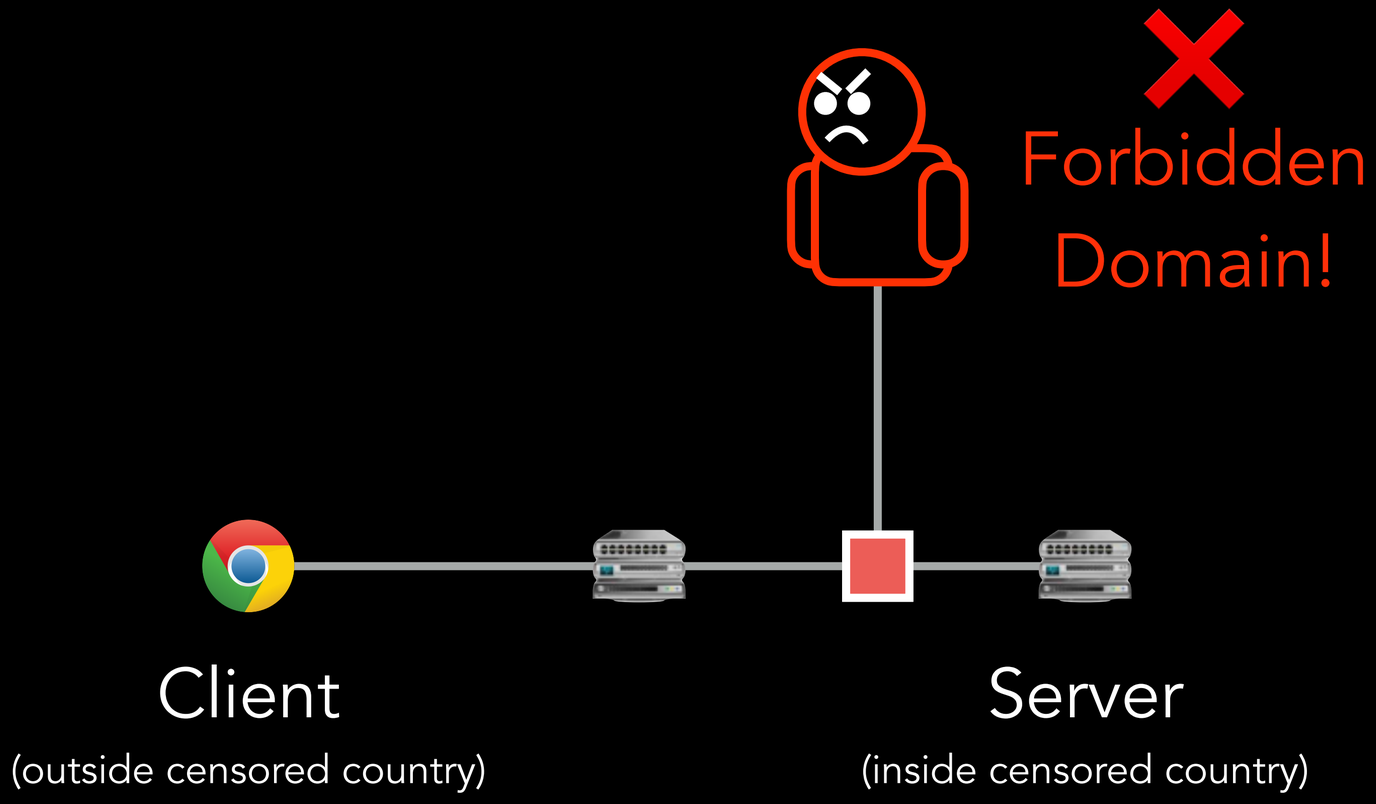

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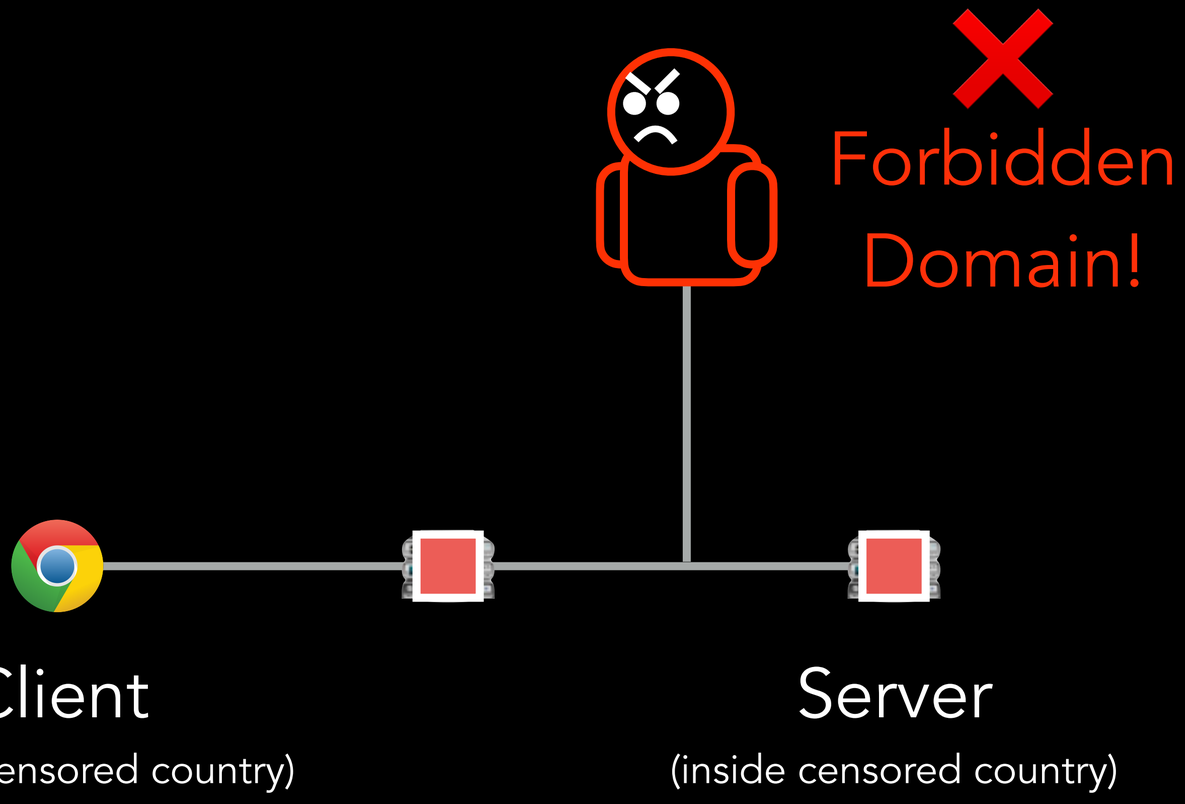

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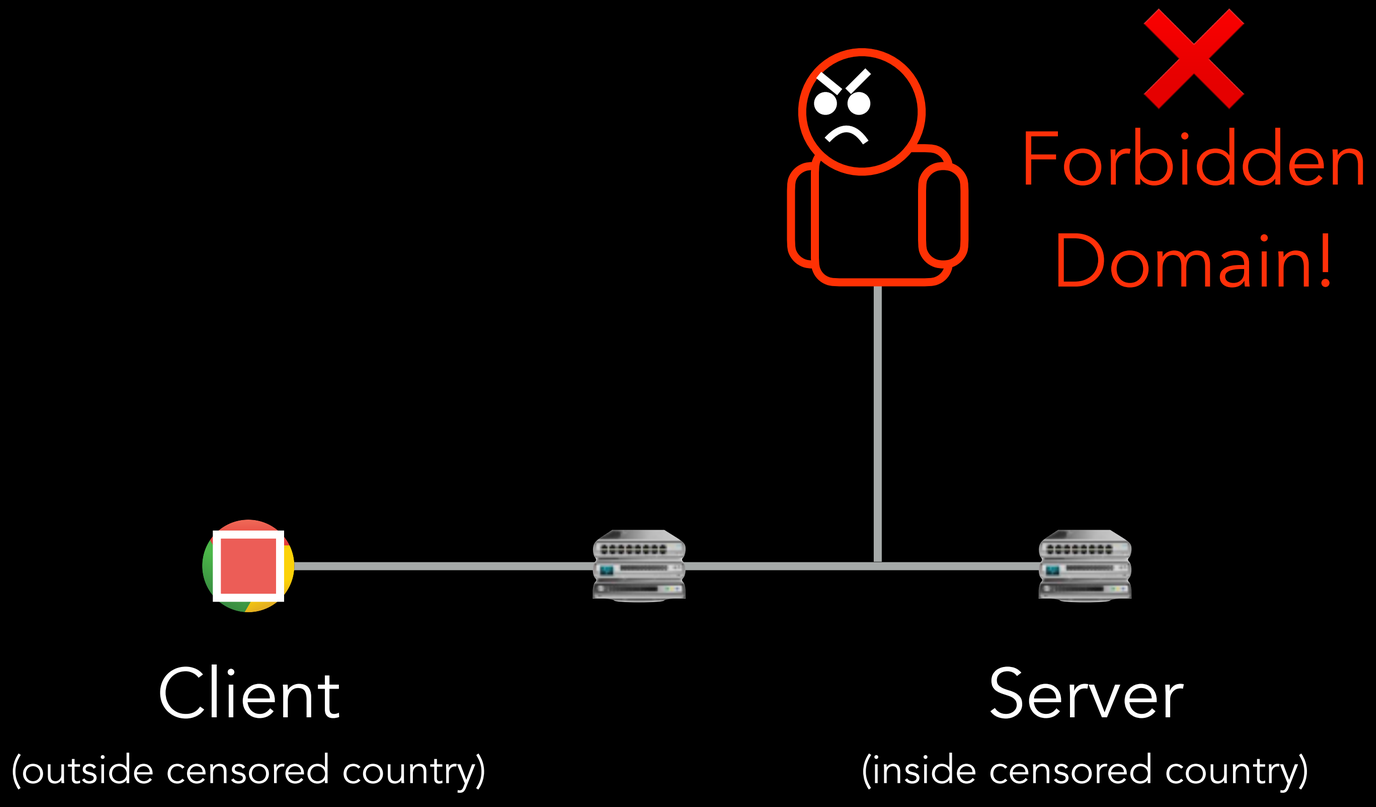

