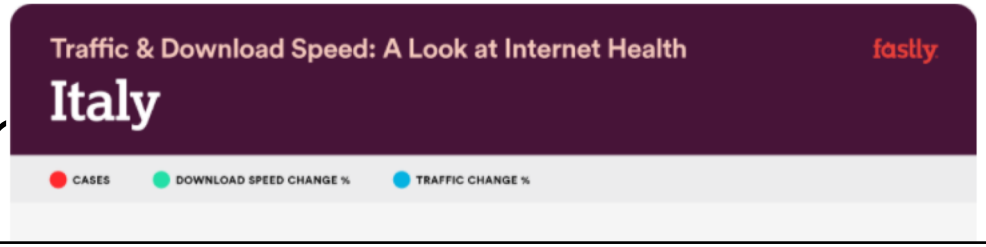
A Social Network Under Social Distancing: Risk-Driven Backbone Management During COVID-19 and Beyond

Yiting Xia, Ying Zhang, Zhizhen Zhong, Guanqing Yan, Chiun Lin Lim, Satyajeet Singh Ahuja, Soshant Bali, Alexander Nikolaidis, Kimia Ghobadi, Manya Ghobadi

COVID-19: the Theme of 2020

COVID-19: the Ther



Mobile Network Traffic Grew 50% Between Q3 2019 and Q3 2020

As in Q2 2020, the year-on-year tra
normal level, around 50%, compar
and the first part of 2019.

The quarter-on-quarter growth for
restrictions, such as lockdowns ar
to be reflected in people's commu

Ericsson | December 1, 2020

COVID-19 Sees Hungar

During the summer, Telenor saw te
and voice calls were 15% longer. Y
internet usage trends: data traffic
for Telenor users. Total used GBs

Budapest Business Journal | November 15, 202

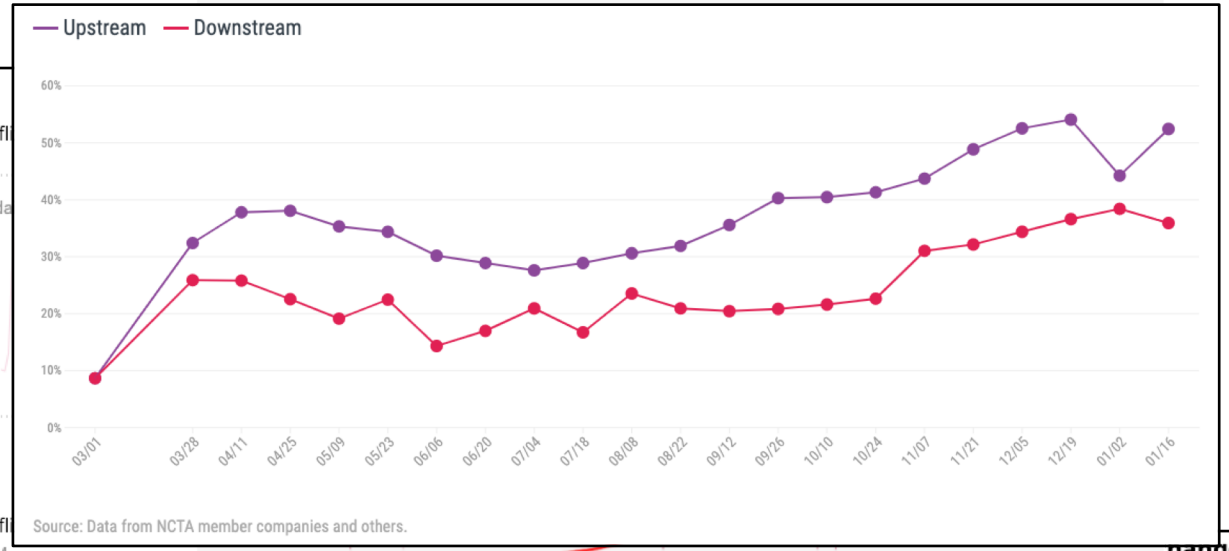
How the Internet reacte perspective from Faceb

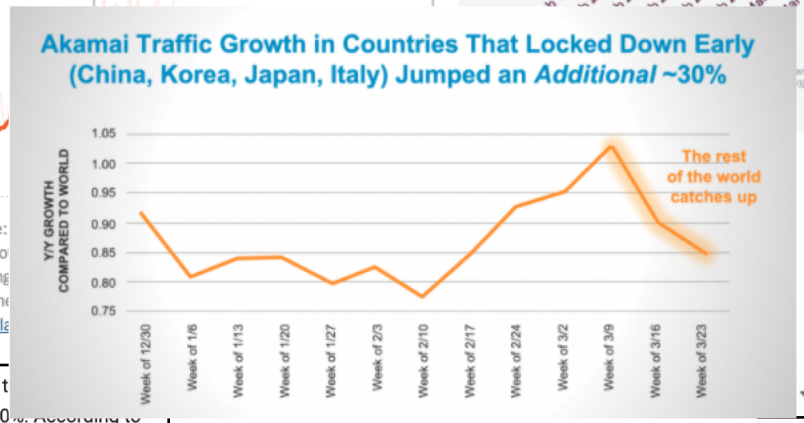
"While a surge in the popularity of
was accompanied by significant tr
largest traffic impact resulted fron
video products. Moreover, we four
mainly on broadband networks."

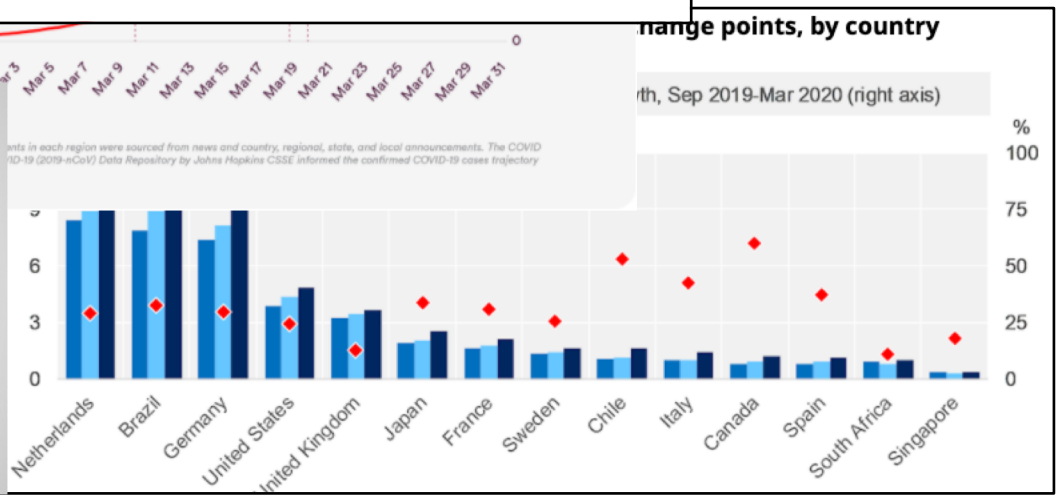
Facebook | October 1, 2020

Ghana's Data Traffic Gr Vodafone Says

Chief Executive Officer of Vodafor
revealed the outbreak of COVID-19 in Ghana has seen t
operations and the demand for its services go up by 50
her, the coronavirus outbreak has seen a surge and data traffic and an
increased demand for network and infrastructure in Ghana.







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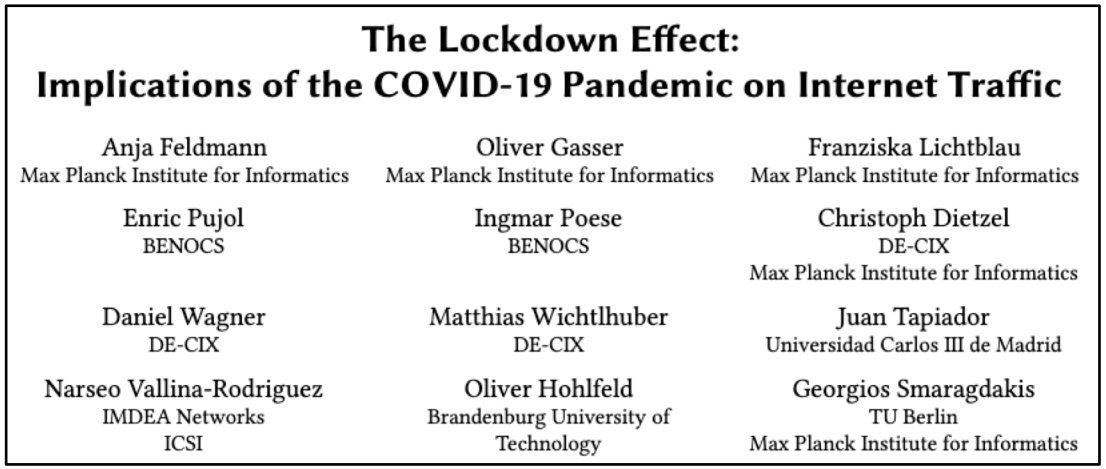
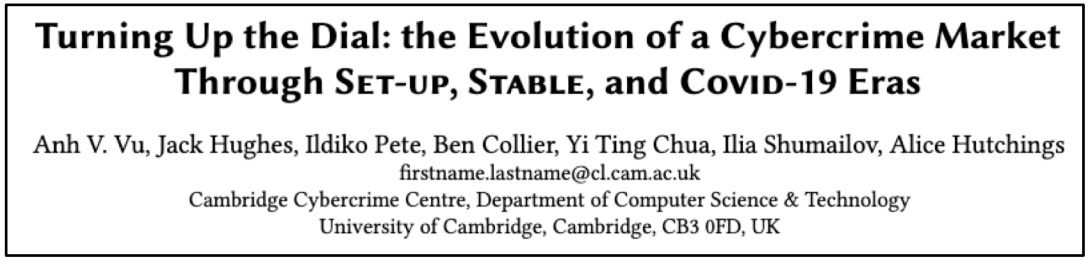


