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The World of 4K

4K is becoming the resolution of premium content around the world, but its future is so much greater – redefinition of the video experience itself, from passive viewing to active involvement, where video is both an experience for fun and a tool for work. How can it achieve this? Read on.

By Jason Patterson

Skepticism of 4K's utility has been rampant since the first TV models started arriving, with consumer tech hub CNET warranting special citation for articles such as 2012's "Why 4K TVs are stupid," and 2013's "Why Ultra HD 4K TVs are still stupid." But despite the naysayers, 4K uptake is actually proceeding faster than was seen with HD. Nine years separated Blu-ray's arrival from DVD, with the first Ultra-HD download service arriving a mere seven years after that. Why the rush? Oh, lots of reasons. A content glut. The decline of

physical media. Eroding margins for TV vendors. Smoother content production (use of 4K image capture equipment actually makes production of standard HD content much easier). Greater awareness of the need for futureproofing. With this many reasons, reasons cease to matter; 4K, and later 8K (human retinal resolution at normal TV viewing distances) are the future of screens.

What is 4K?

4K (Ultra-HD) television is 3840 x 2160 resolution (about 8.2 million

pixels). That's four times the Full HD (1080p) standard that your living room TV or smartphone probably uses today, and about 27 times the number of pixels you had on your CRT screen growing up. That's a lot of pixels, but in the words of Olivier Bovis of Sony Professional Services, "4K is not a resolution quest. It's about how, in a world dominated by content, which you can get anywhere nowadays, how do you make the content more valuable for the people who create the content and for the audience? So, you can get high-definition on a mobile phone these days. So, how do you get



the experience and the ‘wow’ factor when somebody goes back home and switches on their 55- or 65-inch TV.”

How does it wow?

More detail

More pixels means more details, naturally, especially with busy, motion-filled images. A display’s resolution actually decreases when displaying fast moving objects, with losses of 30 to 60% not unheard of. This is one of the reasons why demo models tend to display still

or slow moving images of landscapes, flowers, and the like, as opposed to feature films or sports. If half the resolution is lost from an HD image, the resolution could drop down to DVD-range or lower. But if half the resolution is lost from a 4K image, you are still at double what a 1080p screen could put out today – a big improvement.

The improved color palette (number of colors shadings that can be displayed) expected with 4K will also boost visual detail and image realism. If an apple is entirely a single shade of red, it will look like a plastic toy. But if you add color shadings,

the apple will start looking less like plastic and more like fruit. And the more color variety you add (the broader the palette), the more realistic the apple becomes.

Greater impact

4K is also expected to feature an expanded color space (richer colors) and high-dynamic-range (HDR) technology (brighter whites, deeper blacks). Why are these good? Well, displays that perform poorly in either of these areas tend to look dull, washed-out, or faded. It’s rather like comparing a smartphone photo with that of a dedicated SLR.

1 Framing the debate

4K standards will probably double current image frame rates, to a max of 120fps. Higher rates mean greater image clarity and smoother motion, but these benefits haven't always sold themselves. When *The Hobbit: An Unexpected Journey* was released in 48fps (double the 24fps that theater viewers are accustomed to) in select theaters, it was meant to enhance 3D image clarity, which by all accounts it did, but in a way that many found subjectively unpleasant, so much so in fact that the higher rate was cancelled for the sequels. Complaints were that the image seemed unnatural, hyper-real, or otherwise wrong. Is this valid? Of course not. Higher frame rates are truer to life than lesser rates. Was the audience right to think it looked strange? Absolutely; 24fps film is what we've all grown up with; anything different will seem strange at first. Can we adapt? Many already have. TVs have offered motion smoothing for years, often as part of the factory settings, with many viewers none the wiser.

2 Get the picture

Feature films (and most scripted content) may not prove the killer apps for 4K, as they're inherently something you sit still for, both mentally and physically. But the air of "hyper-reality" you get with 4K's higher frame rates could be a good thing for content where the audience is more aroused. Gaming is most obvious here, but there is plenty of other content out there where the audience tends to participate (content where viewers tend to mimic, shout at, or otherwise talk back to the TV) – music videos, game shows, up-tempo sports, and reality TV all come to mind. What would you add?

Better sound

4K is also expected to bring improved audio standards for television. This won't necessarily improve sound quality much, *per se*, especially if you are using your television's modest built-in speakers, but it may help deliver a more balanced sound experience, as opposed to the situation a lot of people have with their flatscreen televisions today where voices are too quiet but music & explosions are too loud.

