A Look at the Consequences of Internet Censorship through an ISP Lens

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Agenda

- Problem Statement
- Description of Dataset
- Groundtruth Reconstruction
- Analysis
- Discussion

Consequences of Internet Censorship

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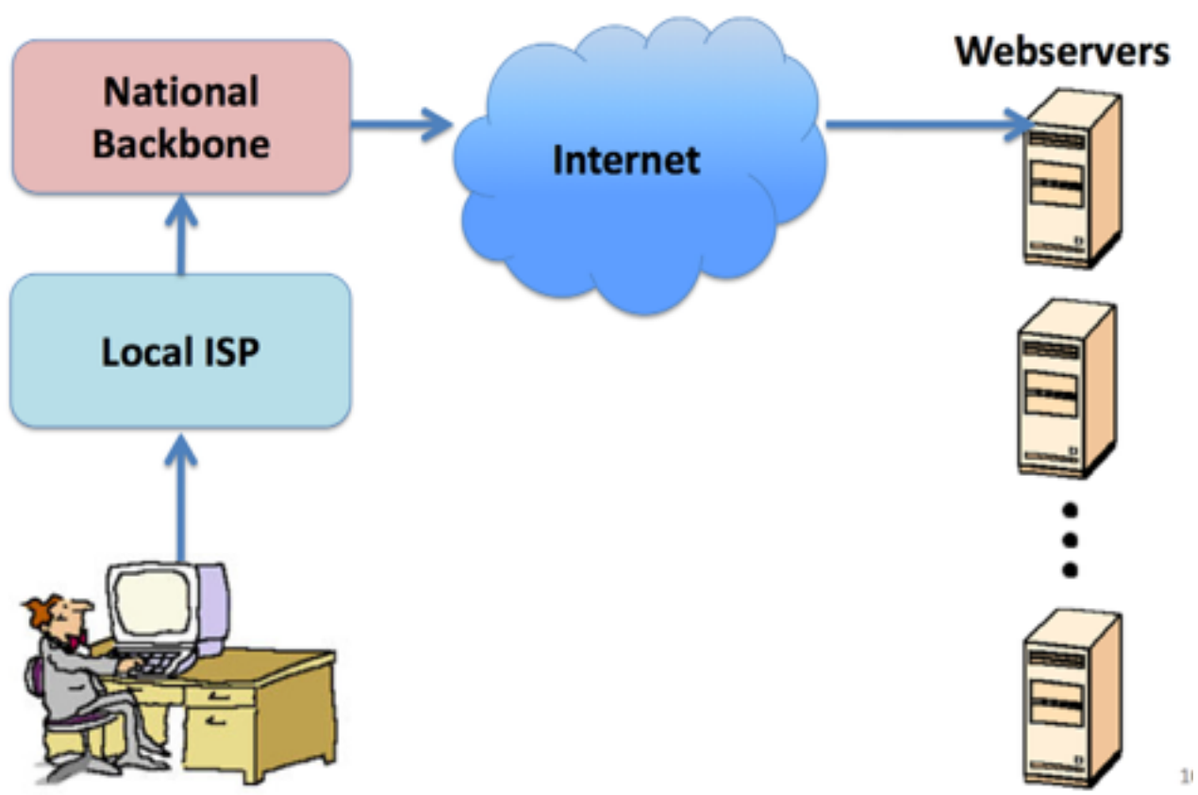
- When a persistent censorship policy emerges:
  - Do users comply and stop accessing the blocked content or do they subvert censorship on a massive scale?
  - Does censorship hurt or benefit ISPs?
  - How much do competing content providers thrive?

Challenges

- Measuring consequences of censorship requires data snapshots before and after the events
- A vantage point that captures all traffic a user exchanges with the Internet



We examine one slice of this overall question (the consequences of Internet censorship) in the context of ISP customers in Pakistan

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- Network traces captured at a medium-sized Pakistani ISP at different points between Oct'11-Aug'13

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- Represent snapshots around two major censorship events:
  - Nov'11: Thousands of porn domains blocked
  - Sep'12: YouTube blocked (continues to date..)

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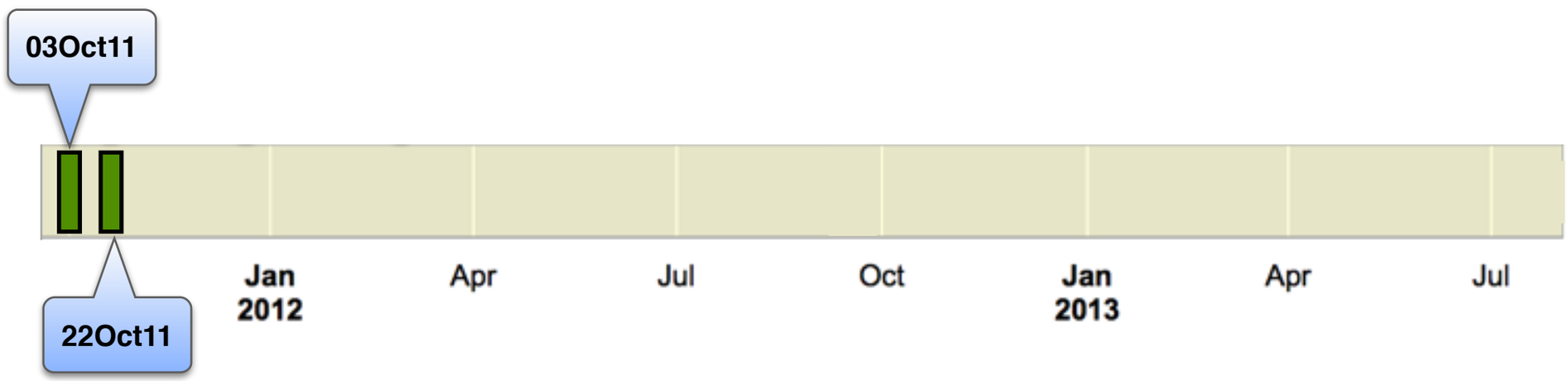

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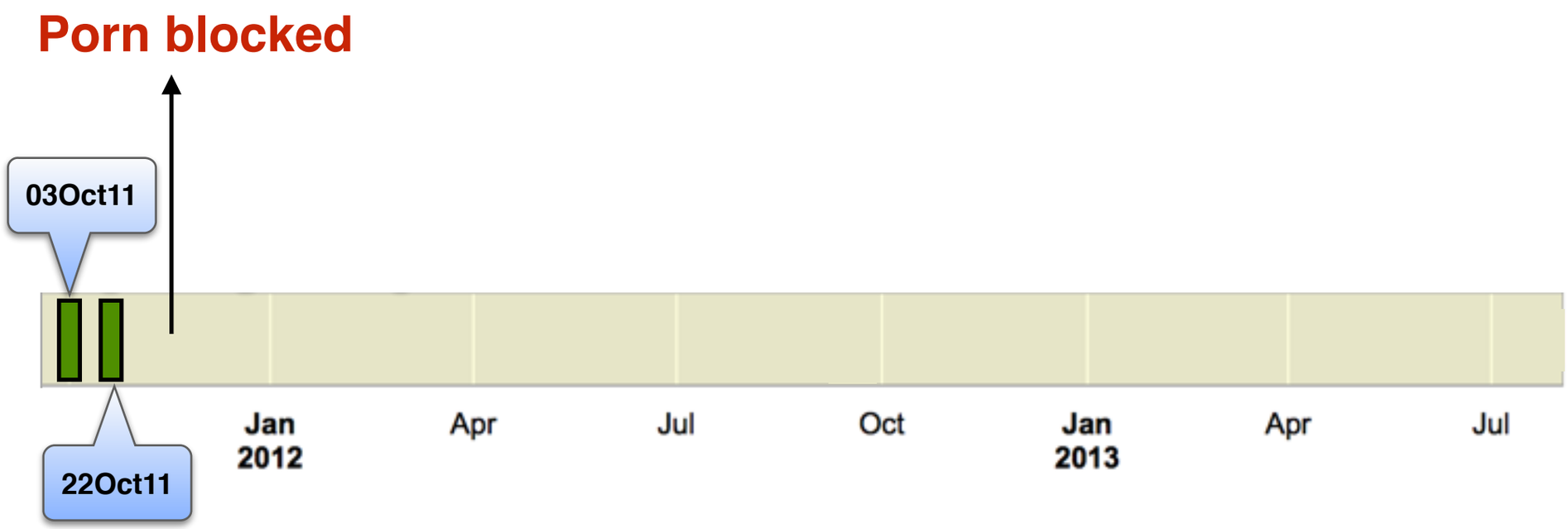

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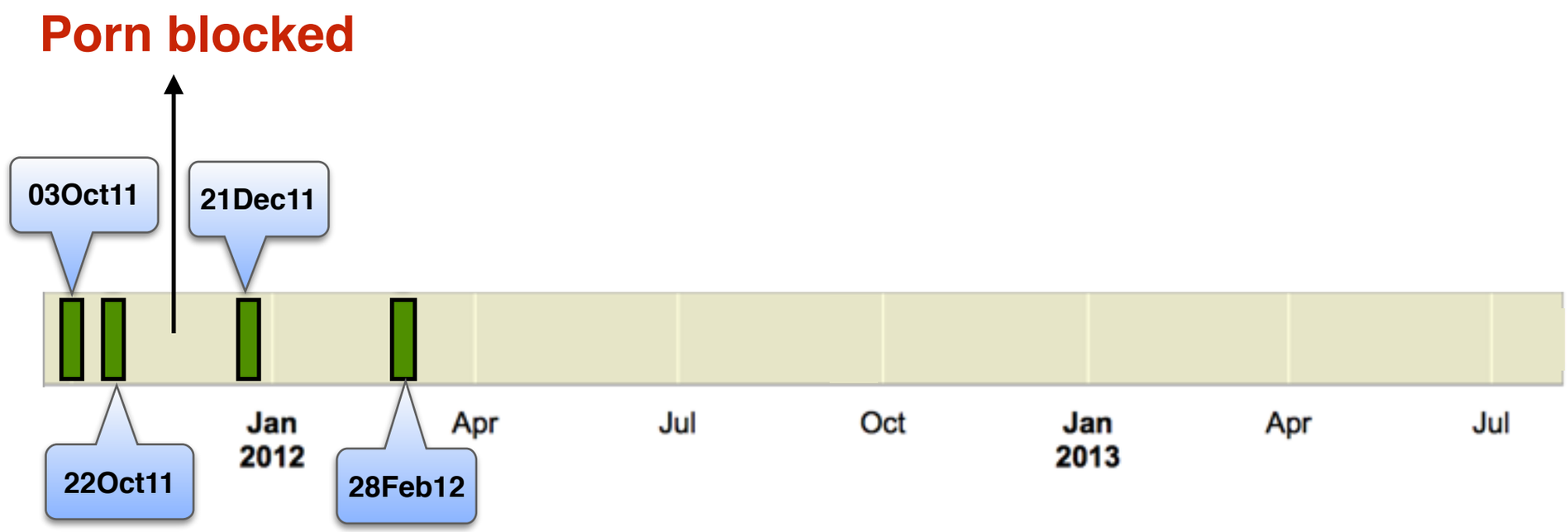

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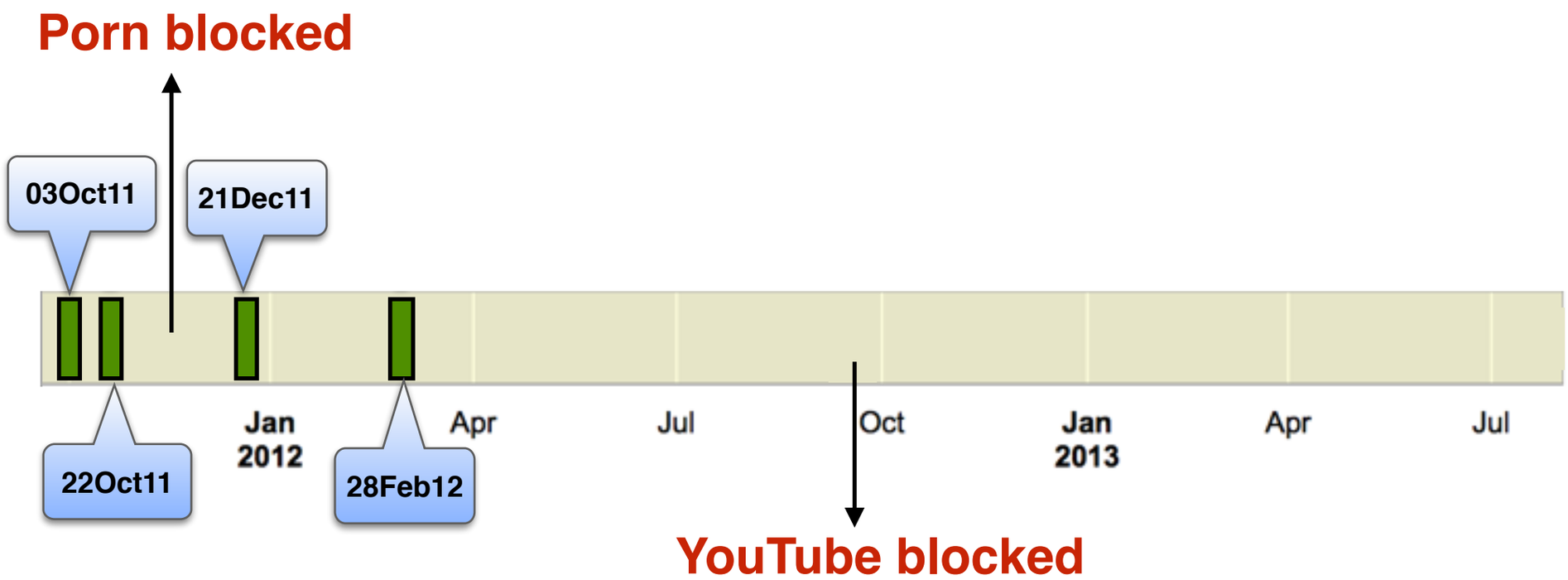

