TM Broadcast
INTERNATIONAL
MEDIA, BROADCAST & INSTALLATION

5G and its impact on Broadcast

Live streaming

ANALYZING RED BULL "BATALLA DE LOS GALLOS"

TONY MILLER

From the fantasy world of "Carnival Row" to the naturalistic touch of "Fleabag"

ESSENTIAL GUIDE FOR CHOOSING A 4K CAMERA

4K, a world with plenty of possibilities

Panasonic
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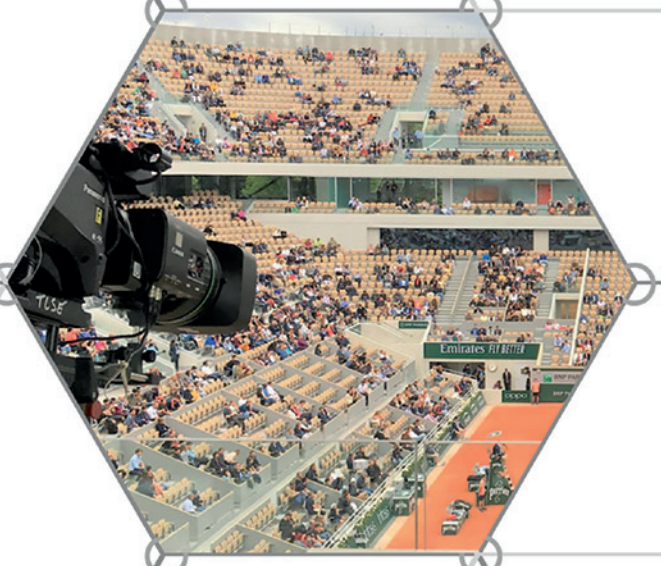

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4K SENSOR FOR SUPERIOR IMAGE QUALITY IN HD & UHD | x2 OR x4 HD HFR SUPPORT
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*Some features might not be available for certain models or optional accessories/upgrade is required

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EDITORIAL

Progress is a double-edged sword. It comes with true revolutions that make our day to day easier. However, sometimes it may turn out to be counterproductive.

Covid-19 has brought about implementation of a number technical innovations that are making the production processes of broadcasters, content producers and service companies evolve. Every week we find instances of new virtualized production projects, remote deployments, exploitation of cloud platforms or advanced systems on IP networks. These opportunities are being seized by scores of organizations, which have been able to correctly identify new gaps in the market; as well as by technical directors, who find solutions perfectly suited to their needs. We dived in this filed through an ambitious project by Square One and Red Bull, as well as in our monographic feature on 5G.

In spite of everything, we must not be let ourselves carried away by this boost caused by the new normal. It is now the time to take a critical eye at the situation and strive to remember all benefits that standards applied before the pandemic were providing us. A clear example of this: the major broadcast shows. We can state unmistakably that virtual alternatives are not satisfactory. Of course, efforts made by NAB and IBC should not be slighted. Yet, this overkill of webinars and videoconferences, as well as this infoxication caused by relentless and unfiltered information impacts, only show that human contact, on-site events and being able to discover in person the possibilities offered by a certain technology are simply better.

Fortunately enough, we can see looming the return of the big shows in full swing. IBC 2021 will be held on 10-13 September and the NAB Show 2021 on 9-13 October. We will not miss them, as we are really looking forward to meeting you again. The time is coming!

THE BEST

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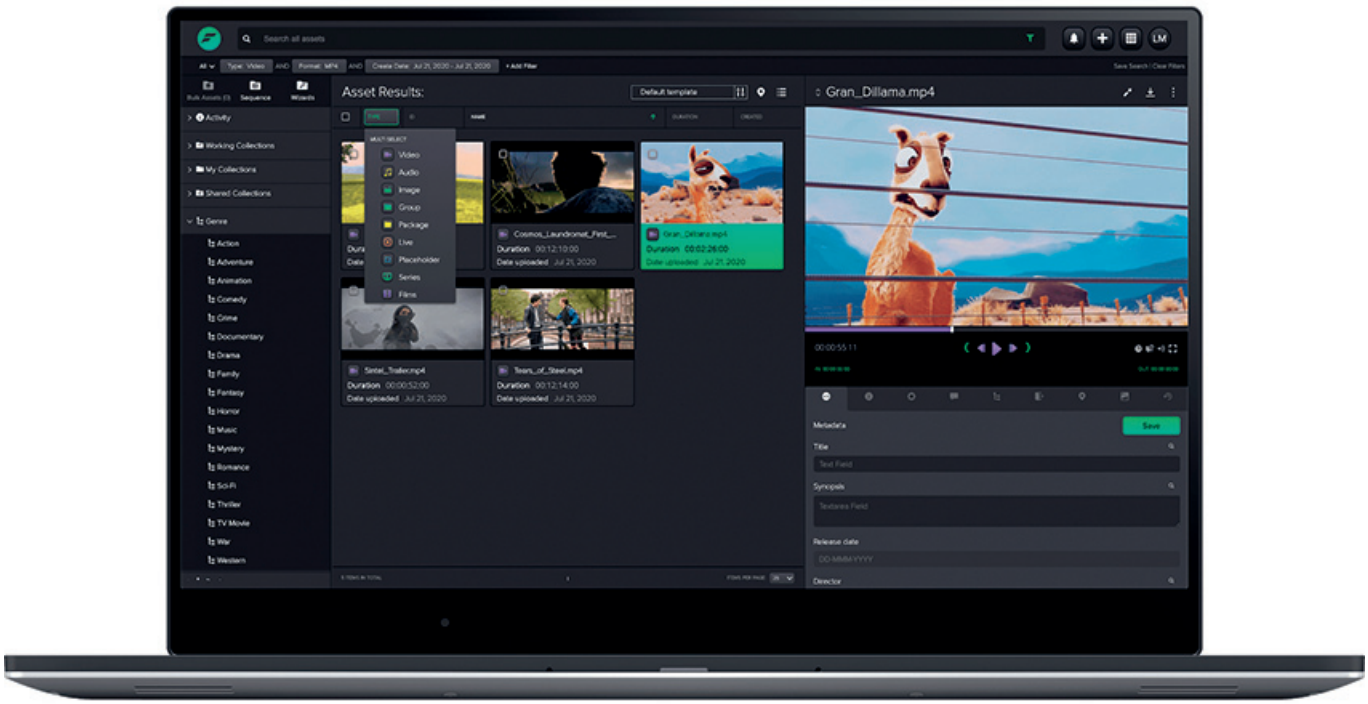
Ooyala Flex Media Platform presents new features to better control cloud costs



The new Ooyala Flex Media Platform capabilities are now available.

Dalet, a provider of solutions and services for media-rich organizations, has announced Ooyala Flex Media Platform new features designed to meet the needs of global program delivery with focus on better control over budgets.

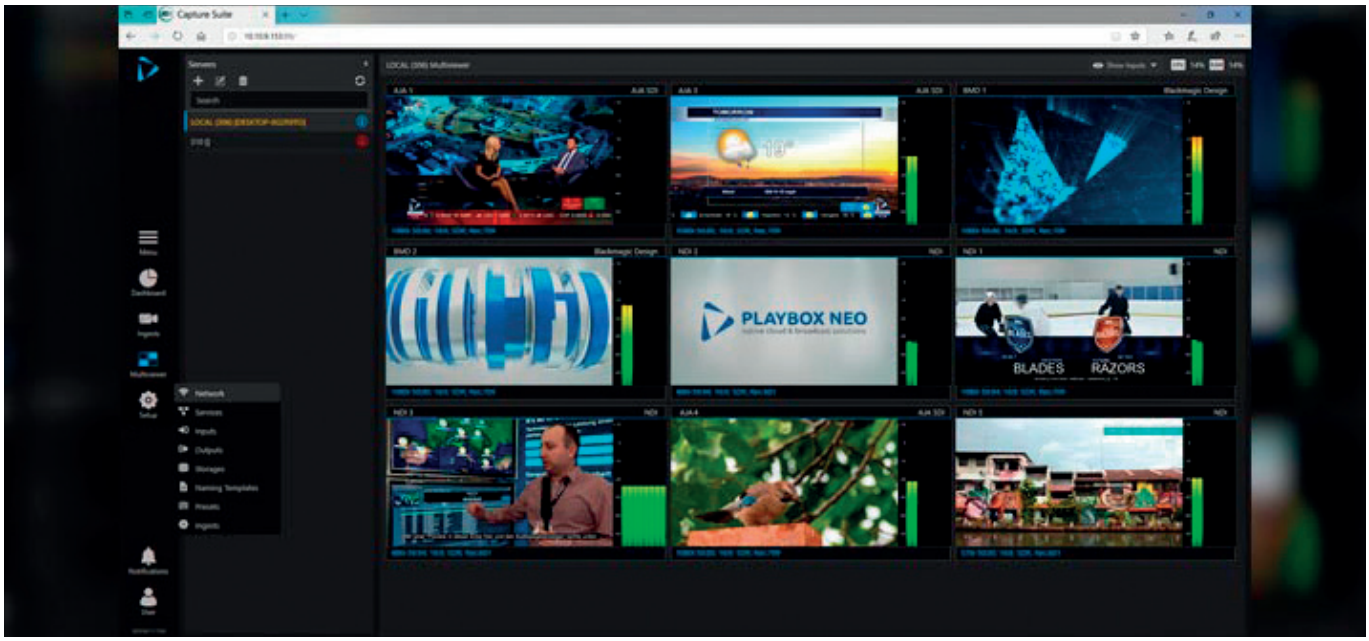
New, under-the-hood Kubernetes capabilities automatically scale cloud computing use for proxy creation and file movement, helping customers optimize cloud costs while having the firepower to manage larger-than-normal content volumes when needed. In addition to the significant cost savings through dynamic autoscaling, customers can set job concurrency quotas and scaling thresholds, keeping a much tighter control over cloud costs.

In addition, Ooyala Flex can now manage and distribute IMF packages, eliminating the need to create multiple versions of a content package. Customers can significantly reduce storage space and

optimize management of common projects such as programs distributed globally in various languages and non-standard viewing formats required by licensees and OTT services. With less physical resources required, customers can deliver multi-version programs faster.

"Today, more than ever, the cloud plays a critical role for our customers and the viability of their business. But they need more than the ability to leverage its computing power, they need better control over how and when to use it," states Lee McMullan, Market Director – Multiplatform Distribution, Dalet. *"Ooyala Flex's new capabilities provide the functions, security and elasticity customers need with simple, yet powerful administration tools that allow them to expand their creative productions while getting better control over unpredictable cloud costs."* ◆

Playbox Neo presents Capture Suite



Playbox Neo, a developer of native cloud and broadcast solutions, has introduced Capture Suite, a multi-channel – multi-server UHD/HD/SD live ingest solution which integrates into the production workflow of television networks, post-production facilities or playout centers.

Capture Suite allows users to control multiple ingest channels, spread on multiple servers from a single user interface. Functions such as input selection, ingest presets, file naming conventions assignments are “a single click away from the user”, according to the company.

These are the Capture Suite features:

- UHD (up to 100fps) / HD / SD ingest
- Industry standard codecs and containers format support
- Manual and Scheduled capturing modes with automated input switching
- File Splitting based on the duration
- Clip duration increase while ingesting
- Controls multiple servers with multiple ingest channels from a single user interface
- Proxy Video and Audio is available few seconds after ingesting starts
- Adding Clip Markers when navigating over the proxy video while ingesting
- OpenMXF support for editing while ingesting in 3rd Party Non-Linear Editing applications (for example Adobe, etc.)
- Playout while ingesting – ingested clips can be used for immediate playout in AirBox Neo

Automation before their ingest process is finished

- Up to 2 presets with different resolutions, frame rates and audio mapping per ingesting channel at the same time
- Presets can have different than the original source standard – automatic Up/Down/Cross and frame rate conversion
- Presets can have different than the original source Audio Mapping (number of streams, codecs and bitrates)
- Scalability – infinite/easy scalability via a client-server architecture
- Custom Naming Template creation for convenient and faster ingest file naming
- Built-in intelligent Resource Monitoring with automatic stopping & saving all files when Low Disk/Storage Space alarm is triggered
- Built-in content transfer/replication of ingested media to another storage/network folder
- Built-In Loudness audio meters for precise audio level fine-tuning
- Built-In Multi-Viewer
- External control from AirBox Neo Automation
- Rest API available ◆

Grass Valley solutions boost Timeline Television's new 4K IP truck

Timeline Television has once again turned to Grass Valley for the newest addition to its outside broadcast (OB) fleet, UHD3. Built around Grass Valley IP solutions including GV Orbit Dynamic System Orchestration and Kahuna 9600 IP production switcher, the all-IP, 4K UHD HDR capable unit gives the UK-based company a future-proof mobile production capability.

The double-expanding truck was originally commissioned for the BBC's presentation coverage of UEFA Euro 2020. With the event postponed until next year, it will initially support the Barclay's FA Women's Super League soccer and various light entertainment programing. The truck will also act as a remote production hub gallery to support Timeline's Ealing Broadcast Centre. In addition, UHD3 will link with Timeline's existing IP 4K UHD HDR truck, UHD2, to deliver expanded production capability when needed – entirely managed by GV Orbit. Built on a smaller scale, UHD3 leverages the same Grass Valley IP infrastructure and Arista 100G switch as Timeline's triple-expanding UHD2.

"We operate in a highly dynamic industry, where having a nimble, flexible infrastructure that can support a diverse range of customer needs and adapt quickly to different production models – especially in these challenging times – is critical," commented Quinn Cowper, head of engineering at Timeline Television. "The addition of another all-IP 4K unit means we can support a wider range of customer needs, from remote production to the largest on-location projects. Grass Valley has continued to drive the

industry's march towards IP, delivering the solutions we need to run a successful business. GV Orbit handles all configuration of the truck's IP backbone which enables our team to remove complexity from the workflow without compromising on functionality."

UHD3 is also fully loaded with Grass Valley's IQUCP25 application platforms with SDI to IP essence processing software, enabling 25GBE ST 2110 IP connectivity for HD and 4K SDI equipment. IQAMD40MADI to IP interfacing modules connect audio to the network, while MV-821-IP Multiviewers handle main production monitoring and additional IQUCP25-MV units support peripheral multiviewer applications. UHD3 also leverages Grass Valley's Audio Live system, allowing production staff to route any source audio to any destination. Dual GV Orbit controllers handle all configuration and monitoring of the truck's IP backbone – including multiviewers and audio. Due to COVID-19 restrictions on travel and staff numbers on site, the Grass Valley team commissioned all equipment remotely. ◆

The Gadget Show stays on air despite covid-19 challenges thanks to **ATEM** Mini Pro

lackmagic Design has announced that an ATEM Mini Pro has helped the latest series of The Gadget Show, produced by North One Television in Birmingham, to stay on air despite lockdown and social distancing challenges. Launched in 2004, The Gadget Show is a consumer technology focused television program, which uses studio links throughout each episode. In the UK, it's broadcast on Channel 5 and is one of the longest running returnable series, providing news, reviews and insight to some of the latest innovations from the world of tech.

Series producer, Tim Wagg, explains: "*When the government allowed TV production to start again in June, the team had only five days to get ready for a studio record. It was an incredibly tight turnaround especially considering we were all working remotely.*" He adds: "*We'd normally have an OB truck, with up to 20 people on set, which had to be drastically reduced to maintain a safe and socially distant working environment*".

"*A crucial part of The Gadget Show is for our presenters to react to the prerecorded segments (VTs) which have just been shown to viewers,*" Tim continues. "*So finding a way to bring these elements into the studio environment makes for a much more fluid program*".

"*We also find it useful during our news segments where content floats up on screen to bring a visual element to the conversation, something which would have required hours of work in post to superimpose the footage onto a blank TV screen. Without the luxury of our usual OB truck and crew, we had*

no way to drive this monitor cleanly, and we wanted an alternative solution that was portable, easy to use and affordable. We also needed HDMI connectivity."

This is where the ATEM Mini Pro came in. "I have all the stings, graphics and VTs, loaded onto my MacBook, and by connecting this via HDMI to the ATEM Mini Pro, we have been able to throw content to the monitor seamlessly. We've also been able to use it to accommodate our 'Wallop of the Week' segment, which is hosted over Zoom.

"*It seems simple,*" he continues. "*But without the ATEM Mini Pro, we would have struggled to implement such a fluid workflow. It has enabled us to continue to produce slick studio elements that go in line with the fast paced, conversational tone we like to set.*"

Adding: "*Like a lot of the industry, COVID restrictions have presented a number of challenges, but as a production company we are well equipped to deal with them, thanks in part to manufacturers like Blackmagic Design*". ◆

Europalco builds its new virtual studio around **Ross Video**'s solutions

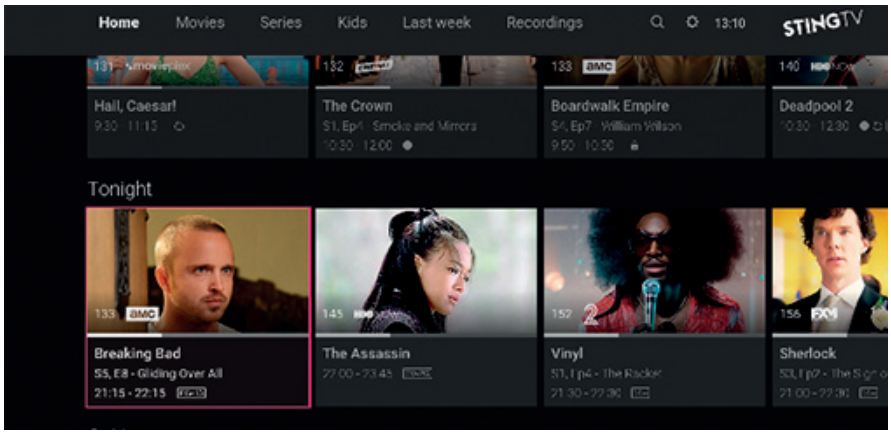
While some business owners might have 'boarded up the windows and waited for the storm to pass' due to covid-19, Europalco, a Portuguese company specializing in corporate events, has decided to invest in a new virtual studio powered by Ross Video's technology.

