Moving to a software-only platform for flexible and cost-effective live video delivery.
# Table of content

- **3** Executive summary
- **4** Customers lead the way on delivery
- **5** Moving away from one-purpose hardware
- **6** Software and IP migration to simplify broadcast workflows
- **7** On-premises, cloud, or both?
- **9** Practical implementation
- **11** Conclusion
The broadcasting and media industry is undergoing seismic changes, for reasons which are well rehearsed. Consumers demand the ability to view content at a time of their choosing, where they want to view it, and on the device which is convenient to them at that time.

The ubiquity of broadband and 3G/4G/LTE mobile connectivity makes this practical. It is now possible to deliver individual content streams for very large numbers of concurrent users.

As this has become commonplace and mainstream, so the nature of the content has changed, and its source. Where once television came from broadcasters, now there is a huge community making its own community, creating YouTube and Twitch stars along the way. Traditional producers and broadcasters have to evolve to compete.

Social media also has an impact, which is likely to grow. Facebook – the world’s largest social media platform with 2.2 billion active users by the end of 2017 – seems set to enter the live sports market. According to a report in Sports Business Daily in November 2017, the company is recruiting a sports rights expert who will have a budget of “a few billion dollars”. For comparison, Discovery-owned Eurosport paid the equivalent of $1.4 billion for the rights to the Olympic Games between 2018 and 2024.

Combine this with the migration from traditional linear television to an assumption that consumers will be watching video content in different ways, and it is clear that the technological platforms for broadcasting and electronic media need to change. The result of these changes is that, where once there was one route from the point of creation to the consumer’s eyes and ears, now there are many. Today, content creators have to deliver their content in many ways, and they need to be adapting quickly.

Software-only platforms and pure IP infrastructures are the only way forward.
Customers lead the way on delivery

For the first 70 years of its existence, television was so demanding of technology that to make it work at all required dedicated hardware. The pioneering broadcasters made much of their equipment themselves; manufacturers quickly recognised the potential market and started developing commercial hardware such as cameras, switchers, audio mixers and graphics.

The advantage that everyone had was that the basic principles had been defined by broadcast engineers, who established a fundamental, standardised framework. Everyone agreed on the screen resolution and frame rate. When colour television came along, there were three colour encoding systems but these were clearly delineated along national lines.

Simply put, using the basis that the technology was demanding, broadcasters were in a position to tell consumers precisely what hardware they needed to watch their programmes. You either had a television receiver that worked the way the broadcaster expected it to, or you could not watch television.

The internet changed all that. The early creators of the web had no idea that it would (or could) be used for watching videos, but inventive people quickly clamoured for solutions. The original MPEG compression scheme was designed to allow small video windows in websites.

By the time Steve Jobs introduced the first iPhone in 2007, the idea that connectivity should allow videos to be received on any device was already firmly in the minds of consumers.

The importance of this revolution should not be underestimated. The consumer is now in control, telling the broadcaster (or content delivery network) what format to deliver the content, not the other way around.

Put that alongside the use of the internet for content on demand, and the balance of power has shifted completely. Broadcasters and media companies have to find practical, reliable and cost-effective ways to meet the expectations of their audiences, if they hope to stay in business.
Moving away from one-purpose devices

As noted above, television technology has always required bespoke hardware: it was the only way to create sufficient processing power for live video. This meant extensive R&D for a relatively small market, and consequently high equipment costs.

The practical effect of this was that a broadcaster would build a capital case for an installation, then specify it to its forecast requirements and the capabilities of the time. Once the new system was installed, it would effectively be frozen for seven to 10 years with little or no upgrades.

Meanwhile, in the IT industry, Moore’s Law has continued to apply, ensuring computers have become increasingly powerful. In 1988 Avid introduced the first nonlinear editor, using a standard computer to handle video (in a very compressed format). More recently, standard computers – often called COTS hardware for commercial off-the-shelf – have become powerful enough to handle even high-bitrate live video content.

There are a number of advantages of using COTS hardware as a platform for broadcast and media applications.

1 First is that it is inexpensive: the scale of the IT market is orders of magnitude larger than the broadcast business. So economies of scale and competitive pressures force the prices down.

2 A second major driver is that the pace of change in the IT industry is fast. It is not just continual improvements in processor density that drive performance boosts. Other IT users – again often very much larger than broadcast – demand changes. The finance industry, for example, sees the shaving of a single millisecond off the latency of a communication link as a major benefit.

These continuing improvements in the underlying hardware provide performance enhancements for broadcast applications running on it, at virtually no cost.

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1 Gordon Moore, one of the founders of Intel, wrote in 1965 that the number of transistors on an integrated circuit would double every two years. The effect of this – that computers would double in power every two years – has become known as Moore’s Law

2 Global IT spending in 2017 $3.5 trillion - Gartner

3 Broadcast and media market for hardware, software and support 2016 $22.07 billion – research by IABM and Devoncroft Partners

4 Intel R&D budget 2016 $12.7 billion; top 10 chip manufacturers total R&D spend 2016 $35.4 billion. Source IC Insights
Software and IP migration to simplify broadcast workflows

Equally, application software can be quickly and readily upgraded, which is much harder to do with fixed hardware. When new requirements come along – such as Ultra HD 4K resolution or high dynamic range (HDR) and extended colour gamut – these functions can be added as a software patch in a matter of minutes.

