Drivers & Key challenges of immersive applications for Future Networks

Context and Objectives

Virtual reality first entered our world through science-fiction novels and movies. It is now a reality. The commercial availability of Augmented Reality (AR), Virtual Reality (VR) and 360° video technologies fosters the development of new immersive services in various industries, such as gaming, collaborative social networking and entertainment. The application of such techniques affects how networking infrastructures should be designed, deployed and operated to best accommodate the multidimensional requirements (latency, bandwidth, etc.) of the corresponding usages. Here's how.

A wide diversity of use cases

We have considered immersive services for both the mass and business markets focusing on use cases relevant for Orange: i) VR and 360° video at home/office without mobility, ii) Outdoor AR with mobility handling. As shown in Figure **1**, these services are utilized in diverse areas, some requiring local coverage: home, indoor areas (factories, offices…) as well as outdoor places (stadiums, streets…), others requiring nationwide or worldwide footprint. On the vertical axis, these services are sorted according to the network complexity using criteria such as usage density and whether remote rendering and computing capabilities should be envisaged.
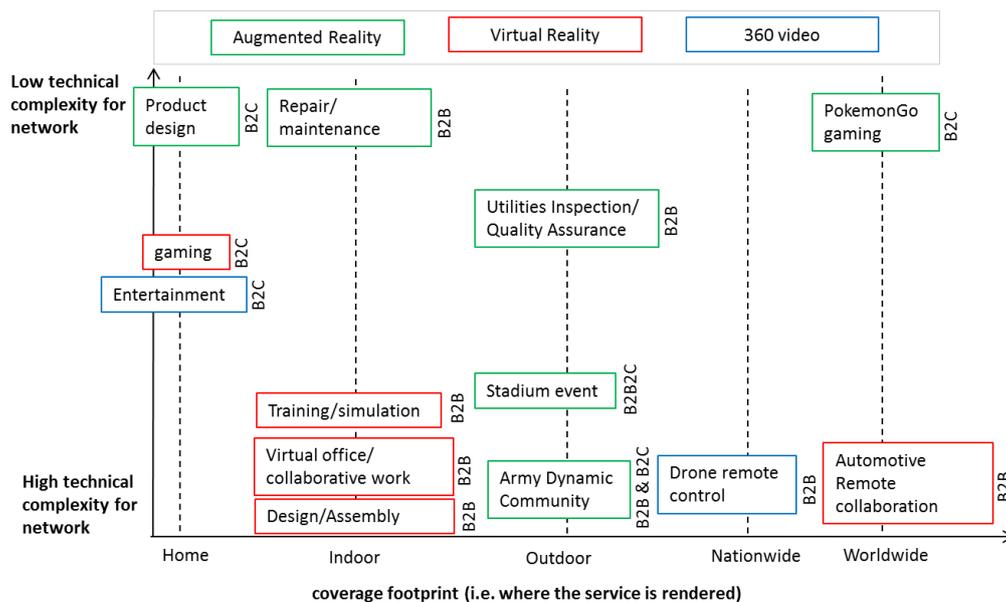

Figure 1: Illustrative use cases selected by NoF to assess their impacts on network infrastructures.

A Cap Gemini[1] study shows there is a real appeal for B2B markets with quantifiable productivity gains. It is clear that several AR and VR services can already be supported by our networks for B2C and B2B markets. Indeed, the trend is to have the real-time processing performed by the user devices: to align virtual objects with the real world for AR services, to render a synthetic and animated world for VR services. In some AR and VR proposals, real-time processing or rendering is performed remotely in the cloud, which therefore raises network latency or bandwidth requirements. The case of 360° videos is different as developed in the next section.

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[1] https://www.capgemini.com/wp-content/uploads/2018/09/AR-VR-in-Operations1.pdf

Impacts of premium 360° video services on network infrastructures

360° video services have disruptive characteristics. Indeed, these services require a much higher bandwidth than current audiovisual services. Basic implementations transfer the whole video sphere into high resolution frames, albeit a viewer only watches the portion delimited by his/her viewpoint (about 15% of the sphere). Besides, in order to offer a satisfactory experience to a user equipped with a Head Mounted Display (HMD), the resolution has to be increased due to the proximity of the HMD with the eyes. The frame rate has to be increased too, in order to reduce motion sickness. The higher resolution and frame rate as well as the stereoscopic vision contribute to a considerable increase in the data rate required to transmit a 360° video flux. As current HMD performances are limited, the quality of experience has a large improvement potential ahead. A first estimation from equipment vendors shows that, for an ideal experience, the data rate could reach 500Mbit/s and even exceed 1Gbit/s per video session. Today's copper networks and Wi-Fi cannot accommodate such bandwidth demands. Nevertheless, more efficient coding schemes are being developed to moderate the bitrate requirements for premium video services.

4G mobile networks are already compatible with low-resolution 360° services, but these are hardly labelled as "immersive". However, the data rates targeted by the 5G mobile network would enable immersive services. In the meantime, techniques such as tiled video streaming are developed to restrict the transmission in high resolution to the area of the video sphere displayed in the user's HMD. Yet, in that case, the fetching of video content has to adapt to head movements. The duration between a head movement and the time it takes to receive high resolution video in the viewport is called "motion to hires". This introduces a new latency requirement for both the content delivery system and the network itself. The contribution of the "motion to hires" metric to the quality of experience remains pretty unknown. Typical estimations are in the range of 20ms which is quite below the current gold standard of 200ms of latency for audio/video communications.

Conclusion and perspectives

To ensure a satisfactory quality of experience, immersive services require a performance increase in terms of bit rate and latency. Some system [vendors](#)[2] mention speeds of at least a hundred Mbit/s for a minimalist implementation (i.e., entry-level VR 8K 2D)[3] to several Gbit/s (such as ultimate VR 24K 3D) for an optimal customer experience. Fiber and state-of-the-art Wi-Fi are therefore a "must have" for the customers eager for an unmatched immersive service experience. On the mobile side, AR services are currently predominant, but there are promising business development perspectives beyond the sole smartphone handsets such as smart glasses and standalone HMD.

From 2019, Orange should take advantage of the first 5G field trials to assess the adequate processing and delivery of true B2C and B2B immersive services like those identified by Orange's marketing teams such as AR gaming, AR-based maintenance procedures (e.g., to follow step-by-step instructions while performing a manual task in manufacturing plants, to facilitate the detection of concealed utility lines in smart cities).

Promoting and getting involved in the development and delivery of immersive services in the coming years is therefore a smart move for the Group to showcase its new AR/VR/360°-compatible network and service infrastructures, thereby capturing additional broadband market shares, both in the fixed and mobile segments. Foreseen usage includes (but is not necessarily limited to) the development of advanced and new B2B services in the medical, manufacturing, military, industrial and tourist industries. Gaming, entertainment, medical, and the retail industries can too benefit from such technologies for the sake of expanding the mass-market [business](#)[4].

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[2] https://www.huawei.com/en/press-events/news/2016/11/whitepaper-vr-oriented-bearer-network-requirements

[3] 4K resolution is 4-times higher than HD 1080p and 8K is 4-times higher than 4K

[4] https://www.jabil.com/insights/blog-main/future-of-augmented-and-virtual-reality-technology.html