"*We already have studios in Sintra, Portugal, and we've used these for video production, but we had a feeling that we'd need more,*" notes CEO Pedro Magalhães. "*Some quick online research into virtual studios led us to Pantalha (one of Ross Video's first partners in Portugal who has recently made a welcome return to the Ross family), and they suggested a virtual studio solution based around Ross Video's XPression graphics platform and Voyager graphics rendering solution.*"

Voyager is based in the Unreal gaming engine from Epic and delivers "hyper-realistic" graphics for virtual studio and augmented reality applications. "*There is no doubt that our system has taken a bit of getting used to,*" comments Nelio Lima, Europalco's Head of Video, "*but we've had excellent support from the friendly team at Ross and we're really getting to grips with it. We've actually taken two Voyager units because we want to take a portable green screen set up to clients' offices or facilities so we can bring the show to them, rather than making them come to us. With a handful of successful customer events already under our belt, and several more already booked, we're really turning the business around, and that's great to see.*"

Benoit Rousseil, Ross Regional Sales Director for Southern Europe, applauds Europalco's foresight during this difficult period. "*Challenging situations call for innovative thinking. While it can be tempting to just sit and wait for normality to return, many companies have realized that they have to communicate even more effectively with their internal and external audiences, and have sought help from experts like Europalco who have the tools and the know-how. Europalco, in turn, are proving that you can still deliver high-quality, visually exciting content to your audiences without the need for a big conference venues and auditoriums. We're extremely pleased they chose Ross as a technology partner, and it's great to see their business thriving as a result.*" ◆

Israel's Yes launches Smart TV Service with Next-Gen experience powered by 3SS



The pay-TV subsidiary of Israeli telco Bezeq (TASE: BEZQ), has incorporated 3SS technology in its STINGTV streaming service.

3SS has developed a full operator application in both English and Hebrew for STINGTV, part of the yes Television portfolio, to offer a range of features to subscribers including video-on-demand, live TV, mini EPG, with restart and parental controls, among others.

The new app, based on 3SS' multiple award winning 3READY Product Framework, is also engineered to accommodate navigation to both right and left to smoothly support the UX in both languages.

The new 3SS-developed STINGTV app is for viewing on Samsung, Tizen and Web OS smart TVs.

3SS' front-end solution has been integrated with infrastructure provided by yes' long-standing technology partner Synamedia, including the Infinite Cloud Platform, security solutions and services, as well as its video network technologies.

3SS delivered the project in accordance with the principles of agile development, including SAFe (Scaled Agile Framework) methodologies.

SAFe is the modern iterative development process which involves frequent communication, cross-party planning and common risk management. With SAFe, all those involved in a project benefit from a clear understanding of their responsibilities and their inter-dependencies. Highly motivated and productive teams, faster time to market and better product quality are the outcomes.

"As we migrate our service to become all-IP by 2026, we are steadfastly committed to delivering the very best user experience possible to our subscribers; 3SS is a recognized leader in UX innovation, and we are excited to share a feature-rich next-gen experience with our viewers," said Itzhak Elyakim, VP Engineering and CTO at yes. ◆

Broadcast Solutions presents Ü3, an OB van designed for WDR (ARD)

Systems integrator Broadcast Solutions has built a new 6-camera television OB van, named Ü3, for German public broadcaster WDR, the biggest broadcaster in the German association of public broadcasters – ARD. The vehicle features a compact design, a "well-thought-out" room concept, eight flexible workstations and focuses on flexible production approaches and novel interconnectivity and stagebox solutions.

The idea behind the concept was to create a multimedia approach for an OB van reflecting the changes in media production. At the same time, WDR and Broadcast Solutions had to take into account the interaction of Ü3 with other mobile production units (legacy and new, TV and radio) of WDR.

Primarily the vehicle is to be used as a TV OB van for smaller productions and is equipped with all necessary video and audio technology. In case the audio capacity (a Lawo mc256 console with currently 16 faders is installed) of Ü3 reaches its limits, e.g. at larger productions such as classical concerts, Ü3 will work in combination with a radio OB van taking over the audio production. Ü3 will then work purely as a video production tool. In such situations, the entire audio production is outsourced and handled by a radio OB van. The audio workplace in Ü3 is then available for other activities.

At the heart of Ü3 is a decentralised Riedel MediorNet UHD structure, that marks the first-ever use of the new UHD cores worldwide. Six of these devices are installed at a different place within the vehicle. Another seven are mounted in stageboxes, which contain the camera CPUs as well as all audio, control and IP interfaces and can be placed flexibly in the set or near the stage. ◆

Cartier Queen's Cup 2020 Polo Tournament, first multi-camera sporting event produced with **LiveU**'s LU800

This year's Cartier Queen's Cup 2020 Polo Tournament, organised by the Guards Polo Club, based in Windsor, UK, was the first sporting event to take advantage of LiveU's game-changing, multi-camera LU800 capabilities. The event was streamed live to viewers on the Guards TV website and a leading sports channel in Latin America. The event was covered using four cameras with the live feeds streamed in low delay from the UK to the production studio in South Africa.

South African based Live Production Tech partnered with Polocam.tv to handle the production. Greg Hughes, Director, Polocam.tv said, "Having covered this tournament and being on-site for the last decade, we were really struggling this year without the ability to fly to the UK or have more staff on site. LiveU provided us with the bonded streaming technology for not only broadcasting this event, but also setting the model for how to move forward with other events around the world."

Having tested the LU800 during the early rounds, the multi-camera unit was used for the semi-finals and final. The commentator was at the event in the UK with the graphics, replays and switching carried out remotely from South Africa. This saved on human and technical on-site resources as well as cost.

For the semi-finals, there were two side cameras, a centre pitch camera and a camera positioned on a crane. Two LU600s were also used to provide goal line coverage. The final was a similar setup, with some drone footage too, the aerial footage further enriching the fan experience, increasing the multi-angle coverage. ◆

LiveU LU800 in action at the Cartier Queen's Cup 2020 Polo Tournament.

SDNsquare's GRID provides IP modularity to the CTV OB Golf Truck

Belgian media networking and storage company SDNsquare has collaborated with UK-based CTV Outside Broadcasts (CTV OB) to entirely upgrade their latest OB Unit to a fully modular ST2110 IP-based infrastructure. The refurbished and IP-based OB12 truck hit the road in September 2020.

The company turned to SDNsquare and its GRID providing software-based IP network management and enabling a full non-blocking of converged IP networks with "guaranteed, predictable and reliable QoS".

"The idea was initiated around the time of refurbishing one of our large SDI-based trucks," explains Paul Francis, CTV's chief technical officer. *"The limitations of SDI infrastructures were apparent in their design, whilst according to research, IP promised flexibility could overcome almost every SDI constraint. IP technology would also need to support our client's needs for the foreseeable future – capable of responding to changes in video formats, for example."* Francis further explains: *"That initial intention turned into a project. Our parent company, Euro Media Group (EMG), launched the OBjective2020 project that would allow us to find partners supporting our migration to a fully IP-based infrastructure."*

CTV OB had two primary needs. The first was that the chosen technology architecture should be both future-proof and agnostic in terms of infrastructure and topology. The second was that those who would operate the system would need to be familiar with it: the operational and high level configuration should be presented as a system that is familiar to CTV's engineers, whilst providing them with tools to diagnose any software and hardware related issues. The truck would need to be able to support CTV's client's needs for the foreseeable future – capable of responding to changes in video formats, for example – and be capable of scaling according to the client's requirements.

"Along with the EMG OBjective2020 team's

aims, our project's technical specification has transformed over the last two years alongside the development and accessibility of the technology provided by manufacturers," Paul Francis continues. *"From the necessity of 10GbE networks, to settling on 100GbE, from a pinnacle of SMPTE2022-6 to fully ST2110 systems, the network core has been ever-evolving. SDNsquare has played a central role in our choices, allowing us to choose equipment vendors that best suited our needs, integrating their technology into the SDN programming and advising closely on topology options and IP related configurations."*

SDNsquare GRID uses software-defined networking to deliver IP network orchestration for media. GRID can cope with all types of data streams in a predictable way. With GRID, IP data paths can be set up *"without packet loss, with low latency and with the exact bandwidth needed"*.

Henry Alexander, CEO of SDNsquare, expands on the technology benefits that the new IP-based OB12 truck has gained: *"A random or flexible spine leaf topology means that, instead of adding a new device and extra Gb to the network, CTV OB can, for example, software split 100Gb into four 25Gb allocations or one 25Gb and leave the remaining 75Gb for further usage. This is called bandwidth management – and it's patented by SDNsquare. The idea is to put everything – video, audio, intercom, management, KVM, office and Internet – on the same network, guaranteeing every single flow at the network switch level."*

"We are immensely proud of our newly refurbished OB12 truck that hit the road last week at the PGA European Tour" says Richard Morton, Head of Projects at CTV Outside Broadcasts. Morton adds: "It was really impressive to see everything working so smoothly. Nobody was really aware of the massive technology change. We look forward to the next chapter in our partnership with SDNsquare." ◆

Pebble Beach Systems strengthens sales operation in North America and LATAM with new VP of Sales

David Kicks is the new VP of Sales for the North America and LATAM regions at Pebble Beach Systems.

David brings 40 years of diverse industry experience to his new role, having begun his career in engineering roles at Pro-Bel in the UK and then taking on sales responsibilities with Pro-Bel and Chyron. He moved to North America in 2004 as part of an MBO, and went on to hold senior regional and national sales roles with Snell Group, Vidcheck and Telestream. ◆

TAG Video Systems releases **Zixi** Integration for Multiviewing

TAG Video Systems has integrated Zixi to allow customers to aggregate all sources into one visual mosaic monitoring platform. The Zixi protocol and video solutions stack, including Zixi Feeders, Receivers and Broadcasters, are now supported internally in the TAG MCM-9000 eliminating the need for outboard processing or servers as previously required.

With the Zixi protocol, the SDVP is the only solution that can provide five and six nines availability utilizing patented sequenced hitless and bonded hitless failover over mixed IP networks such as internet, fiber, satellite and cellular. The ZEN Master control plane enables users to manage large-scale configurations and orchestrate, analyze, monitor, alert and report on live video streams and devices across the Zixi Enabled Network of customers, integrated devices and platforms and service providers standardized on Zixi. With this integration into TAG's MCM-9000, NOC operators can gain workflow flexibility and agility, monitoring all broadcaster formats, from uncompressed to highly compressed HLS. Mosaic display outputs can now be protected with Zixi, maintaining image and sound integrity and fidelity even in work from home situations. Operators can now be confident that any impairments they see in the mosaic images are present in the monitored signals. ◆

Sony acquires **Nevion** to strengthen its portfolio of IP/cloud based production solutions

Sony Imaging Products & Solutions Inc. ("Sony") has announced that it is acquiring Nevion AS ("Nevion"), a provider of virtualized media production solutions, to further enhance its portfolio, providing end-to-end IP and cloud-based production solutions for broadcasting and other applications. Sony, which has been a minority shareholder in Nevion since July 2019, is purchasing the remaining shares in the company, and making it a subsidiary.

Acording to Sony, the spread of COVID-19 has accelerated IP-based productions, and the need of combining on-premise facility and cloud processing, enabling remote work and resource sharing, has become the basis of business continuity planning for the broadcast and production community. Since June 2019, Sony has had a strategic partnership with Nevion, and both companies have been collaborating to address those markets. This investment will enable Sony to build a much closer relationship with Nevion and lead to the delivery of more integrated solutions. ◆

Euronews partners with **Globecast** for the launch of Euronews English HD in Asia and Oceania

Globecast has announced that long-term customer Euronews has selected the company to provide distribution services for the launch of its new HD version of Euronews English HD, covering Asia and Oceania .

Globecast is acquiring the signal from Euronews' HQ in Lyon, France, in IP over fibre. It is then fed into the company's international Globecast BN fibre network to reach the Jordan Media Center in Amman. There it's uplinked at the teleport to Asiasat 5. During the course of the contract, Globecast will also add Viaccess PC6.0 encryption to the signal, at a time of Euronews' choosing, with cards also supplied. ◆

5G and its impact on Broadcast

5G technology is something widely commented that has been here for some months now. It seems that 2021 will be the year for implementation of 5G, so let us review what this technology is about and what it is going to mean for our industry.

By Yeray Alfageme,
Service Manager Olympic Channel

The next generation of telecommunication networks (fifth generation or 5G) started to reach the market by late 2018 and has continued expanding all over the world. Everything indicates that 2021 will be the final year in which 5G technology will be fully implemented throughout the world.

Beyond increased speeds, it is expected that 5G will unleash a massive ecosystem of IoT (Internet of Things) where networks will be able to meet the communication needs of virtually billions of interconnected devices, achieving high performance with regards to speed, latency and cost.

More specifically, the 5G technology relies on 8 essential pillars:

- Speed up to 10Gbps - > 10 to 100 times faster that 4G and 4.5G networks.
- 1 millisecond latency.
- Capacity 1,000 faster per antenna.

- Up to 100 times more devices connected per antenna (as compared to 4G LTE networks).
- 99.999% availability.
- 100% coverage.
- 90% reduction in network energy consumption.
- Up to 10 years battery duration in low-power IoT devices.

Aside from speed -which means a leap of 10-100 times faster than 4G and 4.5G networks, what does make a difference is latency. While in 4G networks response latency of a device against the network was about 200ms under optimal conditions, in 5G networks latency is as low as 1 millisecond, the same as in an Ethernet network and even better than WiFi networks.

Let us make a comparison in order to get an idea of what this may come to mean. Reaction time of a human being is about 250ms, being as low as 190ms in F1 drivers. If we compare these 250ms with the millisecond that a 5G network can take to respond, this should give us an idea of how fast it really is. Imagine that a connected car can react a quarter of a second faster than us when facing an incident on the road. This could save countless lives.

5G vs. 4G

Although the 4G networks meant a real boost to mobile Internet, 5G is the next step towards IoT (Internet of Things) where everything –basically everything- is connected to the Net, thus changing the concept of connectivity we had known up to now.

The main differences between 4G and 5G are:

- Low latency. As we have mentioned before, this is a vital feature, for instance, for driverless cars.
- Higher device density. A 5G network can support up to 1 million devices per square kilometer. This may seem a lot, but sure we will fall short as it happened with iPv4 addresses.

- Low power consumption, enabling simple devices such as sensors to stay connected for months or even years under today's battery technology.

Present-day IoT services actually mix existing technologies, such as 4G and Bluetooth, in order to provide something similar to what is expected from an IoT service. However, 5G is bound to be what will bring about large improvements and allow everything to remain connected permanently.

Uses of 5G

With the arrival of the 5G technology we will be able to make use of the network of networks in environments or configurations that up to now were just unthinkable. For instance, having a 4G network outside our home and a WiFi network inside will no longer be required as the 5G network itself can provide both services without detriment to reliability, security or interoperability that WiFi offers today as compared to a 4G network.

WITH THE ARRIVAL OF THE 5G TECHNOLOGY WE WILL BE ABLE TO MAKE USE OF THE NETWORK OF NETWORKS IN ENVIRONMENTS OR CONFIGURATIONS THAT UP TO NOW WERE JUST UNTHINKABLE.

Putting everything on a time line:

- Fixed wireless access arrived in 2018. Access to the 5G network for fixed devices.
- Mobile broadband, a network in replacement of 4G already appeared in 2019 but it will be in 2021 when its deployment will be widespread.
- Mass access to IoT will arrive by 2022, if devices and applications that are ready for use are available.

- Low-latency IoT communications, from 2024 onwards.

For this reason, applications as striking as the above-mentioned driverless vehicles must wait a few years to become a reality.

What we will definitely be seeing shortly is an explosion of Big Data, as 5G networks enable much faster collection and larger amounts of data.

5G and mobile carriers

Up to now, a mobile carrier would provide a connectivity service for voice and data over a proprietary network with a number of applications on it, but –somewhat oversimplifying- little else. With the arrival of 5G, mobile carriers will turn from providers of infrastructures and basic services into developers of network services and applications oriented to IoT or to super-connectivity of a large number of devices.

Let us reflect for a moment on how many devices we have at present connected to a 4G network: basically our mobile phones. But with 5G, not only our mobile phones will be connected, but also our watches, computers, land-line phones, virtual assistants or even our pacemakers or insulin pumps. Incredible, isn't it? A major challenge for carriers will be to make existing 3G and 4G networks compatible with the new 5G network, which might also be a problem for regulators, as they scramble to find solutions to allocation and distribution of frequencies.

And what about security?

As more devices are connected -virtually everything will be- one of the main and reasonable concerns that may come to mind is security. It is obvious that the higher the connectivity, the higher the exposure and the higher the risk, but the network itself has security implementations that are much stronger than the current ones. Basically, 5G networks will make use of the most advanced security protocols available in Cloud services such as Amazon Web Services (AWS), Microsoft Azure or Google Cloud, which are more than proven and highly secure.

5G and Broadcast

Our industry is regarded as one of the main pillars in the 5G era. This technology can enhance the mobile experience and offer users unlimited consumption of contents. This idea has been around since the introduction of LTE, but it has been recently improved through the 3GPP group by means

of versions 14 and 15 as further evolved multimedia broadcast multicast service or "FeMBMS".

Known simply as "EnTV" or enhanced TV services, it has been designed to make broadcast of digital TV through the existing mobile networks a reality, thus providing a response to the needs of broadcasters, content providers, mobile carriers and consumers.

5G Broadcast is not only designed for live mobile TV, but also for –as we have already mentioned- mass IoT, as for instance when there is a need to distribute identical content to a large number of devices such as smart household appliances. Today's use of streaming –by which each device is served a different version of the stream even if content is the same- is highly inefficient. 5G will enable carrying out a real broadcast as it is currently being done on IPTV networks, in which a single stream is used by multiple devices at the same time without multiplying the bandwidth in use.

This is only what concerns broadcast, but impact on capture can be huge too. Here there is a longer way to go, as both manufacturers and content producers are waiting for 5G to become a global reality before starting to develop 5G-based technologies but, in view of the increasing interest for remote production -not only because of the pandemic but also in view of the multiple options this offers- 5G could very well mark a before and an after.

And we are not talking only about connected cameras with broadband widths that will enable transmission of images with extremely low compression rates, no latency and from anywhere with a reliability equivalent to fiber-connected devices; but also about 100% virtualized production environments whereby replay servers, graphics, arrays and, of course, even video and audio mixing consoles can be made virtual and each and every operator –all of them connected to a network of the global Intercom, without any delay, could operate, regardless or where they are located.

I know the previous paragraph requires a lot of imagination –or not-, but we must be ready as everything we have imagined is technically feasible and will most probably provide improved quality of contents being broadcast, which is ultimately the purpose of all this. ◆


5G

Extraordinary opportunities for the broadcast universe

The global mobile industry acknowledges the important action of GSMA as a hub embodying the interests of the mobile communications industry. Beyond hosting world-class events such as the Mobile World Congress and getting together more that 750 carriers with nearly 400 companies in the mobile universe, this organization promotes countless development projects in many areas.

