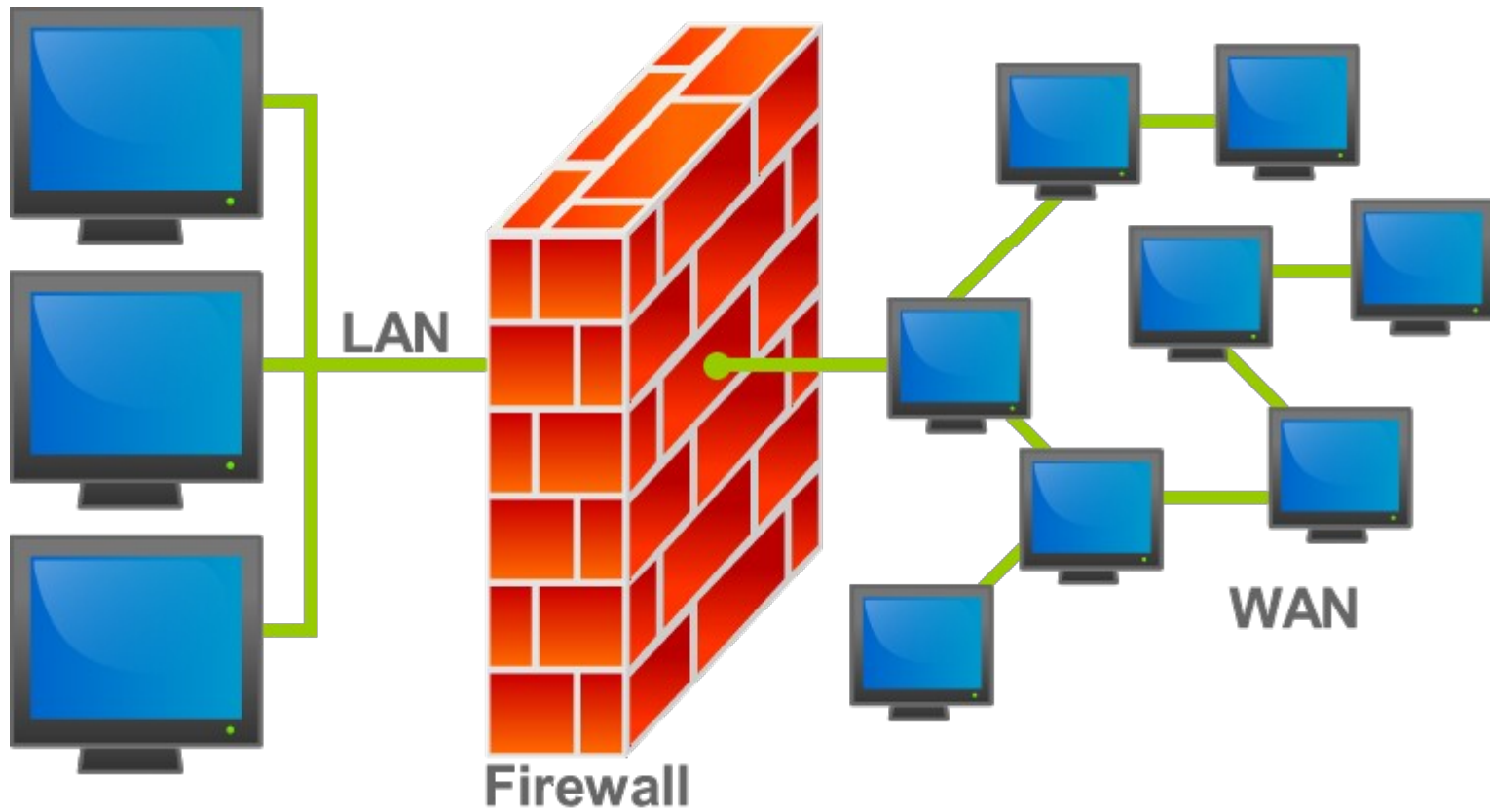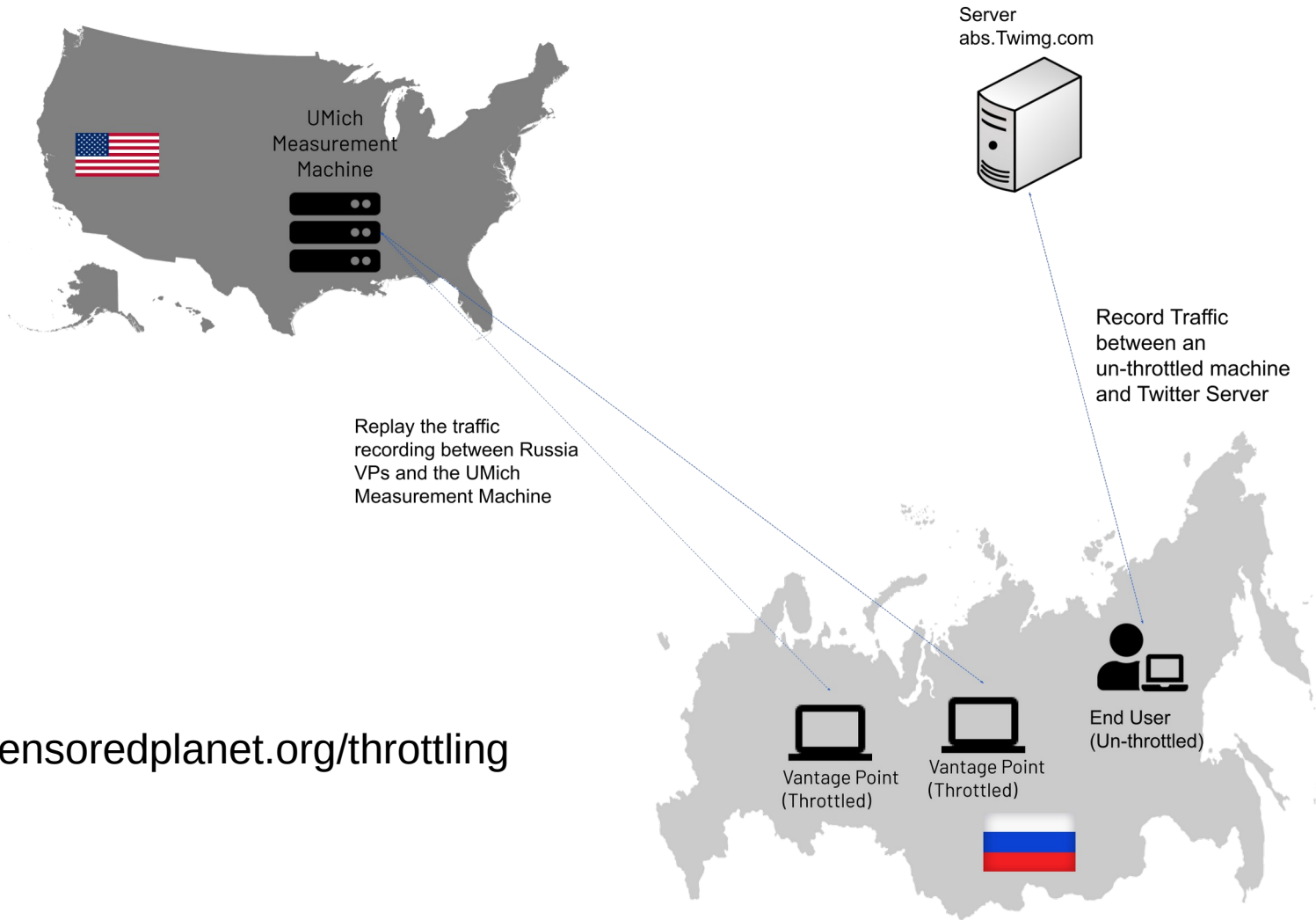# Syllabus...

