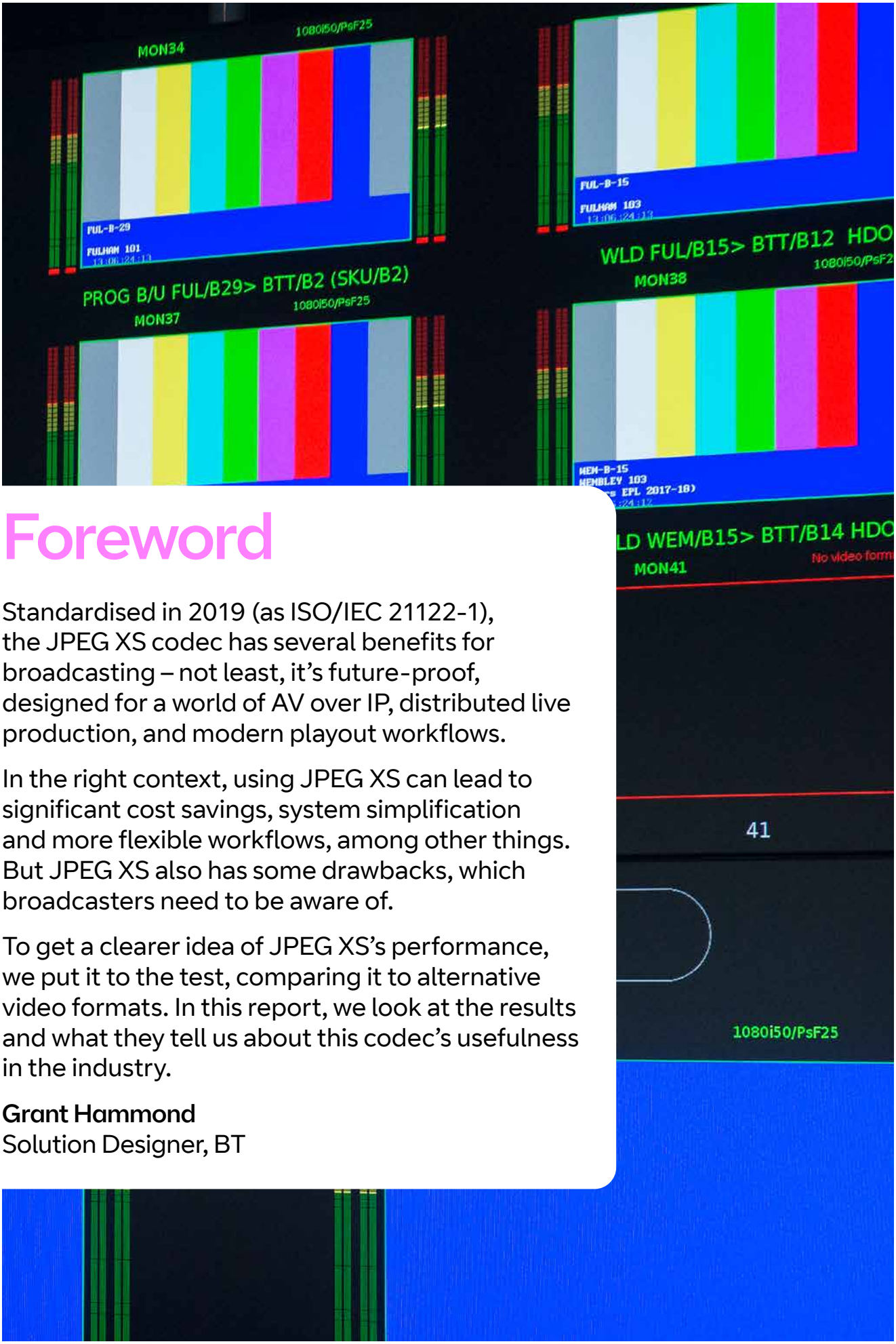
MEDIA & BROADCAST

Building a clearer picture of JPEG XS performance

Find out when this compression technology performs best and how it can help you

Whitepaper



Foreword

Standardised in 2019 (as ISO/IEC 21122-1), the JPEG XS codec has several benefits for broadcasting – not least, it's future-proof, designed for a world of AV over IP, distributed live production, and modern playout workflows.

In the right context, using JPEG XS can lead to significant cost savings, system simplification and more flexible workflows, among other things. But JPEG XS also has some drawbacks, which broadcasters need to be aware of.