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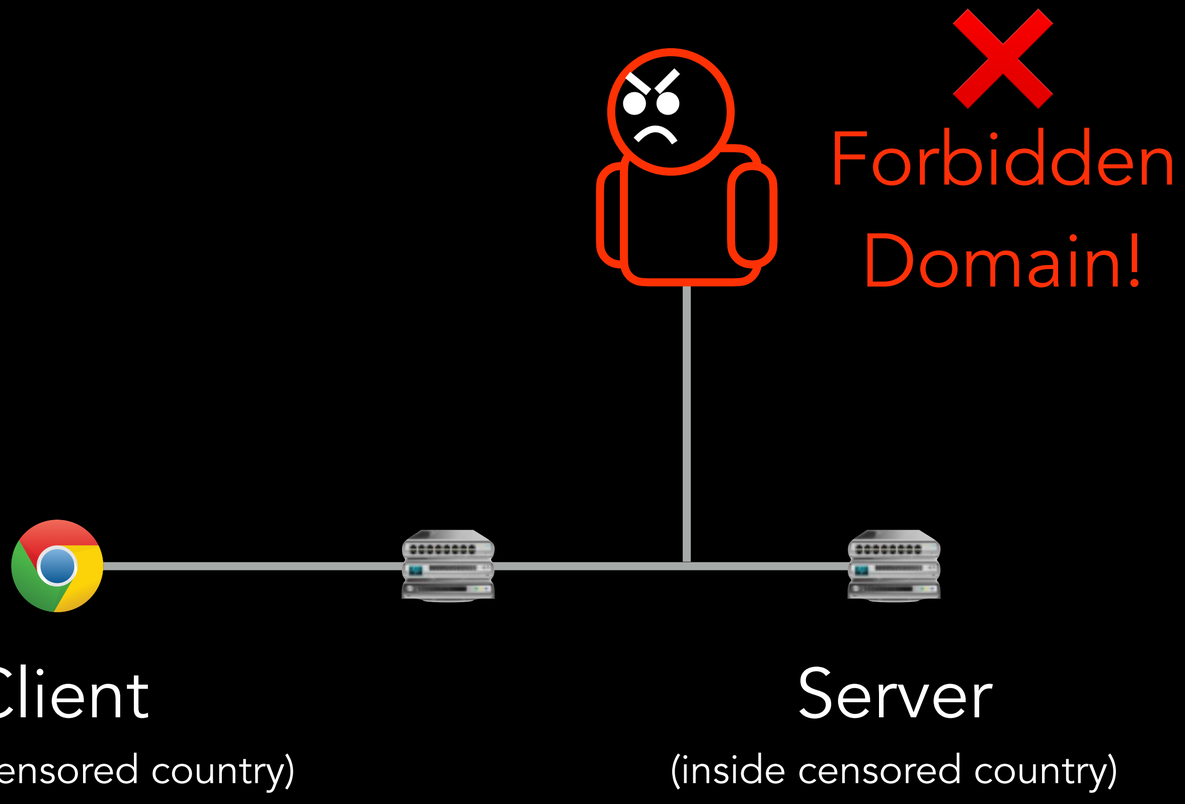

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Requirements

A country is eligible for our measurement system if it has:

1. Confirmed Censored Domain(s)
2. Bidirectional Censorship
3. Little to No Residual Censorship

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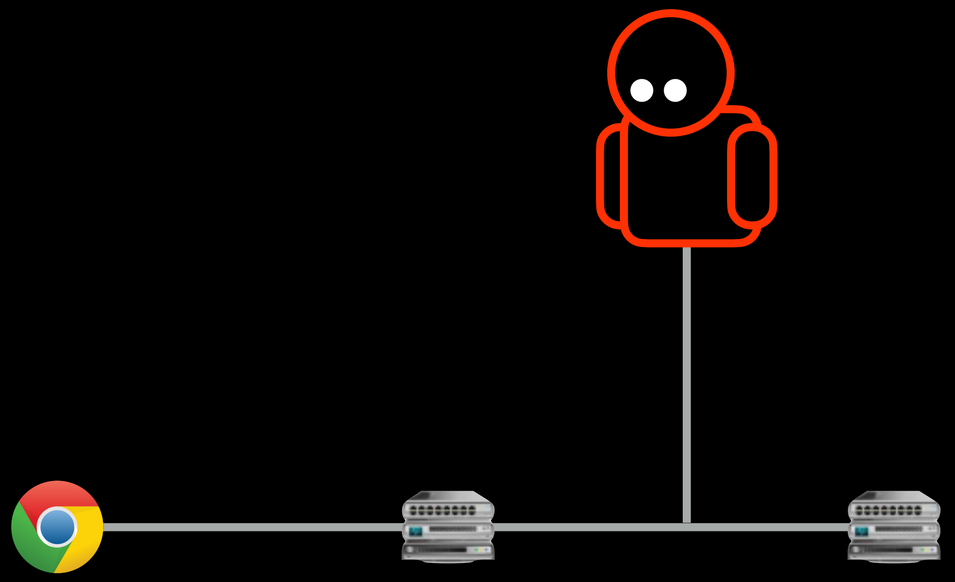

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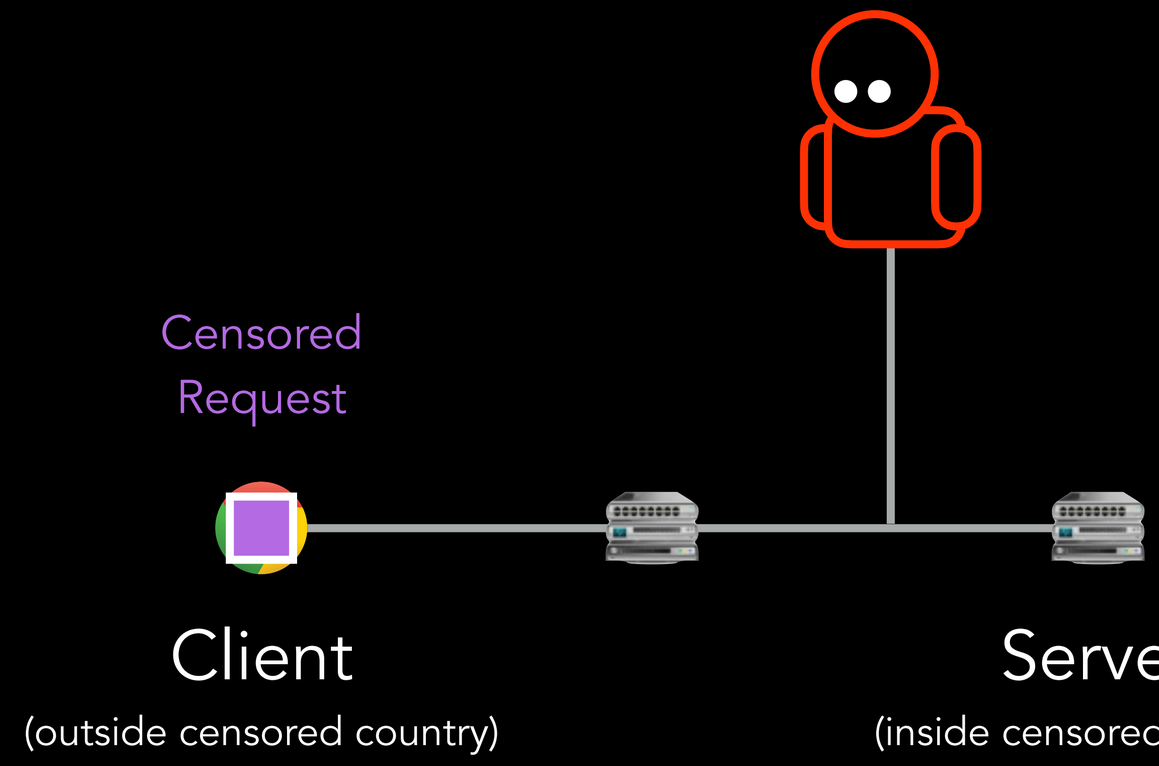

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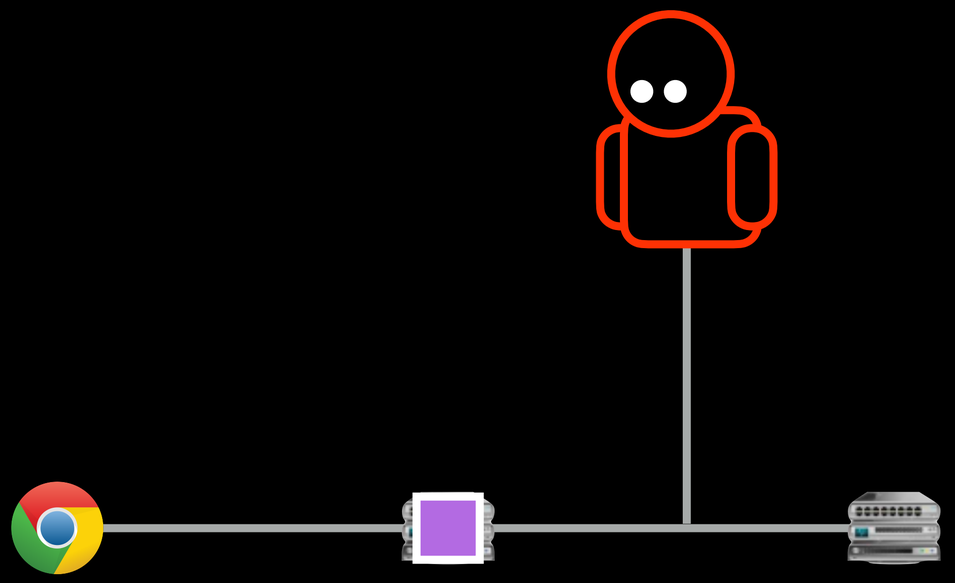