The Lockdown Effect: Implications of the COVID-19 Pandemic on Internet Traffic

Anja Feldmann, Max Planck Institute for Informatics
Oliver Gasser, Max Planck Institute for Informatics
Franziska Lichtblau, Max Planck Institute for Informatics
Enric Pujol, BENOCS
Ingmar Poese, BENOCS
Christoph Dietzel, DE-CIX, Max Planck Institute for Informatics
Daniel Wagner, DE-CIX
Matthias Wichtlhuber, DE-CIX
Juan Tapiador, Universidad Carlos III de Madrid
Narseo Vallina-Rodriguez, IMDEA Networks, ICSI
Oliver Hohlfeld, Brandenburg University of Technology
Georgios Smaragdakis, TU Berlin, Max Planck Institute for Informatics

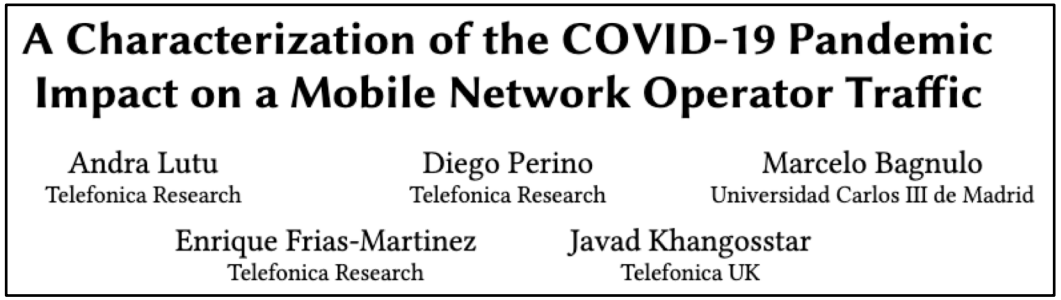


Turning Up the Dial: the Evolution of a Cybercrime Market Through Set-up, Stable, and Covid-19 Eras

Anh V. Vu, Jack Hughes, Ildiko Pete, Ben Collier, Yi Ting Chua, Ilia Shumailov, Alice Hutchings
firstname.lastname@cl.cam.ac.uk
Cambridge Cybercrime Centre, Department of Computer Science & Technology
University of Cambridge, Cambridge, CB3 0FD, UK

How the Internet reacted to Covid-19 – A perspective from Facebook's Edge Network

Timm Böttger, Ghida Ibrahim and Ben Vallis
Facebook



A Characterization of the COVID-19 Pandemic Impact on a Mobile Network Operator Traffic

Andra Lutu, Telefonica Research
Diego Perino, Telefonica Research
Marcelo Bagnulo, Universidad Carlos III de Madrid
Enrique Frias-Martinez, Telefonica Research
Javad Khangosstar, Telefonica UK

- How well has the current network infra responded to the COVID stress test?
- How should the network infra evolve in the post-pandemic era?

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How the Internet reacted to Covid-19 – A perspective from Facebook's Edge Network

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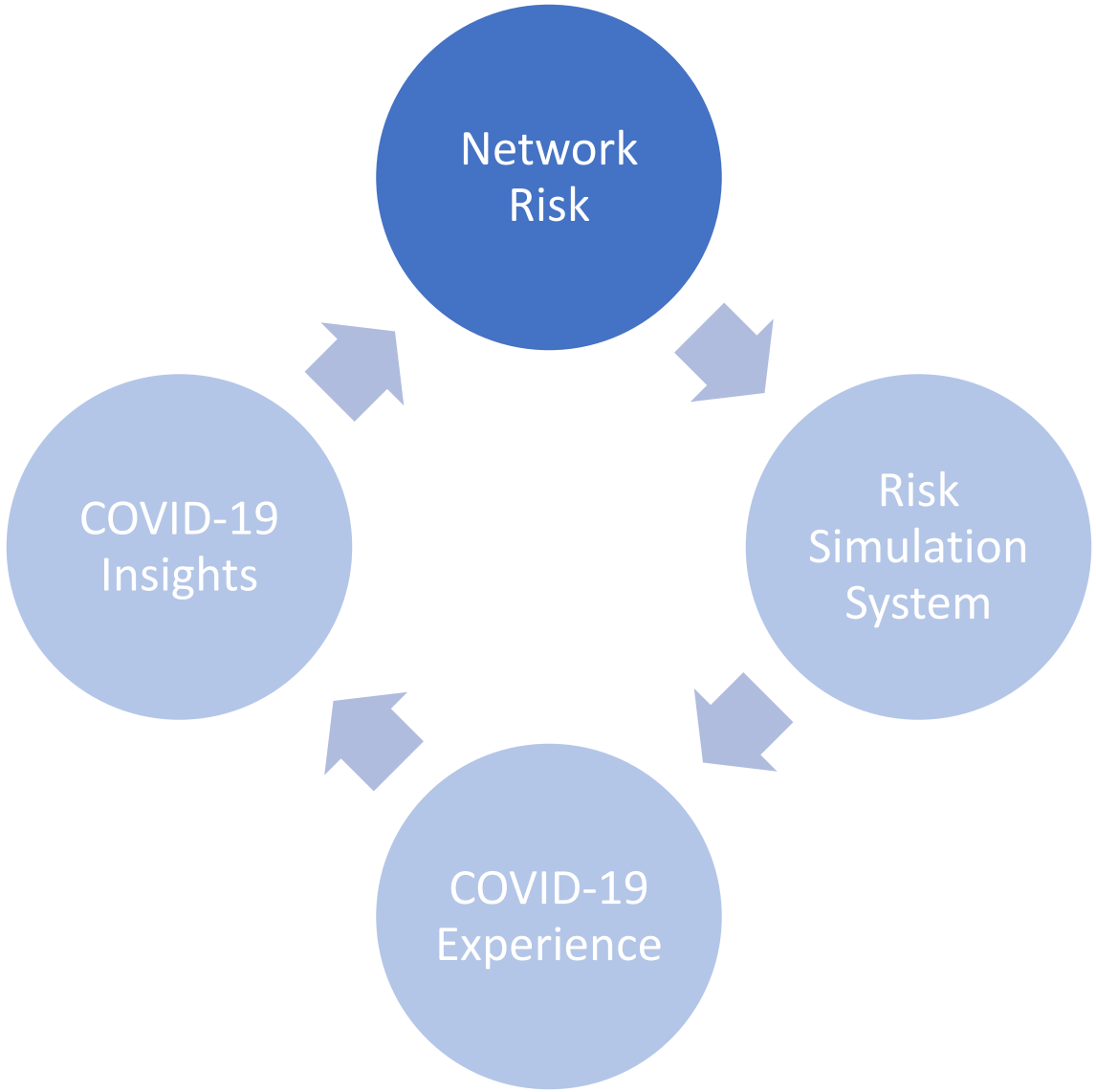
- A year-long measurement in Facebook's the ***backbone*** network
- Use ***network risk*** as an indicator for robustness of the network

- How well has the current network infra responded to the COVID stress test?
- How should the network infra evolve in the post-pandemic era?


