

Experimental Evaluation of YouTube Performance on MPTCP-based LTE-WLAN Integration

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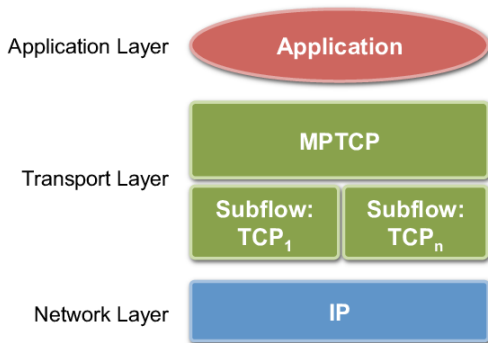
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Overview

- 1 Introduction to MPTCP
- 2 Working of MPTCP Proxy
- 3 Motivation
- 4 Contribution
- 5 Results
- 6 Conclusions

Multipath TCP (MPTCP)



- MPTCP connection is formed of multiple TCP subflows, with coupled congestion control and shared receive buffer.
- Subflows have contiguous sequence numbering.
- Data is reassembled by connection-level sequence numbering.
- MPTCP can retransmit failures on original or new path.

Figure 1: An overview of MPTCP stack.

MPTCP Proxy

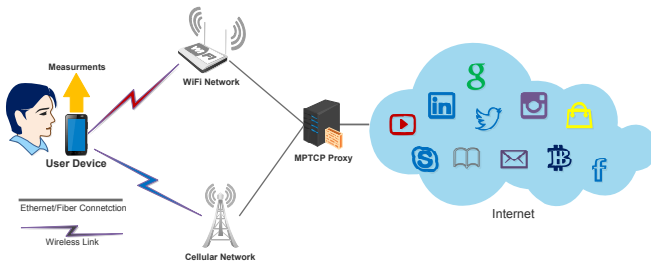


Figure 2: System architecture to enable MPTCP with an MPTCP proxy server between UE and content server.

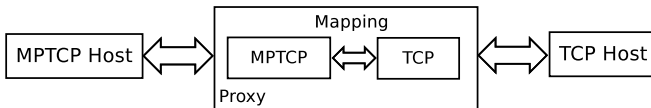


Figure 3: MPTCP proxy mechanism.

Motivation

- Global data traffic will reach 49 Exabytes per month by 2021 and 78% of total mobile data traffic will be video data [1].
- Expanding network capacity may temporarily mitigate the network congestion!
- Data offloading to other network (WiFi) can help.
- Multipath TCP (MPTCP) enables the parallel use of Multiple Network Interface (Cellular, WiFi).
- WiFi does not guarantee the QoS.
- How MPTCP effects the QoE for video services!!!

Contribution

- We develop a web application to measure QoE for YouTube videos in a multi-homed UE.
- Evaluation of LWI using MPTCP proxy in a real test-bed using open source platform for LTE.
- Performance evaluation of LWI using MPTCP for UHD videos in term of Mean Opinion Score (MoS) compared to when LTE or Wi-Fi used alone.

Testbed Setup

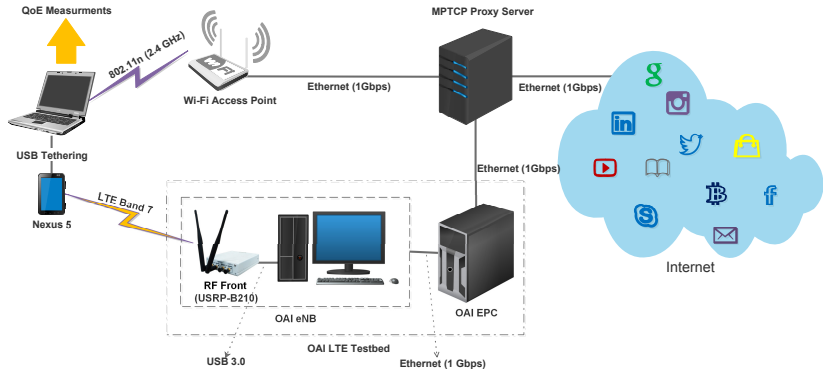


Figure 4: OAI LTE test-bed setup showing LTE eNB connected with USRP B210 RF front, EPC, MPTCP proxy, and UE.

