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COMPARING INTERNET CENSORSHIP BETWEEN IRELAND & IRAQ

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Abstract

This work presents a comparative study of internet censorship in Ireland and Iraq. This work is one of many in a series of such comparisons and was completed alongside Chris Casey. Ireland and Iraq have significantly different political structures, legal frameworks, and cultural norms. As a result, internet censorship is implemented differently in both countries. As a member of the European Union, Ireland implements specifically targeted censorship that stems from legal and regulatory compliance. Iraq demonstrates a more decentralized, reactionary approach, often influenced by political instability and internal events. This work aims to research and analyze each country's technical methods, scope, and motivations behind censorship. The work utilizes the Open Observatory of Network Interference (OONI) Probe to collect network data over a nine-day testing period in both countries. Network testing in Ireland was conducted locally using the OONI Command Line Interface Probe, while network testing in Iraq was done through a Virtual Machine hosted in Baghdad. The data collected included testing for website accessibility, evidence of blocked circumvention tools, instant messaging platform availability, and signs of network manipulation through middleboxes.

Results indicate that both countries exhibit instances of website blocking, with Iraq having a slightly higher block rate of 7% compared to Ireland's 2.5%. Blocking methods in both countries include TCP/IP and DNS interference and evidence that TLS / SNI-based filtering may be present in some areas of Iraq. Most of Ireland's blocks are related to illegal content, legal cases, and EU compliance. Iraq's censorship extends to

political, religious, and, most often, communication platforms, as internet blackouts are common in the region during times of unrest or national exams. Both countries showed little evidence of systemic efforts to block circumvention tools, but some areas in both Ireland and Iraq showed significant evidence of Psiphon being blocked.

This work aids in the global effort to raise awareness of internet censorship worldwide. Contributing to projects like OONI is essential, as it helps researchers identify internet censorship trends across certain countries and raises awareness of network interference. Protecting people's digital rights, privacy, and internet freedoms is growing increasingly important as governments and other entities expand their ability to monitor, restrict, and manipulate online information in ways that can undermine democratic values, personal privacy, and global access to information.

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Contents

1 Introduction

1.1 Project Motivations

As the internet became available to more people worldwide, access to digital information became a fundamental principle of democratic engagement and global communication. The concept of humans being able to know precisely what is happening at any time on any part of the globe is very new, and some countries and regimes have pushed back on this idea. This pushback has led to the censorship of information on the internet in some parts of the world. While countries such as China and Iran are known for having extensive censorship mechanisms in place, this work is motivated by the need to examine different types of regimes - Iraq and Ireland, and the comparison of the two.

Ireland, a member of the European Union, uses a censorship model based on limited and specific censorship. Most of Ireland's censorship is rooted in judicial and legal oversight. By contrast, Iraq demonstrates a relatively more reactive approach to censorship, characterized by intermittent shutdowns and varying regional enforcement. These two countries have significant differences in government, culture, and social norms, which offers a unique perspective on how different regimes manage internet freedom.

This project is also motivated by the need for more publicly available empirical data on internet interference. The Open Observatory of Network Interference (OONI) Probe allows real data to be published to further contribute to the analysis of this

work.

1.2 Project Goals

This project aims to conduct a comparative analysis of internet censorship practices in Ireland and Iraq. Using tools such as the Open Observatory of Network Interference (OONI) Probe, this work aims to identify and document the presence, mechanisms, and extent of internet censorship in both countries.

1.3 Internet Censorship and Privacy

1.3.1 Overt vs. Covert Censorship

There are many different ways to implement censorship, but there are two main categories: Overt and Covert Censorship (1). Overt censorship is openly implemented by governments, ISPs, or legal courts to block or restrict access to certain types of content or specific websites. When the content a user tries to access is blocked using overt censorship, it is clear to the user that it is blocked. An example is the 'Golden Shield Project', 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 the government has blocked access to these websites (2).

Covert censorship is 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 for users to detect, and it is often disguised as a technical issue.

1.3.2 Privacy

A meta-analysis of studies on internet privacy concerns, privacy literacy, and the adoption of privacy-protective measures found 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.

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 using security concerns while often violating privacy rights. 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 use the Tor Browser to avoid abuses by the state (4).

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 (5). 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 (6). 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 were also removed from the platform.

1.3.3 Global Censorship

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")" (7). It is also clear that more and more countries view this as a necessary solution to their unique problems.

Whether this is appropriate or not, it is happening, and users should be aware.

Governments are vested in maintaining control over telecommunications industries and public internet use. Whether protecting state secrets, preventing cybercrime 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 the 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 repress online freedoms through censorship and surveillance. As of 2014, 19 governments fit this criterion, but by now, this number has likely increased (8). 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 decentralized and thus allowed for more expression and freedom in the content consumed by a user. As a result, implementing censorship has become more technically complex, yet it may be easier to carry out without detection. Governments leverage network-level filtering and many other techniques to block undesirable content.

2 State of the Art

2.1 Introduction

This section provides 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.

2.2 Censorship Mechanisms

The following section is based primarily on information from the source *RFC 9505 A Survey of Worldwide Censorship Techniques* (9). Any other information sourced from elsewhere is identified as such.

2.2.1 HTTP Blocking

Hypertext Transfer Protocol (HTTP) is an easy-to-implement application-layer censorship mechanism. HTTP request and response header identification are technically straightforward to implement at the backbone or Internet Service Provider (ISP) level. HTTP header identification relies on reading the information contained in the HTTP request from client to server and filtering packets that contain undesirable host names when unencrypted. HTTP response header identification uses the information sent in response by the server to the client to identify undesirable content.

However, HTTP response header identification has become much less effective with the use of Hypertext Transfer Protocol Secure (HTTPS), as HTTPS encrypts the response and its headers. HTTP request header identification has also been hindered by the use of HTTPS, and it is now commonly used with transport layer mechanisms such as deep packet inspection. As a result, evidence of pure HTTP filtering has become much less common as other more advanced mechanisms have been implemented.

2.2.2 IP Blocking

Shallow Packet Inspection

Shallow packet inspection refers to looking at the transport layer segment (packet) headers to implement censorship based on the transparent source, 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 at scale in backbone or ISP routers. It is usually implemented alongside Deep Packet Inspection using middleboxes.

Internet Protocol (IP) blocking is one of the most straightforward censorship techniques but 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, the limited amount of space in a router's flow table 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 overblocking. Because many websites share the same IP address, blocking one IP address can lead to multiple websites being blocked within a network. Censors also sometimes block a range of IP addresses, which can lead to more overblocking.

IP blocking is often ineffective against Content Distribution Networks (CDNs) and services 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. Virtual Private Networks (VPNs) are an excellent tool to circumvent IP blocking as they route the packets through different servers, changing the source and destination IP addresses. This makes it nearly impossible to stop IP-blocked content from getting through, as the source and destination IP addresses can differ for every packet coming from the original blocked source.

IP blocking can be implemented at either a centralized or ISP level. In Ireland, IP blocking is done at an ISP level to block certain illegal websites in accordance with court orders (see section 2.3 for more information). In Iraq, IP blocking is implemented at the ISP level under the directive of the Ministry of Communications (10) (see section 2.4 for more details).

2.2.3 DNS Interference

Domain Name System (DNS) interference refers to altering responses from the DNS to block or filter access to certain content. This is usually done by 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, usually leading to a warning page or a meaningless domain. In other

cases, such as in Iran, the censor can block the upstream resolver's response, so the accurate IP address is never transmitted.

DNS Lying is the most authoritative approach, where a censor mandates that the DNS responses provided differ from what would be returned by the DNS server (9).

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 the censor does not control. This mechanism can also lead to unintentional blocking in areas 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 this, DNS interference is not a very effective censorship mechanism.

2.2.4 Deep Packet Inspection (DPI)

Deep Packet Inspection (DPI) consists 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. However, 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 (9).

2.2.5 Transport Layer Security (TLS)

Transport Layer Security (TLS) is a protocol that secures most web traffic in our modern-day internet. As more internet traffic has become encrypted, the way censorship is implemented has to adapt. When users use circumvention tools such as VPNs or proxy solutions, more common censorship techniques (such as IP blocking

or DNS interference) are often unable to block undesired content sufficiently. As a result, TLS-based censorship became more common as this mechanism can deny access to specific sites or services without decrypting the actual TLS content.

