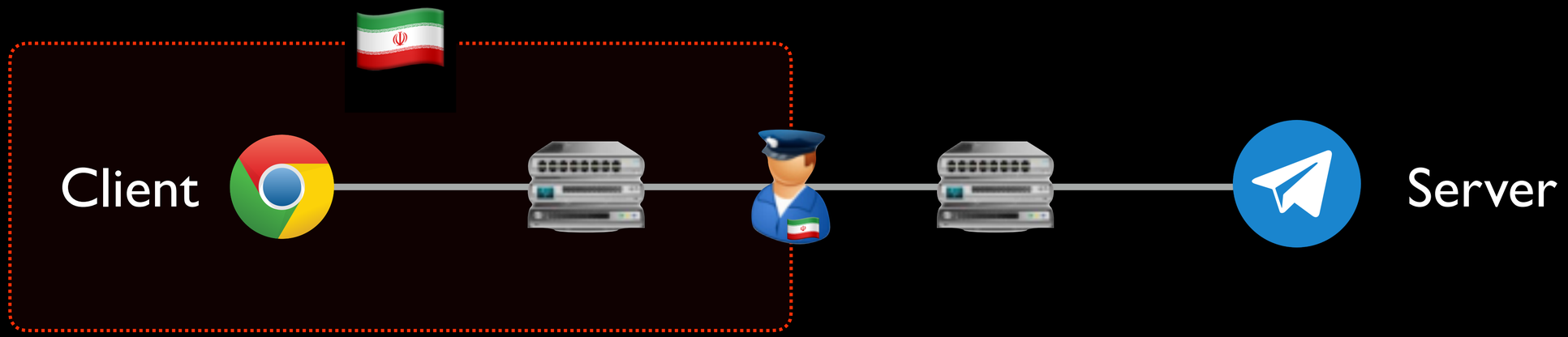
Detecting and Evading Censorship in Depth: A Case Study of Iran's Protocol Filter

Kevin Bock

Yair Fax, Kyle Reese, Jasraj Singh, Dave Levin

UNIVERSITY OF MARYLAND

Iranian Censorship



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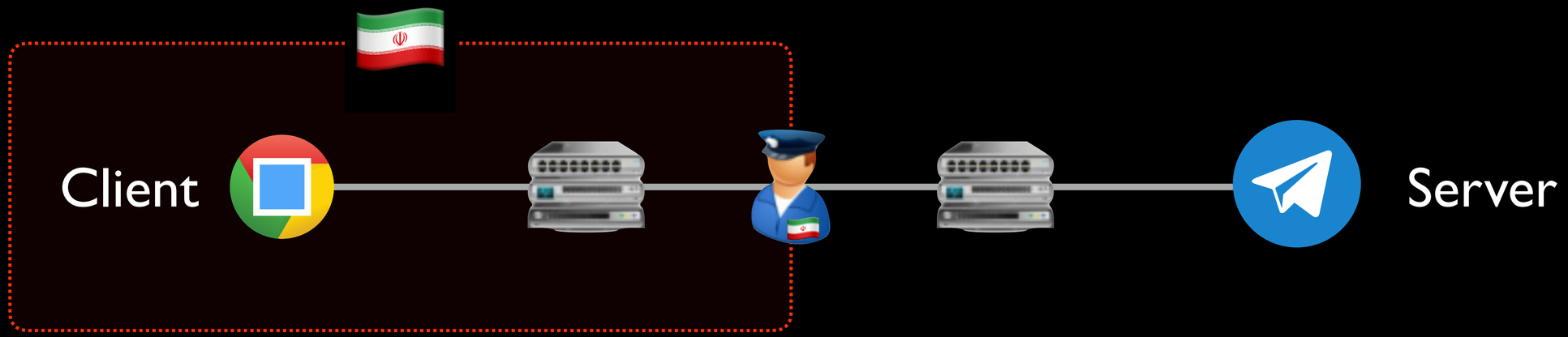

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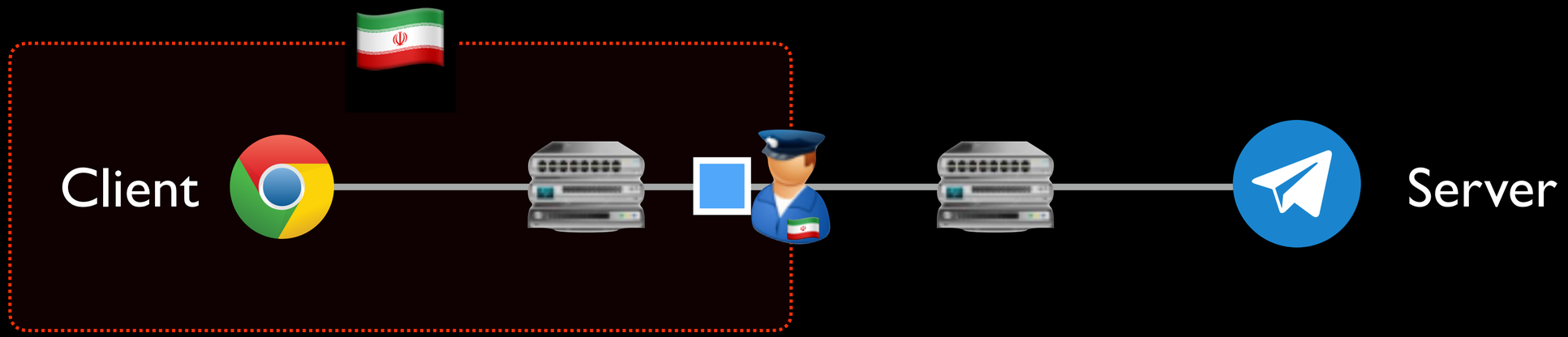

