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QoS aware traffic shaping for TikTok live streaming over congested LAN using MikroTik queue tree

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ABSTRACT

Real time video streaming applications such as TikTok Live are highly sensitive to network instability, especially under bandwidth contention on shared access networks. This paper evaluates a Quality of Service (QoS)-aware traffic shaping scheme for TikTok live streaming in a congested local area network using a MikroTik router with a queue tree configuration. TikTok traffic is identified and assigned minimum bandwidth guarantees and highest priority, while non streaming traffic is treated as best effort. Network performance is assessed under two scenarios: baseline (without shaping) and experiment (with shaping), sing the TIPHON standard and four QoS parameters: throughput, delay, jitter, and packet loss. The experimental results show that although the average throughput only increases slightly from 70.67 Kbps to 80 Kbps and remains in the "Poor" category, the proposed scheme significantly improves temporal QoS metrics: average delay is reduced from 88.65 ms to 45.16 ms ("Very Good"), jitter decreases from 95.61 ms to 89.80 ms ("Good"), and packet loss drops from 7.66% to 3.78% ("Good"). These findings indicate that priority-based traffic shaping using a queue tree can effectively stabilize latency and data delivery for TikTok live streaming on bandwidth-limited networks without requiring capacity upgrades.

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1. INTRODUCTION

Short-form video platforms such as TikTok have rapidly become major consumer of IP traffic, particularly due to their highly engaging live streaming features that blend real-time audio visual content with interactive viewer participation. TikTok Live is increasingly used not only for entertainment but also for social commerce, where live product demonstrations and real time promotions significantly influence purchase decisions. Recent studies in Indonesia show that content, commerce, and community factors jointly have a significant positive effect on TikTok Live engagement, with commerce emerging as the strongest determinant of consumer interaction. Another mixed method study reports a strong positive correlation between the intensity of TikTok live streaming usage and monthly gross merchandise value (GMV), with a correlation coefficient of 0.847 and TikTok Shop GMV reaching IDR 528.6 trillion (approximately USD 22.6 billion) in 2024. These findings underscore that network performance issues such as buffering, delay, and packet loss can have direct economic implications for streamers and merchants operating on TikTok Live [1, 2].

At the same time, many organizations, campuses, and small internet service providers in emerging markets operate under strict bandwidth with infrastructure constraints. Upgrading last mile capacity is often limited by budget and contractual conditions, so multiple users and applications must share the same constrained access link. In such environments, real time video traffic competes with web browsing, file downloads, and other best effort services, While inadequate Quality of Service

(QoS) control leads to buffering, reduced video quality, and audio visual de-synchronization. From a networking perspective, video QoS is typically characterized by throughput, delay, jitter, and packet loss. These metrics are known to strongly affect user experience, with even a 1% increase in buffering reported to reduce viewing time by about three minutes in live and over the top streaming contexts [3].

A substantial body of prior work has analyzed QoS for multimedia and live video streaming using these parameters and standardized frameworks such as the Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON) recommendations. Azhar et al. evaluated live video streaming over an evolved HSPA (HSPA+) mobile network, reporting that provider B achieved an average throughput of 5.295 Mbps [4]. This is higher than provider A, alongside lower average delay (0.618 ms vs. higher delay for provider A), lower jitter (0.420 ms), and lower packet loss (0.451%). Based on TIPHON classifications, the delay values in their study remained below 150 ms and were therefore categorized as “Very Good”, while jitter and packet loss also fell within “Good” or better categories, indicating that well-provisioned cellular networks can support high-quality live streaming. Other work on RTMP-based multimedia streaming using the Red5 server shows that, for both live and video on demand scenarios, measured throughput, delay, jitter, and packet loss all satisfied “Very Good” TIPHON categories, demonstrating that a carefully configured streaming server over an adequate IP link can deliver excellent QoS [5].

Beyond cellular and dedicated streaming environments, QoS studies have also been conducted on institutional and enterprise networks. Ramadhani et al. analyzed QoS on the Internet network of Purwodadi Botanical Garden using a 20 Mbps leased line and multiple hotspot segments [6]. This experiment are obtaining an average throughput of 127.7146 bps, packet loss of 0.0865%, delay of 0.0125 ms, and jitter of 0.0075 ms, all classified as “Excellent” according to TIPHON. Their work emphasizes that even in shared Wi-Fi environments, properly designed infrastructure can achieve excellent QoS across all four metrics. TIPHON itself provides widely used threshold values as standard, such as delay below 150 ms as “Very Good”, 150 – 300 ms as “Good”, and above 450 ms as “Poor”. Similar qualitative categories are defined for jitter and packet loss, with packet loss below 3% generally considered “Good” or better for real-time applications [7]. Collectively, these studies form the state of the art in QoS-based evaluation for live video and institutional networks, but they focus on generic live streaming, RTMP services, or provider-level cellular performance rather than on application-specific traffic such as TikTok Live on constrained local networks [8].