Discussion of the ConceptDoppler paper...

Preview: OSI model

- Layer 1: Physical
- Layer 2: Link
- Layer 3: Network (think IP routing)
- Layer 4: Transport (TCP, UDP, *etc.*)
- Layers 5 and 6: Session and Presentation
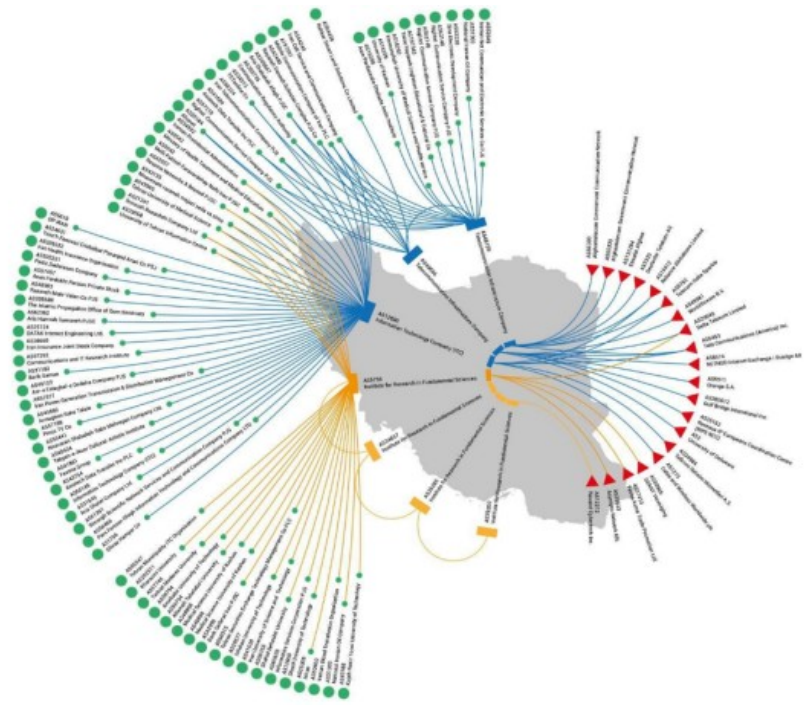- Layer 7: Application (*e.g.*, HTTP)

LAN

Firewall

WAN

https://commons.wikimedia.org/wiki/File:Firewall.png

UMich
Measurement
Machine

Server
abs.Twimg.com

Record Traffic
between an
un-throttled machine
and Twitter Server

Replay the traffic
recording between Russia
VPs and the UMich
Measurement Machine

https://censoredplanet.org/throttling

Vantage Point
(Throttled)