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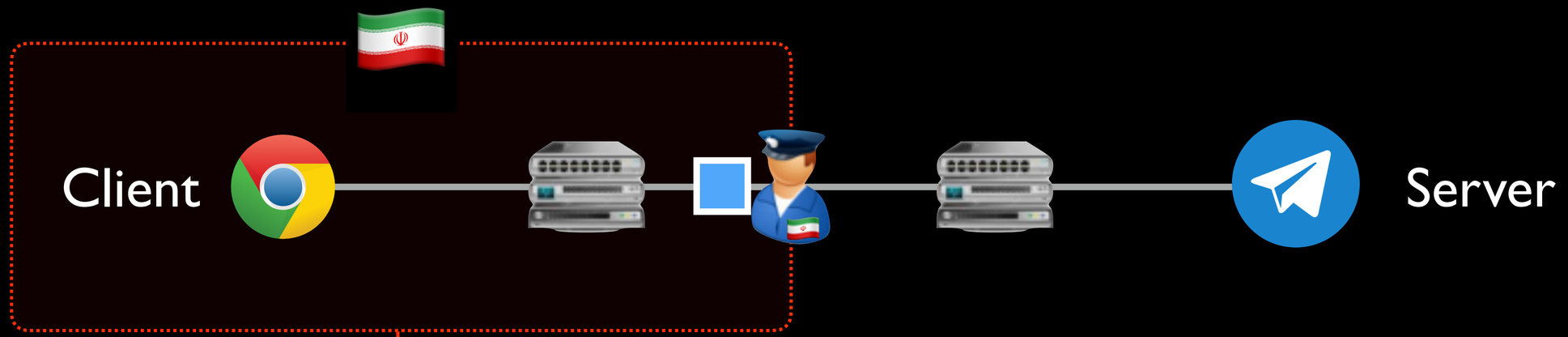

- Censors DNS, HTTP, HTTPS
- Deep-packet inspection for keywords
- Typically injects dummy responses or blackholes
- Applies to all destination IP addresses

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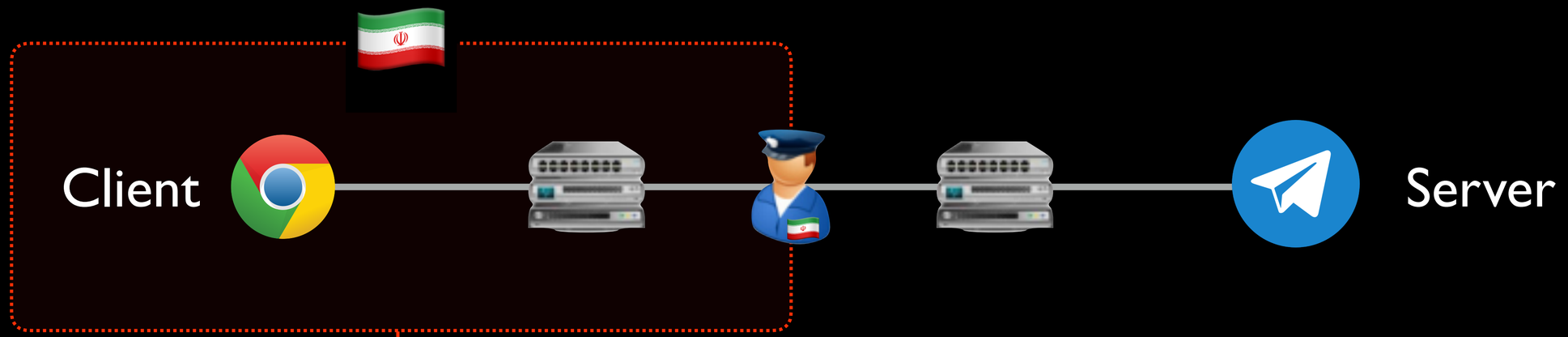

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February 2020

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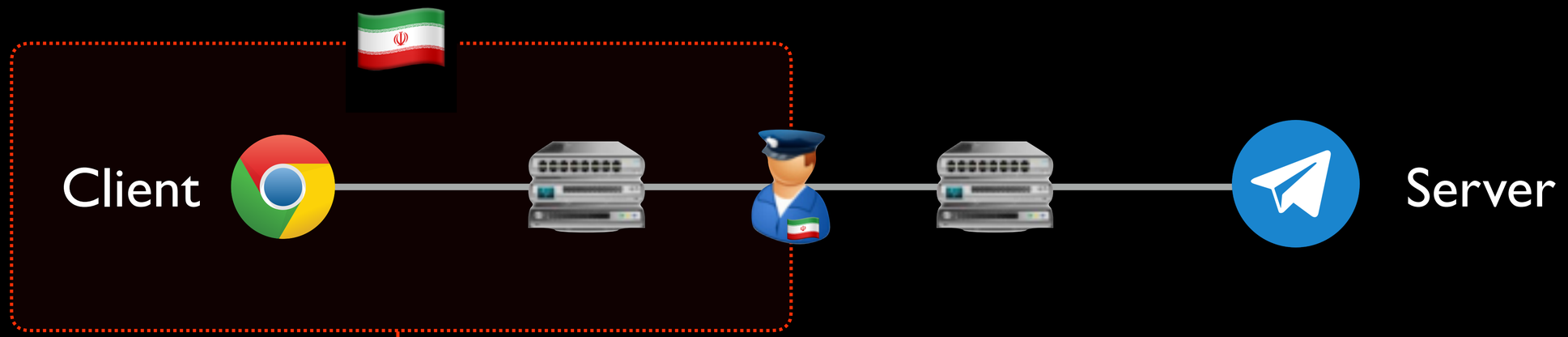

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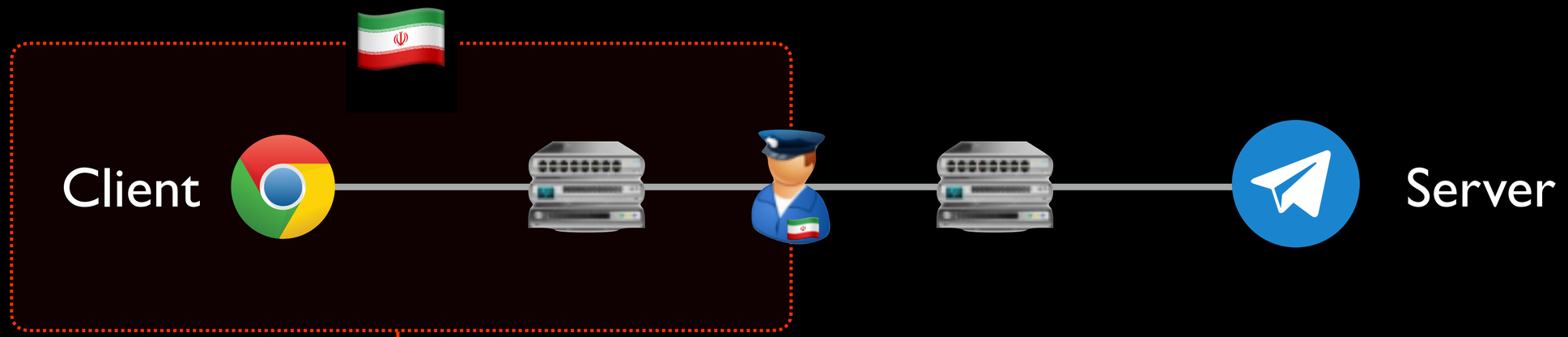