Server Name Indication (SNI) Filtering

SNI Filtering is a widely used form of TLS-based censorship. The SNI is a TLS extension in the client's handshake (ClientHello) that indicates the server's hostname the client wants to reach. In instances of anything up to TLS version 1.3 (assuming no additional encryption extensions are used), the ClientHello is sent in unencrypted plaintext. This allows a censor to read the requested hostname and block the connection if it is on a blocklist (11). Many countries implement this technique, and 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 (12). The Great Firewall of China has *"Long been censoring HTTPS in this manner"* by blocking connections that match forbidden hostnames in the SNI field (13).

The obvious way to circumvent SNI filtering is to encrypt the SNI. In TLS 1.3, this is introduced as encrypted ClientHello (ECH). Before ECH, an extension allowed for the SNI to be encrypted, aptly named Encrypted Server Name Indication (ESNI). However, using ECH or ESNI has led to overblocking as censors simply block all traffic using ECH or ESNI. An example of this can be found again in China, where all ESNI or ECH traffic is blocked.

TLS Fingerprinting

TLS Fingerprinting identifies and blocks tools or protocols that a censor might want to block. The way a TLS ClientHello is structured is like a digital fingerprint that is unique to an application or library. Censors will collect known fingerprints and deploy Deep Packet Inspection rules to block or flag those TLS connections (14). For example, a regime might recognize the unique CLientHello packet of Tor's TLS and

configure the network to drop any matching packets. This technique, which is known to be used in China and Iran, prompted Tor to develop more mimicry in its TLS handshake. Many other circumvention tools followed this example and have since tried to camouflage their TLS handshakes to look more like those of a common browser (14).

2.2.6 Network Blackouts

A very straightforward, holistic, 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 increasingly common across areas in the Middle East and Asia (15). According to a report from *Access Now*, there were 296 internet shutdowns across 54 countries. This is a 35% increase from the previous high in 2022. This form of censorship is very extreme and is often implemented in times of conflict, protest and instability, exams, and elections.

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 (16).

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 worldwide 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 (17).

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 set up a hotline allowing citizens to report websites they suspect anonymously contain illegal content, called hotline.ie (18).

In contrast to other EU countries, Ireland does not have a broad government-mandated filtering system. Instead, the Irish courts have the power 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.

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 (19). After this change, Ireland enacted the *Communications (Retention of Data)(Amendment) Act 2022* (20). This legislation allows for the general and indiscriminate retention of communications traffic and location data on national security grounds, where a judge approves.

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

Ireland has also rolled back blocks on some websites, such as Russian News outlets. Previously, the domain Russia.tv was blocked in Ireland. However, as of 2025, it can 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 can be accessed when EIRCOM's autonomous system (AS5466, IP:

86.47.80.38) is used but is blocked when accessed through Cloudflare's autonomous system (AS14593, IP: 172.69.193.80).

Figure 2.1: Russia.tv website connectivity test from OONI in Ireland

2.3.3 EU Compliance

Aside from Irish legislation, EU directives run in conjunction with the Digital Services Act, GDPR and more. These will be discussed in detail in this section. Let us first establish the primacy of EU law as echoed in the Irish Constitution. "As well as being superior to national law, some EU law directly affects its citizens" (22). The European Commission proposes laws that are sent to the European Commission. Then, the Council of the European Union is to be approved by a qualified majority and passed or rejected (23). This procedure has led to the passing of legislation that affects internet usage in Ireland.

The first law to be discussed is the General Data Protection Regulation (GDPR). This legislation is designed to protect user privacy and bolster data integrity. It highlights the acceptable procedures for handling user data and is used by police organisations. Penalties come in the form of fines, up to 20 million euros (24).

The second law worth mentioning is the Digital Services Act, which came into EU law in November of 2022 and was followed by the Irish law of the same name in 2024 (25) (26). This act addresses illegal content, disinformation and transparent advertising and, thus, is of particular relevance to the research being conducted.

The final example of EU legislation that has undoubtedly shaped internet censorship

in Ireland is the Copyright Directive (2019). This legislation solidifies intellectual copyright law within the EU, providing some edge cases where unrestricted use applies (27). These three important pieces of legislation guide Ireland's internet censorship.

It has been mentioned that compliance is a strong motivation for the Irish government to censor due to EU law primacy. Now, let us focus on some notable real-world examples of legislation being used to censor content online or otherwise reprimand nonconforming organisations. Four high-profile cases of noncompliance will be discussed, as well as the outcomes in each case.

1. Google and the "Right to be Forgotten" (2014) In 2014, the Court of Justice of the European Union (CJEU) ruled in Google Spain SL v. Agencia Española de Protección de Datos. This salient case granted individuals the right to request the removal of outdated personal data from search engine results (28). This landmark ruling was based on the EU's data protection laws. The ruling profoundly impacted how search engines and online platforms handle personal data. As the largest search engine, Google was forced to make stark changes in its browser's operation, reshaping online content management. The decision triggered similar discussions on privacy and free speech, creating a global precedent for data removal requests.

2. YouTube and the EU Copyright Directive (2019) Under the EU Copyright Directive, Article 17 requires platforms like YouTube to prevent uploading copyrighted content without permission (29). This change forced YouTube to implement automatic content filtering systems. This mandated more stringent controls over user-uploaded videos, significantly impacting how online platforms handle user-generated content. Though it aimed to protect copyright holders, it also raised concerns about excessive censorship. Automatic filters could lead to removing legitimate content, raising a significant challenge in balancing copyright protection and free speech.

3. Facebook and the GDPR Fines (2021-2024) In 2021, Meta (formerly Facebook) was

fined €265 million by Ireland's Data Protection Commission (DPC) due to a data breach that exposed the personal information of millions of users (30). The breach was linked to the company's failure to protect user data, violating GDPR standards adequately. Meta has faced many fines from the EU and other regulating bodies. Meta has received fines of over 2 billion euros in 2024 alone (31). This exemplifies the European Union's stringent enforcement of GDPR, which holds companies accountable for safeguarding personal data.

4. Twitter's Noncompliance with the Digital Services Act (DSA) In 2023-2024, Twitter (now X) faced scrutiny under the EU Digital Services Act (DSA) for failing to implement the required measures to combat illegal content and misinformation (32). The platform was given deadlines to comply, including implementing more robust content moderation policies. This case highlighted the increasing regulatory pressure on tech firms to ensure their platforms are safe, free of illegal content, and accountable for user actions. Previously, X withdrew from a voluntary agreement to combat disinformation online. Despite this protest in the face of the Digital Services Act, legislators quickly pointed out that X must still comply with EU standards (33).

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 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 (34). 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 more significant 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 (10).

Historically, most of Iraq's censorship was implemented via DNS interference and IP Blocking. In 2014, a Citizen Lab test found around 20 URLs that were blocked, likely by DNS interference, and displayed a government block page (35). In these tests, when users tried to visit a banned site, they either got an incorrect DNS resolution or their HTTP request was outright blocked. In 2014, TLS usage was much lower, so DNS and IP blocking were more effective than today.

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. However, primary fiber routes and gateways that link Iraq to international submarine cable networks via adjacent countries are still controlled by the Ministry of Communications (36). Baghdad, the country's capital and commercial centre, is a hub of national connectivity, and other large cities (like Basra and Mosul) typically have local backbones that connect to the national fibre 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 (10).

A 2023 report from the United States Department of State found that Iraq's government restricted or disrupted internet access and censored online content in conjunction with monitoring private online communications without appropriate legal authority (37). The Iraqi government and the Kurdistan Regional Government (KRG) consistently engage in implementing internet outages during protests or times

of unrest (10). In 2023, Iraqi officials implemented 66 internet outages, more than any other country worldwide. It is worth noting that another organization, *Access Now* (38), reports a different number for Iraq this year, and their data often conflicts with the data from *FreedomHouse*.

After the fall of Saddam Hussein's Regime in 2003, the internet became much more accessible, and the information landscape was opened. However, the current Iraqi government occasionally blocks websites, and more often social media websites, to maintain stability and control during times of unrest (10). 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 (10). The government routinely engages in the censoring and blocking of Pornography and Gambling websites in the guise of protecting their citizens from harmful content.

