Analysis of 4G and 5G Networks for IPTV Transmission in Albania: Evaluating Key Factors

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Abstract

The increasing demand for high-quality multimedia services has heightened the need for robust, high-speed wireless networks. Internet Protocol Television (IPTV), as a key multimedia service, relies heavily on network performance to deliver seamless content to end-users. In Albania, 4G networks have long supported IPTV delivery across most urban and some rural areas. However, the advent of 5G promises significant improvements in bandwidth, latency, and reliability—factors critical to IPTV performance. This paper presents a comparative analysis of 4G and 5G networks for IPTV transmission in Albania, evaluating their capabilities in terms of network efficiency, infrastructure readiness, and user experience. The study also highlights the essential role of the Electronic and Postal Communications Authority (AKEP) in regulating and facilitating the transition to 5G. Through this analysis, the paper aims to inform stakeholders about the potential benefits of adopting 5G for IPTV and outlines key considerations for successful implementation in the Albanian context.

Keywords: IPTV, 4G, 5G, Albania, network performance, bandwidth, latency, AKEP

JEL classification: L96, O33, L51

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Introduction

The advent of 5G networks has significantly influenced various sectors, notably telecommunications and entertainment. Among the most impacted services is Internet Protocol Television (IPTV), which relies on stable, high-speed networks to deliver real-time, high-resolution video content [Zhang et al., 2020]. IPTV enables the delivery of television programs via IP-based networks, offering flexibility and on-demand access to media from virtually any location (Alfoudari & Alshaer, 2019).

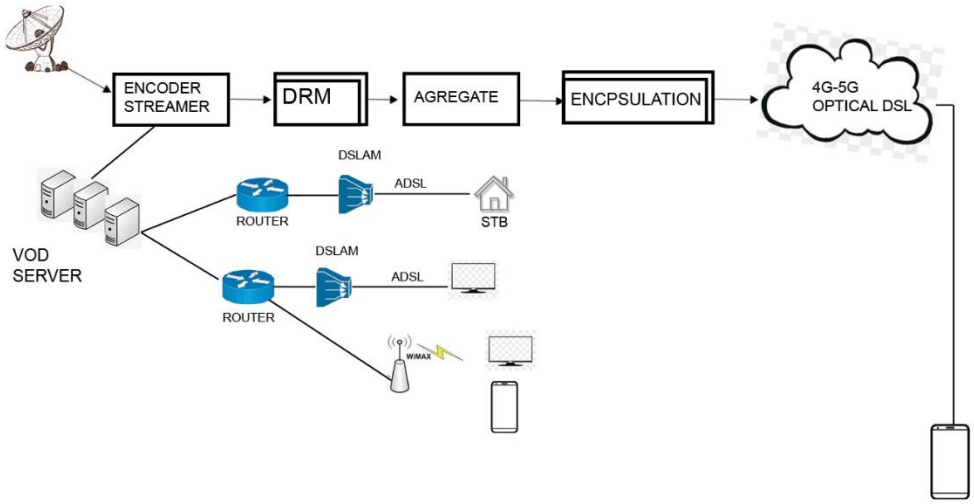
However, the increasing demand for high-definition (HD), 4K, and even 8K content introduces challenges related to bandwidth, latency, and overall network performance (ITU, 2021). While 4G networks have facilitated the growth of IPTV services, they often face limitations in handling the rising volume of simultaneous users and the data demands of high-quality video streaming, particularly in densely populated urban areas (Kim et al., 2018). In contrast, 5G networks are engineered to support higher bandwidth, lower latency, and a greater density of concurrent connections, making them more suitable for modern IPTV use cases (Li & Zhao, 2020). In Albania, the deployment of 5G infrastructure presents both opportunities and challenges. It requires substantial investments in upgrading the existing network, including installing new cell towers, small cells, and fiber-optic backhaul to meet increased data demands (AKEP, 2023). Regulatory hurdles and spectrum acquisition further complicate the rollout (ITU, 2022). Nevertheless, these investments are crucial for enabling high-quality IPTV services. This study analyzes the performance of two leading telecom operators in Albania, Vodafone and One, by measuring key network parameters, including download and upload speeds, latency, and jitter, in the urban centers of Tirana and Durrës. These cities, characterized by partial 5G coverage and high population density, provide a representative environment for evaluating IPTV performance. The goal is to assess the networks' ability to support IPTV streaming in HD and UHD formats, identify peak-hour performance bottlenecks, and propose strategies to optimize Quality of Service. The findings aim to inform telecom providers, policymakers, and IPTV stakeholders in enhancing Albania's digital streaming capabilities.

