How can MPEG-5 LCEVC unlock Ultra HD DTT deployment?

Thierry Fautier
MD Your Media Transformation

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Executive summary

Ultra HD over digital terrestrial television (DTT) is constrained by two critical bottlenecks: spectrum availability and the bandwidth overhead of simulcasting UHD alongside HD services. Current UHD DTT deployments typically rely on legacy simulcast approaches using codecs like HEVC, which inflate bandwidth usage by 150 to 400 percent over HD baselines. This model is increasingly unsustainable, both technically and economically.

MPEG-5 LCEVC offers a fundamentally more efficient alternative. Instead of duplicating content at higher resolutions, LCEVC adds an enhancement layer to an existing HD base stream, enabling full UHD HDR output with just 1.5 to 3 Mbps of additional bandwidth, approximately 10 times less than current simulcast UHD deployments.

Already confirmed for use in Brazil's TV 3.0 rollout and progressing through DVB standardization, MPEG-5 LCEVC enables countries to deliver scalable UHD services without new spectrum allocation or disruptive hardware changes. This approach not only supports native UHD production but also enhances legacy HD sources through de-interlacing, upscaling, and HDR conversion, producing 2160p HDR outputs compatible with formats like HDR10, HLG, Dolby Vision, and more.

The integration path is pragmatic:

- TV sets can support LCEVC via driver-level software or hardware in new chipsets.
- Encoders from Harmonic and ATEME already support MPEG-5 LCEVC through formal integrations.
- Trials and plugfests can be executed with today's equipment, accelerating time for deployment.

Looking ahead, countries seeking to deliver UHD via DTT without costly spectrum tradeoffs or decade-long infrastructure cycles now have a viable solution. Backed by V-Nova's pre-integrated ecosystem and early adoption in Brazil, MPEG-5 LCEVC is positioned to unlock scalable UHD DTT with zero impact on device cost and full compatibility with legacy TV sets.

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UHD DTT use case

Digital terrestrial television (DTT) has historically served as the network for delivering and creating high-audience linear channels. Today, new broadcast channels in HD are simulcast in UHD over DTT, and we are witnessing that this transition is not without its challenges.

Certain premium live UHD channels, distributed by multichannel video programming distributors (MVPDs), garner significant viewership, particularly in Europe where SKY and Canal+ hold exclusive rights to soccer matches. Conversely, in the U.S., Comcast/NBC provided coverage of the last FIFA World Cup in 2160p HDR. It's worth noting that none of these channels are delivered via DTT.

In the U.S., sports channels are still predominantly broadcast in HD, but there's a noticeable trend toward premium sports leagues migrating to over-the-top (OTT) services such as Peacock and Apple TV+, offering content in 1080p SDR. Some services, like Amazon Prime, stream in 1080p HDR, while MAX delivers content in 2160p HDR.

In the U.S., DTT employs ATSC 3.0 for UHD, but the majority of content remains in 1080p SDR. The full deployment of 2160p HDR will only occur once the ATSC 1.0 service is switched off, though no date for this transition has been announced.

The challenge with UHD over DTT lies in the need for spectrum to attract an audience. Without available spectrum, the widespread adoption of UHD DTT, which caters to the largest audience, becomes unfeasible. This scenario forces content providers to rely on either MVPD or OTT platforms for UHD content delivery. This white paper explores how the current framework for deploying UHD DTT falls short of being optimal and how MPEG-5 LCEVC can address this issue.

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How is UHD DTT done today?

UHD DTT world map

We will examine all the various UHD systems deployed and concentrate on a specific system utilizing MPEG-5 LCEVC as an alternative. This solution can be applied to all existing HD systems, except Brazil TV 3.0, as it already incorporates MPEG-5 LCEVC, which will be discussed in a separate white paper.

Traditionally, UHD DTT has been perceived as a simulcast of the already deployed HD service, as outlined in Table 1, leading to a significant bandwidth demand.