COTS hardware already has a proven and universal communication format: IP. Capable of being carried over copper, fibre or wireless ethernet, every computer can talk it.

As broadcast applications moved from bespoke hardware to specialist software residing on COTS hardware, initially interconnectivity followed the established broadcast principles of using SDI and routing switchers. This was well understood and seen as a safe concept. The disadvantage was that each COTS box needed video interfaces on inputs and outputs, all adding to latency as well as increasing cost.

So there was naturally interest in moving to IP connectivity, if only to eliminate the video I/O cards. But IP is essentially a transport layer, so an application specific layer is required to enable broadcast devices to understand how to interpret the data stream. With no standards, media companies were understandably slow to take this up.

Now there are standards, most notably the SMPTE ST2110 family or the lean VSF TR-01, that are more and more adopted by media companies across the board. Based on this, and a growing understanding of non-blocking network architectures which ensure the sort of broadcast performance the industry expects, IP systems are now being rolled out.

Currently the talk is all about IP, but in truth this is just an enabling technology which is a step towards a much bigger technological revolution.
Traditional broadcast infrastructures had dedicated boxes for every function which was likely to be required, even if that particular function is only rarely used.

Of necessity, traditional broadcast infrastructures had dedicated boxes for every function which was likely to be required, even if that particular function is only rarely used. The result is that the infrastructure took up a lot of rack space and machine room real estate, a lot of power even when significant parts of the system were idle, and consequently a lot of air conditioning to take away the effects of all that power consumption.

But if all that functionality is now implemented in specialist software, and that software can communicate directly with other pieces of software using standardised IP, broadcasters can (and should) completely rethink the architecture.

This will allow real benefits to be obtained from a software-defined architecture. Perhaps most important, this includes the potential for greatly reduced latency, because the workflow is moving between functions in the same processor or processors linked by a high-speed bus, rather than moving between devices.

It also increases technical resilience by eliminating unwanted processes such as interfaces to external devices. Finally, of course, it provides a large reduction in hardware cost.

On-premises, cloud, or both?

Applications can now run as virtual machines, using just the processor power it needs at the time, and disappearing completely when the task is complete. Virtual machines can share processing units, or can spread across multiple processors when it needs large amounts of power.

This is not new. The IT industry has been managing virtualised systems for a long while. Broadcast infrastructures are now moving towards this goal. Again, cost is a major factor here: even though COTS hardware is much lower in cost than bespoke broadcast devices, you can save even more by not having a COTS box per function, instead having enough COTS boxes to provide enough power for peak demand.

This can lead to the concept of software-as-a-service (SaaS). This is a broad description for a range of software licensing models which allow the user to determine how to pay for a function, but essentially paying only when you need it. This might be a license by time (hours, days or even months) or material processed, and it can cover portable licenses which allow a defined number of instances of an application to be run across a network or data centre, rather than on specific hardware.
A word here about the cloud. Virtual machines run on COTS hardware which can be located in a conventional broadcast machine room or in a data centre.

The logical extension of that concept is to outsource the data centre to a specialist provider whose core business is to provide IT services. This is what we mean by the cloud.

**There is no conceptual difference between virtualisation inside a broadcast business and virtualisation outsourced to the cloud.** The only difference is the fact that one is inside your building and the other is somewhere remote, which means you have to consider the connectivity to and from your chosen cloud provider.

Cloud providers are primarily in business for the general IT market, but broadcast requirements are significantly different. Whereas an insurance company or an airline might have a very large number of relatively small files, media businesses have relatively small numbers of huge files, typically measured in gigabytes. Project folders for production and post production are likely to be measured in terabytes.

Pricing for cloud services, while reasonably transparent from the big suppliers, can be complex to evaluate. Typically, for example, cloud providers charge to access the data, and determining how often you would want to access content in the cloud requires complex workflow analysis.

There are well-researched papers available such as Jan Ozer’s piece for Hybrik\(^7\), which look at the relative costs of using cloud services for media workflows. **Each media company will need to calculate their particular needs to determine whether an on-premises data centre or the cloud best meets their cost model.** Technologically, they can be regarded as identical, apart from the need to move content.

Processing and storing content in the cloud may well provide worthwhile cost savings for media businesses. Part of the economic calculation will include the fact that using the cloud means you hand over the responsibility of keeping the hardware and operating system over to someone, for whom it is the primary role. There is no need to set up your own systems and maintain specialist IT skills to determine when you need to upgrade processor and server hardware, and what operating procedures to implement.

