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The race is on to demonstrate some form of 5G at the 2018 and 2020 Olympics

**H**ow fast will 5G come out of the blocks? At both the 2018 Winter Olympics in South Korea and the 2020 Summer Olympics in Japan, mobile operators are planning to use 5G to provide innovative new services to spectators, viewers and the organisers. The next generation of mobile technologies could transform the experience of watching live events, but will it be ready to be thrust into the global spotlight as early as February 2018 at the PyeongChang games?



Given the timetable set out by standards body 3GPP, the answer is almost certainly “no”. 3GPP isn’t planning to produce the first incarnation of Release 15 (the first 5G specification) until June 2018. That means any “5G technologies” on show in PyeongChang will need to be pre-standard. Still, South Korea’s mobile industry is confident that the work it is doing developing 5G for the Olympics won’t be made redundant by the standardisation process. And it does seem that the determination in East Asia to showcase 5G at the 2018 and 2020 Olympics is accelerating the global development of the technology.

Byeong-Moo Lee, VP of Olympic Business at mobile operator KT, an official sponsor of the PyeongChang Olympics, says his company plans to install a network based on “common” 5G specifications using the 28GHz frequency band, developed in collaboration with equipment and device vendors for the “PyeongChang 5G Trial Service”. He says 5G will be deployed in the main Olympics venues, Olympic facilities, cities where people are staying and routes that visitors will take. KT anticipates that the 5G technology used in the PyeongChang Olympic Games will be compatible with the first phase of the 5G standard, which will be finalised by 3GPP in 2018, in terms of key technical features and requirements.

The availability of compatible devices will help determine the nature of the 5G services that KT will showcase at the Games in PyeongChang and those who will be able to access them. “We don’t yet know whether we will have sufficient devices,” acknowledges Byeong-Moo Lee. “We are working with all the major vendors to get as many as we can. Our priority is smartphones, but we do have some tablets and wearables in mind too.”

Wireless industry expert Michael Thelander, President of Signals Research Group, doesn’t expect to see 5G devices in the hands of spectators at the PyeongChang games, partly because the battery life will be very limited. “They will be able to showcase the use of higher frequencies, using a handheld device plugged into a long extension chord, loosely based on the 5G standard,” he predicts.

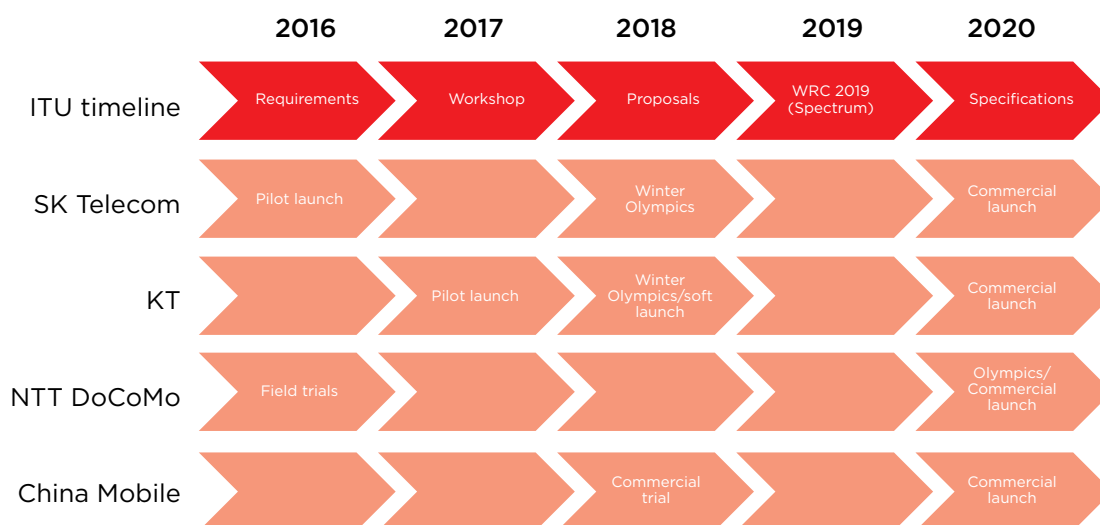
SK Telecom, another mobile operator in South Korea, is also looking to deploy 5G technologies by 2018. It has opened an integrated 5G innovation centre at its corporate R&D centre on the outskirts of Seoul. “Our target by the end of 2016 is to interconnect the key enabling technologies - mmWave 5G radio & device, LTE, 5G, and WiGig interworking, virtualized RAN, network slicing, distributed core network - together to form an end-to-end 5G pilot system in an outdoor environment,” says Park Jin-hyo, SVP and Head of the Network R&D Technology Center at SKT. “SK Telecom is targeting to perform an end-to-end 5G pilot system testing by end of 2016 with a FPGA-based/PC-sized 5G device. By the end of 2017, a chipset-based/tablet-sized 5G device will be available.”

