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SCHOOL OF COMPUTER SCIENCE AND STATISTICS

# **COMPARING INTERNET CENSORSHIP BETWEEN IRELAND & IRAQ**

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B.A.I. COMPUTER ENGINEERING

## Declaration

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# Abstract

A short summary of the problem investigated, the approach taken and the key findings. This should not be more than around 400 words.

The must be on a separate page.

what's the title for our title abstract one page five paragraphs area and digital twin project research questions two paragraphs how to solve them paragraph to implement and evaluate main findings one paragraphs expanding the abstract

introduction literature review design implementation evaluation conclusion

# Acknowledgements

Thanks Mum!

You should acknowledge any help that you have received (for example from technical staff), or input provided by, for example, a company.

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# 1 | Introduction

## 1.1 Internet Censorship and Privacy

The primary aim of this work is to identify and compare internet censorship methods between Ireland and Iraq.

### 1.1.1 Overt vs. Covert Censorship

Censorship can be implemented in many different ways, but there are two main categories: Overt and Covert Censorship. Overt censorship is openly implemented by governments, ISP's, or legal courts to block or restrict access to certain types of content, or specific websites. When the content a user is trying to access is blocked using overt censorship, it is made very clear to the user that it is blocked. An example of this is the 'Golden Shield Project', which is China's internet censorship project. This project blocks access to websites such as google and facebook, and the citizens of China are often aware that they websites have been blocked by the government (1).

Covert censorship is more often harder to detect. Search engine manipulation, throttling or slowness, and shadow banning are some of the primary methods of covert censorship. The goal of this type is to make censorship more difficult to detect by users, and is often disguised as technical issues.

### 1.1.2 Privacy

User Privacy across the internet is directly tied to censorship efforts from different regimes. Censorship often involves the state or corporate monitoring of internet users, and governments that impose censorship frequently justify it using security concerns while often violating privacy rights in the process. In countries where censorship is highly enforced, using anonymity tools to circumvent censorship can protect the right to free expression and access to information. For instance, the *Human Rights Watch* advises people in China to make use of the Tor Browser to avoid abuses by the state (2).

Based on a meta-analysis of studies related to internet privacy concerns, privacy literacy, and the adoption of privacy-protective measures, it was found that there is no strong correlation between national privacy laws and protective behaviors (3). This suggests that individuals do not rely on legal protections in their country, and more often take privacy into their own hands. It was also found that culture did not impact the use of privacy-protective behaviors in different countries.

While it may be easy to think censorship is only prevalent in non-western countries, such as China or Russia, it can also happen in democratic states. Weak privacy protections can lead to surveillance capitalism, where companies act as de facto censors by shaping information flows based on user data (4). For example, during the COVID-19 pandemic in the United States, it was recently revealed that Meta (formerly Facebook) was asked to censor certain information regarding COVID-19 (5). The United States Government and Meta actively engaged in the censorship of the people's right to free speech and expression, as humor and satire was also removed from the platform.

### 1.1.3 Global Censorship (Chris)

Experts suggest that censorship on the internet is increasing at an alarming rate. "The majority of countries that censor content do so across all four themes, although the



depth of the filtering varies. The study confirms that 40 percent of these 2,046 websites can only be reached by an encrypted connection (denoted by the "HTTPS" prefix on a web page, a voluntary upgrade from "HTTP")" (6). It is also clear that more and more countries are viewing this as a necessary solution to the unique problems they have. Whether this is appropriate or not, it is happening, and users should be aware of this.

Governments have a vested interest in maintaining control over telecommunications industries and public internet use. Whether protecting state secrets, preventing cyber crime piracy or acts of terrorism, insulating from perceived negative influence, aiding in the creation of propaganda or otherwise; a large majority of governments choose to exercise inordinate control over the information available to its public.

As more governments and entities began to engage in this, it became increasingly important to hold them accountable. As a result, the 'Enemies of the Internet' list was devised. It contains the governments and entities that actively engage in the repression of online freedoms, in the form of censorship and surveillance. As of 2014, there were 19 governments that fit this criterion but by now this number has likely increased (7). Traditionally, censorship involved monitoring a handful of media and cutting undesirable content, potentially replacing this with a message more in line with the agenda and norms of the locale. However, with the advent of the internet, this distribution of information became decentralised and thus allowed for more expression and freedom in the content consumed by a user. As a result, censorship has become more difficult to conduct, but potentially easier to get away with. Nowadays, governments leverage points of control, network-level filtering and many other techniques to block undesirable content.