Vantage Point
(Throttled)

End User
(Un-throttled)

to DFN (Germen)

Shengyang

Beijing

to USA

Xian

Chengdu

Nanjing Shanghai

Wuhan

Guangzhou

Hongkong

CERNET

International Export

Backbone

Regional Net

https://personalpages.manchester.ac.uk/staff/m.dodge/cybergeography/atlas/more_isp_maps.html

Reproduced and cropped from https://www.article19.org/ttn-iran-november-shutdown/

中国互联网络连接带宽图
Internet Connection Map of China

CNNIC
中国互联网络信息中心
CHINA INTERNET NETWORK INFORMATION CENTER

国家及地区节点（上排，从左到右）：
- 马来西亚 Malaysia
- 法国 France
- 印度 India
- 新加坡 Singapore
- 欧洲 Europe
- 哈萨克斯坦 Kazakhstan
- 中国台湾 Taiwan,China
- 中国澳门 Macao,China
- 德国 Germany
- 越南 Vietnam
- 美国 United States
- 日本 Japan
- 韩国 Republic Korea
- 意大利 Italy
- 西班牙 Spain
- 北朝 (北韩)
- 加拿大 Canada
- 中国香港 Hongkong
- 菲律宾 Philippines
- 瑞典 Sweden
- 俄罗斯 Russia
- 新西兰 New Zealand
- 英国 United Kingdom
- 瑞士 Switzerland
- 荷兰 Netherlands
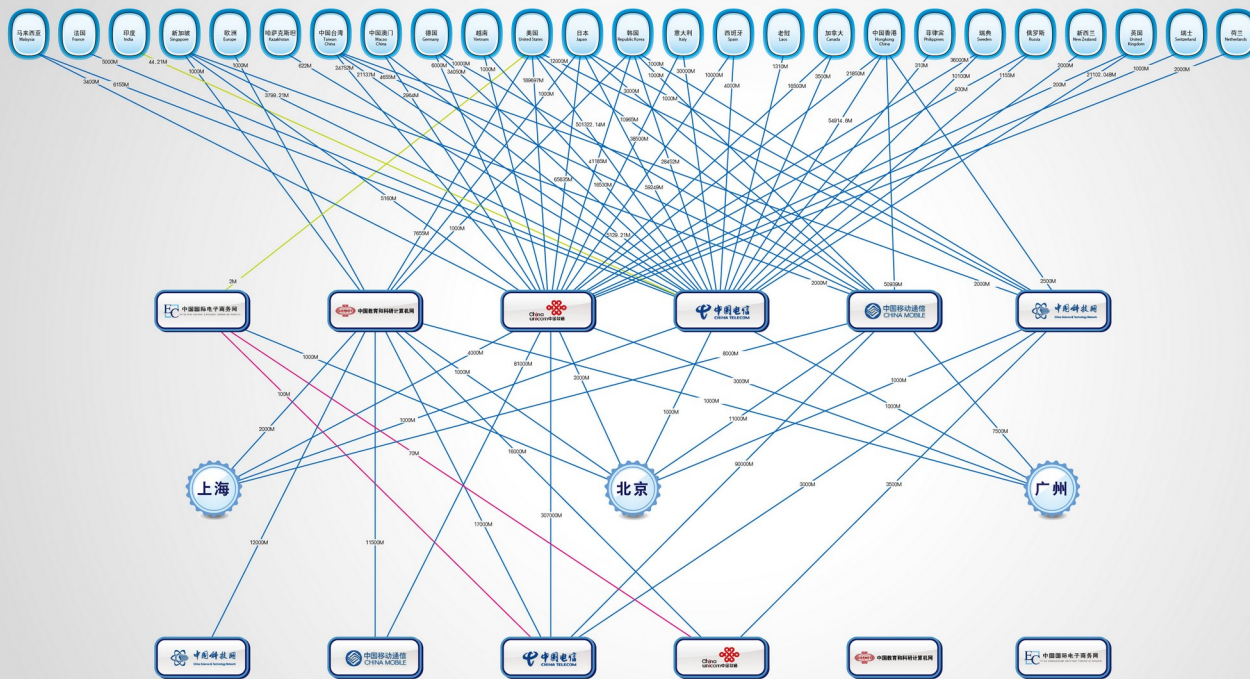
图 例
LEGEND

国家及地区
Country / Region

骨干网运营商
Backbone Network Operator

交换中心
IX

< 45M
45M ≤ X < 155M
≥ 155M

骨干网运营商节点（中排）：
- 中国国际电子商务网 EC
- 中国教育和科研计算机网 CERNET
- 中国联通 China UNICOM 中国网通
- 中国电信 CHINA TELECOM
- 中国移动通信 CHINA MOBILE
- 中国科技网 China Science and Technology Network

