

The Lockdown Effect

Implications of the COVID-19 Pandemic on Internet Traffic

Oliver Gasser, Max Planck Institute for Informatics

IETF 109 · maprg · November 16, 2020

euronews.

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

INSIDE
HIGHER ED

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

The New York Times

Working From Home: How Coronavirus Could Affect the Workplace

 REUTERS

Under lockdown, Italy's social and family life goes virtual

euronews.

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

The New York Times

Working From Home: How Coronavirus Could Affect the Workplace

INSIDE
HIGHER ED

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

REUTERS

Under lockdown, Italy's social and family life goes virtual

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

Lots of data, lots of data crunchers

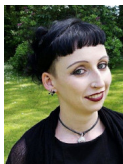
- Edge network: Large European ISP
- Core networks: 3 IXPs in Central Europe, Southern Europe, and US East Coast
- Academic network: REDIMadrid university network in Madrid



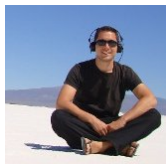
Anja Feldmann
MPII



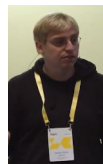
Oliver Gasser
MPII



Franziska Lichtblau
MPII



Enric Pujol
BENOCS



Ingmar Poesel
BENOCS



Christoph Dietzel
DE-CIX



Daniel Wagner
DE-CIX



Matthias Wichtlhuber
DE-CIX



Juan Tapiador
Universidad Carlos III de
Madrid



Narseo Vallina
Rodriguez
IMDEA, ICSI

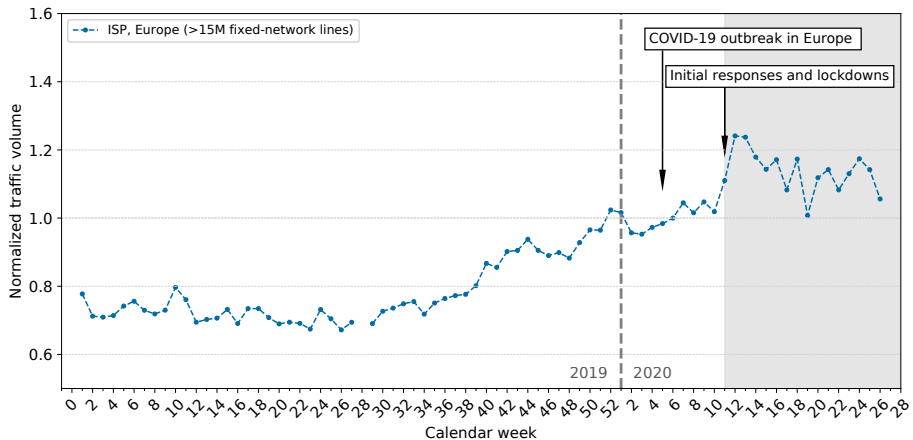


Oliver Hohfeld
Brandenburg University
of Technology



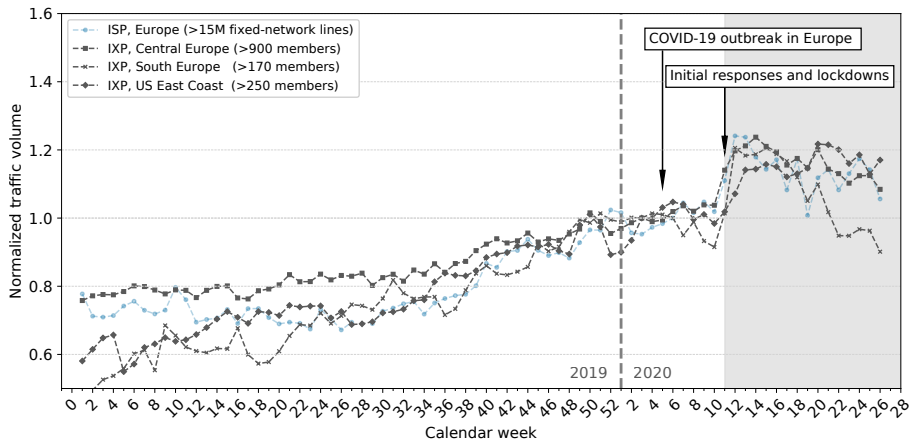
Georgios
Smaragdakis
TU Berlin, MPII

Traffic changes from January 2019 to June 2020



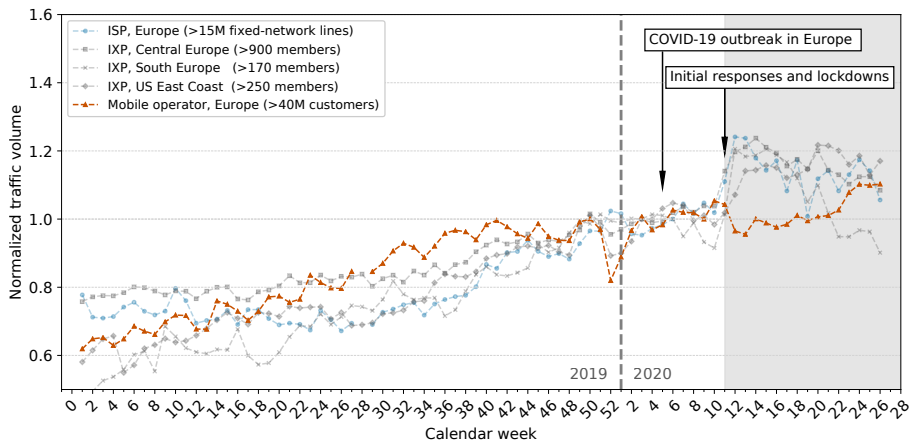
Once the lockdown started the ISP saw a +30% increase in traffic which normally spans over multiple months.

Traffic changes from January 2019 to June 2020



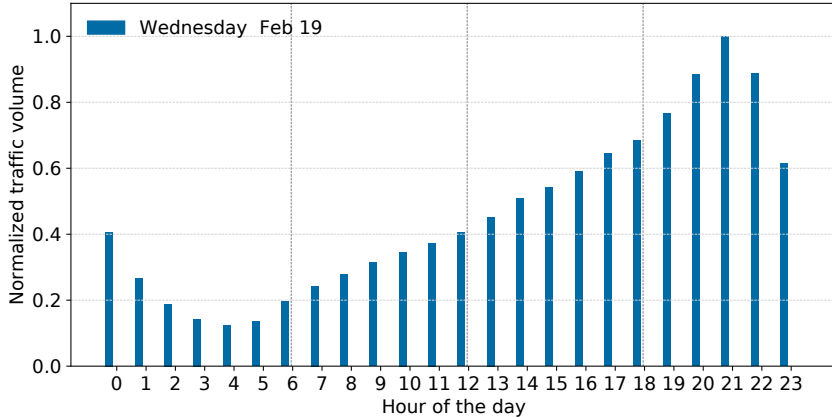
Similar behavior for the IXPs; for the IXP CE and IXP US the traffic levels remain elevated.

Traffic changes from January 2019 to June 2020



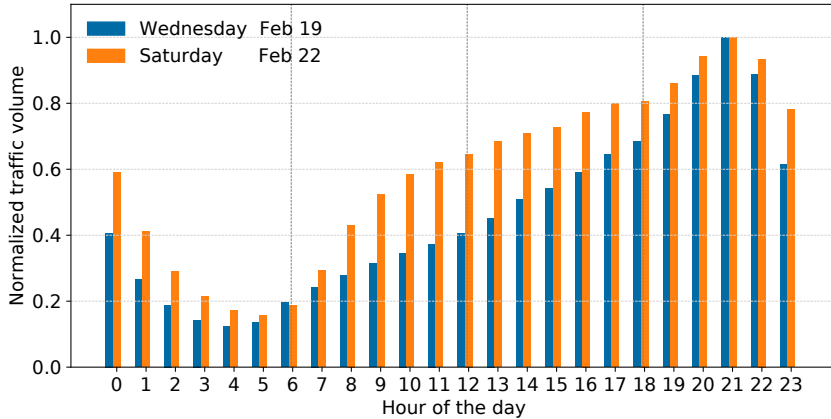
Once the lockdown started mobile traffic decreased measurably and increased again with the first relaxations in mid April.

