The Anatomy of Web Censorship in Pakistan

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This website is not accessible in Pakistan!

- First study of the cause, effect, and mechanism of Internet censorship in Pakistan
- Upgrade to centralized system in the middle of the study (May 2013)
- Censorship mechanism varies across websites: some blocked at the **DNS level**; others at the **HTTP level**
- **Public VPN** services and **web proxies** popular tools to bypass restrictions

Outline

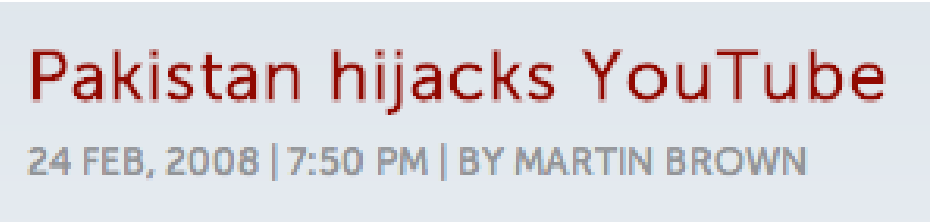
- Background: Pakistan and related work
- Methodology
- Results
- Alternative circumvention methods
- Summary
- Future work
- Qs

Internet in Pakistan

- **16 million** users or **9%** of total population (World Bank, 2012)
- Out of the total Internet users, **64%** access news websites (YouGov, 2011)
- Largest IXP (**AS17557**) owned by the state
- Internet, fixed-line telephony, cable TV, and cellular services regulation by the **Pakistan Telecommunication Authority** (PTA)
  - Also in charge of censorship

History of Censorship

- 2006: 12 websites blocked for blasphemous content
- 2008: A number of YouTube videos blocked
  - IP-wide block via BGP misconfiguration
  - YouTube rendered inaccessible for the rest of the world for 2 hours



Pakistan ban to blame for YouTube blackout

Pakistan blamed for YouTube blackout

Pakistan turns off YouTube worldwide

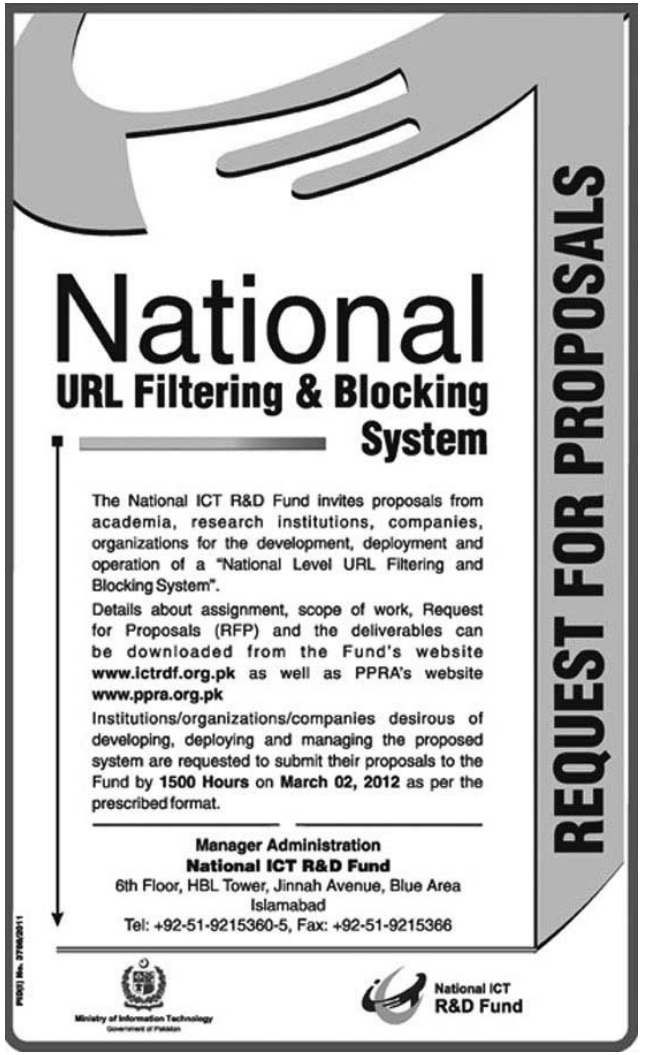
How Pakistan Hacked YouTube for the World

History of Censorship (2)

- 2010: Facebook, YouTube, Flickr, and Wikipedia blocked in reaction to “Everybody Draw Muhammad Day”
  - PTA sanctioned to terminate any telecom service

First Facebook, now Pakistan bans YouTube over 'un-Islamic' content

History of Censorship (3)



REQUEST FOR PROPOSALS

National
URL Filtering & Blocking System

The National ICT R&D Fund invites proposals from academia, research institutions, companies, organizations for the development, deployment and operation of a "National Level URL Filtering and Blocking System".

