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# An Improved Quality of Service Design for Real-Time Services Over Future Generation Wireless Networks using Blockchain Technology

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**Abstract***: The sixth generation of wireless networks, or 6G, is expected to provide unprecedented levels of connectivity and communication capabilities. It is essential to make sure that the underlying infrastructure is dependable, secure, and trustworthy in order to meet the growing demand for high-speed and low-latency communication services. A flexible and scalable solution is also provided by the proposed infrastructure, which is essential to meet future demand for high-speed and low-latency communication services. Blockchain technology has been recognized as a possible option due to its capacity to offer security, accountability, and transparency. The proposed infrastructure is designed using permissioned distributed ledgers, which provide an efficient and secure solution to improve accountability, transparency, and security in the delivery of wireless services. The proposed method makes use of the benefits of permissioned distributed ledger technology and blockchain technology to provide a dependable and trustworthy infrastructure for 6G wireless networks. The proposed solution is modular and easily extendable, allowing for the integration of new services and applications as they become available.*

**Keywords:** Blockchain

## I. INTRODUCTION

### 1.1 Future Generation Technology

The sixth generation of wireless technology, or 6G, is still in its early phases of development. The present 5G technology is predicted to be replaced by this one, which will offer even higher data speeds, lower latency, and more capacity [2]. Furthermore, new use cases and applications are anticipated, including holographic communications, cutting-edge virtual and augmented reality, and more accurate location services [7]. Terahertz (THz) frequency communication, which has the ability to greatly enhance data transfer rates, is likely one of the core components of 6G. But there are still a lot of technical issues with this technology, and it is still in the research stage [2], [7]. Tech companies, academic institutions, and governmental organizations are among the groups working for the development of 6G. Commercial deployments of 6G could start as late as the early 2030s, delaying the widespread use of the technology for a while. In general, it is projected that 6G would usher in a new era of wireless communication with faster speeds and more advanced capabilities, revolutionizing the way people interact with technology and communicate [13].

### 1.2 Distributed Ledger Technology

Data may be kept over a network of computers thanks to a sort of digital database technology called distributed ledger technology (DLT). DLT enables data to be kept and updated by various parties in a decentralized and transparent way, in contrast to traditional databases where data is held in a centralized place and managed by a single company. Blockchain technology, a particular sort of DLT that use cryptographic techniques to generate a secure and open record of transactions, is frequently used in conjunction with DLT. In order to authenticate transactions and maintain the ledger's integrity, the ledger is dispersed throughout a network of computers. DLT offers a wide range of possible applications, including voting systems, supply chain management, and financial services. Due to its decentralized

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structure, it is less vulnerable to hacking and fraud, and its openness can assist increase trust and responsibility across a variety of businesses.

**A. Permissioned Distributed Ledgers**

A subclass of blockchain networks known as permissioned distributed ledgers in blockchain technology requires user consent in order to access the network and conduct transactions [5]. The Bitcoin blockchain is an example of a permissionless blockchain network where anyone can join the network and engage in transactions without obtaining permission [11]. Unlike permissionless networks, distributed ledgers with permissions enable more governance and control, making them better suited for enterprise use cases including identity management, supply chain management, and financial transactions [9]. In a permissioned distributed ledger network, access and participation are restricted to specific users or groups of users who have been granted permission by a central authority or by a consensus process [5], [12]. Due to access being limited to a small number of authorized users, permissioned distributed ledgers offer superior security and privacy compared to permissionless networks. Additionally, since the network may be tailored to the particular use case and the requirements of the authorized users, this can result in greater efficiency and lower transaction costs. A few possible drawbacks of permissioned distributed ledgers are the risk of centralization and the need for a trustworthy central authority to manage access and confirm transactions, even though [9], [11].

**1.3 P2P Network**

The nodes (or "peers") in a peer-to-peer (P2P) network are all equal and have the same capabilities. This form of network is decentralized. In a peer-to-peer (P2P) network, each node can function as both a client and a server, enabling direct communication and data sharing between individual nodes without the need for a central server or intermediary. P2P networks are frequently used for file sharing, allowing users to share data with one another directly without the need for a centralized file server. Each user in a P2P file-sharing network can download files from other users in the network as well as share their own files with the rest of the network. P2P networks can be used for a variety of different uses, including online gaming, audio and video calling, and messaging. Users don't need to rely on a centralized messaging service to connect with one another while using a P2P messaging program, for instance. Since there is no single point of failure and the network can expand as new nodes join, P2P networks can be more durable and scalable than centralized networks. However, because there is no centralized authority to enforce rules and policies, P2P networks can also be more challenging to administer and safeguard.