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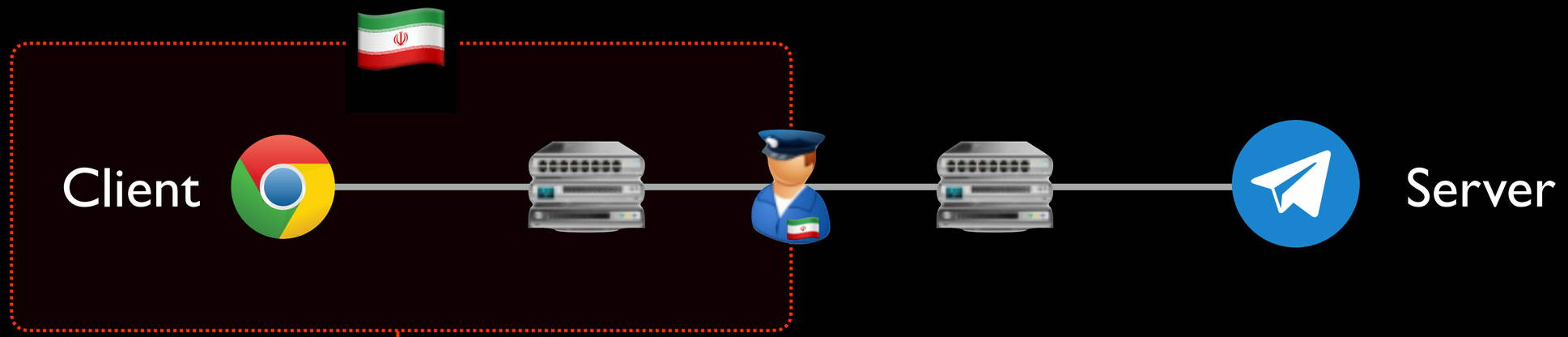

- Censors DNS, HTTP, HTTPS
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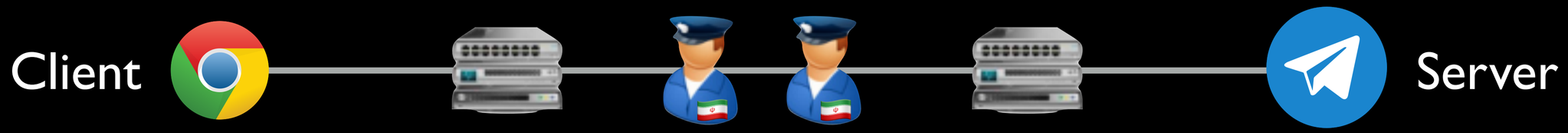
- Applied only to *some* destinations

February 2020

Iran's Protocol Filter



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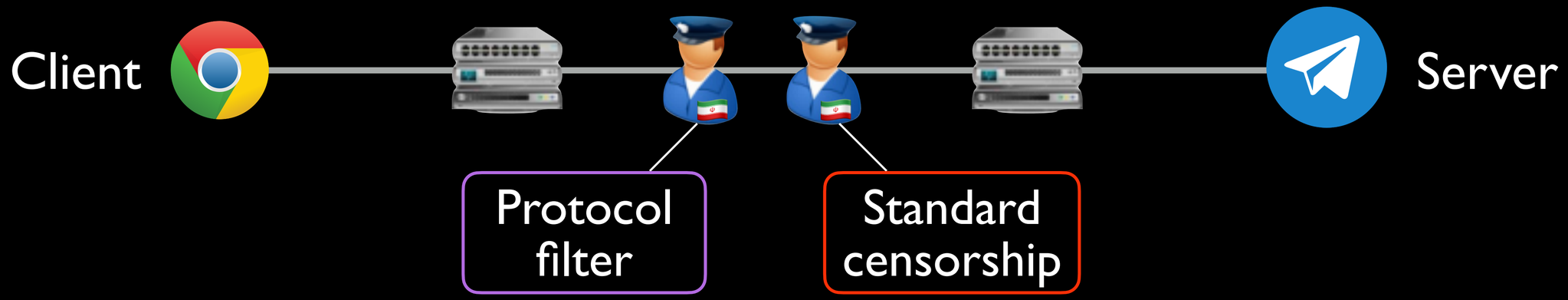

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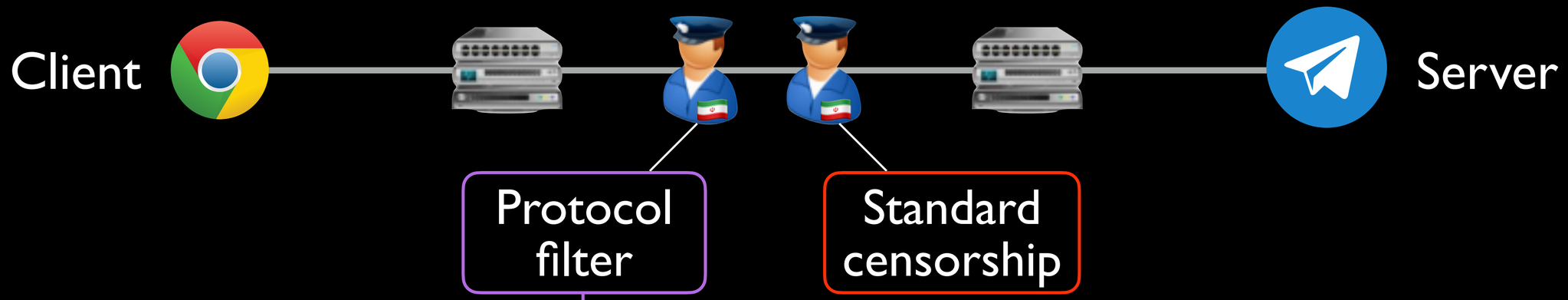

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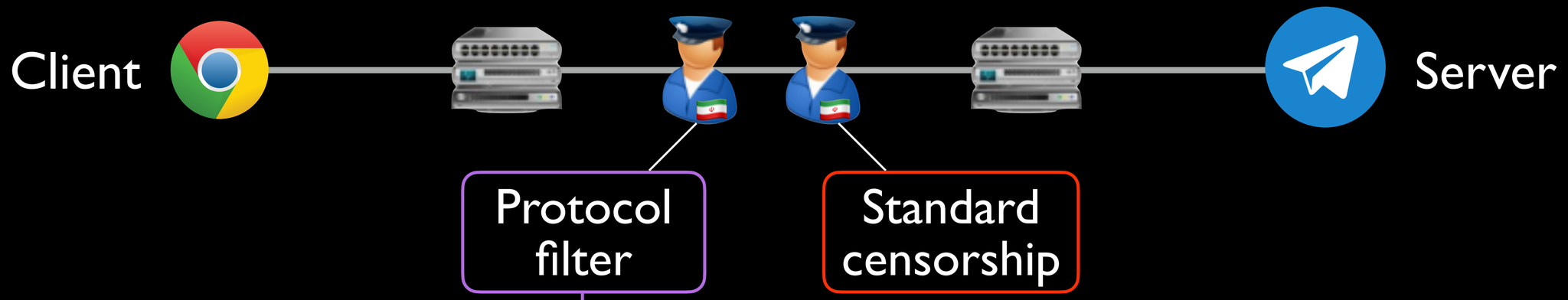