Higher frame rates

4K standards are also expected to raise the frame rates from 30-to-60fps (frames per second) to 100-to-120fps. But before embracing them universally, one should keep in mind that higher frame-rates aren't always well-received in all applications (Sidebar 1). Higher frame-rates probably won't have much impact on feature films and scripted content, but this could be felt with sports, gaming, 3D content (assuming that ever takes off), and other forms of participatory entertainment (Sidebar 2). It will also be felt on your network, as double the frame rate means a higher bitrate.

Speaking of the network

For telecom operators, the good news and the bad news when it comes to 4K is the same news – 4K will definitely encourage data consumption. Estimated bitrates vary (partially because few standards have been set yet), but streaming of the kind that Sony offers (largely uncompressed, crude by tomorrow's standards) consumes about 100Mbps, while Netflix offers 15.6Mbps 4K streaming of certain shows. But both of these examples use today's frame rates for content; tomorrow's will require more.

4K, through the superior resolution

of its source material, should help make the blockiness and pixilation that creeps up with HD streaming a thing of the past, but the challenge for operators is in areas such as packet-loss rate, as 4K requires a hundred-fold improvement for streaming (10^{-5} for those of you keeping score), a tall order in a world where regular HD streaming is not yet universally hiccup-free.

Are they ready? Sameer Ashfaq Malik, Huawei's Deputy CTO for Fixed Networking, says that, in general, they are not. When pressed as to why, he cited issues related to that aforementioned packet-loss rate, E2E throughput (40-to-100Mbps at peak) resilience, round-trip-delay (40ms max), and other tech variables, seeming particularly concerned about their ability to monitor 4K KQIs on a per-service-per-user (PSPU) level and troubleshoot it on the fly. However, he did seem confident that 4K access can be achieved via whatever fixed medium might be available onsite. His advice to telcos – simplify the architecture so that throughput can be more easily guaranteed, add some high-throughput routers, and be able to troubleshoot in real-time, because users have no patience (it takes just a two-second delay for users to start leaving).

Ready or not, telcos must push ahead with 4K. OTT's, who rarely shoulder the blame in the minds of consumers in the event of streaming hiccups, have every reason to push the envelope, despite estimates that 4K content could cost up to six times as much to stream as typical HD content (720p). Telcos have plenty of other reasons to as well. In the near-term, 4K can establish a distinct edge over traditional broadcasters (who face much higher barriers to entry thanks to spectrum limitations and the like). It can also provide an edge over other telcos, especially in fast-growing developing markets where network infrastructure may be relatively robust but services may still be immature, with consumer loyalties yet to be set

in stone. But in the long term, 4K represents the gateway to an entirely new kind of video, one more suited to the sorts of assurances that telcos can provide and OTT players can't.

Interactive video

One major advantage of 4K that was briefly alluded to previously is its “zoomability” – the ability of the image to be expanded on in a particular area with no significant loss in image quality. This happens because 4K offers the resolution of four Full-HD screens. If one-quarter of a 4K image on a 55-inch screen is expanded to fill the entire screen, you'd still have a full Full-HD resolution image (plenty for 55-inches), amplified with the enhanced color space and other aforementioned enhancements that 4K has to offer.

Combine this with the various wonders that are being done with 4K cameras on the image capture end, and video will be revolutionized both in terms of work & play. According to Olivier Bovis, “We have a system called ‘stitching’ which allows us to put two 4K cameras, completely fixed, on a plate. These cameras will create an extended double-4K image. A computer system behind it allows you to navigate within this picture virtually to create a virtual high-definition camera. And not just one, but several at the same time. We use this technology, for instance, in stadium application. You go into a big stadium and you put two cameras completely flat and you shoot the entire stadium and you record with those two cameras if you want to do anything later with it. You can imagine that you can actually navigate through those pictures without having the need for numerous cameras around the stadium that you would normally have. You can imagine that one day in the future the end user on his tablet will be able to navigate what he wants to see.”

The implications of this for live-event streaming are baffling. Viewers will no

longer be at the mercy of broadcasters. They will be in charge of their own entertainment, and this could breathe new life into a lot of old mainstays. How many more people would watch (and tweet about) an awards show if viewers could check in on whatever their favorite stars are doing onsite at all times? How many more digital natives would be attracted to baseball if they could photograph and post wisecracks about any player on the field or in the dugout between pitches? The possibilities are droolworthy.

Ready for primetime?