An overview of IPTV network architecture

IPTV, Internet Protocol television, is a technology that delivers television services over IP networks rather than via satellite or cable. The IPTV industry relies on Internet Protocol Television (IPTV) technology to deliver television programs and other video content to users over the internet. This approach offers users flexible access to media content and enables service providers to manage delivery more efficiently (Lee et al., 2020). A key aspect of this industry is the design and analysis of the underlying IPTV core network architecture, which is essential to providing high-quality, reliable service to customers. To ensure efficient performance, this network must offer sufficient capacity (measured in bits per second), low latency, and minimal congestion (Zhou & Li, 2019). This capacity is typically measured in bits per second (bps), and the capacity requirements vary based on factors such as the number of users, the type of content, and the time of access. Congestion in this network can lead to delays, buffering, and degradation in video quality. Depending on the service provider's network architecture (Figure 1), there are two main IPTV deployment architectures: centralized and distributed. In a centralized IPTV architecture, all the IPTV services are hosted and managed from a central location, typically a data center. In contrast, a distributed IPTV architecture leverages multiple smaller data centers or edge nodes located closer to end users. This approach can improve the overall reliability of the IPTV service by distributing the load across multiple locations, reducing the risk of a single point of failure. A distributed

architecture can also improve end-user quality of service by reducing the distance between the content source and the viewer, thereby reducing latency and improving the overall user experience.

Figure 1
IPTV Architecture



Source: Authors' illustration

For high-quality, delay-free transmission, especially for HD and UHD (4K/8K) streaming, network performance must meet stringent requirements. Two of the most critical parameters are latency and jitter.

Latency is the time it takes for data to travel from a sender to a receiver and back (round-trip time), measured in milliseconds (ms). For IPTV suitability, 4 K video streaming (excellent): latency range is 0-50 ms; HD video streaming (good): latency range is 50-100 ms. If latency exceeds 250 ms, IPTV streaming is not recommended because it will be unstable and cause frequent buffering (ITU, 2021).

Jitter measures the fluctuations in packet delay and is measured in milliseconds (ms). High jitter can disrupt video playback, particularly for live or high-resolution streams. For IPTV suitability and video streaming, a range of 0-50 ms is excellent, with smooth playback and no buffering; 50-100 ms is good. If Jitter exceeds values 250 + ms, IPTV streaming is poor with frequent buffering and interruptions (Cisco, 2022).

Methodology

Data collection

This study evaluates the performance of two major cellular network operators in Albania, Vodafone and One, focusing on their ability to support IPTV streaming in the urban areas of Tirana and Durrës. These cities were selected due to their high population density, where both 4G and 5G coverage are partially available. The performance data was gathered using the speed test tool provided by the Electronic and Postal Communications Authority (AKEP), which measures key internet performance parameters, including download and upload speeds, latency, and jitter. Additionally, geographic data on 4G and 5G network coverage and signal strength in these regions was obtained, enabling a location-based evaluation of network consistency and quality.

Data Collection Method

Seed tests were conducted under real-world conditions using standard mobile devices across multiple locations in Tirana and Durrës. Network selection was automated, simulating typical user behavior and avoiding manual interference. To ensure data reliability, each test was repeated multiple times at different times of day, morning, afternoon, and evening, to account for traffic fluctuations. Tests were performed on both 4G and 5G networks, depending on signal availability at each location, ensuring that the data accurately reflected real-world user experiences.

Performance evaluation

To assess IPTV streaming suitability, several Key Performance Indicators (KPIs) were defined and measured: Download Speed, Upload Speed, Latency, Jitter, Packet Loss (where available), and Perceived Video Quality (inferred from KPIs). Based on recognized industry benchmarks for IPTV quality of service, results were classified into four performance levels: *Excellent, Good, Moderate,* and *Poor*. This classification system enables a clear, systematic comparison of network performance across different conditions, providing valuable insights into the suitability of 4G and 5G networks for IPTV services in Albania.