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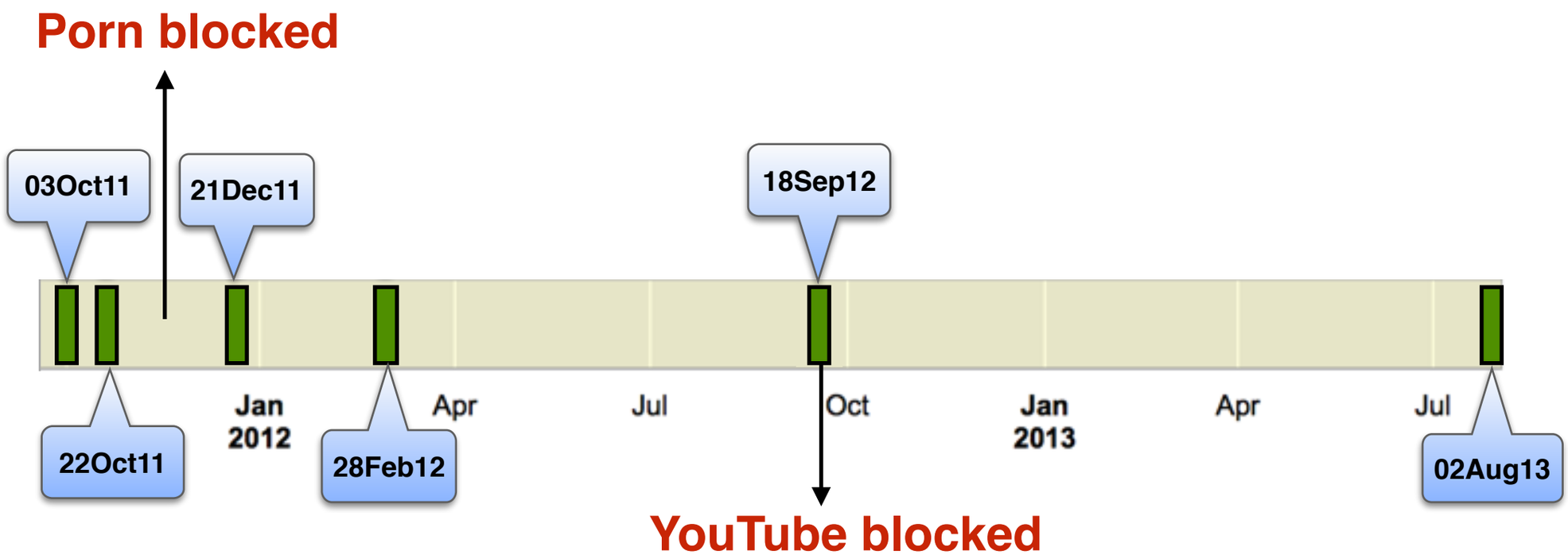

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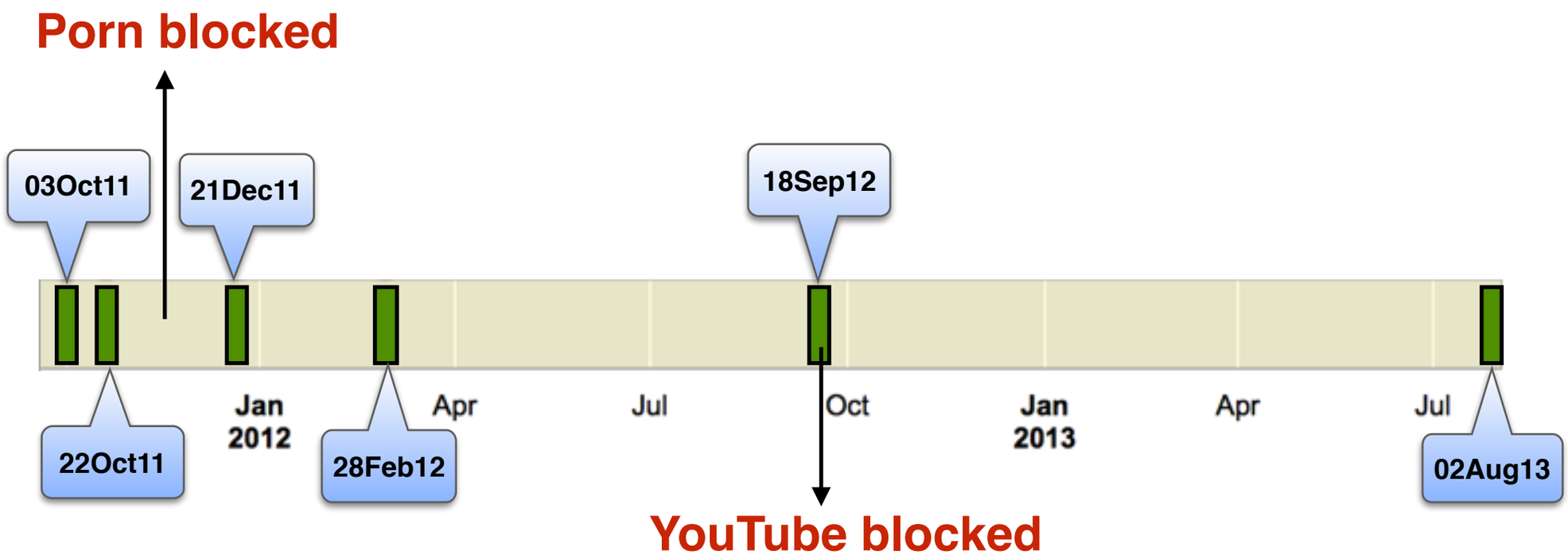

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- Entire analysis based on *Bro* protocol logs

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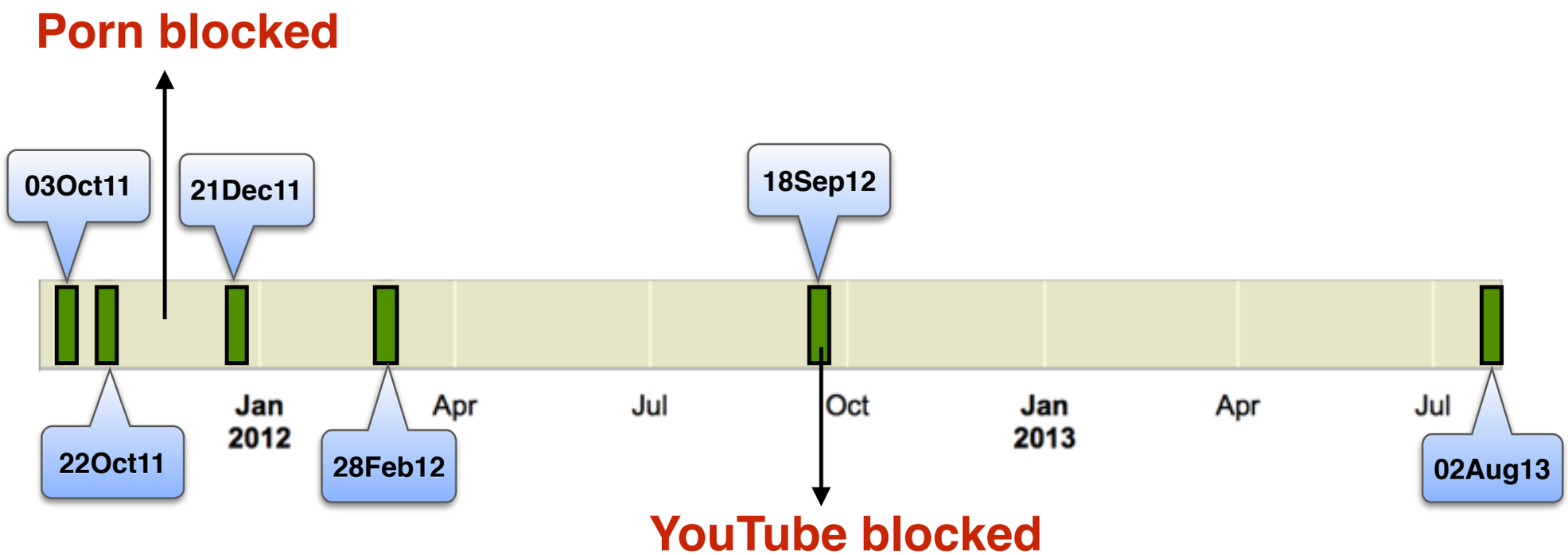

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  - **range between 200-500 GB and 6-20 hours**

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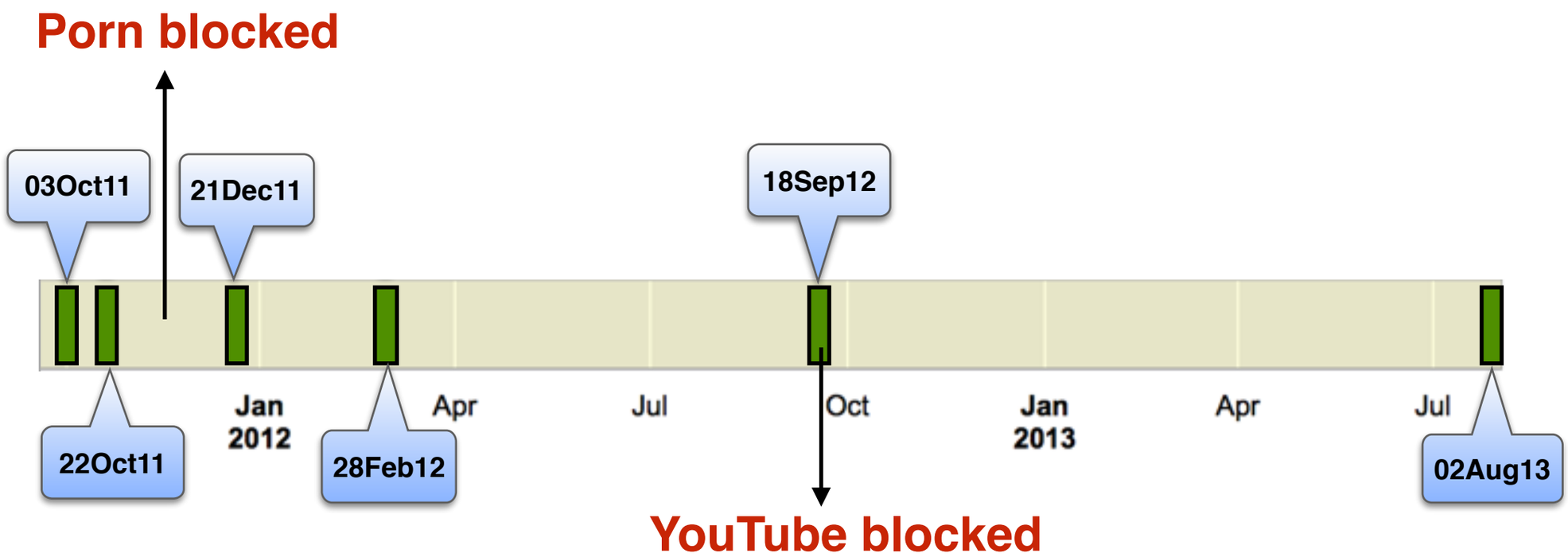
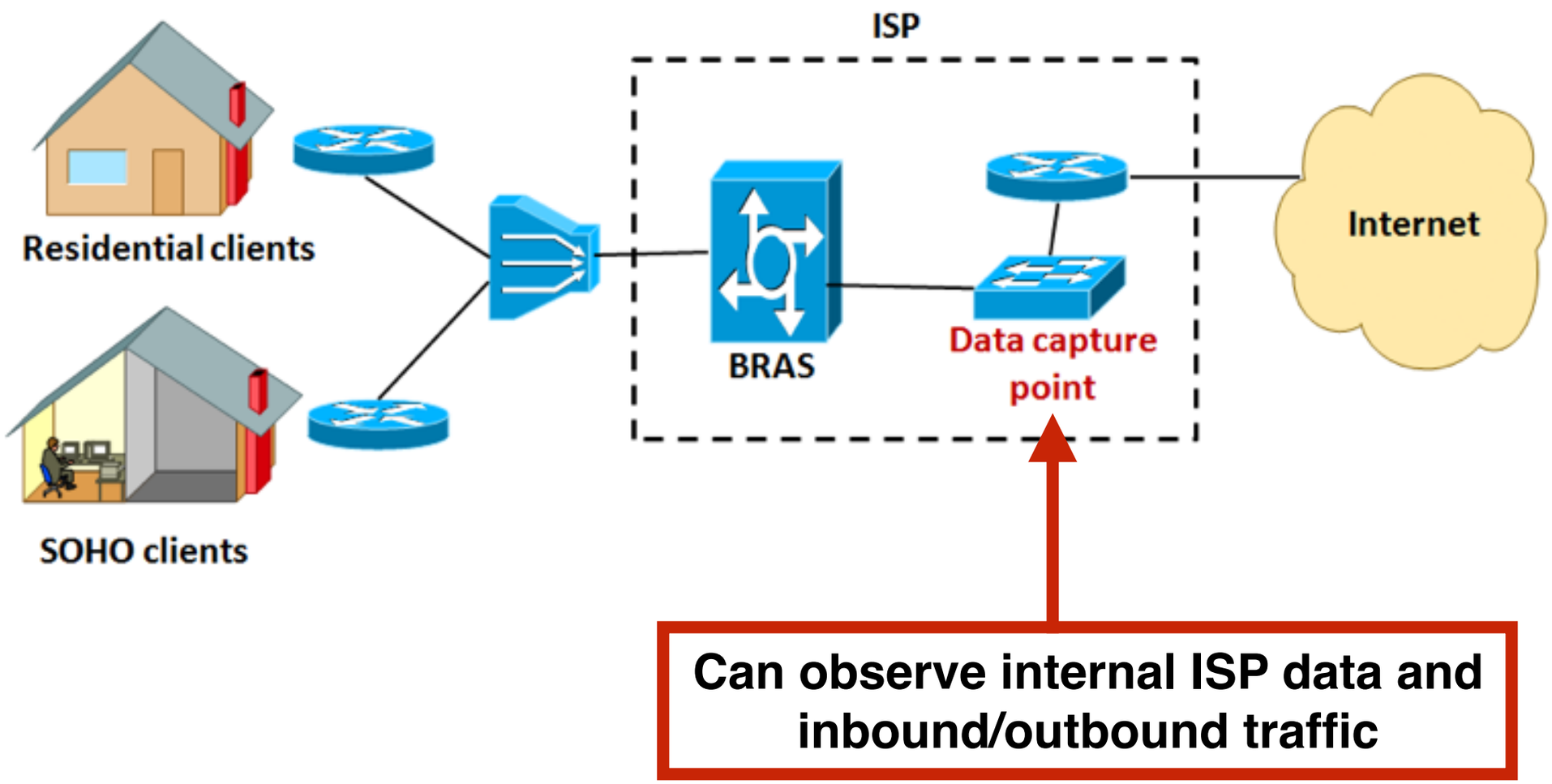


