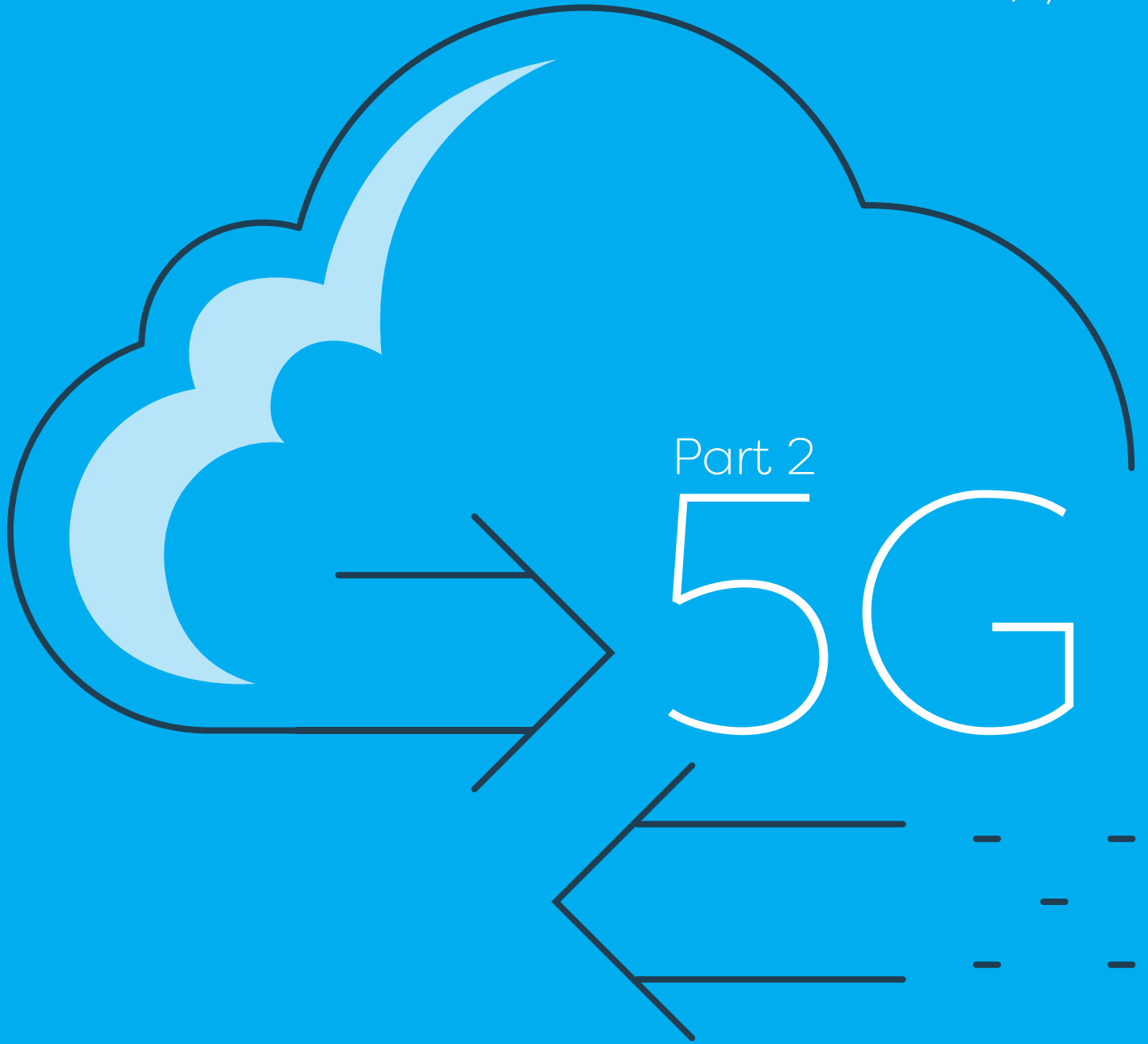


DIGITAL



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Part 2

5G

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5G set for slow-burn uptake

Operators are approaching early 5G rollouts to deliver efficiency savings and enhanced broadband with the more exotic consumer apps lined up for phase two. Adrian Pennington reports.



There is no immediate 'killer application' for 5G. Its early consumer commercialisation should be seen as a way of evolving and expanding the established business of service providers. The prosaic objectives, at 5G's birth at least, are a successful coexistence with existing network infrastructure and applying the lessons hard learnt over the previous decade.