In parallel with academic work, a pragmatic engineering practice has evolved around controlling network traffic using MikroTik RouterOS. Official documentation and expert presentations describe how queue trees, Per Connection Queuing (PCQ), and Stochastic Fairness Queuing (SFQ) can be combined into firewall mangle rules and Differentiated Services Code Point (DSCP) markings to prioritize latency sensitive flows. This is include VoIP and streaming video while deprioritizing bulk traffic. Touw demonstrates a systematic approach in which traffic is identified, marked at the edge, and then managed via queue trees using PCQ or SFQ, with priorities propagated through NV2 wireless links and MPLS labels to ensure consistent QoS across the network path [9]. Community tutorials and MikroTik training materials similarly recommend queue tree based traffic shaping and bandwidth guarantees to stabilize streaming services under congestion [10]. However, these technical resources typically present configuration patterns and qualitative guidance rather than standardized, application specific QoS measurements.

Based on the reviewed literature, several clear research gaps can be identified. First, most QoS studies on live video streaming focus on generic services or specific transport technologies such as HSPA+ or RTMP servers, and do not explicitly consider TikTok Live, even though this platform has distinctive traffic patterns, interaction dynamics, and latency requirements driven by real-time engagement and social commerce. Second, many prior works are purely observational: they measure throughput, delay, jitter, and packet loss on existing networks, but do not design and experimentally validate concrete, application-aware traffic shaping strategies at the access gateway. Third, although MikroTik queue trees are widely used in operational networks and have been compared to simple queue methods for bandwidth management, there is little peer reviewed evidence showing how a specific queue tree configuration, through combining address lists, mangle rules, and hierarchical queues. And how effective TIPHON based QoS metrics for TikTok Live under deliberately constrained and congested LAN conditions. This gap is increasingly important for institutions and small providers that must support rapid growth in TikTok Live usage without immediate bandwidth upgrades and therefore require evidence based configuration patterns to maintain acceptable QoS and user experience.

To address these limitations, the present paper proposes and evaluates an application aware traffic shaping scheme for TikTok live streaming on a bandwidth limited local area network using MikroTik RouterOS. TikTok traffic is first identified through server address lists and classified using firewall mangle rules. Then traffic is assigned to a dedicated child queue within a hierarchical queue tree, where it receives minimum bandwidth guarantees and the highest priority. Meanwhile general traffic is aggregated into a lower priority or best effort queue. The effectiveness of this proposed method is assessed experimentally using two scenarios: (i) a baseline scenario without traffic shaping, where all flows are treated as best effort, and (ii) an experimental scenario with the queue tree based shaping enabled. In each scenario, TikTok Live sessions are executed under congested conditions scenario. Wireshark captures are used to compute throughput, delay, jitter, and packet loss in accordance with TIPHON definitions and qualitative categories.

Relative to the state of the art, this work makes three main contributions. First, it extends QoS analysis to TikTok Live as a specific, high-impact application whose engagement and commercial performance depend critically on network conditions. Second, it moves from passive measurement to active control by embedding a concrete MikroTik queue tree configuration, by combining address lists, mangle rules, and hierarchical priorities. This sttategy is applied directly into the experimental design for TikTok traffic. Third, it provides a TIPHON-based empirical evaluation that quantifies how the proposed shaping scheme affects throughput, delay, jitter, and packet loss categories for TikTok Live on a bandwidth-constrained LAN, thereby offering a reproducible configuration pattern that network administrators can adopt or adapt in similar environments.

2. RESEARCH METHODS

This section describes the experimental setup used to evaluate the proposed traffic shaping scheme, including the network testbed, traffic shaping configuration, measurement scenarios, and QoS metrics.

2.1. Research Design

This study adopts an experimental research design to evaluate the impact of a QoS-aware traffic shaping scheme on TikTok live streaming over a congested local area network. Two network configurations are compared: a baseline configuration without traffic shaping and an experimental configuration in which TikTok traffic is prioritized using a MikroTik queue tree. Both configurations are tested under identical hardware, topology, and traffic load conditions to isolate the effect of the proposed shaping mechanism.