Network Risk
Risk Simulation System
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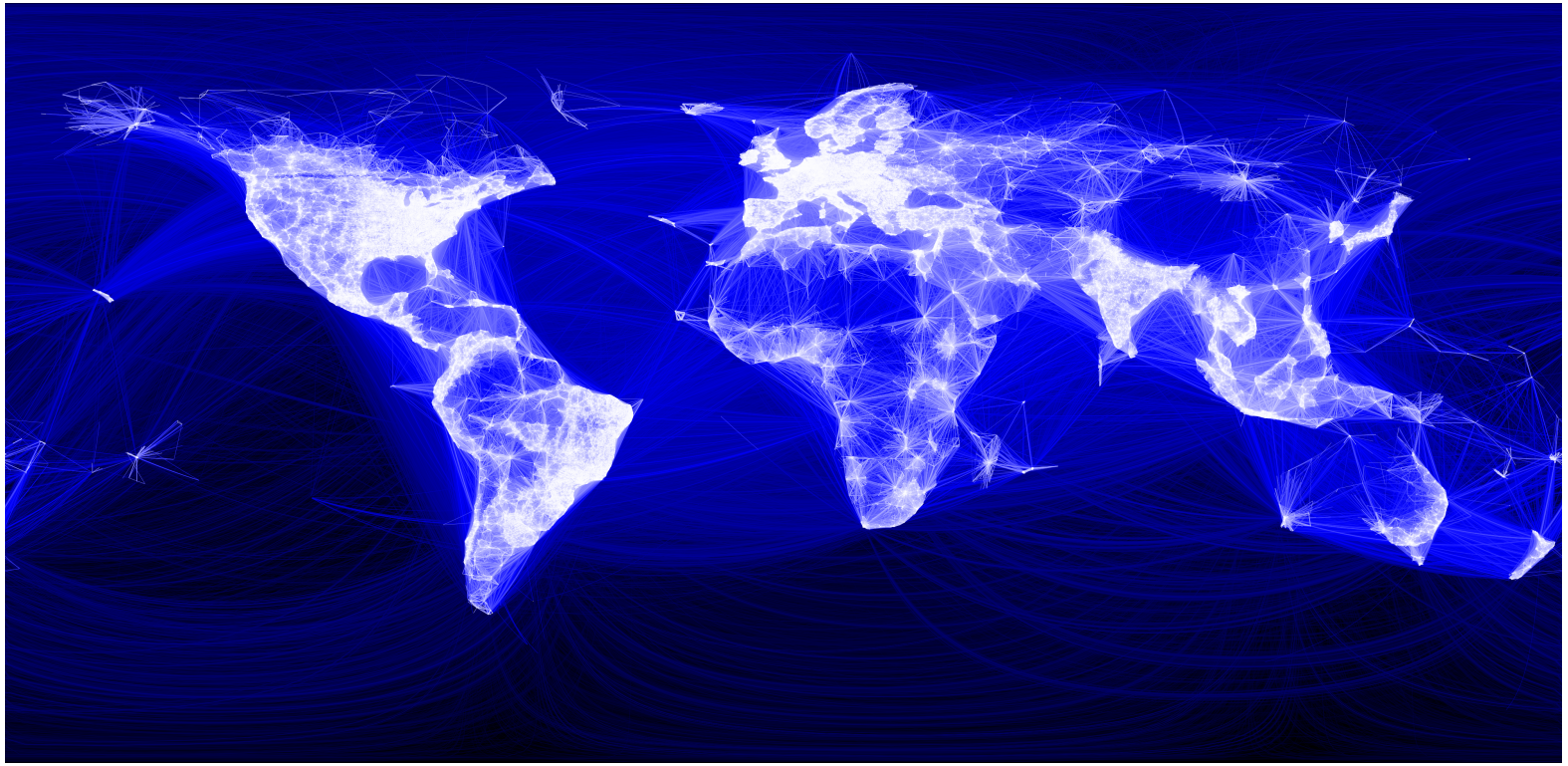
Backbone Network



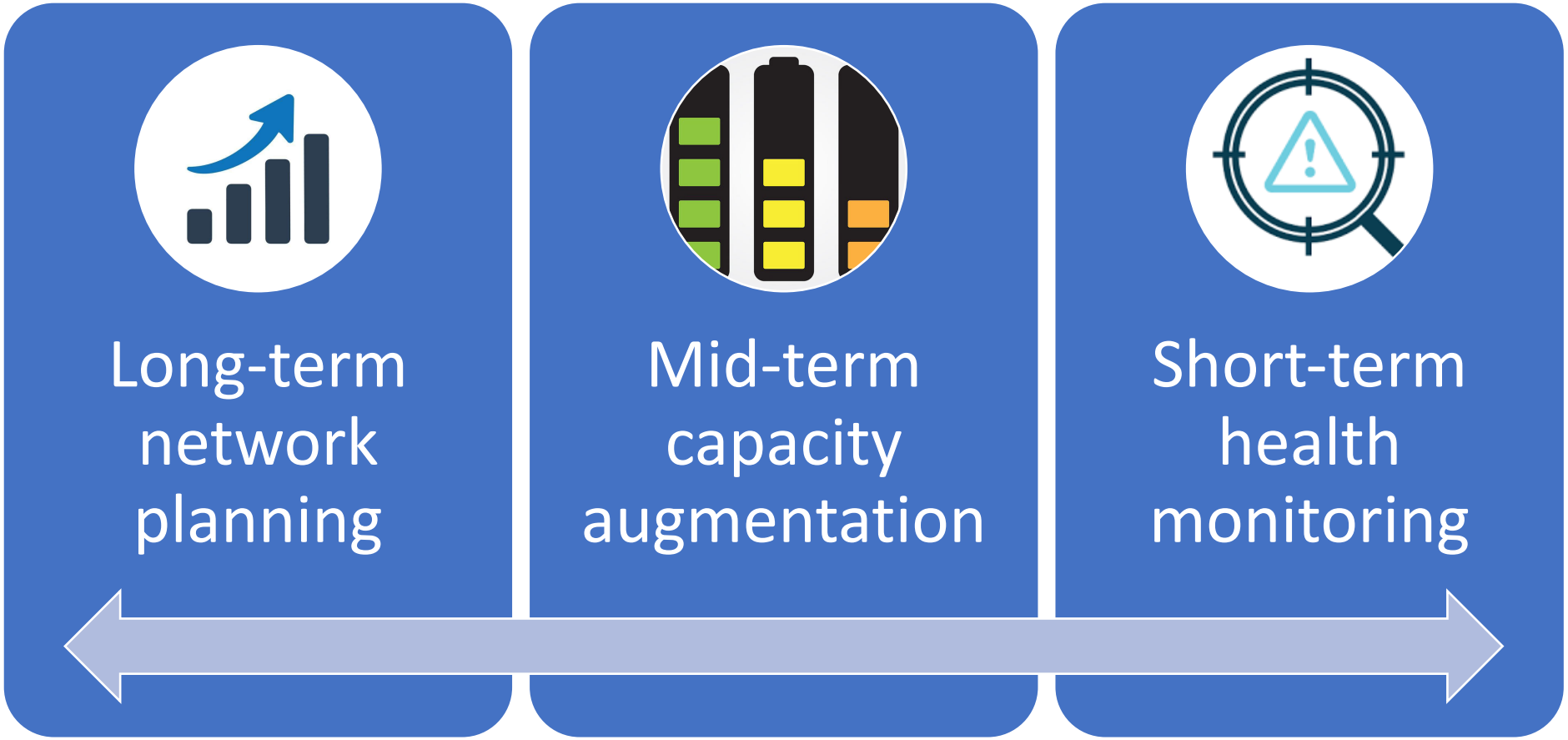
Facebook's Connectivity Map

- Interconnects Point-of-Presence (PoP) and Data Center (DC) nodes
- Large scale
  - Hundreds of PoPs
  - Tens of DC regions (hundreds of DCs)
- Quality of Service (QoS)
  - 4 QoS classes for different services

Network Risk

- Failures are frequent
  - Fiber cuts, power outages, misconfigurations, etc.
  - Device thefts, hurricanes, fires, etc.
- Severe impact
  - Congestion, packet loss, long latency, availability drop, etc.
- Risk
  - Potential failures in the network
  - Anticipate the consequence before bad things happen