To get a clearer idea of JPEG XS's performance, we put it to the test, comparing it to alternative video formats. In this report, we look at the results and what they tell us about this codec's usefulness in the industry.

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Solution Designer, BT

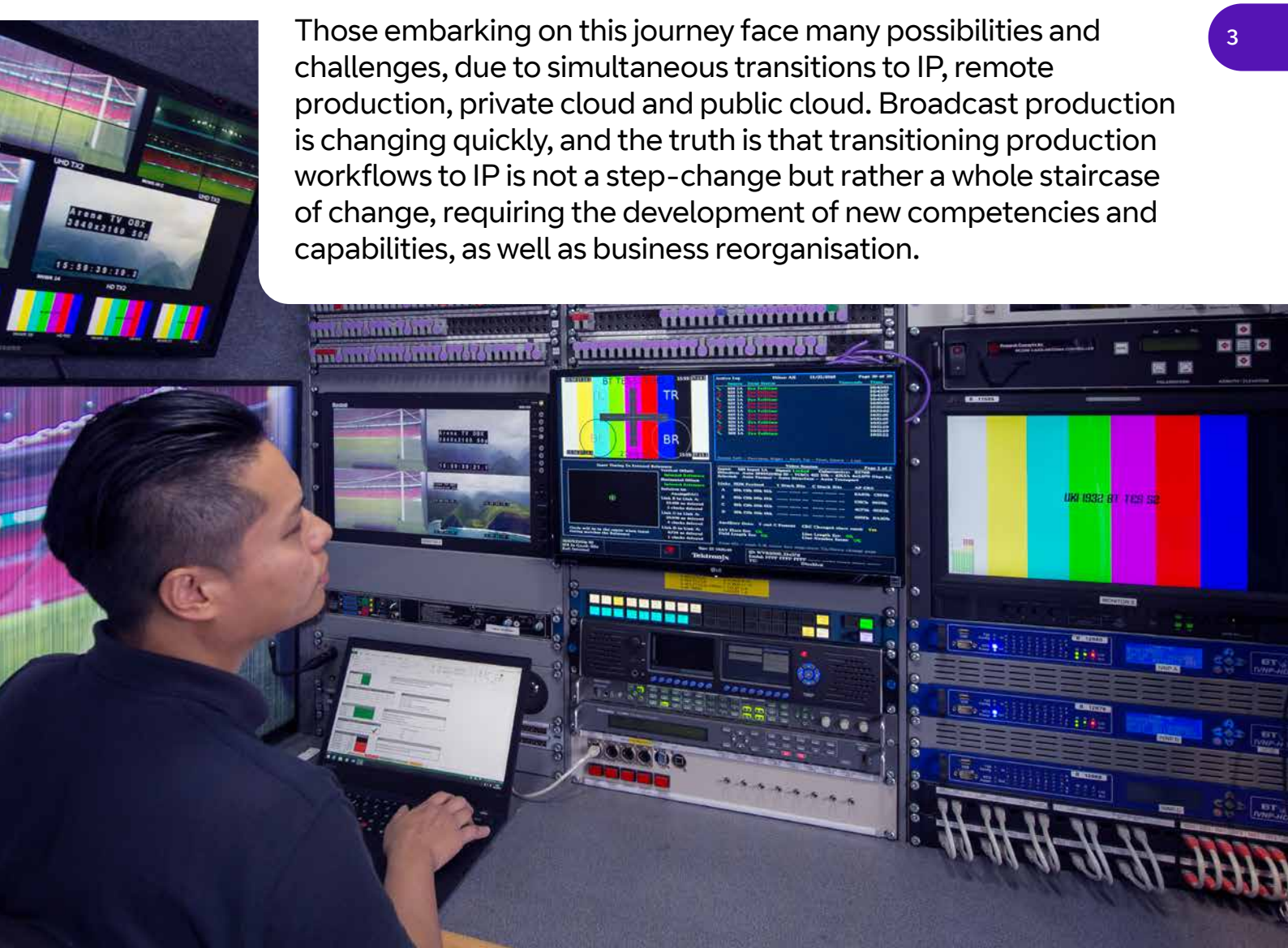
Building a clearer picture of JPEG XS performance

