

## Research Report

# **The Meaning of VR: Delivering 360 Degree Videos by Public Service Broadcasters Towards 2020 and Beyond**

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\*This article is based on the same authors' article *Chosa Kenkyu Note-Kokyo Hosoniyoru 360° Eizo no VRhaishin no Igi ~2020nen to Sonosaki ni Mukete~*, originally published in the October 2017 issue of "*Hoso Kenkyu to Chosa* [The NHK Monthly Report on Broadcast Research]". Full text in Japanese may be accessed at [http://www.nhk.or.jp/bunken/research/domestic/pdf/20171001\\_4.pdf](http://www.nhk.or.jp/bunken/research/domestic/pdf/20171001_4.pdf)

## Introduction

In June 2017, NHK broadcast a program titled, "BS1 Special—Real Trump World: The World That Created the New President Explored with a 360° Camera."<sup>1)</sup> It was filmed using a 360° camera, and broadcast on television as a program for a normal-sized screen. The 360° video was delivered simultaneously over the Internet in sync with the broadcast. It was the world's first experiment in allowing the viewer to freely look at images "outside" the frame that were not visible on the television screen by moving their smartphone or tablet computer up or down and to the left or right.



**Moving the smartphone around makes it possible to see what's "outside" the frame.**

Since 2016—spoken of as being "VR's inaugural year"—360° video has been one of the VR technologies<sup>2)</sup> to become popularized among the mass public primarily through such entertainments as video games. Its greatest distinguishing feature is that it allows the viewer to savor an ambience and a sense of immersion that makes it seem as though they are really at the setting being projected.

The mass media including newspapers, magazines, and television have also begun to move beyond their respective categories to engage in VR journalism over the Internet. For example, NHK operates a website called "NHK VR"<sup>3)</sup> based on the concept of "experience 'firsthand' news and programs in 360°." The site presents 360° video of places the average person cannot see such as Syria, Palestine, the inside of Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Station, North Korea, and the like. Furthermore, Olympic Broadcasting Services (OBS) delivered the first live 360° video from the Rio de Janeiro Olympics in 2016. This new trend in video presentation involving not just seeing but experiencing firsthand is accelerating down the road toward 2020.

With the debate under way about transmitting television broadcasts simultaneously over the Internet, the question arises as to whether present efforts to deliver 360° video in sync with a television broadcast is something that viewers find appealing. In the present article, I will examine the results of this experiment from both a production and a

technological perspective. In addition, I will also report on trends in the field of VR delivery—which comprises the cutting edge of the information technology (IT) and telecommunications industries—as we look ahead to the 2018 PyeongChang Winter Olympics and the 2020 Tokyo Olympic and Paralympic Games. Furthermore, I will also touch on how the world's public broadcasters are dealing with VR and consider the significance of VR delivery as a new type of public broadcast service and public service media linked to 2020 and beyond.



**A 360° camera is mounted on the center pole.**



**Experiencing Manhattan streets "firsthand" in 360°.**



The top photo shows the TV screen, while the bottom shows the production staff captured in 360° video. Taken from "Trump World."

## 1. The First 360° VR Video Delivery Synced to a TV Broadcast

### 1.1 About "Trump World"

NHK broadcast "BS1 Special—Real Trump World: The World That Created the New President Explored with a 360° Camera" on June 4 and 11 in two 50-minute parts. It sought to answer the question of what it was that had created the explosive personality of Donald Trump, who had taken office as president under a banner heralding "America First." The documentary looked for the point of origin by visited places connected to Trump and interviewing witnesses to his development. It was filmed using a 360° camera, with the 360° video delivered over the Internet in sync with the broadcast.

By moving their smartphone or tablet computer up and down and to the right and left while watching the television, the viewer can experience firsthand the 360° world running outside the frame visible on the television screen. Directions were inserted in the narration and on the screen inviting viewers to take in highlight scenes at those points where they would be shown 360° video. These included locations as such the Manhattan Street where Trump Tower is located, the military boarding school that Trump attended, and the scene of a discussion that occurred when he entered the casino business.