"The early days are primarily to support some areas where there's always been a limit to what 4G can do, in stadiums and train stations, for example," says Matt Stagg, director of mobile strategy, BT Sport. BT-owned EE has launched 5G in six UK cities with ten to follow by end of the year. "5G will enable a much better experience in those high footfall areas."

Orange teamed up with France Télévisions to demonstrate 5G video at the French Open.

First-off-the-block launches by the likes of EE in the UK and Vodafone in the UK and Spain are using a 'non-standalone' deployment focused on using the combined power of 4G and 5G to boost mobile broadband (enhanced MBB)

Stagg adds: “We’re addressing urban centres where there’s a high population concentration. You have to be aware that [EE] is still heavily investing in 4G networks, so it’s about being able to provide the best experience for our customers.”

Many of Vodafone’s rivals, such as Movistar, Orange and MásMóvil in Spain, will not launch commercial 5G services until at least 2021. Telefónica is also taking a pragmatic approach.

“They are keen to wait until the technology progresses and to learn from launches in other markets before jumping straight in,” says Kester Mann, director, consumer and connectivity, CCS Insight. “There is consumer benefit in faster, more reliable broadband but 5G will be around for many years and the marketing kudos from launching early is only worth so much. Most operators see far larger revenue opportunities for 5G in the enterprise. The consumer use case is more opaque.”

Orange, for example, has run trials in several countries but is waiting for devices to be ready and available in more brands before commercialisation in 2020. “In some markets we’re waiting for regulators to release spectrum,” says Jean-Pierre Casara, 5G innovation expert at the company. “We expect the smartphone experience will be better but not a huge jump. 4G is good for many, many use cases. What is interesting is to go beyond that with partners and unlock innovation yet to be imagined.”

Operators are also wary of repeating the mistakes that blighted previous generational uplifts. Vodafone CEO Nick Read admitted that MNOs had only themselves to blame.

“As an industry we don’t collaborate well enough and in terms of customer need we are not fast enough,” he told MWC in February. “We were protectionist around text messaging revenues and let OTT players move take over the rich messaging space.”

Beware the dumb pipe

In 2008, 3G smartphones were hitting their stride and revenue for operators in Western Europe was at its peak. At the same time, mobile broadband was developing, and a significant amount of service revenue was lost.

“Over that period, cell operators in Western Europe collectively lost over a quarter of

their service revenues while traffic over the networks grew 50-80% a year,” says Stephen Carson, director of business strategies at Ericsson. “The massive increase in traffic was not matched by revenue growth. The only way to keep pace with demand and not go backwards financially is to serve that traffic more and more efficiently. 5G is a big step in that direction.”

5G eMBB will deliver a significant reduction in cost per bit compared with 4G MBB, and this will continue to reduce (thanks to increased spectral efficiency, higher network utilisation, greater user numbers and higher average speeds). Access to new and wider spectrum also delivers efficiencies.

“The challenge for operators, particularly in Europe, is to have some sort of value proposition and some service that they are in control of rather have it taken OTT,” says Carson.

“The telco reality is that they have to provide ever increasing bandwidth capacity while not ending up a dumb pipe,” agrees Kaltura’s SVP Product Marketing, Gideon Gilboa. “This is a difficult balance to manage. They are looking for ways to ensure the total cost of ownership makes sense by making reasonable commercial propositions balanced with big investments in the network.”

picture is that video will rise in volume and in quality and open up immersive experiences – but we’re at a very early stage yet.”

Raising ARPU

“Not matter how much bandwidth there is or how much the cost per bit comes down, spectrum is still finite,” Stagg says. “If you have payment models where a consumer pays for all their data then streaming 4K quickly becomes expensive. Where the operator such as EE offers all-you-can-eat video passes where a lot of content is zero rated, then the operator pays for bandwidth.”

Early reports suggesting that 5G services would be priced significantly higher than 4G appear to have been overplayed. According to Futuresource Consulting, many operators offering 5G for either the same price or only a small increase over 4G.

“Given the limited coverage of 5G, handsets are likely to be on the existing 4G network for the majority of the time currently, so [exhausting data caps] may not be a major concern in early adopters,” says analyst Simon Forrest.

“Primarily, the question is whether operators could raise ARPU by delivering

“The potential is huge. The ability to enhance sport by, for example, overlaying stats of players taking a penalty – live, is phenomenal.”

Matt Stagg, EE



video is the king of content demand and it will be long into the future. NSR predicts that by 2022, 82% of all IP traffic will be video.

