

The Lockdown Effect

Implications of the COVID-19 Pandemic on Internet Traffic

Oliver Gasser, Max Planck Institute for Informatics

Sixth RSNOG Conference · November 26, 2020

COVID-19 and the Internet

COVID-19 and the Internet

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

COVID-19 and the Internet

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

- 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

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



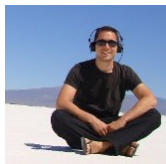
Anja Feldmann
MPII



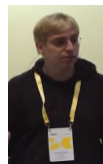
Oliver Gasser
MPII



Franziska Lichtblau
MPII



Enric Pujol
BENOCs



Ingmar Poesche
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



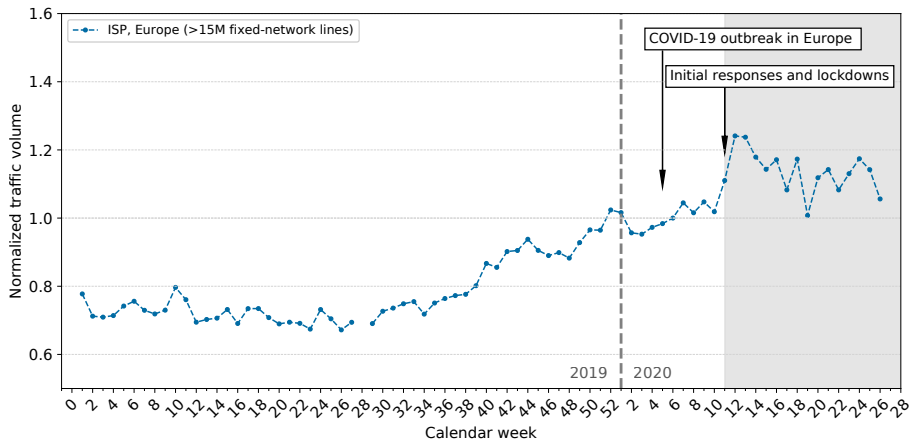
Oliver Hohfeld
Brandenburg University
of Technology