I personally found the scene that took us into the house of one of his friends impressive. The 360° video even showed the production staff surprised to see the house even had a bowling alley.

## 1.2 Viewer Reactions

How did viewers respond to this delivery of 360° video synchronized to a television broadcast?

More than 70% of the 102 members of the NHK Net Club who were asked beforehand to watch the program in response to a questionnaire answered that it was either *"Interesting"* or *"Somewhat interesting."* As to the 360° aspect, a majority of opinions were favorable, including *"I enjoyed it," "I would like to experience it again," "My curiosity was satisfied," "I saw new possibilities for television in the 360° video," "I clearly understood the process by which President Trump's personality was formed," and "Controlling the images was easy to understand."* Incidentally, the answers to a question about what kinds of programs the respondent would like to see in 360° were *"travel," "documentaries," and "sports."*

The program earned generally quite favorable reviews from Net Club members, who are quite familiar from their day-to-day habits with NHK programs. However, the next question is what was the reaction like from the younger generations, who are moving away from television viewing?

Senior Producer Kazuta Hioki of the Content Development Center in NHK's Programming Department said that one of the motivations for making this program was that "with all the attention that VR is getting, presenting television programs like documentaries that have trouble getting an audience via smartphone might be an opportunity to get people to watch them." Just how far did this program go to hit that target among the younger "smartphone first" audience?

Working in concert with Keiko Kurata, a professor at Keio University whose research focuses on information media, NHK got 30 university students to watch the program and investigated the question afterward. Here are some of the things they said.

Good points

- "It has the feeling of being there."*
- "I saw things I normally couldn't see."*
- "The fact that you aren't passive was interesting."*
- "The 360° views of the debate and Manhattan were impressive."*
- "The interiors of his friend's house and the boarding school were interesting."*

In light of how many students normally don't watch much television, these affirmative views to the production gave the creators a sense of the possibilities here.

Points of concern

- "Poorness of connection."*
- "Quality rougher than YouTube."*
- "Production staff included in the filming."*
- "Get motion sick."*
- "When you focus on the 360° video, you don't get the content."*

For university students accustomed to high-quality internet videos, it would seem that the levels here crucial to creating a sense of immersion were lacking. NHK's Internet

performance standards call for a standard video delivery bit rate of 1 Mbps. However, in order to deliver 360° video with its wide angle of view and massive amounts of data without any universal lags meant NHK was forced to reduce the pixel count. This program was delivered using the stable MPEG-1 standard, but it will be necessary in the future to keep a close watch on average communication environments while exploring ways to increase quality.

Professor Kurata noted that while there is deep significance to the attempt of trying to get young people who are shying away from television to watch documentaries, the issue arises as to how to separate the uses of two screens with different media characteristics. Television is a passive medium, while the smartphone is an active one. When you follow the story via the broadcast while operating a second screen, the phenomenon of not absorbing the details as was pointed out in the student responses arises. For that reason, the issue is a matter of how does one incorporate this into the production of a documentary. Kurata also said it appears that there is demand for the provision of simultaneous 360° video and for later replaying through video-on-demand when it comes to nature, travel, sports, and quiz programs. These needs stem from the perspective of experiencing firsthand places and settings that the viewer normally cannot get to.

As the foregoing indicates, there are a number of issues. Nevertheless, "Trump World" did allow for new experiences and discoveries, it created a sense of immersion, and earned a certain level of positive reviews even from university students who prioritize their smartphones.

Expressing his aspirations, Chief Producer Hioki said, "I would like to add new value to television by adding the sense of active control and firsthand experience you get through the Internet to passive broadcasts. The next step with the 2020 Tokyo Olympics forthcoming is for us to take on the challenge of delivering live 360° VR video of a sporting event and synchronizing it with the live TV broadcast."

### **1.3 About the System for Synchronizing Broadcasts with 360° Video Delivery**

"Trump World" also entailed tackling something new from a technical perspective. That effort was the development of the world's first system that made it possible to deliver 360° video synchronized with a television broadcast.