- ~1.8 TB data
- Entire analysis based on *Bro* protocol logs
- Individual traces
  - range between 200-500 GB and 6-20 hours
- **Traces split into Small Office/Home Office (SOHO) and Residential Traffic**

Capture Location



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Groundtruth Reconstruction

- We have historic dataset for which we lack ground truth:
  - What was blocked?
  - How was it blocked (DNS, TCP/IP, HTTP)

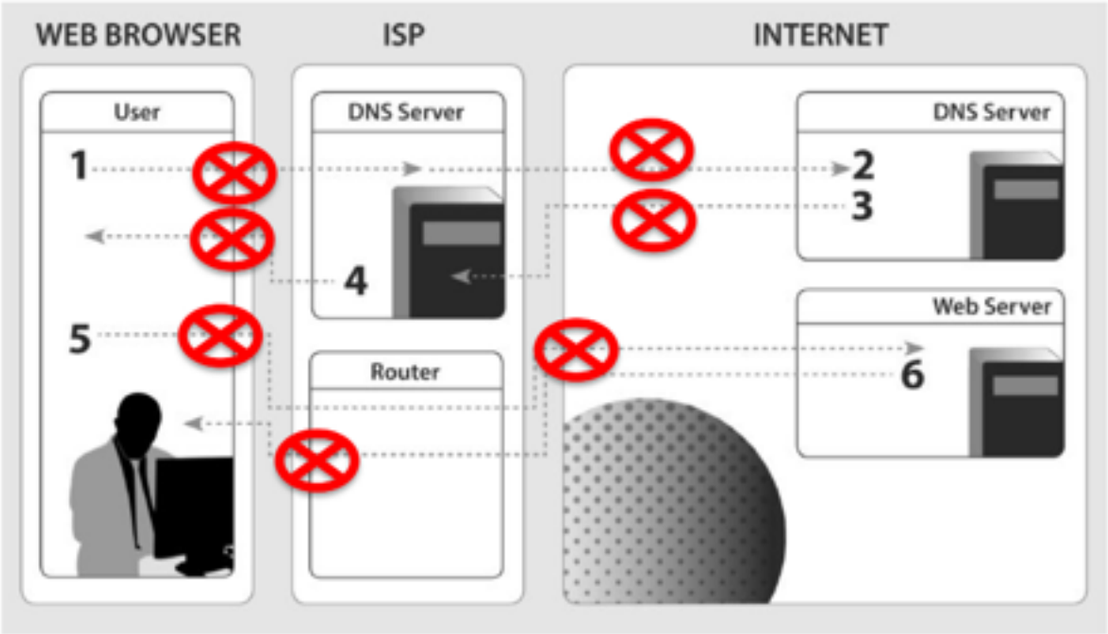
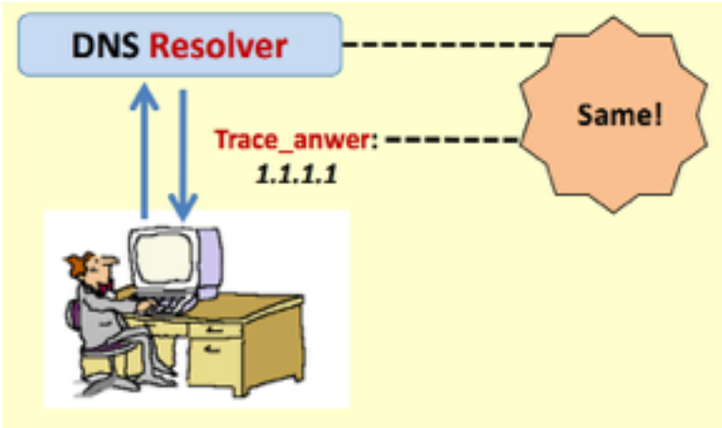


Figure: Murdoch, Steven J. and Anderson, Ross (2008) 'Tools and technology of Internet filtering', in R. J. Deibert, J. G. Palfrey, R. Rohozinski, & J. Zittrain (Eds.) *Access Denied: The Practice and Policy of Global Internet Filtering*. Cambridge, MA: MIT Press.

Groundtruth Reconstruction

- Censorship Indicators: A blocking mechanism leaves a trail in network traces.
- Ambiguous Indicators can occur because of legitimate reasons (server load, measurement loss)

- Unambiguous Indicators can be exclusively attributed to censorship (DNS redirection)



Groundtruth Reconstruction

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  - Known censored content: determined through a supplementary medium (e.g. newspapers)

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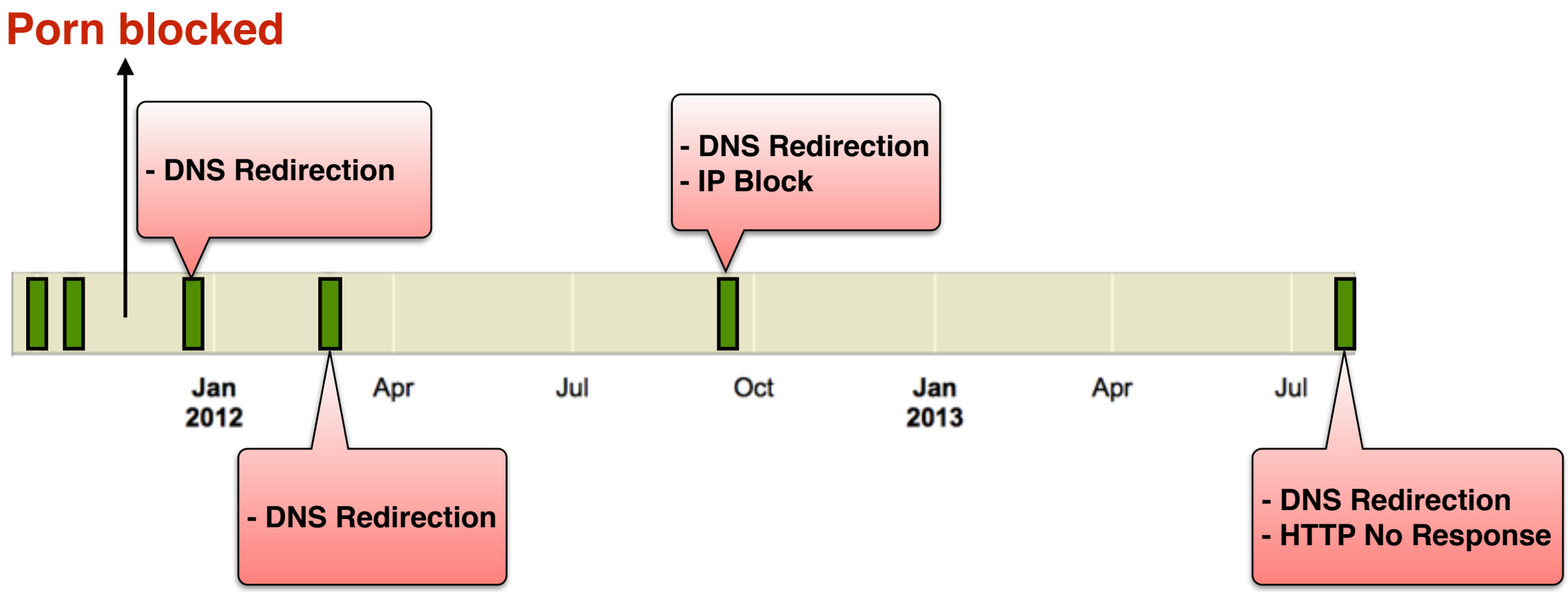
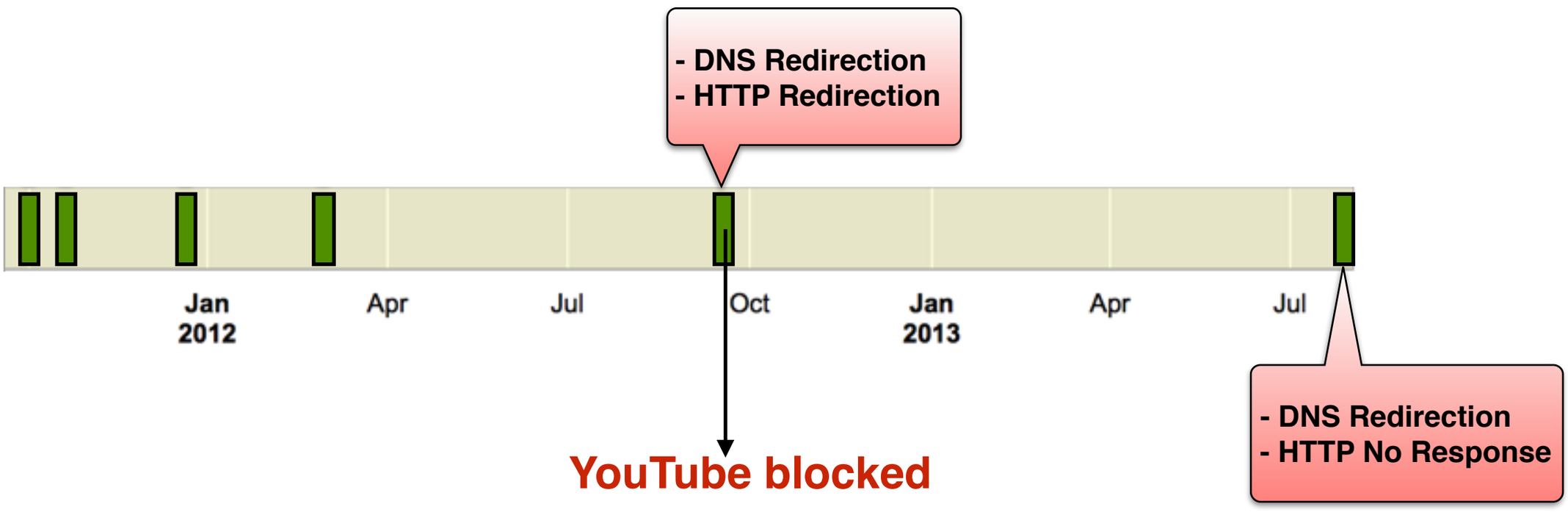
  - Known censored content: determined through a supplementary medium (e.g. newspapers)
  - Example: Consistently observe DNS No Response when the queried domain name is *porn*

Domain	Category	DNS Reply
facebook.com	Social networking	1.1.1.1
bad1.com	**Porn**	**-**
bad2.com	**Porn**	**-**
bbc.co.uk	News	2.2.2.2

Porn Censorship Mechanism



YouTube Censorship Mechanism



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Analysis

- Impact on end users, content providers and service providers
- Go over salient results in question/answer fashion

Analysis

- Consequences on content providers—>What constitutes a content provider?
  - Determine porn content by classifying all websites occurring in our dataset by topic using McAfee URL categ. service