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Composes with standard censorship, creating censorship-in-depth

Iran's Protocol Filter

- How the protocol filter works
  - How it fingerprints connections
  - How it censors connections
- How the filter can be defeated
  - Packet manipulation strategies
  - Client-side and server-side

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How it fingerprints connections

1. Performs deep packet inspection
2. Only matches on TCP
3. Only allows:
   - DNS
   - HTTP
   - HTTPS
4. Only monitors:
   - Port 53
   - Port 80
   - Port 443

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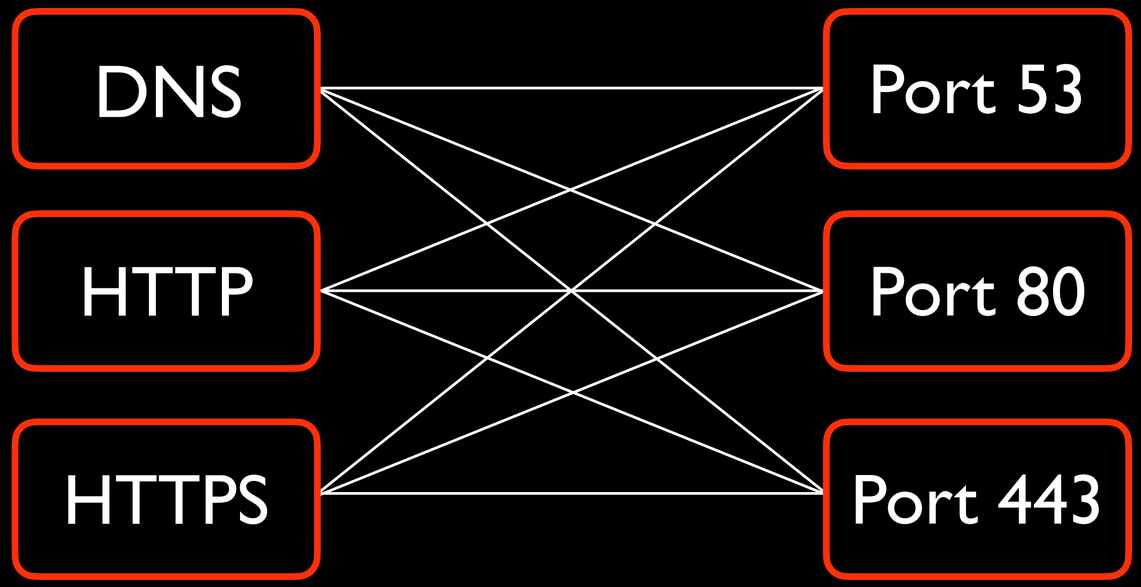

Protocol-specific Fingerprints

DNS

HTTP

HTTPS

DNS Fingerprint

1. TCP payload ≥ 12 bytes long
2. Query/response field = 0
3. Question count < 15
4. Answer count = 0
5. Must have a valid DNS-over-UDP header

