

# Leveraging the 0-RTT Convert Protocol to improve Wi-Fi/Cellular convergence

July 2021

## 1. Introduction

Wi-Fi/Cellular convergence, Multipath TCP, 0-RTT TCP Convert Protocol

## 2. Deployment and measurements

Move traffic from cellular to fixed network, improving the user experience

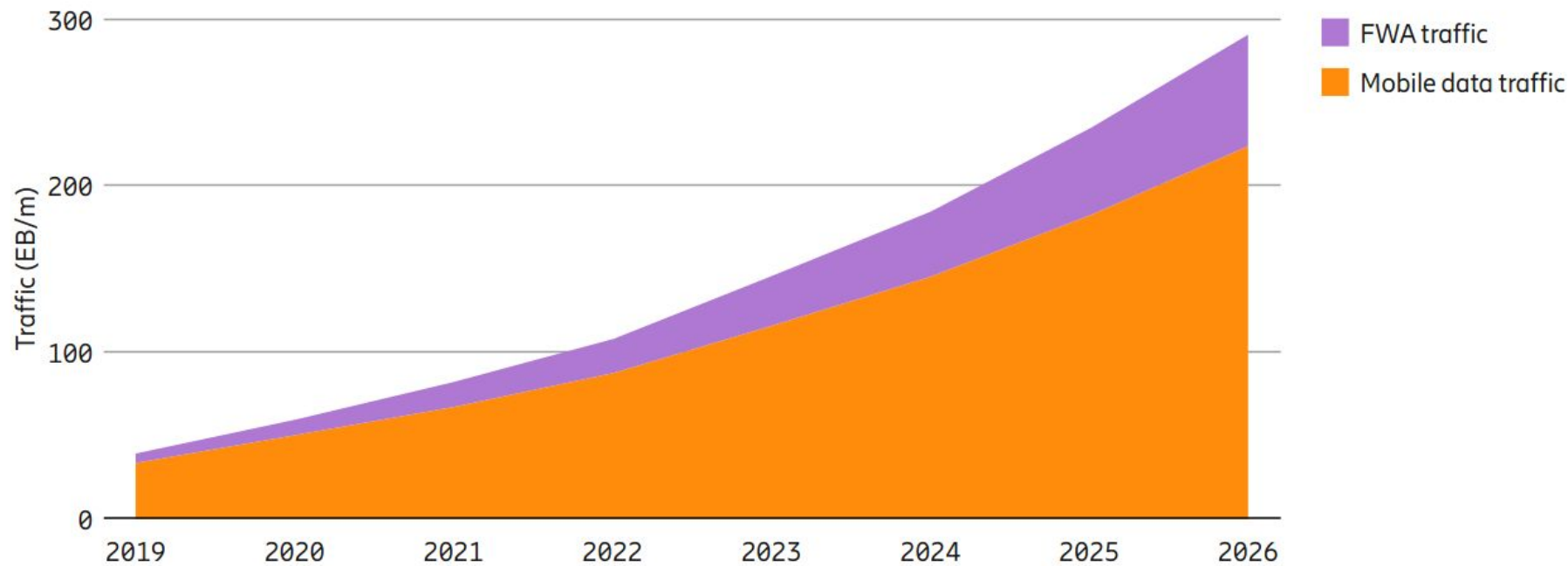
## 3. Conclusion

Future & production ready solution

# Cellular traffic is growing

From Ericsson Mobility Report 2020

Figure 8: Mobile data and FWA traffic



<https://www.ericsson.com/4adc87/assets/local/mobility-report/documents/2020/november-2020-ericsson-mobility-report.pdf>

## From Tefficient AB 2021



<https://tefficient.com/wp-content/uploads/2021/04/tefficient-industry-analysis-1-2021-mobile-data-usage-and-revenue-FY-2020-per-operator-13-April-2021.pdf>

# Revenue is not growing

From Tefficient AB 2021



<https://tefficient.com/wp-content/uploads/2021/04/tefficient-industry-analysis-1-2021-mobile-data-usage-and-revenue-FY-2020-per-operator-13-April-2021.pdf>

# Offload cellular traffic

Wireless access points are already available



Logos owned by TERENA, Fon Wireless Ltd., Wireless Broadband Alliance Ltd.

