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SCHOOL OF COMPUTER SCIENCE AND STATISTICS

# **COMPARING INTERNET CENSORSHIP IN IRELAND VS. ISRAEL**

CHRIS CASEY

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B.A.I. COMPUTER ENGINEERING

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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 Research Motivation

Since its inception, the Internet has served a vast user base that wishes to communicate with one another and spread information. By design, the Internet is a platform that should provide unfiltered content to users. In many cases this content may otherwise be inaccessible by traditional media outlets such as radio or TV.

Originally designed to aid government researchers share information, its open and transparent foundation has since changed. Across the globe, governments and other entities are censoring the internet by network manipulation, legislative pressure or otherwise. This is a global threat to fundamental internet user rights and should be treated as such. It is for these reasons that this area ought to be investigated more thoroughly.

Although censorship of certain content (CSAM, pirated entertainment) is widely considered appropriate, normalising this has far reaching consequences on user privacy and free speech. The importance of establishing a quantitative approach to measuring internet censorship cannot be overstated as users are unaware of invisible content in most cases. As a result, the state has a large influence over what ideas can propagate within its borders. Various open-source and community-led projects aimed at addressing this issue. Notable examples include the Tor project, OONI, Tails OS and others. However, it is coming to light that this technology is becoming deprecated. In 2022, German police were able to make an arrest after de-anonymising



Tor traffic using timing analysis (1). This highlights the large dichotomy between what users believe governments are capable of and reality.

### **1.1.1 User Rights & Privacy**

In discussing internet user rights and how censorship occurs, it is important to mention anonymity and user privacy. DRI, a non-profit that challenges the Irish government on data retention issues is an independent, non-profit organization. They state on their website, that users have "a right to digital privacy [&] data security." (2) Individuals' freedom to access information and be anonymous are inherently linked, however very separate issues. Though censors may actively engage in deanonymisation efforts, potentially using methods described below, this research is focused on internet censorship.

For the above reasons, the increasingly pervasive censorship done by governments and corporations around the world is concerning. The sheer number of individuals affected by internet censorship and the lack of transparency are strong motives for more extensive research.

## **1.2 Background**

### **1.2.1 Global Internet 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")." (3) 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. (4) 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.

## **1.3 Project Scope**

Below is an outline of the goals for the thesis. The stretch goal is to contribute to the OONI project. A more attainable contribution is to merge resources in order to compile a better sensitive domain list that is specific to Ireland and Israel. This would improve the testing capability for the locations being considered.

<b>Review existing literature</b>	<b>Examine notable events in each country</b>
<b>Assess internet censorship mechanisms</b>	<b>Use OONI data to cross-correlate events</b>
<b>Identify censoring parties</b>	<b>Use OONI data to note interference trends</b>
<b>Analyse motives and ethics</b>	<b>Gather ground truth with a virtual machine</b>
<b>Investigate justifications &amp; transparency</b>	<b>Comparative analysis of Israel &amp; Ireland</b>
<b>Note mechanisms used by both countries</b>	<b>Consider security and privacy issues</b>
<b>Investigate public response</b>	<b>Contribute to the OONI project</b>

Figure 1.1: Goals of the research

## 2 | Literature Review

### 2.1 Introduction

The purpose of this literature review is to survey and consider published work regarding internet censorship globally, with a particular focus on that of Ireland and Israel. Legislation, important events and other notable areas will be discussed and compared in order to gain a greater understanding the differences between internet censorship experienced in Israel and Ireland. Internet censorship is constantly evolving as it competes with privacy based tools in an 'Arms race' of sorts. This makes researching and understanding how censors achieve their purpose of particular importance. To properly understand the current situations faced by both Israeli and Irish citizens using the internet, a broad analysis of existing literature and ongoing research had to be considered. This section lays the groundwork for the thesis, detailing how both countries approach to internet censorship has evolved over the years.

Internet usage is rising year on year globally as more users are free to surf the web. Our World in Data, an independent organisation that tracks internet usage statistics suggests that as of 2023, 67.4% of the world was connected to the internet. (5) This is a staggering number of individuals that is only set to increase. With more people relying on the internet for their livelihood, communication or otherwise, internet censorship is becoming a more pressing matter. It has also been noted previously that, based on OONI data, censorship is rising globally. This growth highlights the

need for transparency and regulation surrounding user rights and privacy.

As previously mentioned, a common misconception about the internet is that it's content is not manipulated. Another misconception held by many is that internet censorship occurs in few countries. This is also false, with censors increasing their restrictions continuously. According to Bischoff in his online article mapping internet censorship and geographies "This year we saw nearly 60 countries increase their internet censorship in some way, compared to 50 from last year's study." (6) This is a troubling reality as internet content is increasingly being censored not just in authoritarian countries but by democratic states.

## **2.2 Literature Review Methodology**

In conducting this literature review, sources from a variety of mediums were used. Research was conducted primarily using the internet, focusing on academic papers and peer reviewed literature. Other sources like Trinity College Library, online articles and journals were also considered and sources were cross checked with relevant authorities. Information regarding country-specific legislation was taken from the official state-run website of those countries. Sources deemed potentially unreliable were placed under a higher level of scrutiny. It is worth mentioning that researching this area can be difficult as state level censorship is typically clandestine and covert. This sections aims at laying the foundation for discussing both countries' approach and sentiments towards internet technologies.

## **2.3 Findings of the Literature Review**

### **2.3.1 Ireland Historically**

In researching the early days of internet adoption in Ireland, a fascinating story emerges. As will be discussed, academia paved the way for the internet infrastructure Irish users enjoy today. To research the early days of internet

technologies in Ireland, a variety of sources were used. One that was particularly helpful but admittedly casual resource was [internethistory.ie](http://internethistory.ie). (7) Niall Richard Murphy documents a detailed account of Irish Internet history here. In order to verify this account and investigate specific cases, [techarchives](http://techarchives.org) (8) was used. Other media and press sources such as RTE, The Irish Times and BBC were used in a similar fashion.