Various methods exist for synchronizing broadcasts with video deliveries that include using hybrid cast-capable televisions and specific software applications. However, with evolving from a public broadcaster into "public service media" as its goal, NHK has wanted to have a system that as much as possible would enable every viewer to receive the same service even granting the differences among their communication environments and the devices they use. It would be possible to synchronize the 360° video file (50 minutes long in this case) to the broadcast by having viewers download it to their devices, but for rights reasons this cannot be done. For this broadcast, NHK constructed a framework where the 360° video was broken up into small chunks several seconds long and readied on the server. The server clock time was then synchronized with that of the broadcast, and the 360° images replayed by the viewer several chunks at a time. If the replay fell behind by five seconds or more on viewer's side of things, it would skip ahead to the next chunk that matched the broadcast clock time for synchronizing with the broadcast. This method made it possible to keep the lag time down to one or two seconds or less as a result. Furthermore, it made it possible to synchronize the broadcast with the 360° video being delivered over the Internet even if a viewer started watching the program mid-broadcast.

Using this technology makes it possible to bring latency with respect to the broadcast down to next to nothing when it comes to recorded programs for which chunk files can be

prepared in advance. Also, if the creation of the chunk files goes quickly, it becomes possible to rapidly offer replays from a 360° perspective even during the live broadcast of a sporting event. Looking ahead to 2020, it will be necessary to further develop the technology and make investments in order to deliver live 360° VR video that synchronizes without latency to a live broadcast. Accordingly, it is deeply significant that the technology used to synchronize the "Trump World" broadcast and transmission was developed in-house at NHK for communication environments as they are today.

## **2. The Olympics and VR**

### **2.1 Live 360° VR Delivery Began with the Rio Olympics**

VR is said to be quite compatible with the live broadcasting of sporting events. Viewer excitement will be all the more stimulated if they can get a sense they are on the spot like they are viewing the action from close up even without going to the actual site. The gala occasion, as it were, for such a usage is the sporting event that attracts the world's attention: the Olympics.

The official Olympic Broadcasting Service (OBS) makes the video for live broadcasts of the event. Those videos are distributed to the various broadcasters that have broadcast rights, and the videos in turn are delivered to the general public. At the Rio 2016 Games, the OBS for the first time delivered live 360° VR video. The video taken of the opening and closing ceremonies, beach volleyball, boxing, gymnastics, fencing, basketball, diving, track and field, and other competitions could be viewed in 29 countries. NHK made 67 hours and 25 minutes of the live VR delivery and video highlights available on its website. The British Broadcasting Corporation (BBC) also delivered VR imagery for viewing with special software on head-mounted displays (HMDs).

The live VR delivery in fact was delayed about one minute behind the broadcast. It was not intended to be synchronized with the broadcast, and took the form of video transmitted from a fixed camera. I had the sense that as a new form of video expression, there was considerable room for improvement in terms of quality, camera placement, latency, and other similar factors.

### **2.2 VR Trends Looking Ahead to PyeongChang 2018**

Will viewers be able to get a VR experience that goes beyond that of the Rio Games when the PyeongChang Winter Olympics are held in Korea in February 2018?

The PyeongChang Games are being heralded as the world's first Olympics of 5G and the Internet-of-Things (IoT), and the world's most sophisticated Olympics yet in the area of information and communications technology (ICT).<sup>4)</sup> The term 5G refers to a next-generation mobile telecommunications standard; Korea is seeking to become the first country in the world to launch commercial services based on the standard in 2019. The hallmarks of 5G include its ability to deliver large volumes of data at high speeds, low latency, and hyper connectivity. It is expected to be 100 times faster than 4G/LTE, offer 100 times the connectivity and 1,000 times the capacity of that standard, and provide extremely low end-to-end latency on the order of 1 millisecond or less.

In June 2017, the IT giant Intel announced that it had signed a sponsorship agreement of the highest order with the International Olympic Committee (IOC) running through 2024—including the Tokyo Games—to supply platforms for 5G, VR, developing 360° video content,

and for artificial intelligence (AI).<sup>5)</sup> Seeing PyeongChang and subsequent Olympics Games as offering a showcase for 5G, the company said it would make it possible for viewers to have real-time VR experiences of the events through its True VR and 360° replay technology VR systems. Intel laid out its plans to provide the OBS and the IOC's official Olympic Channel with support that went beyond the technological sphere to the area of content as well.