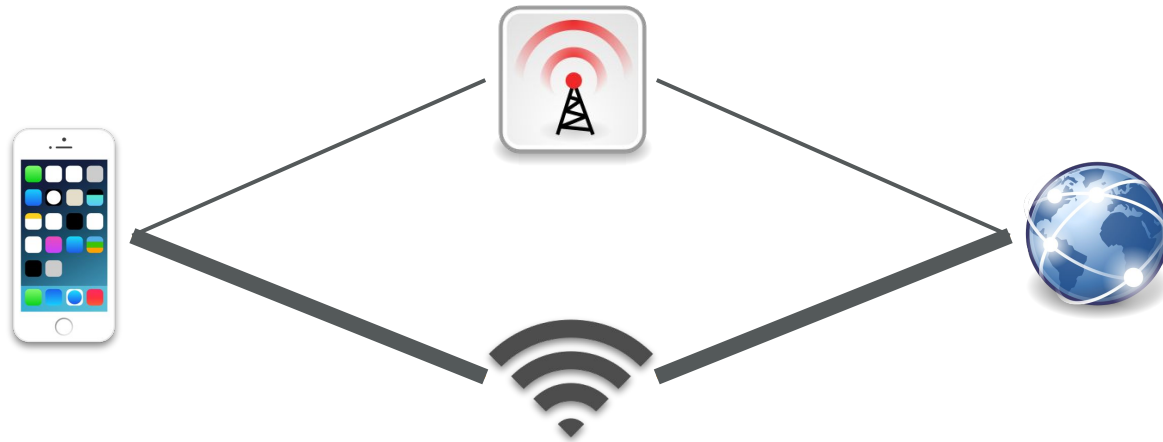


But... Are you ready to be disconnected when moving?  
Or to potentially switch to more limited networks?

# Multipath TCP (MPTCP)

Bonding technologies are available

- Exchange data for a single connection over different paths, simultaneously
- RFC-8684

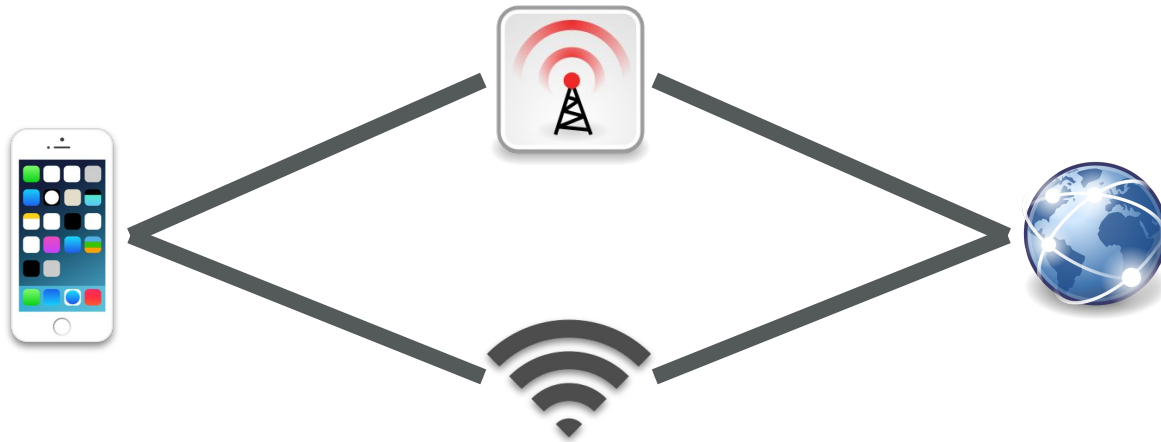


Smartphone and WiFi icons by Blurred203 and Antü Plasma under CC-by-sa, others from Tango project, public domain

# Multipath TCP (MPTCP)

Bonding technologies are available

- Exchange data for a single connection over different paths, simultaneously
- RFC-8684
- More bandwidth:



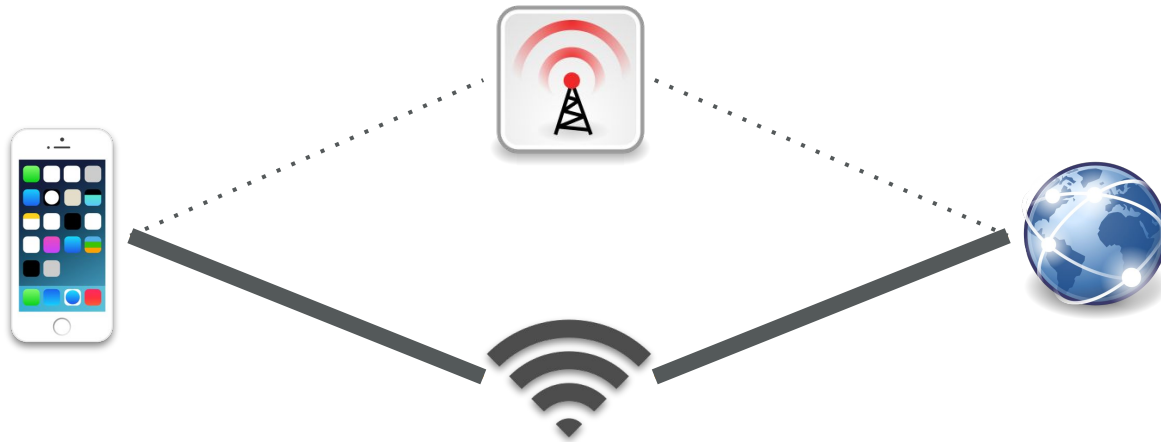
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# Multipath TCP (MPTCP)

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- More mobility (walk-out):

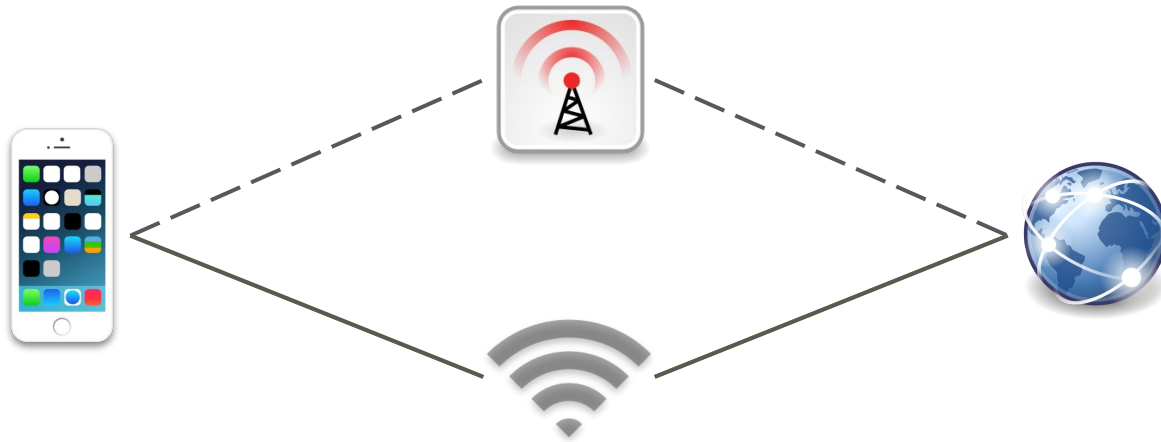


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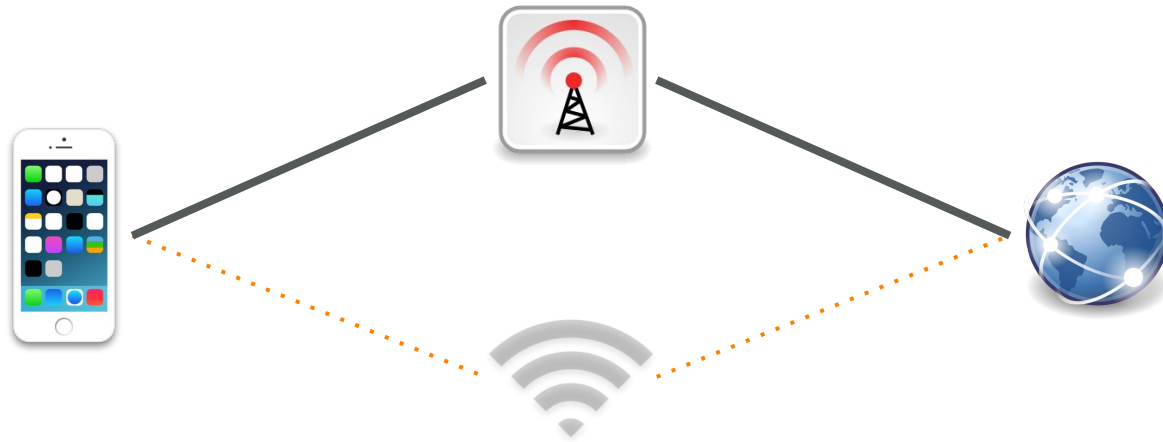