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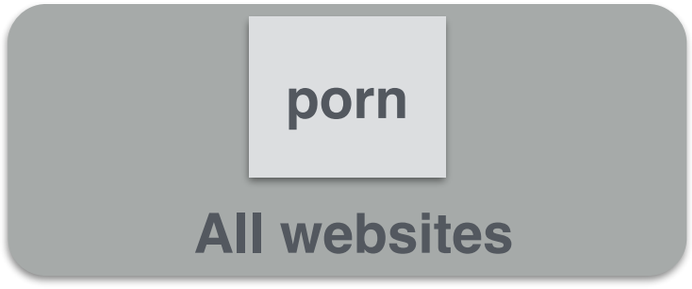
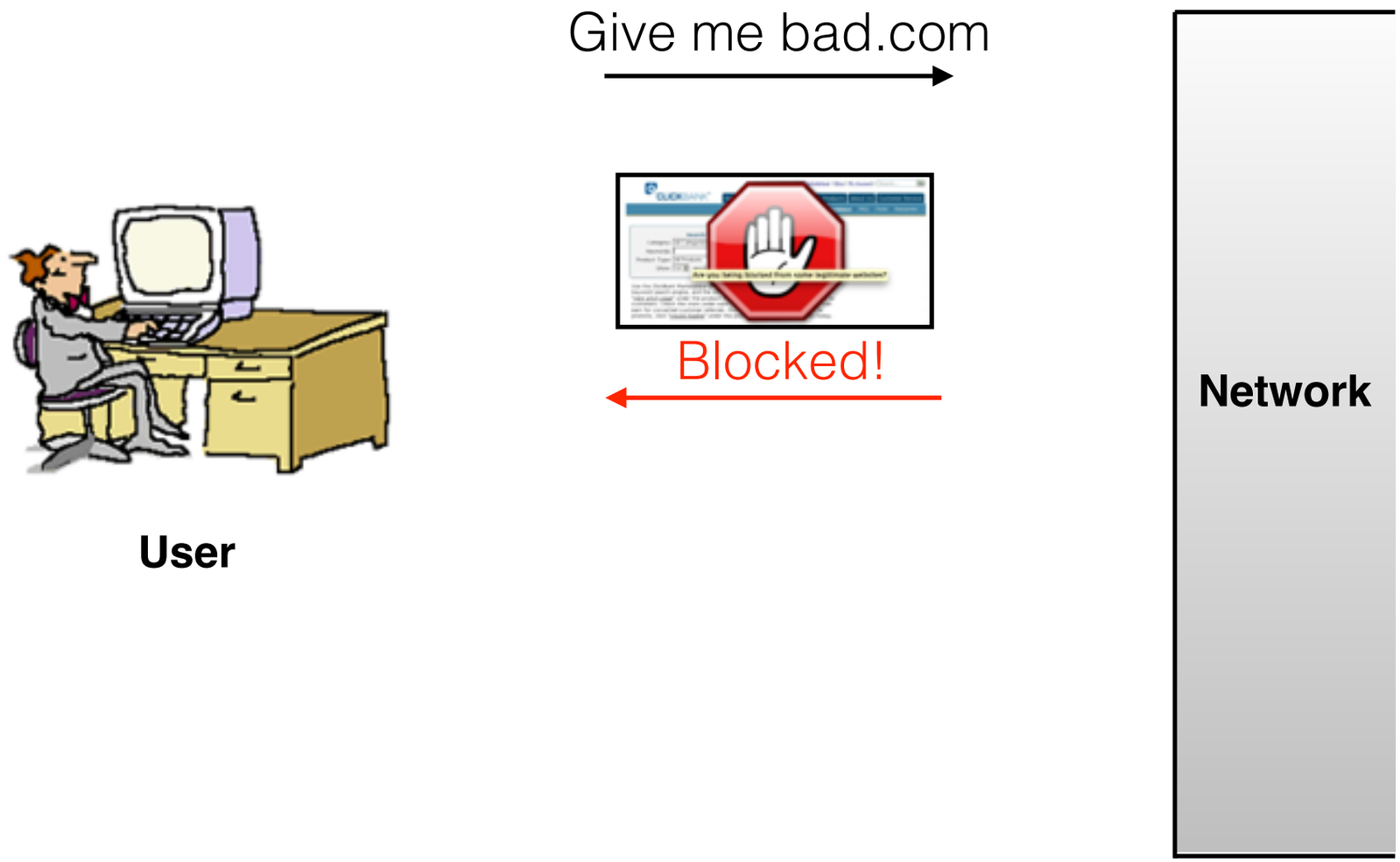


  - Competing content providers to YouTube determined by regional popularity (DailyMotion, Vimeo, TunePK)

Consequences on Users

What is user* response after viewing a block page?



* IP address + HTTP User Agent

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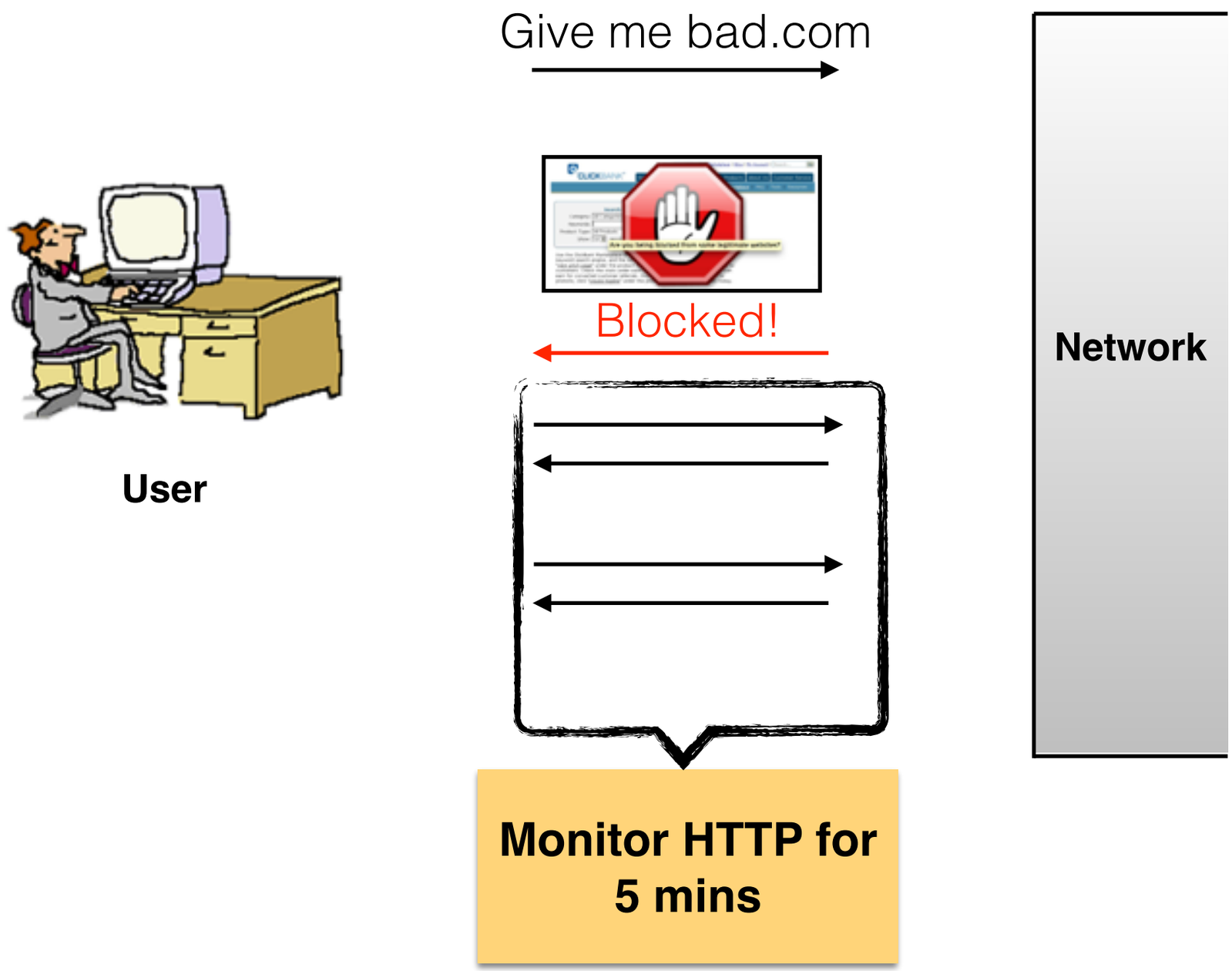

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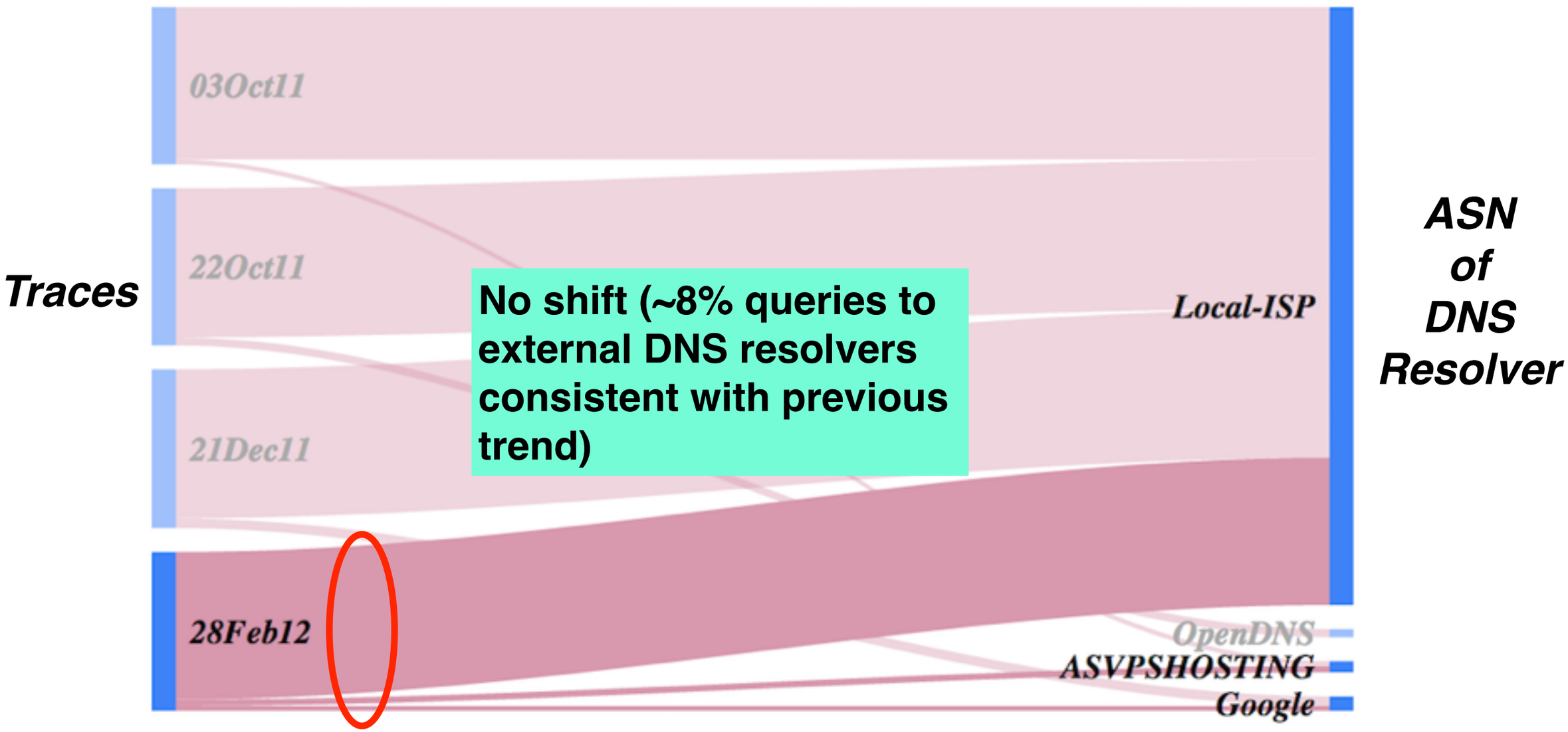
What is user* response after viewing a block page?

- Porn:
  - **60%** users perform **search engine query** (domain-specific)
  - **70%** users **access another porn domain**
- YouTube:
  - **75%** users perform **search engine query** (information retrieval)
  - **7%** users access an **alternate video content provider on the day of block**, rising to **12% a year later**.