2.2. Network Testbed

The testbed consists of a MikroTik router acting as the Internet gateway, an access switch, and several client devices connected via wired and wireless links. One client device is dedicated to running TikTok Live, while the remaining devices generate background traffic (web browsing, file downloads, and other best-effort services) to emulate access-link congestion. The upstream and downstream bandwidth of the gateway are configured to relatively low fixed values, reflecting the constraints typically faced by campus networks, public hotspots, and small ISPs.

The logical topology follows a simple star configuration in Figure 1, with the MikroTik router at the center and all clients behind a single bottleneck link. This topology is chosen to ensure that the effect of traffic shaping at the gateway is observable on end-to-end QoS metrics for the TikTok Live stream.

2.3. Traffic Shaping Configuration

The proposed traffic shaping scheme is implemented on the MikroTik router using a combination of address lists, firewall mangle rules, and a hierarchical queue tree. First, the IP addresses of TikTok content servers are identified and stored in an address list. Second, firewall mangle rules mark connections and packets belonging to TikTok Live based on this address list. Third, a queue tree is configured on the bottleneck interface with two child queues: one for TikTok traffic and one for aggregated general traffic.

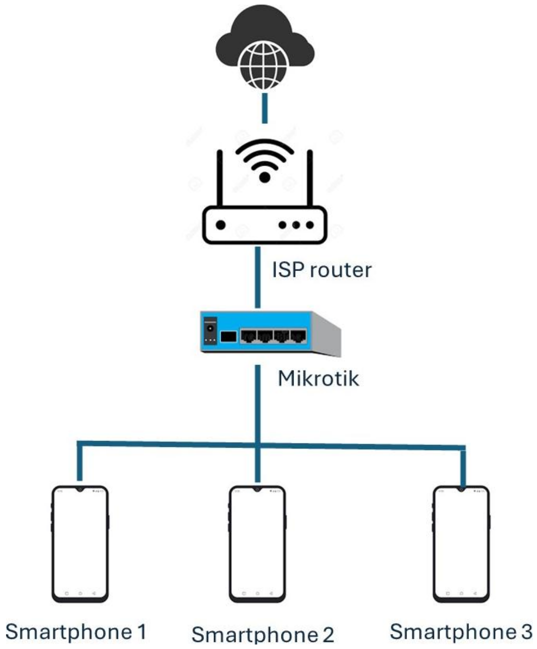

Figure 1. Network design.

The TikTok queue is assigned a minimum bandwidth guarantee and the highest priority (Priority 1), while the general traffic queue is configured with lower priority and no minimum guarantee, effectively treating it as best-effort traffic. This design follows best practices for traffic control in MikroTik RouterOS, where Per Connection Queuing (PCQ) or Stochastic Fairness Queuing (SFQ) can be used as the underlying queue types to ensure fair distribution of bandwidth within each class.

Design of the packet-marking and queue assignment logic can be summarized in pseudocode below:

1. Identify TikTok server IPs and add them to an address list.
2. For each new connection, if the destination IP is in the TikTok list, mark the connection as `conn_tiktok`.
3. For each packet, if the connection mark is `conn_tiktok`, mark the packet as `pkt_tiktok`; otherwise mark as `pkt_general`.
4. In the queue tree, attach child queue `Q_tiktok` to the bottleneck interface and map it to `pkt_tiktok` with highest priority and a minimum bandwidth guarantee.
5. Attach child queue `Q_general` to the same interface and map it to `pkt_general` with lower priority and best-effort bandwidth allocation.

2.4. Measurement Scenarios

Two measurement scenarios are defined to evaluate the effect of the proposed shaping scheme.

1. Baseline scenario (without traffic shaping)
   In this scenario, all QoS and queueing features related to TikTok are disabled. TikTok Live is executed on one client device while background traffic is generated from other devices to saturate the bottleneck link. All flows are treated as best-effort traffic by the router.
2. Experimental scenario (with traffic shaping)
   In this scenario, the full traffic shaping configuration described in Section 3.3 is enabled. TikTok Live and background traffic are generated under the same conditions as in the baseline scenario, but TikTok packets are now prioritized by the queue tree and receive explicit bandwidth

guarantees.The proposed traffic shaping scheme is implemented on the MikroTik router using a combination of address lists, firewall mangle rules, and a hierarchical queue tree. First, the IP addresses of TikTok content servers are identified and stored in an address list. Second, firewall mangle rules mark connections and packets belonging to TikTok Live based on this address list. Third, a queue tree is configured on the bottleneck interface with two child queues: one for TikTok traffic and one for aggregated general traffic.

Each scenario is repeated three times to reduce random variation, and all experiments are conducted during similar time periods to minimize external network fluctuations.