Based on a CloudFlare analysis of internet shutdowns in Iraq during national exams in 2022-2023, it was found that instead of complete shutdowns, Iraq would instead employ IP Blocking, SNI/HTTP-based filtering, and DNS interference (39). This shows that Iraqi authorities can implement TLS or SNI-based filtering. It is important to note that Iraq's censorship framework is not as technologically entrenched or constant as China's or Iran's. A 2022 Freedom House report states that *"advanced automated censorship is not used outside the banking sector in Iraq"* (10). So, until 2022, Iraq did not have an automated censorship system that monitors all traffic.

However, Iraq has been moving toward a more formal and structured censorship system in recent years. In 2023, the Iraqi government announced plans to block Google's public DNS (8.8.8.8) and instead force users to use state-run DNS resolvers (40). The stated reason was to block "immoral" websites by domain name lookups. However, as it stands right now, while Iraq engages in internet censorship, it is much more a reactive approach than a proactive one.

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 project's goal 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 (41). Initially, the United States Government used the Tor network to access potentially illegal websites anonymously and transmit data. However, 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 sent over the network was related to the United States Government/Military.

To prevent this, 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 US 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 the 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. The Tor browser sends the data through at least three nodes, and the pathway of these nodes is randomly constructed and reconstructed during the user's session (42).

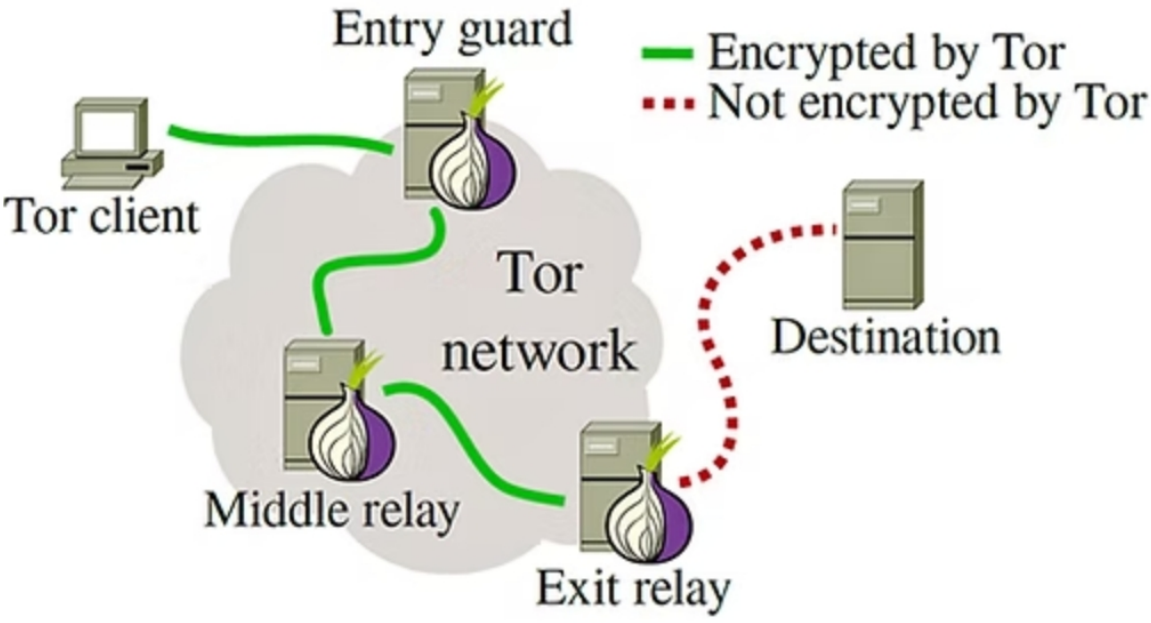

Figure 2.2: How the Tor Network Works (43)

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 can use "Bridges", which are Tor nodes not listed publicly. A bridge address allows the user to connect to the network covertly (44). 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 (45).

2.5.2 Virtual Private Networks (VPNs)

Virtual Private Networks provide an end-to-end encrypted connection between your device and a VPN server. This method hides the user's IP address and grants the user anonymity while browsing over the network. This allows users to bypass censorship by connecting to servers outside their location while masking their IP address (46).

2.5.3 Proxies

A proxy server is similar to a VPN as it fetches content on behalf of a user. When using a proxy, a user can request blocked content via a server in a non-censored region. From the perspective of the censor, the user is only connecting to the proxy server (which is ideally not blocked) and not the actual blocked content. For example, when *The Pirate Bay* was blocked by EIRCOM in Ireland in 2009 by court order, the website was still accessible via proxy servers (47).

2.5.4 Psiphon VPN

Psiphon is an open-source internet censorship circumvention tool developed at the Citizen Lab at the University of Toronto. It uses a combination of VPN, Secure Shell (SSH), and Proxy techniques to give users unfiltered access to the Internet (48). The tool works by attempting to establish a secure tunnel through its distributed network of servers. Once a connection is established, internet traffic is routed through the Psiphon infrastructure. This method circumvents network-level censorship mechanisms such as IP Blocking, DNS Interference, and some forms of Deep Packet Inspection.

The Open Observatory of Network Interference (OONI) Probe has a built-in function to test whether the Psiphon tool is blocked within a given network.

3 Methodology

3.1 The OONI Probe

3.1.1 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 (49). The OONI organization openly publishes measurements and provides a public archive on network interference worldwide.

3.1.2 OONI Probe Data-Collection

Web Connectivity Test

The Web Connectivity test determines if and how access to a specific website may be blocked. To do this, the OONI Probe performs several checks on 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 four different actions: Resolver Identification, DNS Lookup, Transmission Control Protocol (TCP) Connect, and 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 (50).

Circumvention Test

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

The Psiphon VPN serves as a tunnel that enables users to circumvent censorship by connecting them to an uncensored portion of the internet (48). The Psiphon test first uses Psiphon's code to establish a Psiphon tunnel. After the tunnel is created, the test loads a webpage to see if Psiphon succeeds in accessing the internet. If the tunnel is successfully set up and the webpage loads, Psiphon functions 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 (51).

The Tor Test (52) automatically checks whether Tor is accessible in a given network by examining the reachability of core components such as Tor directory authorities, Onion Router (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 unavailable on that network (53).

Instant Messaging Test

The Instant Messaging test checks 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. The OONI probe attempts to perform an HTTP GET request, TCP Connection and DNS lookup to WhatsApp's endpoints. These include the endpoints the WhatsApp mobile app uses, the registration service, and the web interface (54). The OONI probe attempts to open TCP sockets towards WhatsApp endpoints on Ports 443 and 5222 to conduct these tests. 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 registered to WhatsApp. If the resolved IP address does not belong to WhatsApp, it can indicate DNS level blocking or tampering. An HTTP GET request is sent to the URL `https://v.whatsapp.net/v2/register` to check if the WhatsApp registration service is working correctly. The request is considered successful if there is no DNS, TCP connect, TLS, or I/O error (55).

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 (56). The test verifies if Facebook Messenger endpoints resolve to consistently known IPs and if it is 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) (57).

The Telegram Test examines 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 have six unique IP addresses. The test establishes a TCP connection to all access point IP addresses and attempts to send a POST HTTP request to each. If all TCP connections on ports 80 and 443 fail, Telegram is

considered blocked at the TCP level. Otherwise, Telegram is considered to be working as intended (58).

The Signal Test measures 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 (59). A DNS query to `uptime.signal.org` is also performed to check if the backend servers are down (60).

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. Middleboxes can lead to evidence of censorship and/or traffic manipulation, but they can also indicate less malicious intent, such as network caching.

The OONI Middlebox test consists of two primary 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 with capitalization variations. These requests are sent to a backend control server, which sends back any data it receives, and if these requests return exactly as they were sent, 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, which confirms the presence of Middleboxes. It is worth noting that false negatives can happen in this test, as some ISPs use highly sophisticated software that can disguise the presence of Middleboxes (61).