The internet in Ireland has come a long way since The Irish Sugar Company took delivery of the first computer in the country. "The Sugar Company paid £33,000 for the system." (9) Conservatism hampered development early on, however, as the cost of hardware decreased in the 60s Irish universities began investing in computers. Tech Archives suggests of early adopters, "their financial backing was minimal. They relied on students and volunteers to keep running. Their day-to-day operations were largely improvised and sometimes anarchic." (10) This progress continued into the 80s and 90s as the potential became apparent. This progress was also driven by IT professionals who adopted Unix. EUnet was a collaborative effort that succeeded in becoming the "first public wide area network in Europe." (10) The gateway was later relocated and managed by Trinity College Dublin. This advancement set the stage for the foundation of Ireland's first ISP by Cormac Callanan and Michael Nowlan, IEUnet. In a low-key email, Nowlan announced the arrival of the internet in Ireland, aptly stating "No gaurantees of reliable service are offered at present, it is quite likely that the line with go down at no notice. " (11)

Though the Irish government played a passive role in this development, they deserve credit for the legislation they passed in 2000. The E-Commerce Act legitimised electronic transactions by asserting "electronic communications are deemed equivalent to written or oral communications." (12) This seems trivial today, but it was a huge step in the right direction. Though Ireland was in many ways following EU trends, a strong emphasis was placed on privacy. The Irish Times released an article discussing how the legislation "appears to protect the privacy of communications far more than the laws of our neighbours." (13) This is contextually

impressive considering other institutions, such as the FBI, harked "the widespread use of robust non-recovery encryption will ultimately devastate our ability to fight crime and terrorism." (13)

Fast forward to 2002 and Eir has began rolling out broadband internet access to consumers. In 2005, Ireland surpassed 2 million internet users, denoting the successful adoption of the technology. At this point, the internet and its technologies had penetrated industry, academia and consumerism. This time marked a turning point in communications both in Ireland and globally.

### **2.3.2 EU Compliance**

Aside from Irish legislation, there are EU directives that run in conjuncture such as 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 has direct effect on its citizens." (14) The European Commission proposes laws that are sent to the European Commission and then the Council of the European Union to be approved by a qualified majority and passed, or rejected. (15) This procedure has lead to the passing of legislation that affects internet usage in Ireland.

The first law to be discussed is 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 to police organisations. Penalties come in the form of fines, up to 20 million euros. (16) The second law that is 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. (17) (18) 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 seen in Ireland is the Copyright Directive (2019). This legislation solidifies intellectual copyright law

within the EU, providing some edge cases of where free use applies. (19) 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 and 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 non compliance 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. (20) This landmark ruling was based on the EU's data protection laws. The ruling had a profound impact on how search engines and online platforms handle personal data. Google, as the largest search engine, were forced to make stark changes in their 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 the upload of copyrighted content without permission. (21) 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 the removal of 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 personal information of millions of users. (22) The breach was



linked to the company's failure to adequately protect user data, violating GDPR standards. Meta has faced a litany of fines at the hands of the EU and other regulating bodies. Meta has received fines of over 2 billion euros in 2024 alone. (23) This exemplifies the European Union's stringent enforcement of GDPR which holds companies accountable for safeguarding personal data.

**4. Twitter's Non-Compliance 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 required measures to combat illegal content and misinformation. (24) 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 were quick to point out that X will still have to comply with EU standards. (25)

### **2.3.3 Ireland Today**

As of 2024, the Irish digital sector exceeded a valuation of \$50 billion, (26) Bolstered by strong international relations and low corporate tax, Ireland is an attractive location for any tech company looking to infiltrate the EU market. A corporate tax of 12.5% (27) and a skilled and educated work force has proved tantalizing for tech giants. Ireland balances citizens privacy and safety with keeping tech giants satisfied. Over the years, this approach has proved very effective with the likes of Google, Facebook (Meta), Apple and Microsoft setting up EU bases in Ireland. It is clear that Ireland's tech industry is a booming financial success but it has faced criticism for its tax system. Criticism recently came at the hands of financier Howard Lutnick who described Ireland as his favourite "tax scam." (28) He highlights concerns around the number of US pharmacological and tech companies operating in Ireland and the intellectual property acquired by Ireland as a result. Conjecture aside, it is clear that

there are strong forces at play that influence the regulation of tech companies on Irish soil. This influence undoubtedly affects the internet censorship situation faced by Irish users and will be investigated in the context of case studies. Before this, let us briefly go over the legislation that affects this area.

**The Defamation Act (2009)** An early piece of legislation passed by the Irish government that addresses defamation both online and offline. This act describes defamation as "the publication, by any means, of a defamatory statement concerning a person to one or more than one person." (29) Simply, this document aims to uphold an individuals right to a good name.

**Communication Act (2011)** This act strengthened the regulation of electronic communication and focused primarily on issues like data retention, consumer rights and cybersecurity. This act articulates the legal framework for the monitoring and interception of certain online communications in the interest of law enforcement and national security. It mandates timelines for the safe retention and eventual destruction of sensitive consumer data. It also enables a senior Gardai to "request a service provider to disclose to that member data retained by the service provider." (30)

**Online Safety and Media Regulation Act (2022)** This law targets harmful digital content like hate speech and misinformation. This empowers a newly appointed Coimisiun na Meán to regulate content that fits these criterion, addressing issues such as cyber-bullying and extremism. At the head of this organisation is the Online Safety Commissioner who is "responsible for the implementation of a binding online safety code." (31)

Now that we have some background on the legislation passed in Ireland relating to internet censorship, we can examine notable cases.

**The Pirate Bay & More (2009, 2013)** In 2009, major media labels began pressuring six ISPs to block access to the Pirate Bay website. This came to a head in 2013, when the ISPs were ordered to block access by the High Court. (32) This was a momentous

event as it marked the first use of updated EU copyright legislation. The website was and still is one of the most popular torrent sites globally, with total monthly visits exceeding 20 million today, according to Similar Web. (33) Since the 2010s this trend of blocking piracy by judiciary process continued, with site like Eztv, Putlocker and GoMovies being blocked to this day.