* IP address + HTTP User Agent

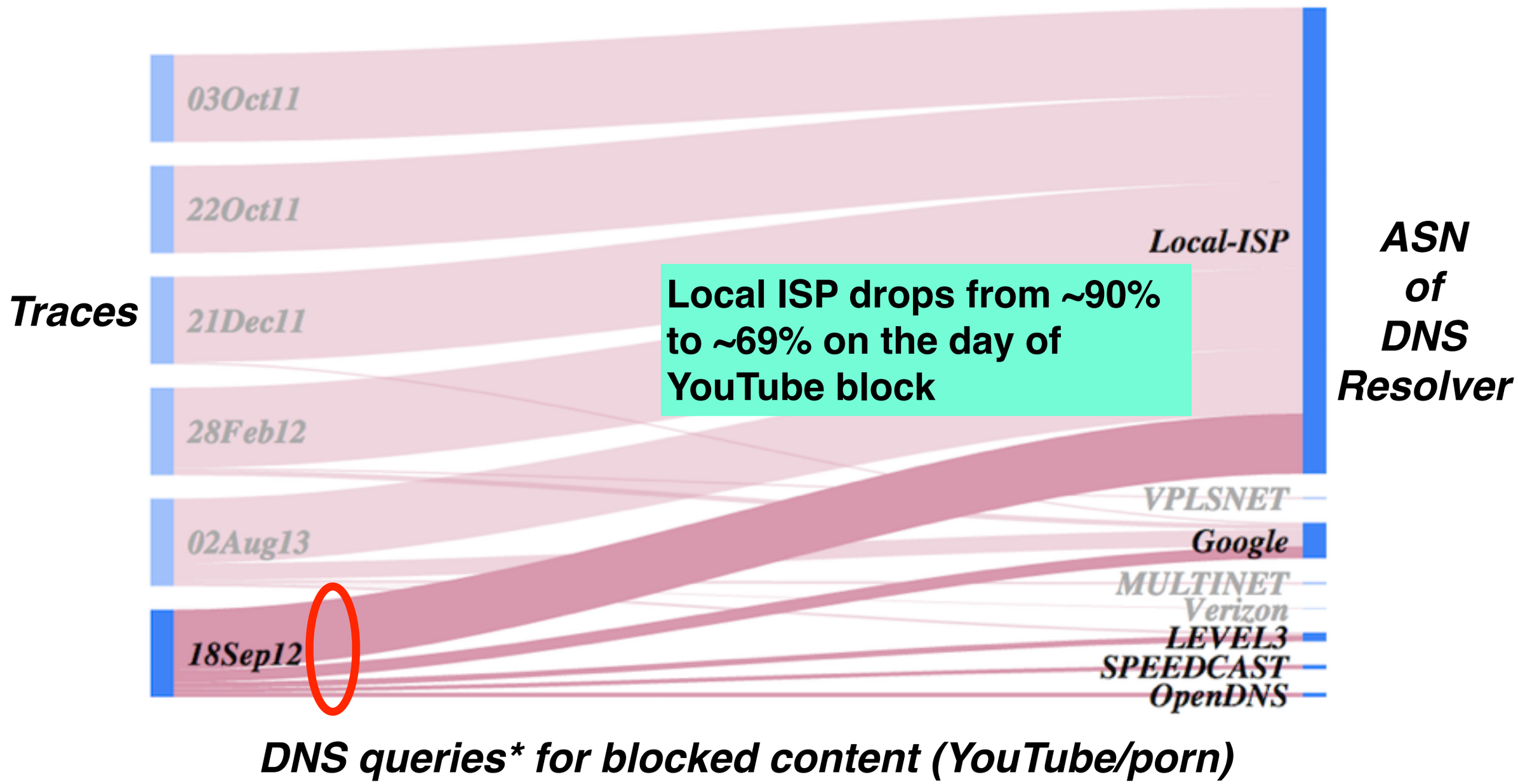
Do residential users shift to alternate/free DNS resolvers?



DNS queries* for blocked content (YouTube/porn)

* Percentage distribution

Do SOHO users shift to alternate/free DNS resolvers?



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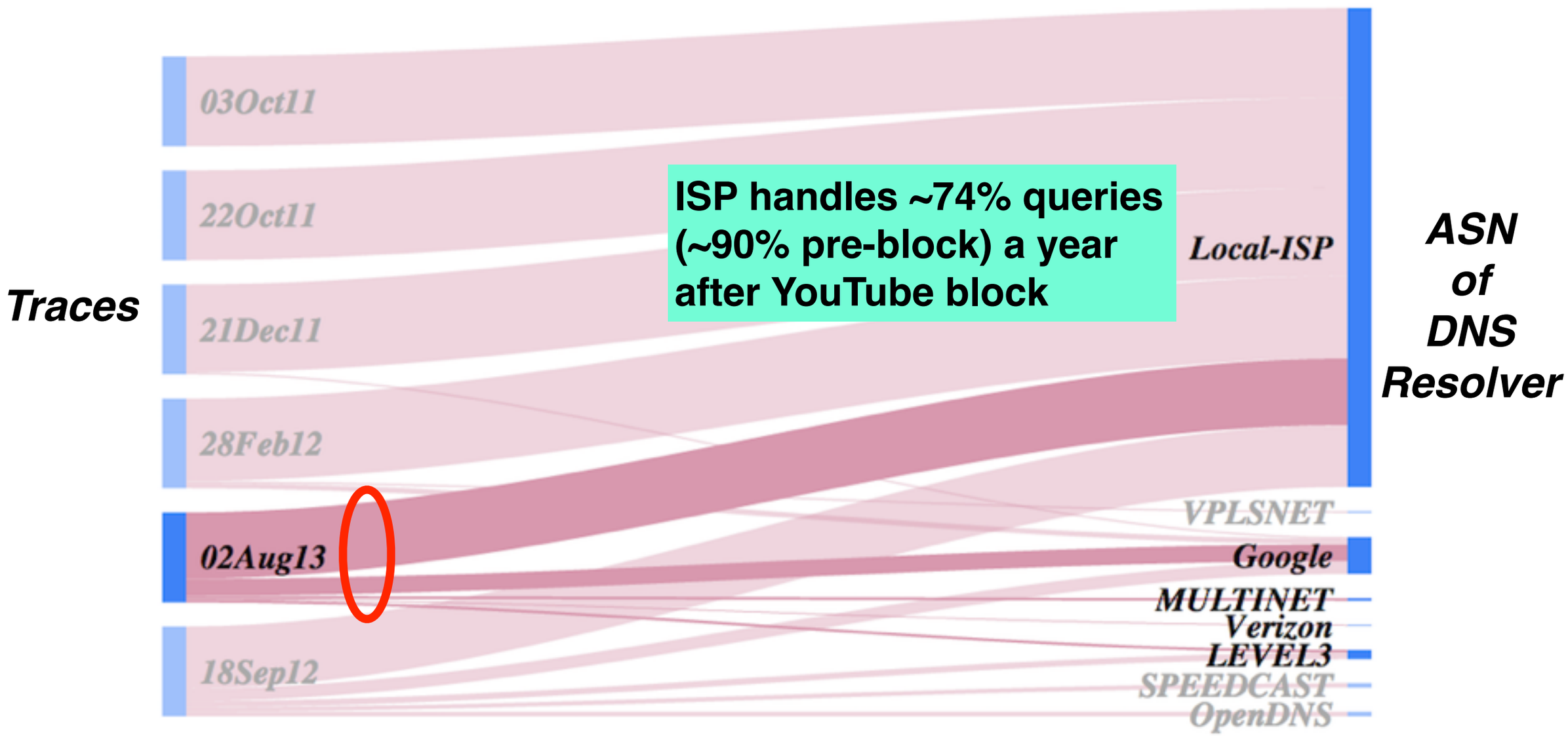

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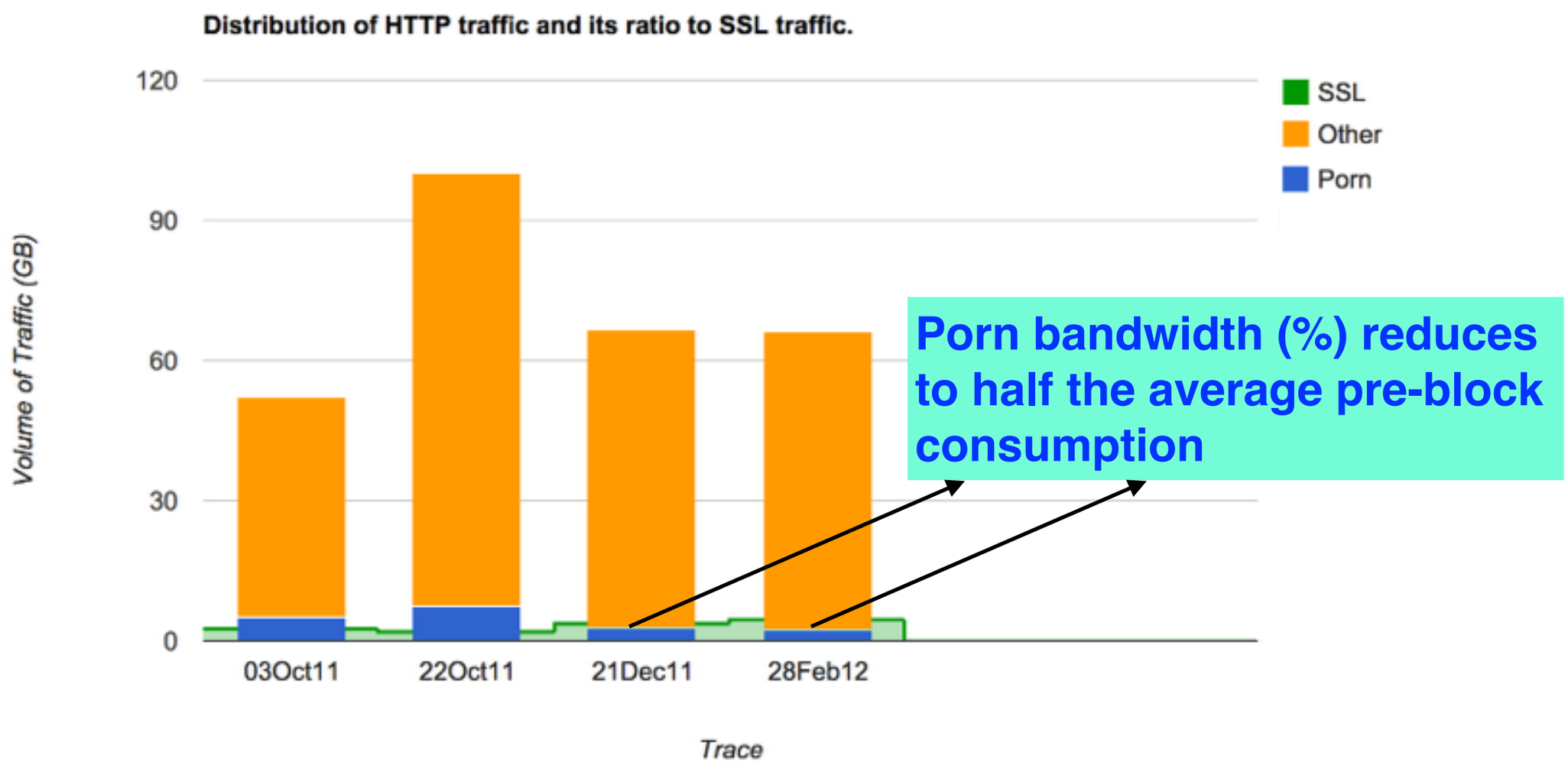
Does traffic generated by residential users change?



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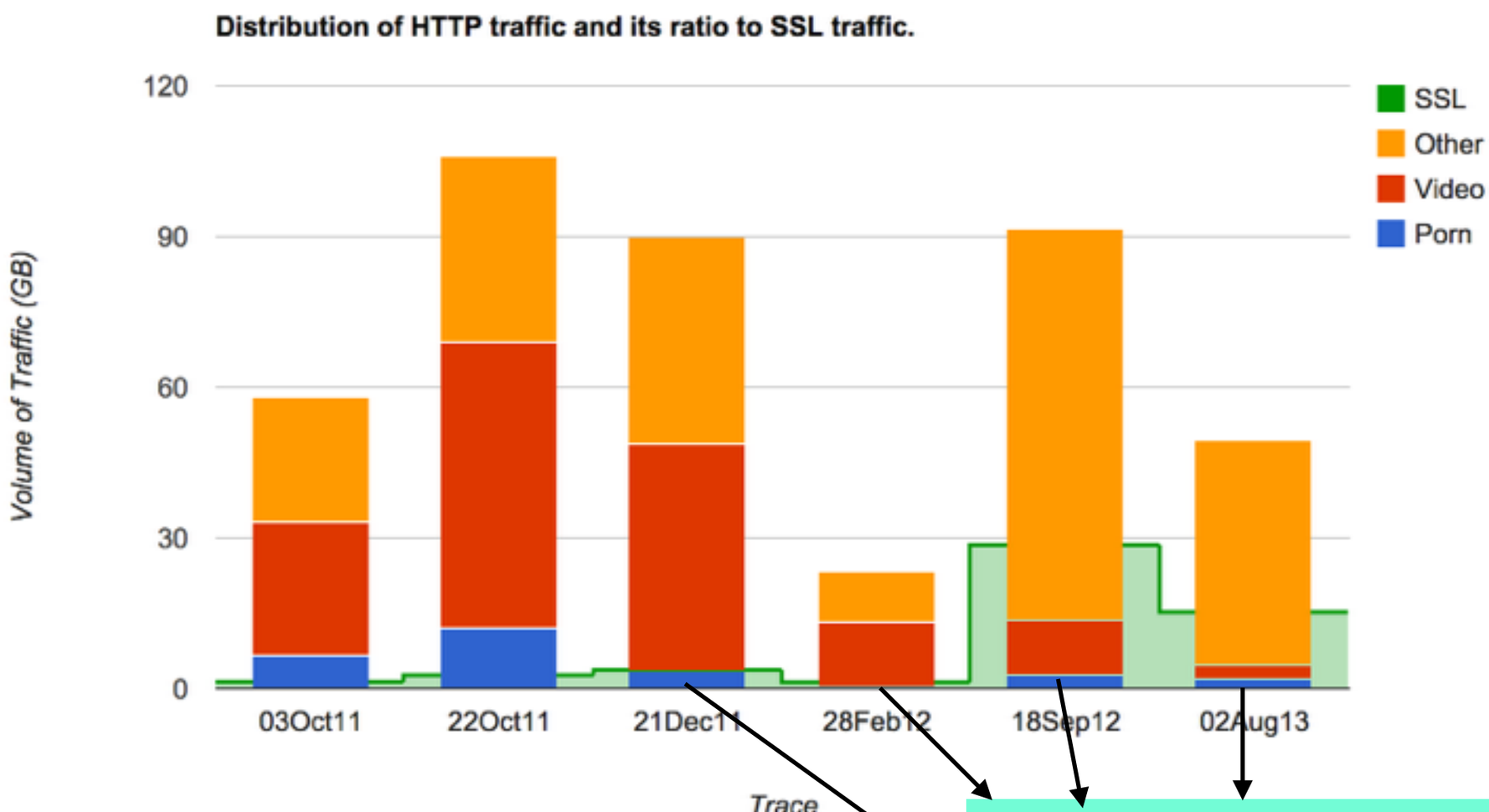