Video is also a prime mover for 5G with upwardly revised predictions by Ericsson that 5G coverage will reach 45% of the world’s population by end of 2024. This could surge to 65%, as spectrum sharing technology enables 5G deployments on LTE frequency bands. Where 60% of data traffic is video today, it believes that close to three quarters will be video in six years’ time.

“In some territories operators are trying to get around unlimited tariff structures,” notes Carson. “You can have all-you-can-eat data plans so long as the video is 480p. The bigger

video over 5G. But since video is regarded as part of the mobile data service, consumers are initially unlikely to consider delivery over 5G as a major differentiator. This would challenge operators wishing to improve the monetisation of such services. However, there are advantages to being able to receive uninterrupted live broadcast streams, especially sports and live events, which present revenue-generating opportunities if packaged appropriately.”

Partly to keep costs down, BT Sport argues against 4K over mobile since no-one can see the extra pixels, even on a UHD smartphone.

“We believe the optimum format for the small screen is HD HFR [high frame-rate]

5G video: the journey begins



5G rollouts are underway, but it is still not clear which applications will drive consumer take-up. Video is likely to play a major part, but operators need space to experiment, as Thierry Fautier, VP of video strategy at Harmonic, explains.

5G is coming. Operators are now launching services in key cities and plans are afoot to expand coverage dramatically over the next few years. But questions over how much demand there is for the great leap forward 5G will bring in terms of bandwidth, and how much consumers will be willing to pay for the ultra-fast connectivity that the technology promises, remain unanswered.

Step forward video. Streaming video is one application that seems, on the face of it, to be made for 5G – costs notwithstanding – thanks to the technology’s ability to deliver a massive increase in bandwidth and extreme low-latency.

The leap forward in bandwidth that 5G will bring holds great promise for video. Currently, with 4G networks, many consumers have become accustomed to service providers’ practice of zero-rating, which enables them to watch unlimited amounts of video content from their provider without eating into their data allowance. However, high levels of demand for live video sessions means that the quality is often compromised, with streams defaulting to a very low-resolution to avoid buffering and freezing.

“The problem is that when you look at video on a phone that is capable of supporting 4K, the quality can be limited, especially for something like live soccer, where you often can’t even see the ball,” says Thierry Fautier, VP of video strategy at Harmonic. “This is where we think 5G can play a role.”

According to Fautier, 5G can provide sufficient bandwidth to support 4K HD quality video, “but we believe as most of the phones are 1080p capable, we will start with HD first. HD 1080p, even zero rated, is already a big leap versus what we experience today on 4G.”

Delivering 100Mbps simultaneously to millions of subscribers, combined with the low latency possible with 5G, could have a transformative impact on video distribution – especially for live streaming. Sports in 4K is today encoded with HEVC at about 25Mbps for reference.

One application that has been widely discussed is live-streaming of sports content from inside a stadium, enabling spectators to see more of the action than is possible from a corner seat behind a pillar, and instant replays of goals and other key moments for everyone else at the ground.

Delivering video to thousands of spectators gathered in a single space has proved challenging until now. Fautier says that eMBMS, or Evolved Multimedia Broadcast Multicast Services, which was part of the 4G standard, proved disappointing, in part because it required

an expensive base station upgrade as well as specific mobile device functionality.

However, in the case of 5G, the 3GPP release 14 eMBMS will be supported by the network and devices from the start, and the network will be able to deliver the bandwidth to support the service.

The challenge of delivering content to a large number of people gathered in a small area such as a stadium remains considerable. Various solutions are under consideration. One is to restrict replay to the stadium from a local MEC (Mobile Edge Computing) server, which could be more achievable than uploading content to the cloud and making it available from there.

“You can capture a live event and transmit it via eMBMS to people in a stadium. Then you can capture a file for time-shift viewing and let people replay a clip of a few seconds, which can be streamed out of a

local MEC server in the stadium in unicast over 5G,” says Fautier. MEC is another innovation that 5G brings.

Harmonic recently tested in-stadium delivery of sports content with France Télévisions.

The trial, which was centred on the

delivery of 8K coverage of the French tennis open using a 5G network at 250Mbps, employed unicast delivery only. While France Télévisions and Harmonic used reception via a PC as decoder for the purposes of the trial, the intention was to demonstrate the potential for the delivery of 8K unicast streams to two Sharp 8K smart TVs. IP streams were uplinked to base stations serving showrooms belonging to France Télévisions and network partner Orange respectively. Harmonic also tested the playback of file-based assets to phones over 5G in the Orange showroom.