## **1.2 Project Goals**

The aim of this project is to ...

## 2 | State of the Art

### 2.1 Introduction

The purpose of this section is to give a high-level overview of common internet censorship mechanisms, the past and present landscapes of internet censorship in Ireland and Iraq, and a brief description of some circumvention tools. This review was conducted using publicly available information and data published on the internet....

(Stephen do you think this section needs to be expanded or is even necessary?)

### 2.2 Censorship Mechanisms

The following section is based primarily on information from the source *RFC 9505 A Survey of Worldwide Censorship Techniques* (8). Any other information sourced from elsewhere is identified as such.

#### 2.2.1 IP Blocking

##### Shallow Packet Inspection

Shallow packet inspection refers to the action of looking at the transport layer segment (packet) headers to implement censorship based on the transparent source and destination IP addresses and port numbers. The information visible in the headers allows a censor to block content via IP blocklisting.

This method is easy to implement in some routers, but difficult to implement in backbone or ISP routers at scale. It is usually implemented alongside Deep Packet Inspection using middleboxes.

Internet Protocol (IP) blocking is one of the most straightforward censorship techniques, but it is also very crude. To implement an IP blocklist, the censor will create a route in a router's flow table that instructs the router to drop any packets matching a set IP address. In IPv4, this is done as a /32 route, and in IPv6 as a /128. However, due to the limited amount of space in router flow tables, this means that only a limited number of IPs can be blocked at a time, making it difficult to scale.

IP blocking can also cause content over-blocking. Because many websites share the same IP address, blocking one IP address can lead to multiple websites getting blocked within a network. Censors also sometimes block a range of IP addresses, which can lead to more over-blocking.

IP blocking is often ineffective against Content Distribution Networks (CDNs) and services that are hosted using multiple load-balanced IP addresses. This is because when the server hosting the content being sent changes its IP addresses, the block list may not include this new IP address, and the packets are not dropped. VPNs are an excellent tool to circumvent IP blocking as it routes the packets through different servers, changing the source and destination IP addresses along the way. This makes it nearly impossible to stop IP blocked content from getting through, as the source and destination IP addresses can be different for every packet coming from the original blocked source.

IP blocking can either be implemented at a centralized level or at an ISP level. In Ireland, IP blocking is done at an ISP level to block certain illegal websites in accordance with court orders (see section 2.2 for more information). In Iraq, IP blocking is implemented at the ISP level under the directive of the Ministry of Communications (9) (see section 2.3 for more details).

### 2.2.2 DNS Interference

DNS interference refers to the altering of responses from the DNS to block or filter access to certain content. This is usually done by either blocking the response, replying with an error message, or responding with an incorrect address. *DNS Mangling* is a network-level technique of on-path interception where an incorrect IP address is returned in response to a DNS query to a censored destination.

*DNS Cache Poisoning* is an off-path technique in which a censor intercepts and replaces the legitimate response from an authoritative DNS name server with a spoofed IP address. Instead of allowing the real IP address of a site to reach the user, the censor replies faster than the real server, and that spoofed IP gets cached (perhaps by numerous recursive resolvers). Subsequent requests will then be redirected to an incorrect IP, normally leading to a warning page or a meaningless domain. In other cases, such as in Iran, the censor can merely block the response of the upstream resolver, so the accurate IP address is never transmitted.

*DNS Lying* is the most authoritative approach, where a censor mandates that the DNS responses provided are to be different from what would actually be returned by the DNS server (8).

The above DNS interference methods require the censor to traverse a controlled DNS hierarchy for this mechanism to be effective. This mechanism can be circumvented by using a different publicly known DNS resolver that is not controlled by the censor. This mechanism can also lead to unintentional blocking in area's not controlled by the censor. For example, sometimes a user outside of the censor's region will be directed through DNS servers controlled by the censor, causing the request to fail. Considering all of this, DNS interference is not a very effective censorship mechanism.

### **2.2.3 Deep Packet Inspection (DPI)**

Deep Packet Inspection consists of any kind of packet analysis beyond IP address and port number. DPI reassembles network flows to examine the application data section, and is often implemented using Middleboxes. DPI is often used for keyword identification, but this method can also determine packet size and flow timings to detect other forms of content, such as the difference between text or video packets. Although DPI has difficulty with encrypted data and is the most expensive form of censorship to implement, it is still the most powerful identification method and is widely used in practice (8).