交换中心：上海、北京、广州

下排节点：
- 中国科技网 China Science and Technology Network
- 中国移动通信 CHINA MOBILE
- 中国电信 CHINA TELECOM
- China UNICOM 中国网通
- 中国教育和科研计算机网 CERNET
- 中国国际电子商务网 EC
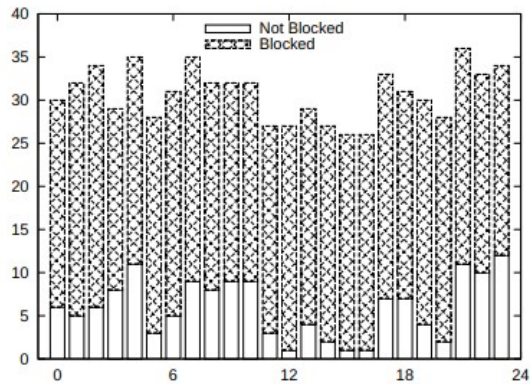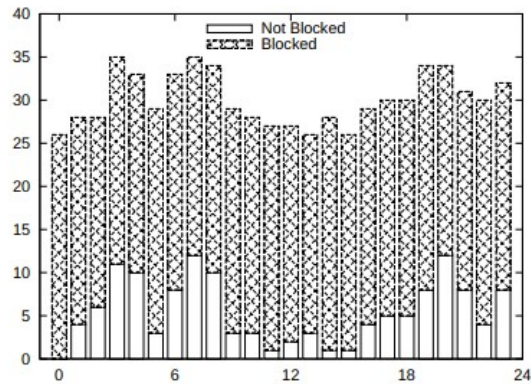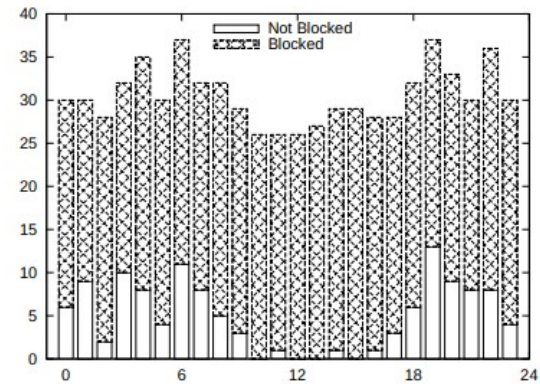
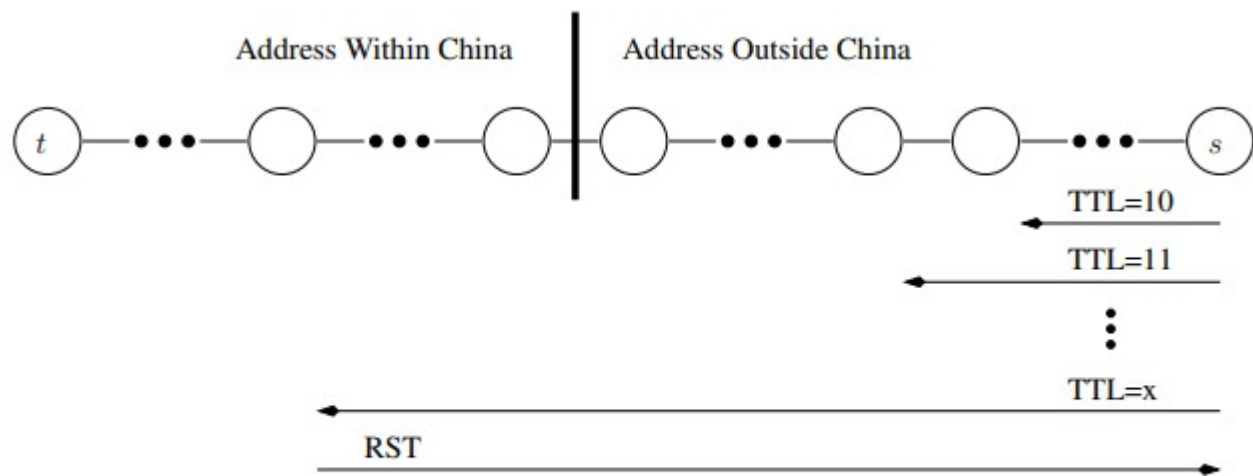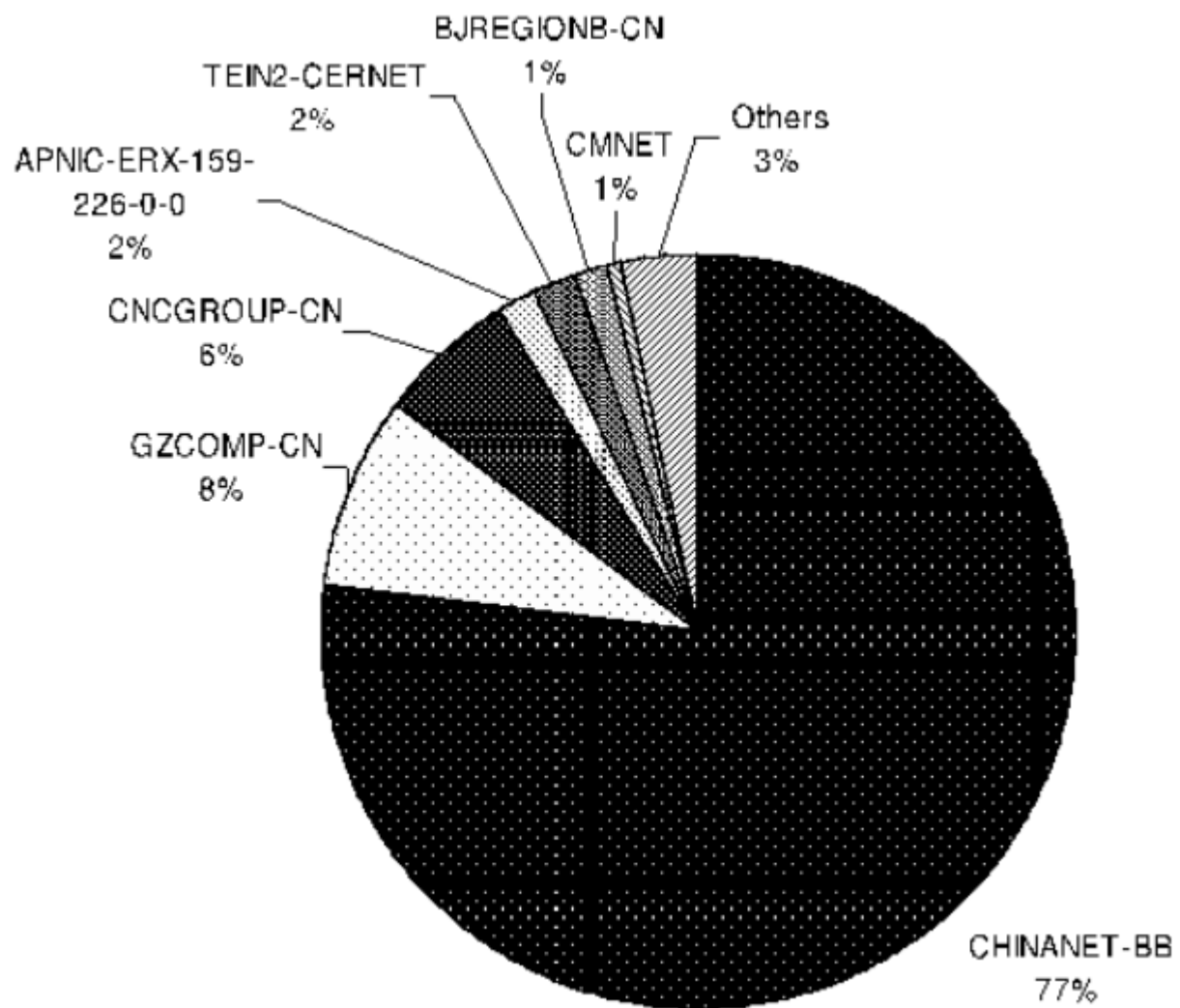**Figure 2: Filtering Statistics For each day from** `00:00` **to** `24:00`**.**