As you may all agree, GSMA is an extremely qualified voice to speak about 5G and the applications to the industry it represents. We met with Henry Calvert, Head of Network 2020 through videoconference. In this interesting conversation he opened us the door to the future possibilities of technology.

By Sergio Julián Gómez, Managing Editor at TM Broadcast International

What's been the role of GSMA in the development and diffusion of 5G technology?

Henry Calvert, Head of Network 2020

3GPP is a very important standards body that defines the 5G specification. That is deployed by the vendors and then the GSMA starts to come into action. GSMA looks at the forecast and demands for 5G, and how that's going to work with previous generations. Our policy teams works very hard to get spectrum allocated and harmonized - they try to get the same spectrum and allocation bands for technologies around the globe.

What I'm most familiar with is the technical implementation of 5G. It revolves around enterprise businesses and how can we define the low-latency high-bandwidth ultra-reliable communications that 5G brings - how do we profile things like network slicing, edge computing, and the new services for customers that 5G enables.

We are also dedicated to solving problems related to the new technology. Now we even work on the 5G indicator, the indicator in the top right corner of the phone: when it should actually be displayed, and what should be the characteristics of a network to show 4G or 5G, so that the customer experience is maintained.

There's a lot of optionality in 5G as well. I think they had 12 different ways of deploying 5G and in the GSMA we've really narrowed it down to 5 key deployments, like non-standalone and standalone, and the different variants of that. So that's sort of what we do. We bring generational technology to life, and make sure it is interoperable around the world.

3GPP take an important role in the development of these new technological standards. What's your relationship with 3GPP as a Market Representation Partner?

You have to realize that mobile is a very large community, because the number of subscribers on the networks: over nine billion connections, almost seven billion unique subscribers... Actually, the people who are defining the specifications in 3GPP are also the same people we speak to in the GSMA association, so we make sure there are not duplications. That's why we're a Market Representation Partner with 3GPP.

Sometimes, we have liaison statements that go between 3GPP and us when 3GPP wants to understand what the overall consensus of the operators is, for example. They will turn to us and say: “Can you find out what the real consensus is here? What will be commercially acceptable?” And then, we will bring the operator’s position as a consensus. I was giving some sort of examples of that earlier, such as the 5G indicator.

We also make voice, video and messaging work, because there are different profiles configuring the networks in a particular way. So, when I leave England and I go to Spain, I know I can still continue my voice service. We're trying to make all of that work and be interoperable. We help 3GPP on those accounts and when there are problems we just say, “We expect this problem to come, because we have seen it several around the world. Can you thing about changing the standards?” The actual sort of request for the change actually comes from an operator, an OEM or a vendor. They know we add weight and advocacy to the actual activity there.

Internally, GSMA has many working groups to drive the industry’s technical evolution. What have been the last movements of the GSMA regarding the broadcast industry?

It is a very exciting time. The way customers consume video content has changed significantly over the last decade. Now, most of the content goes over mobile networks, which have largely been unicast-based services. We have seen people move from linear-based programming. Now, they're consuming it at different places. In fact, we've seen that people now consume content from the bedroom instead

THE WAY CUSTOMERS **CONSUME VIDEO CONTENT** HAS CHANGED SIGNIFICANTLY OVER THE LAST DECADE. NOW, MOST OF THE CONTENT GOES OVER MOBILE NETWORKS, WHICH HAVE LARGELY BEEN UNICAST-BASED SERVICES.

of the living room. Children also now access content very differently. That's the reason why we're very focused on what are the drivers of demand and how it occurs.

I think that's why you see the prioritization around unicast technologies rather than multicast at this point in time, especially from the device sort-of side. The devices predominantly support unicast-based technologies because they know it has different characteristics that were really driven by the consumer behaviour.

We've heard about the benefits that users will get with 5G. What about broadcasters? How can they benefit from this technology?

Broadcasters are going to get a significantly improved customer experience. We've seen the revolution from SD content going to HD content and to UHD content. We might even see 4K. I can't visualize 8K television broadcast streams on a mobile device, unless it's a casting device, an intermediate step. But what I can see is that with the size of tablets and laptops, people will move towards 4K and distribute that. Additionally, the way 5G networks are protected opens up the opportunity for edge computing, which is a higher performing content distribution network. The customer experience is going to change significantly from buffering and lower quality streams to higher quality streams. The switching from a YouTube channel to a new YouTube channel, because the lower latency of the network is going to be significantly improved.

That's really from a consumer point of view. What about outside broadcasting? The connectivity of 4K/8K cameras will improve significantly. But also by bringing edge computing we're going to see that the production and post-production can actually happen in a much more mobile environment. I foresee that the big productions trucks that they used to carry along with all the production equipment will now be able to be quasi-hosted on an operator's network through edge computing. Therefore, we can get to news stories, incidents and emergency situations much quicker.

THE WAY 5G NETWORKS ARE PROTECTED OPENS UP THE OPPORTUNITY FOR **EDGE COMPUTING**, WHICH IS A HIGHER PERFORMING CONTENT DISTRIBUTION NETWORK

Henry Calvert at Nanjing May 2019

I'm sure you know Matt Stagg. We've done a lot of work with BT Sport. In fact, we're looking at the demographics of networks hotspots when football matches are happening. So, if Manchester United is playing Arsenal at Old Trafford, we see the traffic that is required. We also can see all around north London that network hotspots at three o'clock in the afternoon grow significantly as people start consuming this content and interacting with the game or other people. 5G will be able to back that up and provide a much better experience.

A 5G network must be designed in a specific way so broadcasters, users and so on can benefit from edge computing?

Yes. This is a transition of IP enablement that is actually happening. The hyperscalers have been very good at providing store and compute capabilities. This has been quite regionalized. So how can operators open up the facilities and assets they actually have to have your edge computing so we can reduce the latency? Now broadcasters are trying to work things out maybe at Birmingham or London or Barcelona or Madrid. But you're going to be able to go down to much closer areas and get the same quality that you saw before. We see this as a benefit for the broadcasters.

5G is the opportunity. Its architecture is different from 4G or 3G, but that is also a benefit. Not only can you build it in a city, but you can also build it in sporadic areas where it's needed most. And architecture allows you to do that.

GSMA represents the interests of mobile operators worldwide, those who will serve 5G networks both for individuals and corporations such as broadcasters. Will operators be able to offer exclusive channels through 5G networks that help them avoid possible network saturation?

That's a very good point. How is this vertical industry going to ensure the right communications to truly meet demanding needs? That is something the GSMA has been working on and it also has been adopted by 3GPP. We call it network slicing – how can we slice a network in order to bring a certain level of quality of experience to the vertical industry. We have created a template for this that uses the capabilities of 5G to be able to provision an end-to-end network so that the vertical industry can have the network secured when required.

We've done it to improve mobile broadband; we've done it for V2X, vehicle-to-consumer type services; we've been doing for specific IoT devices like drones and aviation industries; and it would be great to get broadcasters together to actually define that template for broadcasting - to know what their needs and requirements are as a vertical industry, so that operators can consistently provide the network that suits them.

We'll be able to do that thanks to the architectural changes that 5G brings around. It will be able to provide enough capacity for the Internet and then you will be able to provide enough capacity for bespoke services without compromising any of the consumer Internet services they may have. Therefore, network slicing is going to be very important. We are probably two or three years away from getting there. Networks are being transformed to be able to support 5G cores. And indeed, we will see that radio connectivity progresses very quickly.

I'd also like to delve into MOJO, Mobile Journalism. The broadcasting industry is moving towards a world in which the contribution of AV content will be provided not only by broadcasters, but by all mobile users. How 5G networks bring new solutions to the mobile journalists?

The opportunity for everyone to provide content... We see that a lot in today's society. But sometimes the quality of the video recording isn't broadcast quality. The next devices probably will have better cameras than what we have seen, and will have great record quality. Usually, it's the

uplink into the network - sending the content- which has been the biggest struggle. That is where 5G coupled with 4G will really improve the uplink. You can get quality video back and it's not transcoded or changed, it remains raw. That is a fundamental shift. We will see mobile journalism taking off a little bit more.

3G to 4G solved the download of content for people. 5G will now really solve content uploading. And, if we use edge computing, that upload will reach the applications necessary to produce the content. Everything will be much faster than before and can be checked on the go. Obviously, there are different privacy rules that need to be included in that, but that can be done much quicker.

Finally, how has covid-19 affected the development of 5G networks?

Let's go back to customer behaviour. The covid-19 has fundamentally changed the behaviour of our lives. It has simply changed the way we live and work. Operators have worked very hard to provide more capacity, so most of the effort has gone into re-dimensioning the network, so that people can work at home with the 4G devices they actually had. From a resource perspective, they haven't been as affected by covid. The operators have been day in and day out making sure that there is enough capacity in the right place, so that people can provide online education, online work and remote working.

That will probably only have a three to six months impact on the actual 5G deployment schedules, because they understand the dynamics and that 5G is more important now because behaviours have changed. We now know that the requirements for uplinks that send video to the network are more important than anything else these days as the dynamics have changed. We're still forecasting that about 20 percent of connections will be 5G by 2025, which is huge growth compared to historical. We see the reduction of 2G and 3G connections, with 4G being the workhorse of the type of connections that we have. Anyway, we see 5G emerging very quickly over the next five years. ◆

Arturo Azcurra runs IMDEA Networks, the main network infrastructure lab in Madrid (Spain). At its core –among a number of projects- can be found the innovative 5TONIC, which is possibly the 5G technology research lab having achieved the most successes in Europe and in which institutions and companies as relevant as Telefónica, Ericsson, Intel, CommScope, InterDigital, Altran and Universidad Carlos III of Madrid actively cooperate.

We talked to him to gain some insight on the development of these technologies at European level, and also to find out the details through which this technology will ultimately reshape the possibilities of broadcast worldwide.

IMDEA-5TONIC

Inside Europe's main lab for 5G technology

By Sergio Julián Gómez, Managing Editor at TM Broadcast International

I would like to begin by having a little context about IMDEA. What is it? What are your goals?

IMDEA Networks is one of the 7 research institutes in the Autonomous Community of Madrid, all of them under the umbrella of the IMDEA model. This institute carries out research on network sciences, mostly on data networks, which is ultimately the Internet and mobile telephony networks. But it also studies social networks, immune system networks, economic networks... In sum, it deals with the notion of network, which is broader and more generic. A network is basically a distributed control system. Therefore, anything being an extremely complex distributed control system can be analyzed as if it were a data network, which is where these technologies and methods stem from.

Thus, our key goal is attaining scientific and technological developments that will support Madrid's economy and society, in such a way that our businesses will be stronger, with higher added value jobs and, in sum, achieve higher social wellbeing.

More specifically, how long have you been studying 5G? What were your first moves?

5G began to take shape back in 2013, when the KPIs were set. The goal was a system that would meet extremely ambitious design goals. That marked the starting point of a research race among the world's most developed regions in order to see what areas would be able to come up with solutions that would enable to reach said goals and, therefore, turn 5G into reality. A very powerful research program was launched in Europe, the 5G-PPP, which was allocated 700 million euros in public funds and 4 billion euros from private financing. This has enabled European companies to be at the world's forefront in 5G products and services.

Is this 5G development idea an initiative that has been mainly promoted by public administrations when it comes to defining networks

providing various possibilities in different areas? Or is it a private initiative aimed at offering products and services to consumers? What is the driving force behind the development of this technology?

The initiative was promoted by the private sector. It is an effort by 3GPP, ITU and various standardization bodies that was mainly fostered by the industry. The players saw that 4G was a very powerful technology; but there was a wide range of uses, especially in professional environments such as healthcare, energy and transport, in which 4G was not capable of providing entirely satisfactory solutions. It was the industry that somehow called for active development. What public administrations have done is supporting, with a varying degree of enthusiasm, research and development as needed to turn this into a reality.

IMDEA Networks hosts 5TONIC, a lab dedicated to researching various 5G applications in coordination with other companies. Do you undertake 5G research projects independently as IMDEA Networks and others with 5TONIC? What is your research structure in regard to 5G?

> AT PRESENT 5TONIC IS THE 5G RESEARCH LAB, BUT WE ARE STARTING TO DO RESEARCH ON 6G. IT IS CURRENTLY, EUROPE'S MOST ADVANCED LAB ON 5G.

Both things. At IMDEA we deal with 5TONIC as one of our ongoing research projects. It is a very important project that in turn branches out into subproject, as this is quite a large initiative. At present 5TONIC is the 5G research lab, but we are starting to do research on 6G. It is currently, Europe's most advanced lab on 5G. Others that are quite strong on this area, but I would say that 5TONIC is the leading one, as we can prove by means of milestones achieved and capabilities demonstrated. It is therefore a very important project from IMDEA Networks.

What are these milestones? Which are the research paths that you deem most satisfactory?

5TONIC is a public-private venture: a consortium of companies and public research entities. As public company we have IMDEA Networks, co-founder along with Telefónica. Other major companies joined in afterwards, such as Ericsson, Intel, CommScope, InterDigital, Altran... On the side of public research there is Universidad Carlos III as well.

From these entities we promote various research initiatives. At 5TONIC was

carried out the world's first test on virtualization technologies for microwave links, run by ETSI Engineering School. To the tests attended 30 companies from all over the world, with 60 highly-specialized technicians. It took months to plan everything, but conformity and interoperability tests were done for this kind of equipment in a time in which nobody knew what 5G was. That was the first trial carried out by ETSI at worldwide level.

We also launched at 5TONIC, in a collaboration initiative among Ericsson, Universidad Carlos III and IMDEA, and with support from Telefónica, the first 5G Master Program 6 years ago. It was a promise, an expectation for the future. On the other hand, we did together with Telefónica, Europe's first tests on OTFS technology, which have been largely positive, with a spectrum efficiency even higher than the 5G targets. They were physically performed in 5TONIC, at the IMDEA Networks headquarters, and subsequently at the Telefónica campus.

Additionally, newspaper Expansión acknowledged 5TONIC as one of the best innovation initiatives in Spain, the only one being carried out in the ICT industry. Last, 5TONIC has been the only entity that has been present at the three demonstration pilots in Europe. Therefore, we have covered a number of international milestones on technology development, training, implementation and demonstration.

To end our picture of 5TONIC, what is the forecast on this project's continuance? Will you change your research focus at some point?

The idea is evolve and continue with the 5G research until the most ambitious goals that were initially set for this technology are reached. At the same time, we will kick off research on 6G. We are already in touch with the PAWR platforms in the USA, a program being funded by the National Science Foundation. In cooperation with the United States we will promote 6G technologies. We will also receive significant support from Europe's main research

labs, which we are in touch with.

Therefore, our roadmap would be to move forward and complete the 5G research and go back to lead the research on 6G. This is our goal. Be again leaders in Europe and in the world.

The technical managers of various TV stations identify in 5G the benefit of attaining the lowest latency and higher capacity for speed. However, if we go further beyond, we come across terms such as Edge Computing in order to provide new tools and solutions for content processing. Can you explain in what way can Edge Computing be applied to 5G for the broadcast environment?

This is an extremely interesting aspect. 5G has two different areas for application in respect of the broadcast environment. One would be doing broadcast as such: instead of broadcasting images and sounds through DVB ad its succeeding evolutions, 5G will now be used for that task. And the other, the use of 5G as a complement to current broadcasting and to offer different kinds of services to content producers, the stations themselves. Here we have two very different things: one thing is disseminating the signal and another generating or purchasing content and injecting the signal to broadcast: these are quite different roles. 5G would have both.

For broadcast itself, 5G has very significant benefits. One of them is that it is much more efficient than DVB spectrally speaking. And not so much so because DVB has technological issues associated, but especially because of the smaller cell size. Since in 5G we have cells that are much smaller than a TV station's coverage area, we have the possibility of attaining a much higher spectrum efficiency. That is, the volume of information that can be sent per hertz of spectrum used is much higher.

It must be taken into account that spectrum is both expensive and a very scarce. The spectrum is first allocated to public uses and in some cases subject to bidding. Sometimes it is charged at a fairly low rate, while in others can get really expensive.

Therefore, it is financially very important being able to make the most of each hertz of bandwidth. In this regard, 5G is much more efficient. Therefore, 5G is a really good candidate for replacing the traditional broadcasting technologies.

On the other hand, as it relies on much smaller cells, 5G would enable for content that would be offered much more 'a-la-carte' than what we have available today. If nowadays you want to broadcast on the coverage area of a DVB station and you have been allocated 10 channels in the spectrum, you can only send 10 different signals to all your population under said coverage. But if you split that into hundreds of small cells, you would then be able to forward local content to each of those tiny cells; you could do it by districts or small towns, or even by specific residential areas. This provides a degree of versatility and capacity for injecting content that faintly resembles the internet.

Internet is 'pull': users decide what they would like to watch and download the desired contents from the net. Broadcast is 'push', as the station pushes from the header side, the content it has within a more or less wide choice. With this technology, viewers would have a much wider choice of content. Not everything would have to be push-based. Therefore, it does not only mean technical or financial efficiency, but it also brings about new business models. For that reason, 5G is being contemplated as a very interesting alternative to traditional broadcasting.