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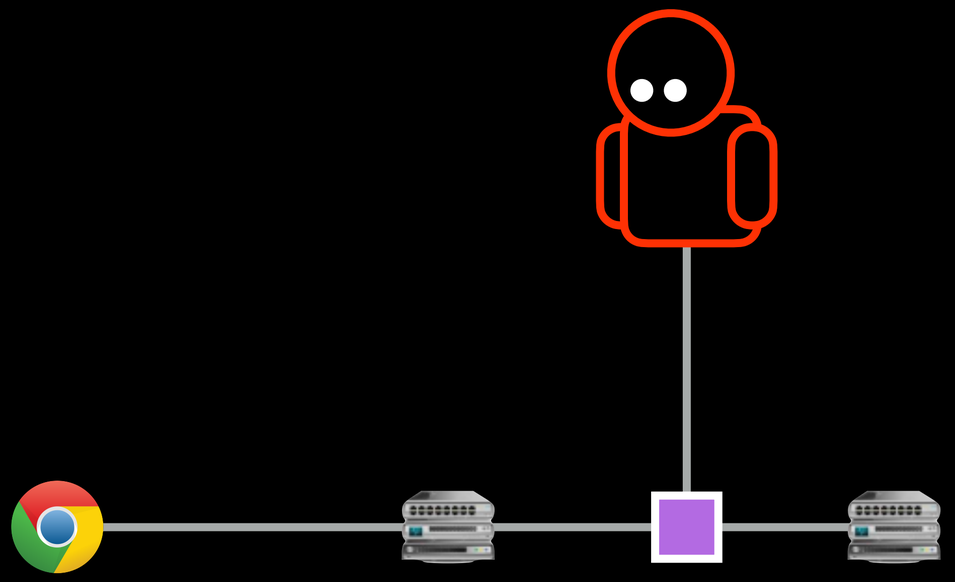

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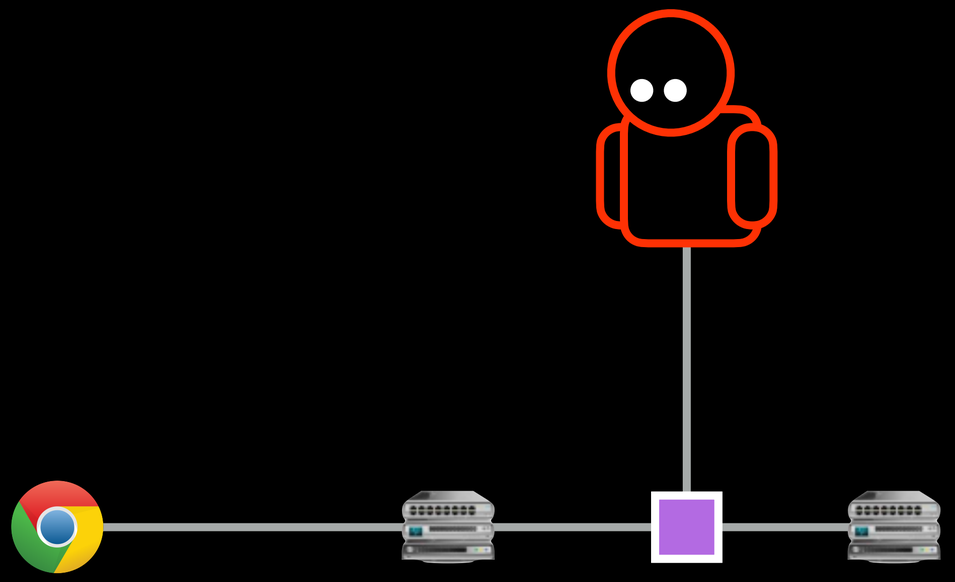

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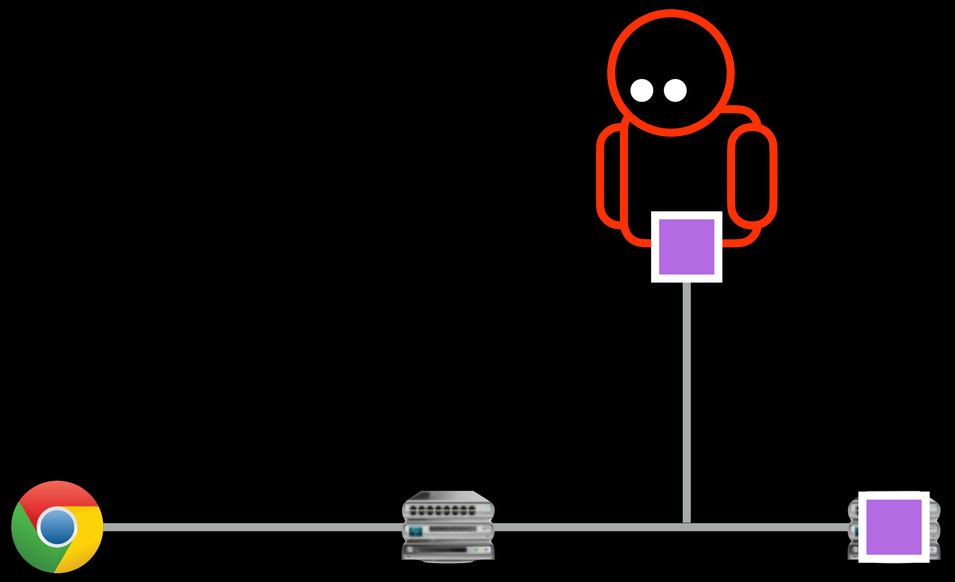

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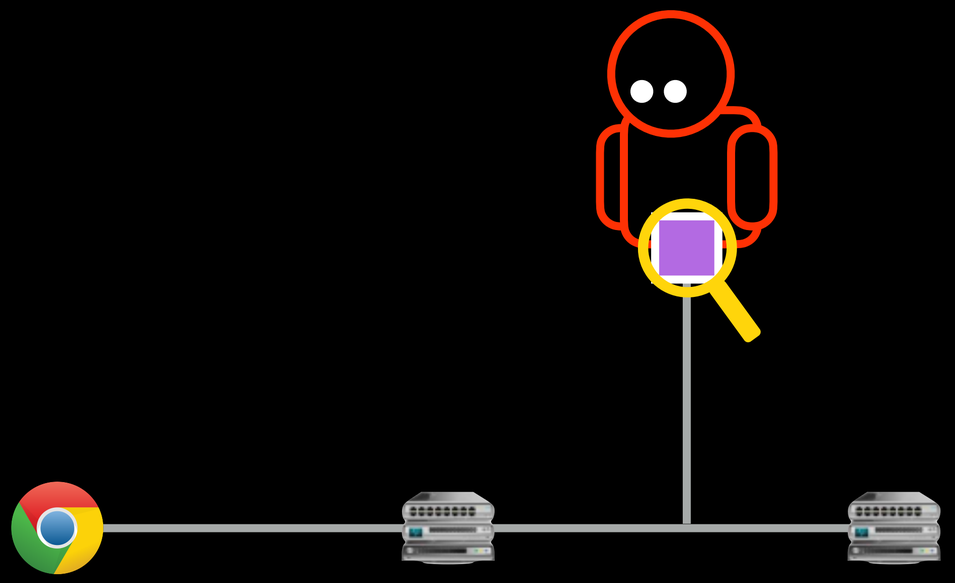

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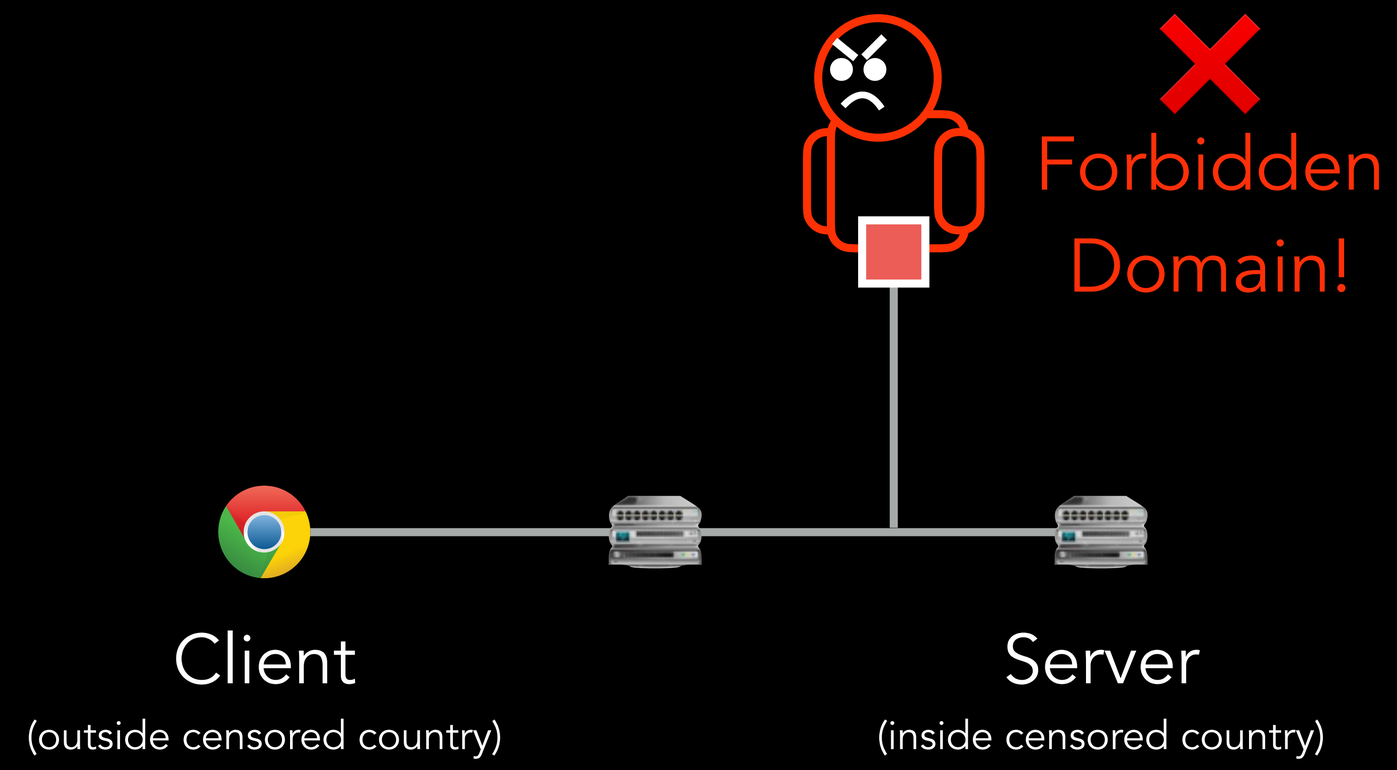