Violating any of these results in censorship

DNS Fingerprint

5 Must have a valid DNS-over-UDP header

```
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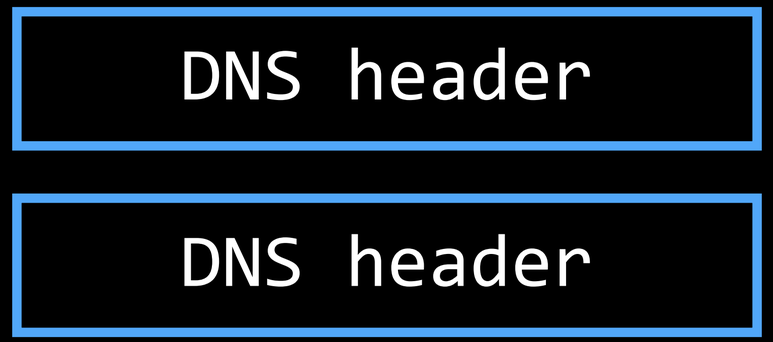

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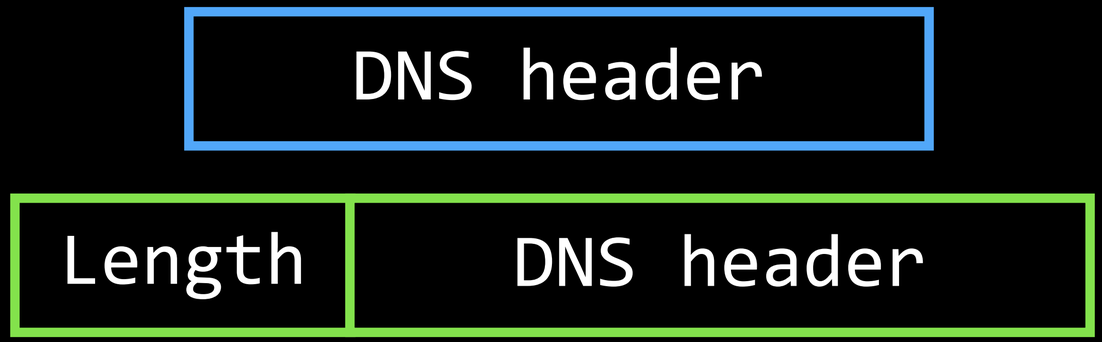

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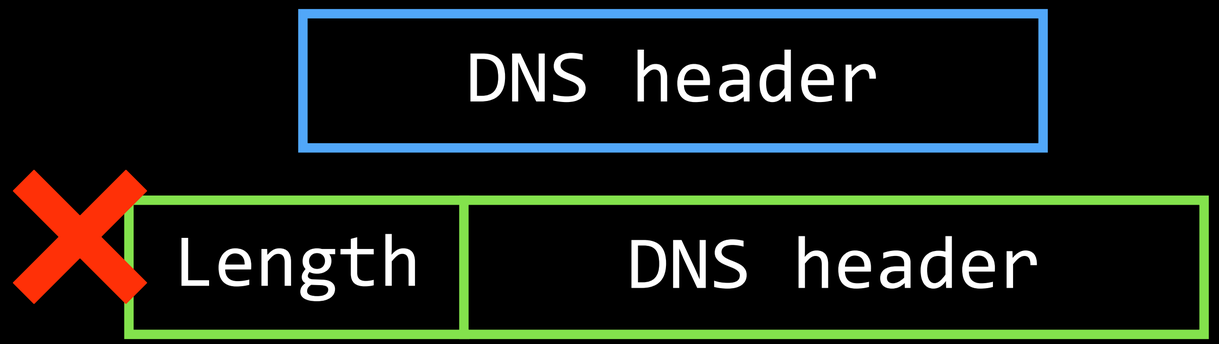

The filter only applies to DNS-over-TCP

Iran's protocol filter *never* permits DNS-over-TCP

Protocol-specific Fingerprints

DNS	Matches for *DNS-over-UDP* header
HTTP	Matches for *most* HTTP verbs
HTTPS	Matches on the TLS ClientHello

Details for each in the paper

How the filter censors connections

Drops all packets from the client

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The filter is not bidirectional

Filters and drops only outbound packets

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Requires vantage points within Iran to study