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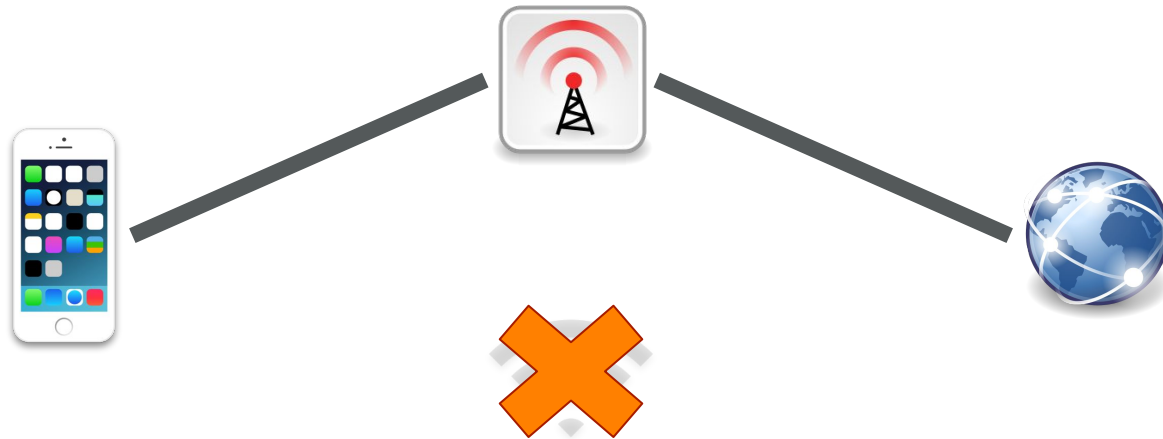


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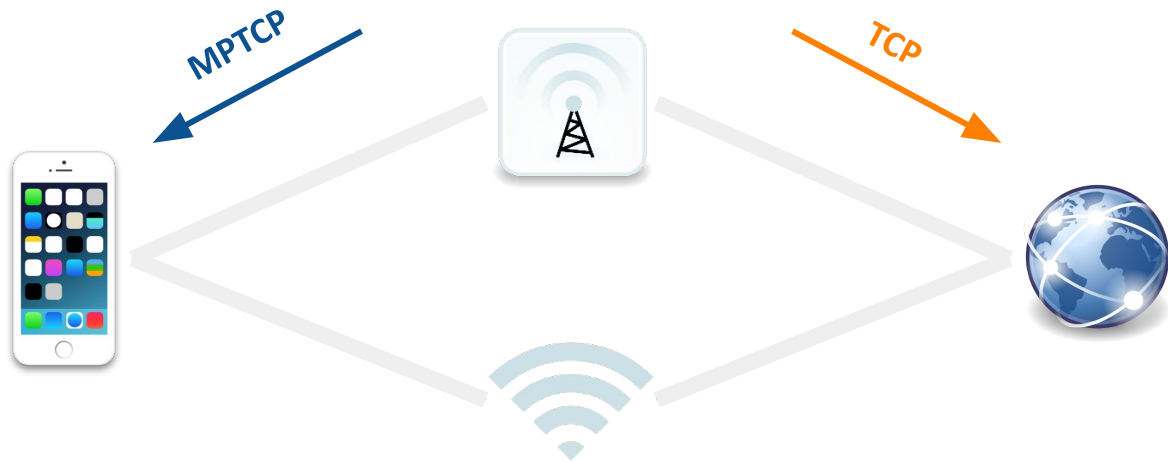
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But...