2.5. Data Collection and QoS Metrics

During each experiment, packet traces are captured at the gateway using a network protocol analyzer. From these traces, four QoS metrics are derived in accordance with the TIPHON framework asn in Table 1:

- Throughput is computed as the ratio between the volume of successfully delivered packets and the total transmission time, and is expressed both in Kbps and as a percentage of the allocated bandwidth.
- Delay (latency) is measured as the one-way transmission time from sender to receiver and is interpreted using TIPHON thresholds.
- Jitter is defined as the variation in delay between consecutive packets and is calculated as the average absolute difference of packet delays over the received stream.
- Packet loss is computed as the percentage of packets that fail to reach the destination relative to the number of packets sent, and is similarly mapped to TIPHON categories.

Table 1. TIPHON classification treshold.

Metric	Poor	Fair	Good	Very good
Throughput (%)	0 – 25	26 – 50	51 – 75	76 – 100
Delay (ms)	> 450	300 – 450	150 – 300	< 150
Jitter (ms)	125 – 225	75 – 125	0 – 75	0
Packet loss (%)	> 25	16 – 25	3 – 15	0 – 2

3. RESULTS AND DISCUSSIONS

This section presents the QoS measurement results for TikTok live streaming under baseline and experimental configurations and discusses their implications with respect to the TIPHON criteria and previous work.

3.1. Baseline Scenario: QoS without Traffic Shaping

In the baseline scenario, TikTok live streaming is executed under congested network conditions without any QoS or traffic shaping configuration enabled on the MikroTik router. Across three experimental runs, the average throughput achieved by the TikTok stream is 70.67 Kbps, which corresponds to a throughput utilization below 25% of the allocated bandwidth and is therefore classified as “Poor” according to the TIPHON categories. The relatively low throughput indicates that, under contention with background traffic, the streaming flow is not able to effectively utilize the available capacity.

The baseline temporal metrics also reveal suboptimal network performance. The average one-way delay is 88.65 ms, which still falls within the “Very Good” TIPHON category (delay below 150 ms), but the jitter reaches 95.61 ms and the packet loss rate averages 7.66%, both mapped to index 3 (“Good”). In practical terms, jitter approaching 100 ms and packet loss above 7% increase the risk of buffering events, frame drops, and audio-visual desynchronization during the live stream, especially when encoder buffers are small or the application demands tight latency budgets.

3.2. Experimental Scenario: QoS with Queue Tree Based Traffic Shaping

In the experimental scenario, the proposed queue-tree-based traffic shaping scheme is enabled, giving TikTok packets the highest priority and a minimum bandwidth guarantee, while aggregating all other flows into a lower-priority best-effort class. The QoS performance obtained from the baseline scenario without traffic shaping is presented in Table 2, while the results after applying queue tree traffic shaping are summarized in Table 3. Under the same congestion conditions and number of repetitions as in the baseline, the average throughput of the TikTok stream increases slightly to 80 Kbps. Although this remains within the “Poor” throughput category in TIPHON terms, the increase suggests that prioritized scheduling allows the stream to capture a somewhat larger share of the constrained link capacity.

The most notable improvements, however, are observed in the temporal QoS metrics. As shown in Table 2 and Table 3, the average delay decreases from 88.65 ms to 45.16 ms, effectively halving the latency while keeping it firmly within the “Very Good” category. Jitter is reduced from 95.61 ms to 89.80 ms, still classified as “Good” but indicating a more regular packet arrival pattern. The packet loss rate drops sharply from 7.66% to 3.78%, remaining in the “Good” category but reducing the proportion of dropped packets by more than 50%. These changes point to a significantly more stable and predictable network service for TikTok Live, despite the absence of any physical bandwidth upgrade.

Table 2. QoS measurement without traffic shaping (baseline).

QoS metric	1	2	3	Average	TIPHON classification
Throughput (kbps)	73	76	63	70.67	Poor
Delay (ms)	104.60	101.81	59.55	88.65	Very good
Jitter (ms)	96.10	93.39	97.33	95.61	Good
Packet loss (%)	7.71	10.83	4.43	7.66	Good

Table 3. QoS measurement with queue tree traffic shaping (experiment).