Network Risk



Network management lifecycle

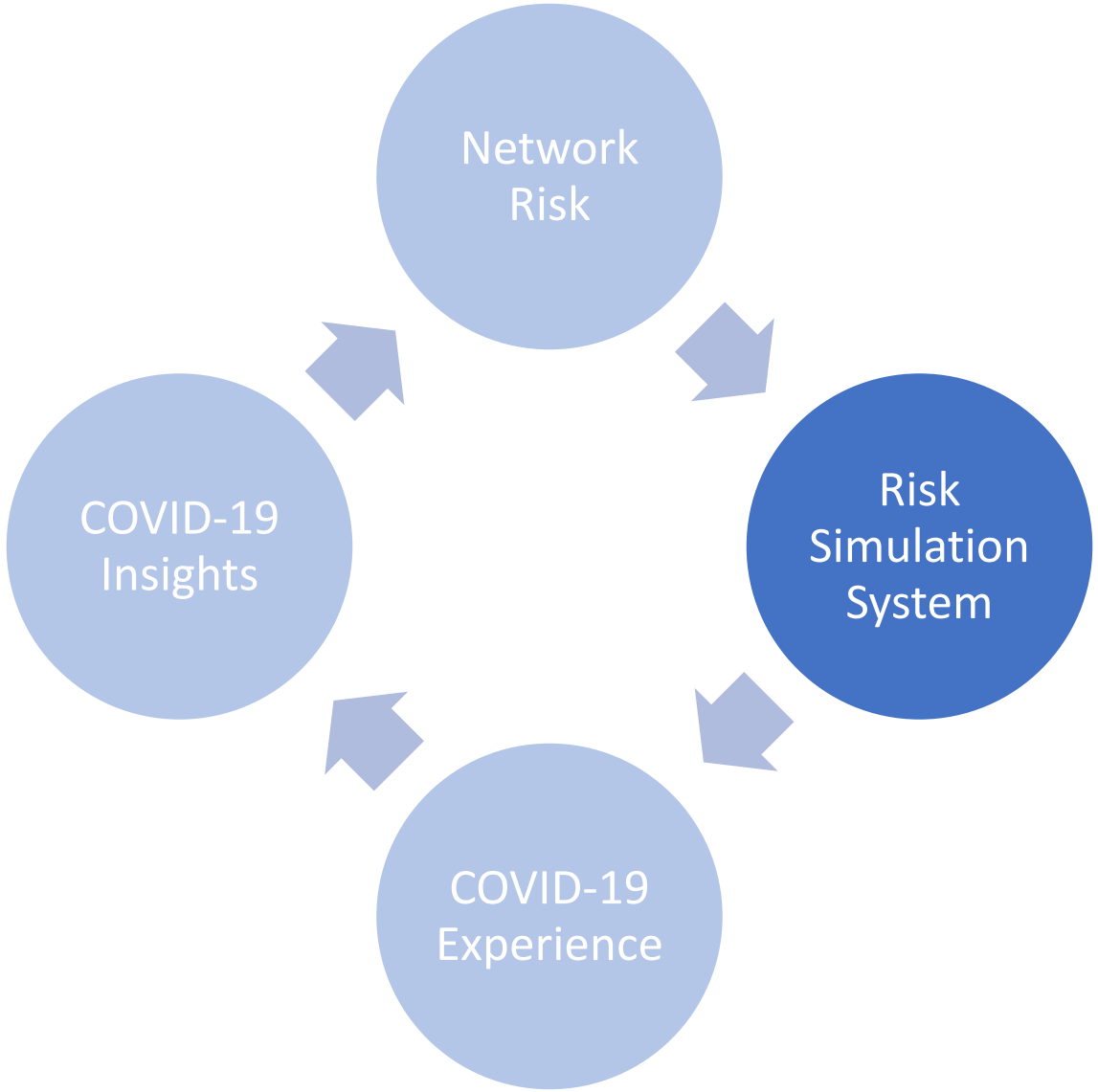
Risk Metrics

Unified metrics across teams

Different aspects of failures

SLOs of QoS classes

- Demand loss
  - Total loss of all the flows in a QoS class
  - Maximum loss across all failure scenarios
- Availability
  - Percentage of time a flow is 100% admitted
  - Lowest availability among all the flows in a QoS group
- Latency stretch
  - Path dilation of a flow against the shortest path weighted by failure probability
  - A set of the latency stretches of all the flows in a QoS group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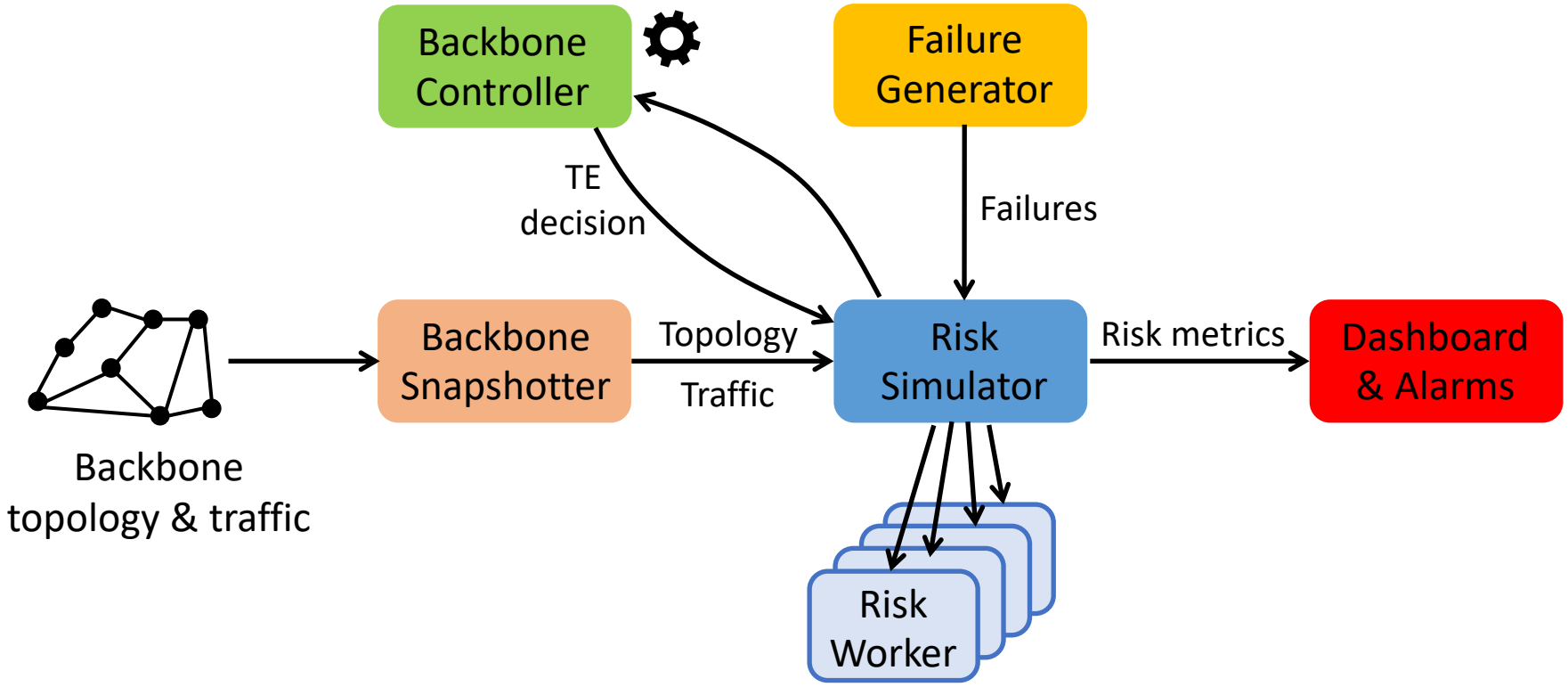
Risk Simulation System (RSS)



RSS Operation Modes

- 18k lines of C++ code
- Several years in prod
- System optimizations

- Customized failures
  - Decommission workflow
  - Natural disasters
- QoS protection policies
  - Protected failures per QoS class