Multicast distribution could have a much wider application than in-stadium delivery of content in the future of course. Much attention has focused on mobile delivery and in-stadium applications, but eMBMS, as defined in Release 14 of the 3GPP standard, could theoretically hold the potential to ultimately serve as a complement technology for digital-terrestrial broadcast.

While broadcasters have been highly protective of their terrestrial distribution networks, they know that in the long terms more people will want to view content on mobile devices – something that could also generate pressure over the future use of spectrum for broadcasting. This is an approach developed by the EBU in Europe, while in the US, some broadcasters plan to use ATSC 3.0 to transmit to mobile devices.

“In principle, a multicast stream can be transported direct to the mobile device, replacing terrestrial distribution. The technology would be built into your phone and you wouldn’t need a SIM card,” says Fautier.

“People want to have a more immersive experience with sports and an interactive and immersive personalised video would be a good way to promote 5G to consumers on their mobile devices.”

“Broadcasters want to be able to offer their content to everyone.”

With a 5G phone, consumers should be able just to download an app and start watching their favourite free TV channel in high quality up to UHD, without any scalability issues. Fautier says that there is a strong level of interest in the technology in countries including Germany.

“There will be trials, this year and next – there is a strong level of interest, including from the EBU,” he says.

Other applications that could drive interest in 5G video in the nearer term include virtual reality and what Fautier describes as immersive personalised 8K streaming services.

First 8K is the only technology that can capture the entire field (whether in tennis, soccer or baseball). “We think there could be interest in this because it is already being done in the broadcast production domain. For sports content, you capture 8K content and via a tiling mechanism, you consume content on your legacy device on a moving window that follows the action and only transmit to the resolution of the device what you watch,” says Fautier.

Harmonic and partner Tiledmedia worked on trialling this during the French Open tennis tournament. 8K coverage was encoded into an HEVC mezzanine file by Harmonic and sent to the cloud where Tiledmedia’s ClearVR streaming technology created a ‘tiled representation’ of the clips that was accessed via a Samsung mobile phone. The technology enabled users to choose between a ‘zoomed out’ view of the action or zoom into get a closer view without any visible loss of detail. Harmonic and Tiledmedia also recently showcased this ‘personal 8K streaming’ application with Hong Kong telco PCCW at the HKT 5G Tech Carnival.

“People want to have a more immersive experience with sports and an interactive and immersive personalised video would be a good way to promote 5G to consumers on their mobile devices,” says Fautier.

Cloud technology

Despite the successful conclusion of trials, Fautier is keen to emphasise that work on 5G video is still at a relatively early stage. The positive impact of the technology will take some time to be felt as operators

build out their networks and experiment with applications that consumers are likely to be attracted to.

For the general public, for example, live mobile broadcast TV, which is attendant on seamless 5G coverage, may have less appeal in the near term compared with easily accessible file-based video-on-demand. Virtual reality is one potential application that could take advantage of 5G, but up until now the appeal of VR has remained limited, except for gaming. Quality of Experience at scale for zero rated services, in-stadium delivery combining live streams with file-based replay clips and personalised streaming 8K video are all potential applications that could capture the public’s imagination and give them a real sense that 5G is delivering something new, but no-one really knows for sure what will be the killer video app of 5G in the video space. Nevertheless, it is clear that mobile operators need to come up with compelling applications to sell 5G to the public.

“All this has to be tested. We have to be careful not to recommend one size that fits all. You have to try things before you know what works, and that is why operators are in test mode,” says Fautier.

For Fautier, it therefore makes sense for broadcasters and service providers to experiment, and they can do this at relatively little risk by tapping the potential of cloud technology.

“You can do all the processing and origination in the cloud and you can use a CDN or a mobile edge network – MEC node – to distribute the content,” he says. “Harmonic can provide an end-to-end solution, with partners, with most of the heavy lifting done in the cloud. What people are asking for is a solution that will enable them to test things on a small scale and a solution that will enable them to deploy on a large scale.”

Ultimately, he says, superior bandwidth, married to the ability to deliver more sessions at scale, means that moving from 4G to 5G will be a bigger step change in the mobile experience than the switch from 3G to 4G. In the meantime, service providers need an opportunity to try different things out and see what works.

5G rollouts are in clear sight, but the applications that will drive take up are only just beginning to come into view.



Harmonic recently tested in-stadium delivery of sports content with France Télévisions at the French Open tennis tournament.

and HDR,” says Stagg. “We don’t advocate 4K other than for casting to larger screens in the house over WiFi. This is the strategy for BT Sport and it should be for every operator.”