The details regarding content remain unspecified. However, based on the materials Intel has posted to the Internet related to True VR it is possible this will go beyond 360° video to include such other VR models as multi-view—which allows the viewer to select from among different viewing angles—and free navigation—which enables the viewer to adjust their perspective at will as though they are actually in the space being presented. Intel says it wants to provide television viewers with the same sort of experience in the future.

Korea's Samsung Electronics, a major player in the field of VR devices, also has a top-level sponsorship deal with the IOC. Furthermore, official PyeongChang Games sponsor and Korea's largest telephone carrier KT Corporation is in negotiations with the OBS over live VR delivery. It is also working to set up a 5G network around the event sites and studying plans to provide point-of-view video from athletes in the ski jump and bobsled events as well as live multi-view and free navigation VR delivery.<sup>6)</sup>

Whatever the case, the inescapable questions remain of what sorts of VR will be used at the PyeongChang Games, to what extent will those transmissions be delivered in real time, how will they be synchronized with the live TV broadcasts, and what sorts of services will be provided for the viewers and users.



**True VR creates its VR content through the placement of multiple cameras so they surround the playing field. Delivery of multi-view video is also possible (photo supplied by Intel).**

### **2.3 The VR Spearhead in IT and Telecommunications at the 2020 Games**

Japan will also see the introduction of 5G networks in time for the Tokyo Olympics set for 2020. As with the PyeongChang Games, the Tokyo event is also highlighting 5G, ICT, and IoT.<sup>7)</sup> The NTT Group, an official sponsor of the Tokyo Games, is making the most of its technological capabilities and capital strength to pour energies into sports-related businesses.<sup>8)</sup> It is also working on VR delivery (360° video, multi-view, and free navigation video) using 5G, and is engaged in the development of immersive telepresence technology,<sup>9)</sup> the next stage in the evolution of live viewing in which the spatiotemporal reality of a distant location is reproduced in its entirety.

To date, broadcasters and manufacturers have taken the lead when it comes to developing new video technologies in conjunction with the Olympic Games. However, it has been ICT companies and telecommunications carriers rather than broadcast services that have been pushing forward on development as part of their Internet offerings when it comes to advanced video experiences like VR.

At the Rio Games, the OBS live delivered 360° VR video to the broadcasters, and they in turn sent the images to viewers over the Internet. However, the emergence of high-speed 5G mobile broadband with the possibilities it provides for delivering large volumes of data, low latency, and hyper connectivity will change this state of affairs. The era is on the horizon when the rich video content that has been delivered B-to-B to a broadcaster can be delivered B-to-C directly to the viewer without the mediation of a broadcaster. At first, this will be limited to playing fields and their immediate surroundings, locations set aside for public viewings, and the like, but eventually it will expand to include individuals and households. The presence of transmissions will be up to par with that of broadcasts for the Olympics and other sporting events, and the day might come when the levels might be reversed.

### 3. VR and Public Service Media



**A demo of synchronizing television with a smartphone.  
Taken from the ImmersiaTV website.**

#### 3.1 VR Initiatives Undertaken by Public Broadcasters in Other Countries

As we have seen, delivering interactive VR content in multi-view, free navigation, and high-quality 360° video formats to large numbers of people without latencies calls for investments and such technological innovations in the IT and telecommunications infrastructure such as with 5G and server technologies. On this point, public broadcasters elsewhere around the world are also engaged in a variety of efforts with respect to VR. In this section, I will touch on the latest developments in this area and give some thought to the significance of broadcasters—particularly public—engaging with VR.

To compile this, I referred to "Opportunities and Challenges for Public Service Media in VR, AR, and MR, " a report issued by the European Broadcasting Union (EBU) in April 2017.<sup>10)</sup> The report was based on a survey conducted in VR's inaugural year (2016) of public broadcasters in Europe, Japan, and Korea<sup>11)</sup> investigating what initiatives each was undertaking with respect to VR and other new modes of video expression over the Internet.