Country	HD	Estimated HD bitrate	UHD	Additional bitrate consumed for UHD	UHD overhead vs HD service
US/Korea	MPEG-2/TS	10M/s	HEVC/MMT/ ROUTE	15-20M/s	150-200%
Spain	MPEG-4 AVC /TS	5.5 M/s	HEVC/TS	15-20M/s	300-400%
France	MPEG-4 AVC / TS	5.5 M/s	HEVC/TS	15 M/s for CBR channel 11.2 M/s for stat mux	300% 200%
Germany	HEVC/TS	3M/s	NA	NA	No UHD service planned
Brazil TV3.0			VVC/MPEG5 LCEVC/IP	10 M/s	NA (2)

Table 1: UHD DTT map

From the table provided, we can discern two primary classes:

- Most countries, excluding Brazil, have opted for HEVC for UHD, resulting in bandwidth consumption ranging from 150% to 400% compared to UHD. This is notably inefficient in terms of spectrum usage when compared to viewership.

- Brazil, on the other hand, has embraced VVC + MPEG-5 LCEVC for UHD, consuming only 150% of the bandwidth used for HD encoded in AVC with a TV 2.5 configuration. Additionally, with TV 3.0, Brazil adopts a greenfield approach where both HD and UHD are VVC encoded using MPEG-5 LCEVC, requiring less than 10 Mbps, making it the most efficient system thus far.

The key takeaway is that employing brute-force simulcast, especially using an older codec like HEVC for UHD, incurs substantial bandwidth costs and spectrum utilization. A simulcast using a more modern codec such as VVC may consume less bandwidth and could be considered by some countries. However, a true layered scheme utilizing MPEG-5 LCEVC proves to be the most optimal, as both UHD and HD can fit within less than 10 Mbps, closely resembling the Brazil TV 3.0 scheme and offering backward compatibility.

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The second issue pertains to spectrum availability, illustrated through a guided tour of the listed countries:

- In the U.S., the simultaneous transmission of ATSC 1.0 and ATSC 3.0 restricts UHD transmission to 1080p (SDR) using HEVC encoded at 6–8 Mbps. This fails to capture consumers' attention, as it only presents a migration from 1080i to 1080p. Moreover, the non-uniformity of HD to UHD upconversion across different TVs, coupled with SDR to HDR conversion, dissuades broadcasters from pursuing this option.
- In Korea, broadcasters have access to a dedicated band for deploying UHD channels, resulting in all UHD content being 2160p60.
- In Spain, while the main channels remain in SD or HD, UHD channels have a dedicated DVB-T2 spectrum.
- In France, similarly, the main channels are in HD, with UHD channels allocated dedicated DVB-T2 spectrum obtained through the reoptimization of HD channel encoding.
- In Italy, the absence of spectrum allocation for UHD precludes the possibility of over-the-air UHD services. Similarly, in numerous countries worldwide, the availability of HD services is not matched by frequencies for UHD, resulting in broadcasters refraining from investing in UHD.

Overall, UHD deployment in many countries faces significant hurdles both in terms of business and technology. The potential of MPEG-5 LCEVC to overcome these challenges will be explored further.

Building a UHD DTT service

The standardization phase starts with ATSC for the U.S./Korea, SARFT in China, ARIB for Japan, Forum SBTVD for Brazil, and DVB for the rest of the world. Typically, it takes around three years, on average, to transition an MPEG standard to a fully ratified standard by a standards developing organization (SDO).

During the SDO process, the decoder chip is assumed to be designed, with no additional delays considered. Following this, TV manufacturers must develop, produce, and sell their TVs. Broadcasters typically contemplate deploying new technology once the installed base surpasses 40% of TVs.

For instance, in the U.S., with NextGen TV commercially introduced in 2020, the volume ramp-up only reached 40% by 2026, six years post-introduction, with 70% achieved in seven years.

In France, for UHD DTT, technical specifications were finalized in 2018, and regulatory approval from ARCOM was granted in 2023 to commence broadcasting by the 2024 Paris Olympics. TV manufacturers anticipated this decision and began producing UHD sets with DVB-T2/HEVC capability from 2018. Subsequent software upgrades addressed interoperability issues without altering the hardware platform on the AV side.