Before the end of next year, SK Telecom is planning a “large scale pre-commercial 5G deployment” to enable it to make a detailed assessment of the overall 5G system. “The device is expected to be a lot smaller and more user-friendly and the coverage will be wide enough to support most 5G services being discussed today,” adds Park Jin-hyo.

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**Byeong-Moo Lee, VP - Olympic Business, KT**





5G development timelines for selected operators (Source: GSMA Intelligence)

Although the timing of the Winter Olympics means Korea's mobile industry is working to a very aggressive 5G timetable, its R&D efforts are at least partially integrated with those taking place elsewhere in the world. In fact, some of the Korean work on 5G is part financed by the European Union, through a collaboration with the Korean government on 5G technologies. The University of Oulu's research unit - The Centre for Wireless Communications - in Finland has been charged with developing the required 5G radio solutions and integrating them into a functioning mobile network, in time for the Winter Olympics. Other partners include operators, vendors and research institutes from Germany, France, Belgium and Korea. Ericsson is supporting KT's efforts to develop 5G.



## The generational shift

It is a big step from 4G to 5G, partly because of the use of new spectrum and partly because the latter involves the deployment of an entirely new radio interface, says Christopher Cave, Director, R&D, InterDigital. “Imagine you have gone from a two lane highway to a six to eight lane highway,” he says, referring to the potential increase in capacity and bandwidth. “4G could in theory get to 1Gb/s, but you would still have latency problems with LTE. There is a lot of talk around the Olympics, which puts a lot of pressure on operators and vendors to get things ready.”

The new 5G air interface, known as New Radio (NR) technology, is still under development. In May 2016, China-based equipment vendor Huawei announced it had completed the first phase of testing of several component technologies for this new air interface. Huawei found filtered Orthogonal Frequency Division Multiplexing (F-OFDM) can provide 100 per cent higher system throughput compared with LTE, while Sparse Code Multiple Access (SCMA) will support “massive connections and obtain higher system throughput simultaneously.” The test results showed SCMA can increase the uplink connection number by 300 per cent and at the same time increase the downlink system throughput up to 80 per cent, Huawei added.

At the Mobile World Congress Shanghai at the end of June 2016, leading chip vendor Qualcomm demonstrated prototype 5G systems running in sub 6GHz spectrum and in 28GHz spectrum. In a blog post, Matt Branda, Director of technical marketing, wrote: “The prototype system is ...a trial platform that will track 3GPP standardisation progress closely to enable timely 5G NR trials with leading mobile network operators, infrastructure vendors, and other industry players. This will also help drive timely commercial network launches in 2019 and 2020.” Qualcomm says the prototype 28GHz system, which employs advanced antenna techniques (smart beamforming and tracking) to address non-line-of-sight scenarios and improve range, is already being utilised in field testing today.

Taking place more than two years after the PyeongChang Games, the 2020 Summer Olympics in Japan will almost certainly showcase 5G systems compatible with the 3GPP standards. “We will develop a commercial system based on

Release 15,” says Seizo Onoe, CTO of NTT Docomo in Japan. “I can’t say whether it will be large scale or limited coverage [...] we will have devices available, but the challenge is to have sufficient volumes. We are preparing in collaboration with the vendors.” As well as enabling its customers to buy 5G devices, Docomo plans to offer international visitors to the Tokyo Olympics the opportunity to rent a 5G handset.