Performance Metrics

Mean Opinion Score (MoS) [2]

$$MOS = 4.23 - 0.0672 \times L_{ti} - 0.742 \times L_{fr} - 0.106 \times L_{tr}$$

Initial Buffer Time

Time taken to start the video playback.

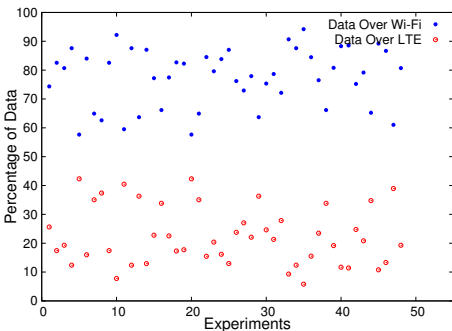
Time to buffer the last byte

Time taken to buffer the complete video.

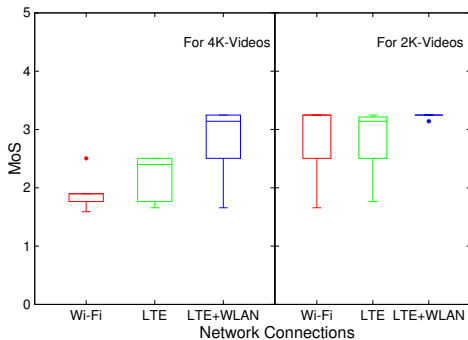
Data Split

Fraction of data send over LTE and WiFi.

Results:



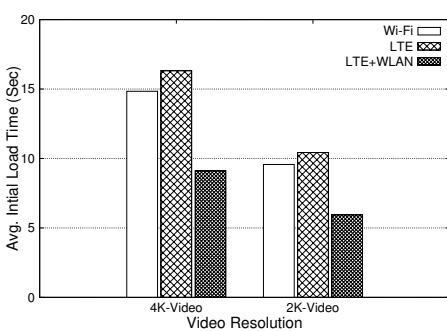
(a)



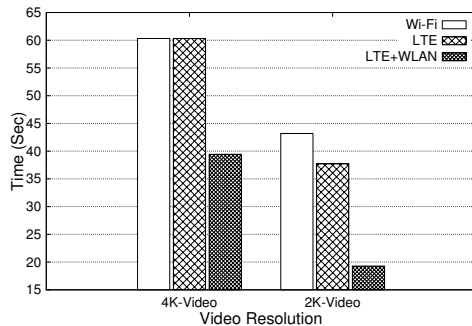
(b)

Figure 5: (a) Percentage of data sent over Wi-Fi and LTE for LWI, (b) Value of MOS for LWI, LTE, and Wi-Fi for 4K and 2K videos.

Results:



(a)



(b)

Figure 6: (a) Average initial load time for 4K and 2K videos using LWI, LTE, and Wi-Fi, (b) Average time taken to buffer the complete video.

Conclusions

- MOS can be increased up to 34.4% compared to LTE and 20.4% as compared to Wi-Fi.
- Initial load time is reduced by 35% and 43% compared to Wi-Fi and LTE respectively.
- Around 75% of data sent over Wi-Fi.
- MPTCP can be deployed without any change required in operator's network.

References



“Cisco Visual Networking Index, Global mobile data traffic forecast update, 2016-2021,” *white paper*, February 2017.



R. K. P. Mok, E. W. W. Chan, and R. K. C. Chang, “Measuring the quality of experience of HTTP video streaming,” in *12th IFIP/IEEE International Symposium on Integrated Network Management (IM 2011) and Workshops*, pp. 485–492, 2011.

THANK YOU

QUERIES ?

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