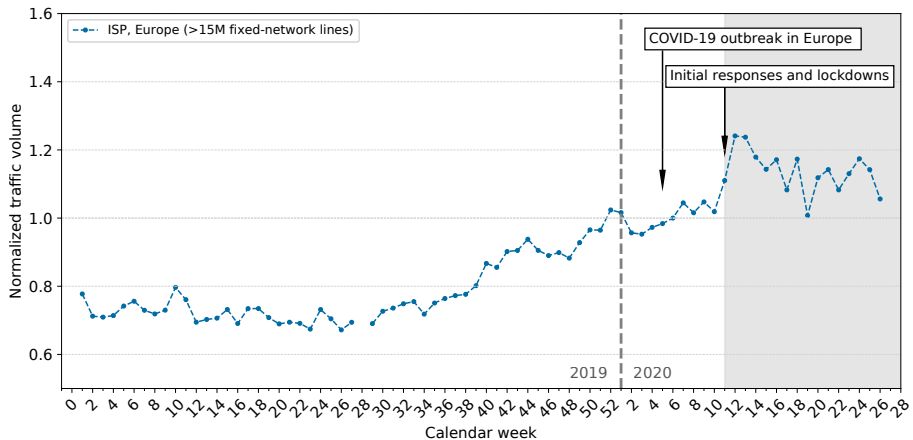
Georgios
Smaragdakis
TU Berlin, MPII

Traffic changes in different networks

Traffic changes from January 2019 to June 2020

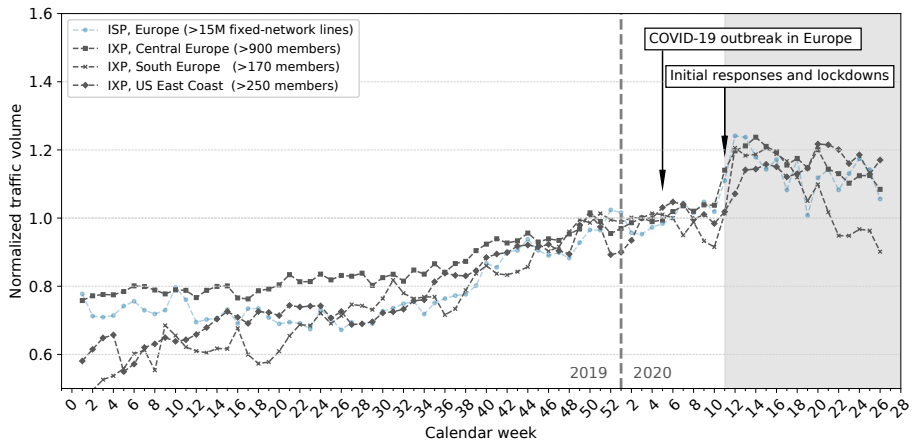


Traffic changes from January 2019 to June 2020



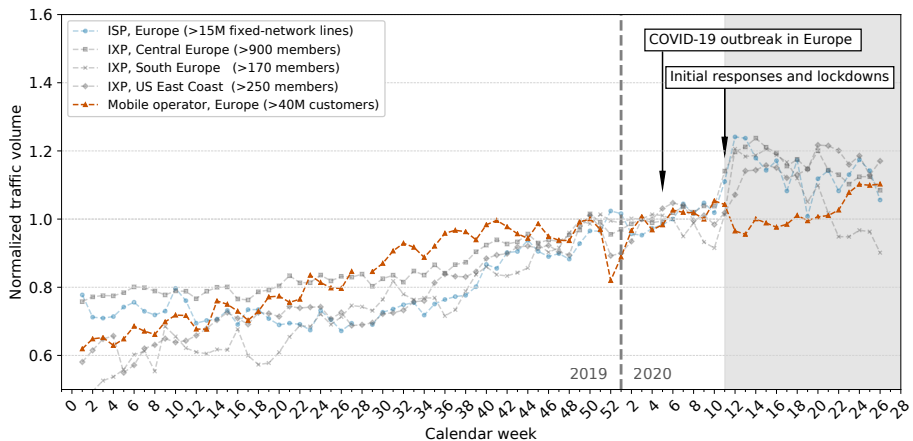
Once the lockdown started the ISP saw a +30% increase in traffic which normally spans over multiple months.

Traffic changes from January 2019 to June 2020



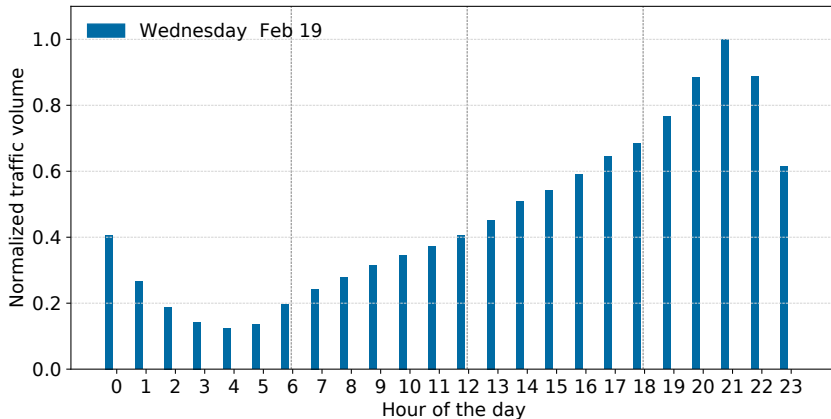
Similar behavior for the IXPs; for the IXP CE and IXP US the traffic levels remain elevated.

Traffic changes from January 2019 to June 2020



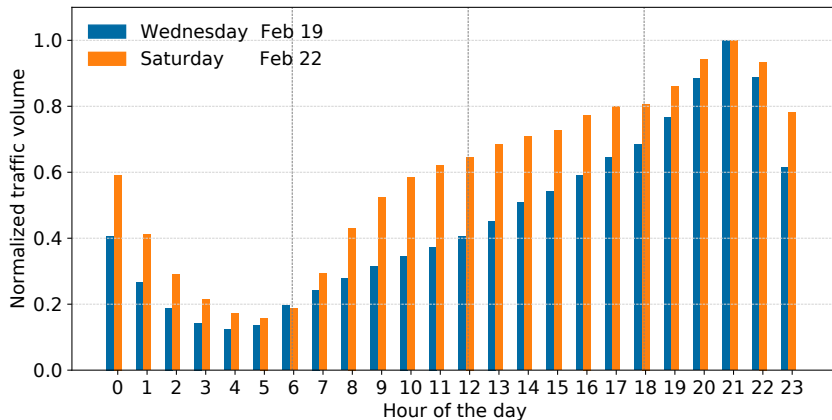
Once the lockdown started mobile traffic decreased measurably and increased again with the first relaxations in mid-April.