Michael Thelander of Signals Research Group anticipates only a small proportion of the Japanese population will have true 5G handsets by the time of the Tokyo Olympics. “We will be right at the very early stages,” he says. “There may be something commercial out there, but Apple is not going to have a 5G handset by 2020...they tend to be laggards when it comes to implementing tech standards.”

In the final quarter of 2015, Docomo carried out a variety of 5G trials with five equipment vendors. For example, Docomo and Ericsson verified the feasibility of massive multiple-input multiple-output (MIMO) technology by achieving a real-time data-receiving speed of more than 10Gb/s using the vendor’s 5G radio prototypes with a 15GHz frequency band. In a separate trial conducted with Samsung in Suwon-city, South Korea, on 12 November, Docomo and Ericsson attained a maximum data-receiving speed of more than 2.5Gb/s in a vehicle travelling at a speed of 60km/h. The trial used a 28GHz high-frequency signal in combination with beamforming, which focuses radio waves in a specific direction, with a high number of antenna elements and beam tracking.

In October, Docomo and Nokia Networks achieved a data rate of more than 2Gb/s using high-frequency spectrum in a trial in the Roppongi Hills high-rise complex in Tokyo using millimeter-wavelength signals in the 70GHz band. The trial used beamforming and beam tracking to control beam direction according to the mobile device’s location. At the 5G World event in London in June 2016, Nokia claimed the “first ever” demonstration of a 5G network running on commercial platforms.



## What services will 5G enable for the Olympics?

Once it becomes commercially available, 5G, supported by advanced 4G and cellular broadcast technologies, could transform the experience of watching live sports. For example, a very fast, low latency mobile connection could enable a spectator to watch an event from different vantage points, switching at will between a camera mounted on a player's helmet to a birds-eye view to a conventional side-on viewpoint. 5G may even allow operators to transmit enough data to enable consumers to watch 3D holograms or 360-degree renditions of the sports action. Equipped with a virtual reality headset, a viewer could simply move their head around to watch different aspects of the event.

At the 5G World event in London, Young Sik Kim, KT's head of network technology, envisioned deploying a 5G-linked drone equipped with a video camera at the PyeongChang Games. During a technical trial last September, images were sent back from the top of a ski jump tower, and on the subsequent route down to ground level.

"We have a variety of services in mind, such as holograms and 360 degree virtual reality," adds Byeong-Moo Lee of KT. "We are planning to show new viewpoints only 5G can provide [...] We have lots of possibilities open for us now." Faster networks will also mean sharper pictures. "We plan to deliver super rich content, such as 4K video, 8K video and virtual reality experiences," adds Seizo Onoe, CTO of NTT Docomo in Japan. "We want to showcase the very low latency of 5G."

Assuming 5G delivers a dramatic increase in cell capacity, it could also enable spectators to choose which athlete they want to follow in events that are spread over a wide area, such as road cycling and sailing. "You could put a connected HD webcam on every bike or on every boat," notes Dan Warren, Director of group architecture at Capita and former Director of technology for the GSMA.

Moreover, augmented reality applications could enable spectators in the venue to point their smartphone at an athlete and see a short bio and statistics superimposed on the display. Depending on the terms of the broadcasting rights, spectators may also be able to use their smartphones to live stream short clips of an event to their friends in another location. "Both 4G and 5G can be used to enable live streaming, but this is really an end-to-end question," says Jawad Manssour, Head of 5G RAN for Ericsson in South Korea. "How much content sharing will be allowed? How much ICT will the Olympic Committee want to use and could that impact the outcome of the event?"

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## Smarter and smoother venues

New mobile technologies also promise to make it easier for the Games venues to accommodate large numbers of people and ensure they are comfortable. Christopher Cave of InterDigital notes how Internet of Things solutions could help to make it easier for spectators to access the stadium, find seats, and pay for food and drink. For example, each seat in a venue could have a connected sensor in it, enabling it to signal when it is occupied or available. “You could manage the stadium as a smart building,” adds Dan Warren of Capita. “There is already a fully automated building in Amsterdam, which knows who you are from your phone, how many people are in the building and how much energy to use and how many printer cartridges to order.”

Mobile service providers could also use connected sensors throughout the host cities to give visitors to the games personalised real-time information about the best transport options to reach a specific venue in time for a specific event.