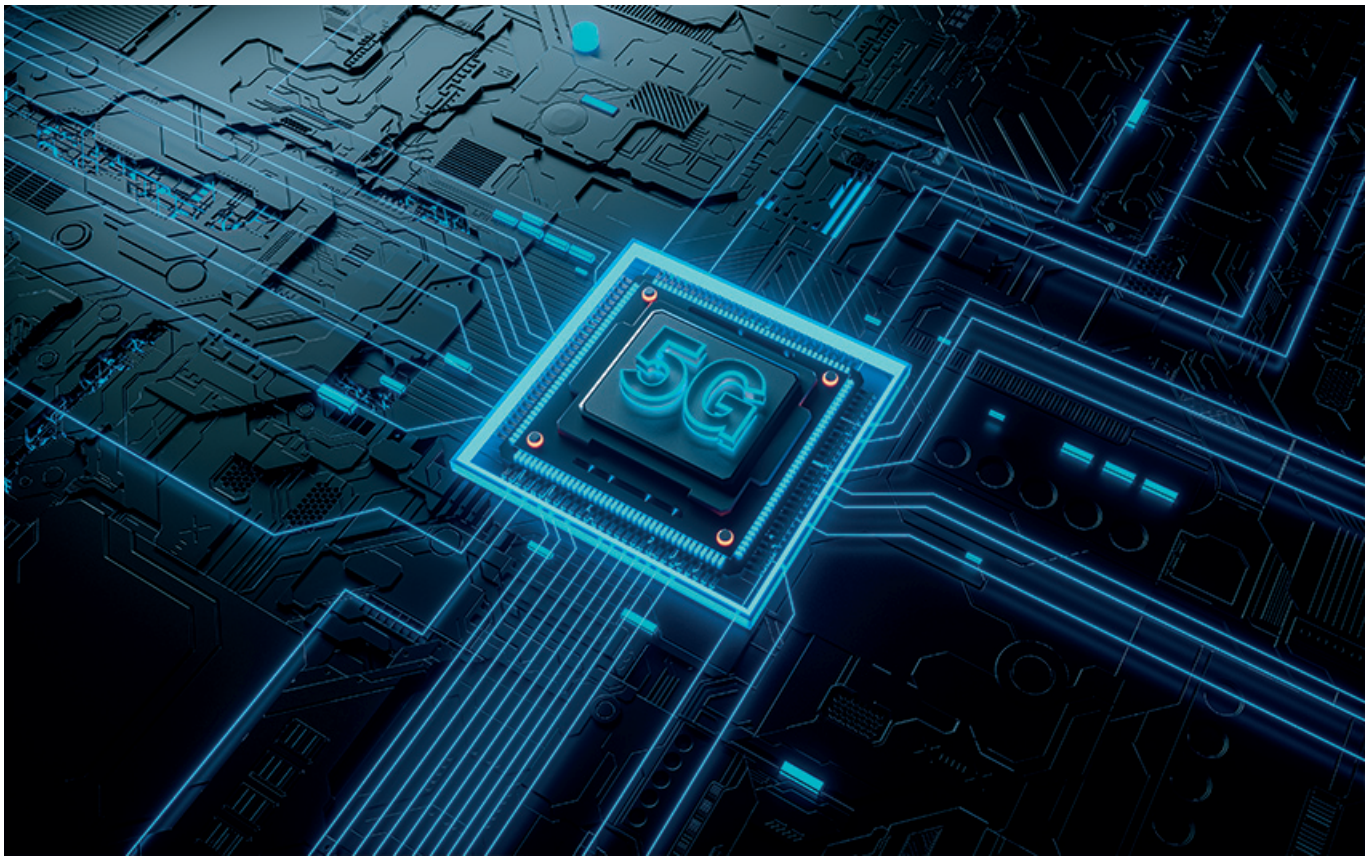
It reminds me in some aspects the HbbTV option, associated to IP-based content. This is a parallel, different route.

It would also be over IP, but it would certainly be a parallel route, as it would go through the 5G infrastructure. In some way it is actually similar. It is like when the move to digital television was made, which also enabled higher spectrum efficiency. But this is a far greater leap. We are not

talking about doubling or trebling the number of channels, but a hundred-fold increase. A residential development could even have its own channels. Not their own in the sense that they will have their own channel injected by themselves: I mean that commercial companies will be able to offer products with a granularity as fine as to enable making them available to clients in very small areas. This could lead to a dramatic shift in today's business model of traditional broadcasters.

I would like you to tell me your views on implementation plans and adoption in various sectors. I understand that Covid-19 has slowed down or even deferred by a few months the original plan. Is this true? What is the roadmap concerning dates and specific milestones?

5G is a very complex technology and has a lot of elements, but three main parts can be identified. One is the full transformation of network control. That is, the network's internal workings: the way it is controlled and how it works internally. This is something that will be noticeable by users because this transformation is going to bring about flexible, customizable services. This is the so-called network core. This core has been fully redesigned:



NOWADAYS WE HAVE 5G RADIO INTERFACE IN MANY COUNTRIES THROUGHOUT THE WORLD. IN FACT, THERE ARE ABOUT 80 OR 90 COUNTRIES THAT ALREADY HAVE A FAIRLY LARGE DEPLOYMENT OF 5G RADIO.

the 5G core is absolutely different from 4G's. In the latest stages of 4G some virtualization and user plane separation and control aspects began to be gradually introduced: CUPS, Control and User Plane Separation. Technology is always more evolutionary than revolutionary. Normally, progress is gradual and substitution does not take place by something completely new. But 5G is really completely different, because the new core is radically dissimilar from the former one in design, concept and capabilities.

Another aspect that has been revamped is the radio interface, which communicates the terminal with the base station. The size of the subcarrier spacing has been increased, flexibility has been improved, slot times reduced... Last, the third main element of 5G is Edge Computing. This is the most revolutionary idea, as it blends communications with computing in such a way that it will form a single, fully integrated system.

Naturally, all this is being deployed in reverse order of complexity. What has been the first thing? The radio interface, which although very important, was the less complex thing. Nowadays we have 5G radio interface in many countries throughout the world. In fact, there are about 80 or 90 countries that already have a fairly large deployment of 5G radio. This aspect will be improved in the next release, but at least we can say that this already existed last year.

As for the core, the first ones will be installed throughout 2020 or maybe by 2021, as Covid has delayed things somewhat. This has forced both carriers and manufacturers to pay great deal of attention to providing today's services, which has caused tremendous tension. No comments have played out on the press, but I really think that ICT services have held their ground really well. Hardly any restrictions have been necessary, even when taking into account that average increase in demand has been around 30% and as much as 300% in some services such as WhatsApp. Infrastructures and carriers have responded admirably well to the big challenge this has entailed. Note that if you intend to treble electrical or water

consumption, it would be impossible because existing infrastructures would not be able to cope with that.

Understandably, this has entailed a delay in plans for new deployments by three or four months. It is possible that the large-scale implementation will arrive in 2021. This is what –using a different terminology- you may have heard as a standalone or non-standalone deployment: this is tantamount to saying if you have a 5G core or you do not. Non-standalone deployments are the ones being made in radio interface implementation. In the end, the whole network control remains 4G. A standalone deployment means that you have a 5G core and the reverse thing happens: 4G or 3G connects to the 5G core.

The third element, Edge Computing, will take longer to get it done. This is an integral part of the core. But one thing is being technically part of the core, and a different one is providing a commercial service. At this stage, understanding business models and how the big players can make the most of this new network capability remains a bit of a challenge.

We are already seeing some brands sharing their first ideas about 6G. Are there any defined lines that will indicate where this technology is going? Is there a widespread idea of the intended direction?

Yes, there is some idea. As it is the case with 5G, here we have two ways of tackling the issue: bottom-up or top-down. When it's

bottom-up it means that there are new technological solutions in place and these new technological and scientific solutions are used to introducing new, enhanced network capabilities. For the top-down design goals are first set and then technologies and solutions making them possible are developed.

5G has been mostly top-down and I think 6G will be similar. And yet, now the momentum is being sustained by academic institutions, as ourselves, that are contributing their vision of what 6G will be like. However, there will come a time in which industrial consortia such as 3GPP will dictate: “our vision on 6G is this", and therefore it will be the one being ultimately developed. In the end, it will be on the one hand what manufacturers are going to sell; and, on the other, what carriers will buy, so it makes sense that they lead this development.

When technological solutions exist in a clear-cut market, we run the risk of failing completely. This is what happened with WiMAX, once a promising technology. There have been more instances of this: technologies that were set to be a whole revolution but ended up as epic fails because there was no clear business model and they did not fit in the strategies of leading players. Therefore, I think it is only logical that 6G will be developed in the way I have described. ◆

Almost-euphoric balance of TV3's 5G experience with Superbikes at the Circuit de Barcelona-Catalunya

The long and exhausting weekend of September 19 and 20 at the Circuit de Barcelona-Catalunya ended with a feeling of almost euphoria of the TV3 team that tested 5G technology during the sixth round of the MOTUL FIM Superbike World Championship (WorldSBK). The results of the experiment, in the end, were more ambitious than the initial human and technical deployment could make think.

The project was a joint initiative of the Government of Catalonia, the Circuit de Barcelona-Catalonia and TV3, the TV channel of the Catalan Broadcasting Corporation (CCMA) within the consortium 5G Barcelona, with the cooperation of Centre of Telecommunications and Information Technologies, Vodafone and the Institute of Robotics and Industrial Informatics (IRI-UPC). Moreover, the participation of the Guttmann Institute in Barcelona added an interesting and infrequent human dimension to the essay.

The goal was to produce and perform the signal of a sports broadcast, the superbike races, using 5G technology for the remote connection of image and sound capture points. But it was not simply a matter of replacing the usual connections with 5G, but adapting the technical and human equipment, and the narration of the events, to the new possibilities and benefits of the latest mobile generation.

Thus, the different actors involved took advantage of the opportunity offered by the World Superbike Championship –at the Circuit de Barcelona-Catalunya for the first time– to experience the use of 5G with "real fire". On the one hand, a mobile network by Vodafone, highly available by the absence of the public in the circuit due to COVID-

19. On the other hand, the racing speed would allow put to the test as in a laboratory, quality of sound, image, and realization, passed through the 5G sieve. Finally, the support of Dorna WorldSBK and the Circuit for everything to go well was a decisive and valuable contribution.

"A superbike race –Marc Sansa, TV3 TV director of the race, explains– is a hell of a lot at once: a hell of sound, a hell of radiofrequencies and a hell of narrative simultaneity of the image. And all with the vertigo of extreme coordination. It was the perfect place to test the project. It would only take a little rain: indeed, it rained on Saturday! "

Replacement of TV cameras by smartphones

"The first big challenge - Sansa explains– was to replace the usual cameras and microphones with state-of-the-art smartphones and use 5G to transport the TV signal, adding all the associated information (commands, returns, etc.)". Indeed, the central leg of the project was producing pictures with the smartphones and sending these signals via 5G to the remote realisation system.

In the realization position, located on the circuit but not necessarily, a virtual mixing board deployed in the cloud was used to produce the TV signal, broadcasted by the CCMA's Esport3 channel. The realization got the signals from the cameras deployed for the project (four smartphones, a webcam and a GoPro), from the official signal of the races provided by Dorna, and from the different necessary elements (graphics, music and videos) also available in the cloud.

"Thanks to the 5G coverage –says Sansa– we did not put a single cable between the live points and the control of realization. Once we had all the SRT (Secure Reliable Transport) signals in the cloud, we performed the transmission with the help of a specific software, remotely managing the image and sound mixing functions, controlling the

play-out of the videos, graphics, signage, overprints, etc., as well as the internal commands."

"Despite the apparent difficulty of working with this deallocated system and without much precedent –explains Alberto Alejo, TV3 engineer–, the advantages weighed more on the scales than the disadvantages". On the positive side of the scale, Alejo points out that the use of smartphones "allowed us a great mobility of the displaced equipment, because of the light weight and energy savings". Assembly and disassembly times of the operation could also be shortened and the number of people on the team reduced. "This speeds up orders and work", says the engineer.

Remote control of a GoPro with the pupils of the eyes

Two smartphones and the GoPro were located on the main line, which was the part of the circuit with 5G coverage, specifically deployed by Vodafone. One of the smartphones sent the signal of TV3 journalist moved on the track and in the pit area. The other one, operated by a cameraman, got the pictures of ins and outs of boxes and so on.

The GoPro, also in the pit-lane, was remotely controlled from the Guttmann Institute in Barcelona, operated by a robotic arm connected to a 5G modem. There, more than ten kilometres away from the circuit in a straight line, Armando Folgado –old patient of Guttmann, slot cars racer and a motor sports fan– drove the GoPro with the pupils of his eyes in real time, thanks to a special screen designed by the IRI-UPC. At the same time, Folgado collaborated as a commentator with the journalists in charge of the transmission and located in the circuit.

"We worked very decentralized", explains Alejo, "but with a common goal", and "the result is up to any production made with the traditional

system". According to Marc Sansa, "the combination of a multidisciplinary team and a very high professional level, in addition to individual enrichment, has greatly multiplied the quality and success of the end result."

Not everything went well

A last-leg of the project was to send via 5G the signal from a 360 degrees camera, installed in the line of arrival, to the YouTube TV3 channel, where viewers could follow events direct and change the point of view from any mobile connected device. "Our goal was that any spectator –Sansa explains– could enjoy this immersive experience, becoming a privileged observer from this unique point of the Circuit de Barcelona- Catalunya". The gap between the events and image live that arrived on YouTube was around 20 seconds or so, more immediate than the transmission by Esport3, about 30 seconds.

This part of the project suffered from various problems, the origin of which is still being investigated. The 360-camera stopped emitting for a few hours and that, among other things, put the counterpoint to the overall positive results of the project. "The ongoing risk of working with a new live technology by antenna", says Alberto Alejo, and the project planning in general, more alluvial than laboratory, was among the causes of what did not end work quite well.

"Technology is evolving at a dizzying speed in all fields", says Sansa. “Traditional TV production will necessarily change in the coming years, simplifying some parts and complicating others, while enhancing TV productions with new and attractive entertainment formats. This project is a good proof of what will come to us in the coming years.”◆

Exploring the potential of 5G in **remote production**

By Olivier Suard, VP of Marketing, Nevion

Mobile technology has played a role in broadcasting for many years now, with consumers often watching TV on the go, streamed over the internet and cellular networks to their devices. It's now such a popular way to watch content that Cisco predicts by 2022, video will make up 79% of all mobile traffic. On the production side, cameras with 3G/4G/LTE connectivity have provided unprecedented flexibility for ingest, especially in situations where mobility is key.

However, the advent of 5G with its promise of significantly greater bandwidth, faster data communication, lower latency, and defined quality of service, is creating a lot of excitement in the broadcast industry. In fact, Nevion research conducted in the first half 2020 has found that broadcasters are optimistic about 5G and the timeframes in which they will be able to adopt it, with 92% expecting to do so within two years. Almost two-thirds (65%) of the broadcasters would consider adopting 5G for remote production, but just how plausible is this and what needs to be considered first?

Opportunities in remote production

It's no secret that broadcasters are looking to do more with less – create more content with fewer resources. One aspect of achieving that goal is to become more light-weight and nimble in the process of acquisition, and to centralize production to make optimum use of equipment and production staff.

The trend for IP-based remote production fits squarely within that framework. With cellular technology, acquisition becomes even more portable and more mobile, thanks to the fact that fewer cables are required, for example. Broadcasters can set up on site more quickly and cost-effectively almost anywhere, which is particularly useful to report on breaking news, for example. It also means that events that require tracking over considerable distances, such as sports including cycling, road running, or cross-country skiing, become easier to cover. This is not just about 5G connected cameras though:, there is also the potential for "pop-up" production facilities using 5G to deliver multiple camera signals back to a central production facility.

One issue, however, is that the environments in which mobile technology would be most suited are often those where there is a lot of contention for bandwidth – like many spectators using their cellphones during a sporting event – which could adversely affect the quality of the media transport. But this problem could be overcome should dedicated 5G bandwidth come to fruition- more about this later.

Mobile technology can also be used as back-up link for more conventional remote production land-based or satellite connections, providing a more versatile and economical solution than traditional diverse routing over fixed connectivity. In fact, of the broadcasters polled in the Nevion survey, 42% thought the biggest benefit of 5G will be providing a cost-effective back-up for contribution links. 4G technology is already being used for that purpose in some deployments – typically for the transmission of a small number of feeds rather than all the feeds, but the extra bandwidth provided by 5G offers the prospect of using the technology to provide more back-up feeds, of higher a quality.

Some in the industry are now envisaging 5G providing the main link for remote production. However, this is a substantial leap in requirement, especially in the level of reliability and Quality of Service (QoS) expected, therefore unlikely to be a viable option for quite some time.

Key consideration for 5G in production

Deterministic data transfer

Live broadcast production has a combination of requirements for networks that exists in no other industry: very high volumes (video signals), ultra-low latency, and absolute reliability. While 5G promises higher bandwidth and lower latency than 4G, the typical enhanced mobile broadband (eMBB) service is still inherently best-efforts connectivity and by design is oversubscribed with significant contention.

The asymmetry and best-efforts behavior of eMBB also make 5G less than ideal for some broadcast production, but for other applications, they may be acceptable. For example, where 5G is used as a backup connection for contribution, using eMBB may well be good enough, in the same way as the Internet, with its fluctuating bandwidth, can provide good enough connectivity as a backup.

One of the new exciting capabilities potentially offered by 5G is the ability to reserve dedicated bandwidth for specific applications. While this bandwidth slicing capability is not yet available, it would be a very attractive proposition for broadcasters, potentially providing the QoS required for real-time production.

The question is whether 5G carriers can be persuaded to provide a "custom slice" of bandwidth for broadcast applications, when other applications maybe be more lucrative. The commercial reality is that broadcast contribution or remote production alone are unlikely to offer service providers a sufficiently large potential market to make it worthwhile for them dedicate valuable bandwidth to broadcasters. However, combining forces with other 'niche' areas, such as emergency services, more generic dynamic event-based data requirements and maybe military applications, could make this approach viable. Ultimately, whether broadcasters get to use a dedicated slice of bandwidth for production will probably be down to pricing.

Timing and Security

Broadcasting has very stringent requirements in terms of timing to synchronize the signals from all the various sources. In an IP world, the industry has standardized around precision time protocol (PTP). The good news is that 5G specifications include time-synch and timing accuracy information

which should potentially be tight enough to meet the requirements of broadcast production. It remains to be established whether that timing information can be extracted and made available in a manner that is suitable for consuming within production devices.

Currently, the EU-funded projects, in which Nevion is contributing to, 5G-VIRTUOSA and 5G-VINNI are leading the way in investigating how to handle timing in 5G, and it's a case of watch this space. This is also true of security where the key focus areas are authentication of devices, encryption of content and secure control channels. There are both existing and emerging standards that can be applied to this area, but it remains to be seen which will reign supreme.

5G's place in the broadcast value chain

We are only just scratching the surface of 5G and its exact place in the broadcast value chain is still to be determined, but initiatives like 5G-VINNI and 5G-VIRTUOSA will help uncover the true potential of the technology in live broadcast production. In the meantime, broadcasters should continue to test the technologies in their broadcast environments and work with the experts to ensure that when the time comes, they are ready to adopt it in whatever capacity that may be. ◆

What 5G means for **media** and **entertainment**

By: Baruch Altman, AVP Technologies and Projects, LiveU and Chair, 5G-IA Trials & Pilots Working Group International Stream

We have been heavily involved in a wide range of 5G trials and demonstrations around the world over the past three years. We have gained a very high level of understanding of the very powerful possibilities for the media and entertainment sector but also the challenges to maximise 5G performance. This is what we have learnt.