Changes in workday vs. weekend patterns at the ISP



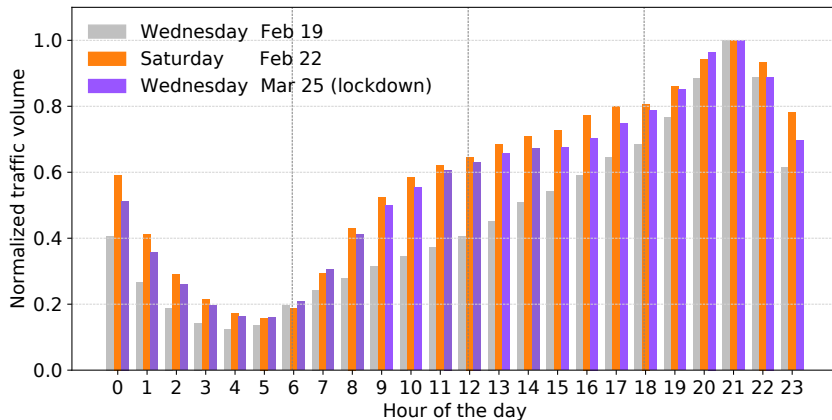
- Regular patterns
 - Workday: Strong increase in evening hours

Changes in workday vs. weekend patterns at the ISP



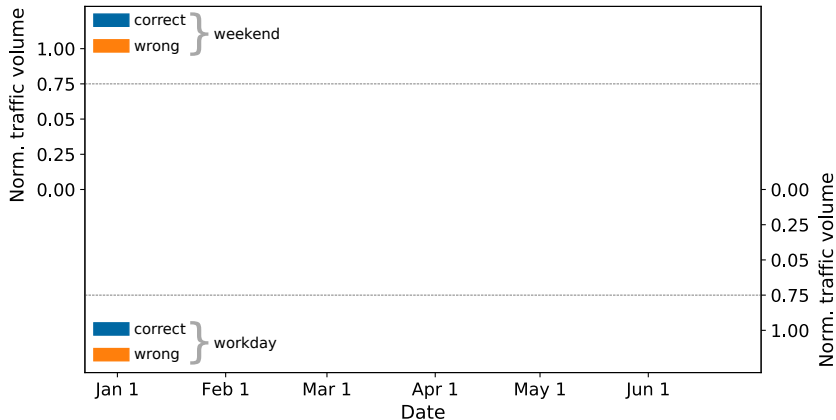
- Regular patterns
 - Workday: Strong increase in evening hours
 - Weekend: More traffic during daytime

Changes in workday vs. weekend patterns at the ISP



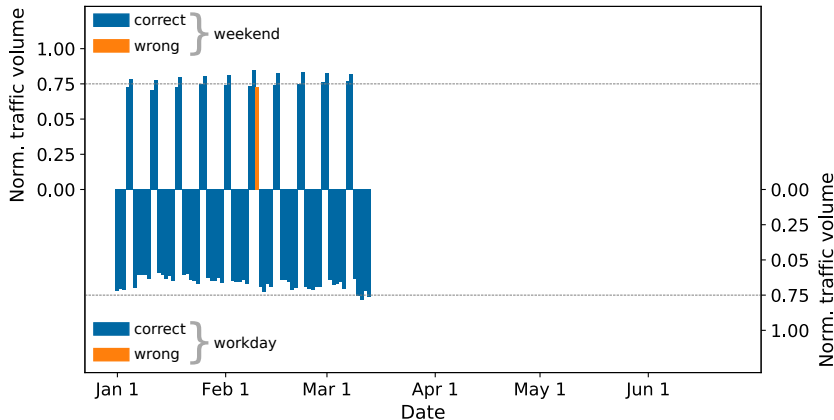
- Regular patterns
 - Workday: Strong increase in evening hours
 - Weekend: More traffic during daytime
- During lockdown: Workdays look more like weekends

