Analysis of the Effects of COVID-19-Related Lockdowns on IMRS Traffic

Matt Larson
Vice President of Research, Office of the CTO

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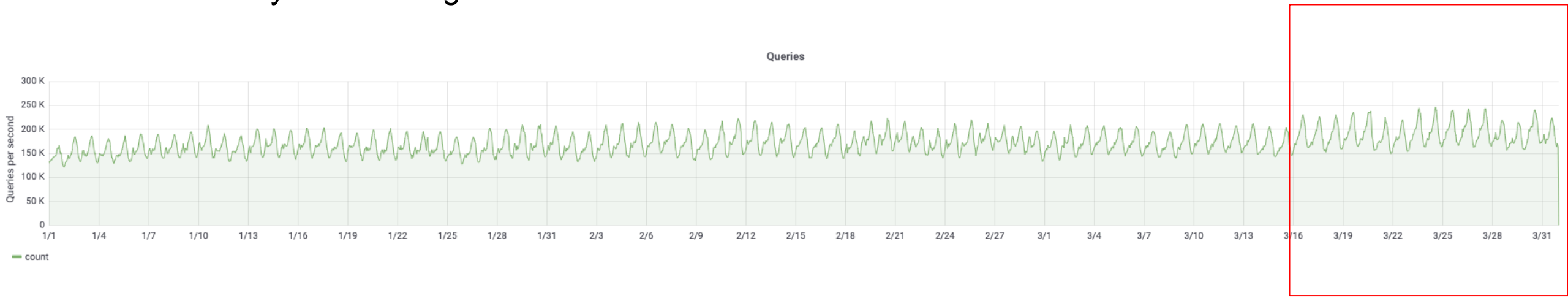
ICANN Managed Root Server (IMRS) traffic analysis

- The ICANN org operates the ICANN Managed Root Server (IMRS)
  - Also known as *l.root-servers.net*
  - IPv4 address is 199.7.83.42, IPv6 address is 2001:500:9f::42
  - One of 13 root server identities
  - IMRS comprises 167 instances in 83 countries as of April 2020
- The Research group in ICANN's Office of the CTO (OCTO) routinely analyzes IMRS traffic
- Recent research question: *Have traffic patterns to the IMRS changed in light of recent events?*
- Investigation is ongoing
- Today's presentation describes initial findings