QoS metric	1	2	3	Average	TIPHON classification
Throughput (kbps)	127	59	54	80	Poor
Delay (ms)	41.70	51.64	45.13	46.16	Very good
Jitter (ms)	83.42	92.80	93.17	89.80	Good
Packet loss (%)	3.15	4.02	4.16	3.78	Good

3.3. Detailed Comparative Analysis

Taken together, the baseline and experimental results highlight an important trade-off. The proposed shaping scheme does not substantially increase the absolute throughput of the TikTok stream, and both scenarios remain in the lowest TIPHON throughput category due to the stringent bandwidth constraints imposed on the testbed. This is consistent with the nature of traffic shaping mechanisms, which primarily reorder and prioritize existing traffic rather than augmenting the physical link capacity.

However, when focusing on user relevant QoS dimensions, such as latency, jitter, and packet loss. The experimental configuration delivers a noticeably better quality profile. Compared to the baseline, average delay is reduced by approximately 49%, jitter is slightly improved, and packet loss is cut nearly in half. Prior work on live video streaming over HSPA+ networks has shown that low delay and jitter, combined with packet loss below 5%, are critical to sustaining smooth playback and high perceived quality. In this context, the experimental scenario moves the TikTok stream closer to the QoS regions typically associated with acceptable user experience, even though the absolute throughput remains modest.

From a system design perspective, these findings confirm that queue tree based prioritization is effective for protecting delay-sensitive flows against background traffic on constrained access links. The results align with previous studies showing that MikroTik queue mechanisms can improve fairness and responsiveness for selected applications in hotspot and campus environments, while leaving aggregate throughput largely bounded by the underlying access rate. For operators who cannot immediately upgrade bandwidth, the proposed configuration offers a practical means of stabilizing TikTok Live traffic and mitigating visual artifacts such as stuttering, frame drops, and spontaneous stream interruptions.

3.4. Practical Implications and Limitations

The experimental evidence suggests that the proposed traffic shaping scheme is particularly suitable for environments where a small number of high-priority real-time flows must coexist with a variety of best-effort services over a limited shared link. By allocating a “priority lane” for TikTok Live, the network can maintain low delay and reduced packet loss for the stream, even when total traffic load approaches the bottleneck capacity.

At the same time, the study has several limitations that should be acknowledged. The experiments are conducted on a single network topology, with a fixed bandwidth configuration and one target application; thus, the results cannot be directly generalized to other platforms such as YouTube Live or to significantly higher access rates without further validation. Future work could extend the evaluation to multiple bandwidth levels, more diverse traffic mixes, and additional streaming applications, as well as incorporate user-perceived quality measures to complement the TIPHON-based QoS metrics.

4. CONCLUSION

This study evaluated the impact of a QoS aware traffic shaping scheme on TikTok live streaming over a congested local area network using a MikroTik router with a queue tree configuration. TikTok traffic was identified via address lists and firewall mangle rules and assigned to a high-priority child queue with a minimum bandwidth guarantee, while all other flows were aggregated into a lower-priority best-effort queue. Network performance was assessed using the TIPHON framework and four QoS parameters: throughput, delay, jitter, and packet loss. This measurement is both under baseline (without shaping) and experimental (with shaping) scenarios.

The results show that the proposed traffic shaping scheme does not significantly increase the absolute throughput of the TikTok stream: average throughput rose only from 70.67 Kbps to 80 Kbps, with both values remaining in the “Poor” TIPHON category. This confirms that queue-based QoS mechanisms primarily redistribute existing capacity rather than extending physical bandwidth. In contrast, temporal QoS metrics improved markedly. Average delay was reduced from 88.65 ms to 45.16 ms (both “Very Good”), jitter decreased from 95.61 ms to 89.80 ms (“Good”), and packet loss dropped from 7.66% to 3.78% (“Good”), yielding a more stable and predictable packet delivery pattern suitable for real-time streaming. These findings indicate that queue-tree-based prioritization is an effective and practical approach to protecting TikTok Live traffic on bandwidth-constrained access links, improving the technical conditions that underpin user experience without requiring immediate bandwidth upgrades.

Several avenues for future work arise from these results. First, the experiments were conducted with a single access bandwidth, topology, and application; further studies should explore multiple bandwidth levels, varying congestion intensities, and different numbers of concurrent streams to assess the robustness and scalability of the proposed configuration. Second, the present work focuses on a specific queue-tree design with static priorities and rate limits; subsequent research could compare alternative scheduling mechanisms—such as HTB, HFSC, or PCC/PCQ combinations—and investigate adaptive or learning-based policies that dynamically adjust queue parameters in response to traffic conditions. Finally, the evaluation relied solely on network-level QoS metrics; integrating user-perceived Quality of Experience (QoE) indicators, such as buffering frequency, playback smoothness, or engagement metrics for live commerce, would provide a more complete picture of how network side traffic shaping translates into actual improvements in TikTok Live viewing and interaction.

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