Changes in workday vs. weekend patterns at the ISP



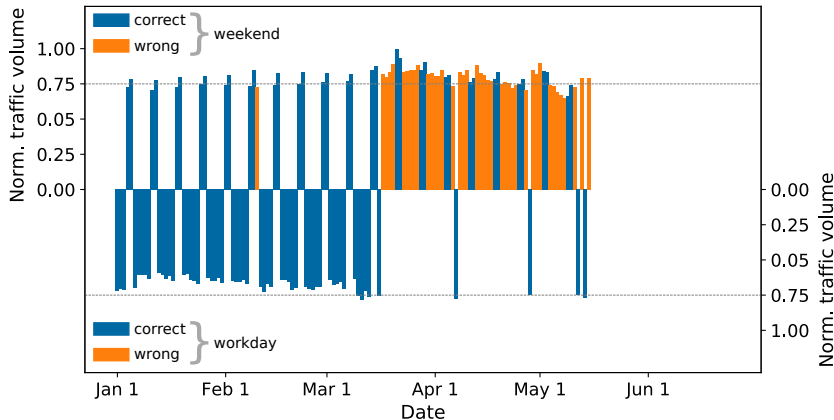
- Classify days into workdays or weekends using traffic patterns

Changes in workday vs. weekend patterns at the ISP



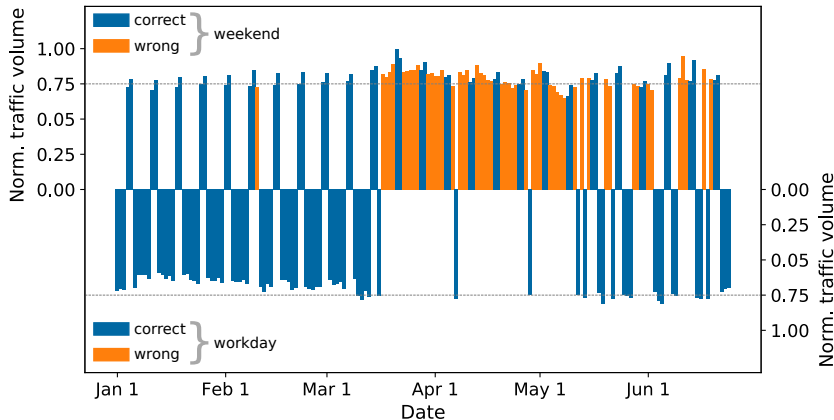
- Classify days into workdays or weekends using traffic patterns
- Pre-lockdown: Most days are classified correctly

Changes in workday vs. weekend patterns at the ISP



- Classify days into workdays or weekends using traffic patterns
- Pre-lockdown: Most days are classified correctly
- During lockdown: Workdays are classified as weekends

Changes in workday vs. weekend patterns at the ISP



- Classify days into workdays or weekends using traffic patterns
- Pre-lockdown: Most days are classified correctly
- During lockdown: Workdays are classified as weekends, recovering mid-May

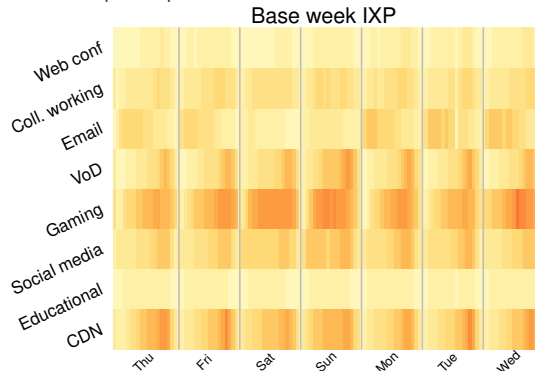
Application-level traffic changes

Classify traffic by application class

- Classify based on transport ports and src/dst ASes

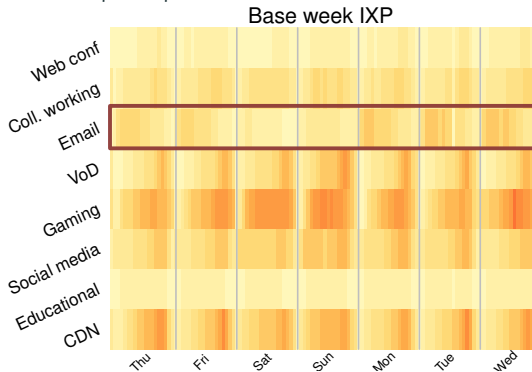
Classify traffic by application class

- Classify based on transport ports and src/dst ASes



Classify traffic by application class

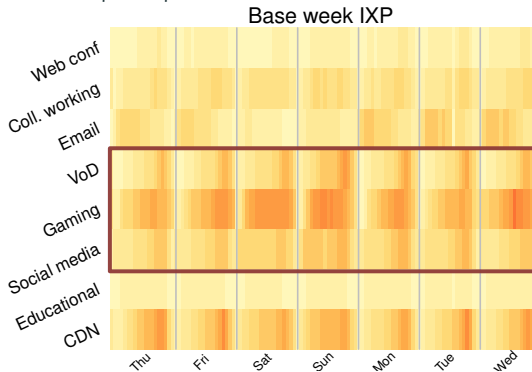
- Classify based on transport ports and src/dst ASes