By 2024, the penetration rate of UHD TVs stood at 70%, achieved over six years, surpassing the previously mentioned 40% threshold. While there's no legal mandate for upgrading deployed TV sets, TV makers at CES 2024 announced that new TVs manufactured in 2024 would receive software support for five years. FAVN (French UHD group) tested a few TVs predating 2020 and found no major interoperability issues on recent TV sets, suggesting a five-year backward compatibility consideration.

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Overall, from the inception of a new codec to deployment, the process takes approximately 10 years. While this pace doesn't match the speed of the internet, it reflects the operational norms within the broadcast space. We'll explore how MPEG-5 LCEVC can revolutionize this dynamic.

Conclusion

In conclusion, the current method of deploying UHD DTT is not only costly in terms of spectrum but also time-consuming. Many countries may not be able to pursue this path in the future, particularly if more efficient alternatives become available. This presents an opportunity to explore alternative methods for UHD DTT deployment, where MPEG-5 LCEVC could offer significant advantages in spectrum efficiency, backward compatibility, and speed to market.

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MPEG-5 LCEVC features

Background

MPEG-5 LCEVC, which stands for Low Complexity Enhancement Video Coding, has been specifically designed to serve as a codec-agnostic enhancement with reduced hardware or software complexity compared to other full-fledged codecs. LCEVC can be implemented in various ways, including traditional hardware integration on chipsets or at the device driver level, leveraging a combination of CPU/GPU software and hardware blocks already available on-chip. This flexibility enables the updating of existing chipsets to support LCEVC.

The performance of the MPEG-5 LCEVC codec depends on several factors, including the type of base codec used, the type of extension layer utilized, and the operating point selected. As a rough estimate, envision an extension layer utilizing around 20% of the base layer to construct a UHD layer from an HD base layer. Further details will be provided in the subsequent sections.

MPEG-5 LCEVC applied to UHD

In this section, we examine two scenarios for the base layer:

- HD 1080i/720p SDR (BT.709) encoded in AVC, as commonly done in most countries.
- HD 1080p/720p SDR (BT.709) encoded in HEVC, as practiced in a few countries like Germany and Italy.

At the output of the MPEG-5 LCEVC encoder, the decoded signal must provide up to a 2160p HDR output, accommodating various HDR formats such as HDR10, SL-HDR1, SL-HDR2, HLG, Dolby Vision, and HDR10+. These formats are standardized by ATSC (HDR10, SL-HDR1), DVB (HLG, HDR10, HDR10+, SL-HDR2, Dolby Vision), and SBTVD (HDR with optional dynamic metadata to support Dolby Vision, SL-HDR2, HDR10+ for broadcast, and SLHDR1/HLG for OTT).

An MPEG-5 LCEVC-enabled UHD encoder must handle two types of inputs:

- Native UHD when the content has been produced in UHD.
- Legacy HD when HD is the source.

For a native UHD source, a pre-processor will convert the UHD HDR signal to 1080i/720p SDR to feed the base layer to an AVC or HEVC encoder.

For an HD source (1080i/720p), several operations must be performed:

- Deinterlacing (if the source is 1080i)
- Upconversion from HD to UHD
- HDR conversion from the SDR source

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Table 2 outlines the two major scenarios that need to be supported to generate a UHD signal from an HD source.

Country	Base	MPEG-5 LCEVC		
		Extension layer	HDR conversion	
			Spec	Beta availability
Italy/Germany	1080p SDR HEVC	LCEVC 10 bits	Standard defined Receiver TBD	Demo HDR10
Other DVB countries	1080i/720p SDR AVC	LCEVC 10 bits	Standard defined Receiver TBD	Demo SL HDR1 & HDR10

Table 2: *MPEG-5 LCEVC scenarios for DTT*

Application

We summarize in Table 2 how each system addresses scalable coding requirements.

