Wi-Fi® delivers immersive VR gaming

Wi-Fi® enables immersive VR gaming experiences

Virtual Reality (VR) gaming refers to the new generation of computer games that utilize XR technology to give players a truly immersive, first-person perspective of in-game action. Participants are able to experience and influence the gaming environment through a variety of VR gaming devices and accessories including Head Mounted Displays (HMDs), sensor-equipped gloves, and hand controllers. VR games can be played individually with multiple players, or in online communities using specialized game consoles or advanced PCs serving as companion compute devices.

Wi-Fi is ideally suited for delivering the full potential of VR gaming use cases by providing high performing wireless connectivity for untethered VR gaming experiences to end users. Wi-Fi CERTIFIED™ programs such as Wi-Fi 6 and Wi-Fi 6E offer the low latency, high throughput, and power efficiency needed to meet performance requirements for high-end VR gaming use cases.

Devices and topologies in typical VR gaming setups

A typical high-end VR gaming setup includes some or all of the following devices:

- VR HMD, controllers, and sensing accessories
- Access Point (AP)
- PC or game consoles

In the simplest setup, the HMD connects to controllers and other accessories, with all computing local to the HMD. The HMD may also connect to a remote server via the AP to offload some or all of its compute. This offloading case requires high throughput and low latency on the wireless link to deliver an immersive experience. Finally, the remote computing and graphics rendering may occur on a local PC (or a laptop, gaming console, etc.) that serves as a companion compute device. In this scenario, the compute device services the compute-intensive workloads for VR gaming, including graphics rendering and video compression. The rendered data is then transmitted to the HMD over Wi-Fi. The PC and HMD may connect via an infrastructure network provisioned by an AP, or they may connect directly via a peer-to-peer (P2P) link. In the opposite direction, pose (Inertial Measurement Unit [IMU], button press, etc.) data is sent from the HMD to the PC. In addition, there could also be best-effort traffic being exchanged with a gaming server on the cloud, such as in multiplayer games. This use case may encompass multiple wireless technologies and has stringent throughput and latency requirements.

Functional requirements for a high-end VR gaming experience

Stringent low latency and high throughput requirements must be met to ensure a smooth VR gaming experience. If these requirements are not satisfied, users may experience significant lags and in the worst case, even VR-induced dizziness or nausea.

Requirements for video frames

Video frames are rendered by the gaming engine on the PC, encoded by the Graphics Processing Unit (GPU), and transmitted from the PC to the HMD through an AP at fixed intervals of time, governed by the refresh rate of the game (currently up to 120 Hz). Video frames are expected to be displayed at a given future (VSync) time on the HMD. Therefore, these video frames must be transmitted over the Wi-Fi link with high likelihood as a function of the latency distribution, as shown in the table below. *Note that these latency numbers account only for the actual transmission time of the video frame from PC to HMD over an AP, and do not include operations such as rendering and encoding/decoding of the frames.*

Requirements for other traffic streams

VR gaming also contains additional traffic streams transmitted from the PC to the HMD and vice versa with requirements captured in the table below. Pose/IMU traffic contains information on the controller and HMD movements made by the user, which must be precisely tracked at a rate of 500 Hz. As such, Pose/IMU traffic has the most stringent latency requirements of all other streams.

Traffic Stream	KPI Description	Specification
Video frames (PC to HMD)	Bit Rate (Throughput)	100 Mbps to 200 Mbps (4k/8k @ 72-120 Hz)
	Latency	P75 < 5 ms, P95 <10 ms, P99.9 < 50 ms
Pose/IMU/Controller button presses (HMD to PC)	Throughput	2 Mbps
	Latency	P90 < 2 ms; P99.9 < 10 ms
MIC Audio (HMD to PC)	Throughput	< 1 Mbps
	Latency	P90 < 10 ms; P99.9 < 15 ms
Haptics (PC to HMD)	Latency	P90 < 10 ms; P99.9 < 15 ms
Audio (PC to MHD)	Throughput	2 Mbps
	Latency	P90 < 10 ms; P99.9 < 15 ms

Wi-Fi CERTIFIED™: Technologies that deliver the ultimate VR gaming experience

Wi-Fi Alliance® certification programs already deliver technologies to enable a seamless and immersive VR gaming experience by providing high data rates, low latency, and low power consumption. Next-generation Wi-Fi certification programs in development promise to further enhance the overall Wi-Fi performance.
Wi-Fi CERTIFIED™ ensures that the devices providing VR gaming experiences will meet high standards for QoS performance, interoperability, and security.

Learn more: https://www.wi-fi.org/discover-wi-fi/xr