- Email during working hours

Classify traffic by application class

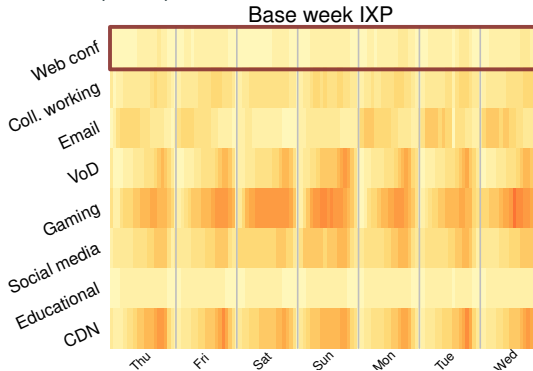
- Classify based on transport ports and src/dst ASes



- Email during working hours
- Video, gaming, and social media during evening hours

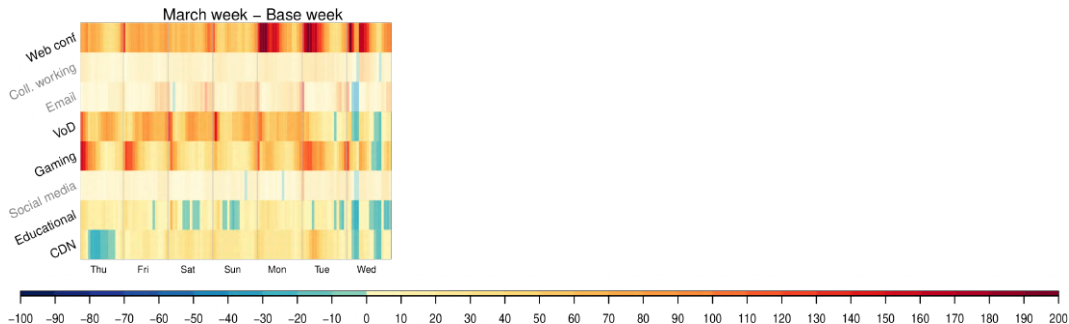
Classify traffic by application class

- Classify based on transport ports and src/dst ASes

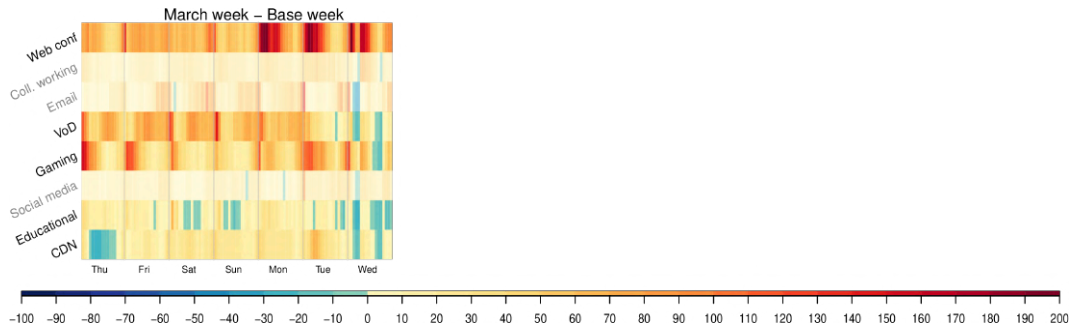


- Email during working hours
- Video, gaming, and social media during evening hours
- Hardly any web conferencing

Changes in application classes: Central European IXP



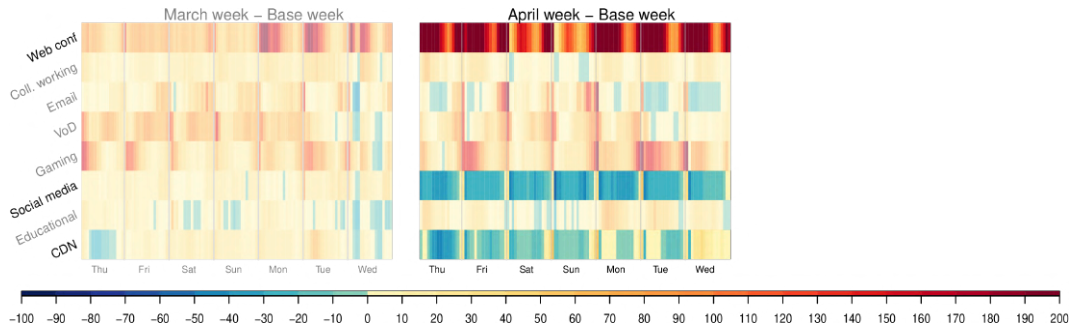
Changes in application classes: Central European IXP