**Ban on Russian State Media (2022)** Following the Russian invasion of Ukraine in February of 2022, the EU released a directive (34) to block access to Russian state media websites. European Commission President Ursula von der Leyen announced "The state-owned Russia Today and Sputnik, and their subsidiaries, will no longer be able to spread their lies to justify Putin's war." (35) Following this, the EU imposed heavy sanctions on those who were found to be hosting versions of these websites. In response, Russia blocked a number of EU based media outlets, particularly those critical and vocal about the invasion. This included the Irish state-owned RTE and the Irish Times. (36)

**Social Media Under EU Law** Under the aforementioned DSA and GDPR legislation, Ireland's Data Protection Committee has required platforms such as TikTok and X to remove non-compliant content. Platforms such as Meta, TikTok and X have faced legal trouble regarding misinformation and hate speech. A salient example is TikTok's refusal to submit a risk report prior to launching TikTok Lite in France, Spain and elsewhere. "Under the DSA, designated Very Large Online Platforms are obliged to submit a risk assessment report." (37)

#### **2.3.4 Israel Historically**

Since the early 2000s, internet access has become increasingly available in Israel. In a paper discussing internet usage in Israel, Fisher speaks of "an increase of 152% in the number of Israeli households connected to the Internet during the period 2000–2005." (38)

An important aspect of this literature review was understanding how the Israel -

Palestine conflict has shaped censorship of the press and the internet over the last few decades. To better appreciate the impact of this war, the Council of Foreign Relations (CFR) provides a brief overview of notable events. (39) MIFTAH, an organisation promoting open dialogue on the Israel - Palestine conflict, released a summary of freedom of press violations for the years 2000-2003. They tabulated 310 separate incidents of press freedom violations during this time, with reporters and journalists consistently being victimised. (40) It is clear from these documents that it is dangerous to report on this conflict. It is also clear that wars such as this one inevitably affect the information available to users online.

In an archived document produced by the IDF in 2016, the details for mandatory conscription of Israeli citizens is described. (41) This military draft has been ongoing since 1948 when Israel declared its independence. Men are required to serve 32 months while women serve 24. This policy, in combination with Israel's renowned intelligence operation has produced highly qualified cybersecurity professionals.

Regarding Israel's freedom of press in the 2000s, the Internet Monitor, a data analysis and collection tool states: "Modern censorship of [press] operates through voluntary agreements between the military and the Israeli Committee of Daily Newspaper Editors. Even though these agreements lack full consent from media in the country, all media organizations operating in Israel must abide by the censor's decisions." (42) Though this pertains to press rather than the internet, it shows a tendency by the state to block political content. This trend would go on to continue in the 2010s and 2020s. The Colombia Journalism Review wrote an article in 2025 discussing the potential bias of Channel 14, a prominent right-wing media outlet in Israel. Channel 14 lends itself to nationalist and patriotic rhetoric and has been subject to criticism as a result. "Netanyahu's relationship with Channel 14 goes back years, to the time when it was Channel 20, called the Heritage Channel." (43) This serves as evidence to suggest the Israeli government has a strong grasp over its media.

### 2.3.5 Israel Today

Today, a large majority of Israeli citizens have access to the internet. DataReportal, a website responsible for collecting and publishing global digital reports states "there were 8.51 million internet users in Israel at the start of 2024, when internet penetration stood at 92.1 percent." (44) It is also pertinent to mention Israel's booming cybersecurity industry. According to YL Ventures' recent report "In 2024, the Israeli cybersecurity industry demonstrated exceptional growth," receiving \$4B in funding, double that of 2023. The roots of this industry come as a direct product of the nation's fixation with intelligence and national security.

Reporters Without Borders (RSF), responsible for the World Press Freedom Index, provide detailed reports pertaining to media censorship globally. They have ranked Israel as 101st in the world as of 2024 in this regard. This ranking is based on the level of freedom enjoyed by journalists and media. "Press freedom is defined as the ability of journalists as individuals and collectives to select, produce, and disseminate news in the public interest independent of political, economic, legal, and social interference and in the absence of threats to their physical and mental safety." (45)

In a 2024 paper discussing digital diplomacy in the Israel - Gaza war, Othman asserts "Governments and non-state actors leveraged social media to influence international public opinion, while misinformation campaigns complicated the narrative, undermining trust in diplomatic channels." (46) The relationship between war and social media in the modern age is a concerning issue. To understand internet censorship in Israel today, it is important to identify what individuals and institutions are behind this activity. Israel entrusts this operation to the Israeli Military Censor, a department of the Israeli Defense Forces (IDF). This group is responsible for state-sponsored censorship online and is headed by the minister of defense, currently Israel Katz.(47) Historically, the IDF have had to answer for media censorship through their Spokesperson Unit (ISU). "the ISU is continually fluctuating between openness and opaqueness because its activities are affected by so many

internal and external factors" (48)

Though internet censorship can prove inflammatory, the internet can also be used to ease tensions. Digital diplomacy can be described as how a government uses the internet and related technologies to manage international relations. "Findings reveal an unmatched proactive approach by Israel's digital diplomacy compared to other states, rooted in a humanitarian grounds concern despite limited peace efforts, and significant obstacles from prevalent anti-Israel online sentiment, changing social media perceptions, and platform executive decisions hindered by personal political inclinations." (46)

According to Zittrain in his 2017 paper discussing internet censorship, Israel has not always been proactive in blocking political content. "In June 2017, after a few years of no blocking, the Palestinian Authority ordered ISPs to block 12 news websites affiliated with the rival Islamist group Hamas which controls the Gaza Strip, websites affiliated with dismissed Fatah leader Mohammed Dahlan, and 10 news websites that provide news and views on Palestinian politics." (49) Zittrain described this trend of blocking undesirable websites in 2017. In 2023, Israel passed what was described as "draconian" legislation by the RSF, that punishes the "consumption of terrorist materials." (50) This law targeted sites such as Aljazeera, a media outlet focusing on covering the Gaza crisis funded by the Qatari government. (51) This example shows the litigious nature of the Israeli state in censoring content online.