It focused first on ImmersiaTV, a project of Belgian public broadcaster VRT. ImmersiaTV has been positioned as part of the European Union's broader Horizon 2020 program and is being pursued with EU financing. The ImmersiaTV project's objective is to create new forms of digital storytelling and a new broadcast structure by (1) making 360° video the central feature of the reporting, production, and transmission of the materials being broadcast, and (2) taking advantage of the unique features of different types of displays—HMDs, "second screens," and conventional televisions—to allow the viewer to move freely about three different displays.

The first ImmersiaTV project was called Pilot 1. Just like with "Trump World," this demonstration saw the producers film a documentary about a young soccer player in its entirety with 360° cameras and then broadcast the program in sync with the 360° video. The plan for Pilot 2 is to film the live broadcast of a bicycle race and synchronize it with 360° and multi-view video.

This approach to development—moving from a documentary to a live sporting event—is the same as that taken by NHK. However, what's noteworthy about this effort is the fact that it is the project for public broadcasters spanning the whole of Europe, and the results of these demonstrations in terms of production know-how and so forth will be shared with broadcasters around the continent.

Meanwhile, KBS in Korea is looking into providing VR content as an add-on service for the next-generation ATSC3.0 broadcast standard used to launch the world's first terrestrial 4K broadcasts at the end of May 2017. With such multinational television manufacturers as Samsung and LG, Korea is expected to push forward in the U.S. marketplace. In 2016, the country abruptly switched from the European DVB 4K digital television broadcast standard to the American ATSC standard. The hallmarks of the ATSC3.0 standard are that it is highly compatible with IP communications, and can easily be extended to cover other broadcast services integrated with mobile devices and IP-connected hybrid devices. The implication here is that the PyeongChang Games will provide a testing ground for seeing what sorts of video services are possible through fusion of next-generation broadcasting and telecommunications (i.e., networks based on the next-generation 5G standard).

The EBU report also brings together opinions expressed by the various public broadcasters regarding the possibilities and issues that VR as a public service media raises. I will pull together some of these here.

- "VR has the potential to give us exciting and impactful new ways of delivering public service content, particularly given its apparent ability to convey emotion, empathy and drive memorability."
- "The audience is small at the moment which makes cost a critical factor. The BBC has found that the cost per hour for CG VR experiences is currently the same order of magnitude as high-end TV dramas."
- "Cannot generate additional revenues even with interactive services that use IP delivery (websites, mobile, and IPTV apps). "
- "We can be cautious about the claim that [VR] could fully replace television...Currently, it seems that viewers prefer to use an HMD for a maximum of about 20 minutes."

- "When it comes to live delivery of VR transmissions, news and sports—two genres where public service media has a role to play—are crucial. "

Three months after the report was issued, the BBC released a smartphone app for 360° VR use. The app allows the user to watch the BBC's VR content without having to rely on a specific VR device. The move can be described as a step toward providing VR delivery in earnest and popularizing it among the general public.

Europe is working toward bringing the delivery of television broadcasts over the Internet into common use. Korea is using the ATSC3.0 as its IP base and working its way toward coming up with integrated next-generation telecommunications services. Both are engaging proactively with VR delivery as a base for telecommunications. There are unknown quantities when it comes to such services in terms of the numbers of users, costs, and the technological issues involved. However, the world's public broadcasters are making VR delivery part of their missions when it comes to being public service media.

### **3.2 The Significance of Public Broadcasters Engaging with VR**

In July 2017, northern Kyushu experienced torrential rains. Immediately afterward, the NHK VR website carried an approximately two-minute long program titled, "Northern Kyushu Torrential Rain Damage, 360° On-site Report." The images captured were of driftwood covering the ground and homes and automobiles buried under landslides. It also showed residents attempting to clean up houses into which the earth and sand had flowed, and members of the Self-Defense Forces checking on people's safety.

I myself shifted around my own smartphone as I watched the video. The conditions on the ground were conveyed to me quite strongly, and it felt much more up close and personal to me than regular news video.