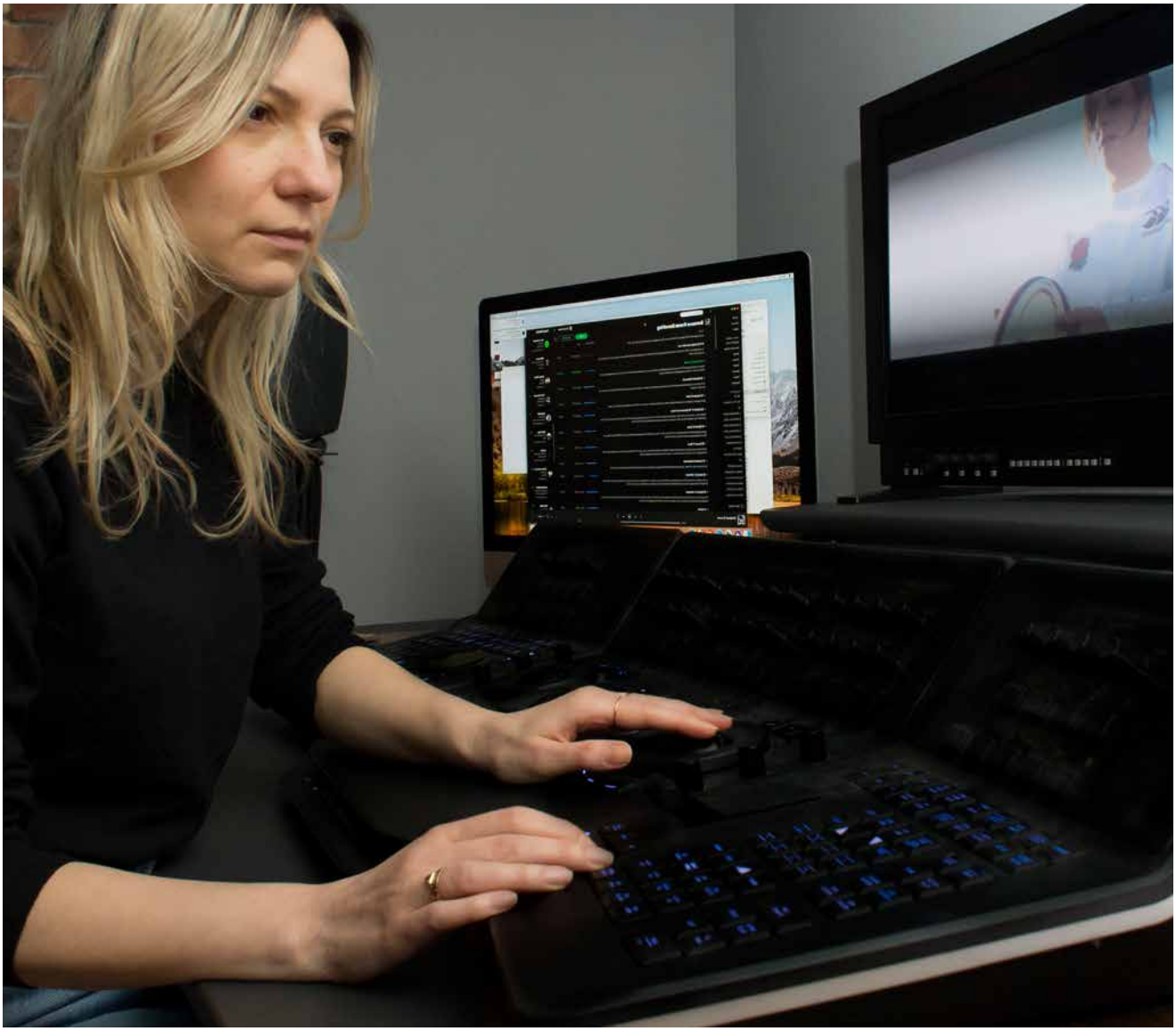
Ultra-high-definition (UHD) TVs, with resolutions like 4K and 8K, are now commonplace in people's homes and can easily be found for less than £800. Yet a lot of live content is still produced in standard high definition (HD) at 25 or 29.97 frames per second.

Certainly, consumers would like live content delivered to their screens at greater resolutions and frame rates, and with better colour reproduction. But the broadcast industry is unable to do that at a reasonable cost.

Enticed by the promise of more flexible, efficient and future-proof operating models, broadcasters are retiring serial digital interface (SDI) infrastructure and rebuilding production workflows on the Internet Protocol (IP).