Having considered the unique national security threats faced by Israel, it is clear that citizens are not overly concerned with the State abusing its power. The tumultuous history faced by the state means that "the IDF is highly trusted by a society that deeply values the defense system, it is very difficult to criticize its deficiencies." (48) A troubling result of the Gaza crisis has been the utilisation of social media during war. On 14 November 2012, a tweet from the official IDF Twitter account stated "The IDF has begun a widespread campaign on terror sites & operatives in the Gaza Strip, chief among them Hamas & Islamic Jihad targets." (52) This marked the beginning of

what Kretschmer described as a war that is "tweeted live." In her research, she describes a concerning account of both sides "constantly informing on rocket attacks." (53) Propaganda and misinformation has been influential in shaping global opinions on this war, and the internet has accommodated this.

## 3 | State of the Art

### 3.1 Introduction

In order to quantify internet censorship conducted across the globe it is important to understand the different methods used by censors to achieve their aims. Censors engage in a range of steps at various layers of the OSI model in order to either stop the publication of information or make it more difficult for the user to attain.

Ultimately, a censors choice of how they detect and interrupt the flow of undesirable information is based on a number of factors such as cost, scalability, and whether the censor wishes to be transparent.

Finding comprehensive and credible resources on censorship mechanisms proved challenging due to the depth of the research area. Requests for Comments (RFCs) proved useful in this regard. These documents highlight internet standards placed by the Internet Engineering Task Force and thus provide the accurate technical specifications needed. RFC 9505 proved invaluable in highlighting the majority of censorship methods used today. It was last updated by the Internet Research Task Force in late 2023 and provides the technical basis for this section of the thesis. The document "describes technical mechanisms employed in network censorship that regimes around the world use for blocking or impairing Internet traffic."(54) In combination with relevant academic papers, other RFCs like 2818 (HTTPS) (55) and 8446 (TLS 1.3) (56) were examined.



### 3.1.1 Overt vs. Covert Censorship

ICLab, a censorship measurement tool very similar to OONI, released a paper in 2020 describing the need for their contribution. In this paper, the author highlights an important distinction between covert and overt censorship: 'In overt censorship, the censor sends the user a 'block page' instead of the material that was censored. In covert censorship, the censor causes a network error that could have occurred for other reasons, and thus avoids informing the user that the material was censored.'" (57) This is a concerning capability as it alludes to the potential for censorship to go unchecked.

## 3.2 Censorship Techniques and Mechanisms

### 3.2.1 Points of Control

Key control points are nodes in the Internet's architecture that connect a large user base to the wider network, making them attractive targets for censorship enforcement. RFC 9505 explains points of control in great detail. It states "internet censorship takes place in all parts of the network topology," however, "There are various logical and physical points of control that censors may use for interception mechanism." (54). Below are some notable points of control explained.

**Internet Service Providers (ISPs)** Entities that accommodate the accessing, using or participating in the internet. Bridging the gap between consumers and the global internet, ISPs are often required to act as "law enforcers and adjudicators." (58) Tosza discusses how ISPs and tech giants alike are self-regulating and implicit in internet censorship. Legislation like the Digital Services Act (EU) allows governments to effectively block content deemed harmful at the ISP level.

**Internet Exchange Points (IXPs)** A common definition for IXPs is a "network infrastructure with the purpose to facilitate the exchange of Internet traffic between

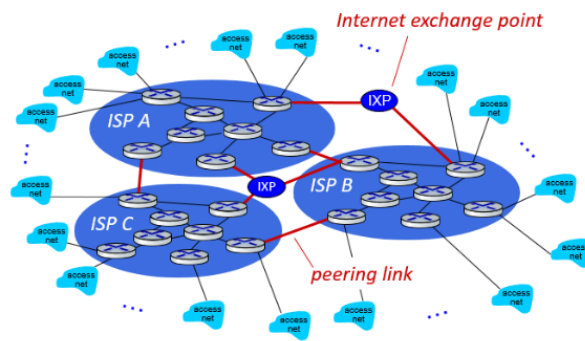


Figure 3.1: Caption

Autonomous Systems (ASes) and operating below layer 3." (59) Put more simply, they are physical locations where different ISPs and networks interconnect to exchange traffic. IEEE describes IXPs as "the facilitator of peering." (60)

**National Gateways** Refers to the centralised infrastructure through which a country's internet traffic is routed. In a 2009 paper discussing internet infrastructure as it relates to censorship, Karlin and Forrest argue that internet traffic is "increasingly affected by national policies." (61) They go on to illustrate how countries like the UK, Germany and the US are "central to international reachability, and their policies thus have huge potential impact." (61)

**Institutions** Businesses, universities and other organisations often have a responsibility to filter the content seen by their users on their network. This is often done to comply with legal obligations, apply ethical standards or to protect network security. This is achieved by a combination of firewalls, keyword-filtering and network level blocking. These techniques are highlighted in Zittrain's 'The Future of the Internet - And How to Stop It,' (62) and will be discussed further below.

Governments leverage these nodes in the network's topology to restrict user access to undesirable content. Institutions will typically use a combination of legislative pressure, technological and economic means to snuff out content. ISPs and VPNs face significant and constant pressure from legal arms to expose user data and manipulate the content available to a user. In his research paper from 2003, Zittrain gives a solid overview of points of control. One issue he raises is the violation of the

end-to-end principle. Simply, this refers to keeping the middle of the network simple and pushing complexity out towards the edge of the network to hosts. The presence of middleboxes and other devices could be impacting performance of the network.