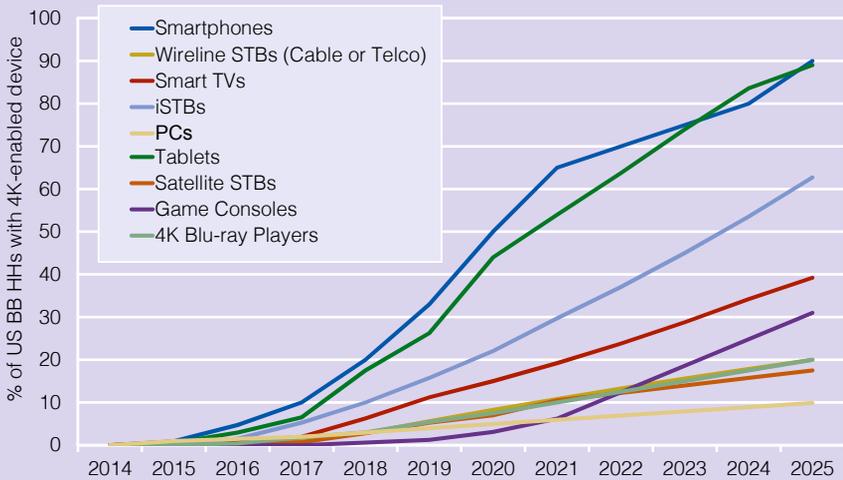
However, 4K adoption is not what it could be. TV vendors have been the primary drivers so far, with pretty much all the name brands and plenty of the next-tier vendors like TCL, Changhong, and Skyworth already offering 4K models, but high prices and long-replacement cycles are expected to keep 4K-capable unit sales modest at best for the next decade. Dolby expects 40% penetration of U.S. broadband-enabled households by 2025 (it's at 2% now). But don't let TV sales throw you off. 4K-enabled set-top boxes (the real mothership of 4K in the home) are expected to be in at least 60% of these homes by that time (and possibly a lot more if a killer app comes along by then). Why are set-top-boxes (STBs) so important? Because a 4K resolution display will not be necessary to enjoy many of the benefits of a 4K pipeline. A 4K source file will deliver improved picture quality with less digital garbage, even on a regular HD display (assuming adequate network capacity). And a 4K image can be zoomed and manipulated with ease, without the need to necessarily display the maximum resolution on the screen.

But still, there is a long way to go here. Only three in ten U.S. consumers are familiar with 4K/Ultra-HD. The



Most name brands and plenty of next-tier vendors already offer 4K televisions, but high prices and long replacement cycles are expected to keep 4K-capable unit sales modest at best for the next decade.

4K-enabled device penetration



Source: The Diffusion Group

PlayStation 4 and Xbox One don't support it. But with Ultra-HD Blu-ray standards finally achieved this past May, a lot of current bystanders should start getting in the game.

Has anyone seen the king?

4K service is now available on four continents, but content is rare and largely sourced from Hollywood. Sony has been its biggest champion, ever since releasing the world's first 4K digital projector in cinemas in 2005, but even their 4K catalog is modest. Netflix, Amazon, and their OTT ilk offer a smattering of 4K content, but little that puts the format in a flattering light. So what'll get the ball rolling? It may not be sports, despite BT's recent announce of their 4K sports channel. 4K broadcast is a lot more challenging than 4K streaming (and the announcement is already out that the 2016 Rio Olympics won't be broadcast in Ultra-HD). A more likely catalyst is the launch of 4K Blu-ray (expected this Christmas), which will force the dwindling number of producers

who haven't already to embrace the format, while motivating the studios who haven't yet to start re-releasing what they already have (plenty of current HD content is sourced from 4K masters).

But media companies shouldn't expect a generational bump like this in traditional content to part the red sea that they're currently awash in. Catalog content will benefit very little from the jump to 4K, and user reactions to image "upgrades" of more traditional forms of content, like higher frame rates or 3D, have been less than predictable.

The truth is that all signs point to traditional "sit & watch" premium content being a game of diminishing returns. The future lies in more interactive forms, and this is where 4K could really make itself felt. Want proof? Sales of the newly-released PlayStation 4 have actually surpassed expectations, despite the lack of a new home video format to entice consumers like the previous two iterations of the console had.

The ecosystem

4K and higher resolutions are quickly becoming the standard for the image

capture of premium content production, but that doesn't make them particularly easy to handle. According to Dolby, an hour of raw 4K content (60fps, 10-bit compression) consumes 11TB of storage, while Deloitte estimates the cost of creating a UHD broadcast channel to be five to seven times that for an HD channel. Considering that a lot of media producers only recently made the upgrade to digital and HD, getting them to upgrade again will be no easy business.

But still, true believers like Sony are helping to create a viable ecosystem, including the cameras, projectors, editing gear, and everything you'd need from inception to production. ICT providers like Huawei are also getting into the game with the likes of routers, storage, and compression, all adapted for high-res media production. There are a lot of steps involved in either streaming or broadcast, and upgrades/replacements will have to be made at every step. There's a company called Envivio actually working now to enable 4K content access over Wi-Fi (though with resolution probably scaled down a bit if a handheld screen is involved), no small feat considering that 4K is considered an ultra-broadband application, while Wi-Fi often barely even qualifies as ordinary broadband.

