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NETWORK-AWARE VR APPLICATIONS

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ABSTRACT

Elements of a modern network environment contain a wealth of important information. Such information may include an advanced digital network architecture management platform’s awareness of the location and wireless coverage information for all of the access points (APs) in a physical space and a cloud-based location services platform’s awareness of the physical location of all of the wireless devices in that space. Techniques are presented herein that support the conveyance of such information to a virtual reality (VR) device for integration with the VR experience of the device user. Though such an integration a user may, for example, be prompted to navigate to a location that offers the best wireless connectivity, thus yielding a better VR experience through less jitter, crisper frames, lower latency for remote frame rendering, etc.

DETAILED DESCRIPTION

Currently, virtual reality (VR) applications are designed to be stand-alone. That is, those applications have no knowledge of the wireless connectivity and coverage information for the physical space in which they are operating. Such information may include, for example, where the regions of good network connectivity are in the physical space in which the VR device resides, how many other contending wireless devices exist in that space, where those devices reside, etc. Importantly, a lack of the above-described information may negatively impact the effective operation of a VR device.

However, such information is readily available through elements of a modern network environment. First, an advanced digital network architecture management platform will be aware of the location and wireless coverage information for all of the access points (APs) in a physical space. Second, a cloud-based location services platform will be aware of the physical location of all of the wireless devices in that space.

Techniques are presented herein that enhance a user's VR experience by conveying the above-described wireless network information from a network to a VR device. Providing such information to a VR application can enhance the VR experience of the user through, for example, less jitter, crisper frames, lower latency for remote frame rendering, etc.

Before proceeding, it will be helpful to briefly differentiate the presented techniques from some existing solutions that try, but fail, to address the above-described challenge.

A first existing solution is only able to measure the raw strength of a signal (i.e., a Received Signal Strength Indicator (RSSI) measure) from the APs at a physical location. This may indicate whether a VR device is receiving a strong RSSI from the connected AP and if there are any other APs in its current physical location that the VR device could associate with for better connectivity (based on an RSSI). However, as will be explained below this does not necessarily translate into the best VR experience. In contrast, the techniques presented herein leverage an advanced digital network architecture management platform’s holistic view of network coverage over an entire physical space to steer the VR device to the appropriate physical location for a better VR experience.

Importantly in the above discussion there may be APs that offer a significantly better VR experience, but which cannot be heard (because, for example, they have a weak RSSI) in the current physical location of the VR headset. This may be because of the distance from the AP, or it may be due to the presence of non-line of sight coverage owing to obstacles such as walls, pillars, etc. Since the presented techniques know the physical location of the VR device (through Wi-Fi localization in a cloud-based location services platform), the physical location of the APs, and a corresponding coverage map of the floor through an advanced digital network architecture management platform and three-dimensional maps, this information may be conveyed to the VR application. The VR application may then leverage that information to physically steer the user to a region that offers better connectivity.

For example, in its current physical location a VR headset might be measuring an RSSI of -65 decibel-milliwatts (dBm), -70 dBm, and -85 dBm from three APs. Based on the first existing solution, the VR headset could associate with the -65 dBm AP. However, the presented techniques offer a holistic network coverage map of the entire physical space and knowledge of where the headset is and where the APs are. Consequently, through those techniques the VR headset user may be instructed to, for example, move 3 meters (m) to the left and straight 2 m to obtain -20 dBm of coverage. Such an approach may be integrated into the VR application logic to physically steer the user to the nearby physical location for a much better VR experience.

A second existing solution simply adds more APs. While adding more APs to create a dense deployment may temporarily alleviate the above-described problem, such an approach is not scalable and would be more of a stop-gap solution. Importantly, the presented techniques are complementary to this solution.

Furthermore, once more users start occupying a physical space the above-described problem will resurface. Additionally, adding more APs translates into a greater cost and a larger power consumption. Currently, customers are not ready to add more APs but prefer similar performance metrics with their non-dense (i.e., existing) deployment of APs due to the above-mentioned costs. Finally, adding more APs also results in issues like co-channel interference which may impact a VR experience. Under such circumstances, the presented techniques actually help to steer a VR headset to regions that can mitigate co-channel interference because those techniques have a holistic network view of the entire physical space.

The benefits of the presented techniques may be illustrated through two examples. Under a first example, through use of the presented techniques a meeting VR application may seamlessly navigate a VR user to a 'virtual room' that coincides with a region of good network connectivity. Under a second example, by employing the presented techniques a VR gaming application may alter the gaming engine intelligence to account for network connectivity information by incorporating logic that moves a VR user into a region of good connectivity so that the VR user receives a better VR experience.

Before describing and illustrating the presented techniques, a brief review of several key VR elements will be helpful.

The VR paradigm creates a virtual environment or scene that is presented to a human's senses in a way that one experiences such an environment it as if it were really there. As depicted in Figure 1, below, a typical VR application runs on a head-mounted

VR device and communicates with a remote VR server over the Internet through a wireless uplink.

