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Investigating Nation-state Internet Censorship Methods

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Summary

Nation-states impose various levels of censorship on their Internet communications. As access to Internet resources has grown among the global population, some governments have demonstrated an increased willingness to filter content, throttle connections, or deny access to Internet resources within their sphere of influence. Researchers, policymakers, and civil liberty advocates need an understanding of the technical means that Internet censors implement. This work presents a research framework that provides a worldwide view of nation-state Internet censorship, derived from Internet measurement data and systematic literature review.

Motivation

UKRAINE — USA TODAY
Russia increases censorship with new law: 15 years in jail for calling Ukraine invasion a 'war'
Celina Tebor, USA TODAY
Published 11:00 p.m. ET March 8, 2022 | Updated 11:12 p.m. ET March 8, 2022 [1]

Americas — REUTERS
Censorship circumvention tool helps 1.4 million Cubans get internet access
By David Shepardson
July 16, 2021 6:58 PM UTC Last Updated 8 months ago [2]

China is now blocking all encrypted HTTPS traffic that uses TLS 1.3 and ESNI
The block was put in place at the end of July and is enforced via China's Great Firewall.
Written by Catalin Cimpanu, Contributor
Posted in Zero Day on August 8, 2020 | Topic: Security ZDNet [3]

70% of global internet shutdowns in 2020 were in India: Report
THE TIMES OF INDIA
Anam Ajmal / TNN / Updated: Mar 4, 2021, 07:44 IST [4]

FREEDOM ON THE NET 2021

Status	Countries
FREE	18
PARTLY FREE	31
NOT FREE	21
Total	70

For more information about the report's geographical coverage, visit freedomonthenet.org. [5]

Framework & Data (Abridged)

Legend:
● = observed, persistent censorship
○ = observed, time-based
▼ = historical observations
□ = unconfirmed