To give you an understanding of our experience, we have taken part in 5G field broadcasts with US, APAC and European cellular providers, including AT&T, NTT DOCOMO and KT (Korea Telecom) and been actively involved in important EU collaborative research and validation 5G projects, along with other key players. Over the last three years, we have, along with others, of course, been a partner in five 5G Infrastructure Public Private Partnership (5G-PPP) projects funded by Horizon 2020, the biggest EU Research and Innovation program. The projects' goals are to provide the broadcast community and other verticals with insights into 5G performance in real-world scenarios, both in production and in consumption/distribution.

We also recently took part in a multi-party 5G demonstration around the IBC timeframe. It took place as part of IBC

Showcase 2020 and was designed to show proof-of-concept remote broadcast production. Broadcasters who took part included BBC and ViacomCBS who championed it, TV2 Denmark and others as well as network operators EE and VodafoneZiggo. The demonstration involved broadcasting live

from RAI Amsterdam into ViacomCBS' London studio with two camera feeds via LiveU's new, multi-camera LU800.

This demonstration revealed many key benefits and was smooth, but it also showed, and this is something that we have repeatedly seen, in order to add the required reliability in terms of uplinking and the bandwidth available, adaptive multi-link capabilities are required.

Separately, in a recent first of its kind 5G-TOURS project test with RAI, TIM, and LiveU, we all demonstrated a live TV transmission over RAI's 5G network. The first part was a lab test. The second part, as 5G-TOURS states, "was performed with a LiveU backpack, using tethering on a Samsung S10 5G smartphone, provided by Samsung, to transmit over the TIM 5G commercial network deployed using Ericsson equipment's in order to verify the whole transmission chain."

This is a key part of the build-up to a planned multi-site musical concert called "Itinerant Orchestra", a trial planned for this autumn, in Turin. 5G-TOURS says that "the event is a concert performed by an orchestra with some musicians located in the main concert hall and some other itinerant musicians walking in the streets while approaching the concert hall. Each itinerant musician is followed by a cameraman shooting their performance and providing cues to stay synchronised with the main orchestra performance."

As a result of the enhanced commercial and research exposure, we see, and believe strongly, in several main media and entertainment use cases (and variations upon them) benefitting from 5G.

The first use case is remote production (REMI) over the public internet, which can also include multi-room distributed production, where multiple production staff operate remotely from one another working collaboratively on the same live content. Remote production involves sending compressed real-time, in-sync multi-camera feeds (including 4K) from the field (venues, events sites, outdoor sports locations...) into the cloud or to the production facility, rather than sending out an OB unit with all the equipment and staff. We see strong demand from customers due to the economic and operational benefits, especially in these days of social distancing. We see strong customer demand for this.

Secondly, we believe in the 5G benefits for enhanced news gathering for live and recorded coverage and much faster pre-edited file uploading, providing additional uplink capacity and enhanced user density support.

On the distribution side, we see sector demand for mass HD content distribution for live and non-live consumer consumption. With more

users, watching more live content, at higher quality, 5G broadcast and multicast have the important potential to reduce network load, enhance the viewer experience and reduce operators' costs.

Then there's AR/VR viewing where the content may be live or pre-arranged: consumers on mobile devices can experience AR/VR, either passively watching or with gaming or other collaborative experiences. The requirement for high bandwidth at very low latency (ensuring that usage isn't inhibited by the physiological phenomena) is expected to be resolved by 5G. This applies to eGaming and eSports as well but these sectors also require multi-player synching with very low latency.

There are also AI-driven media use cases where back-office AI is used to analyse and work on high-quality video coming in from mobile field devices for various outputs.

5G offers a range of key technologies to enable and support these cases. The main ones are higher bandwidth, both downlink (mainly) but also uplink; slicing and orchestrated virtualised services using 5G Core to enable QoS "guarantees" for paying customers in stand-alone (SA) networks; edge computing that enables latency reduction in some uses; support for increased user density – to reduce congestion both for production and consumption; broadcast/multicast support; and NPN networks and NPN-PN roaming and collaboration models.

Returning to a point above, the issue is to close the huge gaps between the promised performance and the current or imminent 5G network deployments, if, and when, all these 5G "goodies" are

enabled and fully deployed. This requires a lot of research and validation – technological, operational and economic (return on investment). Then there's the capital investment, including spectrum, basic infrastructure, optional advanced infrastructure and more expensive end-user technologies; we all need to understand the possibilities versus the limitations. There's also the issue of how widely networks are deployed and network resources allocated. It depends on investment priorities and ROI analysis, which are in competition with other verticals/use cases/markets/businesses such as IoT, smart logistics, autonomous vehicles, smart cities etc. Such full 5G deployments are some way off, though in some countries that see 5G as an engine to drive their economy, rollouts will be earlier than in others.

LiveU is a proud partner in these EU 5G collaborative research and validation projects: 5G-SOLUTIONS (#856691), 5G-TOURS (#856950), 5G-RECORDS (#957102), COPA EUROPE (#957059) and 5G-Xcast (#761498). ◆

From the fantasy world of “Carnival Row” to the naturalistic touch of “Fleabag”

TONY MILLER BSC DIRECTOR OF PHOTOGRAPHY

Tony Miller BSC has been closely linked to photography direction for more than three decades now. Throughout his long career, he has been an exceptional witness of the unprecedented progress seen on the TV scene; he has undertaken projects of all kinds and assumed constant challenges all along.

Two of his latest works, although very dissimilar, do reveal his ability in building truly special atmospheres through his particular perspective: Fleabag, a fiction series promoted by Phoebe Waller-Bridge, winner of several Golden Globe and Emmy awards; and Carnival Row, a tantalizing proposal within the high-budget fantastic genre.

We talked with Tony to get him tell us about his experience in both projects, as well as the technical challenges he successfully overcame.

What's so great about Cinematography that made you stay in the industry during decades?

To be able to create beautiful images that underscore emotion and are relevant, is a privileged position. You get to do this with a giant 'train set' and lots of people to help you achieve your ambition. What is not to like?

I am always challenged by cinematography. I often find it very difficult. Rarely do I think I have done it well – mostly I think in retrospect I could do it better. So, you are constantly evolving, constantly pushing yourself. This is a life journey skill – certainly difficult, but hugely rewarding.

I am motivated by many things – but I will often take a low budget project instead of a large budget project. People and the script are key.

You've state that the story is often what drives your style and what gets you involved in a project. Was there a time when the technical challenges and possibilities of a story were what motivated you to get involved in a movie, series or short film?

Yes, of course – if I am usually motivated by the story and how to underscore the emotions of that story, I am also challenged by taking on a film technically. Our art is a direct combination of the technical and the storytelling. With "Fleabag" what motivated me was Phoebe Waller-Bridges and her brilliant script. With "Carnival Row", it was the technical challenge, VFX and logistics of a vast canvas.

So, I am motivated by many things – but I will often take a low budget project instead of a large budget project. People and the script are key.

We loved a phrase that can be found at your website. You said cinematography has to be "Emotionally relevant and subtly underscoring". Could you elaborate on that vision for our readers?

I grew up in Holland being dragged around countless art galleries by my parents. Cinematography, like painting, has to be emotionally relevant. It has to underscore and bring out the story and emotions of the film. Yet you want to do that without the cinematography being obvious or drawing attention. Like Edward Hopper (the painter), one tries to create a story that reveals the thoughts and emotions of the characters. You do it with the tools of cinematography. So, reading the story beats in the script is for me absolutely key.

We've seen a dramatic evolution of

cinematography on television shows. In your opinion, why has this happened? What are the reasons for this transformation?

In some way, I think it was always there – certainly in the UK where TV has been highly regarded as an art form for years. But suddenly, TV's became much bigger and the quality of HD and HDR made it more realistic for a cinematic look to be seen on the TV at home.

Many of us, now watch their cinema at home on large TV screens. In our house in Tuscany we have a cinema – and I watch most of the year's films over Christmas there or on holiday. Our habits have changed.

I frequently work on TV shows that have bigger budgets than movies. These days the choice is often - of doing a low budget film, that may never get properly seen; versus a big Amazon mini-series, for instance, with a budget that is many times that of a low budget film. It will be seen by many millions. So, the landscape has changed. To work on TV with budgets of $8-10 million per hour is common now. That has a profound impact on what you can do cinematically.

What have been the main technological revolutions for your work? We heard that you're amazed by the possibilities of LED lightning. Is there any other solution you have recently discovered and plan to implement in future shoots?

Well I am just about to shoot a movie – anamorphic on film! Believe it or not, I am going back to the old ways! I love the speed that LED lighting gives me and the versatility – suddenly I need far less lighting fixtures as the LED ones are so versatile. But I still often use large Tungsten sources – Dino's, mini brutes and 20K's, as I love the quality of light you get.

Part of the technology revolution is balancing what you do on set and what you can do in post. It starts with the cameras: as they become so much more sensitive, I use less light. As someone who shoots period films, is a great deal. That means I can use real candlelight much more effectively. Often, I will combine this with halating the source, for instance, in post-production. Previously, I would do all this in camera.

Again, our craft is part creative and technical – we mix both and need to stay on top of these artistic technical tools. Staying 'current' as a pilot

might, means regular immersion in the new technology – testing it and implementing it into one's creative work. We never had to do this so often in the film days – but I really like the evolution of new technology. I like having to change and evolve. How one tells the story is key and these new tools are absolutely part of our craft.

In addition, we're now living the UHD age, especially in TV series as broadcasters + platforms want to take advantage of these technologies to provide an extra value to their platform. What is it like to work in 4K (or bigger res) and HDR? Must HDR be a creative tool to use when the project needs it, or should it be integrated into every TV production?

I think HDR is rapidly becoming the norm. That means that we shoot, post produce and colour correct for it. I have just done 3 Netflix shows in a row and all are for HDR. I think we will see in the next few years that this

I think HDR is rapidly becoming the norm. That means that we shoot, post produce and colour correct for it.

becomes the new standard.

Today we'll focus on Fleabag + Carnival Row. Are there any other challenging or interesting TV projects from a DoP perspective that you're particularly proud of and want to tell us about?

There are many – from my early documentary projects (that so inform how I work in fiction), to key political projects such as "Small Island" a mini-series about race in the 1950's and 60's in the UK with a fantastic cast. Projects that have some form of political relevance or inform our lives, are always the ones that I relate to best.

Delving into the low-budget Fleabag... What was the camera + lenses package for this production? We heard that handheld cameras were deployed to shoot. How did this transform your workflows? What are the pros and the cons of this type of camera?

Fleabag had a reasonable Amazon budget – so it was not as low budget as many think. We shot with an Alexa mini in anamorphic, with Cooke Anamorphic lenses. Workflow was a traditional one. I shot it almost completely handheld – I became like a player in the drama and to be able to react instinctively to Fleabag/Phoebe as she broke the fourth wall meant that handheld was the only way to go.

It is a project that I could only have shot as DP/operator, as the camera was so implicated in the drama. It was exhausting, but very rewarding. At the same time, we wanted it to seem effortlessly cinematic, for Fleabag to be beautiful and radiant when she breaks the fourth wall. I found it a very challenging and demanding project to shoot – much more so (suprisingly) than something like "Carnival Row".

Fleabag has a definite naturalistic touch, but it does not renounce its cinematic feel. How did you achieve this technologically? In addition, about breaking the fourth wall, did you remarked that in some way from the Cinematography side?

There is a sense that when Fleabag breaks the fourth wall, she implicates the audience and makes us also responsible or reflect on our own bad behaviour. I think we all have a bit of Fleabag in us. So that was at the forefront of my mind. But we wanted it to be a cinematic experience.

I had never shot any comedy and was hired as

Fleabag season 2.

the guy who shoots period drama. So, I tried to combine a naturalism with a cinematic look. That affected the way it was lit, the way it was operated and especially how we revealed the emotion of the story.

Carnival Row is a massive project whose cinematography, we think, you designed together with Chris Seger. Again, what were your main camera + lenses options and why did you decide to implement those solutions?

Carnival Row is the other end of the spectrum – it was huge and had great ambition. Alexa Mini and Master primes were my choice here and we had multiple camera packages as often we would have the main unit, a second unit, a green screen unit and even a stunt unit working at the same time. I had about 8 weeks of prep and many sets to pre-light – but also much to integrate with the VFX team who were superb, the stunt team – likewise a great bunch and setting up a look for the series.

There are a wide variety of situations during the series that demonstrated your creativity and technical skills. Could you revamp a particular scene that was especially challenging?

There are many. We had a number of wirecam shots day and night on the Carnival Row street set. It was about 800 metres long and we set up 4 cranes to hold the wire cam and then would swoop down in between the overhead vernacular railway, just missing stunt men, down to ground level

where the grips would lift off the Stableye remote head by hand and walk through the street. We had a stunt team of about 30 and often 3-400 extras. At night I had Wendy lights on cranes positioned up and down the street, balloons and massive night rigs to let us traverse the street in long single shots. Then we would add rain effects etc.... So, it was ambitious – aided by the fantastic Czech crew - this was of course huge team work.

In addition, we would love to address the FX of the production. You used these gigantic sets but you also benefit from great green screens and lots of post-production. How do you work in these circumstances? What's your involvement with the post-production team?

Working on such a large-scale production one has to rely and work very closely with the VFX team and in this case the superb VFX supervisor Betsy Patterson. We would discuss what we intended to do early on, story board it and often previsualise it. As there was so much wire work and people flying, we had to frequently combine location elements with later greenscreen studio work. It was a huge challenge and matching the lighting and movement was key.

Finally, what will your next project be? Will you keep betting on TV shows?

I am about to start a movie – "Mr Malcolm's List", a period drama to be shot in Ireland on film shot anamorphic. For Bleaker Street and Sony Picture Classics. After that I might be doing an Amazon project for TV. I also try and continue to shoot a documentary once a year. I try not to get pigeonholed. ◆

Carnival Row

Live streaming in covid-19 times: challenges and technological solutions – Analyzing Red Bull “Batalla de los Gallos” with Square One Media

Measures for social distancing that are now commonly seen in many countries throughout the world have forced many brands to dramatically change their communication proposal. The solution? Rely on campaigns that are able to offer remote and virtualized production services in order to keep being able to contribute their contents to televisions, digital platforms or social media.

Square One Media is one of the companies that have developed these kinds of services. Throughout the past few months, marked by Covid-19, it has performed a large number of production services in virtualized environments for broadcasters and first-class brands that were in urgent need of a versatile channel for communicating with their public. Among other companies, RTVE, Grupo Henneo, Twitter, Universal Music, Samsung, NH Hotels Group or Mapfre have all acknowledged its good job.

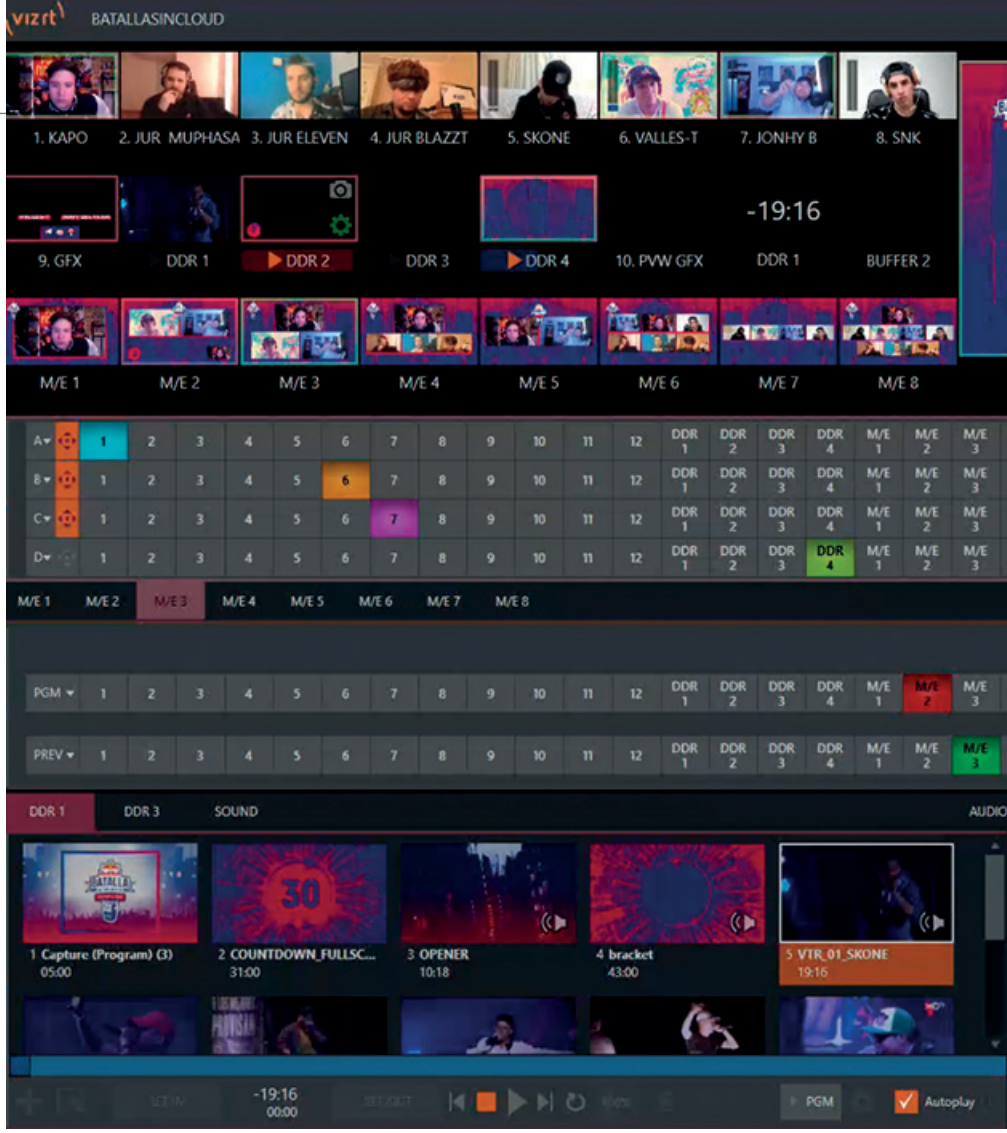
Another one of them is Red Bull. The popular energy drinks brand wanted to keep one of their most celebrated events in the Latin American Market, the “Batalla de los Gallos” (Cockfight), an improvisation contest. And it did so by means of an ambitious production broadcast on YouTube which connected artists from several continents in real time.

We delved in this interesting project thanks to Nacho Galindo, co-founder of Square One Media and person in charge of project Red Bull "Batalla de los Gallos"; and also with a spokesman of the brand itself.

How would you define the job carried out by Square One Media?