System	Scalability approach selected	Status	Use case
ATSC 3.0 (US)	SHVC	Deployed	Mobile (HD)/ OTA (UHD)
Brazil	MPEG-5 LCEVC (green field)	Standardized (’24) Deployed (’25)	New generation of broadcasting system
Japan	Scalable VVC	Standardization stage	Green field 4k/8K scalable
DVB	MPEG-5 LCEVC (backward compatible)	Standardization stage	HD (AVC/HEVC) as base layer to MPEG-5 LCEVC

Table 3: *scalable coding systems in the world*

We find the DVB system particularly attractive for implementing MPEG-5LCEVC in UHD DTT, especially for countries facing spectrum-availability constraints.

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In Figure 1, we illustrate a transmission setup using an HEVC HD (SDR) base with an MPEG-5 LCEVC enhancement layer to produce UHD HDR video. Notably, the system also works when the HD base is encoded in AVC SDR.

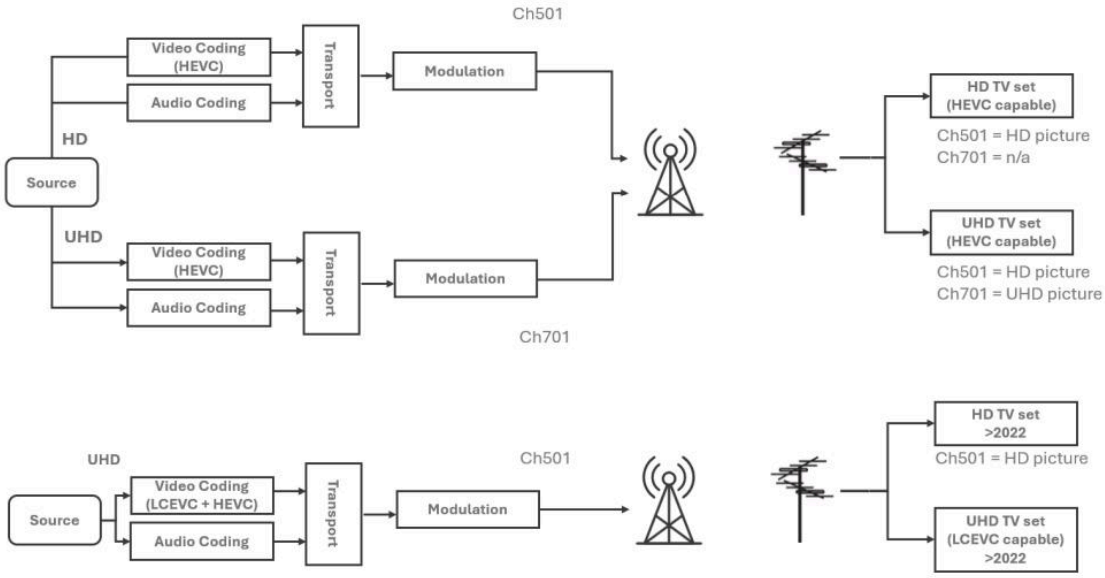


Figure 1: *Application of MPEG-5 LCEVC to the transmission of UHD HDR from a HD SDR base layer*

Spectrum

Because MPEG-5 LCEVC requires approximately 1.5–3 Mbit/s of additional enhancement-layer video bitrate to create a UHD channel, spectrum can be managed via “repacking” in two main ways:

- Maintain the existing channel lineup while improving compression efficiency by ~20%. This approach—seen in France—is challenging, as it depends on substantial compression gains from newer encoders.
- Consolidate channels by merging them to reduce the total count. This method—used in the US—can, for example, turn five channels into four.

In practice, France migrated from six multiplexes to five with similar total capacity, yielding a ~16% bandwidth saving by upgrading to newer encoder generations with better compression efficiency. If the encoders do not achieve the targeted gain, an alternative is to lower the encoding bitrate— but this can introduce additional artifacts and therefore requires quality validation through trials.

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MPEG-5 LCEVC benefits

Background

The primary benefits of MPEG-5 LCEVC compared with a traditional approach include:

- Reduced bandwidth requirement. MPEG-5 LCEVC typically requires only ~20% of the bandwidth of the existing HD signal to deliver a UHD stream. For example, with an AVC base encoded at 7 Mbit/s for 1080i/720p SDR, the MPEG-5 LCEVC enhancement layer would be approximately 1.5 Mbit/s. Similarly, for a 1080p SDR HEVC base encoded at 5 Mbit/s, the enhancement layer would be approximately 1 Mbit/s. These figures are roughly 10× smaller than current values used in simulcast deployments.
- Versatile implementation. MPEG-5 LCEVC can be implemented at the device-driver level on existing video system-on-chips (SoCs) as well as in hardware in the next generation of chipsets. This enables TV manufacturers to deploy a distinctive new feature on current shipping models, strengthening product competitiveness.

