INTRODUCTION

The evolution of communication technologies has reached an inflection point with impending rollout of sixth generation (6G) network. As we transition from established 5G framework, the focus shifts towards not just enhancing speed and connectivity but also remaigination the urer experience in the realm of audio and video streaming. In recent years, the demamd for live audio and video streamig has surged, driven ley proliferation of mobile devices and social media platforms that facilitate real-time interaction. This shift has fundamentally changed how content is consumed, creating pressing need for networks that can support higher quality, lower latency and mote reliable connections.

6G is projected to operate on tetrahertz (THz) frequencies, offering data rates that could exceed current capabilities ley erders of magnitude. This technologies leap opens new avenues for audio and video streaming, enabling ultra-high-definition (UHD) content delivery & real-time interactivity. Furthermore, advancements such as

edge computing and network slicing promise to create a more responsive and personalized viewing experience.

In this report, we will explore methodologies adoption to study the impact of 6G on live audio and video streaming, analyze the results obtained and conduct a critical evaluation of these findings through various graphs and tables We will also consider alternative methadologies that could be employed in future research. By examining the transformative potential of 6G networks, this report aims to contribute to deeper understanding of how emerging will reshape the landscape of digital media consumption

METHODOLOGIES

The research on live audio / video streaming in 6G networks adopts a variety of innovative methodologies that aim to address challeges related to latency, bandwidth, Quality of Experience (QoE), and energy efficiency. This This report outlines the key methodologies employed in recent studies:

Adaptive Streaming Techniques

On prevalent methodology is the use of adaptive streaming algorithms that adjust video quality dynamically based on real-time network

conditions. This approch is crucial in 6G networks where ultra-high-speed data transmission is possible but network conditions can still fluctuate due to user mobility or sudden changes in traffic load. These algorithms involve:

- **Buffer control mechanisms** - that adjust buffer sizes to smooth playback during network fluctuations.
- **Quality switching algorithms** that seamlessly change video quality to match network band width availability.

Simulation-Based Testing

To velidate the proposed methods, several studies use simulation environment:

- **Network simulators** - like NS3 or OMNeT++ are employed to create 6G network
- **User behavior models** - are integrated into simulations to study how users interact with streaming system.

Edge Computing Integration

In many cases the research emphasize the role of edge computing for efficient video streaming. By offloading computational tasks from central servers to edge nodes closer to the user, aim to:

- **Reduce latency** - by processing & caching video data at the edge of network, ensuring quicker access and reducing the round-trip time for data.
- Improve **Scalability** - edge computing allows more devices to stream content without overloading centralized servers which is crucial for live broadcasts of large events

Efficiency Energy Approches

Given the growing concern over energy consuption, many studies integrate

- These techniques often involve adaptive bitrate streaming where lower quality is chosen in low-energy scenarios, thus extending battery life on mobile devices
- Dynamic resources allocation stategies are also employed to conserve energy when streaming in 6G environments by turning off unused components or reducing transmission power during non-critical period.

Quality of Exprience (QoE) Enhancement

- **User centred design** to evaluate QoE measuring factor such as latency, jitter, & frame rate.
- **Real time feedback loops** between client device

and network controllers to optimize video quality based on both network conditions & user behavior.

Network Slicing for Real-Time Streaming

Finally, network slicing in 6G networks is a novel technique that enables creation of isolated virtual network tailored for specific applications like live streaming:

- Network Slices are optimized for low latency, high bandwidth & priority traffic management, ensuring that live events streaming is uninterrupted even during peak usage.
- The methodology is particularly valuable in scenarios like sports broadcasts or large scale live events.

RESULT OBTAINED

Research on live audio/video streaming in 6G networks has yielded several significant result that highlight the potential benefits & challenges of this technology. The outcomes of these studies demonstrate how 6G's high-speed, low-latency capabilities, combined with advanced algorithms & network architectures, can revolutionize streaming experiences across various applications

Improved Quality of Experience (QoE)

A major result across various studies is the improvement in Quality of Experience (QoE). Adaptive streaming algorithms that dynamically adjust video quality based on network conditions leads to reduced buffering b/w video resolutions. Result show that buffer control algorithms are highly effective in maintaining QoE, even during sudden changes in network bandwidth. For instance, in mobile streaming scenarios,

Low Latency in Real-Time Streaming

One of key advantages of 6G networks is their ability to reduce latency to nearly negligible levels. Studies focusing on edge computing integration show that offloading data processing to edge nodes significantly reduces round-trip time required for video data transmission. This has been particularly beneficial for real-time streaming applications such as live sports events, VR, & AR where even slight delay can severely impact the user experience. Simulation results demonstrate that latency improvements in 6G networks enable real-time content interaction, especially for VR & AR streaming. In particular, applications such as virtual reality live streaming benefit from low latency, allowing users to experience

impensive environment without delay. severely delay can severely impact the user experience

Energy Efficiency

Another significant result is improvement in energy efficiency for live streaming in 6G environment. By employing energy-efficient algorithms, such as adaptive bitrate streaming and dynamic resource allocation, studies show a marked reduction in energy consumption without sacrificing video quality

Experiments have revealed that intelligent energy management can extend battery life by adjusting power allocated for data transmission based on real-time network conditions & user activity. This is a promising result for extending usability of mobile streaming devices.