Figure 1: Exemplary VR Arrangement

Despite the network playing an important role in the above-described arrangement, VR applications are typically designed to be stand-alone (e.g., wireless network agnostic). This is because a VR device does not possess sufficient knowledge to reason about the wireless network of the physical space in which it currently resides. The absence of such wireless information can result in choppy, pixelated, jittery, and/or delayed VR frames that impact the experience of a user. Figure 2, below, presents an example of such an impacted VR frame.

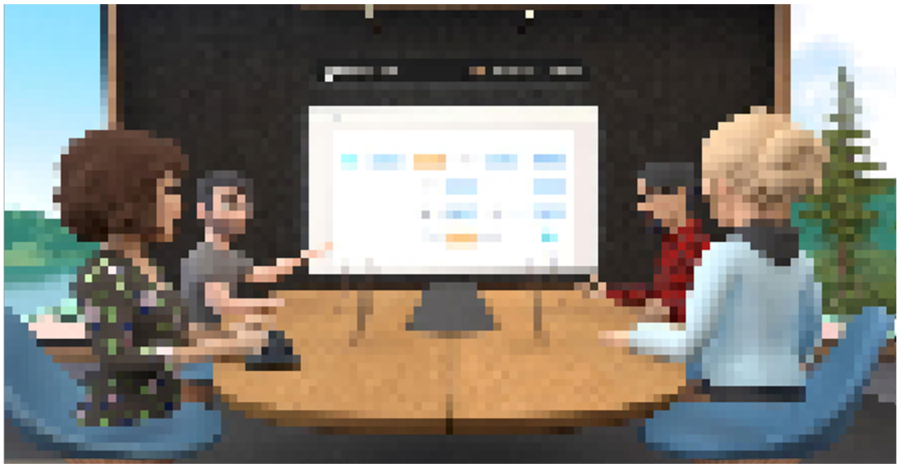

Figure 2: Exemplary Choppy VR Frame

Stated differently, a VR device is currently unaware of the regions that offer good wireless connectivity in the device's operating physical space. Through the presented techniques, the VR device may be made aware of such regions and a VR application may leverage that knowledge, and alter its application logic, to physically steer or guide the user to such a region. The result of such an operation is an enhanced VR experience.

The beneficial use of the techniques presented herein may be further understood with reference to the two example applications that were previously introduced.

First, for the meeting VR application, such an application currently has no knowledge of the different regions within the device’s operating physical space that offer good wireless connectivity. Through use of the presented techniques, the device may be made aware of the same and may then physically steer or guide the user into another 'virtual meeting room' where the location of the virtual meeting room coincides with a region of good wireless connectivity.

Second, for the VR gaming application, through the presented techniques such an application may alter the gaming engine and logic based on the obtained network information such that the VR user (i.e., the gamer) may be physically steered to 'regions of interest' that coincide with areas of good connectivity.

It is important to note that the regions that offer good wireless connectivity are dynamic in that they are affected by the presence of other wireless devices in the space, the channels those devices employ, etc. This necessitates the need for a technique where both static and dynamic wireless network information may be communicated to a VR device. As noted previously, a modern network is aware of such information and when, through use of the presented techniques, that information is communicated to the VR device the VR experience can be significantly enhanced.

Figure 3, below, makes use of an exemplary floorplan to illustrate how an advanced digital network architecture management platform has awareness of the location of the different APs in and the wireless radio frequency (RF) coverage for an entire physical deployment space.

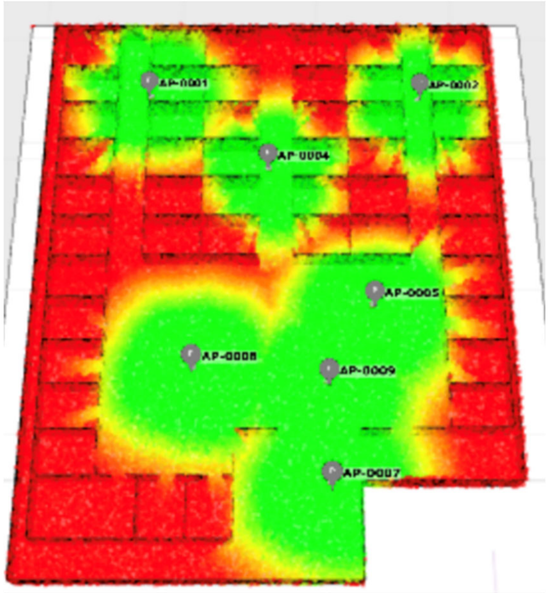

Figure 3: RF Coverage Map

In Figure 3, above, the regions that are shaded green exhibit better connectivity (i.e., a stronger received signal strength) than the regions that are shaded red. Accordingly, a VR device that is located in a green zone would benefit from a better VR experience.

Figure 4, below, employs the same exemplary floorplan from Figure 3, above, to illustrate how a cloud-based location services platform has awareness of the three-dimensional location (i.e., an x-axis position, a y-axis position, and a z-axis position) and the type of each wireless device that exists in a given physical space.