### **2.2.4 Transport Layer Security (TLS)**

Transport Layer Security (TLS) may be censored by mechanisms similar to those against plain HTTP, particularly through the Server Name Indication (SNI) field. In the case of TLS over TCP, the SNI value is seen in the non-encrypted ClientHello message so that censors can inspect the field and exclude connections to those domains they disapprove of. While QUIC encrypts ClientHello, the initial encryption keys are visible to network observers, and therefore it is possible, though more complex, to decrypt and observe the SNI. Since 2018, the governments of China, Egypt, Iran, Qatar, South Korea, Turkey, Turkmenistan, and the United Arab Emirates have implemented widespread SNI filtering or blocking (10).

Attempts to encrypt SNI have resulted in Encrypted SNI (ESNI), which embeds the SNI field in encrypted traffic but can induce blanket blocking by censors who blindly terminate all ESNI connections. Even more comprehensive security improvements, such as Encrypted Client Hello (ECH) for TLS 1.3, aim to encrypt the whole ClientHello rather than merely the SNI, though these enhancements are still underway in standardization and deployment.

Another way is to not include the SNI at all. However, non-SNI connections can be blocked as well, since censors can deploy policies that will drop any TLS traffic that

does not have an SNI. This can again lead to overblocking, since clients that are able to handle older SSL-only configurations, or are deliberately configured not to have an SNI, can get blocked even when they are going to otherwise acceptable sites.

Censors also have the option to examine the server certificate field within the TLS handshake, which contains information on the requested domain. In TLS 1.3, however, certificates are encrypted by default, and thus such censorship is not possible. Certificate-inspecting censors must therefore employ more computation-intensive deep packet inspection techniques and can even be forced to track connections deeper into the handshake process, especially when SNI-based approaches fail or are bypassed (8).

### **2.2.5 Network Blackouts**

A very straightforward, wholistic, and blunt form of censorship is network blackouts. This method involves a large governing body of an area or region completely shutting off internet access for all content. This method is becoming more and more common across areas in the Middle East and Asia. According to a report from *Access Now*, there were a total of 296 different internet shutdowns across 54 countries. This is a 35% increase from the previous high in 2022 (11). This form of censorship is very extreme and is often implemented in times of conflict, protest and instability, exams, and elections.

### **2.2.6 TEMP NAME TABLE**

## **2.3 Ireland**

### **2.3.1 Censorship in the Past**

According to a report from the United States Department of State in 2011, it was found that there were no government restrictions on access to the internet or that the government actively monitored email or internet chatrooms (12).

The Irish government engages in censoring or blocking the distribution of pirated copyrighted material. In 2009, the Irish Telecom Company, EIRCOM, blocked its customers from accessing the website *The Pirate Bay*. The Pirate Bay is a Swedish website which provides links to copyrighted material. The website was hit with a lawsuit from major record labels and many ISPs around the world agreed to block access to the website as part of the settlement. However, not all Irish ISPs complied. The cable TV operator UPC announced that it would not comply (13).

In alignment with international agreements, the Irish Government blocks access to websites that contain illegal content, such as Child Sexual Abuse Material (CSAM). The government has setup a hotline that allows citizens to anonymously report websites that they suspect contain illegal content, called hotline.ie (14).

In contrast to other EU countries, Ireland does not have a broad government-mandated filtering system. They instead have the power through the Irish courts to mandate Irish ISPs to block certain websites. In addition, Irish ISPs may voluntarily enforce content filtering and website blocking in alignment with Irish content law.

Up until 2014, Ireland and other EU countries followed data retention laws, which required ISPs to store metadata for law enforcement purposes. In 2014, the European Court of Justice struck down the directive, which led to a change in this law in Ireland (15). After this change, Ireland enacted the *Communications (Retention of Data)(Amendment) Act 2022* (16). This legislation allows for the general and indiscriminate retention of communications traffic and location data on the grounds of national security, where approved by a judge.

### **2.3.2 Current Censorship**

As a whole, Ireland's censorship efforts are limited and specific. The government and ISPs target mainly illegal and pirated content. Some specific websites that have been blocked include 1337x, Eztv, BMovies, GoMovies, Putlocker, Rarbg, WatchFree, and

Yts (17). However, piracy websites are still widely accessible in Ireland.