Both the client **and** the server need to support MPTCP



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# Multipath TCP (MPTCP)

Bonding technologies are available

A TCP proxy can help supporting MPTCP



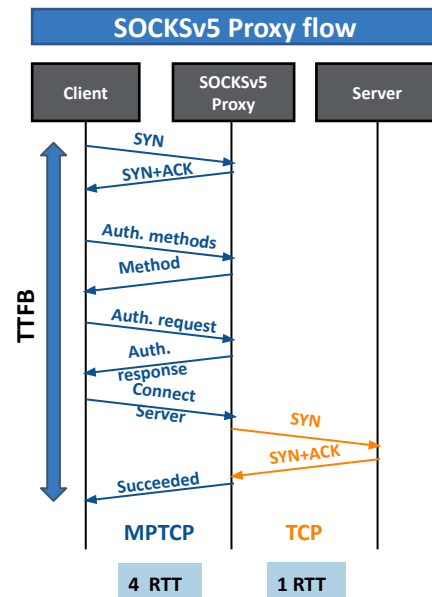
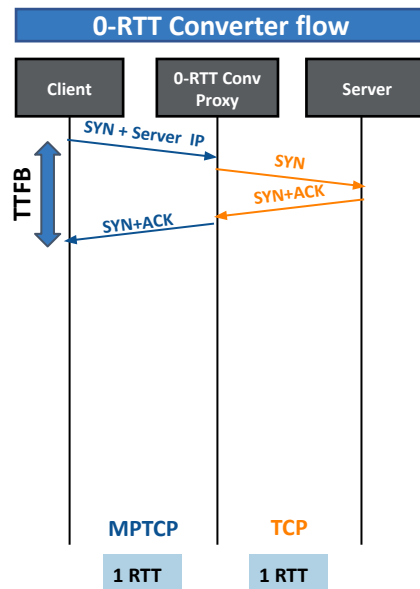
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# 0-RTT TCP Convert Protocol

Smart TCP Proxy technologies are available

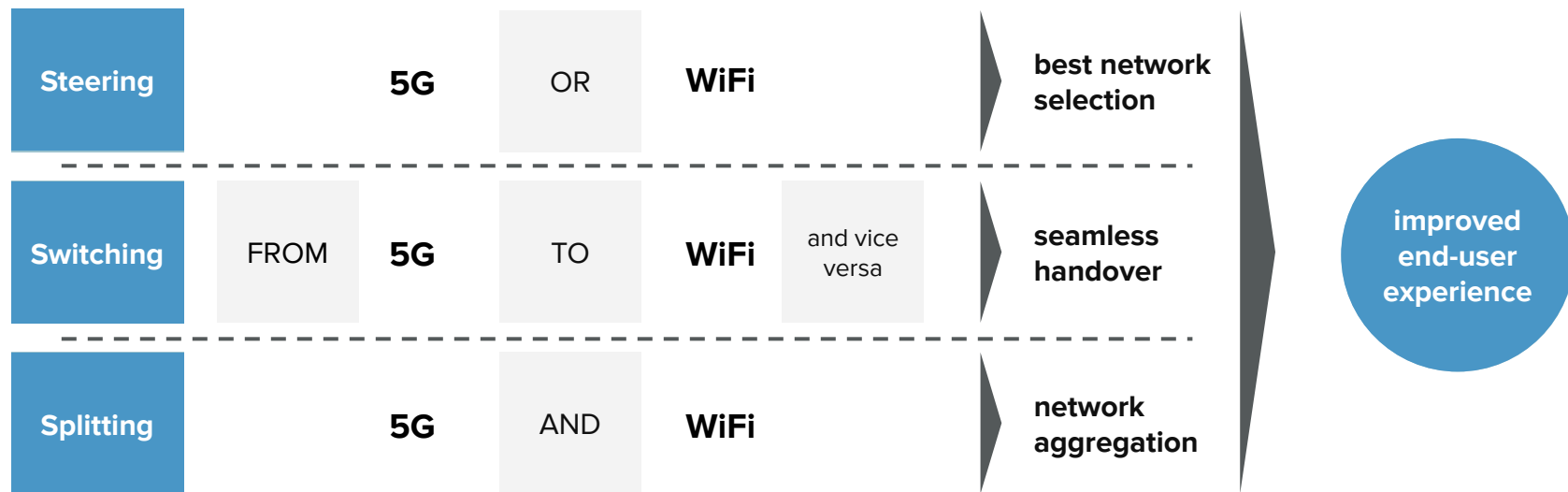
## RFC-8803: Ease the deployment of TCP extensions like MPTCP

- Use TCP Fast Open (with fallback support)
- Client and Server proxies can exchange additional data in the 3WHS.