Fine-grained risk simulation

Thousands of failure scenarios

~ 250s per case

- Potential failures
  - Failure count with cutoff

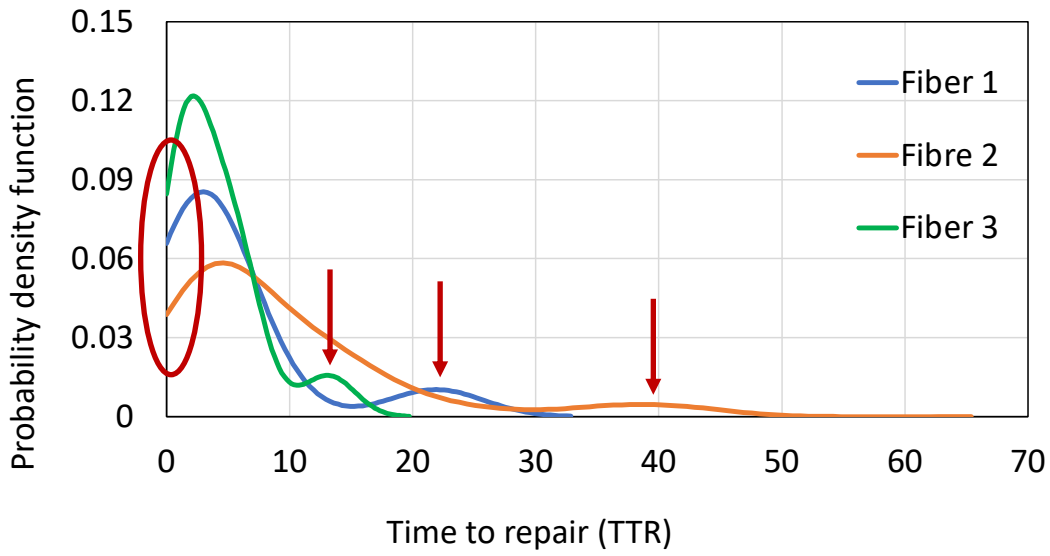
Coarse-grained risk simulation

Millions of failure scenarios

~ 0.1s per case

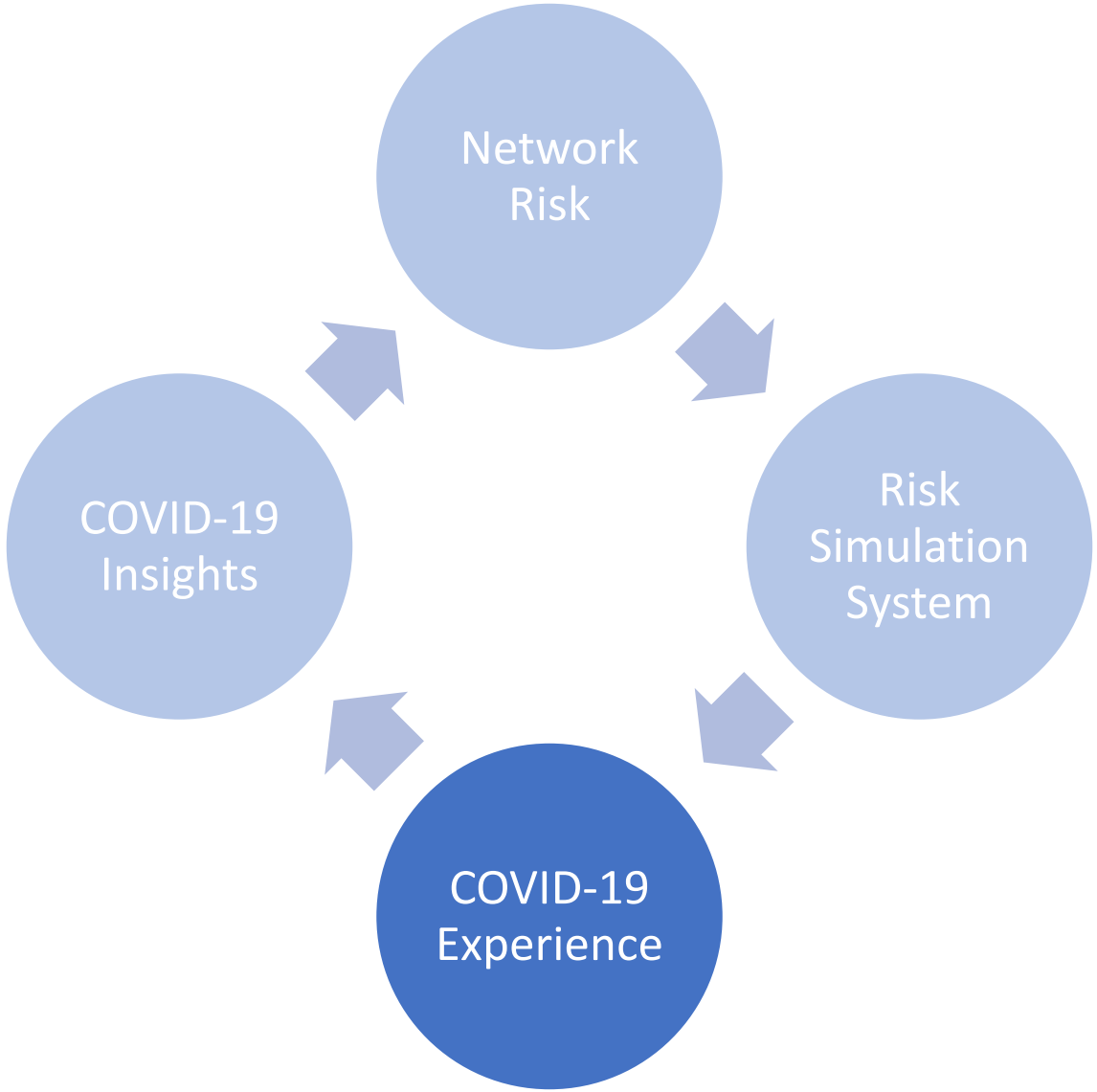
Failure Modeling Challenge

- Time To Repair (TTR) of subsea fibers follow arbitrary distributions



TTR distribution of three subsea fibers

- Lower bound of TTR
  - Physical time constraints for repair
    - Secure permits to enter water
    - Sailing time to failure site
- Multi-modal
  - Distinct parts
    - Different failure profiles
    - Dependent on depth under water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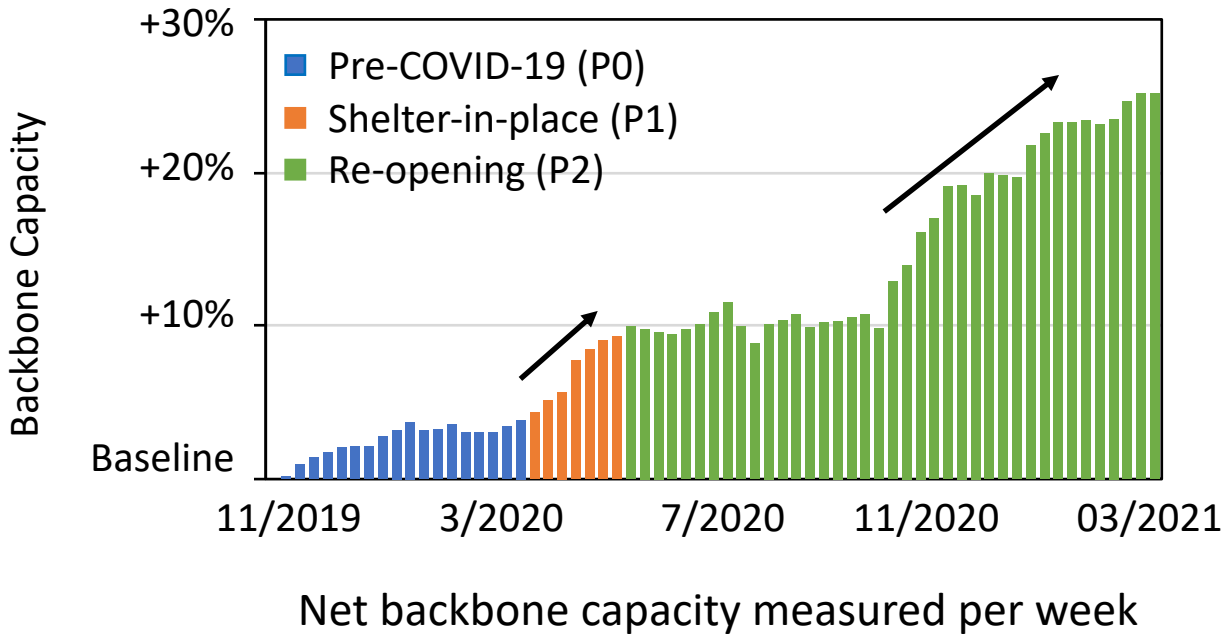
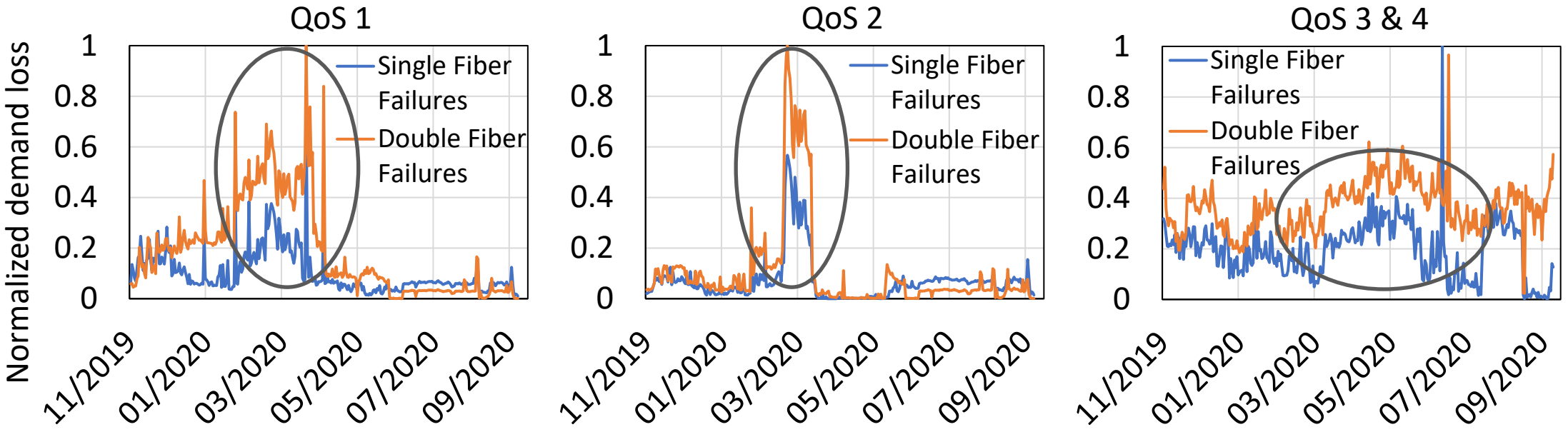
Capacity Enhancement