Figure 2 illustrates the bandwidth savings enabled by MPEG-5 LCEVC.

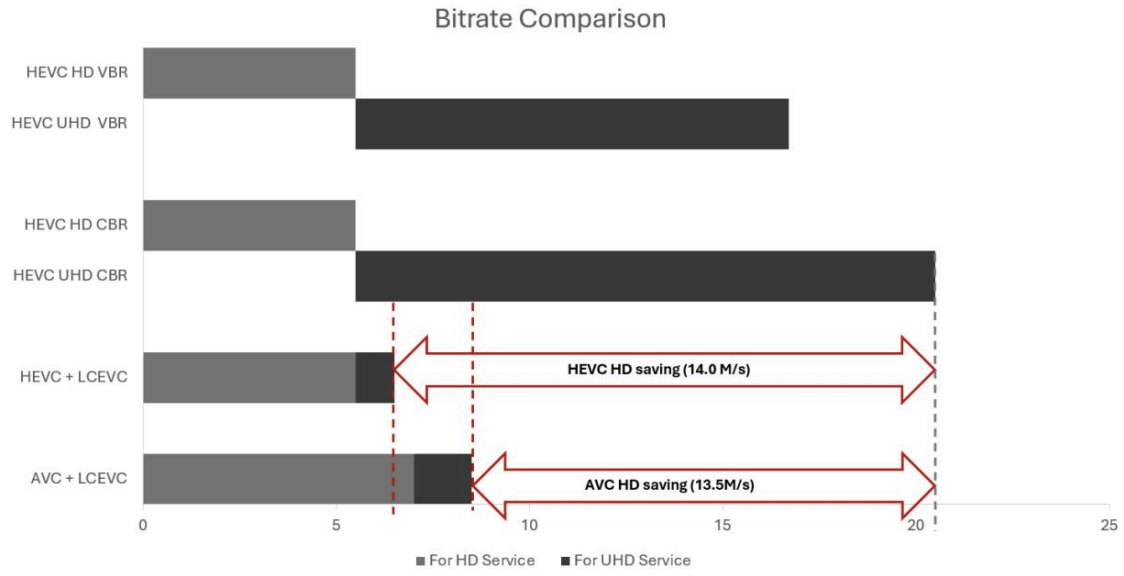


Figure 2: *MPEG-5 LCEVC savings*

Indeed, leveraging MPEG-5 LCEVC with a legacy HD base layer represents the most optimal solution. The additional bandwidth required for this setup typically ranges from 1.5 to 3 Mbps, which stands in stark contrast to the 15 to 20 Mbps required for a UHD simulcast using HEVC as deployed in current setups. This significant reduction in required bandwidth underscores the efficiency and effectiveness of MPEG-5 LCEVC, making it a highly favourable option for UHD content delivery.

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Integration

Different levels of integration are required for MPEG-5 LCEVC implementation in a TV set. Firstly, at the codec level, integration must occur at the systems-on-chip (SoC) level. There are various implementations of MPEG-5 LCEVC at this stage:

- Driver-level integration: software running on the CPU or GPU of the SoC.
- Hardware integration: dedicated hardware embedded in the next generation SoC.

On the head-end side, integration with encoder vendors is necessary. Currently, V-Nova has signed integration agreements with leading encoding companies such as Harmonic and ATEME. These agreements facilitate the incorporation of MPEG-5 LCEVC into their encoding solutions. Notably, public MPEG-5 LCEVC UHD proofs of concept (PoCs) were demonstrated by these companies in 2022/23, showcasing the viability and potential of this technology.