It seems that Ireland has also rolled back blocks on some websites, such as Russian News outlets. Previously, the domain `ruusia.tv`, was blocked in Ireland. But as of 2025, it is able to be partially accessed. Based on data from the OONI project, there is evidence of TCP/IP blocking of this domain in Ireland. Based on the findings from OONI, this domain is able to be accessed when EIRCOM's root DNS server (AS5466, IP: 86.47.80.38) is used, but is blocked when accessed through Cloudflare's DNS server (AS14593, IP: 172.69.193.80).

IE		AS 5466	2025-02-02 01:09 UTC	Web Connectivity Test	<a href="http://ruusia.tv/">http://ruusia.tv/</a>	Accessible
IE		AS 5466	2025-01-31 06:04 UTC	Web Connectivity Test	<a href="http://ruusia.tv/">http://ruusia.tv/</a>	Accessible
IE		AS 14593	2025-01-30 06:45 UTC	Web Connectivity Test	<a href="http://ruusia.tv/">http://ruusia.tv/</a>	<span>tcp_ip</span>
IE		AS 14593	2025-01-30 05:44 UTC	Web Connectivity Test	<a href="http://ruusia.tv/">http://ruusia.tv/</a>	<span>tcp_ip</span>

*Figure 1.3, Russia.tv domain search on OONI*

## 2.4 Iraq

### 2.4.1 Censorship in the Past

Iraqi internet censorship has been radically reshaped over the years. Under Saddam Hussein's regime, only a very few Iraqis had access to the internet, leading to the state controlling all parts of the internet within the country. Post-2003, with more people accessing the internet and the country struggling with internal conflict and the threat of radicalization, censorship was decentralized and usually carried out with little transparency and regionally differentiated. While the constitution and laws of Iraq recognize free expression, actual enforcement is usually slow whenever security is at stake. As the internet began to take a greater role, both as a platform for political discourse and a vehicle for extremist messaging, the censorship and intrusions of the government increased correspondingly. Generally speaking, the



policy of controlling the internet in Iraq has mirrored the broader political and security situation, tightening whenever Iraq is unstable (9).

### **2.4.2 Current Censorship**

Iraq's internet growth has progressed from state-controlled limitations during Saddam Hussein's era, where limited citizens used the internet. After 2003, many private ISPs were formed, but primary fiber routes and gateways that link Iraq to international submarine cable networks via adjacent countries are still controlled by the Ministry of Communications (18). Baghdad, the country's capital and commercial center, is a hub of national connectivity, and other large cities (like Basra and Mosul) typically have local backbones that connect into the national fiber network. The Kurdistan Region of Iraq (KRI) also has standalone network configurations, with cross-border fiber routes—particularly to Turkey—creating a semi-independent internet ecosystem (9).

In a 2023 report from the United States Department of State, it was found that the government of Iraq restricted or disrupted access to the internet and censored online content, in conjunction with monitoring private online communications without appropriate legal authority (19). The Iraqi government and the Kurdistan Regional Government (KRG) consistently engage in implementing internet outages during protests or times of unrest (9). In 2023, Iraqi officials implemented 66 internet outages, more than any other country in the world. It is worthy to note that another organization, *Access Now* (20), reports a different number for Iraq in this year, and their data often conflicts with the data from *FreedomHouse*.

After the fall off Saddam Hussein's Regime in 2003, the internet became much more accessible and the information landscape was opened. However, the current-day Iraqi government occasionally blocks websites, and more often social media websites in order to maintain stability and control during times of unrest (9). During anti-government protests in 2019, the Iraqi government blocked access to Facebook,

X (Formerly Twitter), WhatsApp, and Instagram. In protests in 2018, some users in Iraq found that they were unable to use VPNs to circumvent website blocking. The government routinely engages in the censoring and blocking of Pornography and Gambling websites on the guise of protecting their citizens from harmful content.

## **2.5 Censorship Circumvention Tools**

### **2.5.1 The Tor Browser**

#### **The Tor Project Background**

The Tor Browser is built on a concept called *Onion Routing*, which was developed in the 1990s by researchers at the United States Naval Research Laboratory. The goal of the project was to create a communication method where data is wrapped in multiple layers of encryption so that no point in the network could reveal the sender and receiver (21). Originally, the United States Government used the Tor network to access potentially illegal websites anonymously, and transmit data. But because only the US Government was using it at the time, it was easy to tell who the single anonymous user was, when viewing the site logs. It would also have made Tor a target for bad actors, as they could be sure that all data being sent over the network was related to the United States Government/Military.