"The technical aspect of the end-to-end argument suggests a warning against blocking data transmissions at any point [other than endpoints]." (63)

Although security considerations such as HTTPS and TLS can help protect users from threat actors, points of control are a physical reality to be contended with. As user packets traverse the network they are subject to inspection. In this way, points of control are a key consideration for all internet users. Zittrain concludes his research with a word of warning regarding points of control and their potential for abuse. He highlights the need for "a comprehensive framework where sovereigns' actions to block material are thoroughly documented and open to challenge." (63)

### **3.2.2 Legislative Pressure**

Governments can enforce censorship directly through ISPs, tech companies and social media platforms by creating new legislation or simply mandating content be removed. This is used to de-platform individuals and movements during periods of unrest. This is also done in app stores, shutting down entire platforms that are deemed problematic.

VPN providers are subject to the scrutiny of the jurisdiction within which they operate. NordVPN, a very popular VPN provider based in Amsterdam has said on record "We will comply with lawful requests as long as they are delivered according to all the laws and regulations." This reflects the reality of VPN services as provided by corporations. VPNs in this sense can be described as a double edged sword. In most cases they are very helpful in protecting user anonymity and circumventing censorship. However, if legislative pressure is applied, corporations will have no choice but to comply with the demands of the government. This may be trivial and to be expected by most consumers of VPN services, however, security issues in open

source and previously trusted projects like TOR represent a more grave concern.

### **3.2.3 MITM Attacks**

Kampourakis, Kambourakis, Chatzoglou, and Zaroliagis wrote an academic paper in 2022 arguing the effectiveness of MITM attacks against HTTPS in certain circumstance. They describe a MITM attack as follows. "A man-in-the-middle (MitM) attack enables threat actors to position themselves in a conversation between two parties. It can be used to eavesdrop on, or impersonate, either of the parties and may enable the perpetrator to steal personal information, including login credentials, payment card data and account details." (64) A MITM attack simply involves a threat actor placing themselves in the middle of a conversation, potentially at a point of control. Governments have been seen to pressure VPNs into routing traffic through designated MITM servers. Inevitably this allows for selective content manipulation, deep packet inspection and surveillance. MITM attacks are particularly concerning due to their covert and intrusive nature.

RFC 2818, released in 2000, describes "how to use TLS to secure HTTP connections over the Internet," (55) known as HTTPS. This was designed to mitigate the effects of MITM attacks. Recent research suggests deployments of HTTPS in most browsers is insecure, at least in certain circumstance. Kampourakis and his colleagues went on to say "some insidious variants of MitM against HTTPS remain quite realistic across all popular Internet browser types irrespective of the underlying platform." (64) They mention how "both of the attack variations were successful against all the browser types and versions..." except the latest versions of Firefox that they tested.

## 3.3 Network-Level Filtering

### 3.3.1 IP Blocking

Originally implemented to stop email spam, Internet Protocol (IP) blocking is one of the most straightforward censorship techniques. Each device connected to the internet is assigned a unique numeric label called an IP Address, which serves as an identifier that allows data to travel across the internet to the correct destination. RFC 971 describes the function of the Internet Protocol, "to move datagrams through an interconnected set of networks." (65)

When a government or ISP wants to censor a specific website it can be implemented in either incoming or outgoing traffic. ISP controlled firewalls can be configured so that any outgoing or incoming requests to a selected IP address are dropped. ISPs can also adjust routing tables in their network to remove an IP address, making it unreachable for the user. In a 2009 report, Callanan and co. describe how "the server that contains the website could be blocked at the level of its IP address, preventing anyone using the filter from accessing that address." (66) 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. The primary motivation for the Irish government in doing this is to crack down on piracy. A prime example discussed previously is the blocking of the Pirate Bay. (32)

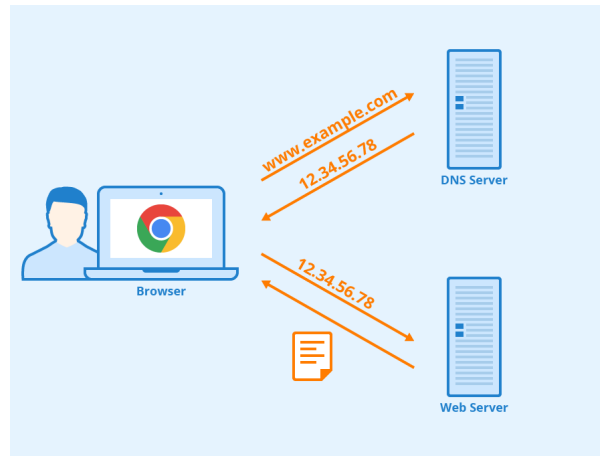


Figure 3.2: DNS Requests and IP

### 3.3.2 DNS Tampering

### 3.3.3 Firewalls

### 3.3.4 Blackouts

## 3.4

Beyond IP and DNS manipulation, censors can examine the contents within packets to make decisions regarding their accessibility. This refers to the concept of application layer filtering or blocking; monitoring a communication channel and detecting offensive keywords. This is seen in more cultivated censorship models. Upon detecting a sensitive keyword, the communication will be disrupted, perhaps by sending TCP reset packets to both sides.

### 3.4.1 Keyword Filtering

Keyword filtering involves

### 3.4.2 Deep Packet Inspection

Deep packet inspection involves looking into payloads and data within packets, beyond its header. It is a sophisticated technique usually performed as part of a

firewall defense and involves making real time decisions about the nature of each packet. DPI functions at the application level and can be used to identify both the sender and recipient of the packet by examining its payload. Compared to regular packet inspection which is only concerned with basic header information, it is considerably more costly.