Porn bandwidth (%) reduces to 1/3 of the average pre-block consumption

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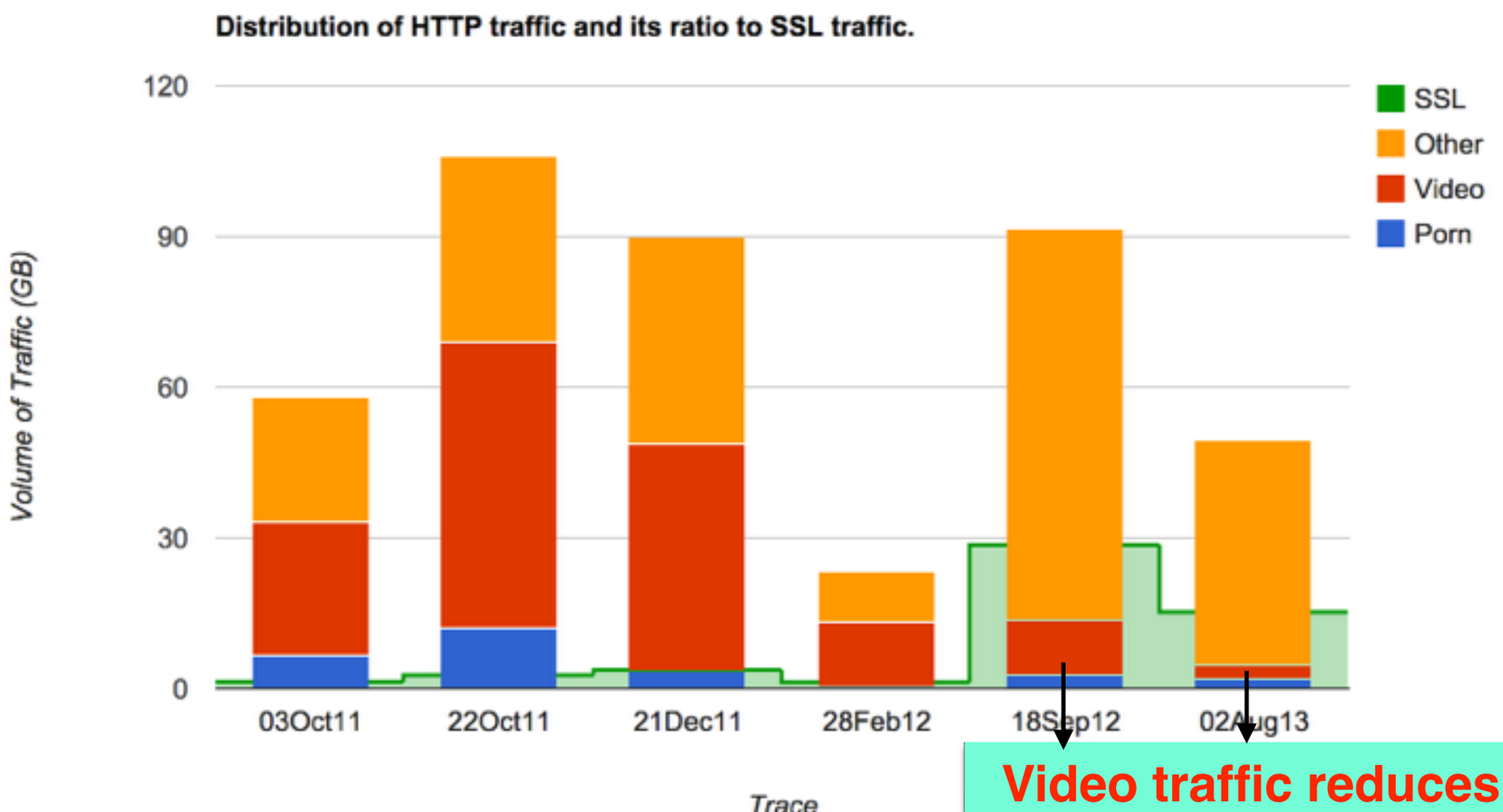

Video traffic reduces to 12% and a year later to ~5% from an average pre-block consumption of 50%

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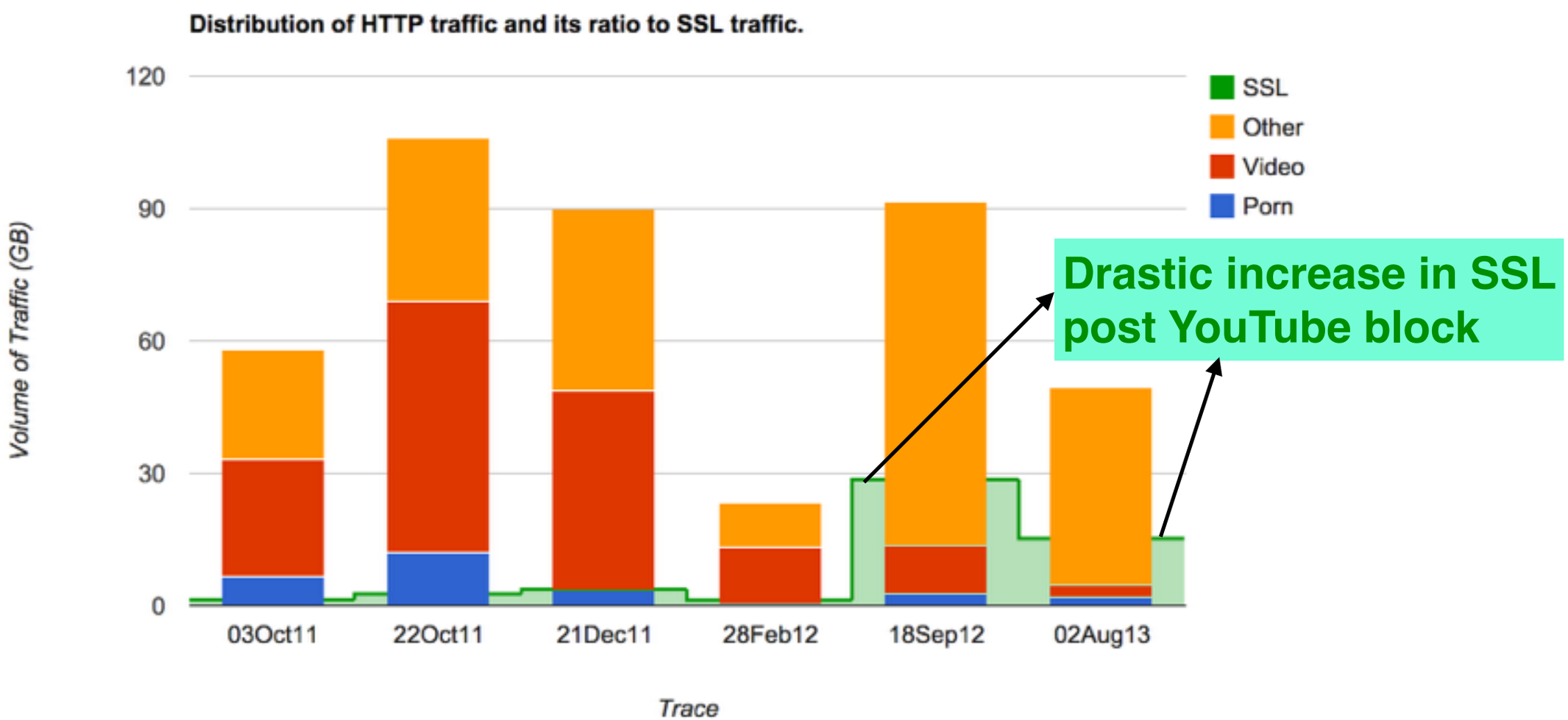
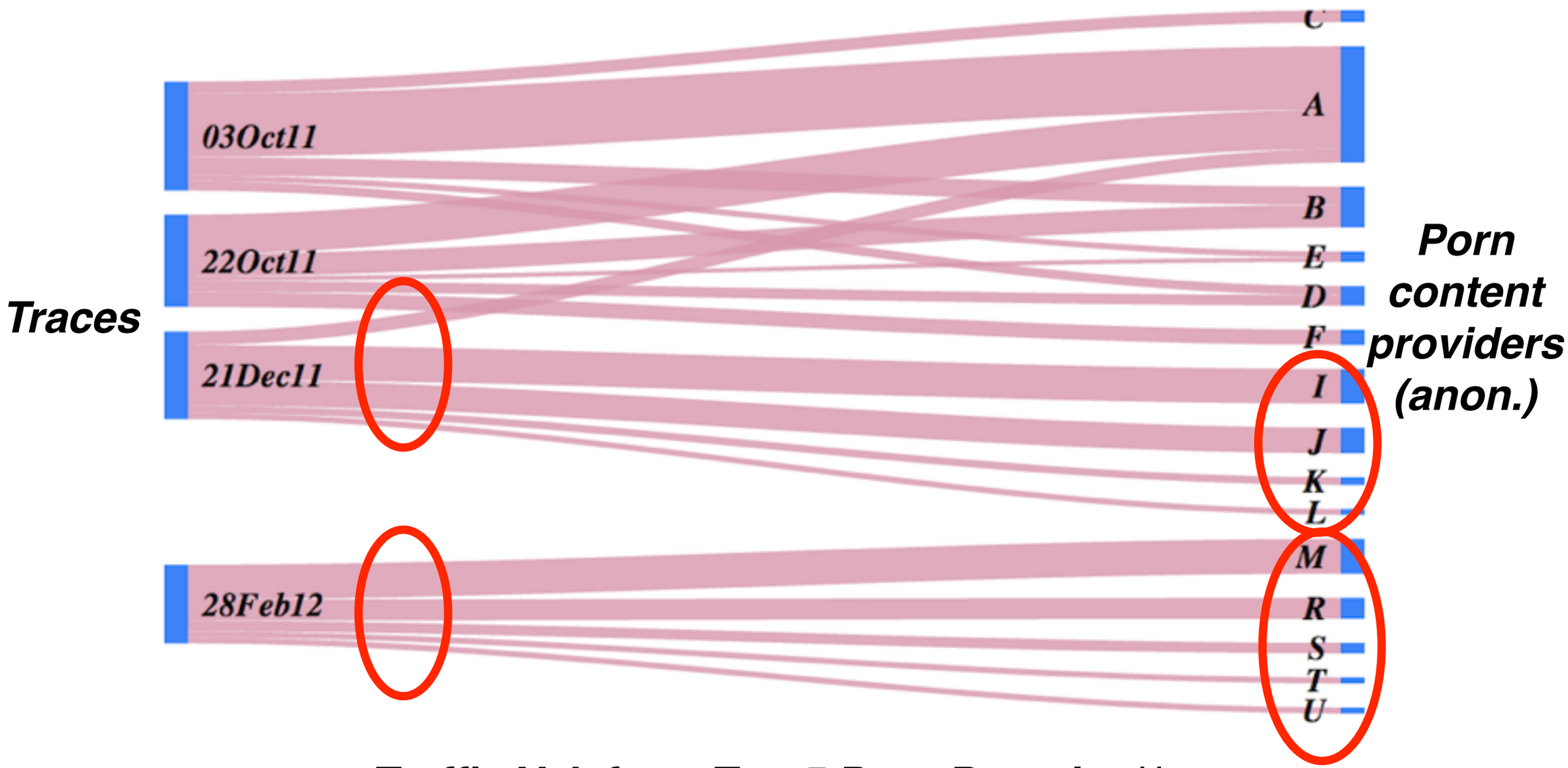


Consequences on Content Providers

Does (residential*) user demand for porn content providers change?