# Multipath TCP, 0-RTT Convert & ATSSS

For tomorrow



Defined in 3GPP Release 16, ATSSS is a core network function in 5G networks, playing a key role in managing data traffic between 3GPP (5G, 4G) networks and non-3GPP (Wi-Fi) networks



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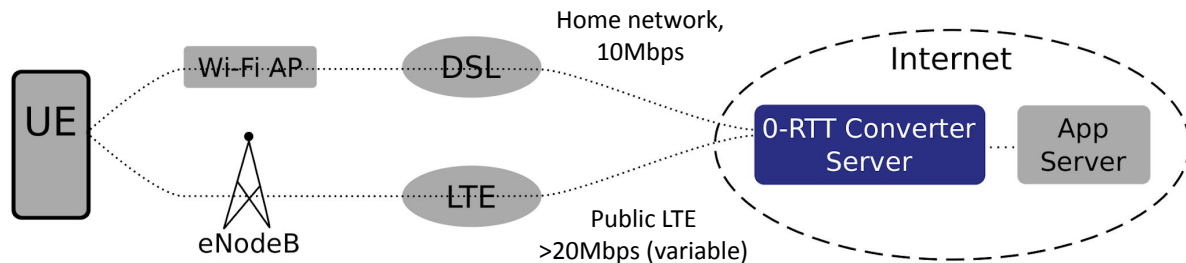
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Future & production ready solution

# Proof of Concept

## High level view

- A smartphone (UE) is connected to two networks:
  - Fixed via WiFi
  - Cellular
- A 0-RTT Convert server is deployed on the Internet
- The smartphone is playing live video streams from Twitch



# Proof of Concept

Client side

- A smartphone: Xiaomi PocoPhone F1
- A modified kernel: Linux 4.9 with MPTCP
- A modified proxy application:  
ShadowSocks with 0-RTT TCP Convert  
Protocol support
- All of the material has been open-sourced:

<https://www.tessares.net/open-source/add-mptcp-and-0-rtt-support-to-a-pocophone/>

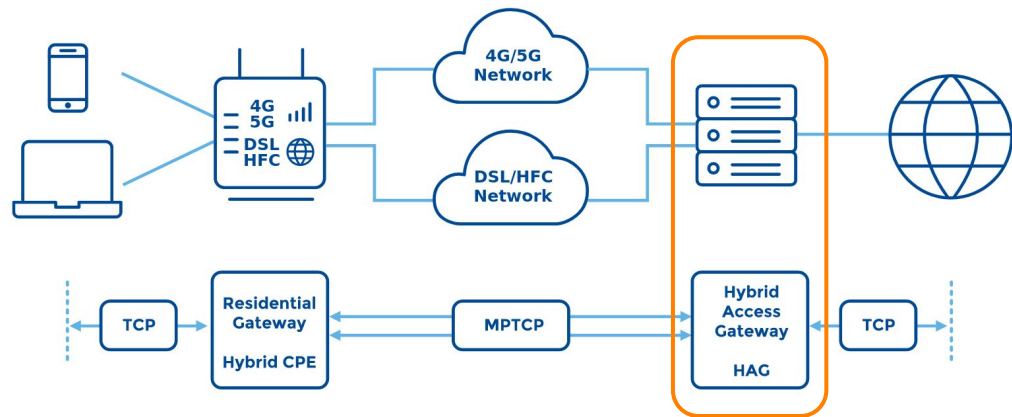
Work supported by NGI POINTER, EU Fund.