Table 1

Results for IPTV performance

Metric	Excellent	Good	Moderate	Poor
Download Speed (Mbps)	50+ Mbps	25-50 Mbps	10-25 Mbps	<10 Mbps
Upload Speed (Mbps)	10+ Mbps	5-10 Mbps	3-5 Mbps	<3 Mbps
Latency (ms)	0-50 ms	50-100 ms	100-150 ms	>150 ms
Jitter (ms)	0-5 ms	5-10 ms	10-15 ms	>15 ms

Source: Authors' work

Data Analysis Tools and Statistical Methods

The data collected from speed tests were analyzed using a combination of descriptive statistics and comparative analysis to assess the overall performance of the two network operators.

Descriptive statistics were used to summarize and interpret the basic features of the collected data. The range was analyzed to assess how performance differed between peak and off-peak hours. Together, these statistical measures provided valuable insights into the dataset's overall distribution and trends.

A comparative analysis was conducted to evaluate performance differences between 4G and 5G networks across key performance indicators (KPIs), including download speed, latency, and jitter. To achieve this, a paired t-test was applied to the data. When the data did not meet the assumptions of normality, a nonparametric alternative, such as the Mann-Whitney U test, was considered.

The key differences between 5G and 4G

All mobile networks, regardless of technology generation, use the same basic principles to operate. Radio waves have been used for wireless communication for 120 years, and we use them for radio and TV broadcasting, mobile network communication, and WiFi. Radio waves are, just as light, a kind of electromagnetic waves. However, they have much lower frequencies than light, which means that they travel around corners and even reach into buildings - perfect for mobile communication (F. Yang, 2010).

The Core Network connects calls or internet services, while the Transport Network links the RAN to the Core. Although both connect devices to the internet, they differ in speed, latency, capacity, and coverage (ZTE Corporation, 2006).

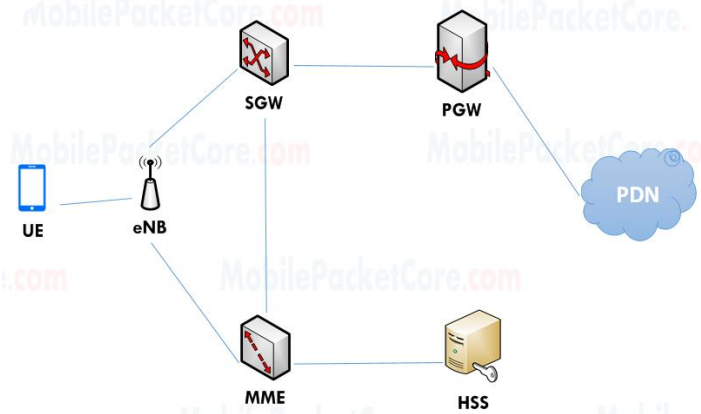
As mobile networks become increasingly advanced, 4G and 5G have become two important terms in wireless communication. Even though both aim to connect devices to the internet, there are unique differences in speed, latency, capacity, and coverage, among others.

4G is a mobile phone network technology that can be used for downloading data and accessing the internet. It provides broadband cellular network services with bandwidth higher than 100 Mbps. With this bandwidth, high-quality multimedia content can be streamed.

4G, uses LTE and WiMax technologies with CDMA as the access system and bandwidths up to 1 Gbps. It offers high-speed cellular broadband services, enabling multimedia streaming. However, 4G LTE, while sufficient for basic IoT applications, struggles with advanced tech like AI, Smart Cities, and Autonomous Vehicles (M. S. Islam, 2021).

The architecture of 4G consists of multiple interconnected components that manage data transmission, mobility, and quality of service, as shown in Figure 2.

