Unveiling the Thrilling Realities of Mobile 5G in London and the Pivotal Role of Ecosystem and Energy Efficiency.

Peixuan Song
University of Cambridge*
ps828@cantab.ac.uk

JunKyu Lee
University of Essex
j.lee@essex.ac.uk

Lev Mukhanov
Queen Mary University of London
l.mukhanov@qmul.ac.uk

Abstract

The technology landscape is swiftly evolving, with a focus on exploiting the capabilities of 5G networks for Edge computing. This transition holds the promise of relocating resource-intensive tasks such as game rendering, Augmented Reality (AR), and Large Language Models (LLM) from mobile devices to the Edge. Our recent study investigates the actual latency and bandwidth provided by 5G Networks and YouTube Edge service in London, UK. Our study has indicated that the primary constraints on 4G LTE and 5G capabilities are the ecosystem and energy efficiency of mobile devices. We demonstrate that to fully unlock the potential of 5G and it's applications, it is crucial to prioritize efforts aimed at improving the ecosystem and enhancing the energy efficiency.

Edge computing was introduced to address the challenge of increasing mobile data traffic. By bringing computing resources closer to the edge of the network, Edge computing can help to reduce latency and increase bandwidth, and, thus, improve the performance of applications that require real-time processing. This can be especially beneficial for applications such as augmented reality and self-driving cars. Google has already implemented 7500 Edge servers to enable the Stadia service, a Cloud gaming service, which however was deprecated recently. In our study, we also demonstrate that Google also places Youtube Edge servers nearby base stations. However, the actual latency and bandwidth that can be achieved in real applications that utilize 5G networks and Edge servers in UK remain unclear. While some studies suggest that 5G networks can theoretically achieve an average latency as low as 1 ms, real-world implementation may encounter significant overhead due to the 4G/5G ecosystem, i.e. base stations, wired/fiber communication network and Cloud/Edge servers.

The **main goal** of our recent study is to investigate what is the maximum latency and bandwidth can be achieved by real mobile applications that use 5G networks and Edge servers in London. We want to understand how location of servers handling data requests from mobile devices affect the latency. We also aim to investigate how down-streaming affects the energy consumption of mobile devices. By studying all these aspects, we want to understand what emerging 5G applications can be enabled nowadays in London and what factors prevent exploiting full capabilities of 4G LTE and 5G networks.

To enable our study, we use a Google Pixel 4a smartphone which supports 5G networks. We test the latency and bandwidth provided the 5G and 4G LTE networks when down-streaming YouTube videos for three major mobile network operators. We track the location of servers which handle data requests and measure down-streaming latency and bandwidth, as well as the energy consumed by the mobile device. We use the collected data to analyze the relationships between latency, bandwidth and geo-graphical locations of servers. In addition, we measure the device current and power to investigate energy efficiency of the mobile device when down-streaming YouTube videos. Given the fact that YouTube is one of the most popular services in the world with billions of users, we believe that it is well optimized to provide the best possible availability, latency and bandwidth. Thus, YouTube can serve as a reliable indicator of the expected 5G network quality when running real applications that utilize Edge and Cloud servers. Based on the results of our experiments, we make conclusions about which emerging 5G applications can be implemented in London, UK.

In our study, we demonstrate that although 5G provides increased bandwidth, specific operators in London exhibited lower latency with their 4G LTE networks. We attribute the challenges in delivering low-latency data transfers to the early stage of development in the 5G ecosystem, which includes base stations, Cloud/Edge servers and interconnection networks in London.

Achieving ultra-low latency and high bandwidth requires strategic investments in high-band base stations that support mmWaves, robust interconnection networks, and widespread deployment of Edge servers across the UK. Moreover, optimising the energy efficiency of mobile devices, particularly 4G/5G modems, plays a pivotal role in facilitating services like Mobile Cloud gaming and remote AR 3D rendering. As we progress into the future, addressing these challenges becomes imperative, particularly in light of the anticipated surge in mobile Internet traffic.

*Author's study conducted during the final year of his undergraduate degree in 2022.