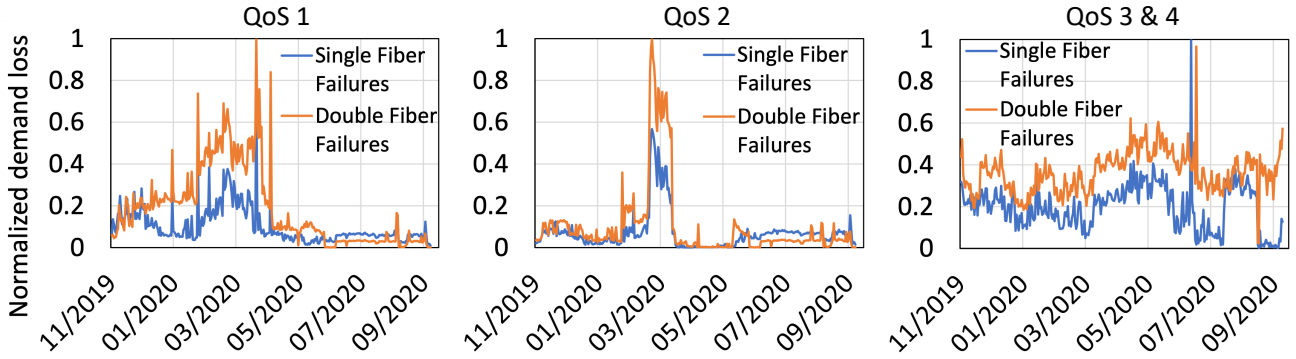
- Capacity up and down
  - Network growth
  - Migrate wavelengths
- More capacity added
  - Turn up dark fibers
  - Provision new wavelengths

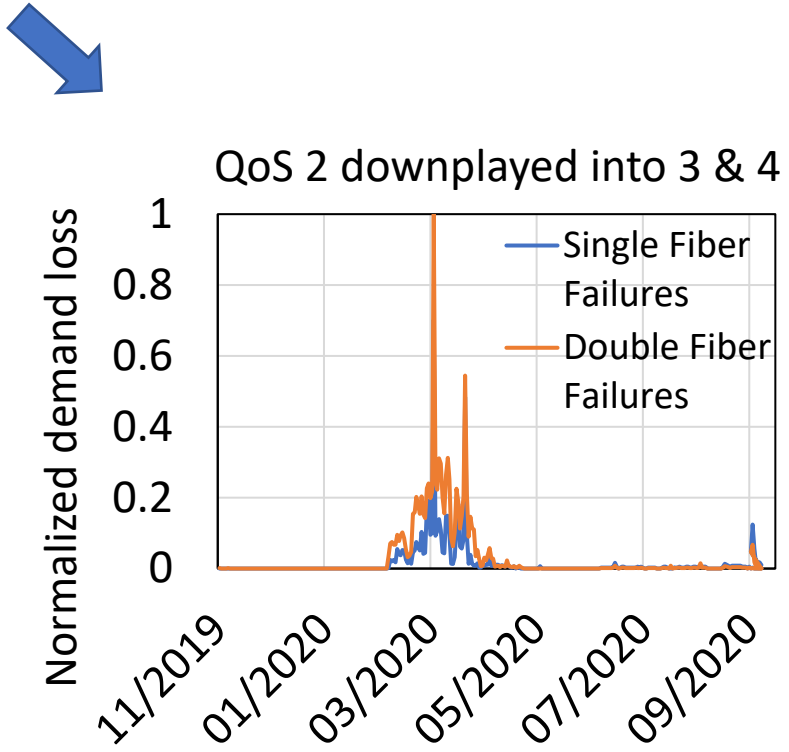
QoS Downgrade

- Higher risk in QoS 1 (control messages) and QoS 2 (user traffic)
- No significant change in QoS 3 and 4 → non-user traffic
- Hypothetical demand loss related to traffic increase