**1.4 Real-Time Streaming**

Multimedia content is continuously delivered over the Internet or other network connections, such as audio or video [1]. It divides the file into tiny data packets that may be transmitted over the network and played back in real-time on the user's device [1], [14]. The data is stored in the device's memory as a buffer so that playing can go without interruption even in the event of network outages or variations in transmission speed. Due to the expansion of the Internet and mobile connectivity, as well as advancements in video and audio compression technologies that enable the delivery of high-quality information over the Internet, real-time streaming has grown in popularity [8]. Applications for streaming include live broadcasts, video conferencing, online video and audio services, and many more. The ability to access and consume content instantly rather than needing to wait for the content to download is one of the main advantages of real-time streaming [4], [14]. This facilitates consumers' speedy access to and consumption of content, which is crucial for time-sensitive or well-liked content like breaking news or live events. The fact that less data need to be transmitted over the network due to real-time streaming makes it more efficient than traditional download-based delivery models [4], [8]. There are various forms of real-time streaming, including on-demand and live streaming. While live streaming permits real-time streaming of live events or broadcasts, on-demand streaming allows users to access and view or listen to content whenever they choose. Recent years have seen a rise in the popularity of live streaming, especially for sporting events, concerts, and other live performances[4]. In conclusion, real-time streaming has completely changed how consumers access and use multimedia content. It now allows users to stream a variety of content instantly from nearly anywhere they have an internet connection [14].

## II. RELATED WORKS

This study proposes the BEAT (Blockchain-Enabled Accountable and Transparent) Infrastructure Sharing architecture as a viable solution to the issues that Mobile Service Providers (MSPs) might face in future networks, including those of 6G and beyond [13]. Due to the increase in the number of devices connected to the network, MSPs must balance the need for network connections with customers' adherence to Service Level Agreements (SLAs). BEAT uses the inherent advantages of permissioned distributed ledger technology to enable accountability and transparency measures when shared infrastructure across providers is required [11][13]. Device-level accountability is made possible via a fast design element, and simulations have shown that BEAT only adds a few seconds of processing cost. BEAT is a reliable and efficient solution that helps MSPs maintain the efficacy and security of their networks [11]. It may be deployed right away by making small software adjustments to networking hardware like routers.

Recently, there has been a significant increase in interest in HTTP adaptive streaming (HAS) solutions from both academics and the industry. The adjustable bitrate (ABR) logic is a crucial component of client-side HAS solutions that video providers use to enhance the viewing experience. With the help of this client-driven method, a suitable bitrate can be dynamically chosen and adjusted to the current network conditions [1]. Several ABR approaches have been suggested in the literature. The selection of content providers and network features, however, affect how the ABR functions. In this article, we examine a number of client-driven, heuristic-based ABR methods for Optimizing on-demand video delivery [4]. To find the major papers on bitrate choice in HAS, we carried out a methodical mapping investigation. We divided the client-driven ABR approaches into two groups depending on the heuristic that ABR employs: throughput-based and buffer-based [1][4]. Researchers and practitioners can use this in-depth information to better decide whether to use certain ABR approaches in HAS.

Real-time streaming services require reduced network capacity use, initial playing time delay, and playing time delay jitter. Our peer-to-peer multimedia caching solution makes use of a group of customers' close proximity as well as the temporal and geographical locality of cached streams on the clients to accomplish these two objectives. Fully linked peer clients can distribute cached multimedia streams to other peer clients in response to a proxy server's request in addition to receiving multimedia streams from a server [8]. The publish-subscribe protocols are used by a cache service to store all data regarding the peer clients, the video segments they cache, and the state of the connection. This work presents techniques for real-time streaming, stream schedule, pre-fetching, and switching streaming clients in a peer-to-peer client environment. Our simulation results show that there is not much jitter or early latency when playing. Due to the increasing demand for live video streaming from mobile devices like Facebook Live, Instagram Stories, Snapchat, etc., network operators are under pressure to increase the capacity of their networks. However, if Quality of Experience (QoE) provisioning is ignored, just increasing system capacity won't be enough [14]. QoE is the cornerstone for network control, client loyalty, and retention rates, all of which help to increase the revenue for network operators. Now, the focus is on coming up with innovative ways to allow QoE while delivering video content across heterogeneous wireless networks since QoE is rapidly gaining popularity, especially in light of the increased customer expectations for quality. This research gives a complete categorization of pertinent state-of-the-art techniques based on three primary axes: flexibility, energy efficiency, and multipath content delivery [8][14]. It also provides an overview of multimedia distribution solutions, identifies the problems, and provides an analysis of the concerns. There are other discussions, challenges, and unresolved issues related to the seamless multimedia provisioning challenges faced by the present and future wireless networks.