Figure 4: GFC router discovery using TTLs.
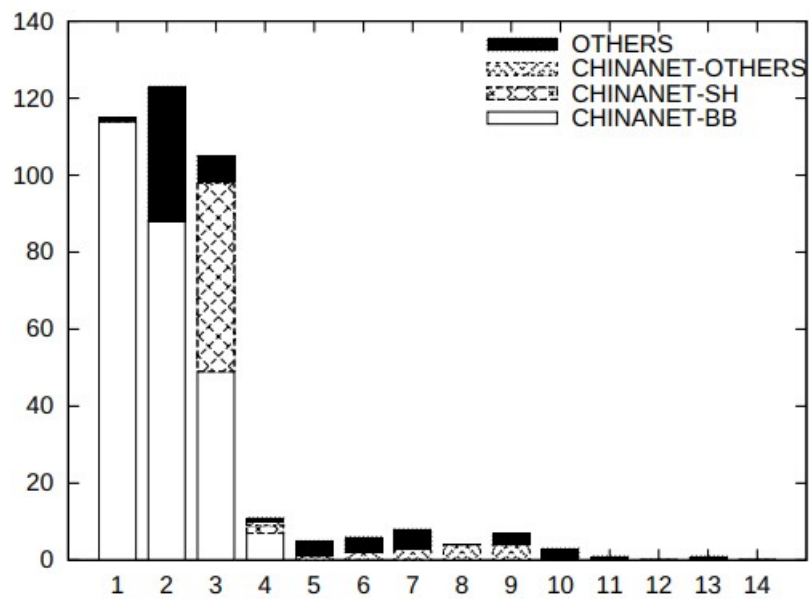
(a) Filtering by hop within China
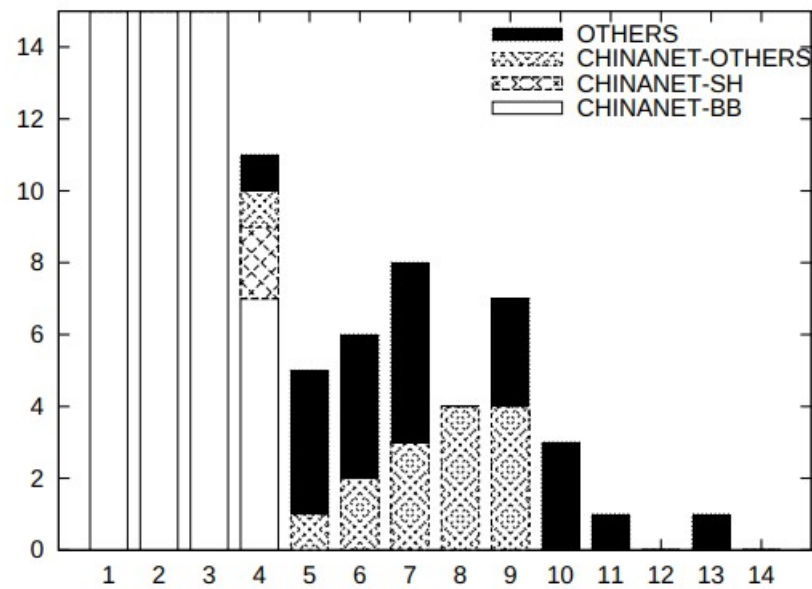
(b) Zooming in on Filtering for #hops > 3

Figure 5: Where Filtering Occurs.