To stop this from happening, the US Government released Tor to the public in the early 2000s, and later it became the Tor Project, a non-profit organization funded by the United States that develops and maintains the Tor software.

#### **Technical & Circumvention Information**

Internet traffic sent over the Tor network is encapsulated in multiple layers of encryption. Think of your data as a letter that is placed inside several envelopes. Each node in the network removes one envelope, revealing only the information

necessary to pass the message along to the next node. To do this, the Tor browsers sends your data through at least three nodes, and the pathway of these nodes are randomly constructed and reconstructed during your session (22).

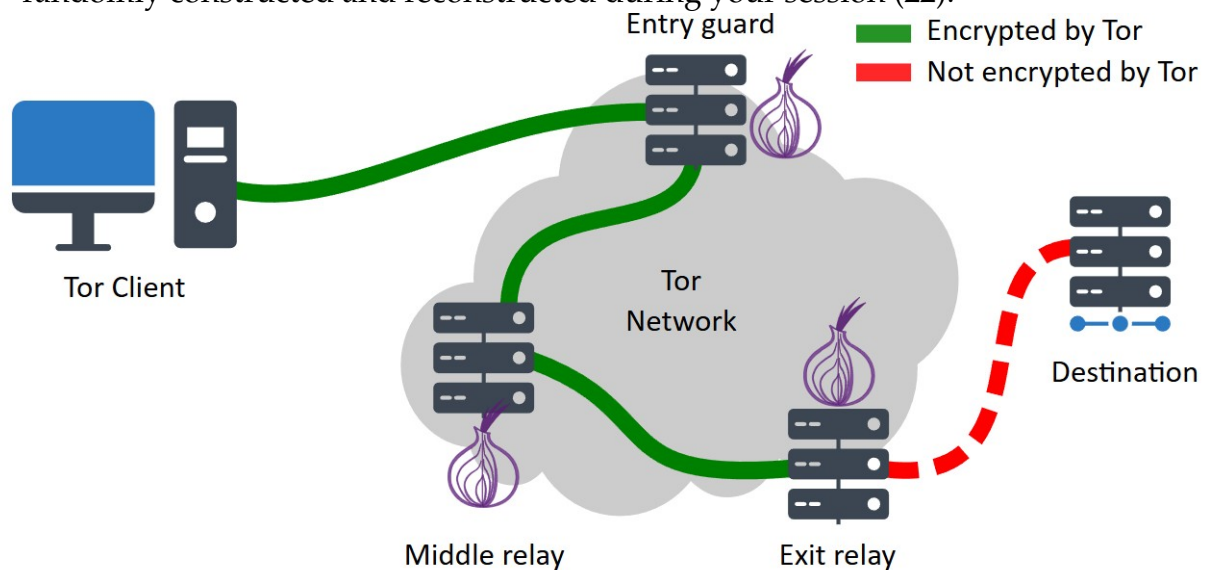


Figure 1.4, How the Tor Network Works

Tor is a great tool to combat censorship. Tor's distributed architecture of nodes makes it resilient against localized censorship efforts. In countries where the Tor network is blocked, users are able to use "Bridges", which are Tor nodes that are not listed publicly. Using a bridge address allows for the user to connect to the network covertly (23). Users can also avail of "Pluggable transports", which transforms Tor traffic to look like regular network traffic. This method can help circumvent censorship in regions that use *Deep Packet Inspection* (DPI) and other forms of advanced internet censorship (24).

## 2.5.2 VPNs

Virtual Private Networks (VPNs) broadly speaking provide an end-to-end encrypted connection between your device and a VPN server. This method hides your IP address and grants the user anonymity while browsing over the network. This allows users to bypass censorship by connecting to servers outside of their location while masking your IP address (25).

## 3 | Methodology

### 3.1 Introduction

### 3.2 The OONI Probe

#### 3.2.1 Background of OONI

The Open Observatory of Network Interference (OONI) project was started in 2012 as a non-profit open-source software project aimed at identifying and documenting internet censorship around the world (26). The OONI organization openly publishes measurements and provides a public archive on network interference from across the world.

#### 3.2.2 Data-Collection

##### Web Connectivity Test

The Web Connectivity test determines if, and how, access to a specific website may be blocked. To do this, OONI Probe performs several checks from the network where the test is run and compares the results with measurements collected from a control network where censorship is not expected. If the measurements differ significantly, censorship techniques are likely used on the local network. This test is designed to perform the four different actions: Resolver Identification, DNS Lookup, TCP Connect, HTTP GET Request.