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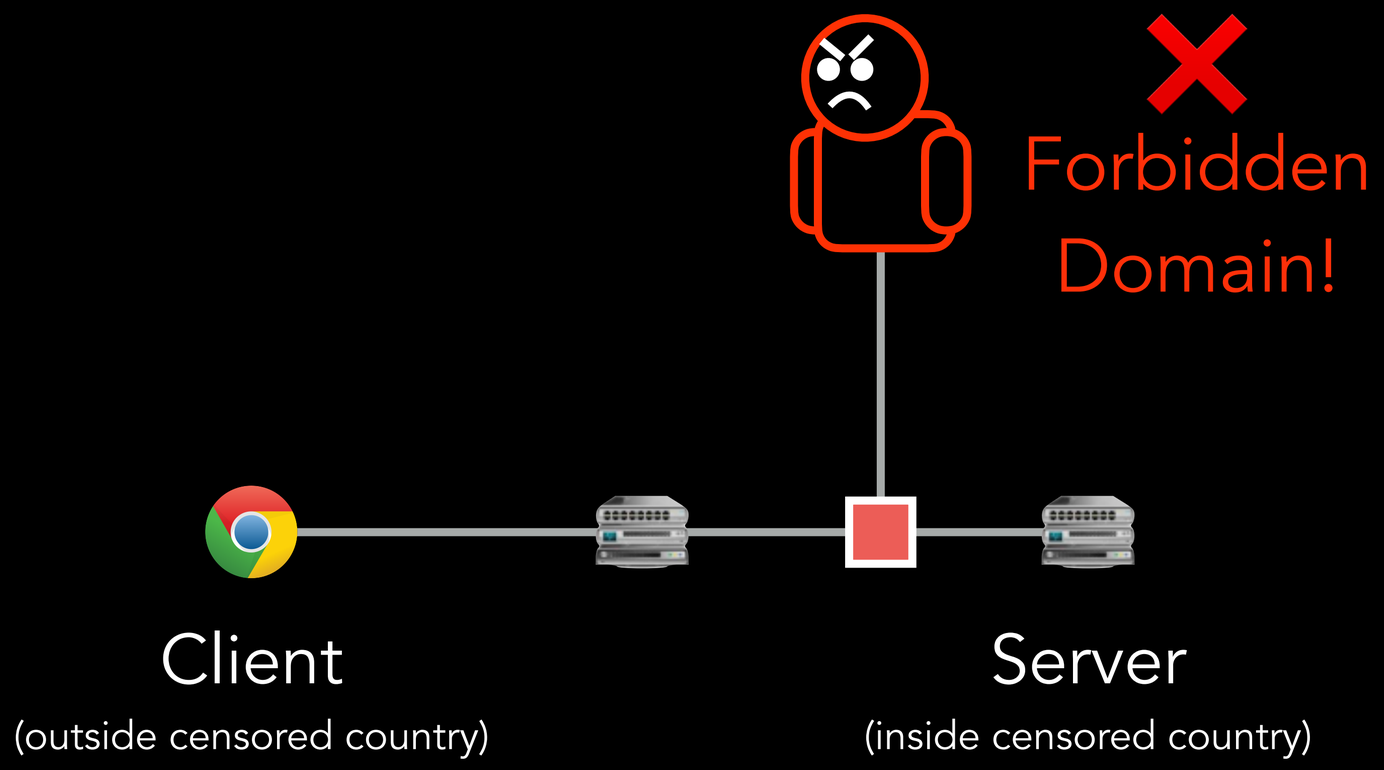

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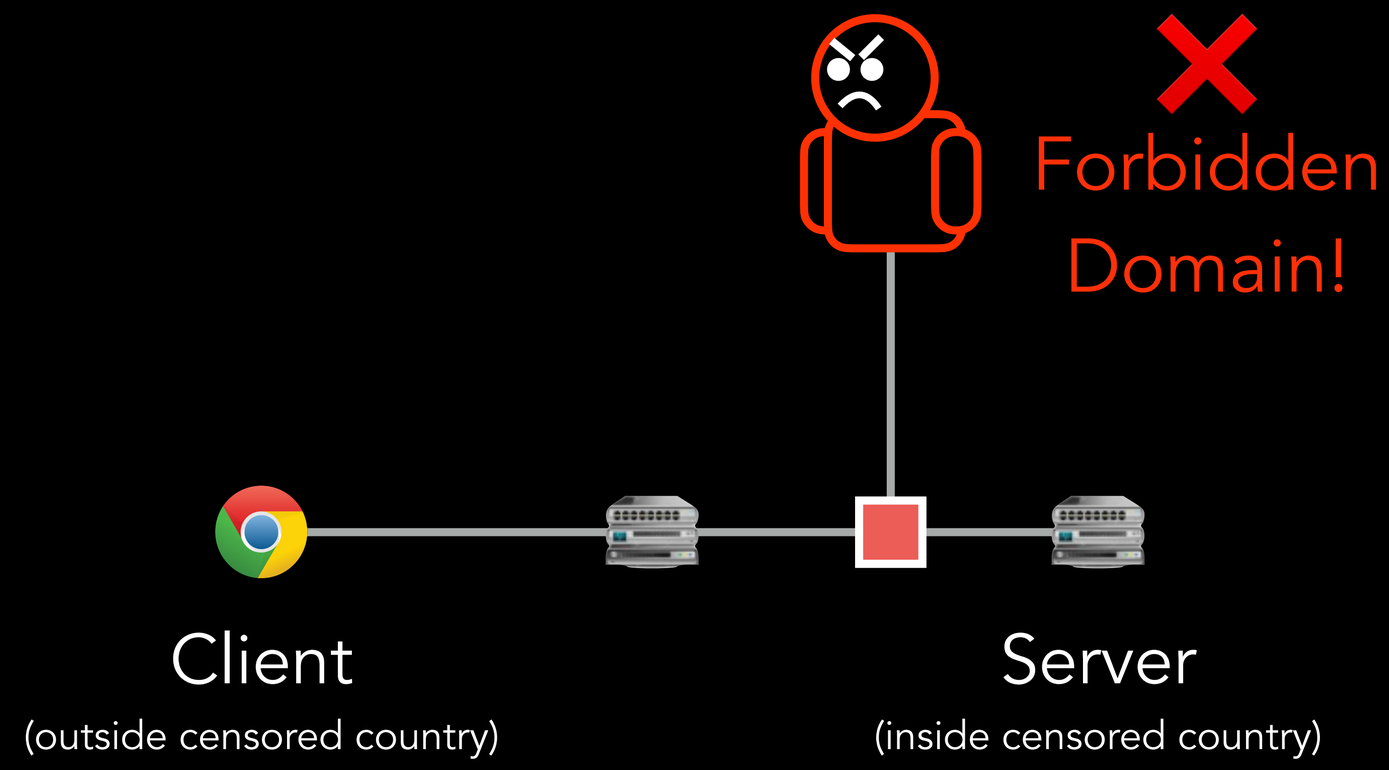

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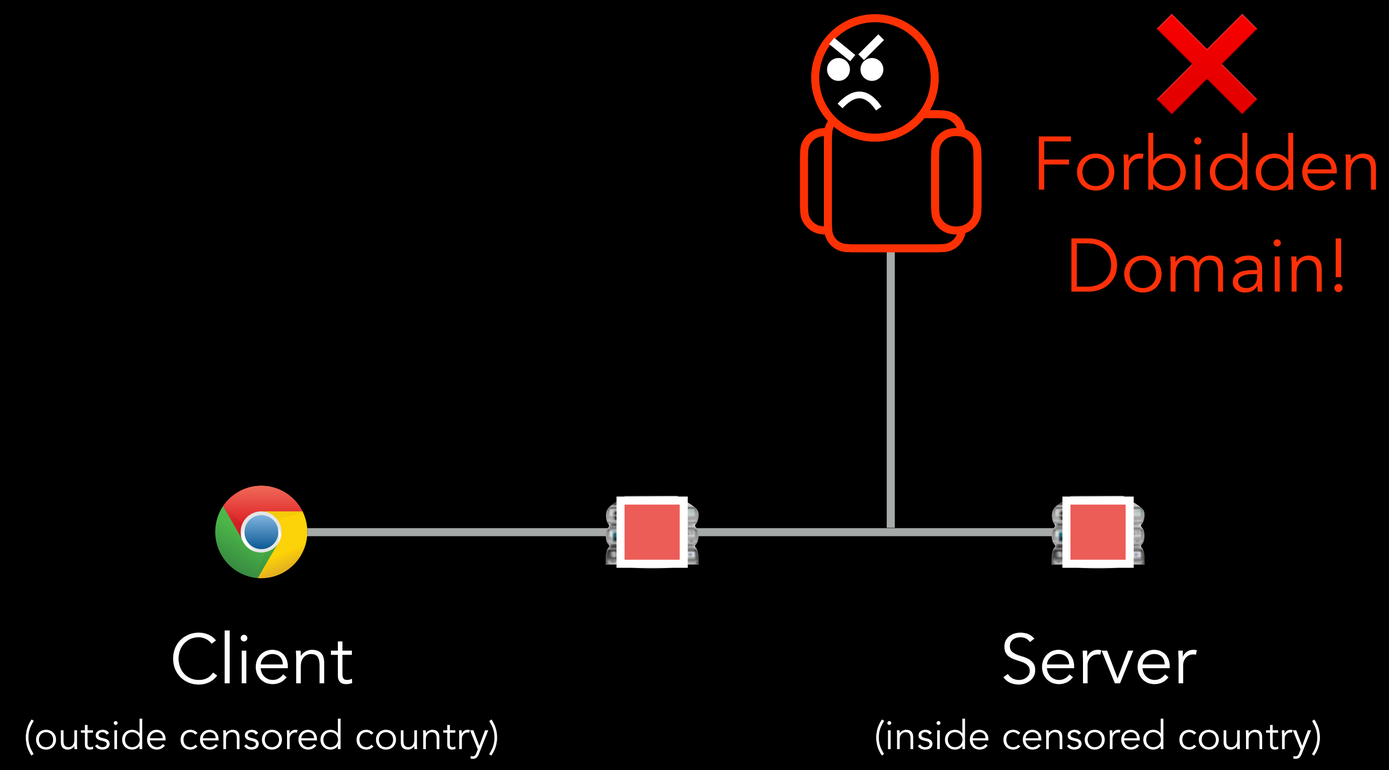