Details about assignment, scope of work, Request for Proposals (RFP) and the deliverables can be downloaded from the Fund's website **www.ictrdf.org.pk** as well as PPRA's website **www.ppra.org.pk**

Institutions/organizations/companies desirous of developing, deploying and managing the proposed system are requested to submit their proposals to the Fund by **1500 Hours** on **March 02, 2012** as per the prescribed format.

Manager Administration
National ICT R&D Fund
6th Floor, HBL Tower, Jinnah Avenue, Blue Area
Islamabad
Tel: +92-51-9215360-5, Fax: +92-51-9215366

Ministry of Information Technology

National ICT R&D Fund

- 2012 (March): Government requests proposals for gateway-level blocking system
  - Filtering from domain level to sub-folder level
  - Blocking individual IPs and/or entire range
  - Plug-and-play hardware units, capable of blocking 50 million URLs
    - Latency < 1ms

History of Censorship (4)

- 2012 (September): Infinite ban on YouTube in retaliation to “Innocence of Muslims”
  - Disruption of other Google services due to IP sharing

Related Work

- Verkamp and Gupta
  - PlanetLab nodes and volunteer machines, **11 countries**
  - Key insight: *censorship mechanisms vary across countries*
- Mathrani and Alipour
  - Private VPNs and volunteer nodes, **10 countries**
  - Key insight: *restrictions applicable to all categories of websites: political, social, etc.*
- Dainotti *et al.*
  - Internet blockage during the **Arab Spring**

Methodology: Dataset

- Publicly available list with **597** websites
- Compiled in **2010**
- Not exhaustive but a fairly rich of complete domains and subdomains
- Dataset after cleaning: **307** websites
  - Redundant, broken, and duplicates removed
- Checked with a public VPN beforehand to ensure connectivity

Methodology: Script

- Modified version of the CensMon system (FOCI '11)
  1) DNS lookup
     - Local and public (Google, Comodo, OpenDNS, Level3, and Norton)
  2) IP blacklisting: TCP connection to port 80
  3) URL keyword filtering: http://www.google.com/fooURL
     - 404 Not Found under normal operation
  4) HTTP filtering: HTTP request, log response packet
- Also, logs transient connectivity errors, such as timeouts

Methodology: Networks

ID	Nature	Location
Network1	University	Lahore
Network2	University	Lahore
Network3	Home	Lahore
Network4	Home	Islamabad
Network5	Cellular (EDGE)	Islamabad

- *Network1* and *2*: gigabit connectivity
- *Network5* only used for post-April testing
- Tests performed at night time to minimize interaction with normal traffic
- Performed on multiple occasions for precision

Results: Pre-April

- Most websites blocked at **DNS-level**
  - Local DNS: “Non-Existent Domain” (`NXDOMAIN`)
  - Public DNS: `NXDOMAIN` for Google DNS and Level3
    - `NXDOMAIN` redirector in case of Norton DNS, Comodo, and OpenDNS
- No evidence of **IP** or **URL-keyword** filtering
- Some websites filtered through **HTTP 302** redirection
  - Triggered by **hostname** and **object URI**
  - Done at the ISP level

ISP-level Warning Screens

Dear Valuable Customer,

Your requested site is blocked by PTA. Please consult PTA if you have any query regarding requested site

Visit=?

Valued Customer!

This website access is restricted either due to instructions of Pakistan Telecommunication Authority or because of Policy Implementations by concerned ISP/WebAdmin.