Deep packet inspection is used in specific cases where a higher level of audit is required. This includes packets carrying malware, content that has been blocked and intrusion efforts. DPI is usually performed by network middle boxes, devices that lie between end points. One of these middle boxes is BlindBox, a system that accommodates DPI while preserving privacy and encryption. The creators of this system highlight the potential risks to user privacy with other black boxes. "To enable middlebox processing, some currently deployed middlebox systems support HTTPS in an insecure way: they mount a man-in-the-middle attack on SSL and decrypt the traffic at the middlebox." (67)

Though its deployment is limited, DPI represents a significant risk to user privacy. Not all middle box providers offer the protections and guarantees that BlindBox offer. Forecasts for the market show a troubling trend, with no guarantees of user privacy. "Global deep packet inspection (DPI) market size was anticipated to be worth USD 10.63 billion in 2024 and is expected to reach USD 79.26 billion by 2033 at a CAGR of 25% during the forecast period." (68)

### **3.5 Surveillance and Deanonymisation**

Though censors may actively engage in deanonymisation efforts, potentially using methods described below, this research is focused on internet censorship. Hence, deanonymisation and surveillance will only be touched on briefly.

Efforts to identify users based on their traffic range from trivial to extremely complex based upon the protections employed by the user. Operational security, the collection of measures taken by an individual to protect their online anonymity, is often

overlooked by casual internet users. Projects like Tor, Tails OS (an amnesiac Linux distribution), and Briar (secure off-grid communication) as well as VPNs aim to protect users' identity. However, these methods are not fool proof.

### **3.5.1 Side Channel Attacks**

Previously, it was touched on that German authorities managed to de-anonymise Tor users by deploying timing attacks. This was a concerning development in 2022 as basic internet privacy was called into question. Side-channel attacks are a sophisticated technique used for deanonymisation and key cracking. One example of this is timing attacks. These attacks are based on physical phenomena experienced by electronic parts such as power consumption in CMOS devices. These attacks are typically used to crack keys, voiding unprotected implementations of cryptographic primitives such as DES (Data Encryption Standard). Standaert, when discussing side channel attacks mentions two ways of looking at a cryptographic primitive. One could view it as a black box, some mathematical functions that translates inputs to outputs. However, another approach could be to consider how this black box will "have to be implemented in a program that will run on a given processor, in a given environment, and will therefore present specific characteristic." (69)



## 4 | Circumvention Tools

### 4.1 Circumvention Tools

Users who care about privacy and anonymity have options to increase their operational security and avoid censorship. Some of the most noteworthy tools are briefly explained below. It is worth mentioning that accessing these tools can be difficult for certain individuals. ProtonVPN discusses some of the countries that have outlawed VPN usage. (70) Some notable examples include Cuba, China, Vietnam and Egypt. This is a common theme; an arms race between oppressive regimes interested in censorship and circumvention and privacy based tools.

**Encryption** Encryption is the fundamental security element driving communication over the internet. Bhanot describes encryption as "the process of converting normal data or plaintext to something incomprehensible or cipher-text by applying mathematical transformations or formulae." (71) The importance of cryptography in security cannot be overstated. "Today, end-to-end encryption is the standard by which almost if not all communication over the internet occur. Examples of messaging platforms that offer this as standard include Telegram, Whatsapp and Facebook Messenger. CloudFlare states that end-to-end encryption "gives people total control over who can read their messages, enabling them to keep their messages private." (72) Encryption is the backbone of privacy online which allows users to leverage math to provide anonymity, at least in the best of cases. Zeadally, Das and Sklavos state the following about encryption "These techniques provide several

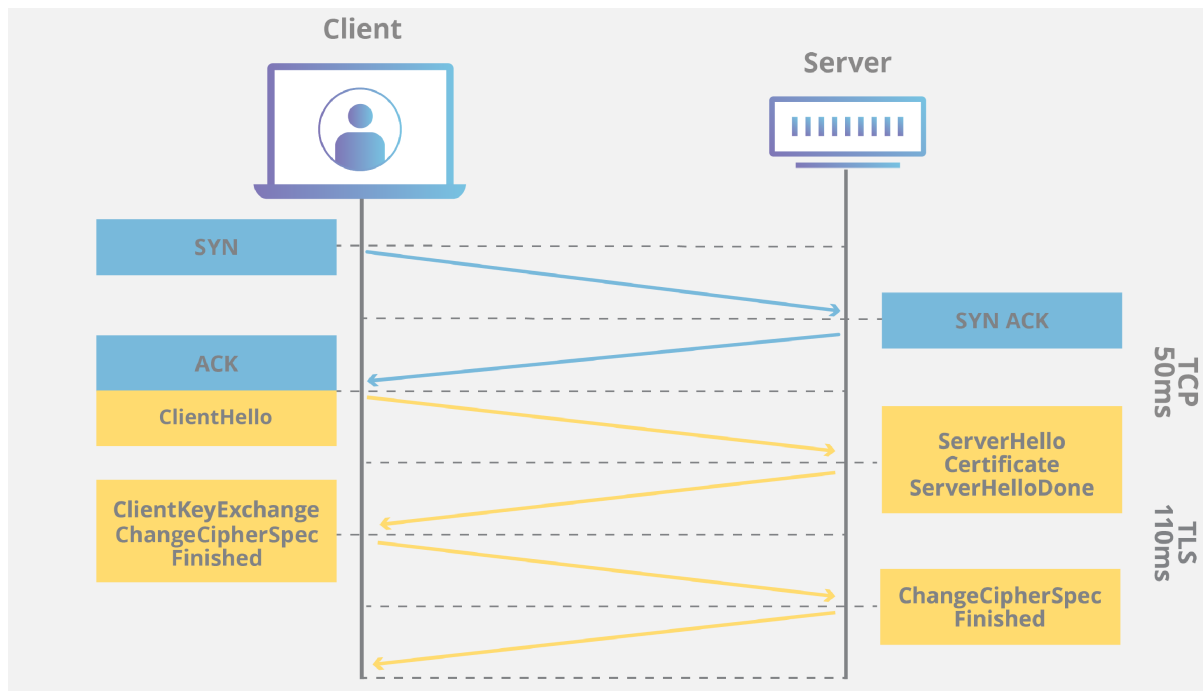


Figure 4.1: TLS Handshake, source cloudflare.com

security requirements, such as confidentiality, data integrity, entity authentication, message authentication, key management, non-repudiation, trustworthy data platforms, and digital signatures." (73) It is clear from the research conducted that encryption benefits internet users.