ICANN Managed Root Server (IMRS) traffic analysis

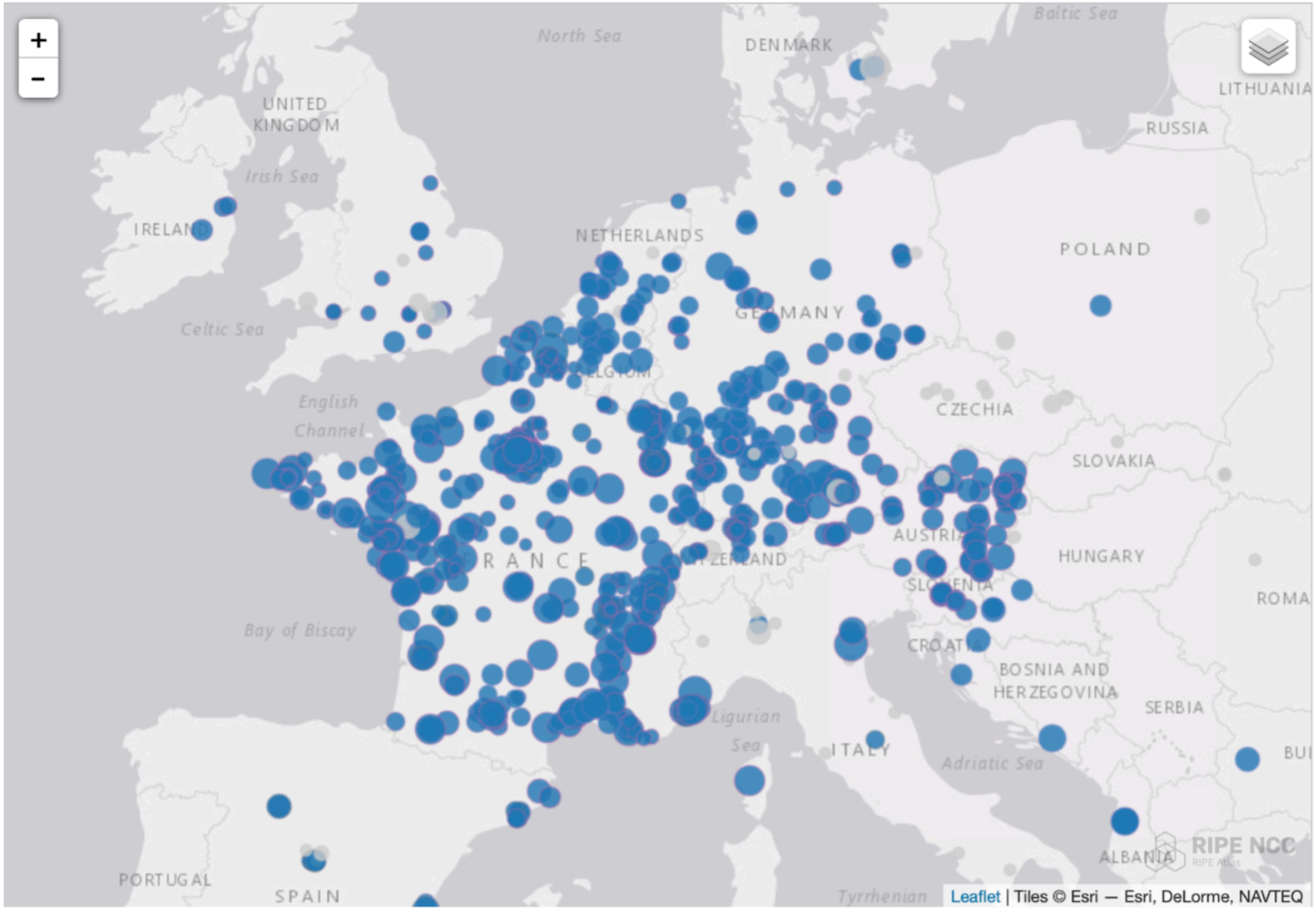
- **Peak traffic to all IMRS instances combined has increased 20-25% starting in mid-March 2020**
- The graph shows DNS queries per second to all IMRS instances worldwide from 1 January 2020 through 31 March 2020:



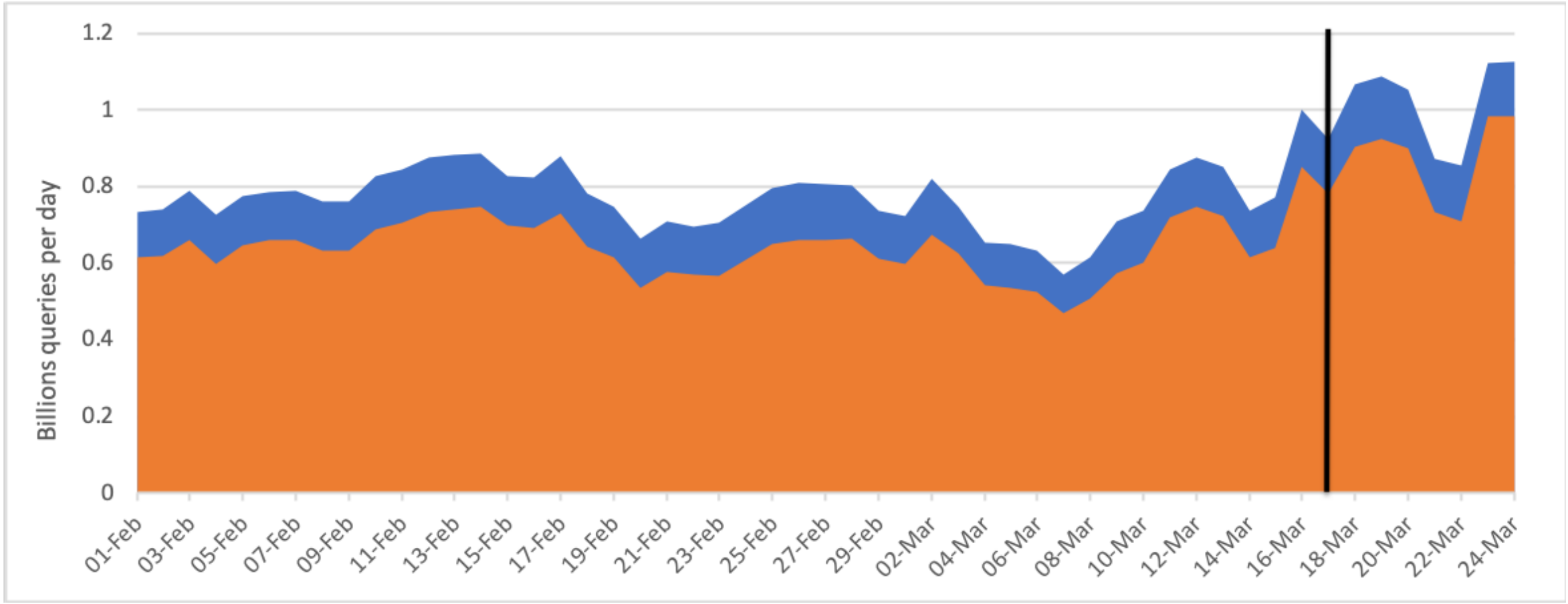
ICANN Managed Root Server (IMRS) traffic analysis