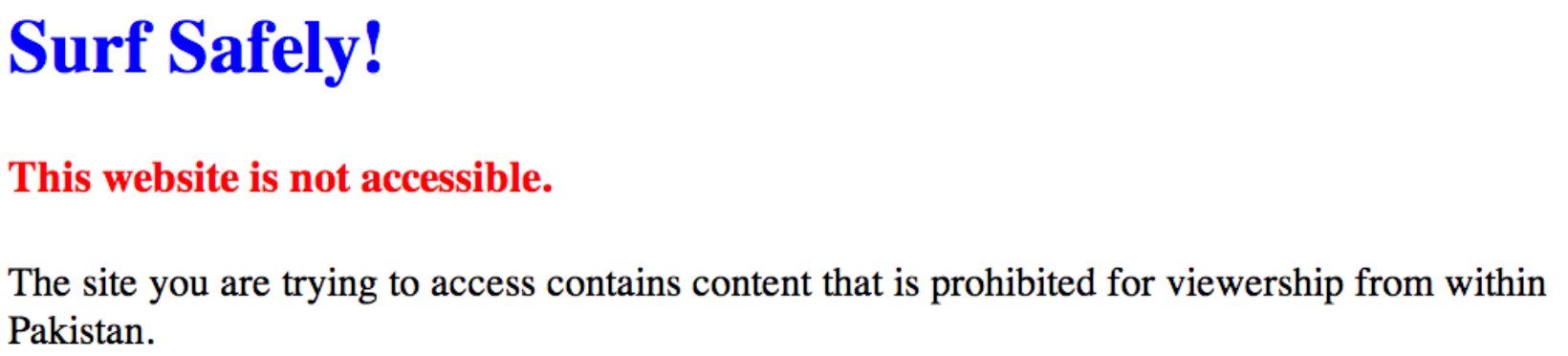
In case you feel this webpage is legitimate and should be accessible, please contact our Customer Care Centre @1218.

Apologies for inconvenience..

Results: Post-April

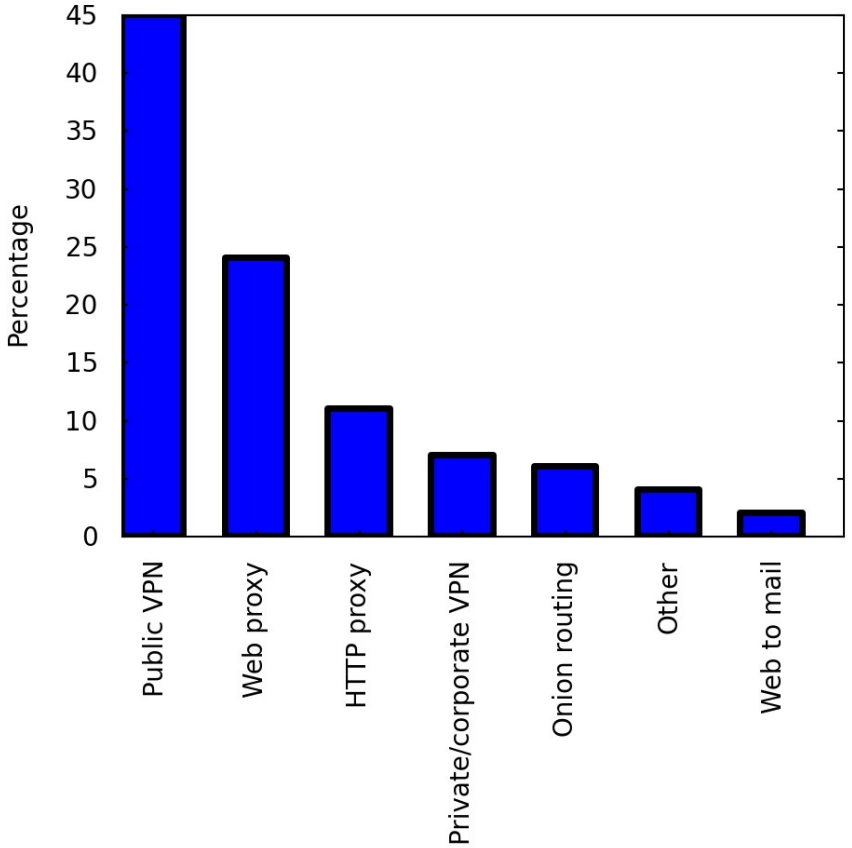
- HTTP 302 redirection replaced with **IXP-level 200 packet injection**
  - Triggered by **hostname and URI**
  - Because of the 200 code, the browser believes it's a normal response
    - Stops it from fetching content from the intended destination
    - Original TCP connection times out
- Same response packet and screen across ISPs
  - Except *Network4* (still under the influence of pre-April censoring)