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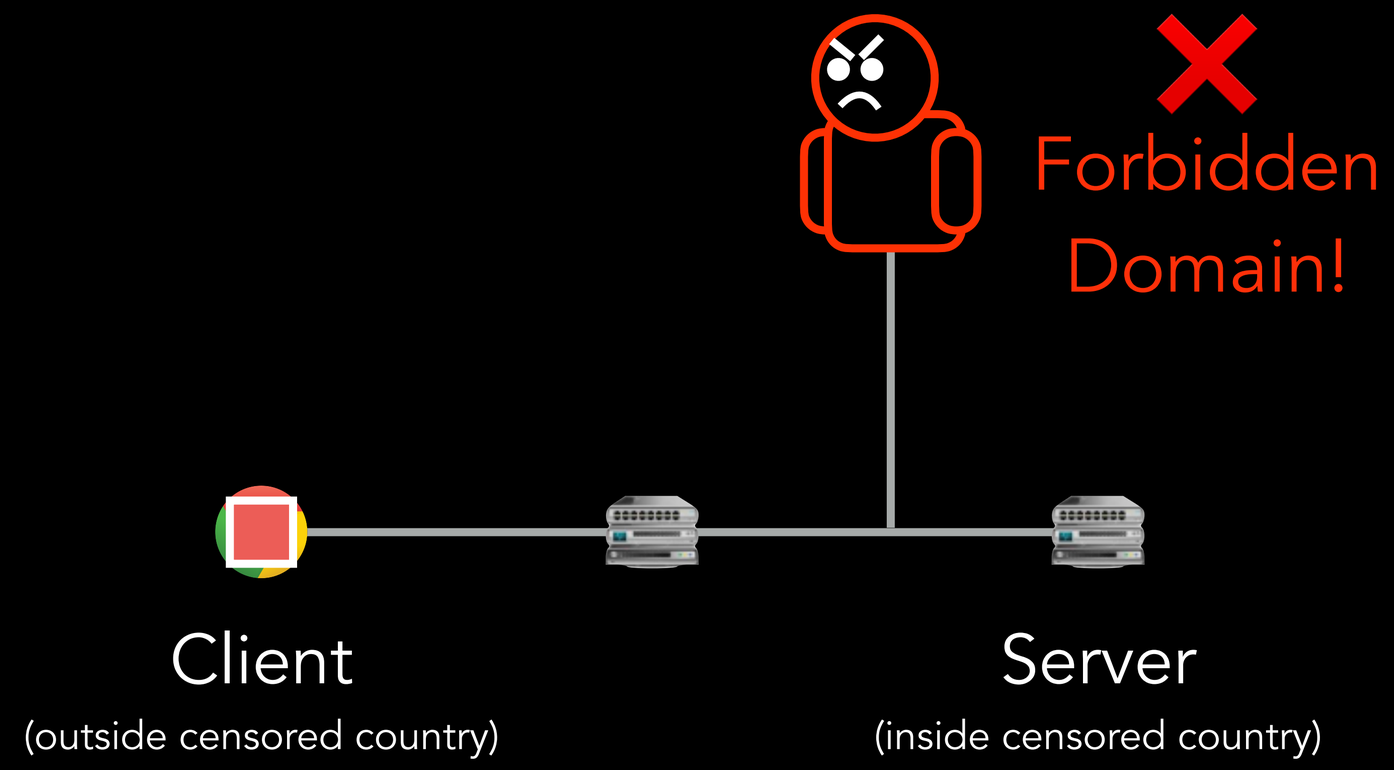

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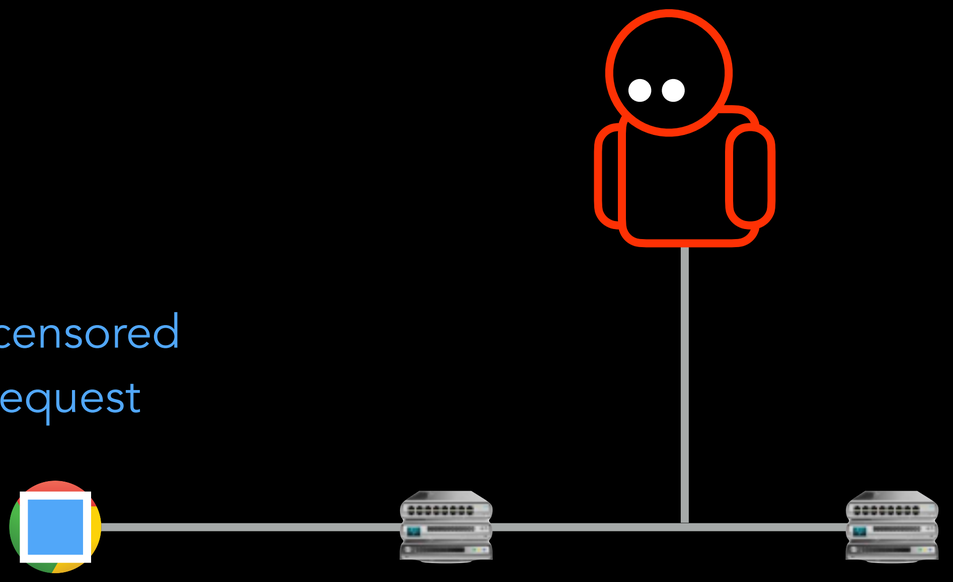

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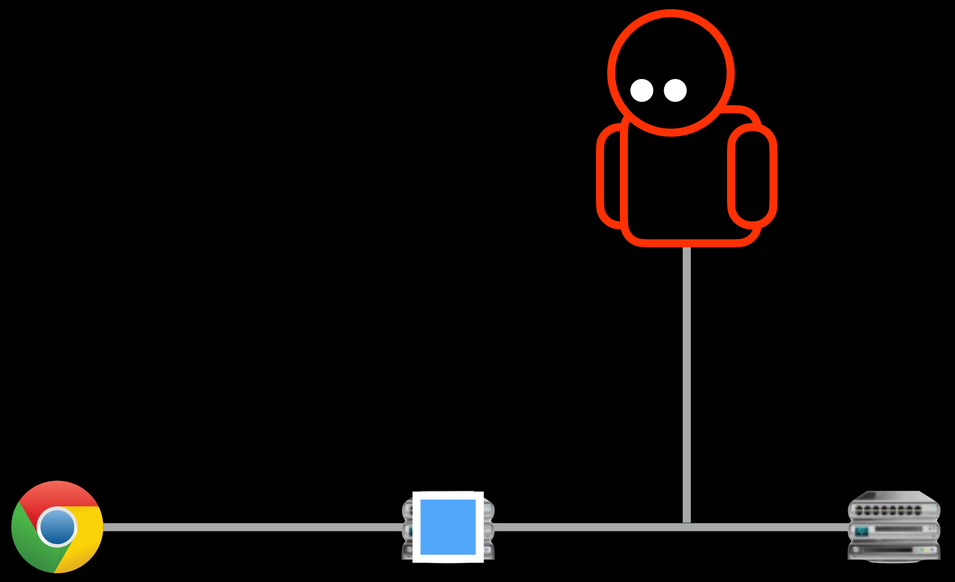

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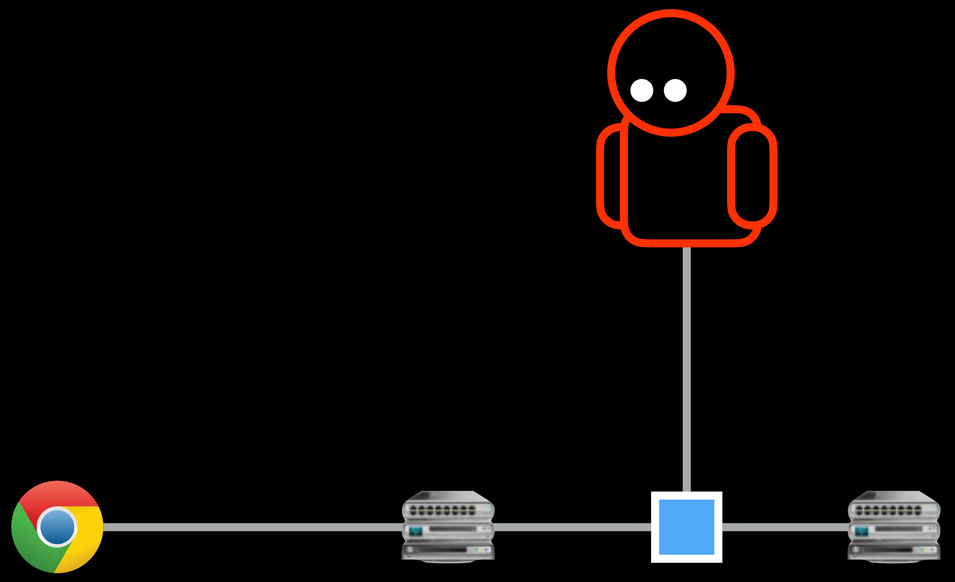