Other details in the paper

Protocol fingerprints	Full details on DNS, HTTP, HTTPS
Whom does it censor?	Some entire /24 and /16 prefixes But no clear pattern as to whom
How many packets?	First two data-carrying packets
How long does it block?	60 sec (resets with each packet)

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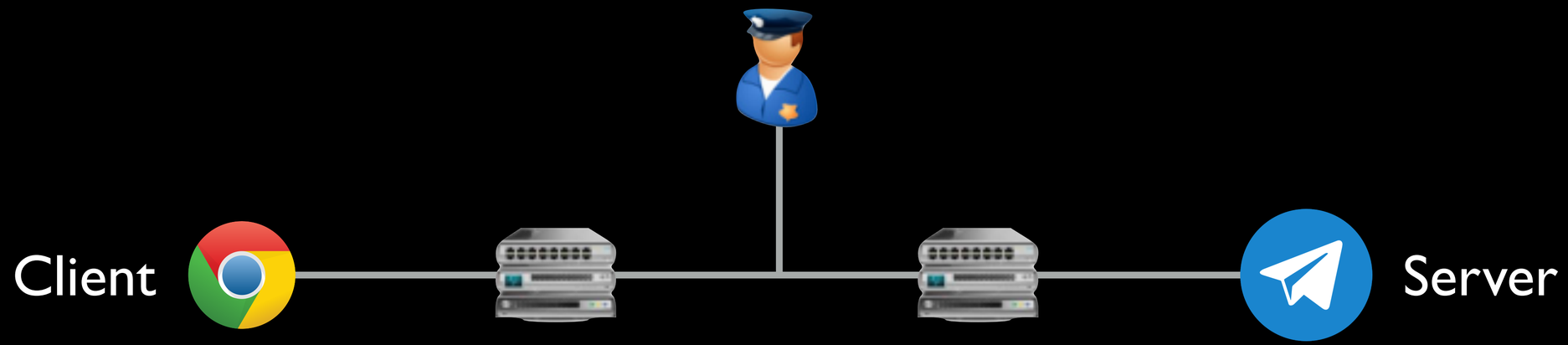
Geneva

Genetic Evasion



Bock et al. CCS'19

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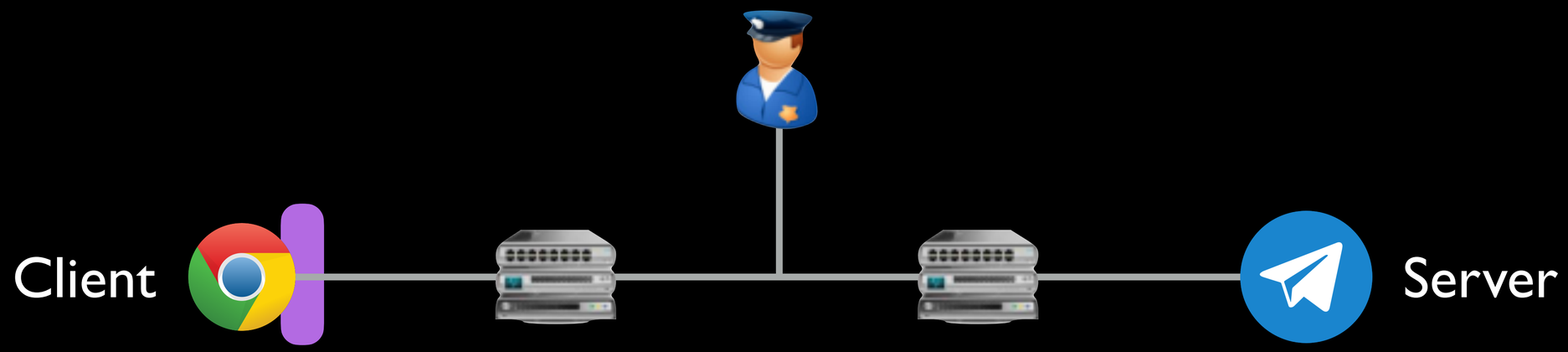
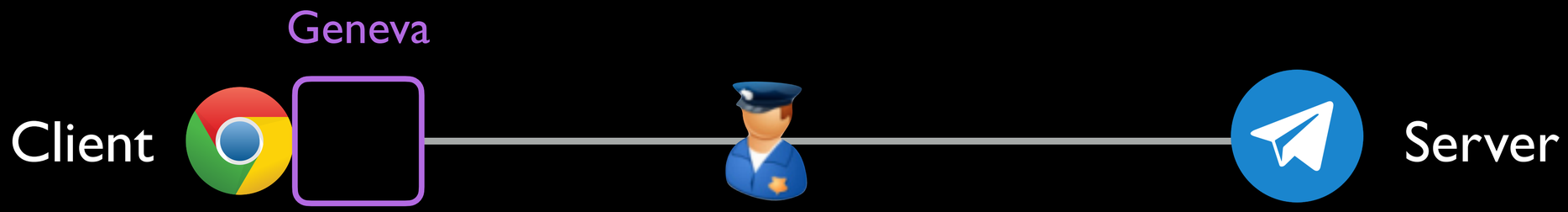


Geneva runs strictly at one side

Discovers packets manipulations to evade censorship

Bock et al. CCS'19

① Inject Fingerprint



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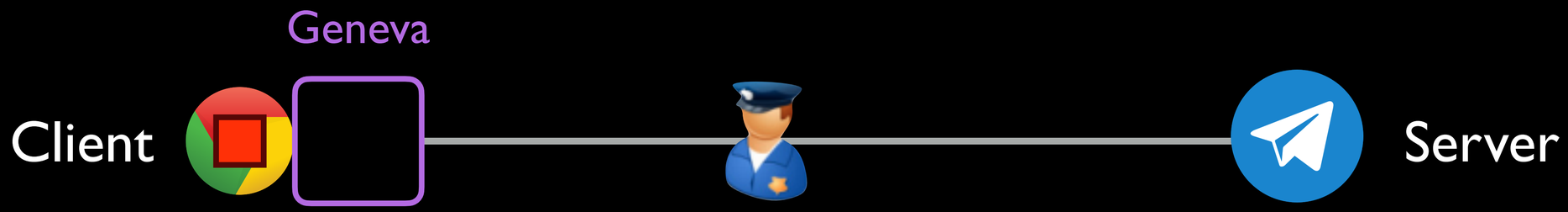

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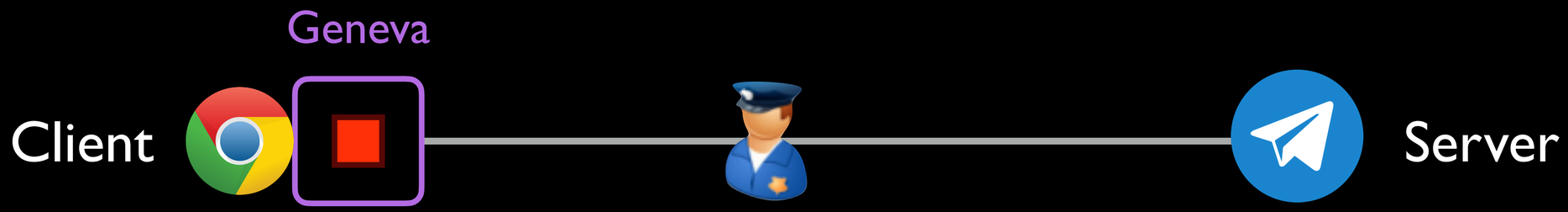