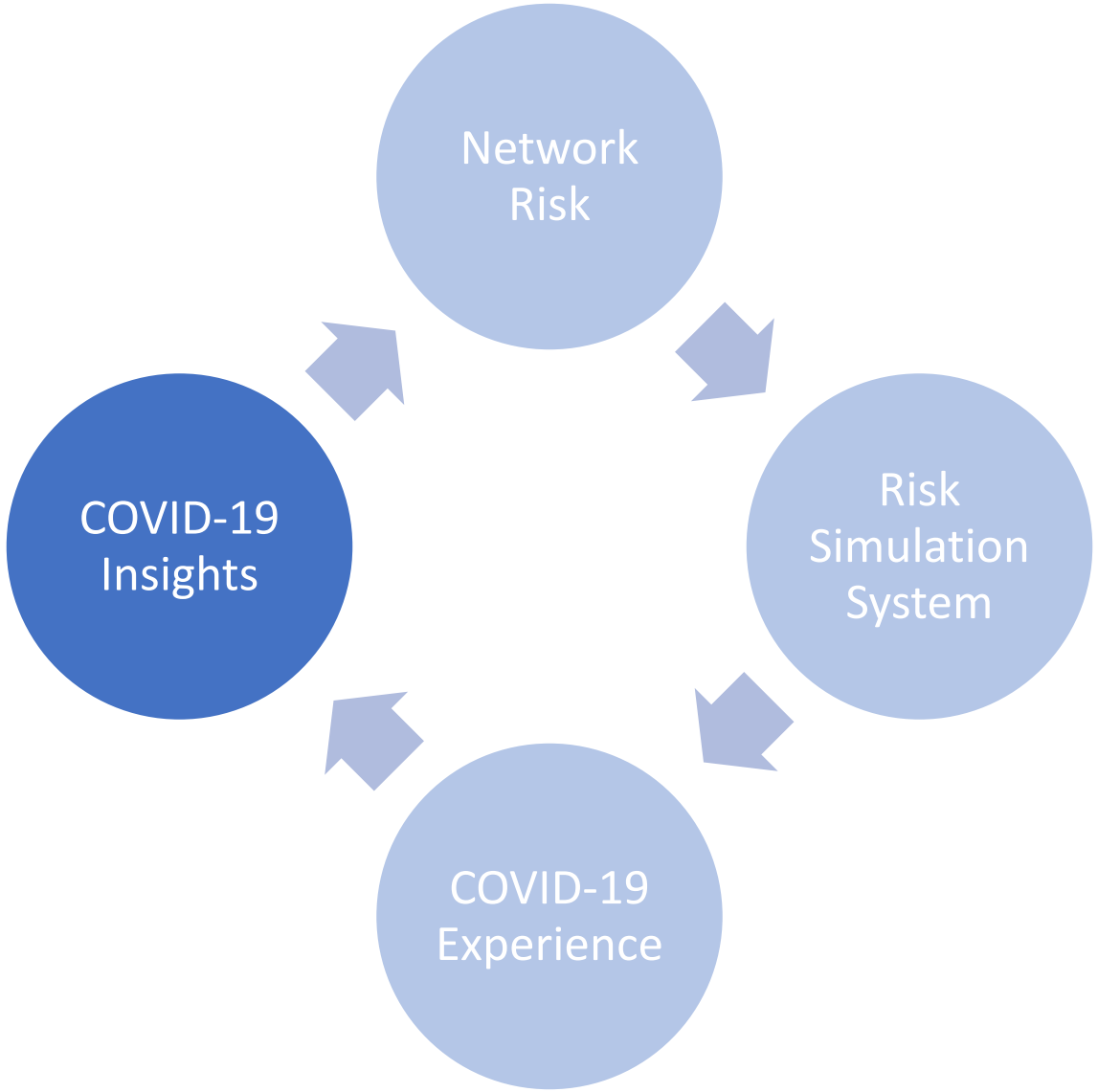


QoS Downgrade





- QoS classes assigned by service
- Opportunities for optimization
  - User traffic vs. machine traffic
  - A service downgrading QoS classes if possible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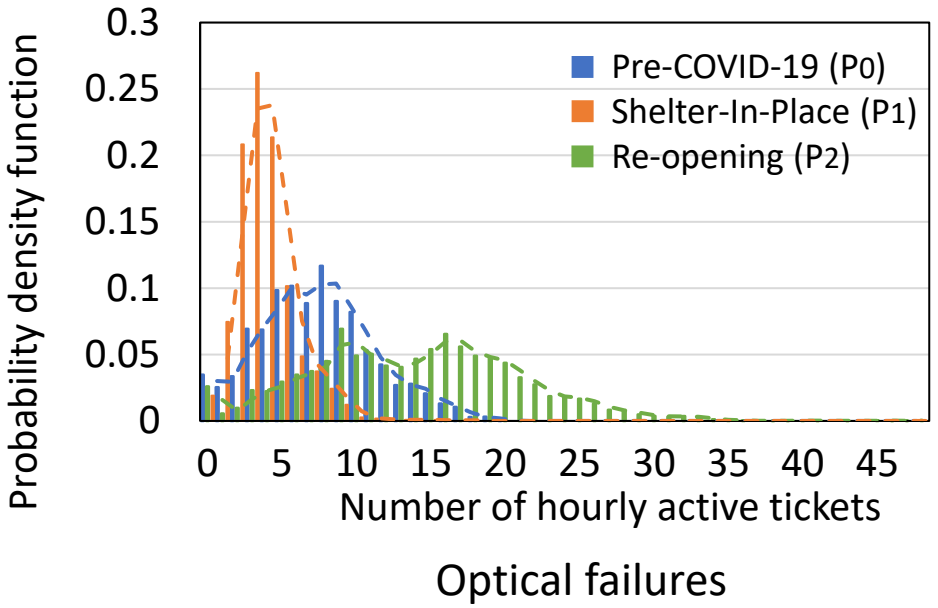
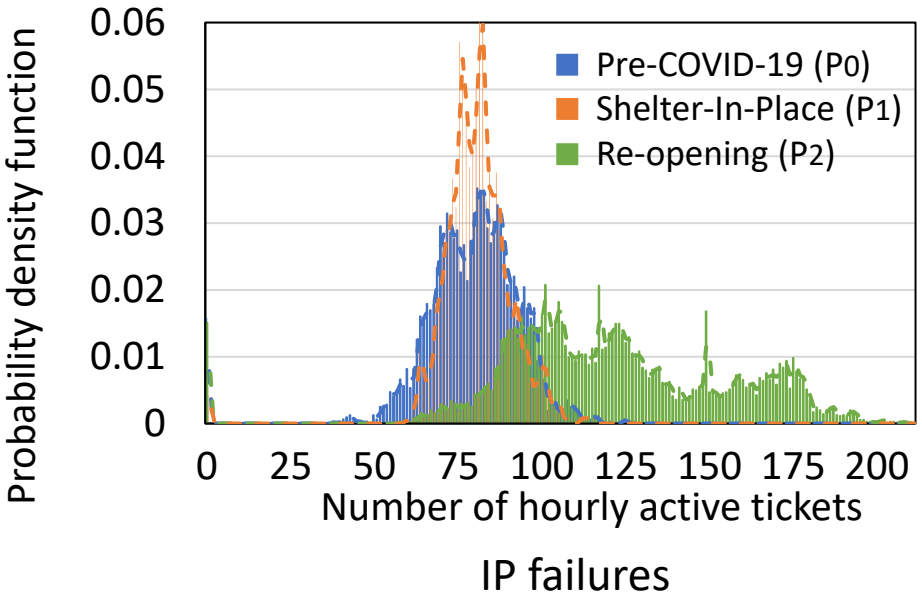
Failure Statistics Change



Optical failures

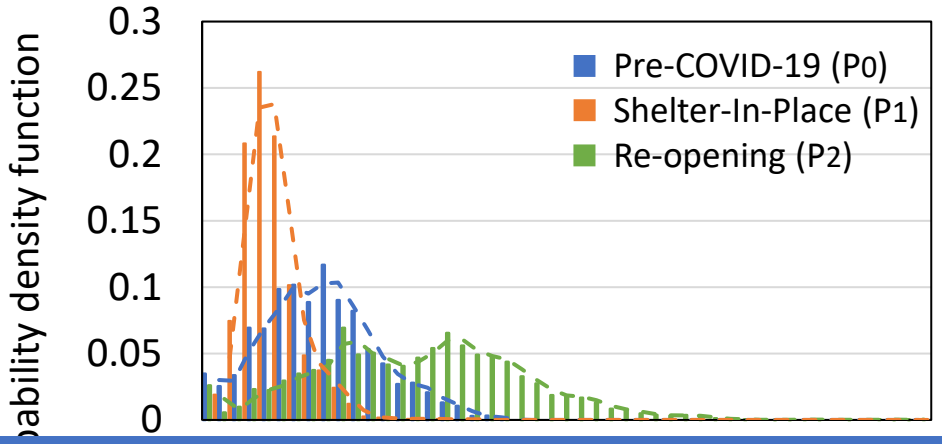


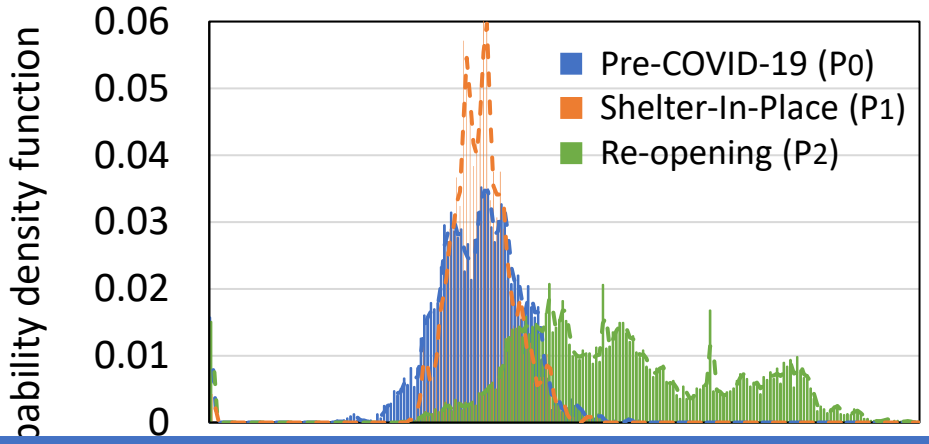
IP failures

- Fewer optical failures during lockdown
  - Reduced human activity
- More optical failures after re-opening
  - More maintenance work

- IP failures remain the same during lockdown
  - Less impacted by human activity
- More IP failures after re-opening
  - More maintenance work

Failure Statistics Change





- Automate network operations → reduce human activity
- Short-term failure statistics → tradeoff between model stability and agility

- Fewer optical failures during lockdown
  - Reduced human activity
- More optical failures after re-opening
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- IP failures remain the same during lockdown
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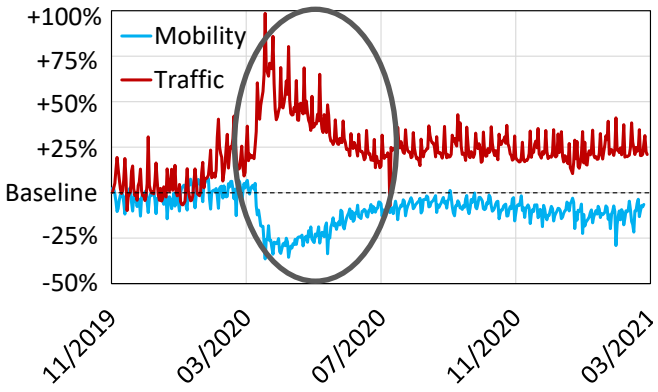
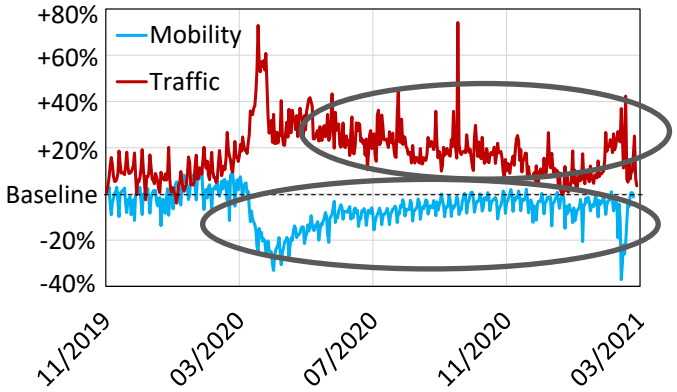
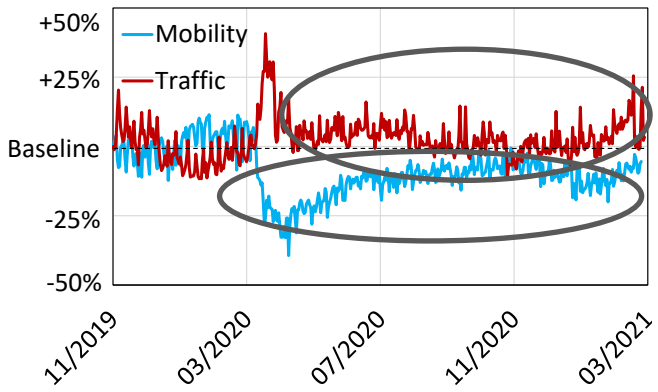
Mobility Correlated with Traffic