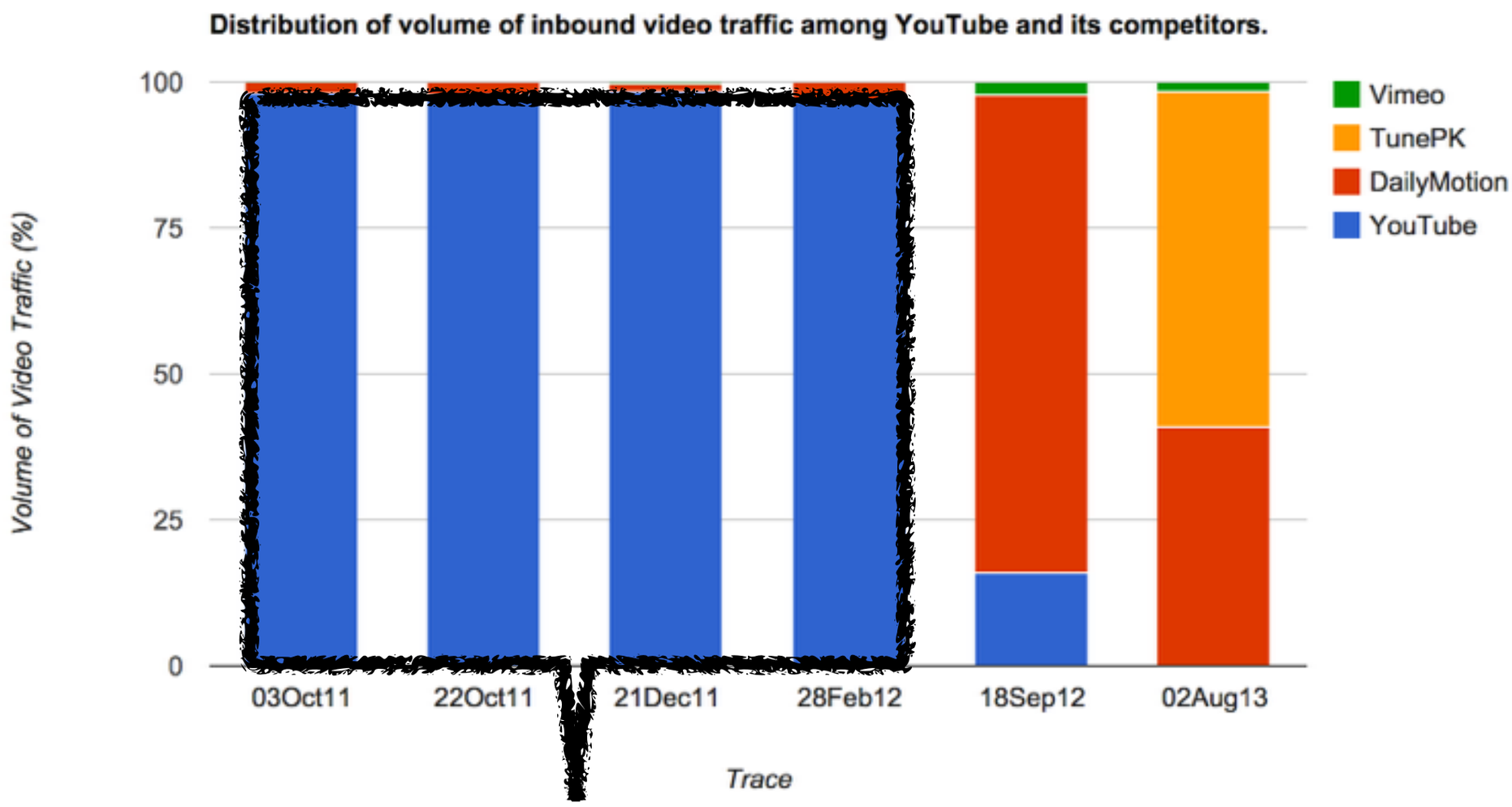
Ongoing churn in porn domains post block



Traffic Vol. from Top-5 Porn Domains*

* Similar trend for SOHO users
** Percentage distribution

How is video traffic distributed among content providers?



YouTube rules the world prior to the block

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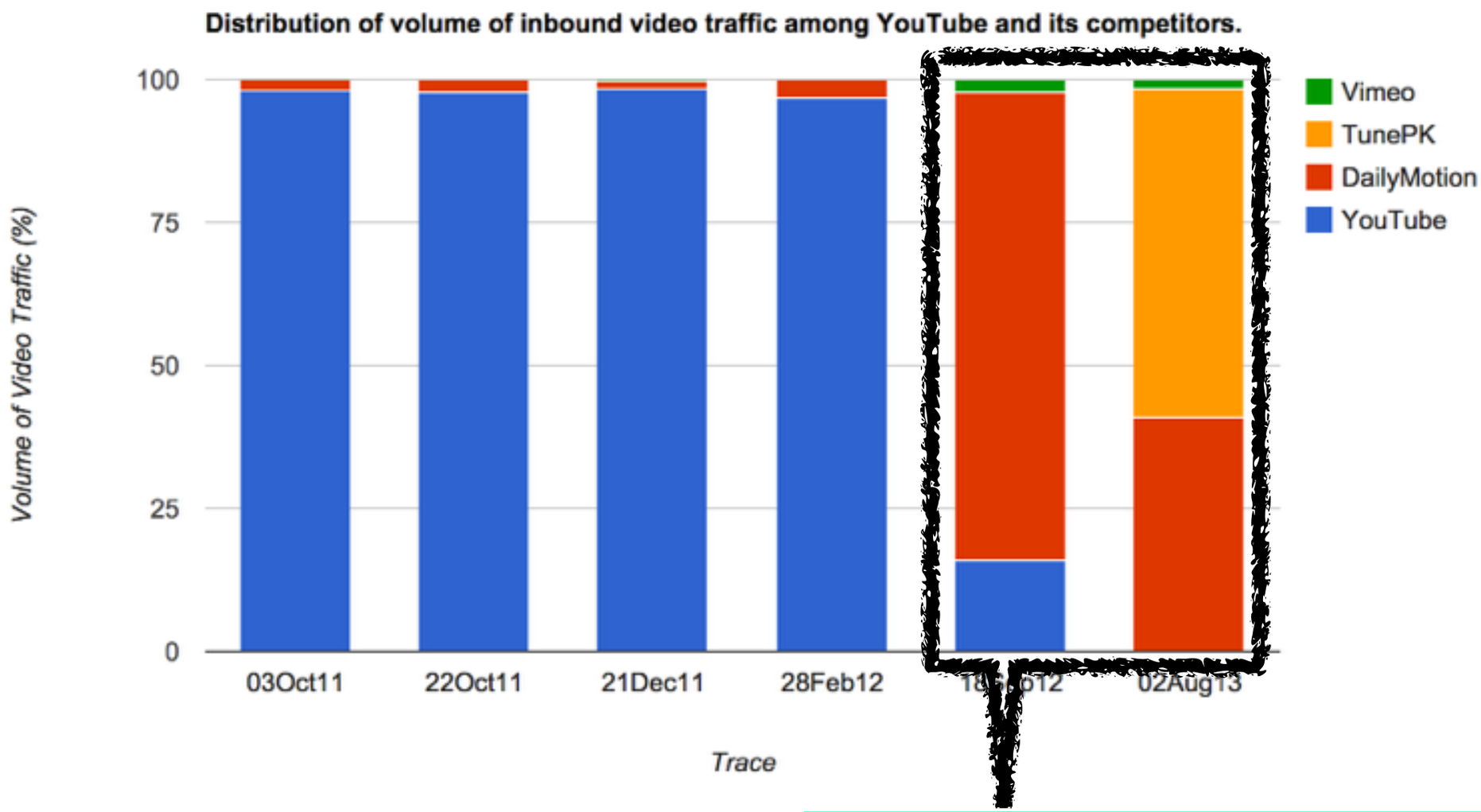
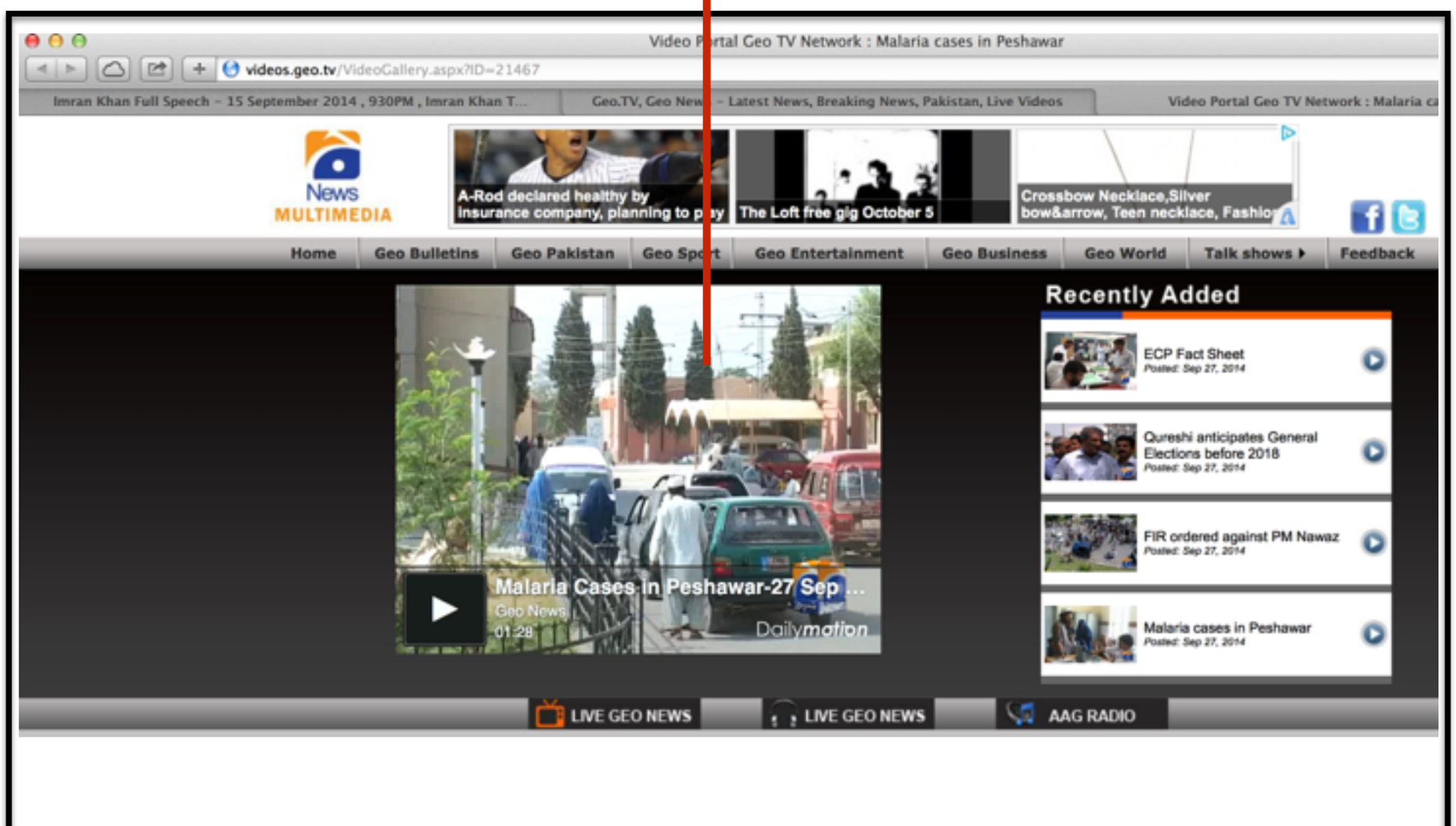


Competitors pick up the slack post YouTube block

How are users' embedded video watch requests distributed among content providers?

<iframe frameborder="0" width="600" height="300" src="//www.dailymotion.com/embed/video/x26ql41" allowfullscreen></iframe>