According to Envivio CEO Jean-Pierre Henot, "The appetite for video from consumers is not abating. 4K is already an accessible technology for the greater public. Anybody can easily shoot 4K video with consumer cameras, or create 4K time-lapse content, and display it on a 4K TV screen that costs well below USD1,000. However, there is still reluctance from broadcasters to launch 4K services, as there is considerable investment required across the production chain. Envivio demonstrates that end-to-end distribution of 4K is completely efficient and reliable, and now is the right time for operators to catch up to consumer expectations for a better video

experience. Envivio won an important evaluation with a Tier-1 U.S. operator in the encoding area, confirming that the market is coming towards us.”

Video as a tool

Business applications of 4K will redefine video as a tool, a medium for interaction, an experience. This is the real potential of 4K.

For surveillance, 4K will reduce the number of cameras needed for effective coverage of a given area, and enable navigation within a virtual image so that subjects of interest can be followed, as opposed to switching between different cameras and hoping that your mark goes where expected.

4K will also greatly reduce the need to have trained personnel leave the office, in a broad variety of scenarios. Drones that survey accident and disaster sites can reduce the need to have insurance investigators onsite. Patrolmen at crime scenes can be the eyes and hands of detectives. Diagnosis and surgery can be supervised remotely. The possibilities are endless, and lucrative.

According to Edwin Diender (Sidebar 3), Member of Huawei’s Global CTO Office, other early verticals where 4K will make inroads include medicine and enterprise communications. For the latter, Diender anticipates a future where “video becomes more and more a function of how people work together, of day-to-day work.” For the former, he relayed a wonderful example of how 4K is already being used to save lives. “In a hospital in the Netherlands, we’re working with a local partner and some technology specialists in this specific hospital to see if we can do something else with 4K. They’ve already created a cube that represents the heart, and so the medical specialist holds the cube. As he twirls, flips and turns the cube around, the image of the heart follows that movement in the screen. And the next level would be us

trying to connect that to a 3D printer, so we’re printing a 3D model of the actual heart, which means the medical specialists are holding the actual image of the heart in their hand as they’re looking at the 4K-generated image of that heart. That gives them a more intuitive way of working and looking at specialized items such as a heart.”

What comes next?

In the words of Erik Keith at Current Analysis, “Ten years from now, 4K will be ubiquitous.” That doesn’t seem too far off from Dolby estimates, which see 90% of tablets and smartphones being 4K-enabled by that time (though largely for image recording as opposed to viewing).

After that will be 8K, considered roughly equal to what the human eye can perceive at home viewing distance, so it would seem unlikely that we’ll see anything beyond on the living-room flatscreen (even if it’s wall-sized). But that doesn’t rule out higher resolutions for movie/stadium screens, zoom-friendly applications, and virtual reality.

As tends to the case with these things, East Asia will probably be the first to embrace what’s next. Each video generation jump is a four-fold increase over what came before. Moore’s Law can handle such a jump every three to four years. 4K arrived about two years faster than the previous generation did, but there are signs that 8K may arrive even faster yet. As already stated, the 2020 Olympics in Japan are slated for 8K broadcast, despite the fact that 4K broadcast scarcely even exists today. NHK (a Japanese broadcaster) has said that they have no plans to even use 4K, instead preferring to leapfrog to 8K broadcast, and rumors are bouncing around the Internet that TV manufacturers may start testing the technology next year.

If so, media providers would seem to be facing a potential dilemma. Upgrade now to 4K and risk committing to what

3 The business of 4K

According to CTO Edwin Diender of Huawei UC&C Solutions, “From a business point of view, 4K also has severe disruptive possibilities. The key early adopter is healthcare, especially where medical images are being shared between medical specialists. For collaboration, video becomes more and more a function of how people work together, of day-to-day work. Where 4K comes in, where the images try to provide a more real-life experience, you can imagine the screen on the wall not cutting it anymore. The wall itself becomes part of the immersive environment. With 4K, you’re indulging yourself in a visual experience while you’re collaborating and talking to others, from head-to-toe.”



may soon be an antiquated technology, or fall further behind awaiting the chance to jump ahead later with 8K. But when asked about this very issue, Huawei experts seemed unmoved by 8K, stating that the buzz seems confined to Japan. They pretty much considered the resolution useless for home display, though they didn’t rule it out for stadium screens and other professional-grade uses. They also indicated that the file sizes you get with 8K content are mind-boggling, and that there’s a lack of gear of available that can render it in a timely fashion. Their advice – embrace 4K, without hesitation. [uvm](#)