- We looked into the cause of this traffic increase
- We decided to focus on the four IMRS instances in France
  - Paris (2 sites), Lyon, Marseille
- The lock down in France happened relatively quickly:
  - March 12: government announces school and university closures by March 16
  - March 13: gatherings with more than 100 people prohibited
  - March 14: non-essential public places closed
  - March 16: national lockdown beginning 17 March announced
- A significant portion of DNS queries to IMRS instances in France originates from within the country
  - We used RIPE ATLAS probes in France as a proxy for recursive resolvers
  - Each ATLAS probe sends a periodic diagnostic query to each root server address and the response indicates which instance the sent the reply

Location of ATLAS probes routing to IMRS instances in France



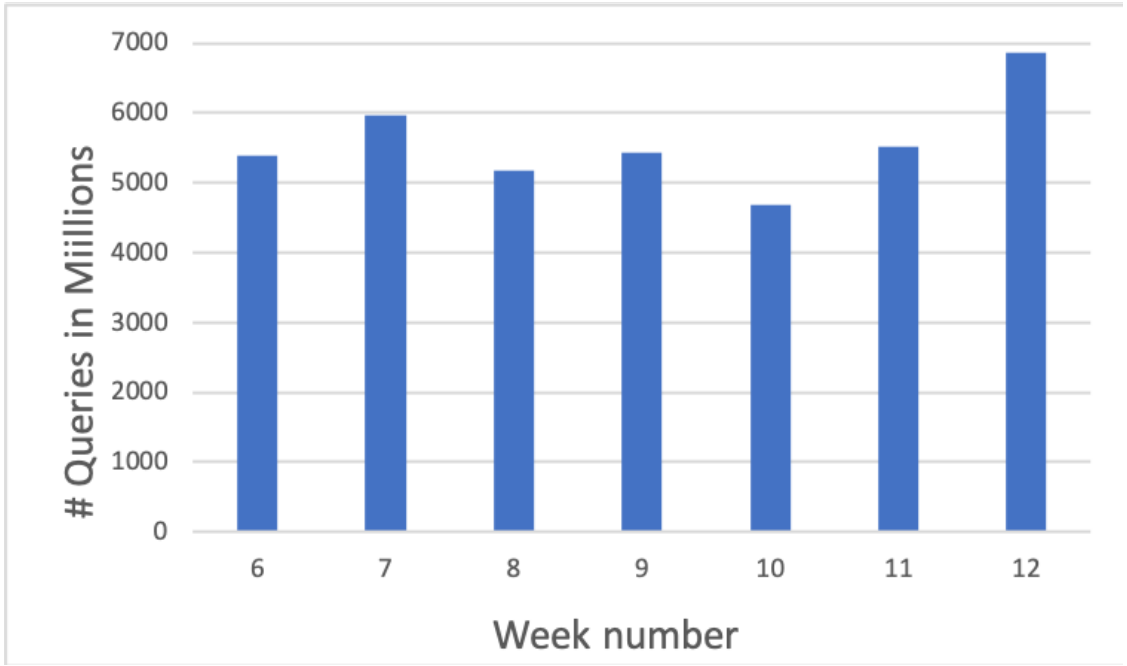
Traffic increase to IMRS instances in France