Things to think about...

- What assumptions did the authors make that maybe they shouldn't have?

- What if they measured *from* many places in China instead of *to* many places in China?

- Other problems with methodology?

- Statefulness of TCP, other evasion possibilities

Great Walls by Different Dynasties

https://www.nouahsark.com/img/great_wall/maps/great-wall-of-china-history-map.php
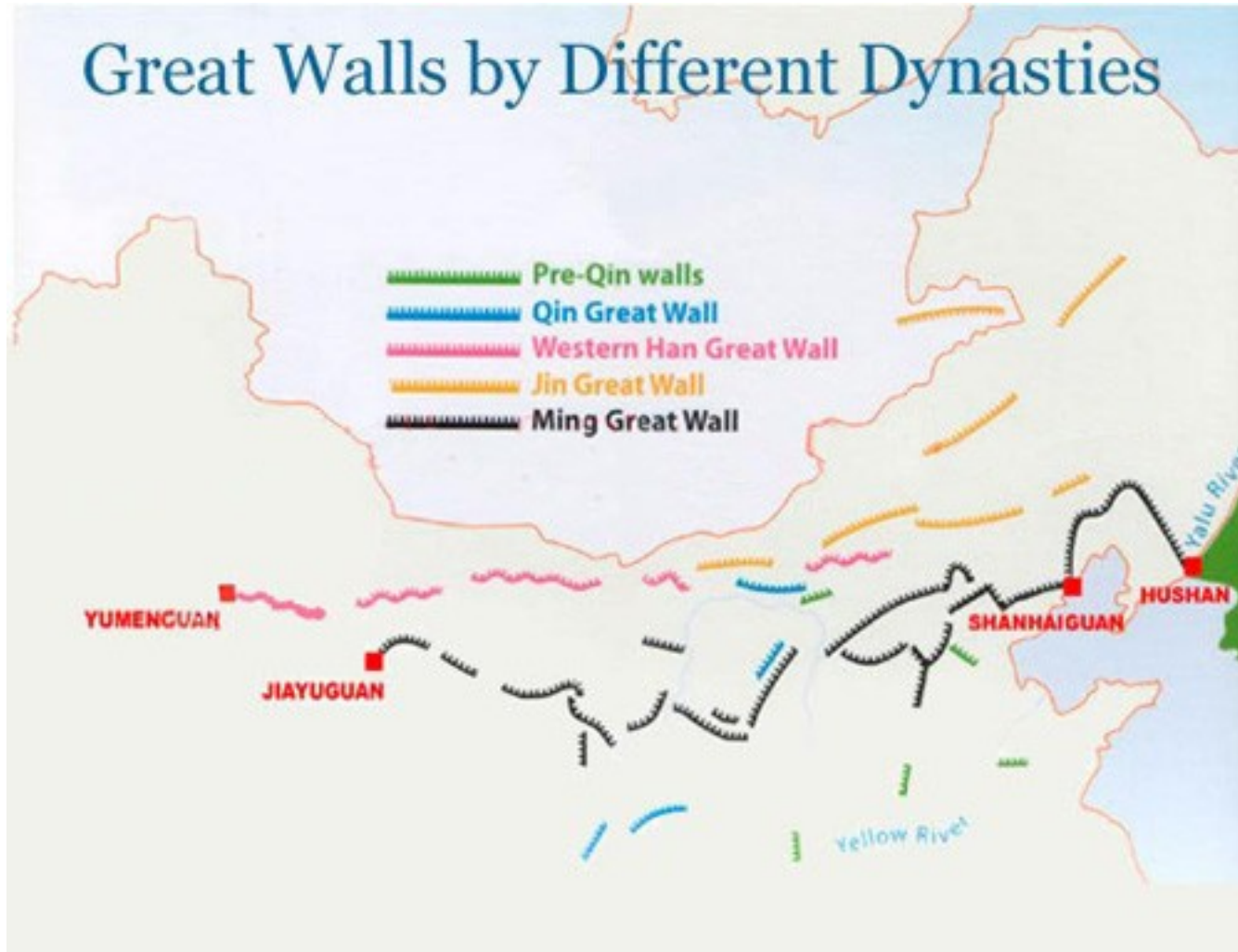
典型意义下GFW线路拓扑
Topology of GFW networks in a typical sense

GFW地区交换中心
GFW exchange point (regional)