Those embarking on this journey face many possibilities and challenges, due to simultaneous transitions to IP, remote production, private cloud and public cloud. Broadcast production is changing quickly, and the truth is that transitioning production workflows to IP is not a step-change but rather a whole staircase of change, requiring the development of new competencies and capabilities, as well as business reorganisation.





How JPEG XS can help

The JPEG XS codec provides an open, lightweight, visually lossless, ultra-low latency compression scheme. As a result, it can be an important enabling technology for remote and cloud production models, as well as offering a path towards increased 4K and 8K UHD production. Furthermore, to improve product interoperability, the Video Services Forum (VSF) has defined standardised profiles for encapsulating JPEG XS coded video in MPEG2-TS (VSF TR-07) and SMPTE ST 2110-22 (VSF TR-08) transports.

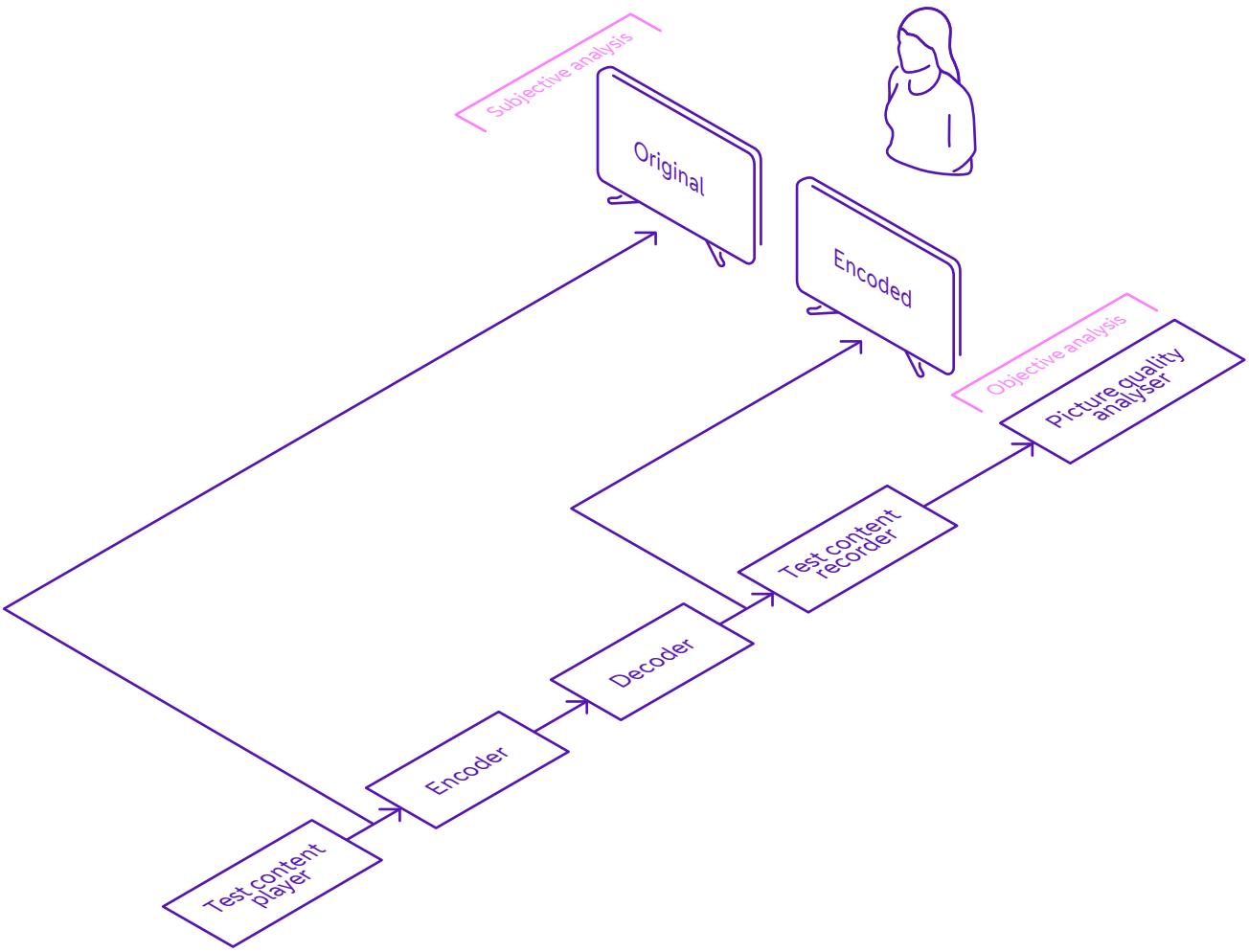
JPEG XS is positioned as an IP-friendly replacement for uncompressed video. Proponents claim it delivers visually lossless quality at a ratio of 10:1, which is impressive and puts it on par with JPEG 2000. However, as market adoption of the codec has increased, anecdotal feedback from real-world deployments warn that this claim is optimistic, and broadcasters should expect to run the codec at significantly lower ratios.