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, this invalid request can be intercepted by a

Middlebox that triggers an error that is sent back to the probe. This is evidence that a middlebox is present in the network. It is worth noting that false negatives are possible as some ISPs use highly sophisticated software designed not to trigger such errors (62).

3.1.3 Test Versions

The table below shows the version of each tech used to carry out this work.

Table 3.1: OONI Probe Test Versions at the Time of this work

Test Name	**Version**
OONI Probe Engine	v3.23.0
Web Connectivity Test	2024-02-14-001
Tor Test	2022-06-13-001
Psiphon Test	0.3.4
Facebook Messenger Test	2016-10-25-001
WhatsApp Test	2022-12-07-001
Signal Test	2023-12-01-001
Telegram Test	2022-12-07-001
HTTP Header Field Manipulation Test	0.2.1
HTTP Invalid Request Line Test	1.0.0

3.1.4 OONI Data Transparency

All results from OONI Probe tests are automatically sent to OONI's servers and published on the OONI explorer. This transparency ensures that anyone can explore the measurements for themselves. OONI aggregates measurements by country, time, and type of test. It highlights "confirmed" cases of blocking when there is strong enough certainty in the test result, but it also publishes anomalies that might be considered false positives.

The OONI team also works to release comparative analyses and real-time alerts for significant internet censorship-related events. These would include events such as a sudden surge in social media blockage or a complete drop in internet traffic in certain

areas. The OONI Measurement Aggregation Toolkit (MAT) can be used to visualize these events and identify emerging trends.

3.2 OONI Probe Methodology

Ireland

The OONI CLI was installed on a MacBook Air M2 located in Ireland to collect network data in Ireland. The OONI probe was installed based on the CLI instructions on the OONI website (63). The OONI probe, by default, does not run automatic tests on the Mac version of the CLI, and this was manually enabled during the installation process. All tests run in Ireland used the providers HEAnet CLG (AS1213) and Liberty Global B.V. (AS6830).

Iraq

To collect network data in Iraq, a Virtual Machine was set up using the provider *LightNode* (64) on a cloud server located in Baghdad. The cloud server was running the Linux Ubuntu version 20.04.3 LTS. The OONI probe was installed using the CLI instructions on the OONI website (63). By default, the OONI probe runs censorship tests in the background once per day, saves that data in a specific directory, and publishes the data publicly. All tests run in Iraq were using the provider Kaopu Cloud HK Limited (AS138915)

Overlapping Information

In addition to these automated tests, manual tests were conducted once per day to collect data. The OONI CLI user guide provided the specific commands to carry out these tests and how to run tests on specific files or test sets (65). The first and second days of the data collection period used the comprehensive OONI test suite, which ran every test available, including 2200 websites. This broad test suite was used to identify blocked websites that could be added to a smaller test set of websites.

Following the initial testing, a set of 127 websites was collected. This test set included blocked websites from the broad OONI test set, some websites from the most known blocked websites worldwide (66), the top 50 most visited websites in Ireland (67), and the top 50 most visited websites in Iraq (68). This test set was used in both countries for 9 days.

Each website in the list was categorized. The number of websites in each category is shown in the table below.

Table 3.2: Number of Websites in Each Category

Category	**Number of Websites**
Uncategorized	30
Piracy / Streaming / File Sharing	20
News / Media	20
Adult Content	20
Creative / Educational / Misc	15
General / National Services	9
Streaming / Social Media	9
Religious	4
VoIP / Communication	2
Gambling	2
Email/Privacy Tools	2
Adult / Alcohol	2
LGBTQ+	1
AI / Technology	1

To parse the OONI data, a Python script was written that took in the raw bash/cmd output and organized the test results into a neatly formatted CSV file. This made data analysis much easier to complete. Each of the four main tests was recorded as raw bash/cmd output and parsed into CSV files for analysis. All results and OONI links are available on this project's public GitHub Repository, which can be found in the appendix of this report.

3.3 Challenges & Limitations

While the OONI probe and its tests give a good baseline of internet censorship in a country, it may be difficult to draw definitive conclusions based on these tests alone. The list of websites used in this work, while tailored to fit these two countries, still has massive gaps and may not show the entire picture of what content is blocked in each country. As of 2024, there are about 200 million active websites on the internet (69). Testing every single one in both countries would provide a much more comprehensive view and potentially more concrete results, but this approach is not practical. Therefore, this work is limited in its actual data collection, but conclusions can still be reached with the aid of past data and known censorship environments.

4 Results and Discussion

The data and discussion of results below combine data gathered using the OONI probe in Ireland and Iraq with published OONI data from the OONI Measurement Aggregation Toolkit (MAT).

4.1 Test Results

4.1.1 Website Accessibility Results

Collected Data

This section analyses website accessibility data collected using the OONI Probe. Tests were conducted locally in Ireland and through a virtual machine (VM) hosted in Iraq. The results reflect the average number of websites blocked daily over a 9-day testing period. The findings are categorized by country, blocking method, and website category to highlight differences in censorship patterns.

Table 4.1: Proportion of Blocked vs. Unblocked Websites by Country (Daily Average Over 9 Days)

Country	Unblocked	Blocked	Blocked (%)
Ireland	105	32	23.4%
Iraq	108	29	21.2%

Despite expectations of greater censorship in Iraq, the average number of blocked

websites per day was relatively similar between the two countries, with Ireland showing a slightly higher blocking percentage.

Table 4.2: Distribution of Detected Blocking Methods by Country

Blocking Method	Iraq Frequency	Iraq %	Ireland Frequency	Ireland %
TCP/IP	18	60.0%	15	55.6%
DNS	1	3.3%	6	22.2%
HTTP	3	10.0%	1	3.7%
Error/Failure	8	26.7%	5	18.5%

TCP/IP blocking emerged as the most common method, indicating low-level network interference. Ireland had more cases of DNS-based blocking than Iraq, whereas HTTP and Error/Failure blocks were more evenly distributed.

Table 4.3: Number of Blocked Websites by Category and Country

Category	Total	Ireland Blocked (%)	Iraq Blocked (%)
Uncategorized	30	12 (40.0%)	10 (33.3%)
Piracy / Streaming / File Sharing	20	10 (50.0%)	4 (20.0%)
News / Media	20	2 (10.0%)	2 (10.0%)
Adult Content	20	0 (0.0%)	0 (0.0%)
Creative / Educational / Misc	15	0 (0.0%)	0 (0.0%)
General / National Services	9	1 (11.1%)	2 (22.2%)
Streaming / Social Media	9	1 (11.1%)	1 (11.1%)
Religious	4	2 (50.0%)	3 (75.0%)
VoIP / Communication	2	1 (50.0%)	1 (50.0%)
Gambling	2	2 (100%)	2 (100%)
Email/Privacy Tools	2	0 (0.0%)	1 (50.0%)
Adult / Alcohol	2	0 (0.0%)	2 (100%)
LGBTQ+	1	1 (100%)	1 (100%)
AI / Technology	1	0 (0.0%)	0 (0.0%)

The most frequently blocked category in Ireland was “Piracy / Streaming / File Sharing” (50%), followed closely by “Uncategorized” sites (40%). In Iraq, “Religious” websites experienced the highest rate of censorship (75%), with additional blocks

targeting sites associated with adult content and gambling.

Public OONI Data

This section is an analysis of publicly available OONI data over the previous 30 day period in Ireland and Iraq. The data in table 4.4 is the average over the 30-day period.

