Design and Evaluation of CCA for fluctuating bandwidth scenarios of 5G-A/6G mobile networks

Jorge Ignacio Sandoval [1], *Sandra Céspedes* [2],
[1] Department of Electrical Engineering, University of Chile
[2] Department of Computer Science & Software Eng. Concordia University

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1. Introduction

The requirements of the new services point to bandwidth-demanding and delay-sensitive applications, through the use of high frequency bands and mobility that require constant adaptation to the conditions of the medium to cope with interference and losses, resulting in the use of low-order modulation schemes and retry schemes to protect the information sent, leading to a scenario of high fluctuations in bandwidth and delay, causing congestion and affecting the performance of upper layer protocols and their applications.

The objective of this work is to investigate the impact of AQM within RLC buffers in gNB on video streaming over state-of-the-art CCA.

2. Methodology

The methodology employed focuses on designing and evaluating network strategies that enhance algorithm performance, aiming for faster bandwidth optimization in state-of-the-art methods under high jitter, high throughput demands, and delay-sensitive 5G-A/6G scenarios.

An outdoor environment with a gNB operating in a mmWave band and UEs moving around it. The blocking of buildings generates alternating LoS and NLoS zones

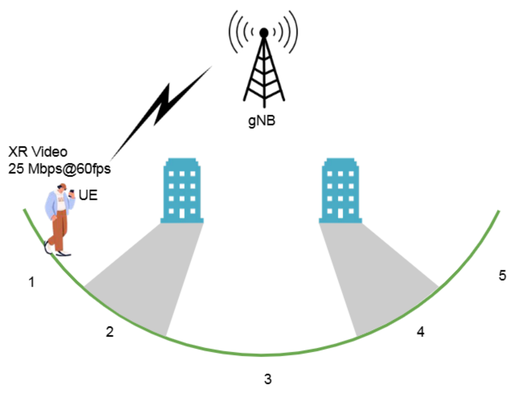

Fig. 1 – Simulation Scenario

The building obstructing the signal has a high decrease of the SINR added to the normal decreasing associated to the high-frequencies usages. This mean only is possible to use low order MCS, decreasing the bandwidth available

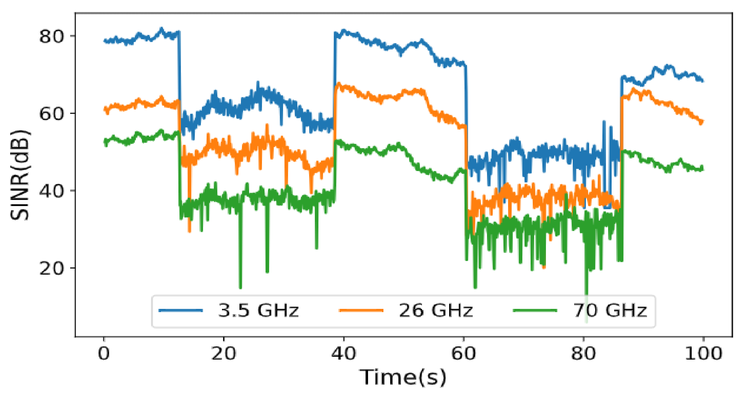

Fig. 2 – Effect of the high frequencies on the SINR

The ns-3 framework and the 5G-LENA module were used, and a congestion control module has been developed to detect the congestion and optimize the data flows improve the network performance of the gNB [1][2].

This work studies the performance of different AQM such as RED, ARED, CoDel, and L4S, using proactive packet dropping to prevent an extreme congestion scenario and ECN marking technics.

3. Results

Initially, we introduce new metrics such as convergence time, added to the traditional throughput and delay, allows to describe the phenomena in a more adequate way [2].

First results show that current CCAs have high convergence times in fluctuating media. Algorithms such as BBR perform better than more traditional algorithms such as HighSpeed and even CUBIC.