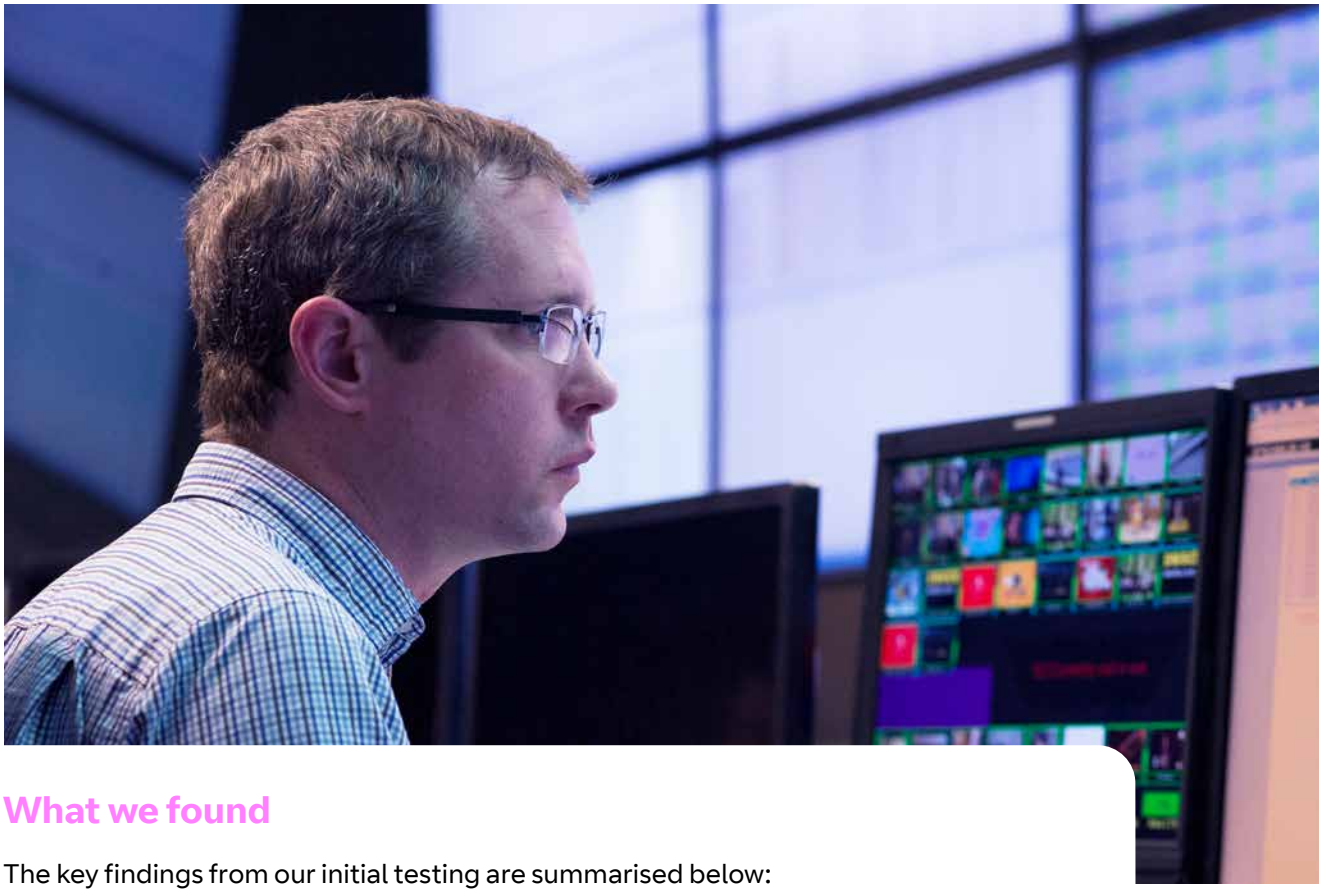
So what's going on? How well does JPEG XS perform, and to which use cases is it best suited? To understand this discrepancy, we decided to take a closer look and have been conducting some preliminary picture quality tests at our labs in Adastral Park, Martlesham.