(Orange represents queries for names for non-existent TLDs, blue for existing TLDs)

Methodology

- Compared two weeks of traffic to the four IMRS instances in France
  - Week 6: week starting 3 February 2020
  - Week 12: week starting 17 March 2020
- **28% increase in overall traffic**
  - Average 5.4B queries/week in weeks 6-11
  - 6.9B queries/week in week 12



Methodology *(continued)*

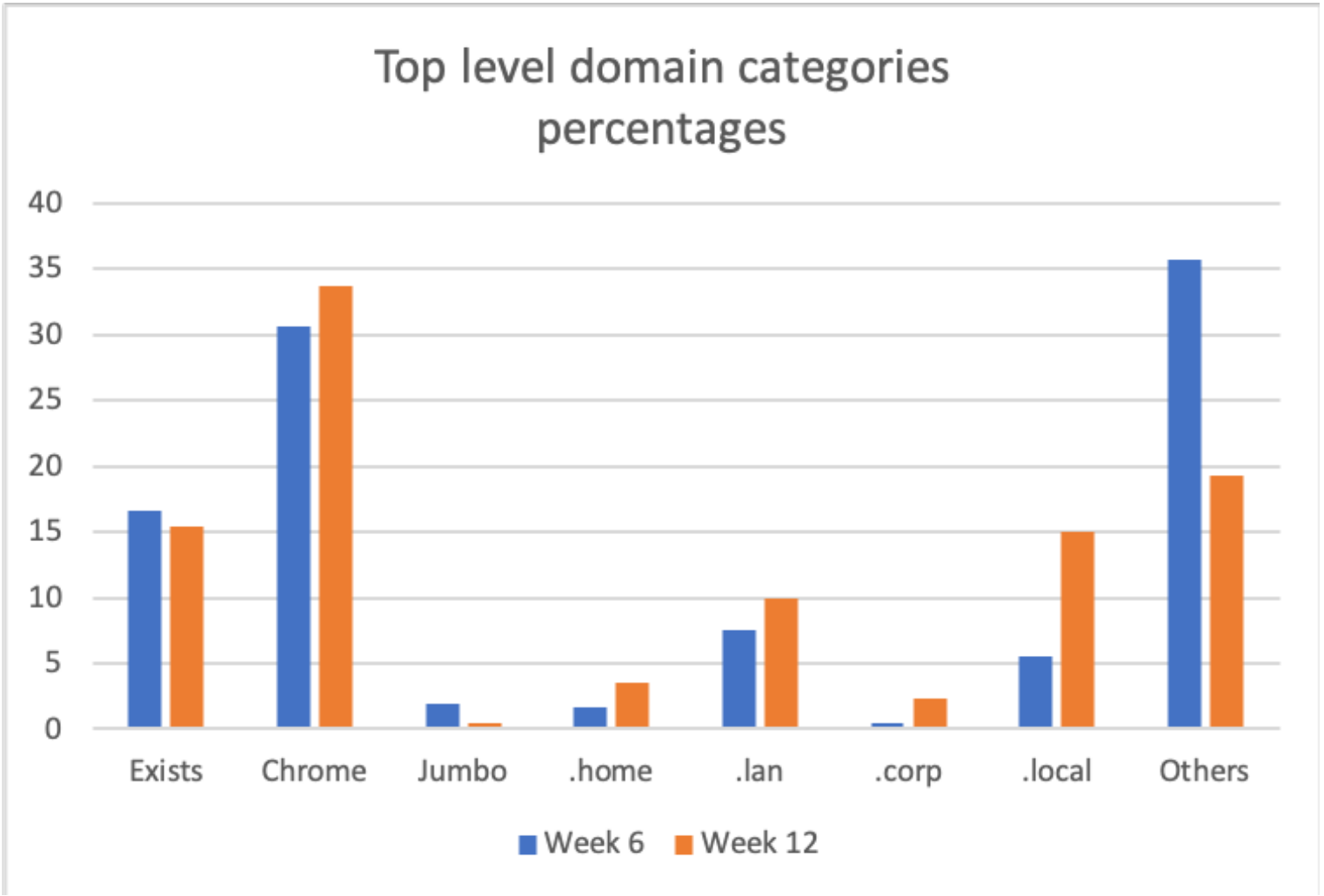
- We grouped each query into one of eight categories:

Category	Represents queries for…
Exists	Domain names in TLDs that are currently delegated in the root zone
Chromium	Domain names in non-existent TLDs between 7 and 15 characters long
Jumbo	Domain names in non-existent TLDs longer than 15 characters
.home	Domain names in the non-existent TLD *".home"*
.lan	Domain names in the non-existent TLD *".lan"*
.local	Domain names in the non-existent TLD *".local"*
.corp	Domain names in the non-existent TLD *".corp"*
Others	All other non-existent domain names

Queries per category compared Week 6 to Week 12

	Week 6 (3 February 2020)		Week 12 (17 March 2020)		Increase/ Decrease
Exists	892,368,008	16.6%	1,058,216,729	15.4%	**19%**
Chromium	1,648,137,196	30.6%	2,317,414,531	33.8%	**41%**
Jumbo	102,962,057	1.9%	36,596,751	0.5%	**-64%**
.home	87,155,981	1.6%	244,878,703	3.6%	**181%**
.lan	408,542,223	7.6%	679,890,040	9.9%	**66%**
.corp	25,291,920	0.5%	163,473,699	2.4%	**546%**
.local	296,288,423	5.5%	1,035,726,205	15.1%	**250%**
Others	1,922,600,465	35.7%	1,327,598,837	19.3%	**-31%**
Total	5,383,346,273	100.0%	6,863,795,495	100.0%	**28%**

Changes in category of queried domain names



(All categories other than “Exists” represent non-existent domain responses)

Queries for popular non-existent TLDs

	Week 6 (3 February 2020)		Week 12 (17 March 2020)		Increase/ Decrease
Exists	892,368,008	16.6%	1,058,216,729	15.4%	**19%**
Chromium	1,648,137,196	30.6%	2,317,414,531	33.8%	**41%**
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Queries for popular non-existent TLDs *(continued)*

- The most popular non-existent TLDs queried were *.corp*, *.home*, *.lan*, and *.local*
- Significant increase in non-existent domain responses for *.corp* (546%), *.local* (250%), and *.home* (181%)
- Hypothesis: The increase in queries for these TLDs is due to more users working from home
  - The *.corp* TLD is potentially used by employers to name internal devices
    - Older Microsoft documentation for Active Directory used *.corp* as an example TLD
  - The *.local* TLD is used by mDNS (Multicast DNS)
  - The *.home* TLD is used by early versions of the Home Networking Control Protocol (HNCP)
  - Devices previously using employers' resolvers are now sending queries to the users' configured resolvers on home networks
  - Queries for domain names in these TLDs get spread out through more resolvers
  - More resolvers means more caches, which means more cache misses, which means more queries to the root servers