As urbanization continues to spread around the world, residents' quality of life has improved. Urbanization issues are reduced when a new technology for smart cities is combined with smart healthcare, smart transportation, and other services [3]. However, in order to sustain the infrastructure of smart cities, these services require huge data technology. The Internet of Things, big data platforms, and smart transportation are just a few of the smart city technologies that may be used with blockchain technology to improve automation, security, and decentralization of services. One of the biggest issues with blockchain systems is how hard it is to find a transaction record by searching the network. The procedure asks for requesting results from the blockchain ledger [3][9]. This work employed a variety of smart contract structures to enable indexing and querying the blockchain for ride-sharing information. Our studies examine how difficult it is to index and retrieve data from the blockchain using two different smart contract types, Catalogue and Sparse. Regarding trust, incentive structures, data quality assurance, data security, and privacy, PDL-based Distributed

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Data Management (DDM) uses PDL to address significant issues in DDM situations [9]. DDM applications, such as federated learning, can benefit from this in both their roles as data sources and consumers.

## III. LITERATURE REVIEW

| Reviews | Factors | | | | | |
|---|---|---|---|---|---|---|
| | Block chain | RTS | Adaptive Bitrate Streaming | Future Networks | CDN | Heterogeneous Network |
| Ramona Trestian et al [2017] | – | ✓ | – | ✓ | – | ✓ |
| Tooba Faisal et al [2022] | ✓ | – | – | ✓ | – | ✓ |
| M. Zachariadis et al [2019] | ✓ | – | – | ✓ | – | – |
| S. Goldberg et al [2008] | – | ✓ | ✓ | – | ✓ | ✓ |
| K. J. Argyraki et al [2005] | – | – | – | ✓ | – | ✓ |
| T. Maksymyuk et al [2020] | ✓ | – | – | ✓ | – | ✓ |
| S. Brakeville and B. Perepa. et al [2018] | ✓ | – | – | ✓ | – | ✓ |