"The 360° report on the rains in northern Kyushu received 130,000 views in a short period and also got a lot of comments," says Yoshinori Adachi, Senior Manager of the NHK News Bureau, which administers the NHK VR website. "VR has possibilities in that it can make news to seem not like it is some stranger's affair but rather something 'personal.' I'd like to see us do more with live VR delivery in the future." From a disaster-prevention perspective, this technology is extremely important in that the viewer can get a sense of damage that has occurred far away as something "personal," and decide what can be done to be prepared for such events. Using VR thus can be said to have possibilities with respect the mission of a public broadcaster to protect lives and livelihoods from disaster.

Furthermore, once it becomes possible to deliver video from where some newsworthy development—not just disasters— has occurred in 360° and moreover live may lead differences in how people feel about and take in the news. They may notice things they didn't notice before when all they had was the edited videos. They may make new discoveries, and identify with the subjects captured on the other side of the screen. This might lead to some sort of action, and by extension provide the strength to move society in a good direction. Perhaps there is significance to public broadcasters engaging with VR from this journalism perspective as well.

Public broadcaster efforts to engage with VR like the "Trump World" broadcast have only just begun and many issues remain. What is it that public broadcasters should do when it comes to basic telecommunications services looking toward the 2020 Tokyo Olympics and Paralympics and beyond? VR will offer an important perspective in keeping with the aspirations to become a public service media. (Masaru Yamaguchi)



### NHK VR, Northern Kyushu Torrential Rain Damage, 360° On-site Report

#### Notes:

- (1) See <<http://www.nhk.or.jp/bs360/>>.
- (2) Virtual reality models include "multi-view," which uses 360° images created from computer graphics or video footage and permits the user to choose at will from among multiple perspectives (cameras), and "free navigation," which enables the user to adjust their point of view as though they have freely entered into the space depicted. Virtual realities can be delivered through many means including smartphones, tablet computers, head-mounted displays (HMDs), and personal computers, among others. The user views and experiences firsthand the depicted environment interactively.
- (3) See <<http://www.nhk.or.jp/vr/>>. The material carried at this website has been updated every few months since 2015.
- (4) Changeun Cho, Report to 3rd Lecture Meeting of the Association for Promotion of Advanced Broadcasting Services (A-PAB) (July 26, 2017); and *ibid.* (2017), "A 'More Connected' Future Visible from an IoT Advanced Country: Korea's Quest for an ICT Olympics through Use of 5G, IoT, and Advanced Technologies" , Huawei, no. 26 (July 1), pp. 22-23.
- (5) See <<https://newsroom.intel.com/press-kits/ioc-intel-worldwide-top-partnership/>>.
- (6) See Note 4)
- (7) For example, in its "Report on the Round-table Conference on Radio Policies 2020" (July 2016), the Ministry of Internal Affairs and Communications listed sports as the top field in which ample use is particularly expected to be made of such ICTs as 5G, IoT, AI, and big data.
- (8) For example, the February 2017 launch of a service partnering NTT DOCOMO with the U.K. Perform Group which offers the DAZN service for live-streaming sporting events.
- (9) NTT, "R&D Underway on 'Kirari!' Immersive Telepresence Technology!: Developing a Technology That Will Make It Possible to Transmit Indoor Sports with High Realism" [in Japanese], NTT Press Release, February 13, 2017.
- (10) "Opportunities and Challenges for Public Service Media in VR, AR, and MR," EBUTR039 SOURCE: BTF-VR Working Group, Geneva, April 2017, p. 24. Augmented reality (AR) entails superimposing created imagery over real world views. Mixed reality (MR) entails superimposing created imagery over real world views, and also making it possible to control that reality. For further details about AR, please see Masaru Yamaguchi, "The Future of Disaster Digital Archives to 'Pass Down and Utilize'", in The NHK Broadcasting Culture Research Institute, NHK Monthly Report on Broadcast Research, vol. 66, no. 7, pp. 88-107.
- (11) The six public broadcasters are BBC (United Kingdom), RAI (Italy), VRT (Belgium), ZDF (Germany), NHK (Japan), and KBS (Republic of Korea).