March:

- Increase in web conf., VoD, and gaming
- Partial decrease in CDN and educational traffic

Changes in application classes: Central European IXP



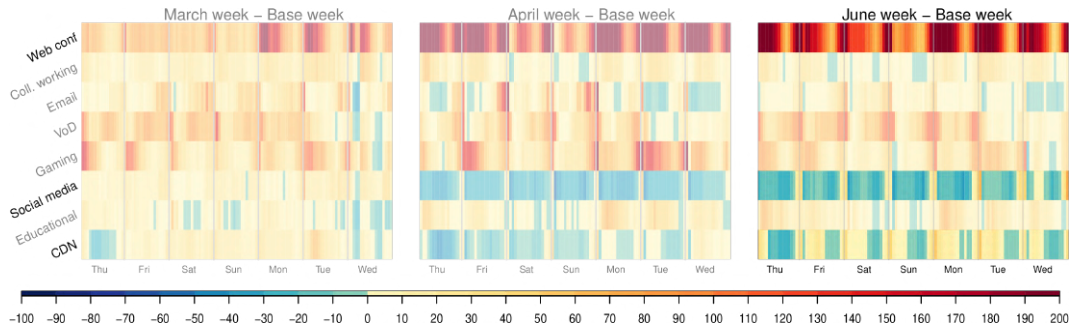
March:

- Increase in web conf., VoD, and gaming
- Partial decrease in CDN and educational traffic

April:

- Strong increase in web conf.
- Decrease in CDN and social media traffic

Changes in application classes: Central European IXP



March:

- Increase in web conf., VoD, and gaming
- Partial decrease in CDN and educational traffic

April & June:

- Strong increase in web conf.
- Decrease in CDN and social media traffic

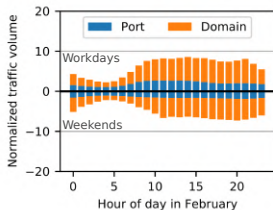
VPN identification

- 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: Central European IXP

VPN identification

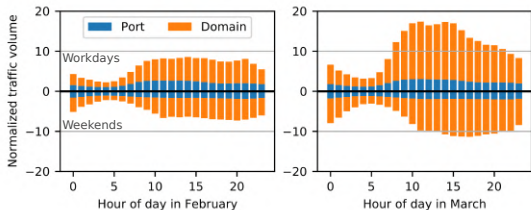
- Port-based: Well known port/proto combinations exclusively used by VPN services
- Domain-based: For TCP/443 traffic, IPs labeled *vpn*, but not www.



VPN traffic: 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.

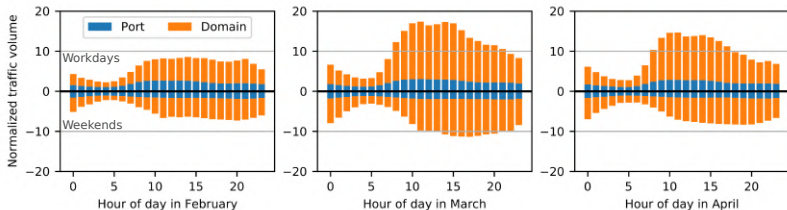


- 200% increase in VPN traffic in March during working hours

VPN traffic: 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.