干扰通信
disruptive traffic

海缆
cable

路由器
router

分光
splitter

ISP骨干网
ISP backbone

互联网交换中心
Internet
exchange point

防外线

ISP国际出入口局
international gateway
最后一跳 the last hop

海缆登陆站
cable landing
station
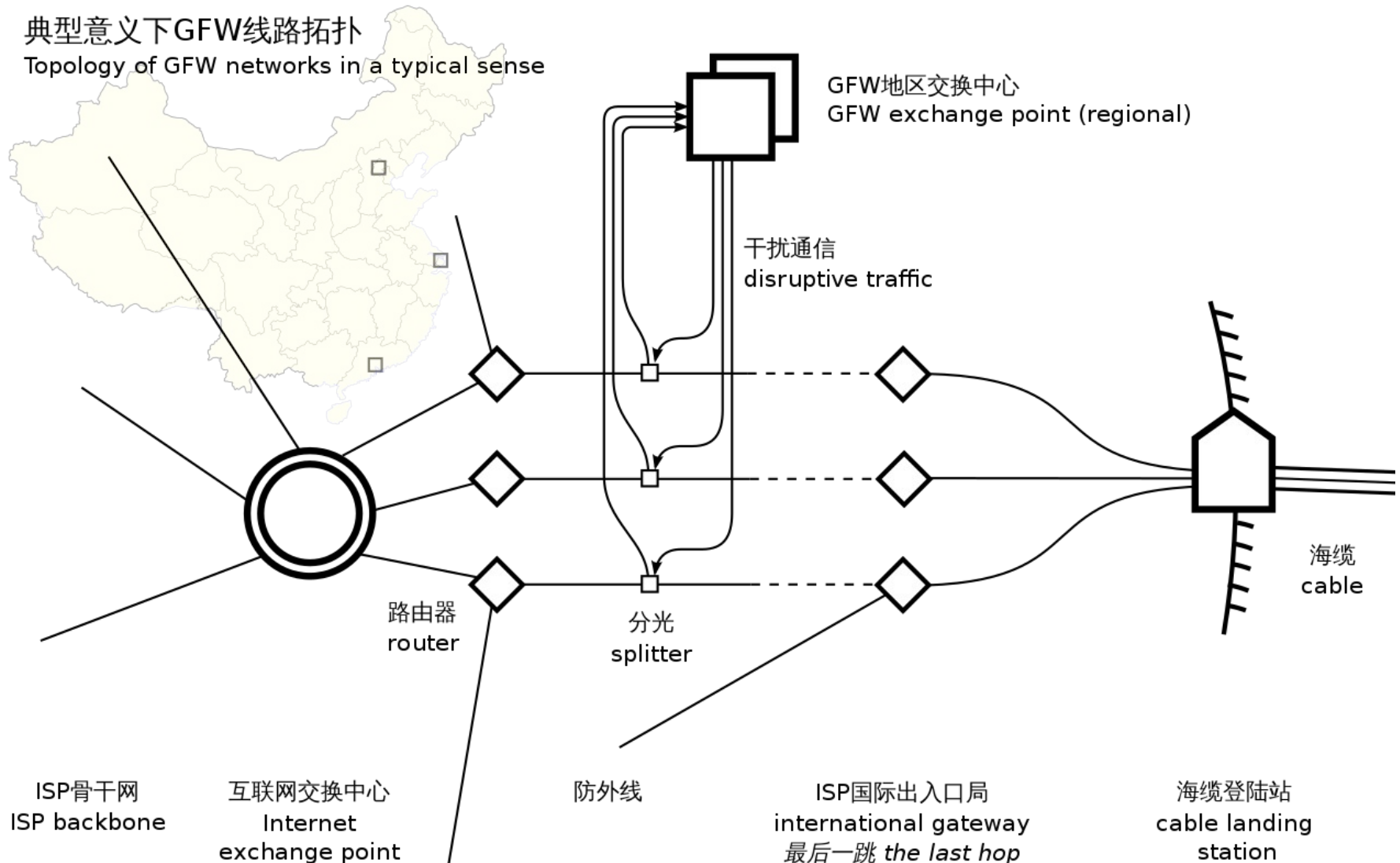
Internet Censorship in China:
Where Does the Filtering Occur?

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http://www.cse.umich.edu

Abstract. China filters Internet traffic in and out of the country. In order to circumvent the firewall, it is helpful to know where the filtering occurs. In this work, we explore the AS-level topology of China's network, and probe the firewall to find the locations of filtering devices. We find that even though most filtering occurs in border ASes, choke points also exist in many provincial networks. The result suggests that two major ISPs in China have different approaches placing filtering devices.

Keywords: Censorship, topology, network measurement.