Photo from Mi.com

# Proof of Concept

## TCP Proxy server side

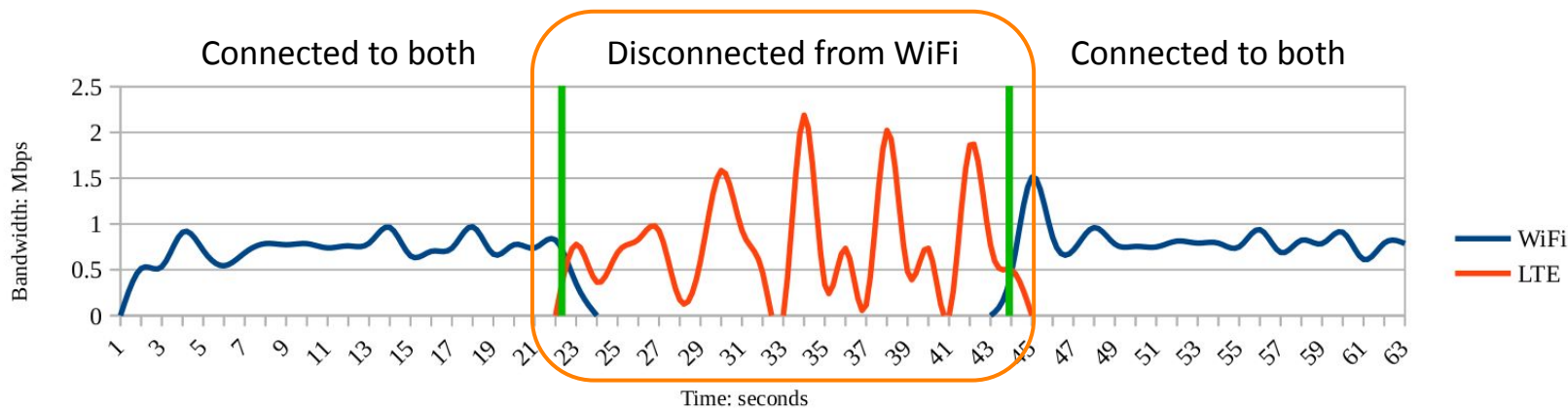


- Re-used a Hybrid Access Gateway (HAG) following Broadband Forum standards (TR-348 and TR-378)
- With 0-RTT Convert support
- Deployed in the cloud (AWS EC2)

# Scenario

Twitch live stream: Cellular offload

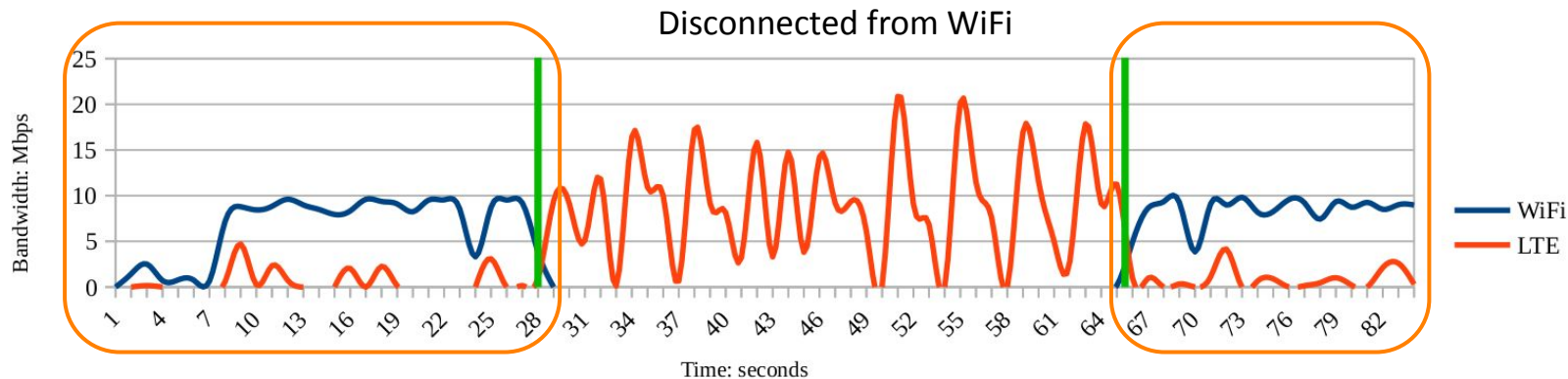
- Use Wi-Fi network in priority: traffic is fully offloaded



# Scenario

Twitch live stream: Cellular used to improve UX

- Use Wi-Fi network in priority: cellular is used if needed



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- This PoC shows that the ATSSS already works:
  - Help mobile operators to reduce their mobile traffic
  - Help improving user experience.
- MPTCP and 0-RTT Convert can play a role in WiFi & Cellular convergence today in 4G networks and tomorrow in all 5G networks.



# Thank you

## Any questions?

Feel free to contact me by email: [matthieu.baerts@tessares.net](mailto:matthieu.baerts@tessares.net)

 matttbe8

# Backup slides

- We are doing some experimentations with tunneling solutions using MultiPath QUIC (MPQUIC).
- MPQUIC has not been standardised (yet) but Tessares is contributing.
- Hard to predict the standardisation work that will be done
- We can be contacted offline.