IXP-level Warning Screen



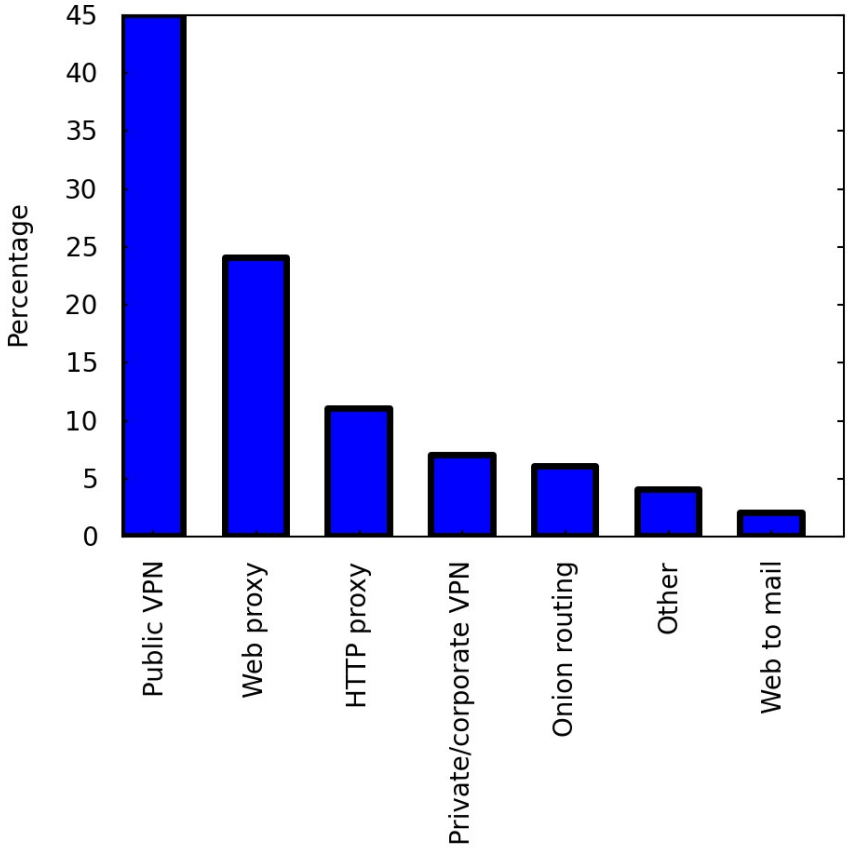
- Same results reported by “The Citizen Lab” in parallel in June, 2013
- System attributed to the Canadian firm Netsweeper Inc.
  - Also applicable to Qatar, UAE, Kuwait, and Yemen

Results: Survey



- 67 respondents
  - Results biased towards individuals with above-average computer skills
- Public VPN services, such as Hotspot Shield, most popular
- Web proxies also popular

Results: Survey



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Alternative Circumvention: Web-based DNS

- Generally, web-based service can also be used for lookup
- Results show that same websites also blocked at HTTP-level
- Similar to South Korea
  - DNS filtering used for websites that resolve to a single site
  - HTTP-level mechanism exclusively used for websites with IPs shared across hostnames and filtering needs to be selective
    - YouTube, Wikipedia, etc.

Alternative Circumvention: CDNs and Search Engine Caches

- No URL-keyword filtering
- Blocked websites accessible via CoralCDN
- Cached pages of blocked content also accessible on Google, Bing, and Internet Archive

Summary

- Pakistan has undergone an upgrade from ISP-level to centralized IXP-level censorship
- Most websites blocked at the DNS level, while a small number at the HTTP level
- Websites blocked at the DNS level also blocked at HTTP-level
- Most citizens use public VPNs and web proxies to circumvent restrictions

Future Work

- Expansion in the number of websites and networks
- Deeper analysis of DNS blockage
  - For instance, not clear if censoring module maintains a list of all resolvers and their redirectors or it queries the actual resolver each time
- Examination of side-effects of DNS injection (similar to China)
- Analysis of “Streisand Effect” in Pakistan
  - Early results look promising!

Q?