Putting it to the test

The basic test environment can be summarised as follows. Source material contained live sports coverage and a mix of talking heads, panoramic shots and action shots. It was captured as 1080i/25 and stored in ProRes422 HQ format. A file player presented the material as HD-SDI to JPEG XS and JPEG 2000 encoders, then the output of each was decoded and recorded to file in RAW format. Using products available today, content was encoded at multiple compression ratios ranging from 5:1 to 12:1.

Both objective and subjective comparisons were made between source reference material and compressed material. Codec performance was measured using the peak signal-to-noise ratio (PSNR) and Video Multimethod Assessment Fusion (VMAF) techniques. Content was viewed on calibrated monitors in a controlled viewing environment both as moving pictures and static frames. The objective analysis tools provided frame-level scoring of material and reporting on differences between RAW, JPEG XS and JPEG 2000 versions.





What we found

The key findings from our initial testing are summarised below:

- JPEG XS latency was imperceptible.
- At compression ratios less than 6:1, JPEG XS is very nearly visually lossless.
- At compression ratios of around 6:1, the picture quality differences between codecs are not noticeable.
- As compression ratios increase, JPEG XS quality drops off more quickly than JPEG 2000.
- JPEG 2000 is in the order of 25% more efficient than JPEG XS.
- In blind testing at compression ratios above 7:1, JPEG 2000 was preferred.

Implications for the industry

What can we take away from this? Our preliminary testing indicates that JPEG XS encoded live sports content is not visually lossless at 10:1 compression. While this may come as a surprise, the question is how much does this matter? The answer depends on the use case. If we consider the primary use cases for JPEG XS (namely contribution and as a replacement for uncompressed video), arguably, even at lower compression ratios, it delivers substantial benefits.

For contribution, there's a simple bandwidth versus latency discernment. In practice, on a 1Gb connection, you'll see a difference of four (JPEG XS) or five to six (JPEG 2000) 1080i/25 flows per connection. You should consider using JPEG XS in the following scenarios:

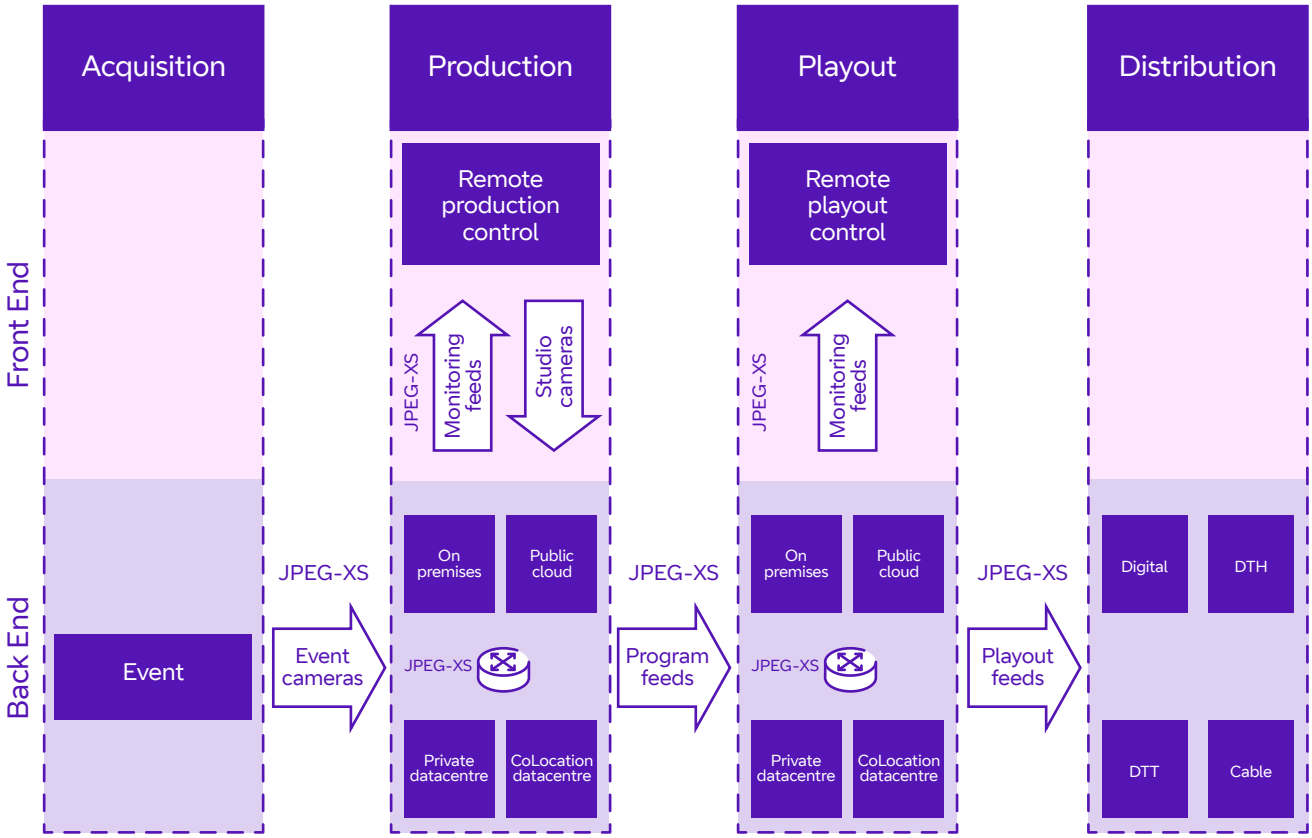
- If you're already running low JPEG 2000 compression ratios of around five or six to one, where a visually imperceptible quality difference is an acceptable trade-off for latency gains.
- Where headroom on existing connectivity exists to absorb higher bitrates in exchange for lower latency.
- Where a higher bitrate is an acceptable trade-off for very low latency.

