Holographic Communication for Revolutionize the World

Hologram Token

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This white paper presents the critical evolving future communication, called **Hologram**. We can produce images in the air without needing any screen or external refraction media via Hologram technology. The Hologram is a combination of naked-eye three-dimensional (3D) spatial imaging and mixed reality technology, also known as holographic communication or holographic telepresence, holoportation for full-motion, 3D video conferencing, etc. The advancements in metaverse technologies fuels the popularity of panoramic media and applications by using a head-mounted display. However, we are presenting a superior technology to metaverse. In metaverse systems, users are isolated from their environment using special hardware that engages multiple senses, offers various opportunities for interaction, and lacks a sense of the real world, which also introduces health problems. A Hologram is different than 3D images, which are composed of two static 2D images of the same scene. The user would typically need a 3D-enabled TV to watch 3D images. On the contrary, Holograms would be projected in the space as if the object is located there. Hence, holography would allow users to see the object from any direction in a way that is close to reality.

Moreover, the form factor and battery consumption of a head-mounted display represent additional challenges to the metaverse adoption by end consumers. Holographic communication offers a wearing-free alternative and relies on holographic projectors. Additionally, users expect to practice holographic communications and metaverse content similar to video conference which is common nowadays. That is to say, anywhere, anytime without any ties.

For instance, you have a keynote in Tokyo or Shanghai, and you should travel from the United States to Japan to present. Further even, you may be obliged to attend an expo in China to exhibit your product to the local people where the best is to present in their mother tongue. Therefore, we solved the problem by transmitting

you there to give your speech remotely, meet with people in your exact outfit in a live manner over Hologram technology, and you will be able to talk as much languages as you want. The Hologram can revolutionize many diverse types of communications and further the world. Our group is the first to discuss Hologram calls and conferences in a blockchain infrastructure to the best of our knowledge.

How Hologram looks like

The Hologram is made by superimposing a second wavefront (normally called the reference beam) on the wavefront of interest, thereby generating an interference pattern recorded on a physical medium. When only the second wavefront illuminates the interference pattern, it is diffracted to recreate the original wavefront. Holograms can also be computer-generated by modeling the two wavefronts and adding them together digitally. The resulting digital image is then printed onto a suitable mask or film and illuminated by a suitable source to reconstruct the wavefront of interest.

Moreover, 3D objects are recorded using a laser and then restored as precisely as possible to match the initially recorded object. When illuminated via a laser, Holograms can form an exact 3D clone of the object and duplicate its features. To

this end, using Holograms as the medium of communication, emotion-sensing wearable devices capable of monitoring our mental health, facilitating social interactions, and improving our experience as users will become the building blocks of future networks. Therefore, you will see the person precisely with the same outfit of the same size. However, you can scale the Hologram size if you desire, similar to zoom/zoom out images on your mobile phone.

The advance in Virtual reality (VR) and Augmented reality (AR) technologies fuels the popularity of panoramic media and metaverse applications. Metaverse applications are continuously evolving to improve user quality of experience and engagement. However, in metaverse technology, we need to wear a head-mounted display, it has a battery and health issues as shown below:

Head-mounted display

We analyze the requirements of the Hologram applications, considering both session and network perspectives. Afterward, we highlight vital evolving technologies that can satisfy the requirement of holographic communication applications. Moreover, we discuss the key research directions to ensure the successful implementation of Hologram application scenarios. Later on, we solve the holographic communication applications problems even for the cellular network in 5G and Next G networks.

Therefore, we present 3D-360-degree video streaming using joint unicast-multicast in cellular networks for supporting holographic communication applications. We optimize the resource allocation for a group of eMBMS (evolved Multicast

Broadcast metaverse Systems) users to enhance their experience while leveraging the inherent diversity in users' network conditions and field of view (FoV). The key intuition is that combining unicast and multicast for tiled panoramic content would facilitate using the right number of resources for every tile considering the tile popularity and receiving user link quality.

Video streaming applications currently represent the primary shareholder in Internet traffic. More than 85% of all Internet users in the US watch online videos. The global video streaming market size is projected to grow at a compound annual growth rate of 20.4% from 2022 to 2027. The popularity of video motivates the introduction of new engaging holographic and metaverse services and solutions.

