

Abstract

In an era where the internet permeates every facet of life, from essential services to daily entertainment, the need for a deep understanding and efficient management of its infrastructure is undeniable. This thesis delves into how the fusion of Machine Learning (ML) with active and passive network monitoring techniques can significantly enhance the robustness and reliability of network infrastructures. By focusing on distinct but interconnected domains such as Cloud Gaming, the HTTP/3 protocol, Geostationary Earth Orbit (GEO) Satellite Communication (SatCom), and Real-Time Communication (RTC) traffic, we offer insights into optimizing network performance for a variety of internet applications.

Our research begins with an in-depth analysis of Cloud Gaming platforms, including Google Stadia, NVIDIA GeForce Now, and PlayStation Now. We examine their unique network requirements, protocol usage, and the challenges of delivering high-quality gaming experiences also over mobile networks.

Turning our attention to the HTTP/3 protocol, we evaluate its adoption trends and operational benefits. Our findings highlight HTTP/3's role in enhancing web browsing experiences through reduced latency and improved efficiency, particularly in mobile environments. However, we also identify the protocol's varied performance across different hosting setups and its limitations in scenarios with high packet loss, underscoring the complexity of its deployment.

A further advancement in our research is the creation of *Retina*, software tool tailored to simplify the feature extraction process for analyzing SRTP traffic, which is widely used in videoconferencing applications. *Retina* streamlines the extraction of comprehensive features from SRTP streams, laying the groundwork for the creation of a Machine Learning (ML) model. We showcase consequently the application of this ML model, which excels at predicting the type of multimedia content transmitted within an SRTP flow. Furthermore, we explore the potential to adapt this model

to similar scenarios by employing transfer learning techniques, demonstrating its versatility and applicability.

To wrap up our research, we delve into the Satellite Communication (SatCom) domain, where we are granted the unique opportunity to analyze the entirety of traffic managed by a SatCom provider. Our initial efforts focus on conducting an extensive measurement and performance campaign, during which we examine the dynamics of traffic over different months. This comprehensive analysis provides insight into how traffic patterns evolve over time in different countries. Following this, we develop a system aimed at estimating the Web Quality of Experience (QoE) for SatCom operators, leveraging both active and passive measurements. This innovative system confronts the complexities introduced by Performance Enhancing Proxies (PEPs) and the ever-changing nature of web content. Utilizing Machine Learning (ML) algorithms to process the extracted features, we establish correlations between network characteristics and key QoE metrics, such as SpeedIndex and OnLoad. This approach highlights the critical role of ongoing adaptation in ML models to maintain consistent performance in the face of network variability.