Square One, as a company providing a comprehensive service of live stream and having a strong focus on the application of technology... but I would say that what we do is alive. On our website we describe ourselves as a full service live streaming company and, in this regard, we are involved in all stages. And the larger the number of stages in which we take part, the more comfortable we are, because we can then add more value to our clients.

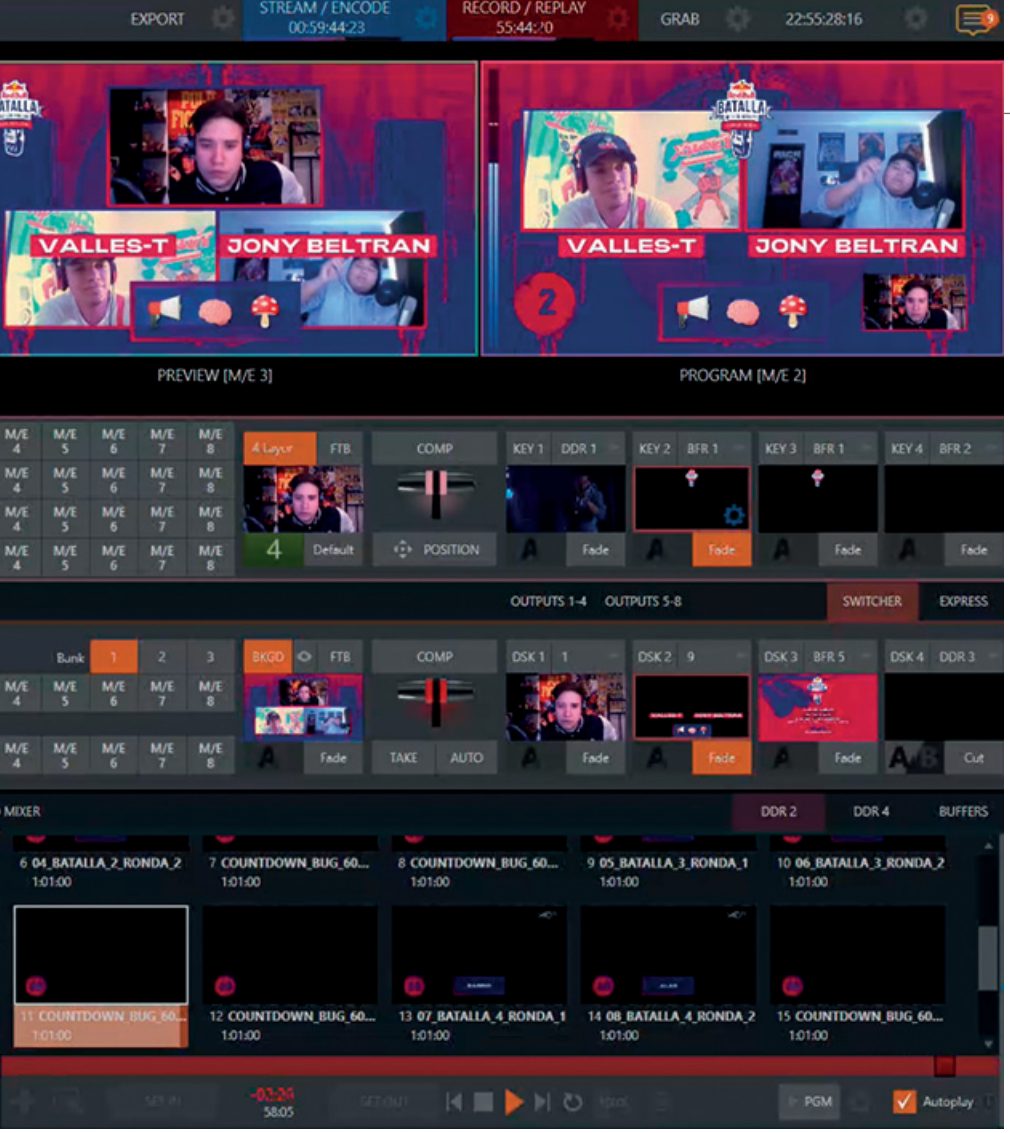
Streaming content must be specifically created for the target and goals that need to be achieved. In this sense, in many instances content creators are not aware of the tools they have and how far they can go. The fact that we are involved in this part provides them with a very strong leverage that makes them reach further that they could possibly imagine. In the end, we convey all our experience to them by means of advice. It is a kind of 'this works and this does not'.



Multiview

We very much like being in this side of content design. And one extremely important thing in these streaming contents is getting the audience's feedback: if communication does not flow both ways, it is just traditional TV content. Viewers must participate in order to have engagement multiply, so we must provide interactivity tools.

Beyond this, we take part in multicamera production, always within environments such as IP. We have also resorted a lot to delocalized contribution, either through basic devices such as laptops or tablets, or by means of professional cameras. At present we have a lot of low-latency, bidirectional full duplex: this is a key requirement for dynamization of content. This kind of production, which some time ago we were already able to do remotely, is being taken to the next stage: remote operation.



From this point, we can perform the signal's transport and take part in its delivery, as we are experts in handling, contribution and distribution through social media. Furthermore, we perfectly operate in the environment of first-class CDNs such as Akamai or Amazon. On the other hand, for many projects we carry out the landing, where users get in for accessing contents.

Many of your services are adapted to the current context, which leads me to the next question. Have you always embraced these services? As a company in constant development... what is your story?

Square One was founded by a group of professionals that had already worked and operated together in other audiovisual projects, especially those relating to streaming. We all have more than 10 years of experience in this field, even more if we take into account audiovisual production as a whole. Back in those years the first trials with live streaming were starting. The usual medium was ADSL and there were neither fiber nor 4G. Work opportunities sprang up and we had to delve deep in the technical side.

We were the first ones to work on the Ka band. And we thought: 'if this works for rural Internet, why wouldn't it work to give me width in a concert? We explored its advantages and drawbacks and from there we introduced the transmission backpacks. We then realized that the world of streaming had not the same budgets as the world of production and we had to be very creative in order to include what we called 'light production'. A really expensive mobile unit was not required for a three-camera production. Our clients had also their own problems on the delivery side, so we had to learn how to work with CDNs and we began to provide that value.

At present, streaming has become a great deal more

democratic. It is something fairly easy and can be done by anyone, but our clients are in the need of being able to provide a high-quality service, with stability as main requirement. But streaming also entails risks. This is the first thing we face: we convey calmness and place reliability as a crucial element throughout all our stages. That is, we revolve around the full service concept.

In recent times you have used the possibilities offered by virtualized production over IP. What is this concept about? How do you assess the versatility of these solutions?

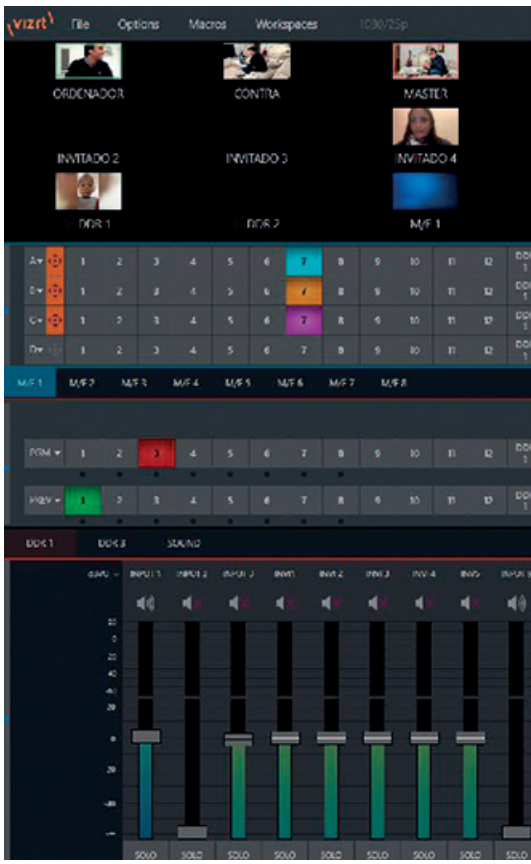
The audiovisual industry is not going to be left aside the technological revolution being experienced in all sectors. You can't swim against that tide. Quite the opposite: you have to make the most of all those advantages. As I was telling you, we had to include many kinds of solutions as creative responses. This innovation is something native to us. In fact, we do not conceive a project that is not within an IP framework.

We have a sort of test lab for ideas in which we examine opportunities for inclusion of new technologies in our workflow. We are tracing and tracking ideas all the time, we take them to our lab, test them and see if they are feasible. If they are reliable, we take them to our workflows. This is usually the result of a need that speeds up everything: a project comes up in which this technology is the solution and, as we already knew it, we take it in.

There is something very important to me: virtualization is not only a revolution from a workflow standpoint, but also financially and this is extremely important. When we virtualize, we have resources in a flexible manner. We go to OPEX resources: I don't have to buy a mobile unit and try to make it profitable, but just rent it on the cloud for a few minutes. This concept change is really quite something, and a very relevant change.

In the end, this provides great scalability and adaptability to you...

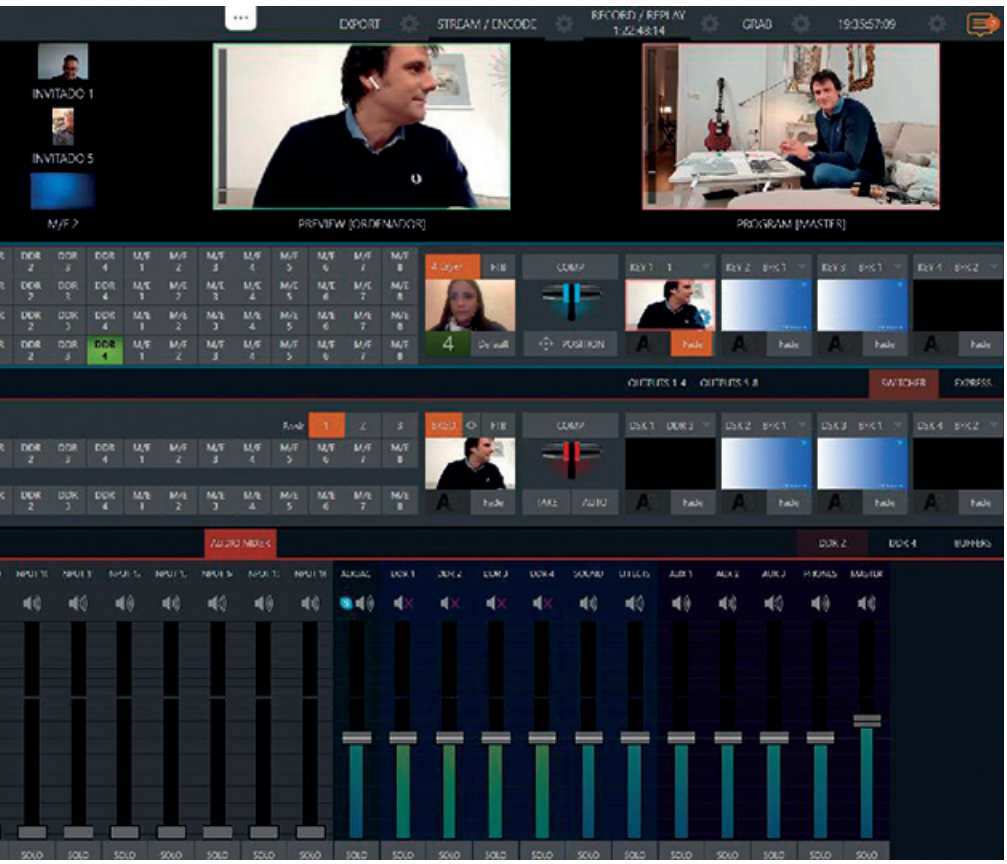
Exactly. We can face overnight 10 simultaneous productions without having to make any investment. This is a remarkable financial change that will mean a complete revolution. In fact, all audiovisual companies are moving their products into a service model. This is here to stay.



There are several essential solutions in your workflows: Vizrt Vectar y AWS. Which are their features and how do they integrate in your workflows?

We have been working with VIZ for many years. Indeed, 5 years ago we already proposed producing basketball games with an IP-based system that would make use of items from VIZ, NewTek, backpacks... It was a good move by Vizrt -and we are so glad- that they acquired NewTek with NDI. They have put together a number of elements that provide a very powerful environment for working. VIZ Vectar is the core of productions: it is not only a mixer, but a full-fledged mobile unit. And then, I see Amazon and its tools as the body.

NDI is also key, as it has led us to take from the equation hardware elements that were not liable of virtualization. We had this workflow nearly ready in our lab when the pandemic arrived. We worked very hard to sort out the loose ends to get the reliability we needed. And we succeeded.

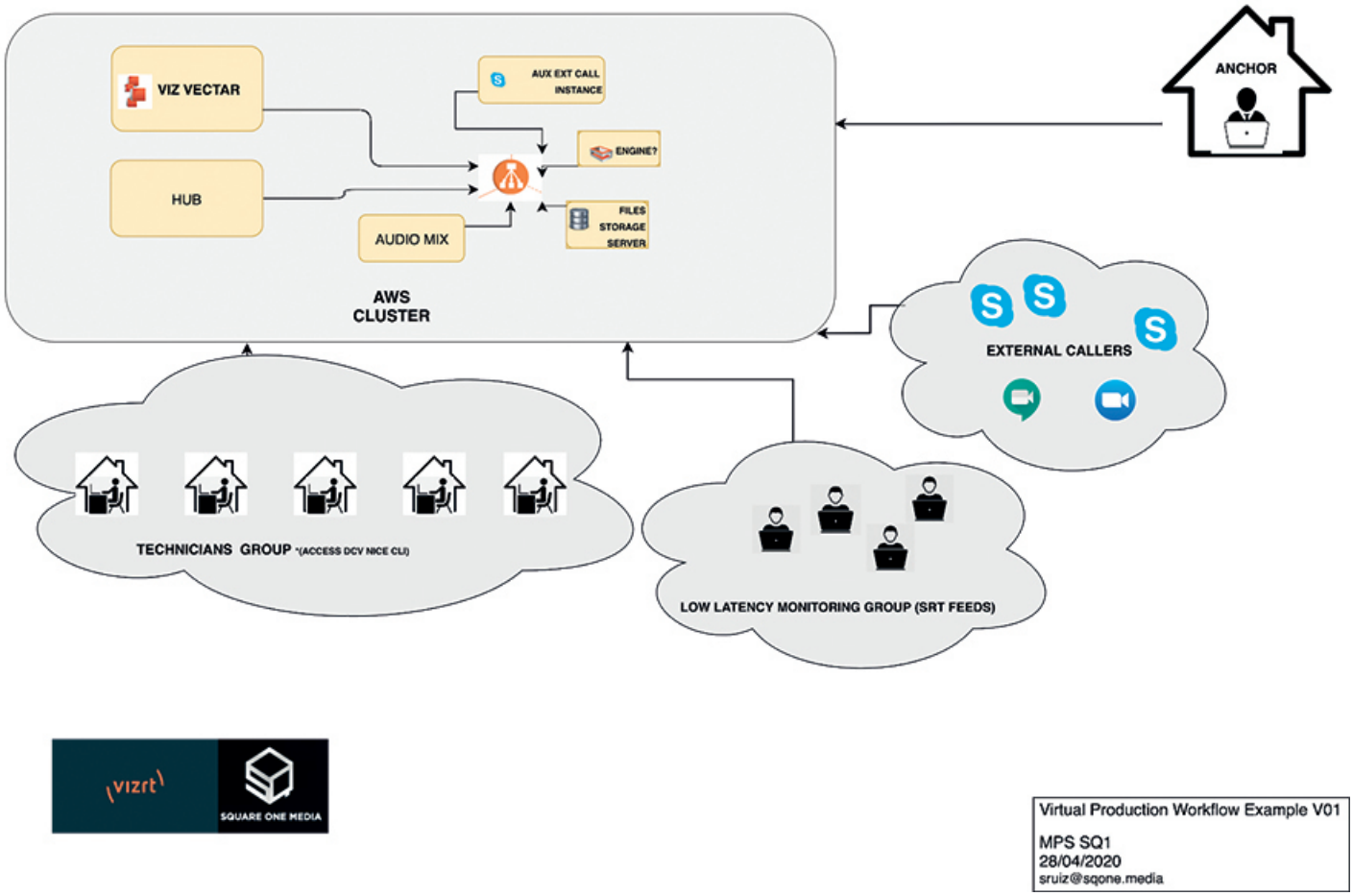


What other solutions from other manufacturers are essential in your day-to-day work?

All that surrounds the NDI environment. Where there was an array, now we have a switch. With an NVIDIA graphic card and a switch we have a lot of tools that can make many things. We are always on the lookout with this environment. Besides, we also look at open-source or free tools.

Do you think that Covid-19 has meant an opportunity causing the various clients to go for this service?

What has been vital it is not that these key technologies were already lying there, but the fact that clients were prepared to take the risk because they had no choice, as there was no other way of doing it. Both in the world of broadcasting and in companies, reliability and



security are a must. In the end, clients are always very conservative when it comes to implementing new ideas. For example, we had a hard time getting people understand transmission backpacks or the Ka band.

You have developed an interesting live broadcast project on YouTube with Red Bull. Can you tell us some more details?

We love joining in projects as native part and Red Bull let us do that. They are wizards of branded content, which is the real future for the audiovisual sector. They have a huge lead over other brands when it comes to generating valuable content for their target and audience, and we learned a lot from them. They came to us with the same need of completing a fully-delocalized remote production operation and we created project 'Red Bull Exhibición', comprising 11 very powerful episodes.