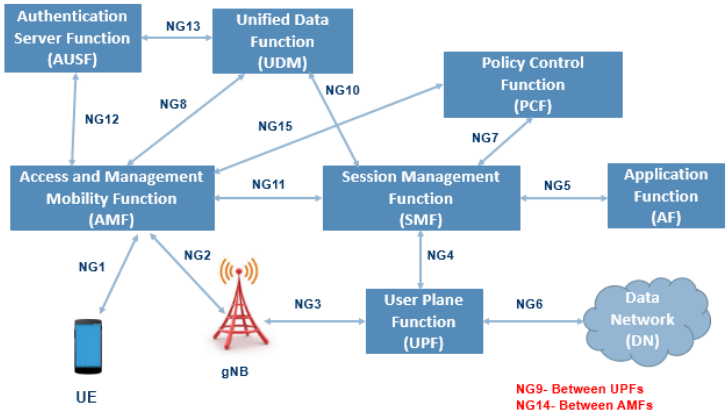
Figure 2
4G Network Architecture



Source: MobilePacketCore.com

Analyzing Figures 2 and 3, it becomes clear that the 5G network reveals a more sophisticated architecture than the 4G. The 5G Architecture (Figure 3) adopts a decentralized and cloud-native approach, including Network Slicing, Edge Computing, and a Service-Based Architecture (SBA), enabling lower latency, higher efficiency, and better scalability. This analysis demonstrates that 5G is a superior infrastructure for supporting bandwidth-intensive applications like IPTV.

Figure 3
5G Network Architecture



Source: Author's illustration

The transition from 4G to 5G networks can significantly impact the quality and performance of IPTV transmission in Albania.

4G networks, while capable of providing high-speed internet access, may face challenges in delivering consistent and reliable IPTV services, especially in areas with high user density or complex terrain. The transition to 5G significantly improves IPTV performance in Albania. 4G networks, although offering broadband, struggle with consistency, especially in high-density areas or challenging terrains, leading to buffering and pixelation issues (Gupta et al., 2024). Specifically, disaggregated and distributed software-defined network solutions, virtualization, and cloud-native functions are at least as impactful as the new 5G radios. 5G networks are designed to be open and virtualized, allowing individual services with different performance requirements to share the same infrastructure. Virtualization effectively separates software from hardware implementations. This allows each function to be scaled independently and distributed optimally, with respect to available bandwidth capacity and latency requirements. Distributed architectural design, enabled by control/user-plane separation, allows operators to position functions and services where they can best serve end users. With progress in virtualized, cloud-native RAN solutions and automation, the hardware at cell sites can be minimized, reducing real estate costs for cell sites. 5G's use three spectrum bands (low, medium, and high), which enhances flexibility in speed and coverage. Multi-antenna base stations enable simultaneous data transmission, boosting performance. Its peak speeds are up to 10x faster than 4G, ideal for 4K/8K streaming (Panwar et al., 2015).

5G latency is four to five times lower than 4G's, and supports up to 100 times more devices. It also consumes 10% less energy on mobile devices. With 1000x data capacity, 5G maintains robust performance even in crowded areas. It supports AI, IoT, autonomous systems, and VR/AR with its low latency and high throughput.
With increased data capacity, performance will remain robust for all users when they connect to public networks in locations such as airports and public transport. AI applications that continuously communicate with the cloud will also benefit from 5 G's performance attributes, especially its low latency. Virtual and Augmented Reality use large amounts of data, are latency-sensitive, and require continuous processing to run in the cloud. Previous Wi-Fi and cellular networks have held back the development of Virtual and augmented reality. Now, with 5G and WiFi 6, efforts are continuing to help accelerate growth.

In conclusion, the analysis of 4G and 5G networks for IPTV transmission in Albania must consider trade-offs among network performance, infrastructure requirements, and potential impacts on user experience. While the deployment of 5G networks presents significant challenges, the enhanced capabilities of 5G, such as higher bandwidth, lower latency, and increased connection density, can enable the delivery of high-quality IPTV services and support the growing demand for multimedia content in Albania. Telecommunications companies like Vodafone and One have started offering 5G services in parts of Tirana and Durrës, but this is still in the early stages. The part of Tirana with 5G access is limited and will take more time and investment to expand coverage (Vodafone, One – Albania).

Factors to consider for IPTV transmission in Albania

According to data from the 2024 annual report of the Electronic and Postal Communications Authority (AKEP), Albania has approximately 99% population coverage for 3G. Regarding LTE (4G) network coverage across both territory and population, Vodafone Albania has the widest coverage with this technology, reaching 97% of the territory with 4G and 100% population coverage. One Albania JCS has 96% territory coverage with a 4G network and 99% population coverage. Additionally, Vodafone Albania has secured the new 5G spectrum in the 3400-3800 MHz frequency band in the latest AKEP auction. This acquisition is expected to enhance the existing mobile network capacity and pave the way for future innovation. In November 2024, One Albania was awarded a 5G license for the 3.5 GHz. The company secured 120 MHz in the 3420-3540 MHz frequency range. Following the acquisition, One Albania partnered with Ericsson to build its 5G network, aiming to enhance network capacity and support innovative applications.