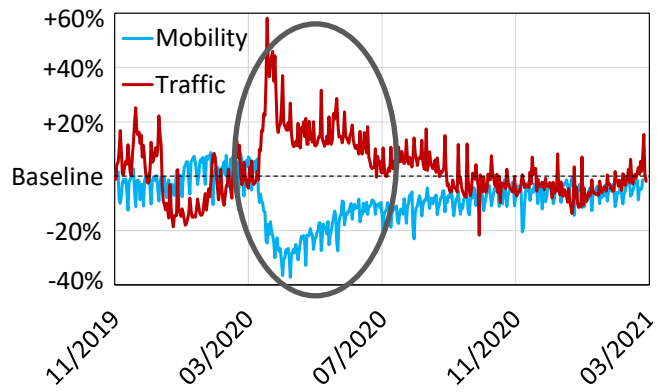
Chicago



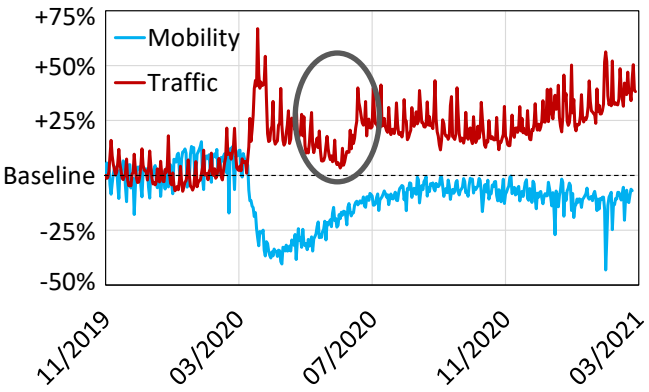
Dallas



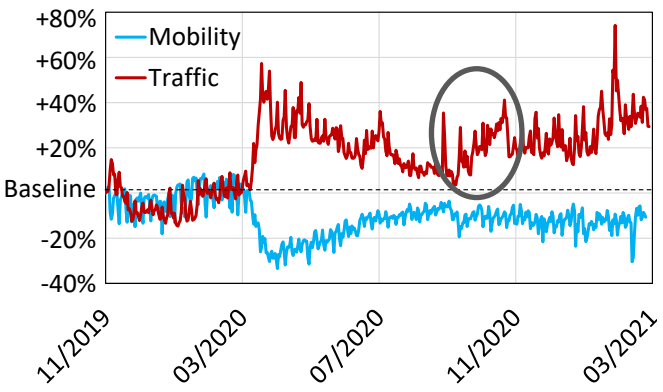
Los Angeles



Miami



New York City



Seattle

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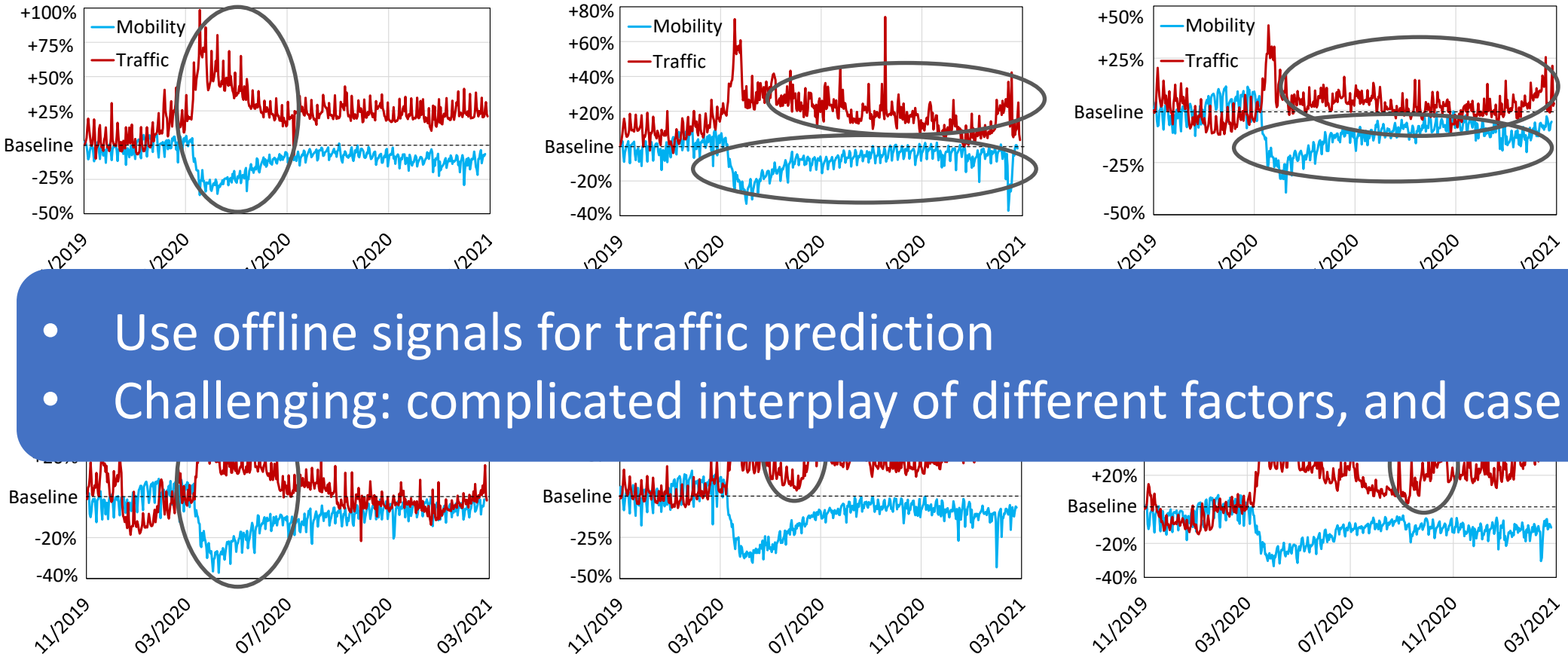
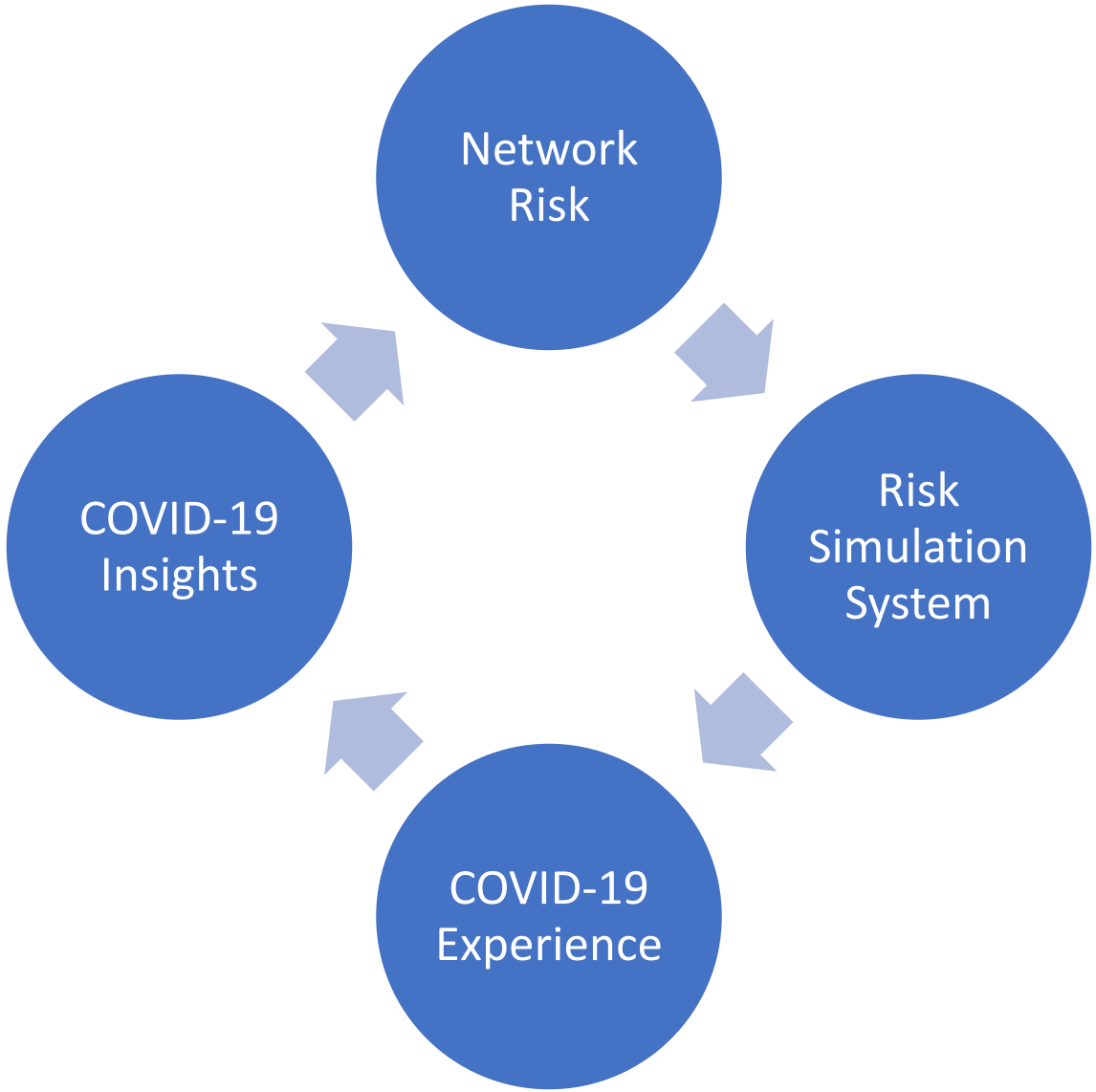


- Use offline signals for traffic prediction
- Challenging: complicated interplay of different factors, and case by case

Miami New York City Seattle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