5G also opens an opportunity to drive fixed line subscriptions to the home by connecting a 5G router to the set-top box or smart TV in the living room and delivering enhanced TV over the last mile.

“We ran some field trials in Romania last year for last mile delivery of high-speed broadband in the mmWave spectrum which worked very well,” says Casara. “It’s probably more a use case in eastern Europe where cable and FTTH are still limited outside of the main cities.”

Cable providers too can put 5G cells into street cabinets and cover the last 500 yards where replacing coax with fibre or enhancing it with DOCSIS 3 is a less viable option.

Stagg urges the industry to be agnostic to the underlying technology and provide “the optimum experience at commercially viable cost. If it’s going to cost a million pounds to dig up a road and we can use a wireless tech that delivers better capacity to the home then this is a good use case. We’ve done a lot of testing on wireless routers. We need to decouple the underlying tech and use whatever makes most economic sense and provides the best experience.”

Tipping point

Arguably it will be the introduction of the full next generation 5G core network, enhanced device chipset capabilities, and increased availability of 5G-ready spectrum which will kick-start more exotic consumer applications.

EE has scheduled this phase 2 rollout from 2022 and promises “truly immersive mobile augmented reality, real-time health monitoring, and mobile cloud gaming.” It is also a vital step to the convergence of fixed, mobile and WiFi “into one seamless customer experience.”

A report by Ovum, commissioned by Intel, suggests 2025 will be the ‘tipping point’ for 5G in entertainment and media. By then, 57% of wireless revenue globally will be driven by the capabilities of 5G networks and devices, rising to 80% by 2028 by which time M&E experiences enabled by 5G will generate up to US\$1.3 trillion or almost half of the projected US\$3 trillion in wireless revenues overall.

Augmented reality is top of the list. BT Sport has AR sports related experiences for both at home and in stadia in the works.

“The potential is huge,” Stagg confirms. “The ability to enhance sport is phenomenal by, for example, overlaying stats of players taking a penalty – live.”

Early AR experiences are imagined via smartphone but BT Sport is casting future interaction toward some form of lightweight glasses.

Telcos are also trialling virtual reality harnessed with 8K capture live streamed over the network. Orange’s partnership with France Télévisions took this to the next stage at Roland-Garros with a demo mostly to devices spread over the stadium.

“We wanted to push the envelope on bandwidth and see how live 8K encoding would cope,” says Casara. “We concluded that 8K is a good format to start with for VR using tiling technology to encode and send just the

parts of the image the viewer is looking at.”

Audible AR could evolve in tandem with 5G ‘hearable’ devices that overlay spoken information from an AI-enabled voice assistant to augment the real-world environment in real-time.

“With 5G connectivity and location-based awareness via an on-board GPS, spoken direction will become an essential skill for hearable products, capable of directing users through spoken step-by-step instructions,” says Forrest. “Advertisers will be quick to harness the opportunity to speak to wearers, conveying precisely timed and relevant information based upon geolocation.”

Given that 5G requires densification of the network infrastructure, it becomes possible to more accurately identify the locations of consumers via cell tower connection.

“This may lead to advanced advertising and improved targeting, perhaps delivering information and advertising based upon

5G as a DTT replacement? Not yet

5G will play a role in eventually replacing digital-terrestrial broadcasting although this is expected to be neither short term, a top priority or universal.

“The requirement is free-to-view, not free-to-air,” says Matt Stagg, director of mobile strategy, BT Sport, who notes the resilient popularity of the linear broadcast schedule. “But as viewing shifts OTT and broadcasters looks to move more things to IP we’re going to reach a point where, with fewer viewers on terrestrial, DTT becomes cost prohibitive. If your percentage of viewers goes down yet your costs of maintaining the broadcast network remain, at the same time as CDN costs rise, then inevitably things will change.”

Operators and broadcasters are collaborating on projects to investigate the overall benefits and efficiencies of 5G broadcast or Enhanced TV (enTV). Examples are 5G-Xcast (a Horizon 2020 and 5G-PPP project); Finland’s 5GTN+ programme; and 5G Today, ongoing in Bavaria, operating trial broadcasts over 5G using the 700MHz spectrum. “One of the objectives is to identify the best solutions to exploit the enhanced capabilities of 5G, notably using the new radio interface [5G-NR] for broadcast TV and digital radio services,” explains analyst Simon Forrest

of Futuresource Consulting. “Television over 5G is especially interesting for Europe, as there is an immediate deployment potential using the 700MHz spectrum band previously occupied by terrestrial services.”