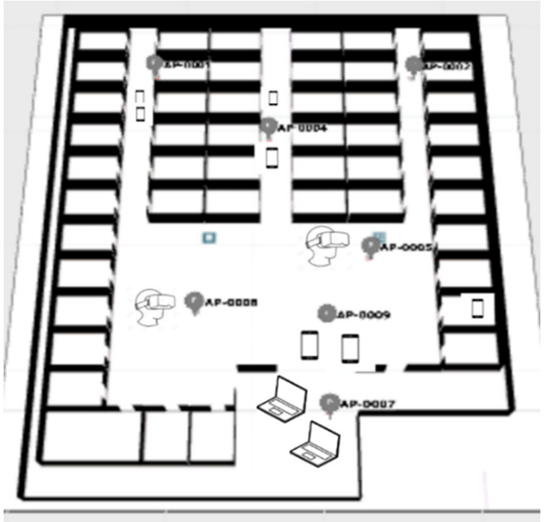

Figure 4: Wireless Device Location and Type Map

Referring again to Figure 3, above, to achieve a better VR experience a VR device would need to be located in a green region rather than a red one. However, as described previously, in the current VR incarnation a VR device in a red zone is unaware of the existence of the green zones (i.e., the regions that offer better connectivity).

Since an advanced digital network architecture management platform has awareness of the RF coverage knowledge for an entire physical space and a cloud-based location services platform is capable of computing the relative displacement for a VR headset to get to a green zone from its current position, the VR headset may (according to the presented techniques) incorporate such information to physically steer the user towards a green zone – e.g., from the current position move 10 m along the x-axis, 5 m along the y-axis, etc.

During a given VR session, other wireless devices may associate with the same AP, or a nearby AP, to which the VR headset is associated. A cloud-based location services platform is aware of the location of those wireless devices and an advanced digital network architecture management platform is aware of the channels through which they are communicating. Consequently, through the presented techniques the network is capable of identifying potential transmission collisions that might impair a VR experience and can proactively inform the VR application to steer or guide the user to another nearby green zone to maintain a positive VR experience.

The result of the above-described process is an enhanced VR experience, as depicted in Figure 5, below, which presents the choppy VR frame that was shown in Figure 2, above, after having been improved through the presented techniques.

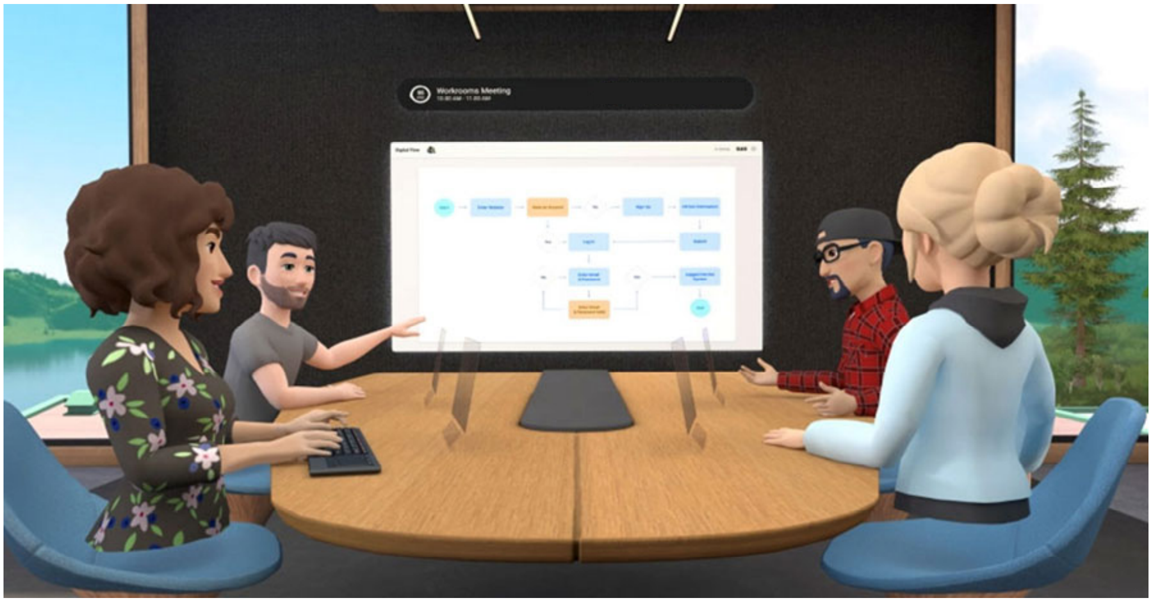

Figure 5: Exemplary Improved VR Frame

In summary, techniques have been presented herein that support the conveyance of key information (including an advanced digital network architecture management platform’s awareness of the location and wireless coverage information for all of the APs in a physical space and a cloud-based location services platform’s awareness of the physical location of all of the wireless devices in that space) to a VR device for integration with the VR experience of the user. Though such an integration a device user may, for example, be prompted to navigate to locations that offer the best wireless connectivity, thus yielding a better VR experience through less jitter, crisper frames, lower latency for remote frame rendering, etc.