The delivery of future metaverse content for many users is challenging by a communication bottleneck, even when future technologies are used. Note that networks are designed with statistical multiplexing in mind. Accordingly, network resources would not serve high-quality content for trendy events, such as the Olympics. Hence, holographic communication systems should be designed to support scalable delivery mechanisms, such as multicast. As holographic communication applications become more pervasive, the network resources would not scale at the same pace as application requirements. Correspondingly, holographic communication systems would adopt design techniques that relax data rate requirements but create tight delay constraints. With tighter delays, higher levels of reliability would also be required as a higher packet loss rate slows down underlying protocol dynamics, e.g., TCP. Such ultra-low delay and high-reliability requirements would be needed to ensure accurate tracking of user interaction with the content to avoid any degradation in the user quality of service.

Holographic communication types can be in the form of stored, that users can watch it again like moves aid in visiting NFT museums, video games, and 3D or 5D cinema. Live holographic communication streaming represents a class of applications that immerses the user in an environment captured and delivered in real-time like video calls, and conferences.

In live streaming systems, video liveness is typically defined as the delay between content capturing on the uploader side and the displaying time on the viewer side.

This delay is determined by the time needed to perform all the required processing, including capturing, encoding, uploading, re-encoding, streaming, decoding, and rendering. Enhancing the liveness implies optimizing each of these operations to minimize this delay. Leveraging parallelism represents a key approach to achieve better liveness, i.e., shorter delay.

In the case of telemedicine, it can allow professional doctors to interact with colleagues and patients in real-time. Accordingly, patients anywhere can benefit from the best expertise in a convenient realistic fashion. Holographic communication technology will reduce the travel for conferences, and business meetings through remote presence.

Holographic systems can be optimized to reduce the bandwidth demand by only transmitting and projecting what the receiving party can see. However, this design would require tracking the relative viewing Hologram angle in full mobility at six degrees of freedom.

Supporting holographic communication applications implies relying on state-of-the-art fiber technologies for various wired network sections, such as fronthaul, backhaul, and metro. NG-PON2 supports 40 Gbps throughput using Time and Wavelength Division Multiplexing (TWDM). Wavelength Division Multiplexing (WDM) technology precisely can convey multiple optical signals in parallel by modulating each signal on different wavelengths. Modern WDM systems can serve up to 160 signals, each with a bandwidth of 10 Gbps for a total theoretical capacity of 1.6 Tbps per fiber. These data rates are sufficient to support multiple high-quality sessions.

Guaranteeing a delay bound is a desired feature for various future services, such as metaverse communication, autonomous vehicles, and many industrial applications. To achieve this goal, several technologies such as IEEE 802.1 Time-Sensitive Networking, Software-defined Networking (SDN), and network slicing are envisioned as key enablers for reducing network delays. Mobile edge computing would facilitate processing and storage resources close to end-users. Edge storage of metaverse content would benefit various metaverse applications. First, media streaming from a server close to the end-user improves the streaming quality.

Second, it would enhance the responsiveness to user actions, e.g., using MIMO represents another key approach to improving the received signal strength through beamforming or spatial diversity through multi-user MIMO (MU-MIMO), which is considered in our Hologram project.

Some major applications that will further expanded in future are as follow:

- **Telecommunications**: Several pilot tests for holographic video calls have already taken place.
- **Culture & Arts:** Holography has already been used to generate realistic experiences with the image of celebrities. It can also be applied to the live broadcasting of concerts in different locations.
- **Tourism**: For example, Stirling Castle in Scotland welcomes visitors with a hologram of the historical hero William Wallace.
- **Industry**: Through the use of holograms, relocated factories will be able to speed up the process of manufacturing and assembling metal parts.
- **Automotive:** Such as the three-dimensional representation of GPS addresses or pedestrian identification.
- **Health:** By projecting the patient's organs, their condition can be studied and the different parts of their body can be manipulated through infrared, guaranteeing completely sterilized intervention.

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