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**Christopher Cave, Director - R&D, InterDigital**

## Not just 5G – the supporting cast

As well as showcasing new 5G technologies, the upcoming Olympics is also likely to be supported by commercial 4G services providing downlink speeds of about 1Gb/s, enabled by the ongoing advances in LTE technology, says Jawad Manssour of Ericsson. “There are lots of use cases that we will be able to run on a stable and commercial network,” he notes. “A lot can be done on a LTE network with carrier aggregation and 4X4 MIMO and we recently announced Ericsson 5G Plug-Ins that support advanced MIMO and latency reduction technologies.”

LTE may even be able to deliver live VR – a very demanding application – with the help of appropriate compression and link technologies. However, Manssour acknowledges that 5G could offer a significantly better combination of latency and reliability, when “intelligent connectivity” is enabled between 5G and LTE.

Both the 4G and 5G networks used at the Olympics could be enhanced and supported by other new technologies, such as Network Function Virtualisation (NFV) and Software Defined Networking (SDN), which help mobile operators to allocate network resources more efficiently and effectively. Dan Warren at Capita notes that Wi-Fi, which continues to improve, and evolved Multimedia Broadcast Multicast Service (eMBMS), which enables the same content to be sent to a large number of subscribers at the same time, could also be used to enhance the Olympics experience. At the same time, local caching and edge computing could help to ensure the popular content is delivered quickly to spectators.

## Why the urgency?

As a television audience of more than 3.5 billion people typically watch each edition of the Olympics, the Games provide a golden marketing opportunity for individual companies and the host countries. But the 2018 Games will be the first time a new mobile technology has enjoyed this kind of coming out party. “It is surprising how important the Olympics have been in driving the timeline for 5G,” says Christopher Cave of InterDigital. “I can’t remember any other technologies being showcased on this stage in this way. The games are a great tool to demonstrate the technology to a smaller number of users, such as journalists and bloggers, who will benefit from lots of capacity with a limited number of 5G users.”

In particular, the 2018 Winter Olympics in Pyeongchang, the 2020 Summer Olympics in Tokyo and the 2022 Winter Olympics in Beijing will throw a spotlight on East Asia’s impressive high-tech capabilities. South Korea, Japan and China are driving the development of mobile 5G, in a similar way that Europe pioneered 3G and North America led 4G, says Calum Dewar, Director of forecasting at GSMA Intelligence. East Asia’s leadership in mobile 5G reflects the appetite of the region’s consumers for high-speed

connectivity. “South Korea has the highest rate of LTE adoption of any country with almost three-quarters of connections using the technology as of March, and we expect this to move past 90 per cent by 2020,” he notes. “This level of 4G maturity means that operators in the country see the early launch of 5G as necessary for future revenue growth [...] As with 4G, given the country’s relatively small geography, the rate of 5G adoption will likely be faster than anywhere else.”

“Presenting 5G service for the first time in the world throughout PyeongChang 2018 will be a triggering point for Korea to lead the 5G industry, which aligns with KT’s goal,” says Byeong-Moo Lee of KT. “As the Olympics is a world event, being the official telecom partner will be our starting point for 5G.”

Docomo, which is aiming to maintain technological leadership over its rivals, intends to use the Tokyo Olympics as a springboard for a broader deployment of 5G across Japan. “5G will not be just a hotspot system,” says Seizo Onoe. “The network service capabilities will be enhanced further. I have asked my team to create a wide coverage system, even with high frequency bands. In time, 5G will be expanded into the rural areas and into developing countries.”





## Commentators:

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## About InterDigital

InterDigital, Inc. designs and develops advanced technologies that enable and enhance mobile communications and capabilities. Since our founding in 1972, our engineers have designed and developed a wide range of innovations that are used in digital cellular and wireless products and networks, including 2G, 3G, 4G and IEEE 802-related products and networks.

For over four decades, InterDigital has been a pioneer in mobile technology and a key contributor to global wireless standards. Our team of more than 170 engineers – approximately 80 percent of whom hold advanced degrees, including over 50 PhDs – has unparalleled expertise in major mobile connectivity and content delivery technologies. Since 2000, InterDigital has spent close to \$1 billion on technology research and development.

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