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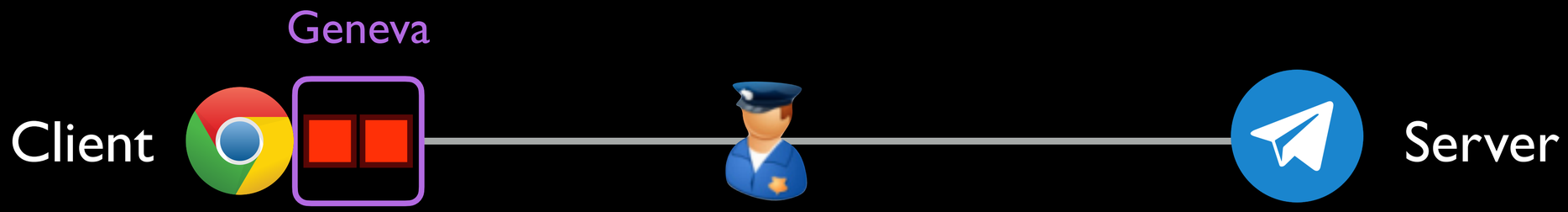

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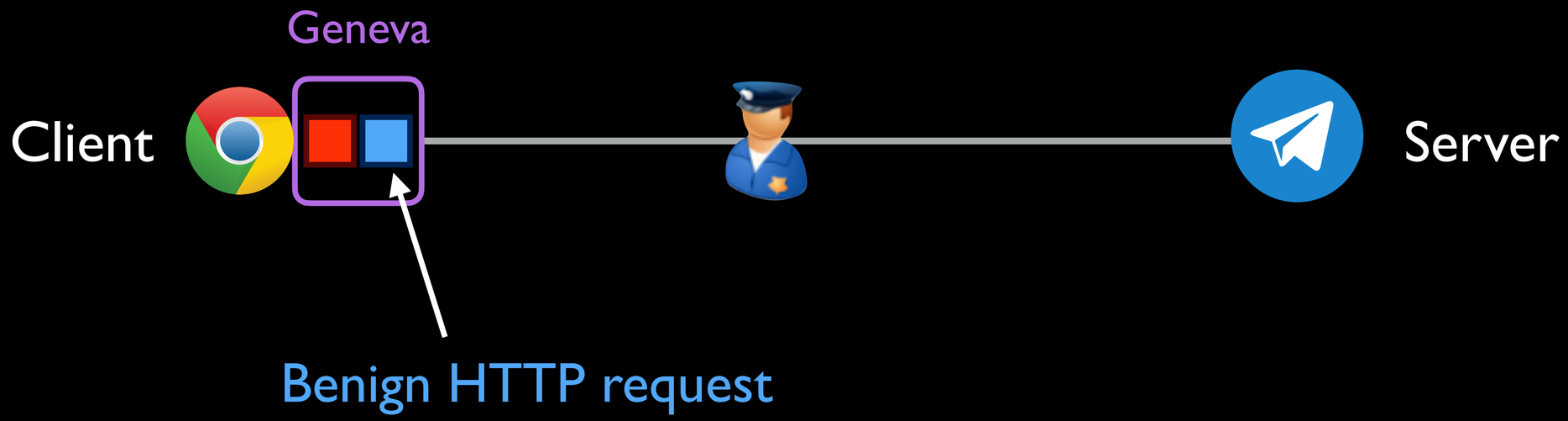

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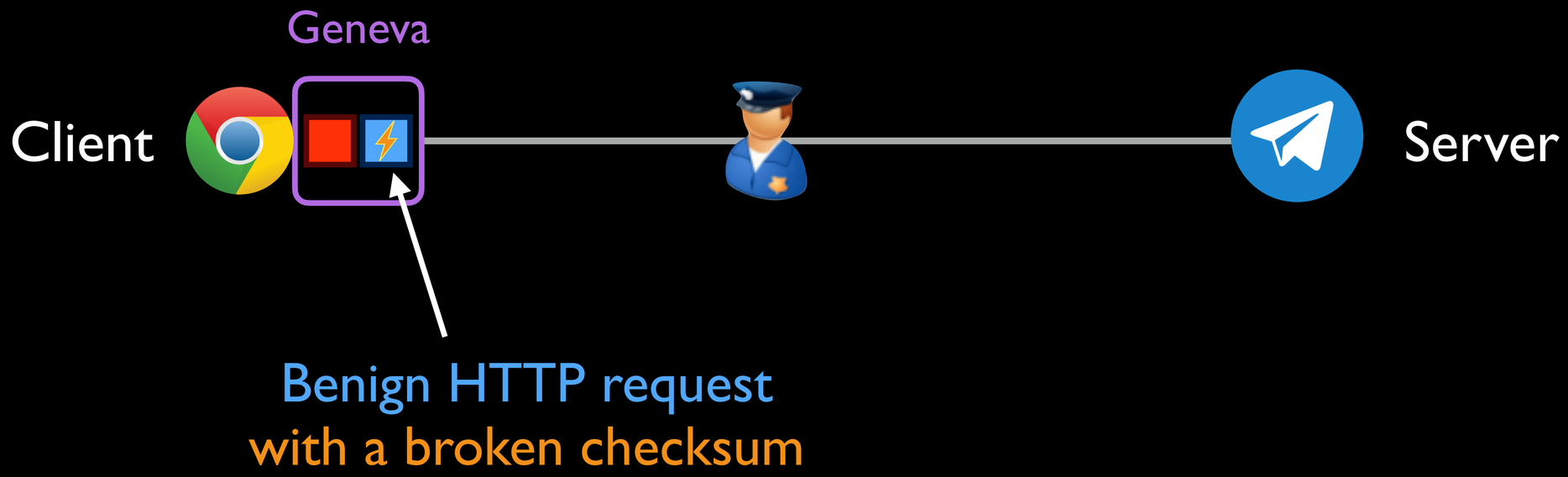

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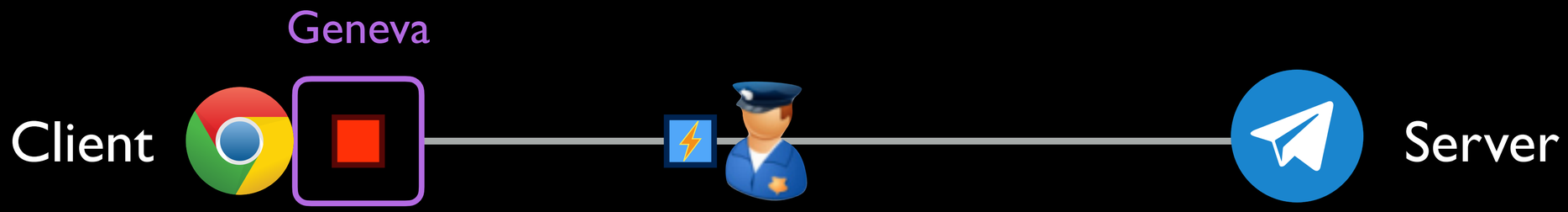

Benign HTTP request
with a broken checksum

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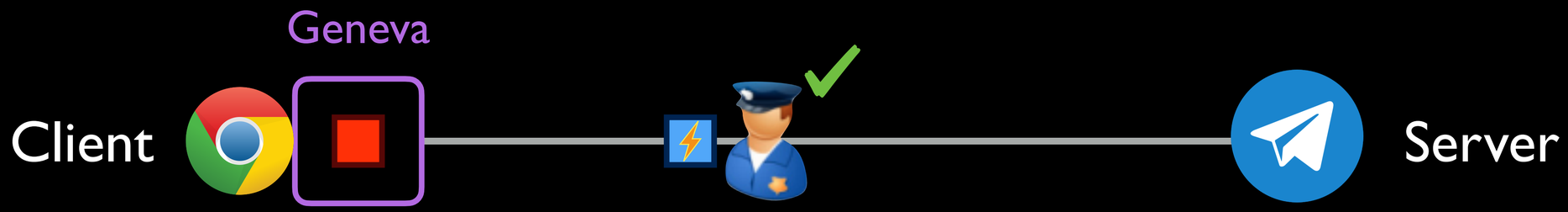

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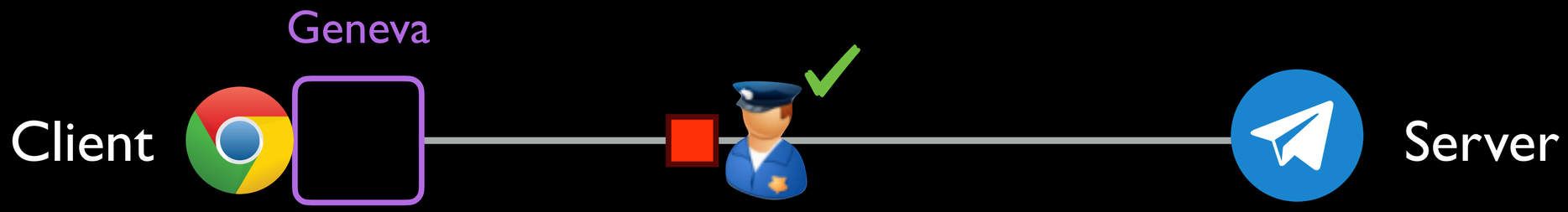

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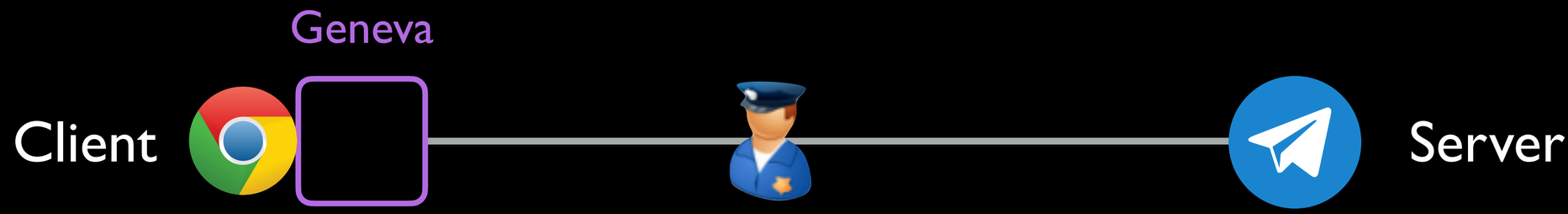
Client-side Evasion Strategies

1. HTTP Request — Send a benign HTTP request with a broken checksum
2. FIN × 2 — Send 2 FIN packets before starting the handshake
3. ACK × 9 — Send 9 ACK packets to complete the handshake