Table 4.4: Website Blocking based on Public OONI Data

	Ireland	**Iraq**
Number of Websites Tested	1695	3703
Number of Successful Connections	1628	3353
Number of Anomalies	43	262
Number of Failures	24	88
Percentage of Total Blocked	2.5%	7%

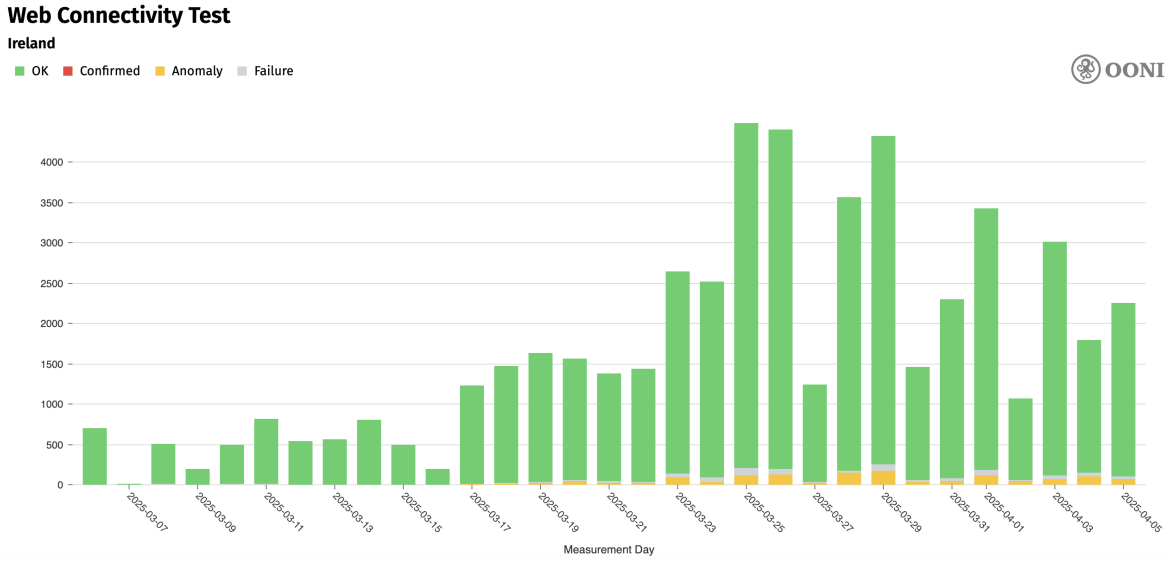

Figure 4.1: Ireland Web Connectivity Test: March 6, 2025 – April 6, 2025

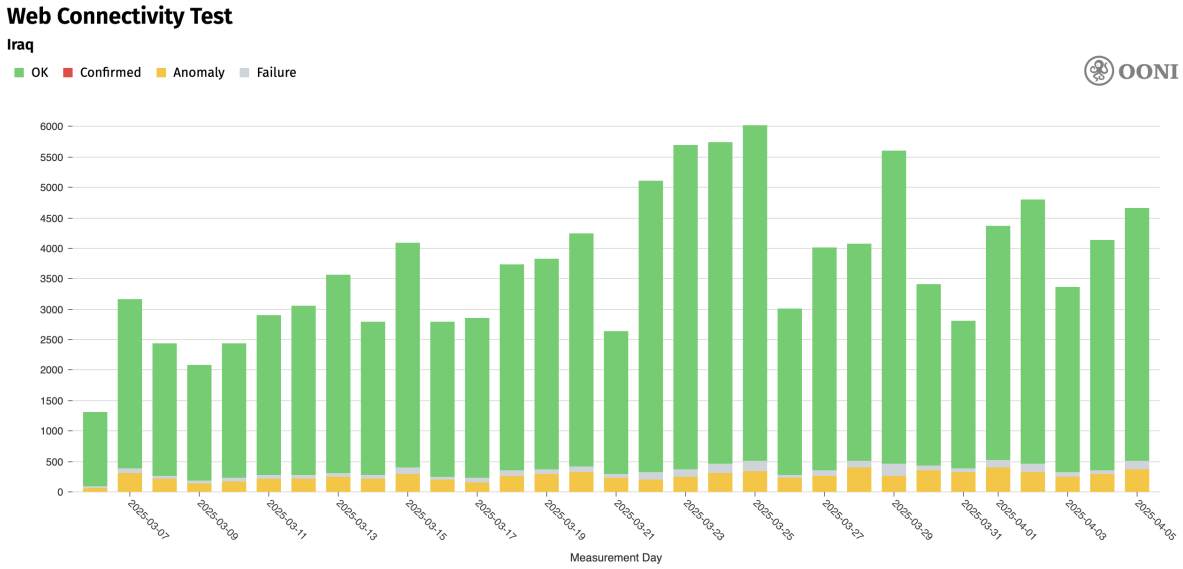

Figure 4.2: Iraq Web Connectivity Test: March 6, 2025 – April 6, 2025

4.1.2 Circumvention Test Results

Ireland

Ireland likely does not block Tor on any ASNs, as it is largely accessible outside two anomalies.

March 18, 2025 - Magnet Networks Limited (AS34245) - Tor Test (1 anomaly out of 78 measurements)

March 31, 2025 - Liberty Global B.V. (AS6830) - Tor Test (1 anomaly out of 191 measurements)

Outside of these two anomalies, there is no evidence that Tor is being blocked in Ireland.

Psiphon, on the other hand, yielded different results. While Psiphon was largely able to be accessed on most ASNs, there were a few where access was likely blocked.

Table 4.5: Networks in Ireland with Evidence of Psiphon Blocking

Network Name	ASN	Psiphon Blocking Events	Total Measurements	Block Rate (%)
Microsoft Corporation	AS8075	1	1	100%
HEAnet Ltd.	AS1213	33	35	94%
O2 Ireland Ltd.	AS13280	8	12	66%
Vodafone Ireland Ltd.	AS15751	1	9	11%
Liberty Global B.V.	AS6830	16	215	7.4%
Total		**59**	**494**	**12.1%**

Note: "Psiphon Blocking Events" represent detected anomalies during testing of the Psiphon circumvention tool. "Block Rate" indicates the percentage of measurements that showed blocking behavior.

Iraq

Like Ireland, Iraq does not block access to Tor, except for a few outliers.

March 20, 2025 - Super Cell Network for Internet Services LTD (AS209193) - Tor Test (1 anomaly out of 92 measurements)

March 30, 2025 - Hulum Almustakbal Company for Communication Engineering and Services Ltd (AS203214) - Tor Test (2 anomalies out of 160 measurements)

March 30, 2025 - Valin Company for General Trading and Communications LTD (AS205254) - Tor Test (1 anomaly out of 17 measurements)

Outside of these anomalies, no significant evidence exists that Tor is being blocked in Iraq.

There is also little evidence of Psiphon being blocked in Iraq significantly. Aside from a few outliers, Psiphon only seemed to be blocked on one ASN.

Table 4.6: Networks in Iraq with Evidence of Psiphon Blocking

Network Name	ASN	Psiphon Blocking Events	Total Measurements	Block Rate (%)
HulumTele	AS203214	127	165	77%
NB Telecom	AS208324	1	3	33%
AsiaCell Telecom	AS51684	4	23	17%
Valin Co LTD	AS205254	1	30	3.3%
Earthlink Telecom	AS199739	1	352	0.2%
Total		**134**	**1107**	**12.1%**

Note: "Psiphon Blocking Events" refer to instances where the Psiphon circumvention tool exhibited signs of interference. "Block Rate" is calculated as the percentage of blocked measurements over the total measured on each network.

4.1.3 Instant Messaging Test Results

The results of the Instant Messaging tests were very similar in Ireland and Iraq. Both tests showed no signs of interference or blocking of Facebook Messenger, Telegram, Whatsapp, or Signal. However, looking outside the tested ASNs reveals a significant difference between the two countries. The tested data in Ireland is consistent with public OONI data and shows no blocking of instant messaging platforms. The Iraq data is also consistent with tests run on the same ASN, but in Iraq, other ASNs show signs of blocking.

Ireland

In the past 30-day period, there were only 2 anomalies found that shows any kind of instant messaging blocking:

March 24, 2025 - Packethub S.A. (AS136787) - Facebook Messenger Test (1 anomaly out of 3 measurements)

March 24, 2025 - HEAnetCLG (AS1213) - Signal Test (1 anomaly out of 37 measurements)

Outside of these anomalies, there was no evidence of instant messaging

blocking.

Iraq

Iraq had significant evidence of instant messaging platforms being blocked in certain ASNs. The table below shows each ASN and the percentage of tests where an anomaly was found.