The 3GPP Release 14 specs already meet all EU digital TV broadcast requirements; technical studies conclude this is approximately twice as efficient as DVB-T which would open up spare capacity in the spectrum for alternative use cases. “In this instance, the remaining DTT frequencies (470MHz to 694MHz) could be reallocated to 5G, with TV broadcasts migrating from DVB to 5G broadcast technology,” says the analyst. “This consumes less bandwidth, leaving the remaining spectrum free for mobile use.”

Gideon Gilboa, SVP, product marketing, Kaltura notes moves among DTH providers to switch services from satellite to IP. Among them, Sky’s launch of Sky Q over IP in Austria and Italy and a DirecTV DTV package with an IP only connection. “5G is an enabler for more video to IP and in that sense, we see the trend to IP continuing and maybe even accelerating the transition,” he says.

Even in the case of 5G and its capacity, unicasting to the entire nation is still too costly for live events especially at high bitrate 4K/8K.



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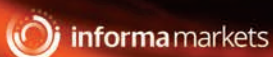
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ZTE and China Telecom demonstrate a 5G 8K and VR ultra-wide bandwidth experience

over mmWave frequencies that won't easily penetrate walls, so indoor coverage will be close to non-existent."

The 5G network will be meshed with the Internet of Things, allowing operators to rollout new consumer services hooked into smart cities. Apps for parking, waste disposal, real-time traffic management and the leisure/tourism industry can all be introduced as part of a wider city-wide data grids.

For EE, this falls into Phase 3 of its 5G rollout, from 2023, when "ultra-reliable" low latency communications, network slicing and multi-gigabit-per-second speeds are introduced. This phase will enable the "tactile internet" it predicts, where a sense of touch can be added to remote real-time interactions.

"Everybody is talking about new immersive AR/VR forms all the way out to volumetric 3D holograms but in order to have such experiences you need six degrees of freedom to look all around you and see superimposed data on reality," says Carson. "You need extreme low latency and a shift of heavy compute processing to the edge to feed all the calculations for rendering. You might also need new forms of compression."

5G may not even be good enough in the next decade to cope with the plans telcos have scoped out for it.

"The increasing number of new applications such as VR/AR, autonomous driving, IoT, and wireless backhaul as well as newer applications that have not been conceived yet, will need even greater data rates and less latency than what 5G networks will offer," states NYU Professor Ted Rappaport, in a paper published by the IEEE.

US government agency the FCC recently voted to grant licences for research into submillimetre wavelengths in the terahertz frequency range to unearth 6G bandwidth capacities.

If the risks of working in potentially radioactive frequencies are overcome, then 6G – and ultimately 7G and beyond – promises such high capacity and instant data transmission that – it has been speculated – it could deliver artificial intelligence to wireless devices operating at the speed of the human brain. ●

time of day and location to generate uplift in engagement," says Forrest.

In parallel, this should open up more flexible pricing models to target the generation of consumers who don't want lengthy fixed-term contracts.

"This generation is used to bite-sized video and Netflix-style subscriptions and want the same from their connectivity provider," says Adam Davies, product manager, Synamedia. "We've been talking about being able to build those flexible consumer models for years and with 5G, service providers have the network to make localised, personalised and flexible video packages happen."

Next-gen entertainment

Intel predicts that AR and VR will deliver cumulative revenues of US\$140 billion between 2021 and 2028.

Immersive and new media applications which don't even exist today are estimated to generate US\$67 billion a year by 2028 – equivalent to the value of the entire global media market in 2017, including games, music and films.

Perhaps the most significant new consumer application twinned with 5G is cloud gaming. Some see it as more of a game-changer than video since real-time multiplayer gaming isn't possible, certainly over mobile, without it. One of the first games to tap into this is *Harry Potter: Wizards Unite* from Niantic which claims to render AR in tens of milliseconds.

Synched with this is the need for edge computing in which logic is moved out of the device into the cloud. If you can process more encodes and transcodes there you can create thinner client apps, effectively streaming from the edge with less rendering on the device.

However, Forrest suggests that the industry is confused over what could be done with a 10Gbps low-latency WiFi network versus what should be done with a 10Gbps low-latency 5G mobile network.

"The parallel development of WiFi 6 – 802.11ax – promises to closely match the performance of 5G for local/indoor communications," he says. "This provides an alternative choice for networking of VR, AR and other applications, especially given that high-bandwidth 5G services are carried