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\(^7\) OZER, Jan. Cloud Pricing Survey Shows Hybrik Least Expensive Option By Far. Streaming Learning Center [online]
Another primary concern is security. While on the one hand, businesses whose sole function is to hold the data of its clients are likely to employ the best IT security people in the business\(^8\), lawyers charged with controlling the intellectual property rights of content creators are notoriously conservative, and may regard cloud storage as letting the material out of the direct control of the broadcaster.

For many media companies, the likely solution is to go for a hybrid architecture, in which functionality is virtualised on premises, with the ability to go to the cloud when demand outstrips resources.

**Practical implementation**

To bring together the need to deliver in a very large number of formats to a wide range of devices with the migration from dedicated broadcast hardware to virtualised software, it will help to look at a typical challenge and how it can be served in the new architecture.

There are many points in a broadcast flow from origination to the consumer at which content needs to be transcoded: to move from one codec to another, or to a different bitrate. The same requirements apply for live and packaged content, although obviously live links require realtime performance.

In a traditional architecture, each of these transcoding points required a separate device. Limitations on fixed-function hardware may have required broadcasters to have more transcoders than they need with many lying idle, because of the need to match up input and output codecs.

Different signal paths also require different functionality. So a contribution circuit – from a remote production such as a sports event – may arrive at the broadcaster in high quality JPEG2000 or H.264. It is then processed internally and handed over to the distribution chain.

The distribution chain may take JPEG2000, high bitrate H.264, or raw SMTPE ST2110 format. This then needs to be passed to an ABR (adaptive bitrate) encoder to create multiple streams to be passed to the content distribution network (CDN) for OTT delivery.

If it is a live broadcast, then there will also be a parallel broadcast distribution chain transcoding the internal mezzanine content to low bitrate H.264, with perhaps different data rates and wrappers for terrestrial, cable and satellite broadcast.

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\(^8\)OZER, Jan. Cloud Pricing Survey Shows Hybrik Least Expensive Option By Far. Streaming Learning Center [online]
It is clear that a large number of transcoders is required. Treating each one as an individual device creates an inflexible architecture, and requires a large amount of rack space and power.

The alternative is to use powerful software to achieve the same functionality. The Comprimato Live Transcoder provides an extremely compact solution: 32 simultaneous one-to-one high-quality transcode streams (or 16 one-to-eight ABR streams) in a single 1U box or even double when running on high-performance setup.

That density makes a significant difference to an installation. If you plan for 100 transcode streams, the Comprimato Live Transcoder could accomplish it in 4U (7U if they are all ABR). Other more hardware dependent solutions available today would require 24U or more.

The software is an image downloadable from Comprimato, which is activated by a flexible licence. Because every application is different, Comprimato offers licence deals from two weeks to two years.

However long the licence, the user receives full access to software updates during that period. So the system is always using the most functional, reliable and fast version.

As new functionality comes along, so it can be added. You may be focusing on HD production and delivery at present, but if you need to move to 4K Ultra HD, then all you need to do is upgrade the codecs to the 4K version. There are no changes to the workflow, and no disruption to processing.

This inherent agility also allows you to offer more services to the consumer which will aid in attraction and retention. Because it is simple and very low cost to add more transcode paths, you could, for example, bring multiple feeds back from the sporting event rather than just one. These can then be offered as alternatives to the consumer.

At major multi-sport events, like the Olympics, you can ensure that your audience has live access to every event, even when there may be 20 or more different things happening at the same time. This can be set up by adding short-term licences to the Comprimato Live Transcoder platform, minimising the investment needed.

The transcoding network is simply set up and managed through a web services connection. Once the server has been mounted in the rack, and power and network cables attached, initial set-up takes around 10 minutes: the Comprimato manager software includes a set-up wizard. New signal paths can be added with little more than a click.
Conclusion

The Comprimato Live Transcoder platform is an excellent example of the advantages of software-based live content processing, which is joining the functionality of several hardware devices into one flexible and easily manageable software. It is already implemented in a number of content companies, and implementation has been proven on the Amazon and Azure clouds.

Technically, it provides a seamless path from origination to multi-platform distribution, keeping signals in the domain that all these devices understand: IP connectivity. The extremely efficient Comprimato codecs, together with the virtualisation allowing them to run on common hardware, mean that the end-to-end latency is extremely low: potentially one-fifth the latency of current systems.

Using standard hardware, or competitive cloud providers, the system can be implemented for very low capital cost. This, together with the flexible licensing model, reflects the growing desire to move to operational expenditure financing and its direct link between costs and revenues.

Using Comprimato Live Transcoder, broadcasters and content deliverers can expect to save up to 60% of encoding and transcoding costs, up to 80% on infrastructure costs and, because of the ability to implement rolling software and hardware upgrades, extend the time to product renewal by 100%.

The move to software-based technology is allowing the media industry to be more responsive to the demands of its consumers, and at the same time move its operations to a more efficient, reliable and resilient basis.

Software-only platform benefits

- Lower initial and total costs
- Flexible pricing models
- Multi-format inputs/outputs
- Superior density
- Simple scalability
- Ready for IP-only workflows
- Extremely low end-to-end latency
Request your Live transcoder demo

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