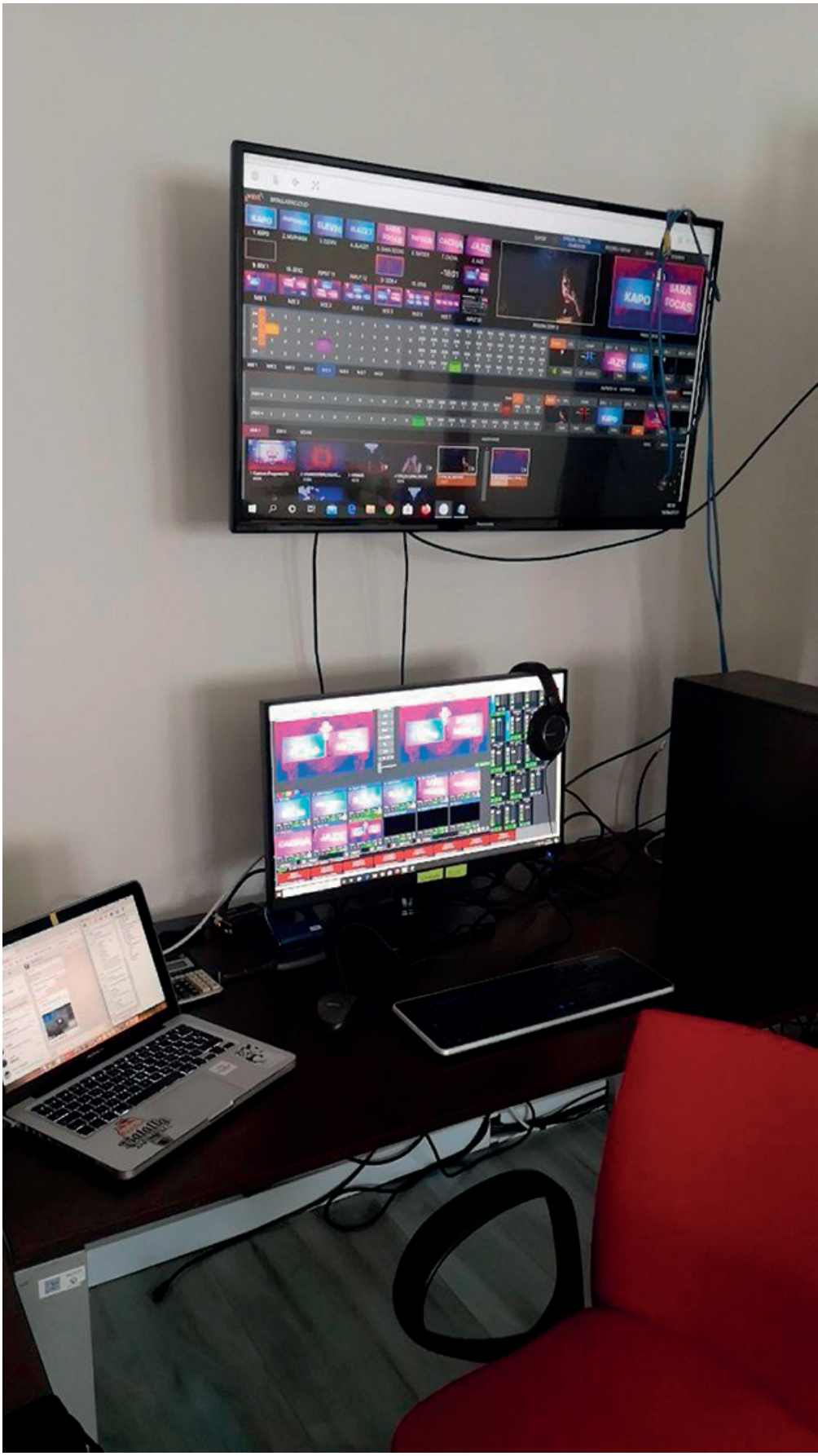
It is true that Spain offers a large advantage when it comes to fiber, and one of the main challenges was connectivity with Latin America, since this was an intercontinental project. As production was delocalized, coordination was a real challenge, because we have worked hand in hand as if it were a mobile unit, but each one from their own place.

Another challenge was to take the feedback in as the project progressed: we were doing it based on what the Red Bull team

was noticing from the audience within the production's dynamism.

How did you sorted out network connections for the Latin American contestants? Did you have logistics support that enabled you to streamline their networks?

We have done a –so to speak- pre-production job. People that were going to take part in the project had to meet a number of requirements. Although these were flexible, we had to fight with Red Bull over the talents they wanted to take part and the means those talents had available. We stretched the limits as much as possible, in the sense that we had to adapt the bandwidth required by each contestant in order to keep both presence and quality. If the event was held on a certain date, we would work with the relevant talent in equipment optimization tasks two weeks in advance. It was not only a matter of connectivity, but it also concerned webcam, microphone, processor



Remote production.

and graphic card. Therefore, pre-production has been a very important item for the success of these contributions.

And by the way, how many people were involved?

About 15 people.

Each time you complete a project, it works as a token of what you can do and the way you can act, always under the rules that the pandemic proposes. During this period, you have also worked with Twitter, Universal Music, Samsung, NH Hotels... Can you briefly tell us what kind of productions you created with them?

In line with what you just said when introducing your question, our experiences work for us both as a way of showing what we are able to do and also as experience for offering multi-faceted value solutions to our clients. And NH Hotels is nothing similar to Red Bull at all. Their goals are completely different, yet our ability for adaptation and our technical solutions can help to meet both goals.

In NH we are dealing with a corporate environment. Their Annual General Meeting is a formal, important event. Their directors were scattered all over the world so, even if the production was not a particularly dynamic one, reliability certainly was extremely important. On the other hand, working with Twitter's audience it is really exciting, because in the end, the conversations that take place and our ability to take those conversations to the content are very versatile and powerful- And, as for Universal Music, the key is that they have a truly good content: the artists. Working with such content is a blast, as it is very pleasing because it is useful in order to

reach the fans. Last, Samsung as a brand works a lot with the social media internationally, but this time they were looking for a global partner that would give them stability.

We guess this is a usual concern amongst the brands. Is this a really reliable production method nowadays?

It is very reliable, and the real secret lies in pre-production and planning, in not resorting to improvisation. However, chance is always a factor and you must know how to respond to unforeseen issues. Design is the key. Clients are made aware of the risks, of course. They ask you if they can get to a certain point and you tell them about the risks involved in reaching there. Sometimes risks are shared, but when we see they exceed what it is reasonable we just refuse to do it. We are not going to take on a project that is sheer tightrope-walking.

Virtualized production is poised to become a true standard in the future. What solutions would you like to see developed that are yet to come to light?

We are really keen on using 5G. It is going to be a very significant leap forward. We will be able to operate remotely just as if we were connected through a local network. At present it is what we really want to see implemented when the networks is available. It will technologically mark a before and an after. Then, from our side, we would like to provide tools to the people who create contents. The technology may be available to creators, who will be the ones bringing a lot of new and innovative things for us.

Are you contemplating any updates in your workflows in the near future?

We would like to adjust an environment and hand it over the client for operation. Being able to convey this knowledge on technologies to third parties; that we do not have to be present in the operation, but be able to convey these environments and train clients so they will be able to operate them. The challenge for us right now is scalability.

And how is this achieved? What are the steps towards that goal?

We have an R&D project in which we are carrying out automations and integrations among all systems that take part so they can be jointly managed.

The global situation is certainly complex. How are you addressing your daily routine? Is the industry responding well to your services these days?

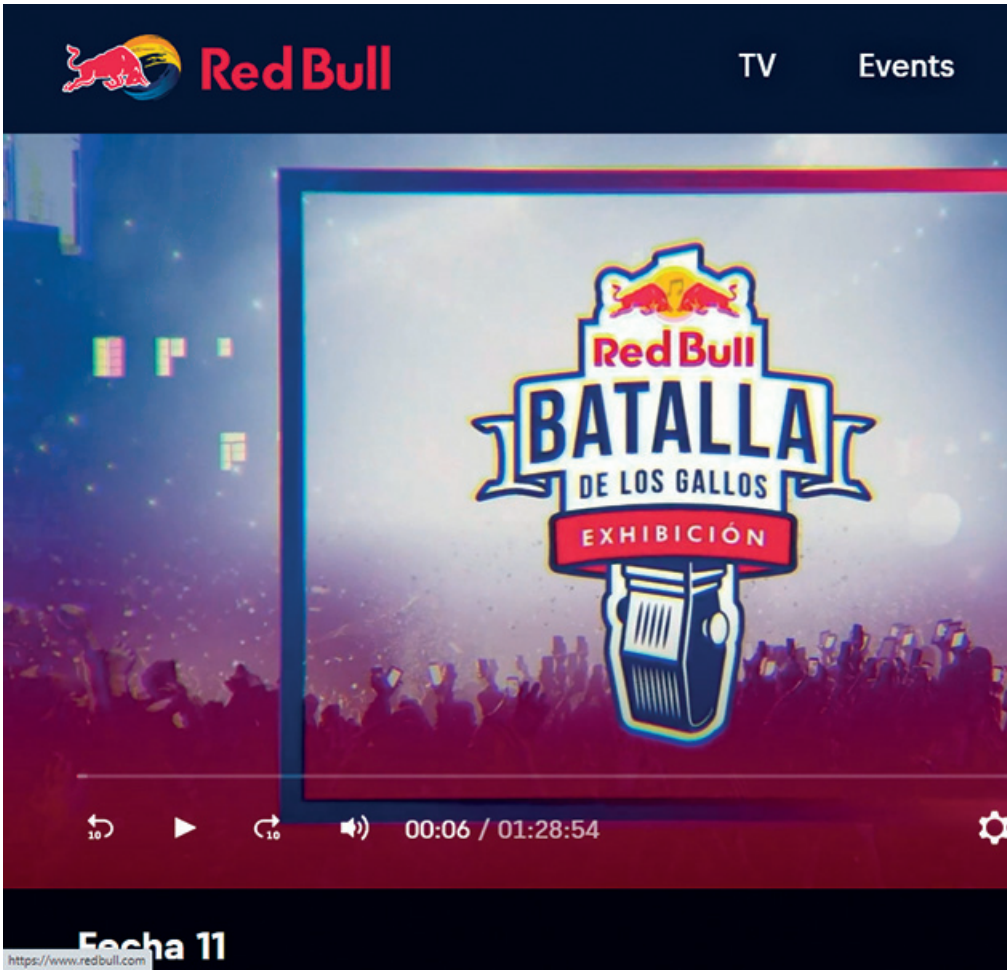
In the context of the pandemic we are all facing, we feel really lucky as we have a place in the workflow that had never been so important. Streaming in an event was just one more thing, even a nuisance. And now it is the core of the event. This is a very big opportunity for us. Some changes are here to stay. The thing to do is adapt to the new situation, in which a bunch of new opportunities exist. Traditional events, even if the pandemic were over, would seem outdated.

INTERVIEW WITH RED BULL

Red Bull produces challenging AV content in line with its brand image. What are the main challenges that Red Bull has faced during this covid-19 period?

The core of our media business relies on telling amazing stories and profiling great characters to excite and inspire our audiences. These stories develop mainly around the brand events and projects which got cancelled during the covid-19 period, forcing us to find new ways and platforms to reach our consumers. Budget was shifted to tackle other business priorities and we also faced the challenge to be more cost efficient.

Could you tell us more details about the Red Bull team dedicated to the generation and broadcasting of content? What is their involvement on the technical side? Are they self-sufficient or do they tend to depend on external production companies?



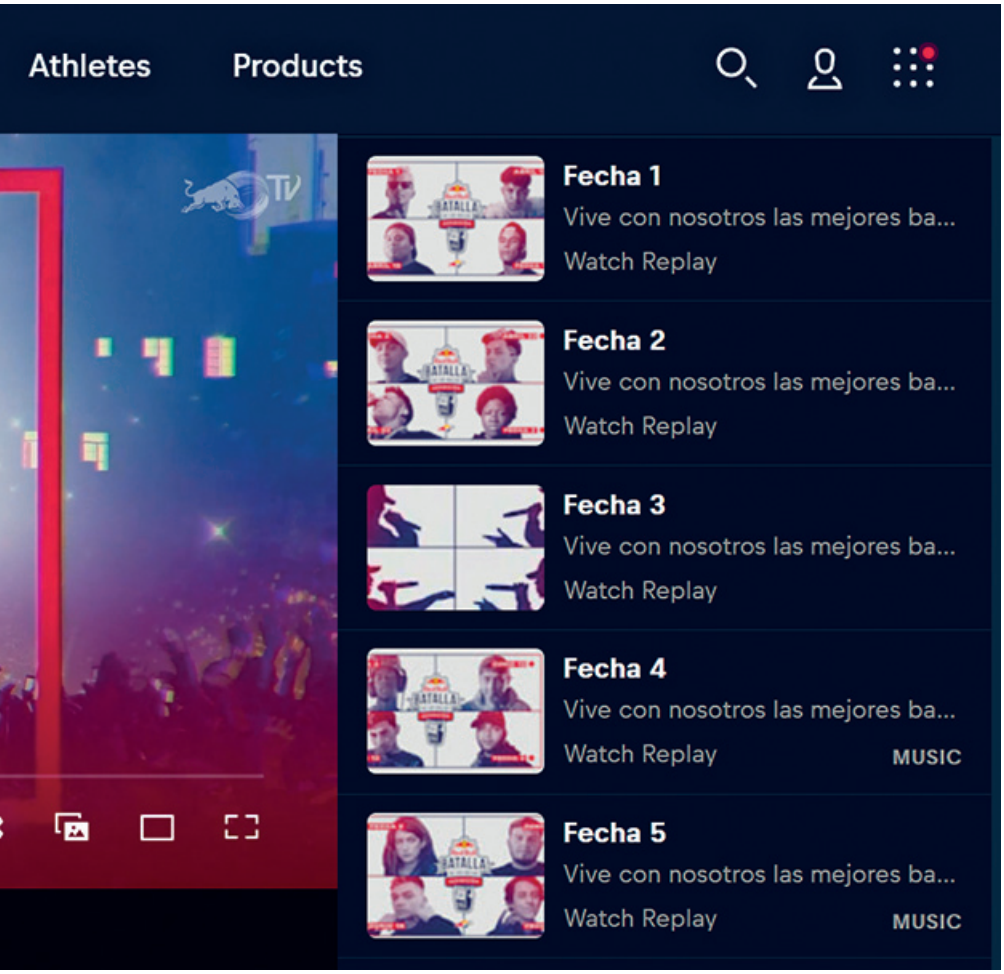
Red Bull TV

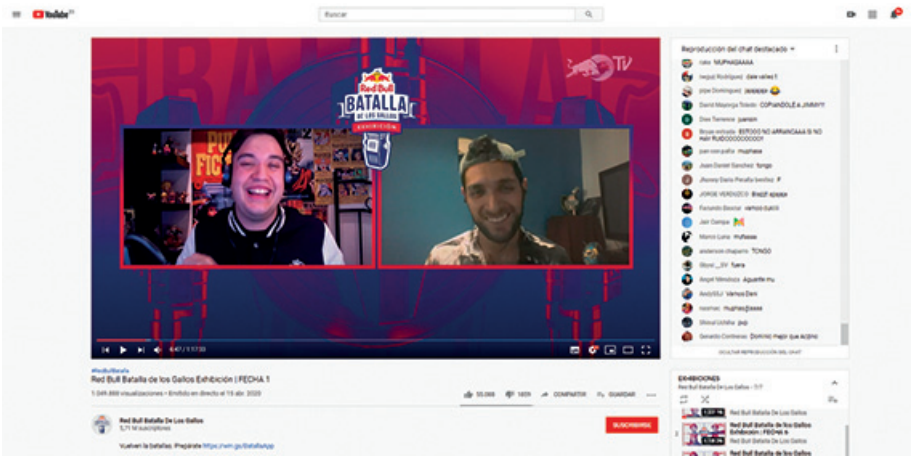
Red Bull Spain has an internal department fully dedicated to Moving Images production (live and non-live) and it's formed by producers which are responsible for project commissioning to external Production Companies based on the characteristics of the project.

For streaming and broadcast, we work with editorial producers and technology partners for support.

You have relied on Square One, who provided its services for the remote broadcasting and production of your live virtual events. How was the experience?

The experience has been as expected from a





professional company with knowledge and resources on every country we needed to connect with.

The biggest challenge for Red Bull Batalla de los Gallos Exhibición, was to connect people from different countries with different connection situations... from participants that didn't own a laptop, to youtubers with a full studio set up, and maintaining the quality of our products.

You had the important challenge of connecting collaborators from all over the Spanish-speaking world without latency for "Red Bull Batalla de los Gallos Exhibición". What other technically ambitious productions have you undertaken during these months of social distancing?

In Spain, we've had to adapt our event's plan and find an alternative to continue developing the scenes that we work on while giving a good experience to participants and online spectators.

During these months we've developed Red Bull Solo Q National Final – League of Legends gaming event. We have Red Bull Batalla de los Gallos National Final going live from a TV Set. ◆

4K, A WORLD WITH PLENTY OF POSSIBILITIES

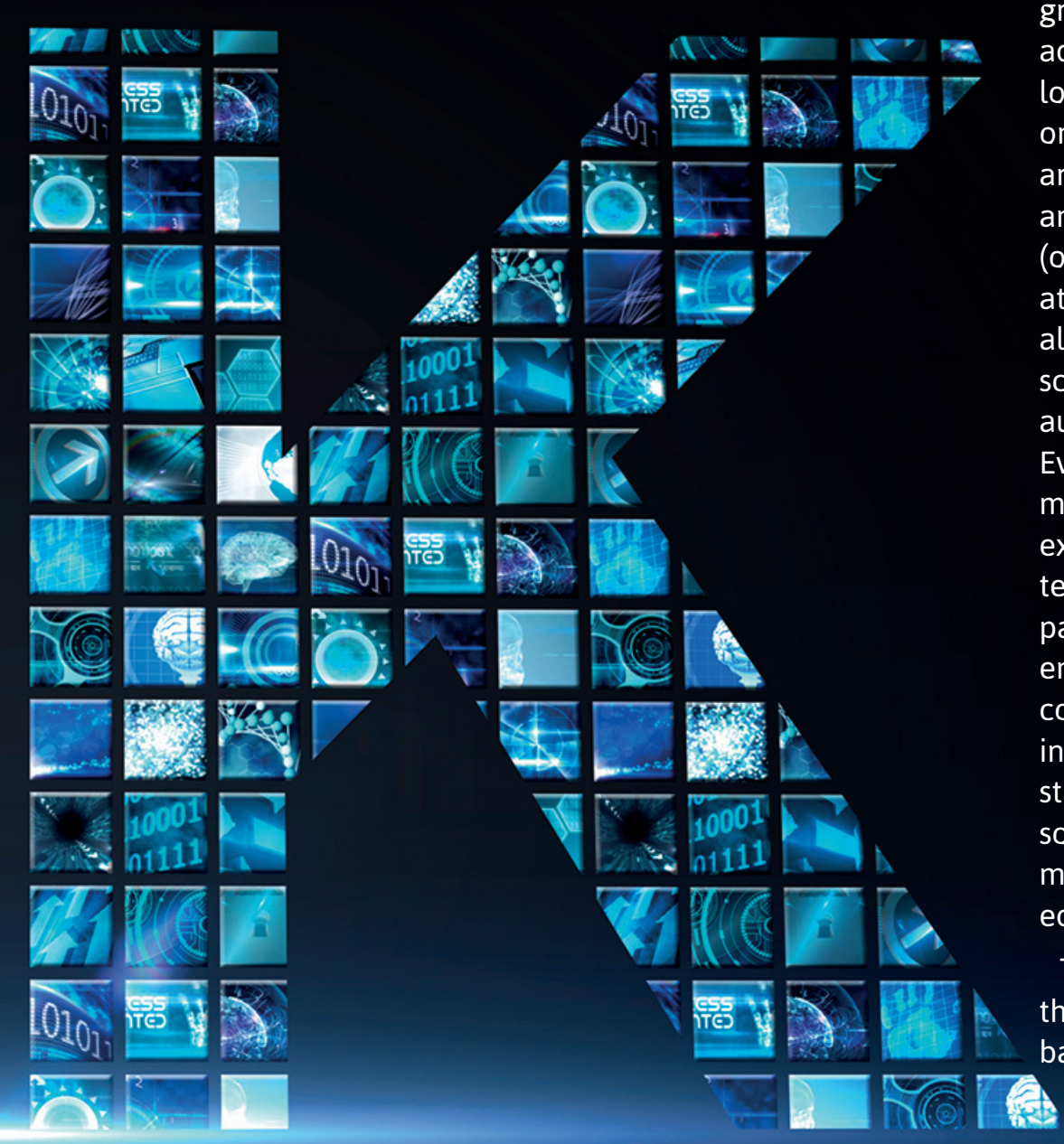
ESSENTIAL GUIDE FOR CHOOSING A 4K CAMERA

By Carlos Medina,
Audiovisual Technology Expert and Advisor

The professional environment of the audiovisual sector has it very clear that the only way in which contents created stand the test of time depends on the theme, type of content, and the technology use. The topic covered by this article deals with everything concerning today's technology in image capture devices, i.e. cameras.