Chromium queries

	Week 6 (3 February 2020)		Week 12 (17 March 2020)		Increase/ Decrease
Exists	892,368,008	16.6%	1,058,216,729	15.4%	**19%**
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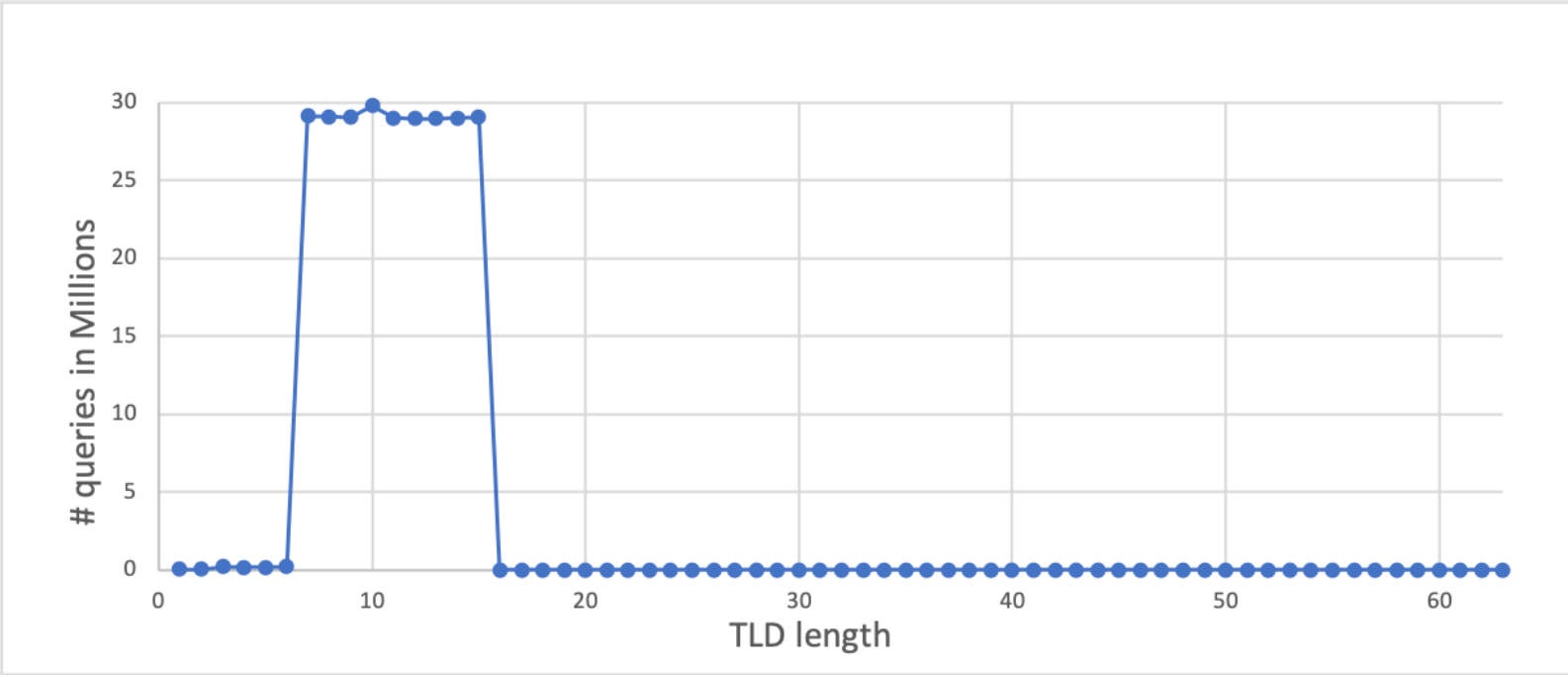
Chromium queries *(continued)*

- Browsers based on Google Chromium send queries for random single label names between 7-15 characters long to check the local resolver's behavior (e.g., behind a captive portal)
- Histogram of TLD length in all queries for non-existent domain names on 19 March 2020:



Chromium queries *(continued)*

- Queries for non-existent TLDs from browsers derived from Google Chromium account for around **one third of all queries to the IMRS**
- The relative percentage of Chromium queries grew
  - 30.6% of all queries in Week 6, 33.8% in Week 12
- The absolute number of Chromium queries grew more than non-Chromium queries
  - Chromium queries increased 41%
    - 1.6B in Week 6, 2.3B in Week 12
  - Non-Chromium queries increased 22%
    - 3.7B in Week 6, 4.5B in Week 12
- Hypothesis: More devices running Chromium-derived browsers are now being used

Summary of findings

- Traffic to the IMRS has increased from levels before mid March 2020
  - Peak traffic to all IMRS instances combined has increased 20-25%
  - Total queries per week to the four IMRS instances in France is up 28%
- There has been a significant increase in queries for non-existent domains in the TLDs *.corp* (546%), *.local* (250%), and *.home* (181%) to the four IMRS instances in France
  - Likely because user devices are dispersed more widely in homes rather than concentrated in offices and these devices are therefore using more recursive resolvers
- Google Chromium-based browsers continue to send a lot of queries to the IMRS for non-existent TLDs: about one third of all queries
  - This Chromium-based traffic to the IMRS has increased along with all other traffic, suggesting more devices with Chromium-based browsers are now in use

Acknowledgements

- Roy Arends (OCTO Research team) is the primary author of the paper that this presentation is based on
  - “Analysis of the Effects of COVID-19-Related Lockdowns on IMRS Traffic”
    - https://www.icann.org/en/system/files/files/octo-008-en.pdf
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