## IV. SYSTEM ARCHITECTURE

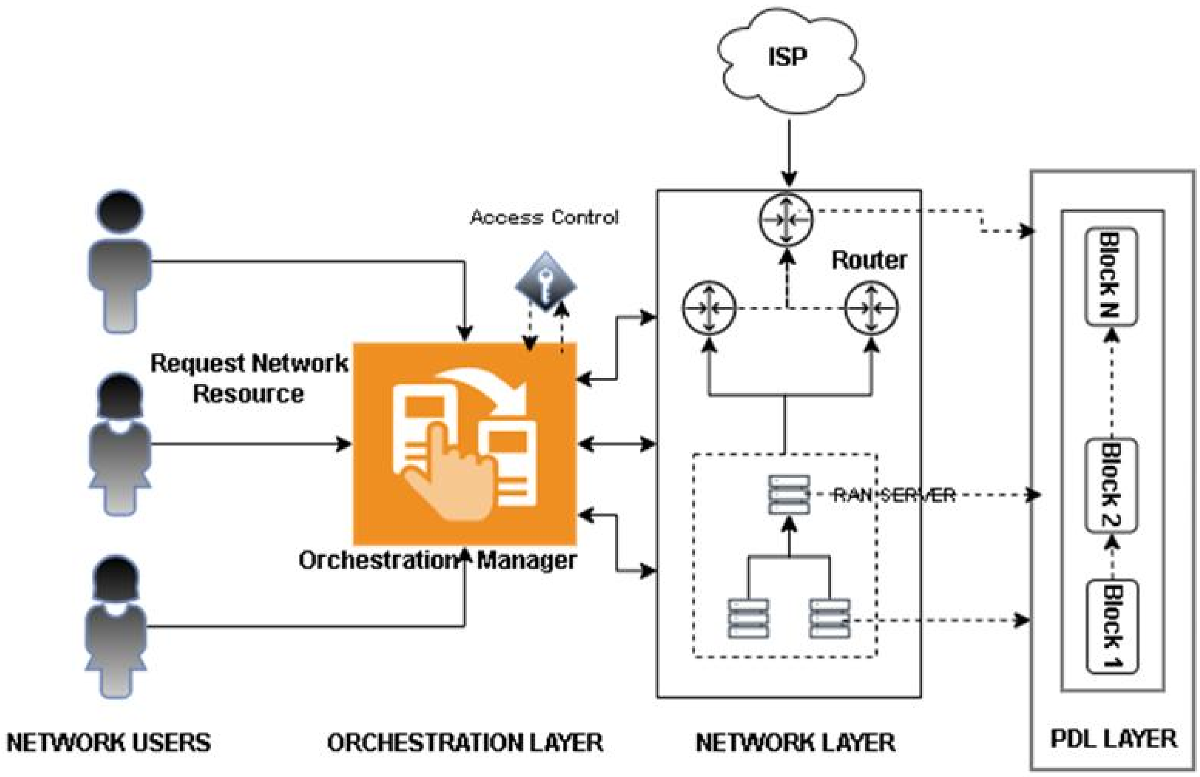


Fig. 1. System Architecture

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### 4.1 Beat Architecture

The architecture is underpinned by the following actors:

- Network Users: These can be grouped into three other groups: 1) Network Owners, which are people or businesses that possess the infrastructure 2) Network Tenants: These individuals pay network owners to use their infrastructure, or 3) Both: These parties each own a section of the infrastructure that is made available for lease to other tenants. They also lease or rent some network equipment from the owners in order to serve their clients.
- Device Vendors: They provide networking hardware, such as switches and routers.
- Governance: The network governance committee, which takes decisions, is made up of a group of network users that includes their representatives. The network users decide how governance representatives are chosen, such as by voting. Management decisions like access control and conflict resolution are part of governance. Members of the ruling body have no control over the devices of their other members; they are only allowed to use their own. Therefore, only one vote would be in jeopardy if a malicious person tried to meddle with the government.

### 4.2 Orchestration Level

Client requests for network resources are managed by the Orchestration Layer, which is the top layer. It performs in a manner that is comparable to the Management and Orchestration Layer (MANO) of the ETSI. The maintenance and management of this tier are the responsibility of the PDL governance. There are three primary parts to the orchestration layer:

1) Orchestration Manager: This response to queries has features like Universal View that are similar to those of the Software-Defined Mobile Network Orchestrator (SDM-O) stated in [8] and the SDN-Server of [14]. When a network user joins the network, the Orchestration Manager assigns the credentials and keeps track of the record. The Orchestration Manager also gives a device a node ID. Devices' IP addresses can change at any time, but the node ID must remain consistent, which is how this node ID differentiates from Layer 2/3 addresses.

2) Access Control: A facility for access control confirmation that maintains a database of login information and answers to requests for access control confirmation from the Orchestration Manager.

3) Network Log: A repository for network resource logs.

### 4.3 Network and PDL Level

The Orchestration Layer of BEAT oversees and maintains the switches and routers that make up the Network Layer of the architecture. Network devices have a maximum threshold capacity for forwarding network traffic in order to maintain agreed-upon service levels. Since service quality may be affected beyond a certain point, network access needs to be monitored and regulated.

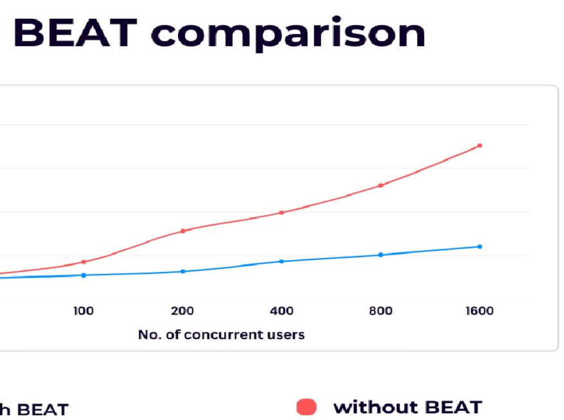


Fig. 2. BEAT Comparison

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The Orchestration Manager will check with the access control entity to see if the tenant already has a contract in place when the tenants seek network resources. If there is an agreement, the Orchestration Manager will then review the Network Log to determine the load that is currently being placed on each device and each path of the network. The tenant might simply wait for the resources to become available if the capacity is not immediately available.