Adopting JPEG XS as an uncompressed replacement for IP production is a complex topic. However, even at its lightest compression ratio of 5:1, it has the potential to deliver significant business benefits including:

- Substantial cost savings.
- System simplification.
- Greater workflow flexibility.
- Support for greater location flexibility.
- Supporting greater 4K and 8K UHD production.
- Reducing environmental impact (less equipment, less power).

Specific benefits depend greatly on workflows and scale and are contingent on broad product support. For simplicity, if we assume that a large broadcaster is undertaking a technology refresh and JPEG XS is used as the standard for video exchange between all equipment and applications located at remote venues, on premises, in a private cloud, and in the public cloud. Front-end production control and playout workspaces are completely IP abstracted and located remotely from back-end production equipment. Possible benefits, relative to an uncompressed workflow, include:

- **Fewer contribution codecs.** Compressing signals at source will result in fewer video codecs, leading to cost savings and increased reliability.
- **Increased flow density per network interface.** Savings on network hardware as great as 75% could be achievable for UHD workflows.
- **Simplification of vision monitoring.** Removing the need to compress flows that feed playout, production or master control room (MCR) monitors located in remote locations results in cost savings on codecs and the supporting network, as well as greater operator confidence and reduced picture latency.
- **Reduced power consumption.** Resulting from less equipment and/or moving equipment into an energy-efficient remote datacentre.



While results from this preliminary study suggest that, for demanding content, JPEG XS does not deliver 10:1 compression, clearly it represents a very important advance that can deliver substantial business benefits. Many of these benefits depend on broad product adoption, which is currently limited, so there's a significant opportunity for both suppliers and broadcasters alike.