Server-side Evasion Strategies



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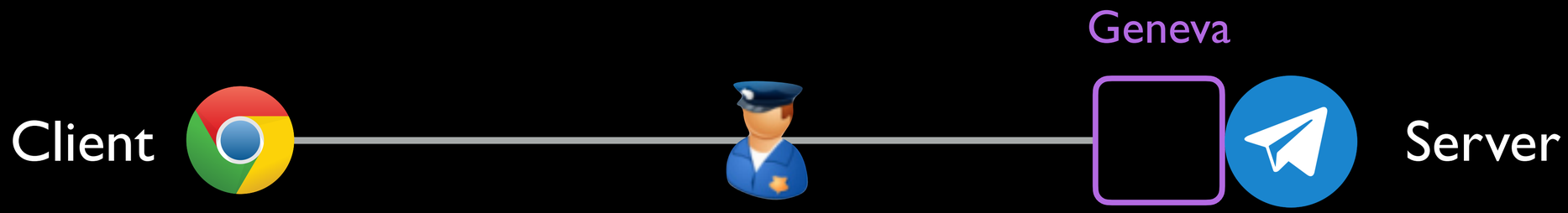

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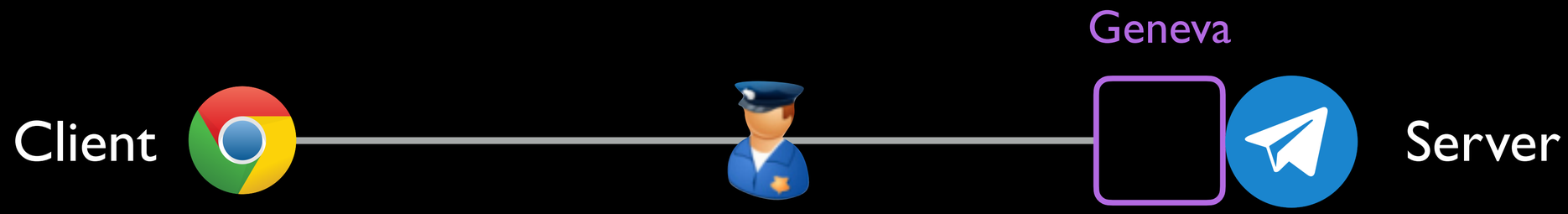

Requires no client-side modifications

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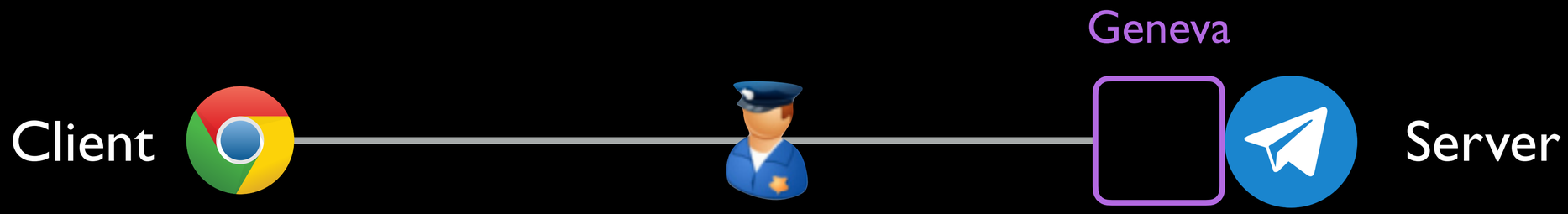

S+A ×9

Send 9 SYN/ACK packets
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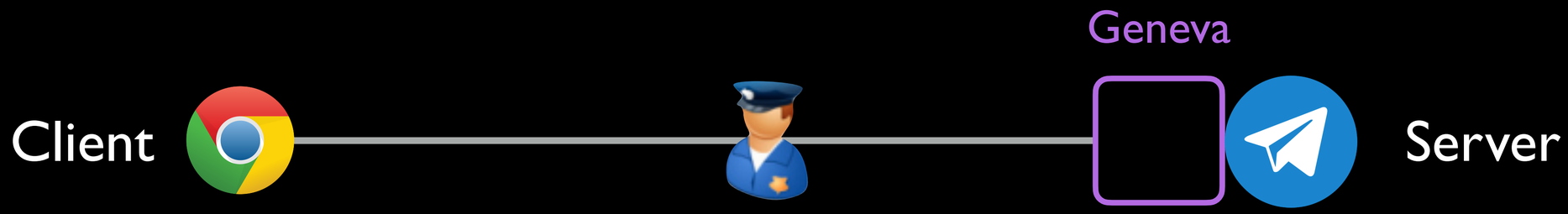

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Induces 9 RSTs from the client

Evading Iran's Protocol Filter

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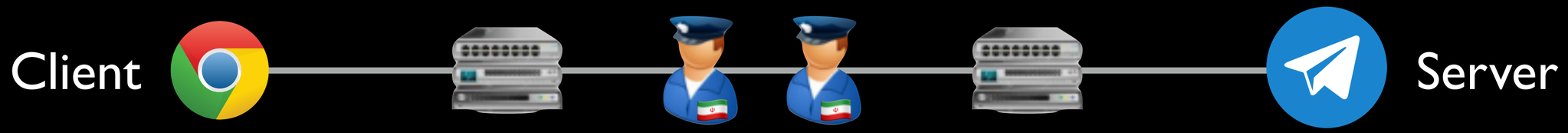

Geneva code and website geneva.cs.umd.edu

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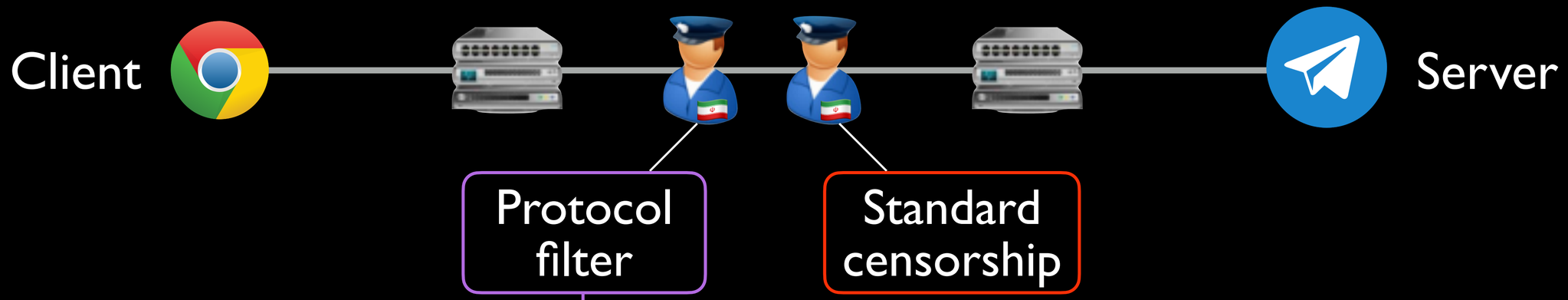

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