COUNTRY	ISO 3166-1 Country Code	Obstacles to Access	Limits on Content	Violations of User Rights	FOTN 2021 Total Score	FOTN 2021 Status	Internet Shutdowns	IP Address or Port Blocking	BGP Attacks and Disruption	Bandwidth Throttling	DNS Tampering	HTTP/URL/Keyword Filtering	TLS-based Filtering	Protocol Fingerprinting	Notes
China	CN	8	2	0	10	Not Free	○	●			●	●	●		Centralized active blocking of VPNs, circumvention tools, secure messengers and more
Iran	IR	8	5	3	16	Not Free	○	●*		▼	●	●	●		*Particular endpoints associated with QUIC/UDP targets
Myanmar (Burma)	MM	4	7	6	17	Not Free	●	●	●	○	●	▼			Military junta coup d'état after 2020 elections
Cuba	CU	5	9	7	21	Not Free	○				●	●		▼	Mass anti-government protests of COVID-19 pandemic response
Vietnam	VN	12	6	4	22	Not Free					▼	▼	●		Censorship focus in print media
Saudi Arabia	SA	12	8	4	24	Not Free	▼			▼	▼	●	●		Reduced overall Internet filtering between 2017-2020
Pakistan	PK	5	13	7	25	Not Free	○	▼	▼*	▼	●	●	●		*Global YouTube disruption via BGP 24FEB2008
Egypt	EG	12	10	4	26	Not Free	○	▼			●	●	●		
Ethiopia	ET	12	4	11	27	Not Free	●	▼				●	●		Tigray civil war
United Arab Emirates	AE	12	9	6	27	Not Free					●	●	●	▼	
Uzbekistan	UZ	9	12	7	28	Not Free	○				●	●	●		
Venezuela	VE	6	12	10	28	Not Free				▼	▼	●	●		
Bahrain	BH	16	8	6	30	Not Free				▼	▼	●	●		
Russia	RU	12	10	8	30	Not Free	○	▼		○	●	●	●	●	Decentralized, novel hybrid censor approaches observed
Belarus	BY	10	14	7	31	Not Free	○	▼			●	●	●		Nation-wide deployment of government-issued root certificate, MITM interception 2019
Kazakhstan	KZ	11	11	11	33	Not Free	○		▼	▼	●	●	●		Limited data available
Sudan	SD	6	15	12	33	Not Free	●				●	●			Limited data available
Turkey	TR	15	10	9	34	Not Free	▼	▼	▼*	▼	●	●	●		*Global Internet disruption via BGP routes to Turkey 24DEC2004
Azerbaijan	AZ	10	14	11	35	Not Free	○			▼	●	●	●		Second Nagorno-Karabakh war, late 2020
Thailand	TH	16	13	7	36	Not Free					▼	●	●		High levels of inconsistency in routing, content mismatches
Rwanda	RW	13	11	14	38	Not Free						▼			Limited data available
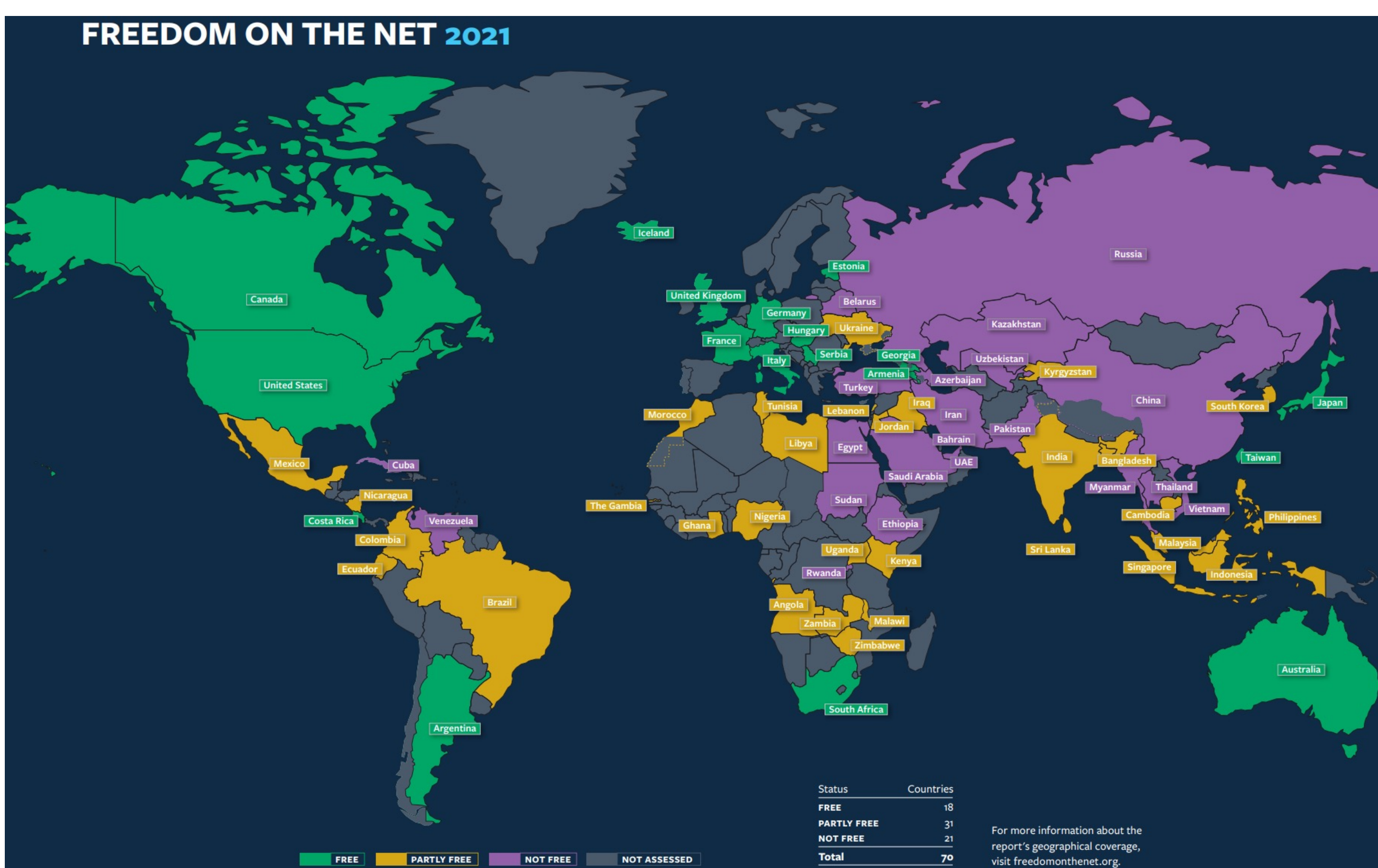
Our Contributions