CASE STUDY/Current situation of signal parameters in Albania

When analyzing 4G and 5G networks for IPTV (Internet Protocol Television) in Albania, several key factors must be considered. We have collected data for technical specifications that must be evaluated for this analysis. Information was collected from the speed test service offered by the Electronic and Postal Communications Authority (AKEP) on its official website. This tool allows users to measure their internet connection's download and upload speeds, latency, and jitter.

Speed tests were performed using real-world conditions on mobile devices in different locations, 3 times daily in Tirana and Durrës.

Table 2

Data collected in Durrës and Tirana of network performance Download and Upload speed

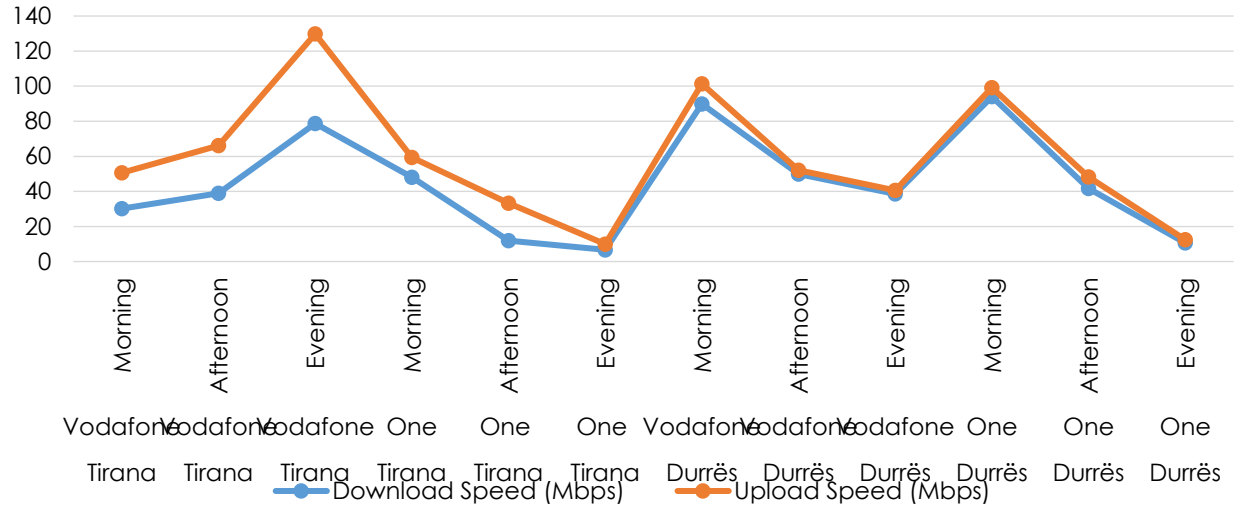
Date	City	Provider	Time	Download Speed (Mbps)	Upload Speed (Mbps)
1/25/2025	Tirana	Vodafone	Morning	30.2	20.5
			Afternoon	39	27.1
			Evening	78.8	51
		One	Morning	48	11.4
			Afternoon	11.9	21.3

			Evening	6.7	3.24
1/26/2025	Durrës	Vodafone	Morning	89.9	11.4
			Afternoon	49.9	2.19
			Evening	38.6	1.97
		One	Morning	94	5.25
			Afternoon	41.7	6.61
			Evening	10.7	1.8

Source: Authors' work

The data collected shows that 4G speeds in Albania can be highly variable, with download speeds ranging from around 6.7 Mbps to over 78.8 Mbps and upload speeds ranging from 1.8 Mbps to 27.5 Mbps (Figure 4).

Figure 4
The result of data collected on network performance, Download and Upload speed



For a deeper analysis of network performance, we have collected latency (ms), jitter, and packet loss data. Jitter represents fluctuations in packet delay. High jitter can cause IPTV buffering, stuttering, and poor video quality, especially for live streaming. Jitter under 10 ms is ideal for smooth IPTV streaming.

