The Lockdown Effect: Implications of the COVID-19 Pandemic on Internet Traffic

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Internet Measurement Conference 2020 | Virtual | 27-29 Oct 2020

Lots of data, lots of data crunchers



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Coronavirus: Half of humanity now on lockdown as 90 countries call for confinement

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The New York Times Working From Home: How Coronavirus Could Affect the Workplace

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Will Shift to Remote Teaching Be Boon or Bane for Online Learning?

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The Internet is essential in all these efforts, but how well does it cope?

• Understand the impact of the COVID-19 pandemic on different networks

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- · Present our results from a diverse set of vantage points

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- Present our results from a diverse set of vantage points
- Highlight how a change in user demand affects traffic dynamics

Vantage points



3 IXPs

IXP Central Europe IXP Southern Europe IXP US East Coast

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Interconnecting networks

- Central Europe: 900+ members, 8+ Tbps peak traffic
- Southern Europe: 170+ members, 500+ Gbps peak traffic
- US East Coast: 250+ members, 600+ Gbps peak traffic
- IPFIX flows collected at the public peering platforms

Data has been analyzed strictly on premise and results are aggregated.

3 IXPs

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Interconnecting networks



ISP Central Europe

3 IXPs

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Interconnecting networks



- Services ${\sim}15M$ fixed line subscribers + Tier 1 transit network
- No hosted CDN caches, but a diverse peering infrastructure
- Subscriber view: Netflow captured at the Border Network Gateways (BNGs)
- AS level view: Netflow collected at the border routers

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ISP Central Europe Residential customers working from home



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Interconnecting networks



Service network interconnecting universities and research institutions

ISP Central Europe Residential customers working from home

- Academic network interconnecting 16 universities and research centers (Madrid region)
- Serves ~290K users (incl WiFi access)
- NetFlow captured at the border routers

The network operators provided anonymized flow data.

base: February before the lockdown

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	ISP-CE	IXP-CE	IXP-SE	IXP-US	EDU
base	Feb 20–26				
March	Mar 19–25	Mar 19–25	Mar 12–18	Mar 19–25	Mar 12–18
April	Apr 09–15	Apr 23–29	Apr 23–29	Apr 23–29	Apr 23–29
June	Jun 18–24	Jun 18–24	Jun 18–24	Jun 18–24	n/a

Traffic changes in different networks





Once the lockdown started the ISP saw an increase in traffic which normally spans over multiple months.





Similar behaviour for the IXPs; for the IXP CE and IXP US the traffic levels keep elevated.





Once the lockdown started mobile traffic decreased measurably and increases with the first relaxations in mid April.

Traffic volumes before and after the lockdown


















- Regular patterns
 - Workday: Strong increase in evening hours
 - Weekend: More traffic during daytime



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- During pandemic: Workdays look more like weekends



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- Pre-lockdown: Most days are classified correctly
- During lockdown: Many workdays are classified as weekends; recovering after mid-May

Changes in workday vs. weekday patterns: ISP vs. IXP

ISP







Changes in workday vs. weekday patterns: ISP vs. IXP

ISP

IXP



At both vantage points workdays are mostly classified as weekends.

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- · Email during working hours
- CDN, VoD, gaming and social media during evening hours
- Hardly any web conferencing





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- Large increase in web conf., coll. working, educational traffic
- Partial decrease in VoD and gaming



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June:

- Web conf. still growing, but more focused on working hours
- Moderate growth in coll. working
- Decrease of VoD, gaming and social media 17





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Case Study: Gaming traffic at a Southern European IXP



week
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Gaming: Large increase in number of active IP addresses and traffic volume

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- DNS-based: For TCP/443 traffic, IPs labeled *vpn*, but not www.

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How did edu traffic change?

Ingress-egress traffic ratio: REDIMadrid





• Large decrease in traffic and number of connections



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- Traffic ratio significantly decreased from 15:1 to 4:1

What we found

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We find, that the impact of the COVID-19 pandemic is directly reflected in changes to Internet traffic patterns.

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