(1) Extensive cross-sectional study of 70 countries
(2) Systematic Literature Review over 20-year period
(3) Easily reproducible framework for global data analysis

Takeaways

Decline in use of blunt/naive techniques
- IP blocklists less effective, difficult to maintain
- IPv6 implementations
- Collateral damage – CDNs, political considerations
- Port blocking is rare

Historical URL filtering (HTTP) is less effective
- Mozilla Telemetry report, Oct 2021 82% of the web is TLS traffic [6]

Troubling rise in use of Internet Shutdowns (29/70 nations)

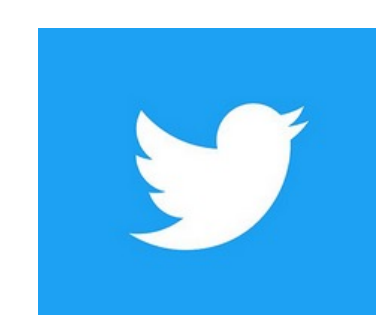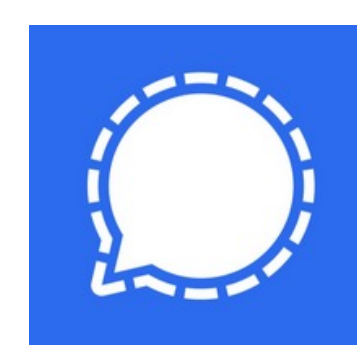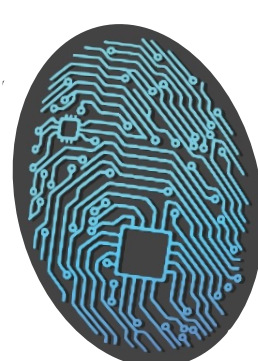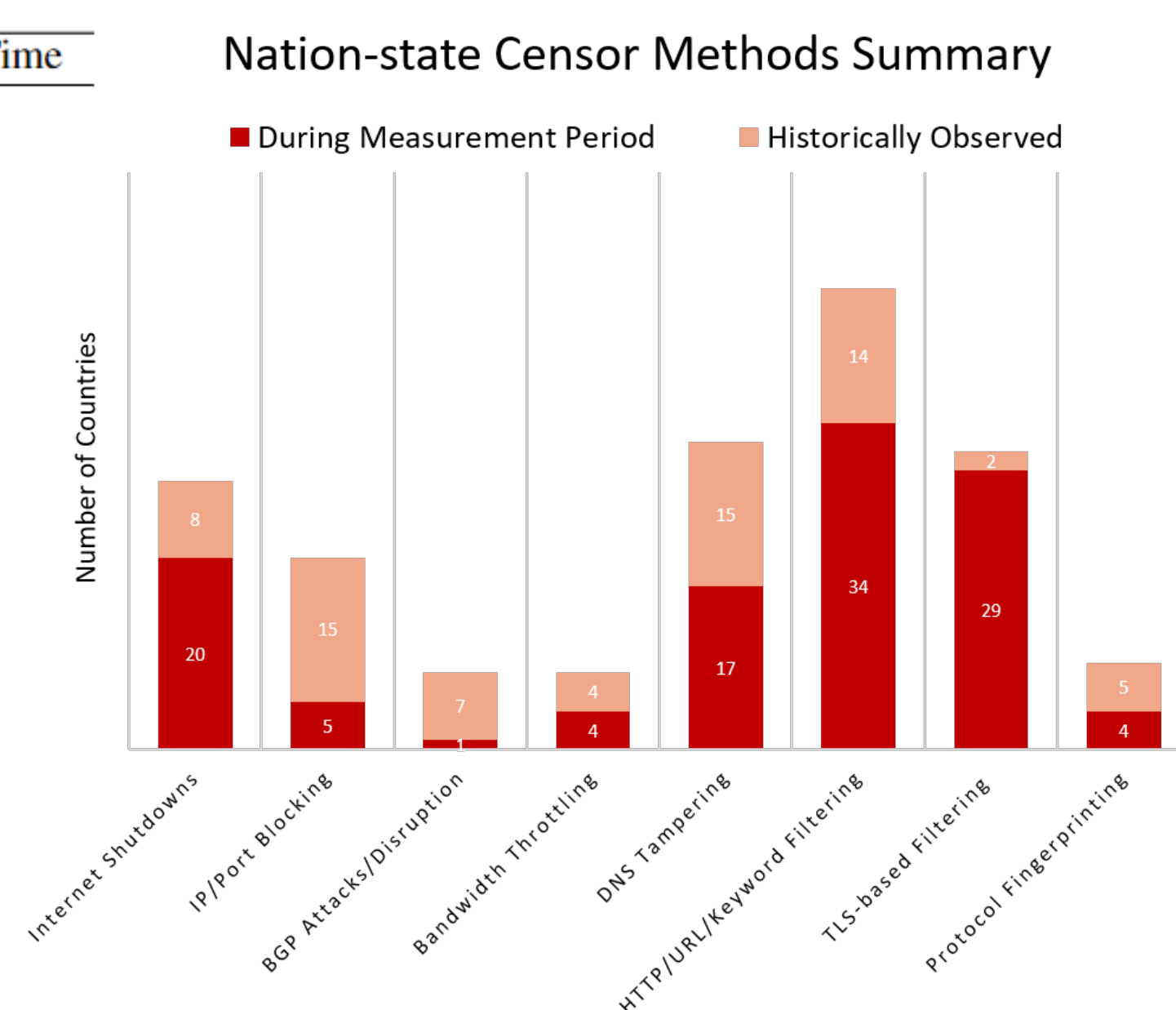**Formerly resource-intensive methods gaining traction**
- Use of SNI-based blocking via DPI (ECH is needed!)
- Protocol targeting as E2EE encryption proliferates
- More regimes willing to invest in deep packet inspection (DPI) technology to meet their goals, while avoiding overblocking which results in economic collateral damage