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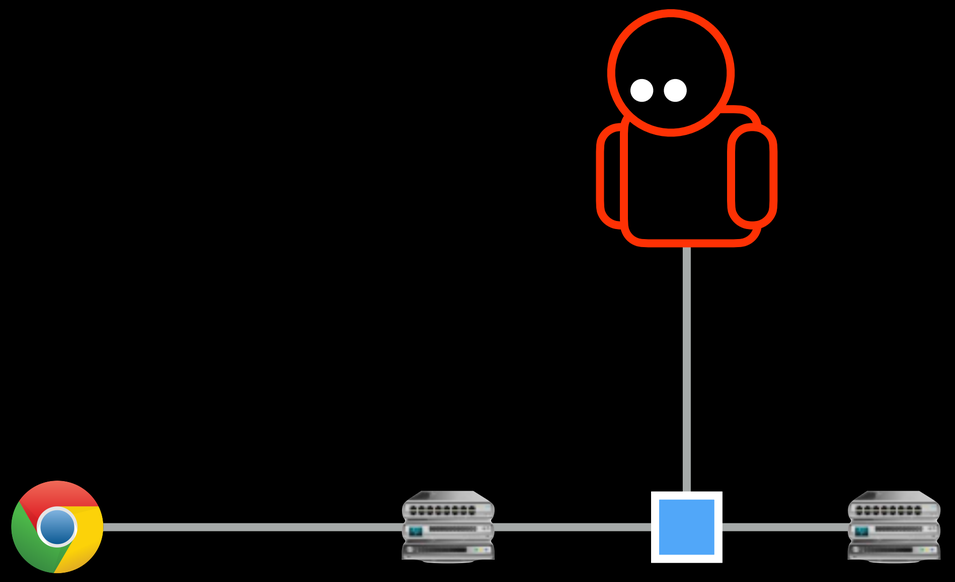

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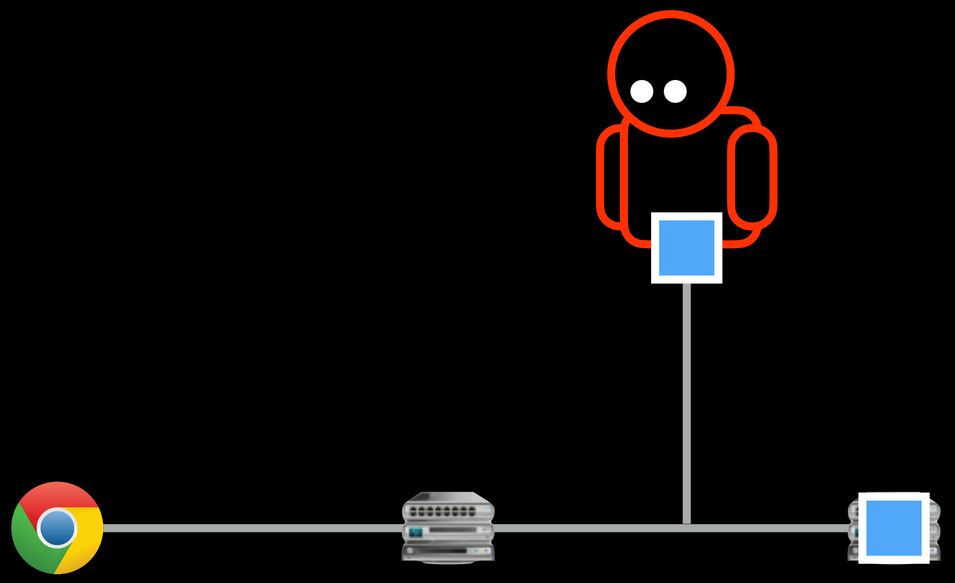

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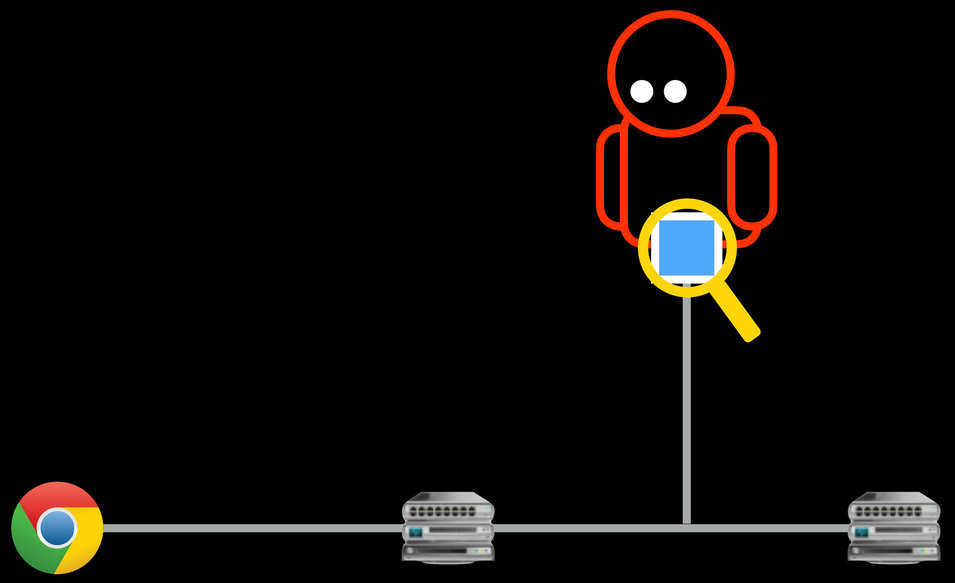

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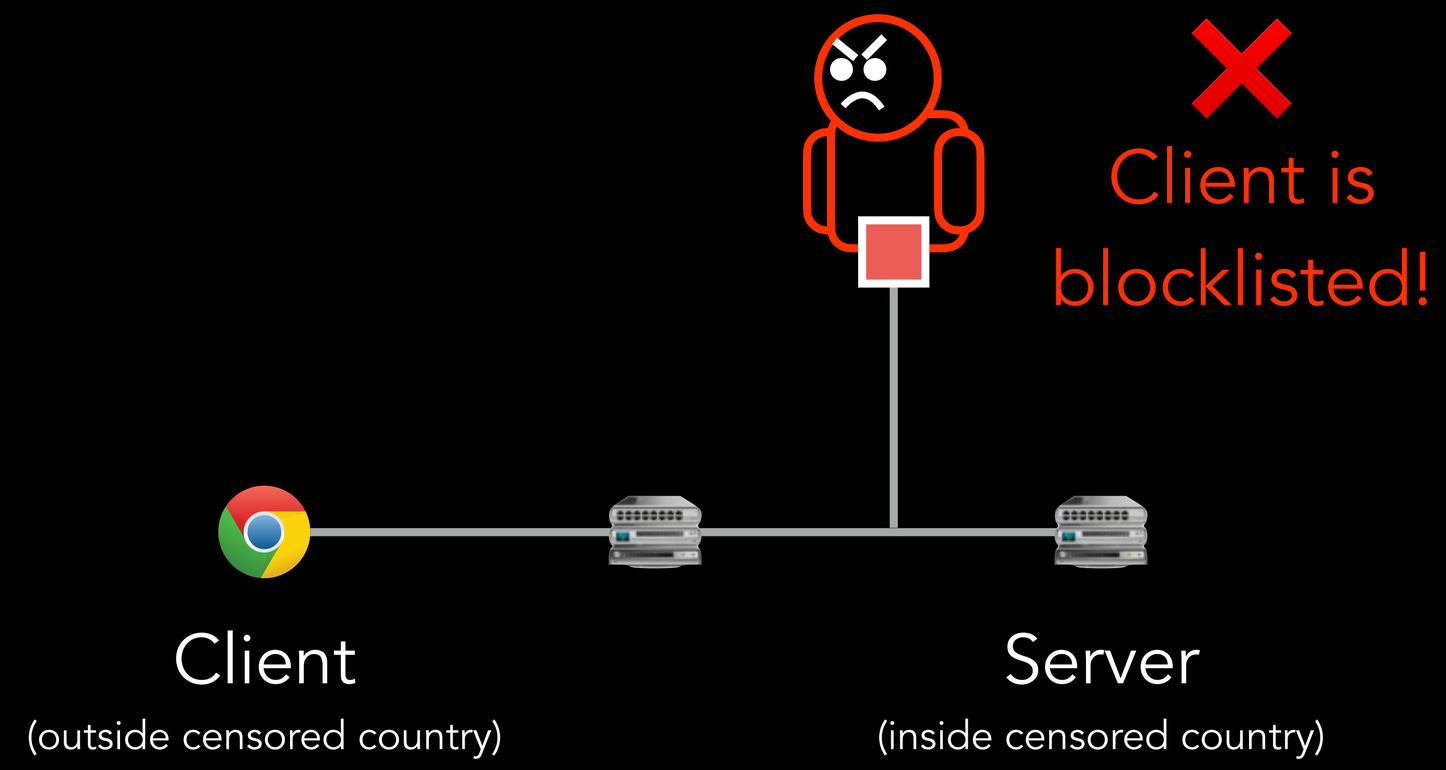