Enhanced Network Slicing for Streaming Applications

The deployment of network slicing in 6G networks has shown to be highly effective for live video streaming. Network

slicing allows for creation of dedicated network paths that are optimized for specific applications, such as live event streaming. Results demostrate that this technology ensure reliable performance even under high demand, such as during large live broadcasts or sports events

The result of live audio / video streaming research in 6G networks show substantial improvement in QoE, latency, energy efficiency & reliability. With integration of edge computing, network slicing & AI-driven systems, 6G networks are to redefine the live streaming experience However, challenges remain in term of energy consumption & infrastructure requirements highlighting areas for further research & development

Latency Reduction Through Edge Computing

One of the key results from the studies substantial reduction in latency enabled by edge computing. By offloading computational tasks from central servers to edge nodes, the round-trip time

Video Streaming is significant reduced

(Method)	(Avg. Latency (ms))
Tradition cloud	120-150 ms
5G Networks	30-50 ms
6G with edge	1-5 ms

The critical observation form this data is dramatic latency reduction which enables realtime interaction in application such as augmented reality (AR), Virtual reality (VR) & live sports streaming. However while edge computing latency it require significant infrastructure investment which is a limitetation for large-scale implementation.

QoE Enhancement with Adaptive Streaming Algorithms

The studies show that Adaptive streaming algorithms improve the overall Quality of Experience (QoE) by dynamically adjusting video quality based on network conditions. The graph below illustrates

the QoE improvement using different algorithms under variable network conditions.

Algorithm	Buffering (s)	Quality Drops (%)	QoE Score (1-5)
Static Bitrate	8.1	15%	2.1
Adaptive Bitrate (5G)	5.2	8%	3.8
Adaptive Bitrate (6G)	1.2	2%	4.9

The critical analysis of data reveals that adaptive algorithms perform significantly better in 6G networks due to their faster response times and greater bandwidth availability. However, further improvement is needed in areas with network instability, as users in highly mobile environments may still experience brief quality drops.

Energy Efficiency in 6G Streaming

Energy consumption is another critical metric, especially for mobile streaming. Studies show that 6G networks, combined with AI-driven energy management techniques, can reduce energy consumed during streaming.

Streaming Method	Energy Consumption (Joules)
Standard 5g streaming	300 J/min
6g with AI-driven optimization	180 J/min
5g with adaptive streaming	140 J/min

Reliability via Network Slicing

Network slicing in 6G networks has been a game-changer for ensuring reliability during large-scale live streaming events. The technology allows service providers to dedicate slices of network specifically for live streaming, which prevent bandwith overloaded

Scenario	Drop Rate (%)	Bandwidth Allocation (Mbps)
5G Streaming	8%	Dynamic
6G Network Slicing	0.5%	Fixed (100 MBPS)

The analysis of the results highlights the stability and reliability of 6G streaming with network slicing. The near-zero drop rate during high-demand events

like concents and sports events represents a breakthrough in ensuring consistent video quality, even during peak traffic hours.

Critical Insights

Strengths:

- **Latency improvements** due to edge computing enable real-time interactive streaming, essential for applications like VR/AR
- **Adaptive streaming algorithms** provide a seamless viewing experience even during fluctuating network conditions, ensuring high QoE.
- **AI-driven optimization** - reduces energy consumption significantly making 6G a viable option for mobile and HD streaming.
- **Network slicing** dramatically includes reliability, ensuring stable streams during high-traffic live events.

Limitations :

- While edge computing reduces latency, it requires substantial infrastructure investment, limiting its scability in the near team.
- Despite improvements in QoE and energy efficiency, high-definition streaming still poses energy consumption challenges
- AI system are resources-intensive & may add complexity to network management, especially in highly dynamic environments

Distributed Cloud Architecture

Instead of relying soley on edge computing, distributed cloud architechture can be deployed to provide flexible, scable solution. By distributing computational resources across multiple cloud regions, latency can be reduced without need for extensive edge infrastructure. This approch allows for a balance b/w benefits of edge computing

Multi-Access Edge Computing (MEC)

Combined with blockchain can offer both low-latecy performace increased security for streaming applications. MEC allows

for efficient processing close to user, while blockchain technology ensure that transictions are securely recorded and verified in real-time.

Fog Computing

an extension of cloud computing, can be adopted to distribute computing storage and network services between cloud & the edge. By placing fog nodes closer to end devica, improving latency & scalability without need for edge nodes every region

Quantum Communication

Technologies, through still in their infancy, offer potential for near instantaneous data transmission over long distances. When applied to live streaming in 6G networks, quantum communication could virtually eliminate latency, making it ideal for real-time interactive applications like virtual concerts & remote surgeries