Changes in workday vs. weekend patterns at the ISP



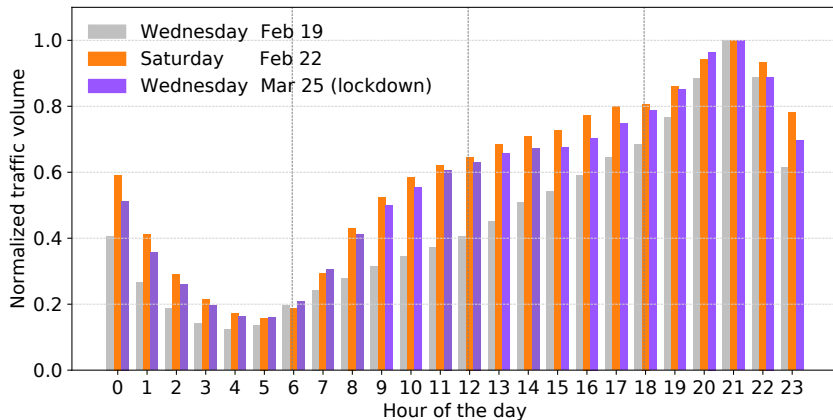
- Regular patterns
 - Workday: Strong increase in evening hours

Changes in workday vs. weekend patterns at the ISP



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

Changes in workday vs. weekend patterns at the ISP

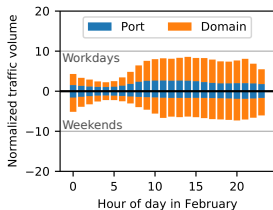


- Regular patterns
 - Workday: Strong increase in evening hours
 - Weekend: More traffic during daytime
- During lockdown: Workdays look more like weekends

VPN traffic at the Central European IXP

VPN identification

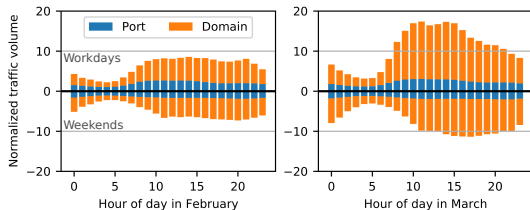
- Port-based: Well known port/proto combinations exclusively used by VPN services
- Domain-based: For TCP/443 traffic, IPs labeled *vpn*, but not www.



VPN traffic at the Central European IXP

VPN identification

- Port-based: Well known port/proto combinations exclusively used by VPN services
- Domain-based: For TCP/443 traffic, IPs labeled *vpn*, but not www.

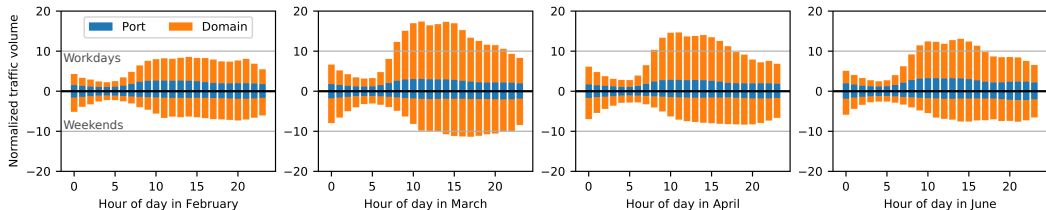


- 200% increase in VPN traffic in March during working hours

VPN traffic at the Central European IXP

VPN identification

- Port-based: Well known port/proto combinations exclusively used by VPN services
- Domain-based: For TCP/443 traffic, IPs labeled *vpn*, but not www.