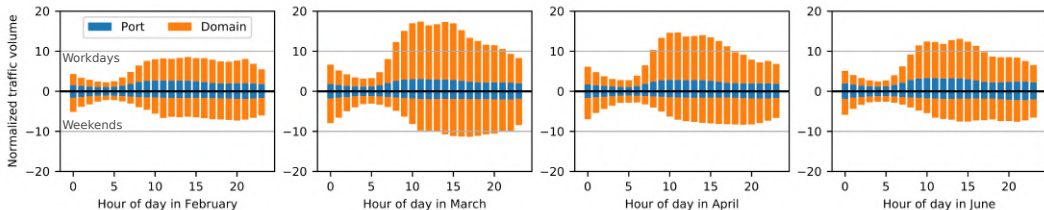


- 200% increase in VPN traffic in March during working hours
- Slight decrease in April

VPN traffic: Central European IXP

VPN identification

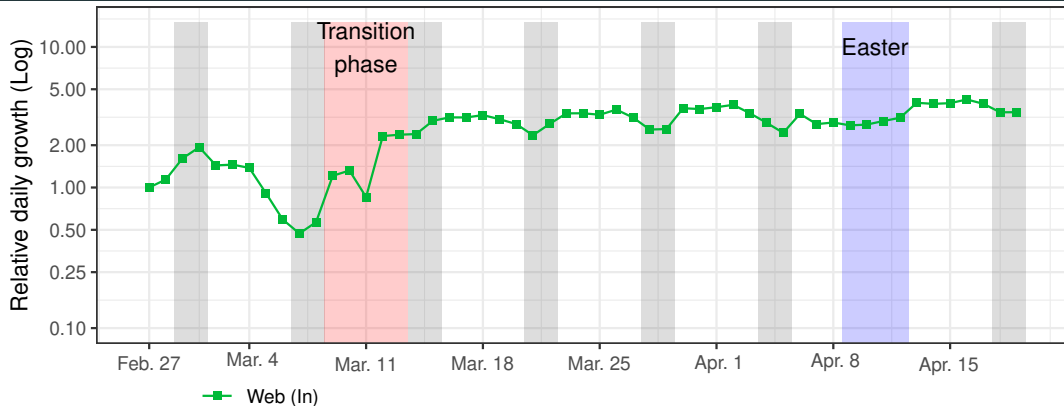
- Port-based: Well known port/proto combinations exclusively used by VPN services
- Domain-based: For TCP/443 traffic, IPs labeled ***vpn***, but not **www**.



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

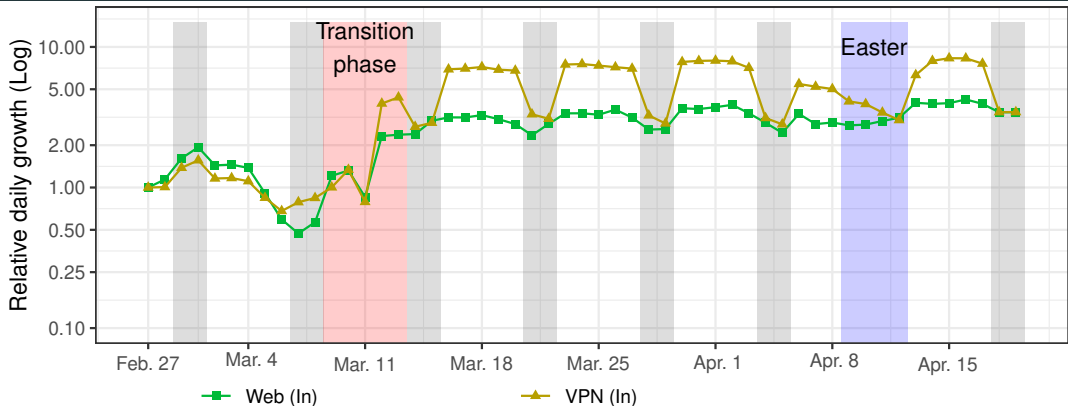
How did educational traffic change?