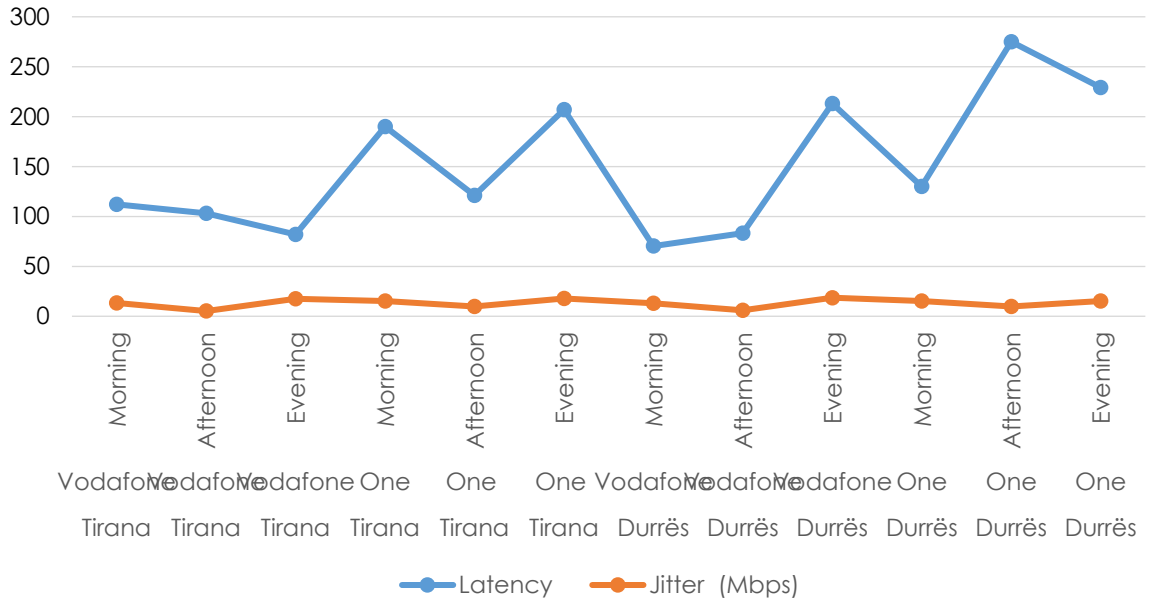
Table 3
Data collected in Durres and Tirana for network performance latency and Jitter

Date	City	Provider	Time	Latency	Jitter (Mbps)
1/25/2025	Tirana	Vodafone	Morning	112	13.2
			Afternoon	103	5.22
			Evening	81.8	17.5
		One	Morning	190	15.3
			Afternoon	121	9.75
			Evening	207	17.8
1/26/2025	Durrës	Vodafone	Morning	70.3	12.9
			Afternoon	83.2	5.93
			Evening	213	18.6
		One	Morning	130	15.1
			Afternoon	275	9.69
			Evening	229	15.3

Source: Authors' work

Vodafone has the best latency (81.8 ms in the evening), which is acceptable for HD IPTV, and can work for 4K if speeds are sufficient. One has high latency (207 ms in the evening), which is not ideal for IPTV. Latency above 150 ms can cause buffering and delays (Figure 5).

Figure 5
The result of data collected for network performance latency and Jitter



Source: Authors' work

Conclusion

The data shows that 4G speeds in Albania can be quite variable, with download speeds ranging from around 6.7 Mbps to over 78.8 Mbps, and upload speeds varying from 1.8 Mbps to 27.5 Mbps. From these tests, we note that in the morning and afternoon, Vodafone in Tirana performs, reaching 78.8 Mbps, which is great for 4K IPTV. One in Tirana is inconsistent; while the morning speed of 48 Mbps is good, evening speeds drop to 6.7 Mbps, which is too low for stable IPTV. There is a significant performance gap between Vodafone and One, even though both provide 4G coverage across most of Albania.

This network congestion makes HD streaming difficult not only in the peak hours but throughout the day. These findings indicate that while 4G networks in Albania can support IPTV, real-world performance can be inconsistent and may not meet the bandwidth requirements, especially for HD and 4K streaming.

Vodafone in Durrës performs better in the morning (89.9 Mbps), making it excellent for 4K IPTV. Evening speed varies (38.6 Mbps), which is still good for HD IPTV, but for 4K can buffer.

One – Albania in Durrës shows great morning speeds (94 Mbps) but drops to 10.7 Mbps in the evening, making it unreliable for IPTV. We notice a higher performance of the One company in Durrës comparing with Tirana, but both providers slow down significantly in the evening, indicating network congestion.