The Web Connectivity test begins by identifying the DNS resolver in use on the network. It achieves this by sending DNS queries to special domains, which disclose the resolver's IP address. Once the resolver is identified, the test performs DNS lookups to determine which IP addresses (and potentially other host names) are mapped to the tested domain. After collecting that information, the test attempts to establish a TCP session on port 80 or port 443, depending on whether the URL uses HTTP or HTTPS. Finally, once the TCP connection is successful, the test sends an HTTP GET request to the server hosting the website; under normal circumstances, the server will respond with the requested webpage content (27).

### **Circumvention Test**

The circumvention test is used to check whether Psiphon, Tor, or RiseupVPN are blocked on a given network. These are tools used to circumvent censorship by utilizing VPN, SSH, and HTTP proxy technologies.

The Psiphon VPN serves as a tunnel that enables you to circumvent censorship by connecting you to an uncensored portion of the internet (28). The Psiphon test first uses Psiphon's own code to establish a Psiphon tunnel. After the tunnel is created, the test attempts to load a webpage to see if Psiphon actually works for accessing the internet. If the tunnel is successfully set up and the webpage loads, Psiphon is functioning on the tested network and can bypass censorship. If the tunnel is established but the webpage does not load, Psiphon is blocked in some way, preventing access to online resources. Finally, if the test cannot even create the Psiphon tunnel, it indicates that Psiphon is completely blocked on that network (29).

The Tor Test (30) automatically checks whether Tor is accessible in a given network by examining the reachability of core components such as Tor directory authorities, OR ports, and obfs4 bridges. It first attempts to retrieve the Tor consensus from directory authorities, then tries to connect to OR ports (including those of directory authorities) via a TLS handshake, and finally tests obfs4 bridges through an

obfuscated handshake. If all of these steps succeed, Tor is likely usable in the tested network (unless it is blocked in ways not covered by the test). If any step fails, Tor may be blocked and therefore unavailable on that network (31).

The RiseUpVPN test evaluates if the bootstrap servers used during the self-configuration of the VPN clients can be reached. The test also checks if RiseupVPN's gateways can be reached on different ports and transports (32). This test was contributed by the LEAP collective (33).

### **Instant Messaging Test**

The Instant Messaging test is used to check whether WhatsApp, Facebook Messenger, Telegram, and Signal are blocked on a given network.

The Whatsapp test attempts to determine if there is any interference or blockage of its App or Web Interface. To do this, the OONI probe attempts to perform an HTTP GET request TCP Connection, and DNS lookup to WhatsApp's endpoints. These include the endpoints used by the WhatsApp mobile app, the registration service, and the web interface (34). To conduct these tests, the OONI probe attempts to open TCP sockets towards WhatsApp endpoints on Ports 443 and 5222. If these connections fail or are rejected, it is seen as an indicator of blockage at the TCP level. The probe then verifies if the DNS resolution returned a valid IP address that is registered to WhatsApp. If the resolved IP address does not belong to WhatsApp, it can indicate DNS level blocking or tampering. And to check if the WhatsApp registration service is working correctly, an HTTP GET request is sent to the URL <https://v.whatsapp.net/v2/register>. The request is considered successful if there is no DNS, TCP connect, TLS (Transport Layer Security), or I/O error (35).

The Facebook Messenger Test is used to examine the reachability of the service within a tested network. The OONI probe begins by attempting to perform a TCP connect and DNS lookup to Facebook's endpoints (36). The test verifies if Facebook Messenger endpoints resolve to consistently known IPs and if it's possible to

establish TCP connections to them on port 443. For each endpoint tested, an A lookup for the domain name is performed and it is considered consistent if the IP is inside of a netblock linked to the *Facebook Autonomous System Number* (AS32934) (37).

The Telegram Test is used to examine the reachability of Telegram's app and web version within a tested network. The telegram access points (DCs) are those used by the desktop client, and they have six unique IP addresses. The test establishes a TCP connection to all of the access point IP addresses and attempts to send a POST HTTP request to each of them. If all TCP connections on ports 80 and 443 fail, Telegram is considered to be blocked at the TCP level. Otherwise, Telegram is considered to be working as intended (38).