At present time, talking about technology and cameras necessarily

implies referring to 4K, a technical parameter that has conquered all markets and areas relating video cameras, be it for inexperienced users, video amateurs or audiovisual professionals. And doubtless it has become the biggest advertising claim when selling an image (fixed or moving) capture device: state-of-the-art mobile phones, proconsumer video cameras, professional (cinema/TV) cameras, drones, action cameras... It seems that these devices are regarded as being from the past century if they do not have this 4K feature on their list of technical specifications and commercial name.



4K is a somewhat complex issue to grasp, so it is very advisable to take a look at what is going on at present in the areas of contribution and distribution (operations/dissemination/marketing in all modes and screens) of the 4K audiovisual product. Everything that makes possible the existence of 4K: technical parameters, encoders, compressors, international standards, hardware, software, manufacturing of equipment...

Therefore, the first thing to do is go back to the origin.

The existing situation is the result of the birth of digital cinema, whose main goal would be to little by little achieve the same quality parameters as the cinema made out of celluloid (a 4-hole 35mm film, mainly). George Lucas was in 2002, with the film *Star Wars: Episode II Attack of the Clones*, the first one to "shoot cinema" with electronic images.

From 2015 onwards, all cinema is electronic-digital. But one of the biggest changes that this progress has brought about –which not many have noticed- is the blurring of separation lines within the audiovisual sector. We can now use the term "global media", a digital ecosystem where cinema, TV, advertising, live events, internet, video, smartphones, computers... are there to create, inform, communicate, participate and enjoy, in a financially affordable way, quality content. And that means talking about 4K. All players involved in the audiovisual sector both advocate for and promote 4K: a novel way of producing content with technical quality and a technology revolution at anyone's reach. This would not have been possible if cinema production had been kept in 35mm, as this is a complex process involving high financial/environmental costs. The ambition of many companies that electronic-digital images would make it to large cinema screens has paved the way to allow any of us to be able to have 4K images in devices as small as our mobile phones.

THE AMBITION OF MANY COMPANIES THAT ELECTRONIC-DIGITAL IMAGES WOULD MAKE IT TO LARGE CINEMA SCREENS HAS PAVED THE WAY TO ALLOW ANY OF US TO BE ABLE TO HAVE **4K IMAGES IN DEVICES** AS SMALL AS OUR MOBILE PHONES.

But, what is actually 4K as we mention it? Well, it depends. In the first place, when asked, most of us -i.e. users/consumers- would simply define it as good-quality images that are huge and really look great on the screen. This means that it is directly related with what -from a more technical point of view- we call image resolution and definition.

Resolution is the number of lines or pixels that comprise an image horizontally and vertically (height and width). Therefore, it is the amount of lines/pixels covering a space. That is why it is also known as spatial resolution. The higher the number of lines/pixels, the higher the level of detail, the better the image's definition, more visual information and, therefore, the higher the quality.

Table 1 shows the difference between images having various resolutions that are most popular and have been generated by digital optical-electronic processes for TV and cinema, sorted out from lowest (SD) to highest (8K).

But if this question is asked in a professional environment, the answer is deeper and more complex. 4K is willing to improve image and sound. It is innovating in order to reach a more complete

NAME (DIGITAL ENVIRONMENTS)	SPATIAL RESOLUTION	NO. OF PIXELS	IMAGE	TRANSMISSION CODEC
SDTV (Standard Definition TV NTSC)	720 H x 480 V	345,600	i	MPEG-2
SDTV (Standard Definition TV PAL)	720 H x 576 V	414,720		
HDTV 720p (High Definition TV) HD Ready	1280 H x 720 V	921,600	p	MPEG-2 Part 2 H.264 / MPEG-4 Part 10 (AVC)
HDTV 1080i (High Definition TV) HD Ready	1920 H x 1080 V	2,073,600	i	
HDTV 1080p (High Definition TV) HD Ready 1080p Full HD (FHD) or True HD (THD)	1920 H x 1080 V	2,073,600	p	
2K (FLAT DCI*)	1998 H x 1080 V	2,157,840	p	JPEG 2000
2K (SCOPE DCI*)	2048 H x 858 V	1,757,184	p	
2K (FULL DCI*)	2048 H x 1080 V	2,211,840	P	
UHD TV1 (Ultra High Definition TV) QFHD (Quad Full High Definition)	3840 H x 2160 V	8,294,200	p	HEVC / H.265 or MPEG-H Part 2
DIGITAL CINEMA 4K (FLAT DCI*)	3996 H x 2160 V	8,631,360	p	JPEG 2000
DIGITAL CINEMA 4K (SCOPE DCI*)	4096 H x1716 V	7,028,736	p	
DIGITAL CINEMA 4K (FULL DCI*)	4096 H x 2160 V	8,847,360	p	
SUPER HI-VISION 8K UHD TV2 (8K TV)	7680 H x 4320 V	33,177,600	p	HEVC / H.265 or MPEG-H Part 2

Table 1. Source: atpformación. Author: CMPC
(*)DCI -Digital Cinema Initiatives, LLC -, a consortium established in 2002 whose founding members were the seven largest US cinema studios (Walt Disney Pictures, Fox Broadcasting Company, MGM, Paramount, Sony Pictures Entertainment, Universal Studios and Warner Bros). And released in 2005 uniform specifications for Digital Cinema

ALL PLAYERS INVOLVED IN THE AUDIOVISUAL SECTOR BOTH ADVOCATE FOR AND PROMOTE 4K: **A NOVEL WAY OF PRODUCING CONTENT** WITH TECHNICAL QUALITY AND A TECHNOLOGY REVOLUTION AT ANYONE'S REACH.

sensory experience. Therefore, although the differences found in spatial resolution are known, the changes are taking place in other parameters that are somewhat lesser known to the public and even to some professionals in the sector. It is now time to keep expanding our knowledge in order to make a good camera choice. For this purpose, we need to start introducing other technical aspects and essential innovations, so we can achieve improved images, both at recording and when viewing, that add up to spatial resolution of the 4K ecosystem:

- High Dynamic Range (HDR). The aim is having the capability of capturing and displaying a higher amount of grey levels by expanding the range of black and white hues. Achieving a greater realism in contrast and exposure between the areas of an image.
- Wide Color Gamut (WCG). Basically, the aim here is getting the electronic media to come as close as possible to the color palette that the human eye is capable of "seeing". In this case they are wider gamuts or color spaces, as defined by the standards used in cinema or TV. The ultimate goal: Using a wide color space (thence the WCG acronym). IT means going from the BT.709 gamut in the FHD environment (capable of displaying only about

35% of colors that the human eye is able to perceive) to DCI P3/YXZ, that covers approximately 54% and to the BT.2020 gamut, that covers nearly 76% of them. And with a view to the future, we will have to follow closely the implementation of the new color space as defined by the Hollywood Academy, also known as Academy Color Encoding System (ACES: AP0/ AP1/CC/Proxy).

- High frame rate. This is recording and playing a higher number of frames per second (fps) or images per second (ips). It is also associated to frequency, Hz. It is known as time resolution as well. This will offer us higher image stability, without any unnecessary flicker and greater smoothness in images in motion. We all know that analogue cinema used to be shot at 24 fps and also that SDTV PAL is at 25 ips (30 ips in NTSC). And so, 4K content goes for new HFRs, as for example the film The Hobbit: An Unexpected Journey (Peter Jackson, 2012) was a project conceived in 48 fps and spectacular differences were noticeable in the big screen. This progress is related to VFR, or Variable Frame Rate.
- Sampling and quantification. It takes place in the image digitalization process (and audio as well) in regard to the taking of samples from the signal,

in its respective RGB in the case of video. It means increasing bit depth or color depth. This is, a higher quantification level means increasing the number of bits per sample. And higher levels in each sample entail more information, and this means being closer to analogue reality. This aspect is very well appreciated for color correction and post-production as well as for video/audio effects. These are parameters that are very important, that define the quality of the digitalized records in 4K productions, which are deemed advisable from 10-bit onwards.

- Surround or immersive audio. Entails developing sound systems that provide a third dimension and give deeper spatial depth in audio playback when it comes from different areas (because of the speaker placement and design of sound distribution in audio channel setup). The 4K ecosystem means going from 2.0 to 5.1 or higher. But this parameter is not decisive when it comes to choosing a camera model.

Therefore, bearing these issues in mind, we are now in a position to take a first approach to models that manufacturers are offering in order to choose a UHD/4K (and some with higher resolutions) in comparative terms on resolution, progressive images and the most panoramic aspect ratios that comprise various sectors and environments in the audiovisual industry.

As for mobile phones, worth noting are GOOGLE Pixel 4 XL and Pixel 3 (3 XL, 3a and 3aXL), ONE PLUS 7 Pro (Plus 7T, Plus 7T Pro), HUAWEI P30 (P30 Pro), IPHONE 11 (11Pro and 11Pro Max), XIAOMI Mi Note 10, SONY Xperia 5 and SAMSUNG Galaxy S10 (S10e and S10 Plus) as well as Galaxy Note 10+5G, being this manufacturer capable of recording 8K with model Note 20 (20 Ultra 5G 8K).

In non-professional video cameras, FHD are still on top, although we now find some manufacturers that offer the possibility of recording in UHD, such as

Panasonic AK-UC4000

SONY FDR (AX43, AX100 and AX700), CANON Legria (GX10, HF-G26 and HF-R806), XA 40, JVC GZ-RY980, PANASONIC HC-X1E and HC-V180EC.

In the scene of professional photographic cameras, which have made the move from fixed image capture (photography) to the possibility of recording 4K video, there is a really wide offering for users. The following models are worth mentioning: PANASONIC Lumix (G7, GX8, GH5 and GH4), OLYMPUS OM-D E -M10 Mark III, SIGMA FP45 UHD, CANON EOS 77D, EOS 1DC, EOS 5D -Mark IV and III-, NIKON D7500, FUJIFILM X-T2, SONY a6500 and Alpha A7S II.

Within the TV sector, spanning several types of camera for studio production modes, EFP and ENG, the following manufacturers are to be highlighted: CANON XC15 UHD, PANASONIC (AK-UC4000, AK-UC3300, AJ-CX4000GJ, AG-CX350, AG-CX10, AG-UX90, AG-AC30, DVX 200, HC-X1), JVC (GY-LS300 UHD, GY-HC550, GY-HM170), SONY (NEX-FS700 EK UHD, PXW-Z750, PXW-Z450, PXW-Z90, PXW-Z150, HDC-5500, HDC 3500, HDC-4800) and the LDX 86 series by GRASS VALLEY.

Digital cinema is the environment where cameras having resolutions higher than 4G can be found and where there is a really strong competition by all manufacturers in order to position their models. Therefore, we find here

manufacturers such as ARRI (Alexa Mini and Amira Premium), RED (Ranger Monstro 8K; Weapon Monstro 8K, Epic-W 8K Helium, Epic Dragon 6K, Gemini 5K and Raven), and BLACKMAGIC (Pocket Cinema 6K; URSA Mini Pro 12K). And also proposals from PANASONIC (AU-EVA1 4K; AU-V35C1G Varicam 4K; AU-VREC1G Varicam), CANON EOS (C700, C500 Mark II 6K; C200 4K; C300 Mark II 4K), SONY (VENICE, PXW-FX9 6K; PXW-FS5M2K 4K; PXW-FS7M2K 4K; PMW-F5, PMW-F55) and PHANTOM FLEX 4K.

As for drone-mounted 4K cameras, the leading manufacturer in this area must be mentioned: DJI with models such as Mavic Air 2, Phantom 4 and Inspire 1; or other brands such as: YUNEEC Q500, ROBOTICS 3DR, HUBSAN Zino Pro, XIAOMI FIMI X8 SE and Mi Drone 4K, PARROT Anafi, or even AUTEl EVO II 8K, the latter even allowing 8K recording.

In the market of video cameras that are regarded as sports or action cameras, models allowing 4K recording can be found: GOPRO Hero7 and Hero 8; SK8, DJI Osmo Action and Osmo Pocket, Xiaomi Yi Plus and Mijia, SJCAM SJ8 y SJ7, SONY FDR-X3000 and RX0 II, or INSTA 360 One X.

Blackmagic URSA Mini Pro 12K

To properly close this guide, when dealing with image capture devices, other kinds of features must be taken into account when considering cameras in order to adapt as best as possible to the needs and work modes when it comes to recording.

First of all, if the device will allow us to work with different optics and focal distances (fixed or interchangeable). It is crucial that both design and construction of elements and optical groups are ready for 4K images.

Second, the size of the capture sensor: the larger the sensitive surface, the better the response level achieved, this resulting in more satisfactory images. Therefore all kinds of sizes exist, the biggest being Full Frame, Super 35, APS-H, APS-C, Micro Four Hhirds 4/3", 1", 1/1.7", 1/2.3", 1/3.2", 1/3.6", 1/4", amongst others.

In third place, the camera's operation. In this sense, everything that the camera has internally must be taken into account: image stabilizers, focus assistance, automatisms, exposure assistance, changes in sensitivity and gain, controls for technical adjustment of images, black and white balancing... amongst other; and also what is shown outside in regard to design and placement of buttons and access menus to facilitate recording routines, microphone, type of display, grips... In this last aspect, the size of the camera's body is important, because the smaller ones only have what is essential for operation.

Canon C700

Fourth, we must take into account what is termed as recording media, this is, the type of media used by the camera to store 4K videos. Thus, we have the manufacturer's proprietary solid-state memory cards, as it is the case with ARRI or RED ONE, and even media as unique as P2 cards (PANASONIC) or SxS cards (SONY), or other more widespread media amongst users, such as SDHC/SDXC and Compact Flash cards.

In fifth place, the camera's weight and size. Although the trend in the market is for cameras that are as 'mini' and as light as possible, we do have to bear in mind the camera's stability, balance and robustness for a correct operation. Nowadays, technological innovations and newly developed construction materials have indeed helped to come up with cameras that are increasingly less heavy and featuring designs based on modular approaches.

Sixth, and of no lesser importance, is the price of the camera to use. Currently we find a truly wide range of prices and we can only recommend to carefully consider the options to make it within the required budget, the type of production and the number of recording sessions we are going to do.

As a conclusion, we must say that 4K cameras are firmly established in all kinds of markets concerning capture equipment: smartphones, handheld video cameras, TV cameras, cinema cameras; and also in more specific environments such as drones, action... Although the truth is that we have not yet reached a real ecosystem comprising production, distribution and marketing of 4K

GRASS VALLEY LDX 86

content, as other factors have set the pace in regard to implementation in society, from continued technological progress to the economic situation in which they take place.

The term 4K appears in spectacular advertising and marketing campaigns as a distinctive 'new and good' landmark for the purchase of equipment, both for recording (photo and video cameras) as for enjoying content on TV screens, as well as when it comes to signing up for TV or internet services. It is of vital importance to know the actual resolution of equipment in order not to buy a 'pig in a poke': a pseudo 4K, just UHD or if there is just no 4K.

This could cast a shadow over full implementation of 4K amongst the public. Therefore, 4K content will always be available provided two essential conditions are met. First of all, that the players in the audiovisual industry standardize the whole process by means of technical decisions enabling maintenance of 4K in a simple, economic, standard, synchronized manner in all areas, as this must come as a direct solution that will be as global as possible. And number two deals with the decision of users/consumers to be willing to purchase, enjoy and consume 4K (or at least UHDTV) content. In principle, we assume this is the case, in light of the considerable benefits.

This 4K panorama, which has been for several years now present in all the audiovisual industry's trade shows and events, must gradually address some other unknowns that affect to contribution and distribution of contents, so viewers will easily assimilate the changes. A number of conundrums dealing with bandwidth, production and exploitation formats, displays, connectivity of equipment, media and storage systems, audio and even viewer tastes and demands.

Having in mind all these requirements and decisions, as mentioned above, which will better shape the 4K video camera scene, we can say that any user or professional of images can definitely find a whole world with plenty of possibilities when it comes to choosing a 4k camera. ◆

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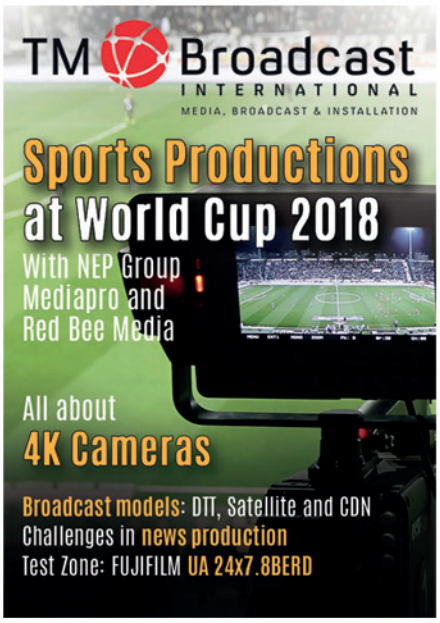

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