For a deeper analysis of network performance, we have collected latency (ms) data, jitter, and packet loss.

Vodafone has the best latency (81.8 ms in the evening), which is acceptable for HD IPTV, and can work for 4K if speeds are sufficient.
One has high latency (207 ms in the evening), which is not ideal for IPTV. Latency above 150 ms can cause buffering and delays.

Vodafone in Durrës performs well in the morning (70.3 ms) and afternoon (83.2 ms), but evening latency spikes to 213 ms, likely due to congestion.
One's latency is unstable, reaching 275 ms in the afternoon, making it unsuitable for IPTV, especially for live content.

Comparing this result with the throughput data, we can conclude that while 4G networks in Albania have the technical capabilities to support IPTV, the real-world performance can be inconsistent, especially during peak usage times.
Jitter represents fluctuations in packet delay. High jitter can cause IPTV buffering, stuttering, and poor video quality, especially for live streaming. Jitter under 10 ms is ideal for smooth IPTV streaming.

Analyzing Jitter, we found that the results are consistent with those of other factors. Vodafone demonstrates good jitter performance, even during peak times in Tirana, while One's jitter is significantly higher, especially in Durrës, suggesting potential IPTV issues. Packet loss is a critical factor in IPTV quality, as lost packets can cause pixelation, freezing, and synchronization issues. Packet loss under 1% is generally considered acceptable for IPTV.

Vodafone maintained packet loss under 1% across all tests, while One experienced significantly higher packet loss, especially in Durrës in the afternoon and evening, reaching over 3%. This high packet loss would likely result in an inferior IPTV experience for customers.

In summary, the analysis of 4G network performance in Albania shows that while the underlying technology can support IPTV, real-world performance can be inconsistent, especially during peak usage periods. Vodafone appears to offer better, more stable performance than One, with lower latency, jitter, and packet loss. Vodafone likely has better backhaul capacity, more optimized towers, better Congestion Management, and Coverage Quality.

Suggestion

The analysis of 4G and 5G networks for IPTV transmission in Albania highlights the potential for 5G to revolutionize the delivery of high-quality multimedia content in the country.

By addressing the key requirements of IPTV, such as high bandwidth, low latency, and high connection density, 5G can provide a superior user experience and enable the deployment of advanced IPTV services.
To realize this potential, it is crucial for the Albanian government, through AKEP, to work closely with Telecom Operators to create an enabling environment for 5G deployment.

This includes addressing the operators' concerns, providing necessary infrastructure support, and launching a comprehensive public awareness campaign to educate the population on the benefits of 5G for IPTV and other digital applications.
The successful implementation of 5G for IPTV in Albania can have far-reaching implications, including:

1. Improved access to high-quality multimedia content for citizens across the country, including in rural and underserved areas.

2. Increased opportunities for IPTV service providers to develop innovative and interactive services, driving digital transformation.
3. Optimizing Quality of Service for IPTV over 4G/5G in Albania and implementing Advanced QoS Mechanisms, focusing on reducing latency, jitter, and packet loss while ensuring stable bandwidth.
4. Investing in Network Infrastructure Improvements: Optimize 4G LTE Networks, upgrading backhaul capacity (fiber-optic links) to prevent network congestion, upgrading cell sites, using more efficient modulation schemes, and increasing spectral bandwidth utilization.
5. Optimize IPTV Delivery Architecture: Utilize Content Delivery Networks, edge caching, and load balancing to reduce latency and packet loss.
6. Leverage 5G Technology: 5G offers significantly enhanced capabilities in throughput, latency, and reliability, making it well-suited for IPTV delivery. Telecom providers in Albania should develop a fast strategic migration plan to 5G to future-proof their IPTV services.
7. Collaborate with IPTV Content Providers: Work closely with IPTV content providers to optimize video encoding, streaming protocols, and delivery mechanisms for the Albanian market.

By implementing these strategies, Albania can significantly improve the quality and reliability of IPTV services nationwide. The transition to 5G offers a promising solution to overcome the limitations of 4G networks, enabling the delivery of high-quality IPTV content with reduced buffering, latency, and packet loss. In doing so, Albania will bridge the digital divide and enhance the IPTV experience for users in both urban and rural areas, ultimately contributing to the country's overall digital transformation.

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