The Signal Test is used to measure the reachability of the Signal messaging app within a tested network. The test checks if it is possible to establish a TLS connection and send an HTTP GET request to the Signal server endpoints (39). A DNS query to `uptime.signal.org` is also performed to check if the backend servers are down (40).

## **Middlebox Test**

A Middlebox is a computer networking device that transforms, filters, and manipulates traffic for purposes other than packet forwarding. These include network address translators, load balancers, and deep packet inspection (DPI) devices. The presence of Middleboxes can lead to evidence of censorship and/or traffic manipulation, but it can also be indicative of a less malicious intent, such as network caching.

The OONI Middlebox test consists of two main operations: HTTP Header Field Manipulation and HTTP Invalid Request Line. The HTTP header field manipulation test emulates an HTTP request towards a server, but sends HTTP headers that have variations in capitalization. These requests are sent to a backend control server which send back any data it receives, and if these requests return exactly as we sent them, it

is assumed there is no middlebox present. If the alterations of the headers come back normalized, it can be assumed that there was packet manipulation of some kind, leading to the confirmation of presence of Middleboxes. It is worthy to note that false negatives can happen in this test, as some ISPs use highly sophisticated software that can disguise the presence of Middleboxes (41).

The HTTP Invalid request line test sends an invalid HTTP request to an echo service listening on the standard HTTP port, rather than a valid one. If the request is returned to the user exactly as it was sent, it can be concluded that there is no evidence of the presence of a Middlebox. However, it is possible that this invalid request can be intercepted by a Middlebox that triggers an error that is sent back to the probe. This is evidence that there is a Middlebox present in the network. It is worthy to note that false negatives are possible as some ISPs use highly sophisticated software that is designed not to trigger such errors (42).

### **3.3 Challenges & Limitations**



## 4 | Results and Discussion

## 5 | Security and Privacy

This section addresses security and privacy concerns involved with operating the OONI probe in relation to this work while considering both the technical aspects and the broader legal or regulatory aspects. The comparison of censorship between Ireland and Iraq is significant. While using the OONI probe within both countries comes with its own risk, the use of the probe in Iraq carries much more concern when it comes to security and privacy. The environment in Iraq is significantly more dangerous with ongoing government surveillance, frequent shutting down of social media sites, and the risk of authorities considering unauthorized data-gathering activities as suspicious. All these factors indicate the need to carefully plan where, how, and why measurements are taken, as well as how resulting data will be stored.

### 5.1 OONI

Although OONI strives to minimize the collection of personal data, its measurements are published openly, which may inadvertently disclose approximate locations and times when tests occurred (43). If the individual running OONI is tied to a VM in Iraq with an IP address, local authorities or ISPs might link test activity back to the source. This risk is particularly heightened if the probe is frequently connecting to or testing politically sensitive, banned, or controversial websites. In a high-censorship environment, repeated network tests can attract attention and might be interpreted as an intentional challenge to government policies.

## **5.2 Iraq Virtual Machine**

When deploying a VM in Iraq, the potential security and privacy risk increases due to the possibility that authorities or other outside sources might attempt to compromise the server. The government of Iraq might be motivated to confiscate or check the contents of the VM in order to identify individuals who are actively monitoring sensitive network interference. It is also possible that the hosting provider itself can be forced to give logs, user connections, or site testing targets, which removes all privacy the user has. To avoid this, one should ensure that no personal data is used on this VM, and tools for circumvention are used to encrypt the origin of the user accessing the VM.

Even beyond direct government intervention, there is the risk of third-party hacks or malware injection. A public and well known measurement platform like OONI will attract hackers looking to disrupt users of this tool or introduce malware that will capture all incoming and outgoing traffic. In Iraq, the network infrastructure might already contain middleboxes or deep packet inspection systems that are actively filtering or manipulating data. These devices sometimes disrupt the traffic generated by the OONI probe measurements, leading to manipulated data to be collected.

## **5.3 Legal Risks**

## 6 | Conclusions

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# A1 | Appendix

You may use appendices to include relevant background information, such as calibration certificates, derivations of key equations or presentation of a particular data reduction method. You should not use the appendices to dump large amounts of additional results or data which are not properly discussed. If these results are really relevant, then they should appear in the main body of the report.

## A1.1 Appendix numbering

Appendices are numbered sequentially, A1, A2, A3... The sections, figures and tables within appendices are numbered in the same way as in the main text. For example, the first figure in Appendix A1 would be Figure A1.1. Equations continue the numbering from the main text.