Table 4.7: Networks in Iraq with Evidence of Instant Messaging Platform Blocking

Network Name	ASN	Facebook Block Rate	Telegram Block Rate	WhatsApp Block Rate	Signal Block Rate
CIT Co LTD	AS212330	100%	0%	0%	0%
KNET	AS206206	60%	0%	0%	0%
Cloudflare, Inc.	AS13335	47%	0%	0%	0%
Earthlink Telecom	AS50710	33%	0%	0%	0%
HulumTele	AS203214	27%	7.8%	25%	44%
Valin Co LTD	AS205254	26%	3.8%	7.6%	7.6%
Al-Nazeera Co.	AS51020	0%	0%	0%	32%
Noor Al-Bedaya Co.	AS202651	0%	0%	0%	23%
TLLG Co.	AS210022	0%	0%	0%	82%
Al Atheer Co. LTD	AS59588	0%	0%	1.9%	1.9%
Earthlink Telecom	AS199739	1%	0.5%	0.2%	0.8%
Super Cell	AS209193	0%	0%	0.7%	0%
Total Block Rate		**6.2%**	**1.4%**	**4.1%**	**6.2%**

Note: Each percentage reflects the proportion of measurements on the respective network where blocking behavior was detected for a specific instant messaging platform. The platforms analyzed include Facebook Messenger, Telegram, WhatsApp, and Signal.

4.1.4 Middlebox Test Results

The results of the Middlebox Test were the same for both countries. Both the HTTP Header Field Manipulation and HTTP Invalid Request Line tests detected no Middleboxes in either country. However, while there was no evidence of Middleboxes being found using the providers tested, it is possible that other providers in both countries have Middleboxes present in the network.

Using publicly available OONI data for Ireland and Iraq, it was found that Middleboxes were detected in both countries over the past 30 days (March 6, 2025 - April 6, 2025).

Ireland

There is very little evidence of Middleboxes in Ireland. Over the past 30-day period, only two anomalies have been present. Both of these anomalies are from the HTTP Invalid Request Line test.

March 25, 2025 - Meteor Mobile Communications Ireland (AS15751) (1 anomaly out of 9 measurements)

April 1, 2025 - Vodafone Ireland Limited (AS15502) (1 anomaly out of 79 measurements)

These results are likely outliers, as there were very few Middlebox tests for Meteor Mobile Communications Ireland during this time span and no other anomalies for Vodafone Ireland Limited.

Iraq

There is considerably more evidence of Middleboxes in Iraq. Over the past 30 days, there were 125 anomalies in the HTTP Invalid Request line Test and 19 anomalies in the HTTP Header Field Manipulation Test.

The table below lists the ASNs suspected to have Middleboxes present using the HTTP Invalid Request Line test. It then shows the number of anomalies, the total measurement count, and the percentage of the total count that was anomalies.

Table 4.8: Networks in Iraq with Evidence of Middleboxes (HTTP Invalid Request Line Test)

Network Name	ASN	Detected Events	Total Measurements	Block Rate (%)
EarthLink Ltd.	AS50710	1	1	100%
Al-Jazeera Co.	AS198589	68	70	97%
Cloudflare, Inc.	AS13335	8	10	80%
IQ-Online	AS48492	2	4	50%
Al Atheer Co. LTD	AS59588	13	53	24.5%
HulumTele	AS203214	32	158	20.25%
Total		**125**	**1071**	**11.6%**

Note: This table presents results from the HTTP Invalid Request Line Test. "Detected Events" refer to anomalies suggesting the presence of network middleboxes. "Block Rate" is the percentage of such events relative to the total measurements per ASN.

The table below lists the ASNs suspected to have Middleboxes present using the HTTP Header Field Manipulation test. It then shows the number of anomalies, the total measurement count, and what percentage of the total count were anomalies. Note that any ASN that had less than 0.5% anomalies was ignored.

Table 4.9: Networks in Iraq with Evidence of Middleboxes (HTTP Header Field Manipulation Test)

Network Name	ASN	Detected Events	Total Measurements	Block Rate (%)
EarthLink Ltd.	AS50710	1	1	100%
Cloudflare, Inc.	AS13335	8	10	80%
IQ-Online	AS48492	2	4	50%
Total		**11**	**15**	**1.7% of full dataset (1074)**

Note: This test detects potential middleboxes by observing anomalies in how HTTP header fields are processed. "Detected Events" are instances of irregular responses, possibly caused by network interference. "Block Rate" indicates the ratio of these events to total measurements per ASN.

Note: All CSV files gathered from the public OONI database can be found on the public GitHub for this work; see Appendix A1.2.

4.2 Comparative Analysis: Ireland v. Iraq

The combined results of OONI probe testing and public OONI data reveal differences in censorship between Ireland and Iraq. While both countries implement content restrictions and other blocks, there are significant differences in the scale and motivations behind these blocks.

Website Accessability

The manually run web connectivity test yielded unexpected results. The proportion of blocked websites in both countries was similar, with Ireland having a slight edge over Iraq. This was unexpected, but because these tests were run manually on only one or two networks in each country, these results may only give a partial view of the country's Internet censorship. The results become more expected when looking at the publicly available OONI data. In the 30 days, Iraq blocked significantly more websites than Ireland and at a higher rate. Of the 3703 websites tested in Iraq, 262 had anomalies (7% blocking rate), while of the 1695 websites tested in Ireland, only 43 had anomalies (2.5% blocking rate). Looking at the figures, it is clear that Iraq blocks more content and on a more consistent basis than Ireland.

The blocking rates of websites by category reveal more expected results. Ireland blocked significantly more Piracy / Streaming / File Sharing websites outside of uncategorized websites than Iraq, which aligns with Ireland's court-mandated approach to censorship. Conversely, Iraq blocked a wider range of content by category, with a significant blocking rate of religious websites (75%).

TCP/IP blocking was the top blocking method in both countries, indicating simple censorship mechanisms. Ireland, however, had a significantly higher rate of DNS blocking, which is likely due to its approach to targeted website blocking and EU compliance.

Circumvention Tools

The accessibility of Tor and Psiphon was essentially the same in Ireland and Iraq, with a few exceptions. Tor was widely accessible in both countries, indicating that Ireland and Iraq have no significant mechanisms to block this tool. If they do, there is no evidence that it is effective. There is evidence that Psiphon is blocked on specific ASNs in both countries, with public OONI data backing this up. In Ireland, Psiphon is blocked on HEAnet CLG (AS1213), as indicated by manually tested and public data. Over the same 30-day period, Ireland and Iraq blocked Psiphon 12.1% of the time. As a result, there is little evidence of systemic efforts to block access to Psiphon, similar to Tor.

Instant Messaging Platforms

In Ireland, there is no evidence that instant messaging services are blocked meaningfully. This is in line with Ireland's stance on censorship and was expected. In Iraq, however, there is evidence that instant messaging services are blocked in some areas, but according to public OONI data, they are widely accessible. Some ASNs had implemented blocks on all four services tested to some capacity, indicating regional blocking in response to specific events. This is aligned with Iraq's more reactionary censoring practice.

Presence of Middleboxes

The use of Middleboxes in Ireland was almost non-existent, as there were only two anomalies over the 30-day period. These were likely false positives. This data indicates that Ireland does not implement TLS or SNI-based filtering systematically or widely. By contrast, Iraq showed significant evidence of Middleboxes being present. AS198589 showed significant signs of Middleboxes being present, and other ASNs have significant anomalies. This indicates that Iraq may implement TLS or SNI-based filtering in some areas of the country, which makes sense as we know that much of Iraq's current censorship efforts are decentralized.

4.2.1 Summary of Comparative Observations

Table 4.10: Comparative Summary of Internet Censorship: Ireland vs. Iraq

Metric	Ireland	Iraq
Block Rate (OONI)	2.5%	7%
Blocking Methods	TCP/IP, DNS	TCP/IP, DNS, SNI
Tool Blocking	Rare, selective	Targeted, ASN-specific
Messaging Blocking	Negligible	Present on some ASNs
Middleboxes Detected	Minimal	Present on some ASNs
Motivations	Legal, EU compliance	Political, cultural control

These findings support the initial research, showing that Ireland and Iraq have different censorship approaches. Ireland maintains a limited, legal-centric censorship model that is transparent and aligned with most other Western nations. Iraq's approach, while less centralized, is more reactive and inconsistent, often tied to internal events.