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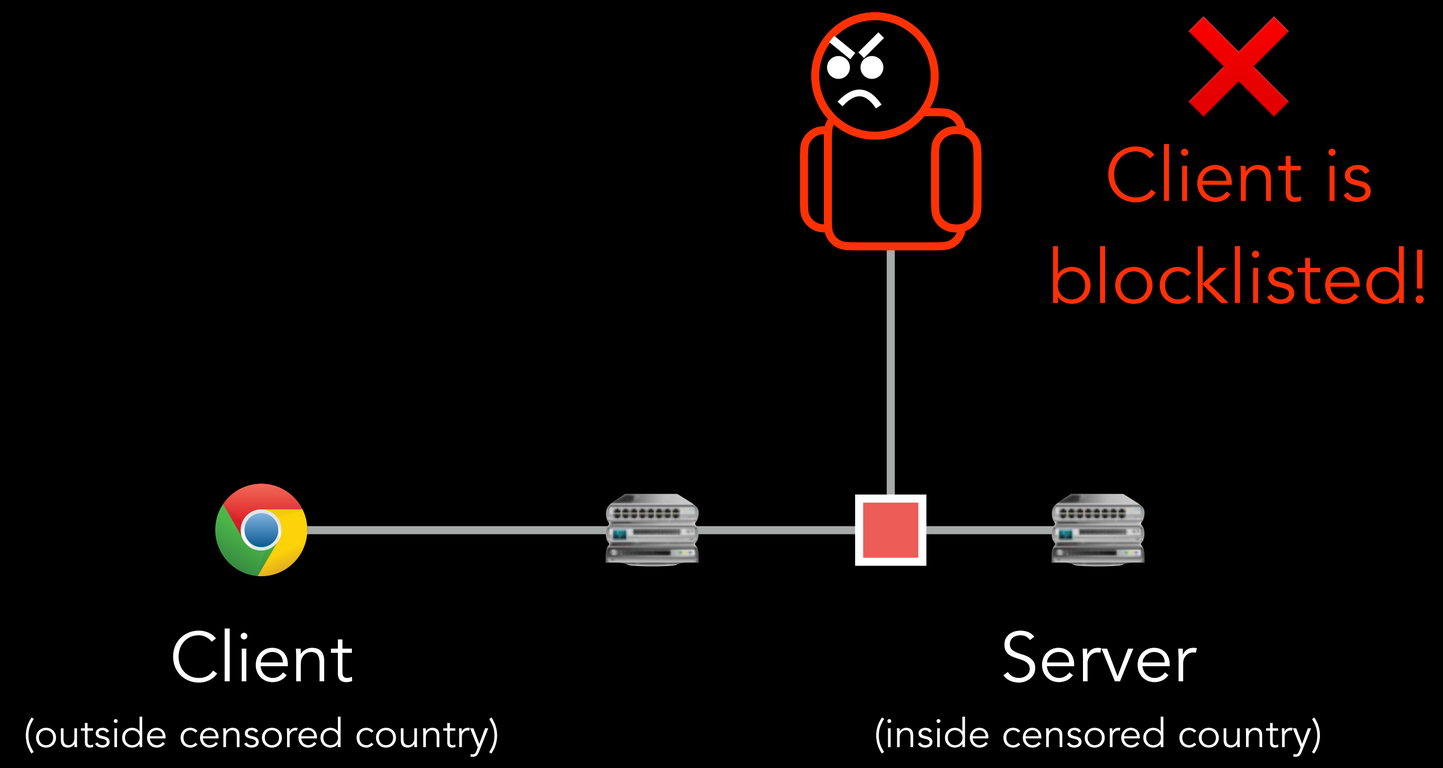

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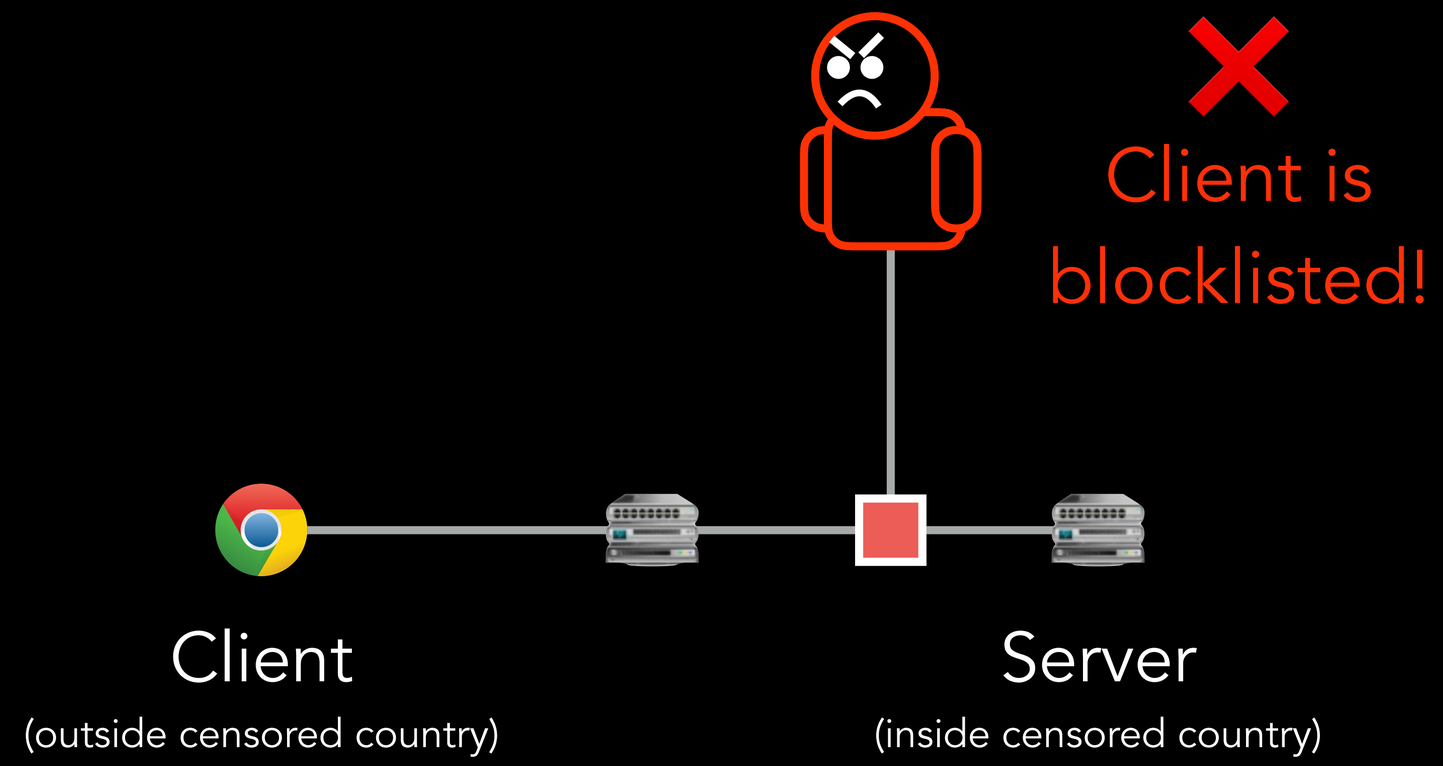

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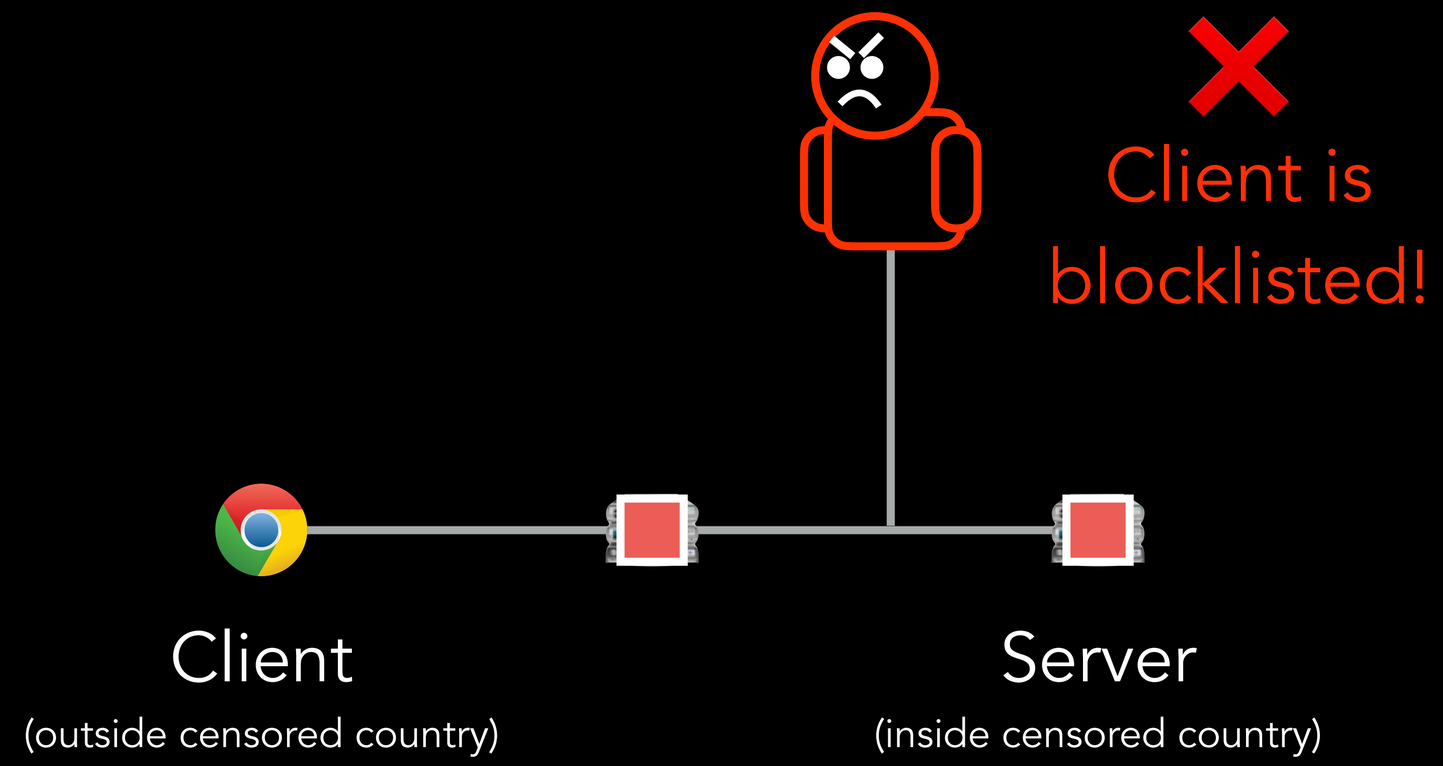