BEAT offers an ecosystem that includes a number of manufacturers and operators. Therefore, stakeholders must be well-informed on the functionality and efficiency of each particular network component. Such performance evaluations are required for sharing agreement accountability and future SLA compliance.

## V. IMPLEMENTATION

### 5.1 Improving QoS using DASH

Step 1: Set initial variables for available network bandwidth, buffer level, and playback position.
Step 2: Choose an initial bitrate based on the network speed.
Step 3: Request the first video segment from the server at the chosen bitrate.
Step 4: Continuously monitor the buffer level and network bandwidth.
Step 5: If the network bandwidth is sufficient, switch to a higher bitrate. If the network bandwidth is low, switch to a lower bitrate.
Step 6: Request a new video segment at the new bitrate.
Step 7: Add the new segment to the buffer and adjust the playback position.
Step 8: Repeat steps 4-7 until the end of the video.

## VI. FLOW CHART

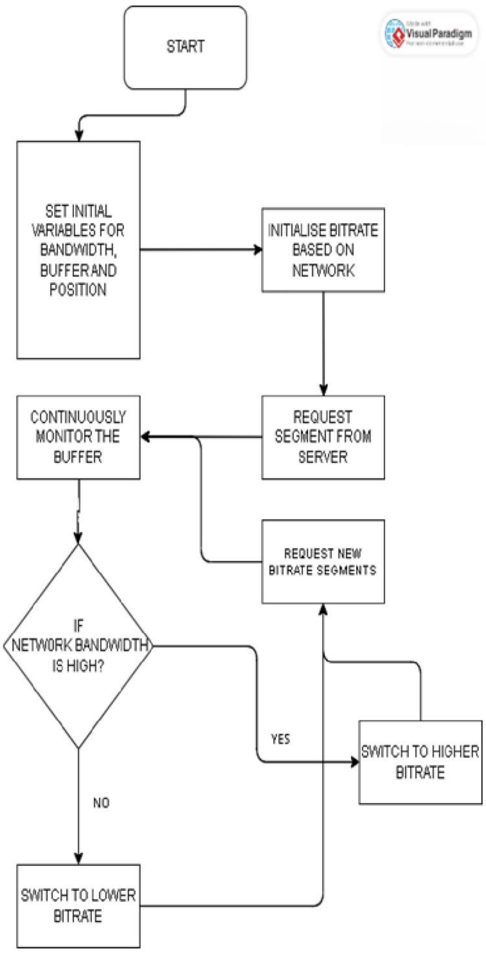


Fig. 3. Flowchart for encoding

| Number of Users | Response time (ms) | |
|---|---|---|
| | Existing | Proposed |
| 50 | 138 | 120 |
| 100 | 212 | 136 |
| 200 | 390 | 158 |
| 400 | 496 | 215 |
| 800 | 653 | 254 |
| 1600 | 880 | 301 |

Fig. 4. Response time comparison

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## VII. CONCLUSION

In conclusion, the BEAT architecture provides a viable solution to the problems associated with real-time streaming over 6G networks. The design assures transparency and security by utilizing smart contracts and blockchain technology, while the adaptive bitrate streaming and performance evaluation modules automatically respond to network conditions, resulting in a superior streaming experience for end-users. With the growing need for high-quality real-time streaming, the BEAT architecture may considerably enhance QoS, making it an appealing alternative for enterprises and organizations wishing to provide their users with seamless streaming services.

Furthermore, the BEAT architecture handles the network congestion, security, and data integrity issues that are frequently encountered in real-time streaming. The use of blockchain technology assures that data cannot be changed or tampered with, while the adaptive bitrate streaming and performance evaluation modules can dynamically adjust to network conditions, guaranteeing that consumers receive high-quality streaming even when networks are congested. As 6G networks become more prevalent, the BEAT architecture offers a realistic alternative for enterprises and organizations seeking to stay ahead of the curve and provide great real-time streaming services to their users.

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