4.2.2 Future Work

During this work, it became clear that exporting detailed public OONI data for web connectivity tests would be difficult. This public data would have provided more detailed insights into the differences between Ireland and Iraq. Future research could gather this data using the OONI public API to build upon this work. Using this API would allow for the automated collection of web connectivity data in Ireland and Iraq, giving the writer a broader foundation for comparison. This data would include blocking types, website categories, and ASN information.

Incorporating this public OONI data would facilitate a more holistic analysis of each country, as manual testing is only limited to one geographical location. This work shows that OONI tests yield different results in different regions of both countries, so relying solely on manually collected web connectivity data only gives a partial view of a country's current internet censorship.

5 | Security and Privacy

The following section contains information on the privacy and security concerns of completing the dissertation. This was completed as an assignment in the CSU44302 Security and Privacy module. In writing a dissertation, it is crucial to consider the potential impacts of the research. This document discusses the security and privacy concerns associated with researching internet censorship.

This section addresses security and privacy concerns involved with operating the OONI probe about this work while considering both the technical and 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 risks, using the probe in Iraq carries much more concern regarding 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 and 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 (70). 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 frequently connects to or tests 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.

The claim emphasizes their positive track record: "To our knowledge, no OONI Probe user has ever faced consequences as a result of using our software."(70). The success of OONI is critically dependent on users conducting tests without repercussions. However, OONI outlines several scenarios where running their probe may be unwise. This includes users residing in countries with a history of prosecuting similar activities, surveillance concerns, or legal restrictions on accessing content. Users in one or more categories should be wary of the potential risks. In this context, operating in Ireland with no reason to believe I am under surveillance, I am considered a low-risk user.

5.2 Iraq Virtual Machine

When deploying a VM in Iraq, the potential security and privacy risk increases because 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 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, third-party hacks or malware injection is risky. 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 actively filtering or

manipulating data. These devices sometimes disrupt the traffic generated by the OONI probe measurements, leading to manipulated data being collected.

6 | Conclusions

This work set out to research and compare internet censorship practices in Ireland and Iraq. These two nations have significantly different governments and cultures. By using both direct network testing and published OONI data, this work has identified the distinct methods and motivations behind censorship in each country.

As a member of the European Union, Ireland implements a limited and legally rooted censorship model. Ireland mainly blocks illegal and pirated content, which is implemented through the country's legal system or EU compliance. The OONI data shows little evidence of widespread censorship of non-illegal content, no use of advanced censorship methods like TLS / SNI-based filtering, and no efforts to block circumvention tools.

Iraq implements a more decentralized and reactionary censorship model, blocking a wider range of content than Ireland. The Iraqi government is known to shut off internet access during unrest or national exams in parts of the country. The OONI data shows evidence of TLS/ SNI-based filters in specific parts of the country, but no evidence supports the widespread implementation of these advanced mechanisms. Additionally, there is some evidence that circumvention tools, such as Psiphon, are being blocked in some areas, but there is nothing to support widespread efforts to block these tools. These findings point to regional and situational censorship, driven by political or cultural events rather than being rooted in a legal basis.

This comparative analysis contributes to the growing importance of digital rights

and government accountability using empirical data and structured analysis. The importance of projects like OONI is that they allow people to learn about the presence and nature of internet censorship in their own countries and allow researchers to identify global trends and document network interference. As the internet continues to grow in importance to civil discourse, education, and access to information, vigilance against censorship becomes foundational.

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A1 Appendix

To aid in the writing of this work, additional tools were used to ensure clarity, presentation, correctness, and structure.

ChatGPT ChatGPT was used to assist in structuring the content of this thesis, and in the naming of chapters and sections. It was also used to help generate tables in Latex, and check for spelling and grammar mistakes. ChatGPT also assisted in parsing data collected by the OONI Probe.

Grammarly Grammarly was used to check for spelling and grammar mistakes throughout the entire thesis.

Overleaf Overleaf was used to write and generate the final thesis.

GitHub GitHub was used to store all data related to this project. The public link to this GitHub is `https://github.com/ccasey300/censorship_project`.

This work was completed alongside Chris Casey, and some sections of this report were authored by him. These sections include, 1.3.1, 1.3.3, and 2.3.3.

A1.1 List of Websites

The list of websites used in the OONI Probe web connectivity test can be found below

Website URL	Category	Website	Category2
http://www.absinth.com/	Adult / Alcohol	https://www.galwaybeo.ie/	News / Media
https://www.literotica.com/	Adult / Alcohol	https://www.deviantart.com/	News / Media
https://www.xvideos.com/	Adult Content	https://www.foxnews.com/	News / Media
https://www.xhamster.com/	Adult Content	https://www.russia.tv/	News / Media
https://www.xnxx.com/	Adult Content	https://www.rt.com/	News / Media
https://www.arabshentai.com/	Adult Content	http://www.utorrent.com/	Piracy / Streaming / File Sharing
https://www.xnxx-arabic.com/	Adult Content	https://www.rarbg.to/	Piracy / Streaming / File Sharing
https://www.hentaislayer.net/	Adult Content	http://www.bitcomet.com/	Piracy / Streaming / File Sharing
https://www.xhexperience.xyz/	Adult Content	https://thepiratebay.org/	Piracy / Streaming / File Sharing
https://www.theporndude.com/	Adult Content	https://libgen.me/	Piracy / Streaming / File Sharing
https://www.xvideos-ar.com/	Adult Content	https://libgen.life/	Piracy / Streaming / File Sharing
https://www.arabx.cam/	Adult Content	https://kickasstorrents.to/	Piracy / Streaming / File Sharing
https://www.sexalarab.com/	Adult Content	https://kat.am/	Piracy / Streaming / File Sharing
https://www.spankbang.com/	Adult Content	https://www.bittorrent.com/	Piracy / Streaming / File Sharing
https://www.redtube.com/	Adult Content	https://www.lekmanga.net/	Piracy / Streaming / File Sharing
https://www.onlyfans.com/	Adult Content	https://www.shabakaty.com/	Piracy / Streaming / File Sharing
https://www.youporn.com/	Adult Content	https://www.kurdcinama.com/	Piracy / Streaming / File Sharing
https://www.rule34.xxx/	Adult Content	https://www.kurdsubtitle.net/	Piracy / Streaming / File Sharing
https://www.redgifs.com/	Adult Content	https://www.like-manga.net/	Piracy / Streaming / File Sharing
https://www.stripchat.com/	Adult Content	https://www.topcinema.cam/	Piracy / Streaming / File Sharing
https://www.porn.com/	Adult Content	https://www.egydead.fyi/	Piracy / Streaming / File Sharing
https://www.beeg.com/	Adult Content	https://www.witanime.cyou/	Piracy / Streaming / File Sharing
https://www.chatgpt.com/	AI / Technology	https://www.lodynet.io/	Piracy / Streaming / File Sharing
https://www.chess.com/	Creative / Educational / Misc	https://www.kurdfilm.krd/	Piracy / Streaming / File Sharing
https://www.wattpad.com/	Creative / Educational / Misc	https://www.zoro.to/	Piracy / Streaming / File Sharing
https://www.lichess.org/	Creative / Educational / Misc	http://www.oic-oci.org/	Religious
https://www.9gag.com/	Creative / Educational / Misc	http://www.islamdoor.com/	Religious
https://www.fanfiction.net/	Creative / Educational / Misc	https://nazarene.org/	Religious
https://www.artstation.com/	Creative / Educational / Misc	http://alhikmae.com/	Religious
https://www.furaffinity.net/	Creative / Educational / Misc	https://www.reddit.com/	Streaming / Social Media
https://www.poki.com/	Creative / Educational / Misc	https://www.dailymotion.com/	Streaming / Social Media
https://www.creepypasta.com/	Creative / Educational / Misc	https://www.live.com/	Streaming / Social Media
https://www.etsy.com/	Creative / Educational / Misc	https://www.netflix.com/	Streaming / Social Media
https://www.vimeo.com/	Creative / Educational / Misc	https://www.discord.com/	Streaming / Social Media
https://www.pixiv.net/	Creative / Educational / Misc	https://www.twitch.tv/	Streaming / Social Media
https://www.opera.com/	Creative / Educational / Misc	https://www.omegle.com/	Streaming / Social Media
https://www.wikipedia.com/	Creative / Educational / Misc	https://www.bilibili.com/	Streaming / Social Media
https://www.mozilla.org/	Creative / Educational / Misc	https://www.vk.com/	Streaming / Social Media
https://app.simplelogin.io/	Email/Privacy Tools	http://www.phenoelit.org/	Unknown
http://www.mailinator.com/	Email/Privacy Tools	https://dnsleaktest.com/	Unknown
http://www.eurogrand.com/	Gambling	https://www.mp3.com/	Unknown
https://www.onlinearabiccasino.com/	Gambling	http://www.bittornado.com/	Unknown
http://www.socom.mil/	General / National Services	https://doh.centraleu.pi-dns.com/dn	Unknown
https://www.jsf.mil/	General / National Services	https://1.1.1.1/dns-query?dns=q80B4	Unknown
https://www.donedeal.ie/	General / National Services	http://abpr2.railfan.net/	Unknown
https://www.daft.ie/	General / National Services	https://www.xroxy.com/	Unknown
https://www.rip.ie/	General / National Services	https://www.secfirst.org/	Unknown
https://www.aib.ie/	General / National Services	https://secfirst.org/	Unknown
https://www.sky.com/	General / National Services	https://1.1.1.1/	Unknown
https://www.thejournal.ie/	General / National Services	https://www.gamku.com/	Unknown
https://www.met.ie/	General / National Services	https://www.iasj.net/	Unknown
http://www.queernet.org/	LGBTQ+	http://www.on-instant.com/	Unknown
https://im0-tub-com.yandex.net/i?id=462f375	News / Media	http://www.euthanasia.cc/	Unknown
https://www.rte.ie/	News / Media	http://www.blogeasy.com/	Unknown
https://www.independent.ie/	News / Media	https://www.yahoo.com/	Unknown
https://www.dailymail.co.uk/	News / Media	https://www.tiktok.com/	Unknown
https://www.bbc.com/	News / Media	https://www.skysports.com/	Unknown
https://www.irishtimes.com/	News / Media	https://www.boards.ie/	Unknown
https://www.irishexaminer.com/	News / Media	https://www.imdb.com/	Unknown
https://www.theguardian.com/	News / Media	https://www.telegram.org/	Unknown
https://www.news.sky.com/	News / Media	https://www.uptodown.com/	Unknown
https://www.nytimes.com/	News / Media	https://www.beenar.net/	Unknown
https://www.thesun.ie/	News / Media	https://www.weather.com/	Unknown
https://www.dublinlive.ie/	News / Media	https://www.azoramoon.com/	Unknown
https://www.bbc.co.uk/	News / Media	https://www.kisskh.co/	Unknown
https://www.irishmirror.ie/	News / Media	https://www.tumblr.com/	Unknown
https://www.breakingnews.ie/	News / Media	https://www.4chan.org/	Unknown
https://www.galwaybeo.ie/	News / Media	https://www.crunchyroll.com/	Unknown
https://www.deviantart.com/	News / Media	https://www.pc2call.com/	VoIP / Communication
https://www.foxnews.com/	News / Media	https://www.iconnecthere.com/	VoIP / Communication