Daily connections for different traffic classes at REDIMadrid



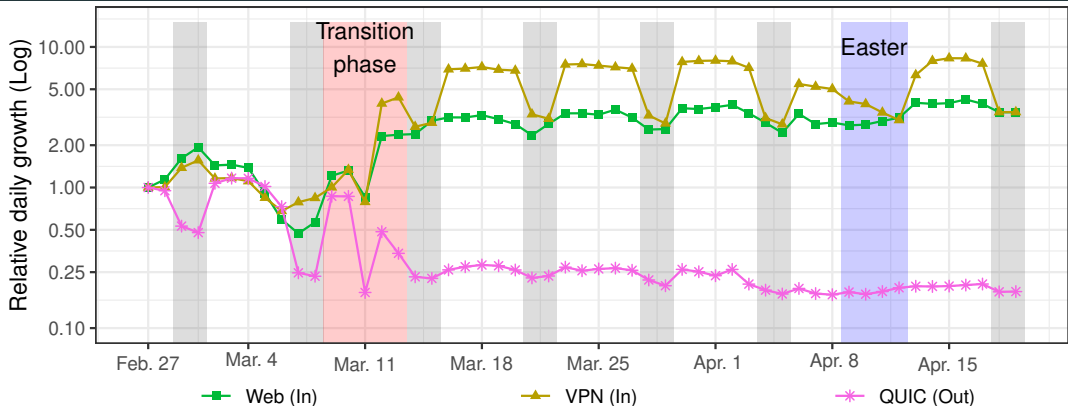
- Increase in incoming web traffic

Daily connections for different traffic classes at REDIMadrid



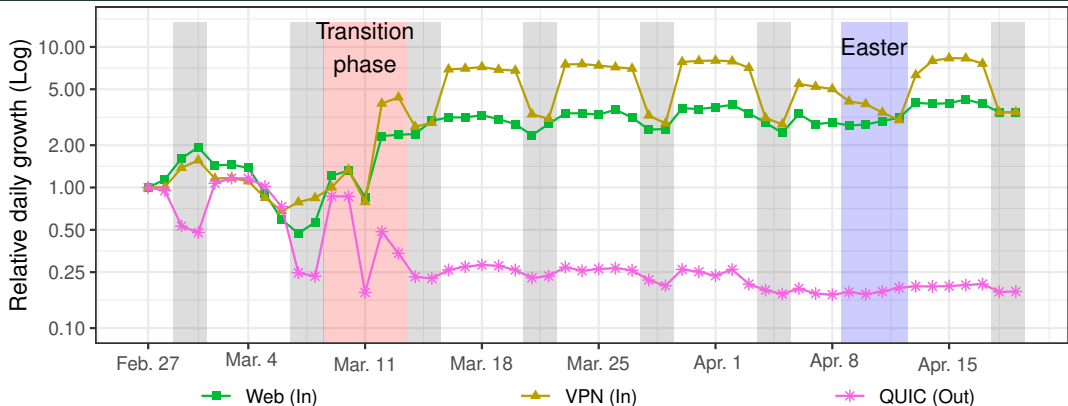
- Increase in incoming web and VPN traffic

Daily connections for different traffic classes at REDIMadrid



- Increase in incoming web and VPN traffic
- Decrease of outgoing QUIC traffic

Daily connections for different traffic classes at REDIMadrid

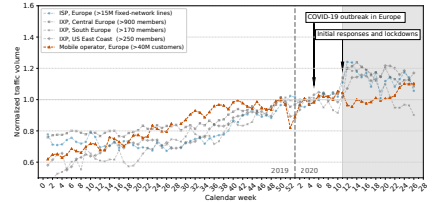


- Increase in incoming web and VPN traffic
- Decrease of outgoing QUIC traffic
- Absence of users leads to traffic decrease

What we found

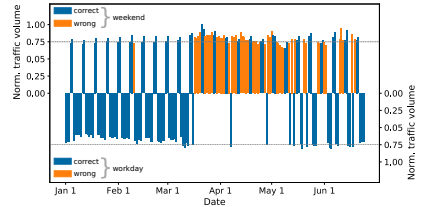
People change → traffic changes

- Traffic increase of 15-30% within a few days



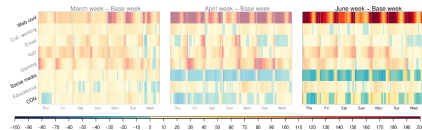
People change → traffic changes

- Traffic increase of **15-30%** within a few **days**
- **Workdays** start to look like **weekends**



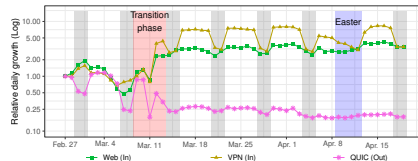
People change → traffic changes

- Traffic increase of **15-30%** within a few **days**
- **Workdays** start to look like **weekends**
- Increase in **remote work**, **education**, **VPN**, and **video conferencing** traffic



People change → traffic changes

- Traffic increase of **15-30%** within a few **days**
- **Workdays** start to look like **weekends**
- Increase in **remote work, education, VPN, and video conferencing** traffic
- **Absence of users** leads to traffic decrease



People change → traffic changes

- Traffic increase of **15-30%** within a few days
- **Workdays** start to look like **weekends**
- Increase in **remote work, education, VPN, and video conferencing** traffic
- **Absence of users** leads to traffic decrease

More in our *The Lockdown Effect* IMC 2020 paper

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