**Transport Layer Security** Transport Layer Security (TLS) is an example of encryption being used to secure data transfer online. TLS replaced the deprecated Secure Socket Layers (SSL), and TLS 1.3 is the standard by which data is transferred over the internet. According to the Internet Society, "TLS is normally implemented on top of TCP in order to encrypt Application Layer protocols such as HTTP, FTP, SMTP and IMAP." (74) TLS operation is described in detail in RFC 8446 (56) (75). Below is a figure that shows a TLS handshake.

INFO ABOUT TLS HANDSHAKE???

However, cryptography has not always had this virtuous reputation. The FBI lead what can only be described as a smear campaign against the technology in the early 2000s. In 1999, the director of the FBI, Louis Freeh, stated "encryption ultimately will devastate our ability to fight crime and prevent terrorism." (76) Unsurprisingly, their

stance has changed along with the growing necessity for encryption. Today, the FBI website states of encryption: "Law enforcement supports strong, responsibly managed encryption. This encryption should be designed to protect people's privacy and also managed so U.S. tech companies can provide readable content in response to a lawful court order." (77) The US government employs more methods than slander to defeat cryptography. The National Security Agency (78) has a colourful reputation regarding its contributions to cryptographic standards. Dual\_EC\_DRBG was a cryptographic standard released by the NSA in 2007 and ratified by the National Institute of Standards and Technology (NIST). It was later found that this was insecure, having back door potential. CloudFlare defines a back door as "an intentional flaw in a cryptographic algorithm or implementation that allows an individual to bypass the security mechanism." (79) The discovery of this vulnerability is credited to Dan Shumow and Niels Ferguson. (80)

**Virtual Private Networks** Virtual Private Networks (VPNs) are one of the most commonly used and important circumvention tools on the market. VPNs use tunnelling to encrypt packets at the lowest level, the OSI link layer. Microsoft developed Point-to-point Tunnelling Protocol (PPTP) which is now deprecated, having been shown to be insecure. (81) More relevant examples of VPN protocols include IPsec (82) and WireGuard (83). These protocols work by encapsulating packets and encrypting all of the information within. This provides secure data transfer over an insecure network. (84)

VPNs also allows users to effectively mask their IP address and change their apparent geo-location. This grants both privacy and circumvention potential; VPNs can be used to avoid geo - restrictions by routing traffic through more lenient countries. The role of VPNs in personal privacy and censorship circumvention cannot be overstated due to how commonplace the technology has become. According to SurfShark, a prominent provider, "over 1.6 billion people use VPNs." (85) Forbes states "Both the availability and usage of VPNs for personal use continue to rise," and this appears accurate. (86)

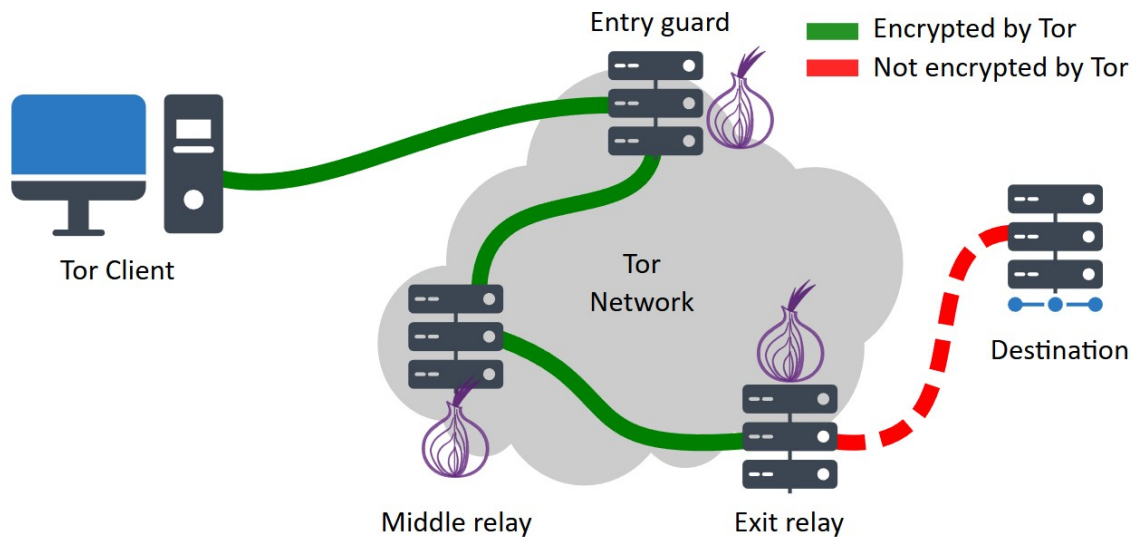


Figure 4.2: How TOR works

**The Onion Router (TOR)** The Onion Router, originally developed by the US government, is an open-source network overlay that routes internet traffic through volunteer-operated relays. According to the founders, "Onion Routing is a distributed overlay network designed to anonymize TCP-based applications like web browsing, secure shell, and instant messaging." (87)

Requests travel through a relay passing three separate nodes. As a result, it is significantly more difficult to interpret the request's origin and destination. Aside from granting privacy, Tor is also commonly used as a censorship circumvention method. Tor was believed to be secure for a long time but recent developments would suggest otherwise. (88)

**TOR Bridges** Previously, we have mentioned TOR relays and how three of them make up a circuit. The first hop over a relay is an important one; TOR bridges act as the first relay in certain circumstance. "Bridges are onion routers in the Tor Network whose IP addresses are not public." (89) Bridges act as a hidden and flexible way to access the TOR network. This allows individuals, (particular in countries where TOR is heavily blocked), to bypass censorship, communicate securely and enhance privacy. For example, TOR bridges have been used to access TOR within China. (90) (91)

**Psiphon** Psiphon is a "free and open-source Internet censorship circumvention tool that uses a combination of secure communication and obfuscation technologies." (92) During the 2021 Cuban protests, the government shut down several social media sites. This led to over 1 million protesters using Psiphon as a circumvention method. (93)

Typically, circumvention tools either divert web traffic so it avoids the machines that filter, or disguise the traffic as that that does not need to be filtered. Psiphon states on their website that "the Psiphon app has the ability to relay traffic through various communication protocols. It attempts to connect through different protocols until a connection is made." (92) As previously mentioned, this technology has proved its value in combating internet censorship.