Table 1. Chinese ISP with most number of unique peerings to foreign AS

ISP	AS Numbers	Peerings
CHINANET	4134, 4809, 4812, 23724, 17638	62 (46.6%)
CNCGROUP	4837, 9929, 17621, 4808	23 (17.3%)
TEIN	24489, 24490	8 (6.0%)
CNNIC	37958, 24151, 45096	8 (6.0%)
CERNET	4538, 4789	9 (6.8%)
Other	9808, 9394, 4847, 7497, 9298, 23911	23 (17.3%)

Table 3. Locations of filtering devices in AS4134

Province	# Devices	Percentage
Backbone	49	13.10%
Guangdong	84	22.46%
Fujian	29	7.75%
Hunan	28	7.49%
Hubei	24	6.42%
Sichuan	22	5.88%
Yunnan	21	5.61%
Guangxi	19	5.08%
Jiangsu	19	5.08%
Zhejiang	15	4.01%
Guizhou	14	3.74%
Jiangxi	14	3.74%
Hainan	11	2.94%
Chongqing	10	2.67%
Anhui	6	1.60%
Unidentified	6	1.60%
Xinjiang	2	0.53%
Tibet	1	0.27%

Roya Ensafi*, Philipp Winter, Abdullah Mueen, and Jedidiah R. Crandall

Analyzing the Great Firewall of China Over Space and Time

Abstract: A nation-scale firewall, colloquially referred to as the "Great Firewall of China," implements many different types of censorship and content filtering to control China's Internet traffic. Past work has shown that the firewall *occasionally fails*. In other words, sometimes clients in China are able to reach blacklisted servers outside of China. This phenomenon has not yet been characterized because it is infeasible to find a *large* and *geographically diverse* set of clients in China from which to test connectivity.

Number of users in China vs. Date in 2014 (Jan–Jul)
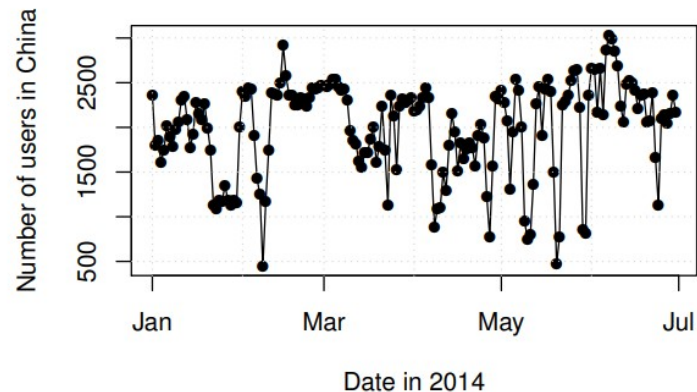
Fig. 3. The geographic distribution of all tested Tor relays (shown as onions) and of our global IPID clients in China (shown as red marks). Note that outside of Xinjiang the west of China has very little Internet penetration, which is why we have few data points in this region and the distribution is biased towards the eastern parts of China. (Map data © 2014 Google, INEGI)

Client Server	$S \rightarrow C$ (%)	None (%)	$C \rightarrow S$ (%)	Error (%)
CN Tor−Relay	116,460 (81.52)	555 (0.39)	786 (0.55)	25,061 (17.54)
CN Tor−Dir	8,922 (64.91)	31 (0.23)	2,696 (19.61)	2,097 (15.25)
CN Web	306 (1.23)	15,663 (62.95)	2,688 (10.80)	6,226 (25.02)
EU Tor−Relay	18 (0.20)	8,589 (96.79)	22 (0.25)	245 (2.76)
EU Tor−Dir	2 (0.25)	776 (96.76)	0 (0.00)	24 (2.99)
EU Web	19 (1.23)	1,333 (86.28)	95 (6.15)	98 (6.34)
NA Tor−Relay	45 (0.39)	11,022 (94.48)	33 (0.28)	566 (4.85)
NA Tor−Dir	4 (0.37)	1,025 (94.73)	3 (0.28)	50 (4.62)
NA Web	32 (1.52)	1,794 (85.06)	98 (4.65)	185 (8.77)

#	Network name (from whois information)
503	**CERNET**
81	**CNC Group CHINA169 Shanxi Province Network**
78	**China Unicom Henan province network**
58	**Anhui Informationg [sic] Center**
41	**CHINANET**
37	**CNC Group CHINA169 Xinjiang Province Network**
35	**CNC Group CHINA169 Neimeng Province Network**
31	**China Unicom Heilongjiang Province Network**
25	**China Unicom Shandong Province Network**
22	**China Unicom Shanxi Province Network**
20	**China Mobile**
17	**China Unicom Hebei province network**
14	**China Unicom Liaoning province network**
13	**China Unicom Shandong province network**
13	**China unicom InnerMongolia province network**
10	**CHINANET ningxia province network**

Bandwidth

Internet Service: International Outlet Bandwidth(Mbps).

1997 - 2020 | SEMIANNUALLY | UNIT TH | CHINA INTERNET NETWORK INFORMATION CENTER

CN: Internet Service: International Outlet Bandwidth(Mbps) data was reported at 11,511.397 Unit th in Dec 2020. This records an increase from the previous number of 8,827.751 Unit th for Dec 2019. CN: Internet Service: International Outlet Bandwidth(Mbps) data is updated semiannually, averaging 640.287 Unit th from Dec 1997 to Dec 2020, with 45 observations. The data reached an all-time high of 11,511.397 Unit th in Dec 2020 and a record low of 0.241 Unit th in Jun 1999. CN: Internet Service: International Outlet Bandwidth(Mbps) data remains active status in CEIC and is reported by China Internet Network Information Center. The data is categorized under China Premium Database's Information and Communication Sector – Table CN.ICE: Internet: International Outlet Bandwidth.

LAST	FREQUENCY	RANGE
▲ 11,511.397 Dec 2020	semiannually	Dec 1997 - Dec 2020