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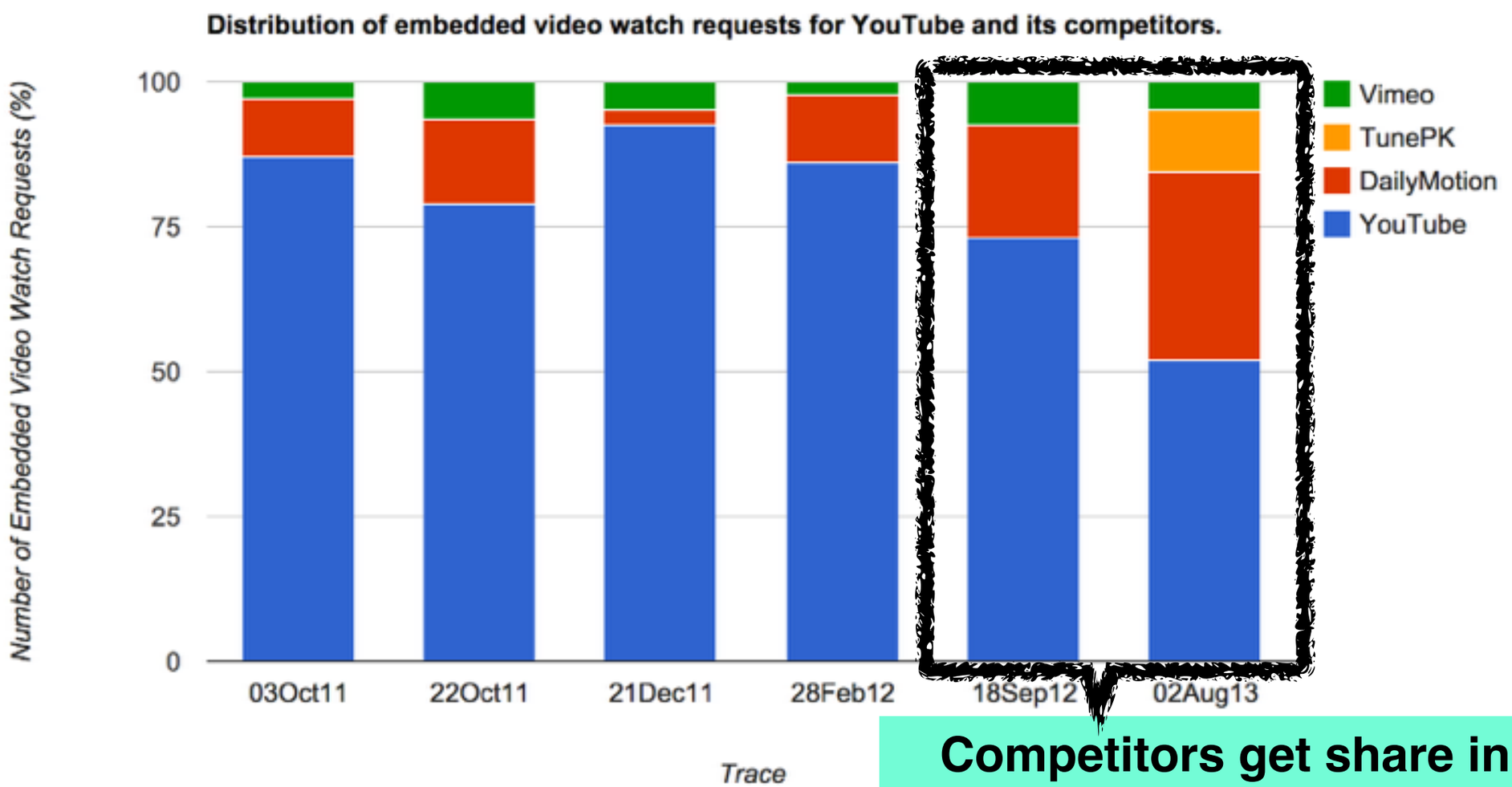
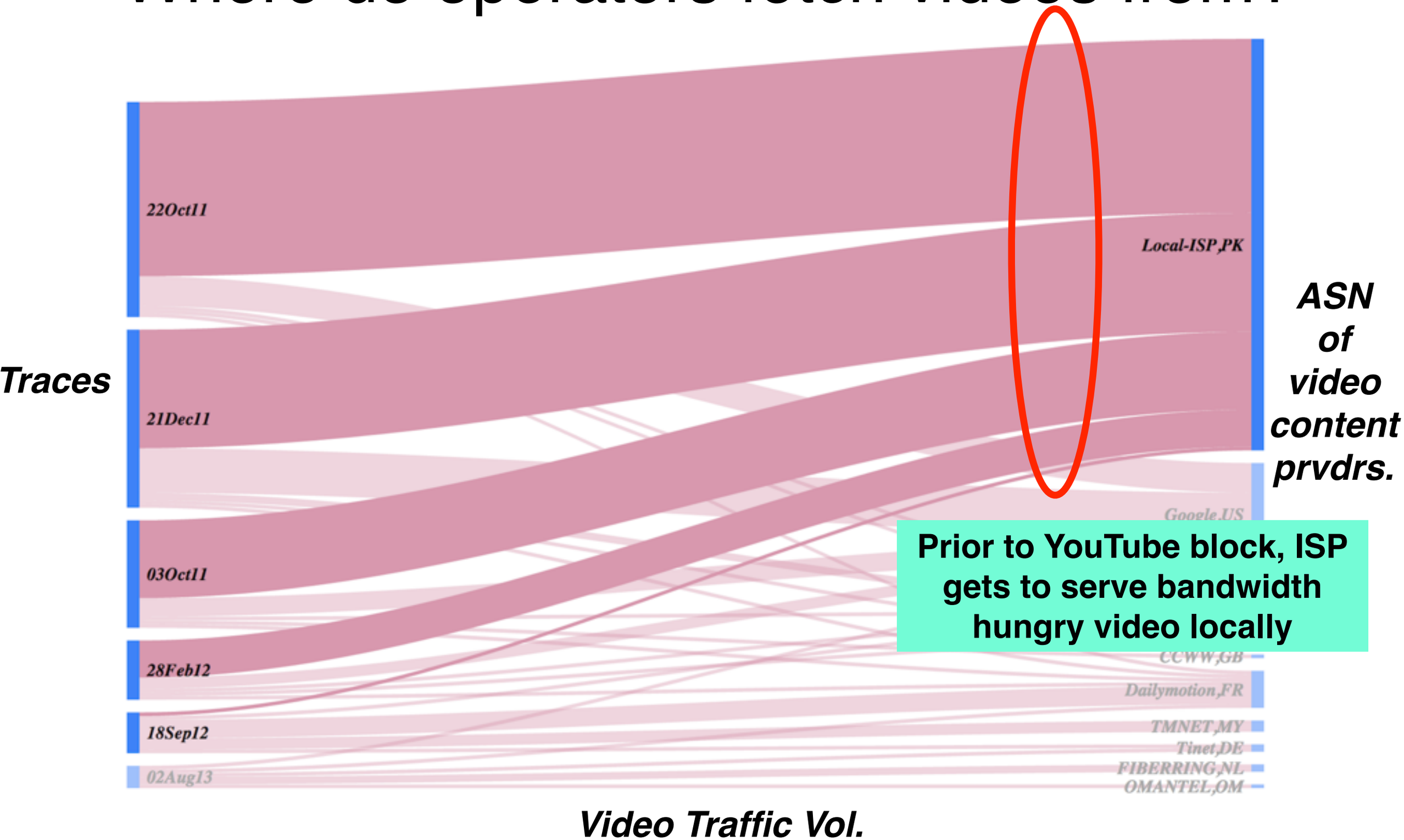


Competitors get share in YouTube's pre-block dominant position in embedded video requests

Consequences on Operators

Where do operators fetch videos from?



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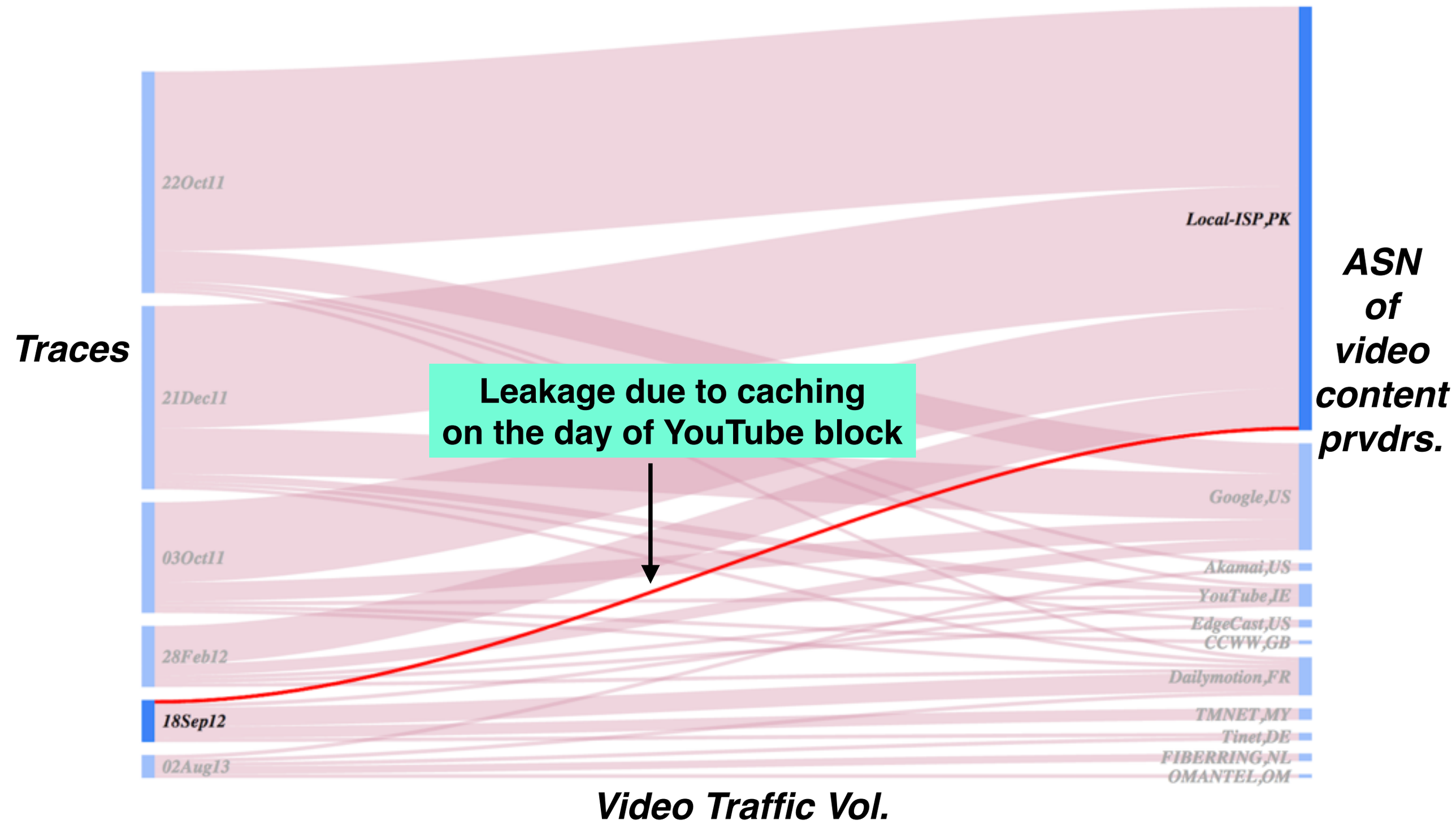

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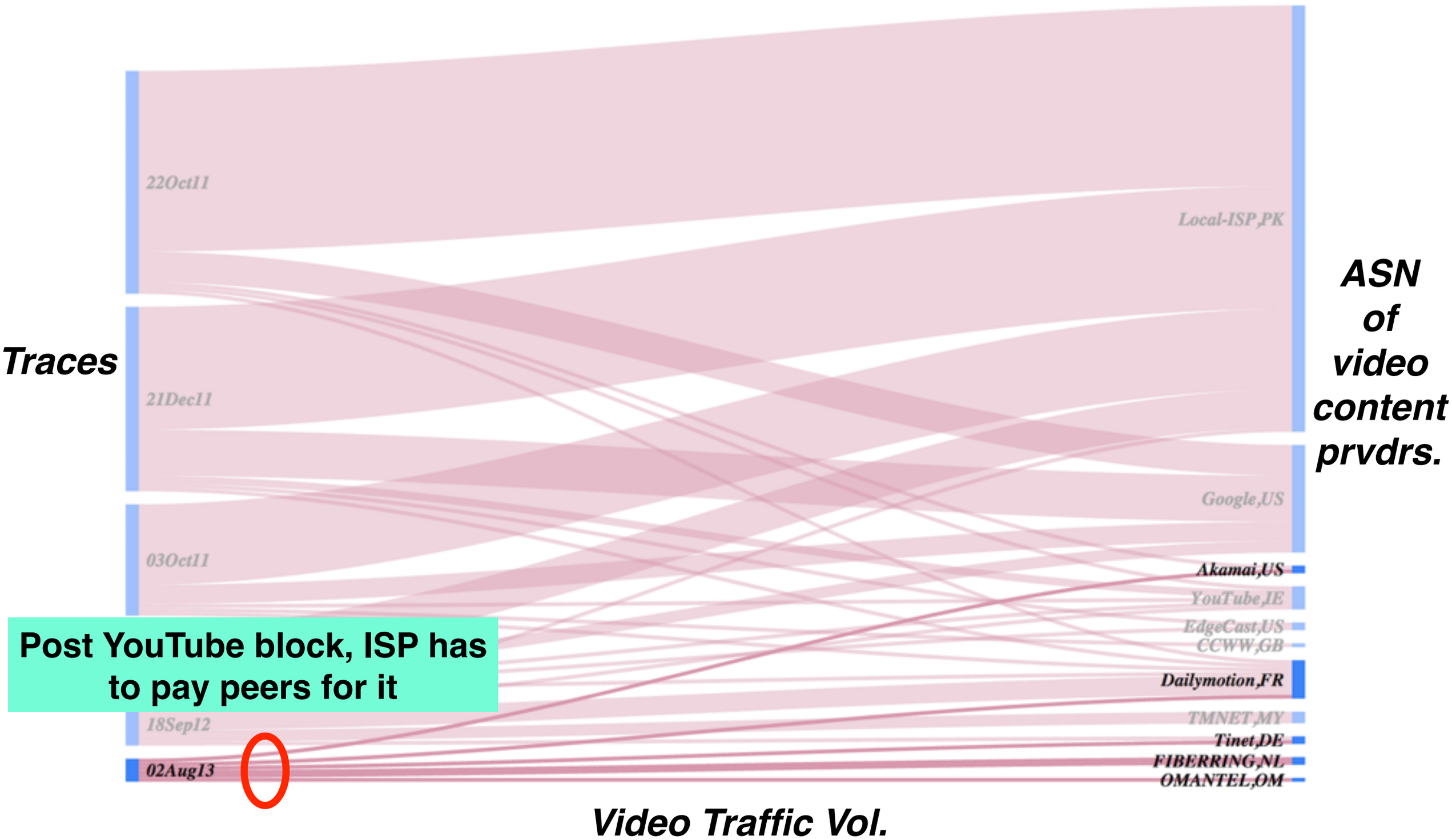

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  - Censor's presumed goal at least partially met

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  - Censor's presumed goal at least partially met
- YouTube block:
  - Spurred some users to outsource their DNS
  - Spurred shift to SSL
  - Shifted cost structure: ISPs burdened, YouTube competitors thrived

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- We looked at how YouTube block impacts competing content providers
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- Identities on the Internet are not entirely isolated (YouTube, Google)
  - What is the impact of YouTube block on other Google services?

Traffic to YouTube (as seen by Google)

Browse real-time traffic to Google products and services

This page provides near real-time information about traffic to our products and services around the world. Each graph shows historic traffic patterns for a given geographic region and product. For more information, see our FAQ.

Pakistan | YouTube

Fraction of Worldwide Traffic, Normalized

E. Data after this point are still being finalized. Interpret them with caution.
2014-9-26

D. Pakistan Lifts YouTube Ban, for 3 Minutes – New York Times [Read More]
2012-12-29

C. Pakistan blocks YouTube over anti-Islam film – AFP [Read More]
2012-9-17

Traffic to Google Docs (as seen by Google)

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2014-9-26

2. Impact on Ad Targeting (and Revenue?)

- What does the wide usage of circumvention tools mean for ad targeting?

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- What does the wide usage of circumvention tools mean for ad targeting?
  - Anonymise IP address—>ad geotargeting is hurt
  - Strip off HTTP cookie—>ads cannot target user profile any more

Thanks

Q&A

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