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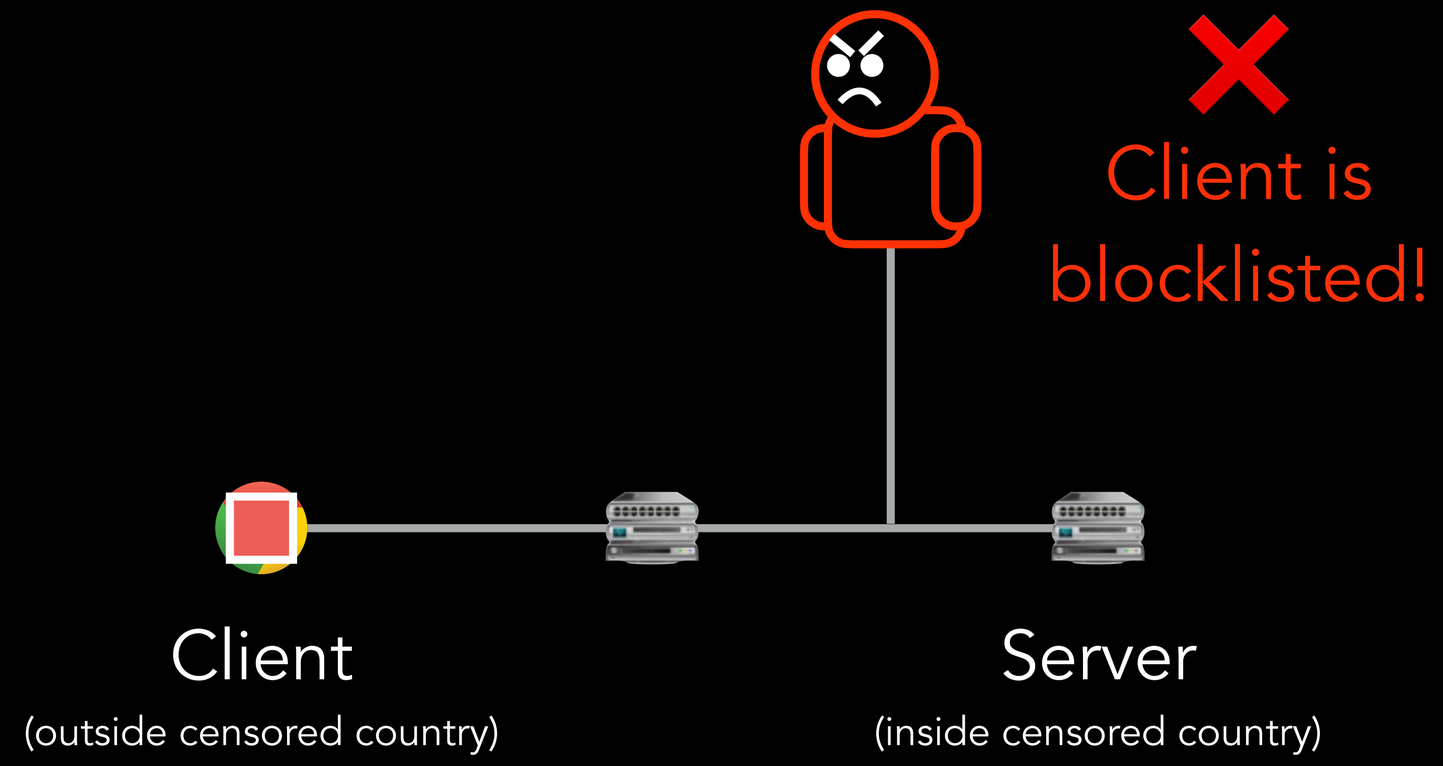

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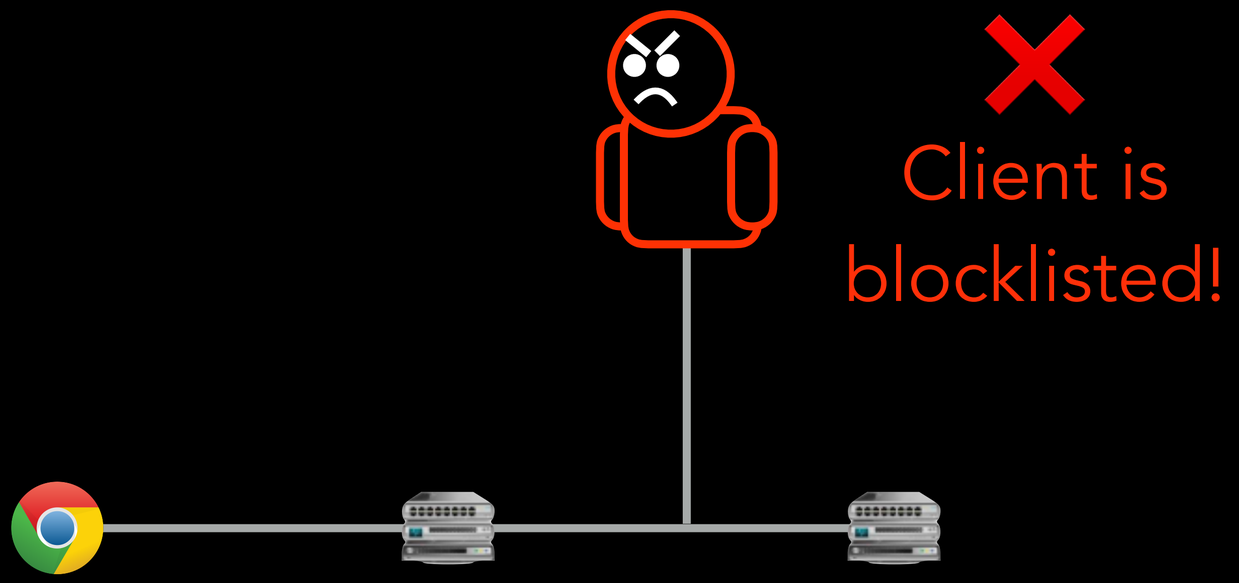

High-Level Design

Measurement Probe

Train Geneva on non-responsive IP addresses in the country

If packet sequence Geneva discovers receives a response, it must have come from censor

Send packet sequence with test domains to all other non-responsive IP addresses to conduct measurement

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1. Background
2. High-Level Design
3. Preliminary Results

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Preliminary Results

Brunei

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Bidirectional
Censorship in AS10094

Preliminary Results

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Bidirectional Censorship in AS10094

SYN followed by PSH+ACK triggers censorship

Preliminary Results

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No Residual Censorship

Preliminary Results

Tajikistan

Preliminary Results

Tajikistan

Bidirectional
Censorship in AS24722

Preliminary Results

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Bidirectional Censorship in AS24722

Sending a PSH+ACK packet *twice* triggers censorship

Preliminary Results

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Bidirectional Censorship in AS24722

Sending a PSH+ACK packet *twice* triggers censorship

No Residual Censorship

Preliminary Results

Negative Results

We were not able to trigger bidirectional censorship in:

Burundi

Equatorial Guinea

Kyrgyzstan

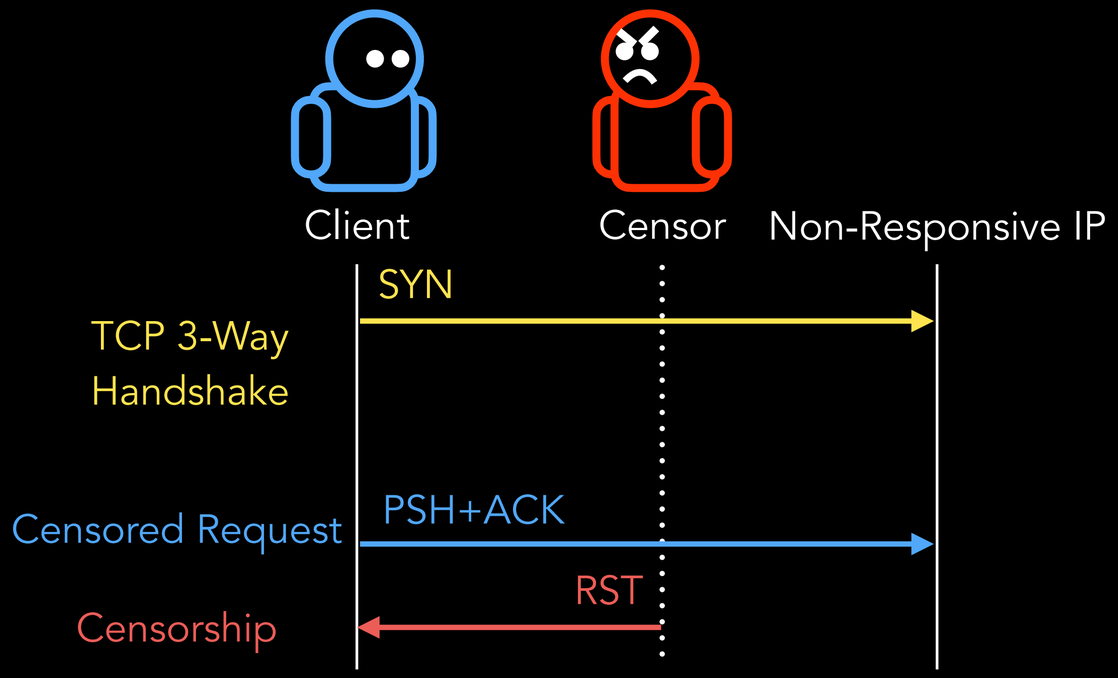
Myanmar

Detecting Network Interference Without Endpoint Participation

Can measure censorship in hard-to-reach networks and hit more endpoints in reachable networks

Limitation — not all ASNs and prefixes in censored countries meets requirements

Open Question — What challenges are we overlooking when implementing this system at a global scale?



Triggering HTTP/HTTPS Censorship Without Endpoint Participation

Website censorship.ai