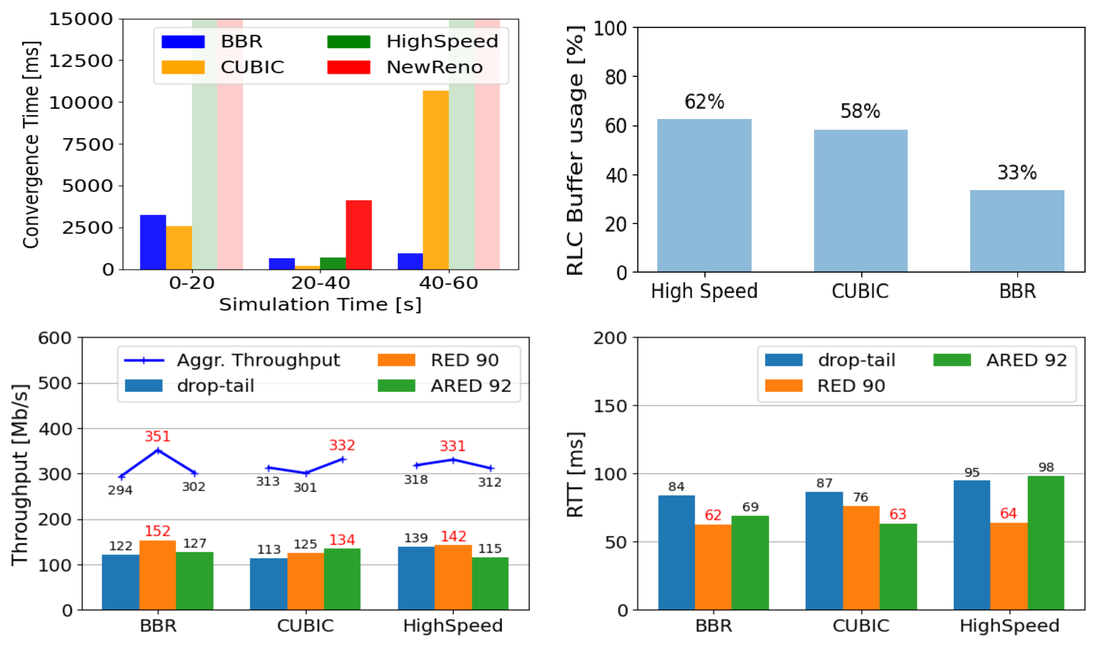

Fig. 3 – First Results

Then, the usage of AQM techniques allow to improve the performance of the CCA increasing the throughput of each UE and the aggregated traffic, while the RTT decrease. The usage of ECN mark allow improve more the performance in protocols that support this functionality

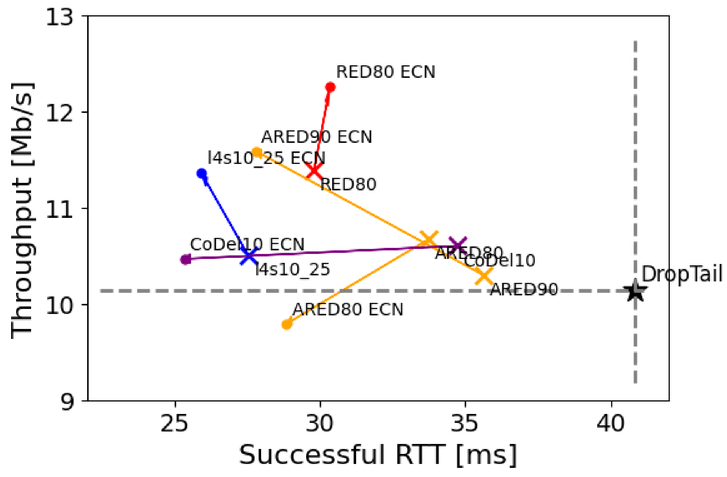

Fig. 3 - Comparation of a selection of AQM under DC TCP using proactive dropping and ECM marking

Although these techniques improve the performance of CCAs, the fine-tuning process is not fast and depends on the scenario and the type of traffic, hence the need to develop a self-adaptive algorithm to cover all scenarios.

Summary / Conclusions

- Using AQM techniques is possible improve the performance of the state-of-the-art CCA while improving the efficiency of the mobile network.
- AQM requires a complex setting of parameters depending on the type of flow and CCA used.
- Future research will explore the development and implementation of new AQM mechanism Reinforcement Learning-based

Bibliography or Website Project

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[2] J. I. Sandoval, S. Céspedes, A. González, D. Torreblanca, and I. Bugueño-Córdova, “A Deep Dive into Congestion Control and Buffer Management for Fluctuation-Prone 5G-A/6G Links,” in 7th Conference on Cloud and Internet of Things. In press. IEEE CIoT ’24, 2024.