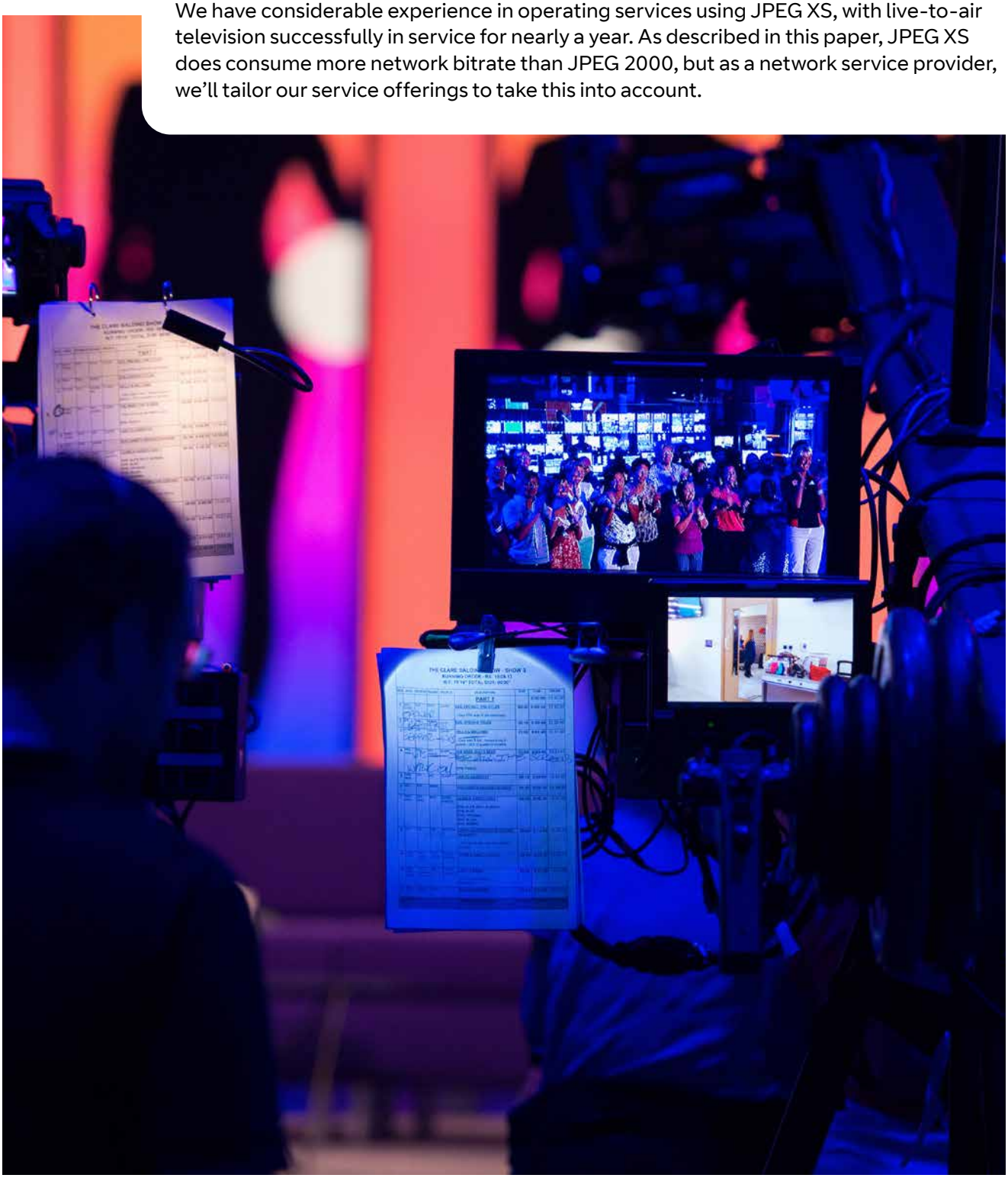
Though the study provided some valuable early insights, we believe a broader, more comprehensive analysis is necessary. With that in mind, we'll be rebuilding our lab to enable testing of a greater range of resolutions, frame rates, colour variations and codecs, as well as preparing a range of pristine, RAW content. Visitors to the lab are always welcome, and we'll be reporting on our findings in the coming months.

Making the move

So what does this mean for those who already have services based on JPEG 2000? We believe JPEG XS is an excellent codec for broadcast contribution, with two clear benefits for broadcasters:

- It has inherently **lower latency** than JPEG 2000, which translates to noticeable operator benefits for remote production.
- It's **future-proof**, designed for a world of AV over IP, distributed live production, and modern playout workflows.

We have considerable experience in operating services using JPEG XS, with live-to-air television successfully in service for nearly a year. As described in this paper, JPEG XS does consume more network bitrate than JPEG 2000, but as a network service provider, we'll tailor our service offerings to take this into account.



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Let's talk

If you'd like to talk through your requirements and start benefiting from JPEG XS today, we can help. Vena, our smart broadcast network, supports JPEG XS, as well as a range of other popular hand-off formats, enabling you to intelligently optimise your media supply chain.

To start a conversation, fill in our contact form, and we'll get back to you.

Get in touch now >

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