- 200% increase in VPN traffic in March during working hours
- Slight decrease in April & June

People change → traffic changes

- Traffic increase of **15-30%** within a few **days**
- Difference between **workday and weekend** vanishes
- Applications for **remote work, education, VPN, and video conferencing** see significant increase in traffic

People change → traffic changes

- Traffic increase of 15-30% within a few days
- Difference between **workday** and **weekend** vanishes
- Applications for remote work, education, VPN, and **video conferencing** see significant increase in traffic

More in our *The Lockdown Effect* IMC 2020 paper

- Changes in transport ports
- Different traffic classes
- Educational network
- Hypergiants vs. non-hypergiants
- ...

oliver.gasser@mpi-inf.mpg.de

dl.acm.org/doi/10.1145/3419394.3423658

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

Anja Feldmann Max Planck Institute for Informatics	Oliver Gasser Max Planck Institute for Informatics	Franciska Leiblein Max Planck Institute for Informatics
Erice Papad REDCS	Dagmar Fose REDCS	Christoph Dietel DE-CIX
Daniel Wagner DE-CIX	Matthias Wehrhager DE-CIX	Jean Tapakar University of Caen II de Normandie
Narveso Valdez-Rodriguez ISG& Networks	Oliver Hohfeld Rheinisch-Westfälische Technische Universität Aachen	Georgios Sotiriadis TU Berlin Max Planck Institute for Informatics

ABSTRACT
Due to the COVID-19 pandemic, many governments imposed lock-downs that forced hundreds of millions of citizens to stay at home. The implementation of confinement measures increased Internet traffic demands of residential users, in particular, for remote work, entertainment, education, and telehealth, which, as a result, caused traffic shifts on the Internet core.

In this paper, using data from a diverse set of vantage points (DE, US, CN), and one metropolitan educational network, we examine the effect of these lockdowns on traffic shifts. We find that the traffic volume increased by 19.3% overall within a week, while overall still peaked. This constitutes a large increase within the short time period. However, despite this surge, we observe that the Internet infrastructure is able to handle the new volume, as most traffic shifts occur outside of traditional peak hours. When looking directly at the traffic sources, it turns out that, while hypergiants still constitute a significant fraction of traffic, we see (i) a higher increase in traffic of non-hypergiants, and (ii) traffic increases in applications that people use when at home, such as their workdaying, VPN, and gaming. While many networks see increased traffic demands, in particular those providing services to residential users, academic networks experience major overall decreases. In addition, we can observe substantial increases when considering applications associated to remote working and lecturing.

ACM Release Form:
Oliver Gasser, Anja Feldmann, Franciska Leiblein, Jean Tapakar, Dagmar Fose, Christoph Dietel, Erice Papad, Daniel Wagner, Narveso Valdez-Rodriguez, Matthias Wehrhager, Oliver Hohfeld, Georgios Sotiriadis, and Oliver Gasser. 2020. The Lockdown Effect: Implications of the COVID-19 Pandemic on Internet Traffic. In *Proceedings of the ACM on Internet Measurement Conference (IMC '20)*, October 15–16, 2020, Virtual Event, USA, 15 pages. <https://doi.org/10.1145/3419394>

1 INTRODUCTION
The profile of a typical residential user—in terms of bandwidth usage and traffic distribution—is one of the most critical parameters that network operators use to drive their network operations and to tune investments [23, 41, 44]. In the last twenty years, user profiles have changed significantly. We observed user traffic shifts from peer-to-peer applications in the early 2000s [24, 38, 40], to bandwidth-hungry and streaming applications in 2010 [2, 13, 17, 37, 42], and more recently to mobile applications [32, 42]. Although changes in user profiles are a recurring topic, they typically have time scales of years. This, together with data, e.g., via measurements, was feasible.

The COVID-19 pandemic, as most likely a one-in-a-generation global phenomenon that drastically changed the habits of millions of Internet users around the globe, is a result of the government