Figure A1.1: List of Websites used in the Web Connectivity Test

A1.2 OONI Data

All OONI data collected during this work can be found at the following link on this project's public GitHub: `https://github.com/ccasey300/censorship_project/tree/main/Griff/OONIData`

A1.3 Python Script for Website Categorization and Parsing From OONI Data

```
import csv
import re


# Load the raw text data from the file
file_path = "FILE_PATH_HERE"
with open(file_path, "r", encoding="utf-8") as f:
    raw_text = f.read()


# Categorization of websites (this is manual)
def categorize(url):
    url = url.lower()
    if any(k in url for k in [
        "torrent", "piratebay", "rarbg", "kickass", "bitcomet", "
           utorrent", "bittorrent", "kat.am", "libgen",
        "zoro.to", "topcinema", "kurdfilm", "shabakaty", "
           kurdsubtitle", "kurdcinama", "lekmanga", "like-manga",
           "lodynet", "witanime", "egydead"
    ]):
        return "Piracy / Streaming / File Sharing"
    elif any(k in url for k in [
```

```
        "xvideos", "xhamster", "xnxx", "sexalarab", "theporndude",
            "redtube", "porn.com", "xvideos-ar", "arabx", "
           arabshentai",
        "beeg", "stripchat", "onlyfans", "spankbang", "rule34", "
           redgifs", "xhexperience", "hentaislayer"
    ]):
        return "Adult Content"
    elif any(k in url for k in [
        "eurogrand", "casino", "onlinearabiccasino"
    ]):
        return "Gambling"
    elif any(k in url for k in [
        "mailinator", "simplelogin"
    ]):
        return "Email/Privacy Tools"
    elif any(k in url for k in [
        "voip", "pc2call", "iconnecthere"
    ]):
        return "VoIP / Communication"
    elif any(k in url for k in [
        "rte.ie", "yandex", "bbc", "independent", "irishtimes", "
           dailymail", "theguardian", "news.sky", "thesun", "
           breakingnews",
        "irishexaminer", "galwaybeo", "dublinlive", "irishmirror",
            "foxnews", "nyt", "russia.tv", "rt.com"
    ]):
        return "News / Media"
    elif any(k in url for k in [
        "nazarene", "islamdoor", "oic-oci", "religion", "alhikmae"
    ]):
        return "Religious"
```

```
    elif any(k in url for k in [
        "absinth", "literotica"
    ]):
        return "Adult / Alcohol"
    elif any(k in url for k in [
        "netflix", "twitch", "discord", "omegle", "vk", "live.com"
           , "youtube", "bilibili", "dailymotion", "reddit"
    ]):
        return "Streaming / Social Media"
    elif any(k in url for k in [
        "wikipedia", "mozilla", "opera", "chess.com", "lichess", "
           9gag", "poki", "etsy", "vimeo", "pixiv", "creepypasta",
        "wattpad", "fanfiction", "deviantart", "artstation", "
           furaffinity"
    ]):
        return "Creative / Educational / Misc"
    elif any(k in url for k in [
        "donedeal", "daft.ie", "rip.ie", "aib.ie", "sky.com", "
           thejournal", "met.ie", "jsf.mil", "socom.mil"
    ]):
        return "General / National Services"
    elif any(k in url for k in [
        "chatgpt", "openai"
    ]):
        return "AI / Technology"
    elif any(k in url for k in [
        "queernet"
    ]):
        return "LGBTQ+"
    else:
        return "Unknown"
```

```
# Block by Block parsing of each
blocks = raw_text.split("processing input:")

results = []
for block in blocks[1:]:
    try:
        url_match = re.search(r"(http[s]?://[^\s]+)", block)
        date_match = re.search(r"(\d{4}/\d{2}/\d{2})", block)
        blocking_match = re.search(r"Blocking:\s*([\w\-]+)", block
            )
        access_match = re.search(r"Accessible:\s*(true|false)",
            block)
        measurement_match = re.search(r"Measurement URL:\s*(https
            ://explorer\.ooni\.org/m/[^\s]+)", block)

        if not url_match:
            continue  # Skip this block if no URL

        url = url_match.group(1)
        date = date_match.group(1) if date_match else "Unknown"
        blocking_method = blocking_match.group(1) if
            blocking_match else "Unknown"
        accessible = access_match.group(1) if access_match else "
            false"
        measurement_url = measurement_match.group(1) if
            measurement_match else "N/A"

        blocked = "No" if accessible.lower() == "true" else "Yes"
        category = categorize(url)
```

```
        results.append({
            "Date": date,
            "Country": "COUNTRY",
            "Website URL": url,
            "Blocked?": blocked,
            "Blocking Method": blocking_method,
            "Category": category,
            "OONI URL": measurement_url
        })

    except Exception as e:
        print(f"Skipping block due to error: {e}")
        continue

# Write to CSV
output_csv = "OUTPUT_FILE_PATH_HERE"
with open(output_csv, "w", newline='', encoding="utf-8") as f:
    writer = csv.DictWriter(f, fieldnames=results[0].keys())
    writer.writeheader()
    writer.writerows(results)

print(f"Done! Parsed {len(results)} results into CSV.")
```

Listing A1.1: Script for Categorizing and Parsing OONI Web Connectivity Test Output