Computer Networks Assignment -

**Critique on “5G realising next generation immersive multimedia experiences”**

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## Abstract

This report provides a critique of a whitepaper titled '5G Realising Next-Generation Immersive Multimedia Experiences' generated by ChatGPT-4o, a generative AI chatbot developed by OpenAI. The critique focuses on validating and verifying the analysis provided by ChatGPT in relation to the challenges in delivering immersive XR (Extended Reality) experiences, the role of 5G in enhancing user Quality of Experience (QoE), and the network management strategies required to enable these advancements. By assessing the whitepaper against key criteria and verifying sources of the data provided by ChatGPT, the accuracy and relevance of the AI-generated content can be verified and reported.

## Introduction

The development of 5G technology has created new opportunities for improving immersive Extended Reality experiences, encompassing Augmented Reality (AR), Mixed Reality (MR), and Virtual Reality (VR). Industries such as entertainment, healthcare, education, and manufacturing should be considering how they can implement XR in their organisations. However, for effective implementation of XR, low latency, high bandwidth, and ultra-reliable connectivity is required. 5G networks can provide this. Therefore, it is essential to understand the interconnection of 5G technology and XR.

A whitepaper focusing on the challenges of delivering XR experiences, the role of 5G in improving Quality of Experience, and the network management strategies to support these advancements would offer valuable insights into leveraging these technologies to create tangible business assets.

# Discussion on ChatGPT-Generated Whitepaper

## **Abstract and Introduction**

The purpose of the whitepaper is clearly explained in the abstract section, which highlights the exploration of 5G's role in enabling next-generation immersive multimedia experiences and sufficiently outlines the core details of the topic being discussed. Additionally, this section emphasises that the paper leverages specifications from ITU, IEEE, and 3GPP - key organisations responsible for developing and harmonising global telecommunication standards, including those necessary for 5G.

The introduction section effectively establishes the topic of 5G’s role in immersive multimedia experiences by outlining the significance of XR and highlighting challenges that could be addressed by 5G advancements. This creates a strong foundation for discussing 5G's potential in enabling next-generation applications. However, some elaboration on core topics would be beneficial. The introduction also includes detail, such as specific references to the paper's structure and content, that may be more appropriate for the abstract. Additionally, the section misses an opportunity to provide detail on relevant topics like other use cases for 5G and the broader implication of 5G beyond XR e.g. Industry 4.0, IoT and Wearable devices applications. By expanding on this topic, the introduction would better position the paper within the wider context of 5G-related discussion.

## **5G architectures and key aspects**

While the GPT was instructed to include a dedicated section summarising 5G architectures, such a section is absent from the whitepaper. Instead, the paper integrates discussions on 5G architecture within the context of its applications to immersive multimedia experiences like XR. It highlights core architectural aspects of 5G that address challenges, including reference to enhanced Mobile Broadband (eMBB), millimeter waves, Ultra-Reliable Low Latency Communications (URLLC), and massive Multiple-Input and Multiple-Output (MIMO) and beamforming. These technical aspects of 5G are discussed by global standardisation bodies and telecommunications organisations referenced in the whitepaper, such as the 3rd Generation Partnership Project (3GPP) [1], the International Telecommunication Union (ITU) [2] and the Global System for Mobile Communications Association (GSMA) [3]. The paper links these architectural elements to outlined XR challenges, effectively connecting this architecture to the broader context of immersive multimedia.

Additional research was required to confirm accuracy of some of the content in this section of the whitepaper, such as claimed data delivery speeds using mmWaves. Refer to [4].

It would be beneficial to have more detail on each architectural element. However, ChatGPT may have limited content based on the request that the whitepaper fit within six pages of text.

## **Network management for 5g**

There is some detailed explanation for key components of 5G network management on the whitepaper. Such as highlighting how Self-Organising Networks (SONs) optimise 5G networks to ensure high reliability, how machine learning enables predictive resource management to deliver better service, and how network slices are managed to prioritise immersive experiences (e.g. XR / AR use cases). Dynamic Spectrum Management is also discussed, which is relevant to 5G network management as it facilitates intelligent management of Radio Access Network (RAN) frequencies. The whitepaper identifies this as essential for optimising 5G network resources. Again, further discussion on this and other topics would be beneficial to a whitepaper document.

Further research was conducted to confirm the accuracy of the details regarding the highlighted components in the whitepaper. The following references were consulted for specific sections: [5] – SON background, [6] – Application of AI in 5G Network operation and maintenance, [7] – Network slicing: opening up new 5G opportunities, [8] – State of the art, [9] – 5G Service Enablers.

## **How 5G networks support enhanced user QoE of Immersive multimedia experiences**

The ChatGPT-generated document discusses challenges affecting user QoE of immersive experiences such as high bandwidth demand, ultra-low latency, and reliable connectivity. The paper then outlines 5G features which address these challenges: enhanced data-rates enabled by eMBB and mmWave, ultra-low latency enabled by URLLC (through reduced Transmission Time Interval (TTI), and flexible numerology), network slicing, and higher capacity and reliability enabled by Massive MIMO and Beamforming. Edge computing is also discussed as a key 5G capability that enhances QoE by reducing latency through minimisation of the distance that data needs to travel to centralised cloud servers. This aligns with statements in the whitepaper reference 'Convergence of Edge Computing and Deep Learning: A Comprehensive Survey' [10] and Ericsson article “What is edge computing and why it matters” [11].

## Conclusion

While the GPT-generated document demonstrates potential as a tool for generating initial drafts of technical content, it seems that human collaboration remains essential to achieve the desired level of detail, accuracy, and relevance. One specific challenge highlighted in the generated article, which I had not previously considered, is power efficiency. However, the paper only briefly mentioned this issue without delving into much detail, prompting me to conduct further research in order to fully comprehend what this means for user experience. The advanced architecture of 5G, including features like Massive MIMO, mmWave, along with its high data rates and low latency capabilities, places significant demands on power consumption for both networks (e.g. powering base stations and small cells) and devices. As a result, it may be necessary to improve the design of both networks and devices through energy-efficient hardware, dynamic resource allocation, and AI-driven optimisations to enhance power efficiency and ensure consistent usability, especially for battery-dependent XR devices. This is all relevant to the topic of 5G realising next generation immersive multimedia experiences and it is discussed in articles referenced on the whitepaper – the GSMA article [3] in particular, does include a specific section on “5G-era energy”.

If the original request had specified a requirement for more extensive discussion or directly included a request for detailed discussion on specific areas, I believe ChatGPT could have provided more comprehensive and in-depth information. The generated whitepaper lacked significant focus on any single aspect of 5G technology. Furthermore, the references provided by GPT did not fully align with the paper's content, necessitating additional research and the consultation of multiple sources to validate the information.

## References

*It should be noted that the ChatGPT-generated whitepaper does not assign correct naming to referenced documents. Naming for the references in this section have been confirmed at source.*

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