## 5 | Methodology

### 5.1 Collecting Data: OONI

#### 5.1.1 Background

Released under the TOR project in 2012, the Open Observatory of Network Interference (OONI) is a non-profit open-source software project whose goal is to empower decentralized efforts to document internet censorship worldwide (94). The OONI organization openly publishes measurements and provides a public archive of network interference across the globe. This has produced a database of more than 2.6 billion individual tests. (95)

OONI data has been used extensively by third parties both for research and advocacy. Examples include the Freedom on the Net 2024 (96) report, iMAP reports (97) by Sinar, and Access Now's annual #KeepItOn 2023 Report. (98) (99) Based on these high profile endorsements and the wealth of data available, OONI is a perfect tool to measure internet censorship.

#### 5.1.2 OONI Probe

Released in 2017, the OONI Probe is a mobile app and software designed to test internet censorship. Users can install and run this software, contributing to the growing dataset in the OONI database. OONI's mission is to *"ensure a free and open internet by increasing transparency of internet censorship worldwide."* While no user

appears to have faced repercussions from using the OONI probe, this may lead to a false sense of security or incorrect assumptions about anonymity. As emphasized in OONI's onboarding quiz, probe tests can be visible on the network.

Virtual Machine & Other In order to gather ground truth, a virtual machine in Israel is used to run OONI command line interface locally. This machine is accessed via SSH. These technologies will be discussed further below. The chosen provider, *interhost.co.il*, has a strong track record regarding data integrity and security; however, further scrutiny is necessary. (100)

These tools were audited for any security and privacy concerns and the results are below. Tools like CloudFlare's TCP reset dashboard (101) gave further insight on instances of throttling, blocking or otherwise. In order to expand the web connectivity tests included with OONI, resources like Citizen Lab's sensitive domain list were included. (102)

## 5.2 Privacy & Security Concerns

The following section contains information on privacy and security concerns associated with the completion of the dissertation. This was completed in conjuncture with an assignment given 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. Initially, theoretical vulnerabilities will be explored. Specific cases such as Israel and Ireland will then be analyzed. Finally, a practical perspective will examine realistic security and privacy concerns, along with relevant case studies.

### 5.2.1 OONI Probe

OONI's positive track record is emphasized by the claim: *"To our knowledge, no OONI Probe user has ever faced consequences as a result of using our software."* (103). The success

of OONI is critically dependent on users conducting tests without repercussions. However, OONI outlines several scenarios in which 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 who fall into one or more of these 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.

### **5.2.2 SSH & Virtual Machine**

A virtual machine (VM) emulates a computer system. It is a file (.img) that contains instructions to create a virtual environment, leveraging physical PC resources. The provider was chosen based on location availability, with Interhost offering a machine in Tel Aviv. The shared nature of resources introduces vulnerabilities. The number of users sharing the same hardware is unknown, so file-sharing precautions were taken. Storing sensitive information on this VM may be unwise for these reasons.

SSH is a cryptographic protocol that allows users to securely and remotely control a machine over an unsecured network. It employs a client-server model with public-private key pairs for encryption and password authentication. In this project, SSH was used to remotely control the VM in Tel Aviv. Upon generating key pairs, authentication was established, and the VM became accessible. Provided secure settings are maintained and the private key is never shared, SSH is a reliable and trustworthy protocol (104).

### **5.2.3 Other Security and Privacy Considerations**

Personal safety risks in researching internet censorship must be addressed. My supervisor highlighted that selecting a comparison country required more than just finding a contrast. Publishing documents that critique government censorship has historically been risky (105, 106). However, this research is relatively low-risk.



Particularly compared to cases like Assange or Snowden. MIFTAH, an organization advocating open dialogue on the Israel-Palestine conflict, reported 310 press freedom violations from 2000-2003 (107). Although Israel has a history of reprisals, these incidents were tied to conflict zones such as Gaza. This research is not of a whistleblowing nature, reducing potential risks.

Researching Israeli state-sponsored internet censorship inevitably intersects with ongoing conflicts. The thesis remains unbiased and non-political. Historical events are included only to provide accurate context for internet censorship analysis. While Israel's military has strong ties to information control (108), it is crucial that internet censorship is examined from an empirical lense.

The security and privacy considerations for this project required assessing all tools used. OONI's privacy and security protocols appear robust. Its strong track record reinforces this confidence. SSH, as a long-established protocol, remains secure when best practices are followed. Potential consequences of researching this area are more extensive than initially anticipated. However, given my threat model, adverse effects are unlikely. Best practices will continue to be followed to ensure nonpartisan, data-driven research.

## 6 | Results

## 7 | Conclusions

### 7.1 Analysis: Ireland vs Israel

It is clear from the research conducted that Ireland and Israel's internet censorship situations share commonalities. Specifically, both countries are active in censoring pirated media and otherwise illegal content. However this is not the only similarity shared. Both Israel and Ireland were early adopters of internet technologies as illustrated above. Though the two governments participated in this development to varying extents, it resulted in the successful deployment of the internet in both cases. Both countries leverage judicial process to combat pirated media, copyright infringement and otherwise illegal content. Ireland benefits greatly from its membership in the European Union, however this means enforcing GDPR, DSA and more.

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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.