

# Machine Learning Assisted Real-time DASH Video QoE Estimation Technique for Encrypted Traffic

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## ABSTRACT

With the recent rise of video traffic, it is imperative to ensure Quality of Experience (QoE). The increasing adoption of end-to-end encryption hampers any payload inspection method for QoE assessments. This poses an additional challenge for network operators to monitor DASH video QoE of a user, which by itself is tricky due to the adaptive behaviour of HTTP Adaptive Streaming (HAS) mechanisms. To tackle these issues, we present a time-slot (window) QoE experience detection method based on network level Quality of Service (QoS) features for encrypted traffic. The proposed method continuously extracts relevant QoE features for HTTP Adaptive Streaming (HAS) from encrypted stream in real-time fashion basically, packet size and arrival time in a time-slot of (1,2,3,4,5)-seconds. Then, we derive Inter Packet Gap (IPG) metrics from arrival time that result in three recursive flow features (EMA, DEMA, CUSUM) to estimate the objective QoE following the ITU-P.1203 standard. Finally, we compute (packet size, throughput) distributions into (10-90)-percentile within each time-slot along with other QoS features such as throughput and total packets. The proposed QoS features are lightweight and do not require any chunk-detection approaches to estimate QoE, significantly reducing the complexity of the monitoring approach, and potentially improving on generalization to different HAS algorithms. We use different Machine Learning (ML) classifiers to feed the QoS features and yield a QoE category (Less QoE, Good, Excellent) based on bitrate, resolution and stall. We achieve an accuracy of 79% on predicting QoE using all ABS algorithms. Our experimental evaluation framework is based on the Mininet-WiFi wireless network emulator replaying real 5G traces. The obtained results validate the proposed methods and show high accuracy of QoE estimation of encrypted DASH traffic.

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## CCS CONCEPTS

• **Information systems** → **Multimedia streaming**.

## KEYWORDS

HTTP adaptive streaming, 5G, QoS, QoE, Encryption

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