Surprising incidents in understudied countries, such as Canada and the United Kingdom

Analysis & Trends

Table 1: Percentage of Countries that Use Each Internet Censorship Method in the Framework

Censor Method	% During Study Period	% All-Time
Internet Shutdowns	29	40
IP/Port Blocking	7	29
BGP Attacks/Disruption	1	11
Bandwidth Throttling	6	11
DNS Tampering	24	46
HTTP/URL/Keyword Filtering	49	69
TLS-based Filtering	41	44
Protocol Fingerprinting	6	13

Nation-state Censor Methods Summary
(Legend: During Measurement Period / Historically Observed)

Method	During Measurement Period	Historically Observed
Internet Shutdowns	20	8
IP/Port Blocking	5	15
BGP Attacks/Disruption	2	2
Bandwidth Throttling	4	4
DNS Tampering	17	15
HTTP/URL/Keyword Filtering	34	14
TLS-based Filtering	29	
Protocol Fingerprinting	4	5

Twitter Throttling Censorship Russia

References:
[1] https://www.usatoday.com/story/news/world/ukraine/2022/03/08/russia-free-speech-press-criminalization-misinformation/9433112002/
[2] https://www.reuters.com/world/americas/censorship-circumvention-tool-helps-14-million-cubans-get-internet-access-2021-07-16/
[3] https://www.zdnet.com/article/china-is-now-blocking-all-encrypted-https-traffic-using-tls-1-3-and-esni/
[4] https://timesofindia.indiatimes.com/india/70-of-global-internet-shutdowns-in-2020-were-in-india-report/articleshow/81321980.cms
[5] https://freedomhouse.org/report/freedom-world/2021/democracy-under-siege
[6] https://letsencrypt.org/stats/

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