Adoption

In terms of timing for MPEG-5 LCEVC adoption, V-Nova has been collaborating with systems-on-chip (SoC) manufacturers for several years. It is anticipated that by 2025, major SoC manufacturers will have a General Availability (GA) version ready to support both AVC and HEVC base layers for delivering UHD HDR content on TVs. This indicates a significant step forward in the integration and adoption of MPEG-5 LCEVC technology within the television industry.

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Next steps

There are different steps to reach a deployment.

a. DVB standard:
First, we need DVB to ratify MPEG-5 LCEVC as one possible option for deploying a broadcast system.

b. National standard:
To consider MPEG-5 LCEVC as part of a DTT deployment in Italy, several parameters need to be defined:

- Base-layer codec: decide whether to use AVC or HEVC.
- Input resolution: determine the input resolution for the base-layer codec (1080i/720p or 1080p).
- Output resolution: define the desired output resolution (e.g., UHD (2160p) HDR).
- HDR format: specify the HDR format to be used, such as HDR10, HLG, or Dolby Vision.
- Bitrates: determine the target bitrates for both the base-layer codec and the MPEG-5 LCEVC enhancement layer.
- Encoding scheme: decide whether to use constant bitrate (CBR) or variable bitrate (VBR) encoding.

Once these parameters are defined, Italy can proceed with the implementation of MPEG-5 LCEVC as part of its DTT infrastructure, enabling more efficient and cost-effective delivery of UHD HDR content to viewers.

c. Trial:
Here is a checklist of things that need to be prepared for a trial:

- Identify TV sets: select TV sets that are ready to support a UHD DTT MPEG-5 LCEVC trial. These TVs should be equipped with the necessary hardware or software to decode MPEG-5 LCEVC-enhanced signals.
- National specification subset: choose a subset of the national specification to be implemented in the trial (base-layer codec, input and output resolutions, HDR format, bitrates, and encoding scheme).
- Encoder upgrade: upgrade existing encoders to support MPEG-5 LCEVC and run a trial using spare units. This allows broadcasters to use their current infrastructure while testing the new technology.
- Trial goals: assess platform stability on both the encoder and TV sides, evaluate video quality across different operating points, and test various modulation configurations, especially T1/T2 mix options.

d. Plug fest:
After a successful trial, we need to organise a plug fest under the umbrella of the technical arm of the regulator, such as the Ultra HD Forum Italia in Italy. This event brings together different encoder manufacturers to test their products against commercial TV sets.

e. Regulation:
Obtaining regulatory approval for commercial deployment is key. This may involve securing the regulator's stamp of approval and addressing any spectrum reallocation required to accommodate the additional 1 Mbps needed for MPEG-5 LCEVC deployment.

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Conclusion

In this white paper, we've evaluated various options for transmitting UHD over DTT, and the most compelling solution emerges as MPEG-5 LCEVC, particularly when ensuring backward compatibility for legacy TV sets. Brazil has pursued a more innovative approach with its TV 3.0 system, implementing a greenfield deployment with VVC as the codec alongside MPEG-5 LCEVC.

MPEG-5 LCEVC significantly reduces bitrate requirements, making UHD DTT feasible even in scenarios where spectrum availability is limited. V-Nova, the creator of MPEG-5 LCEVC, stands as the natural partner to deliver UHD over DTT, offering a pre-integrated ecosystem encompassing encoders, chipsets, TV sets, and STBs, thereby bringing UHD DTT to a wider audience.

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About MPEG-5 LCEVC technology

MPEG-5 Part 2 LCEVC is an ISO/IEC video compression standard from MPEG that works alongside any codec to improve efficiency and quality. It delivers up to 40% better compression and can cut transcoding costs and power use by up to 70%. Now mandated as part of Brazil's DTV+ (TV 3.0) standard, LCEVC runs across broadcast, streaming and device platforms and is supported by LCEVC capable devices and AI ready workflows. Learn more at www.lcevc.org.

About V-Nova

V-Nova, a London based IP and software company, is dedicated to improving data compression by building a vast portfolio of innovative technologies based on the game-changing use of AI and parallel processing for data, video, imaging, point cloud compression, with applications across several verticals.

This is achieved through deep-science R&D (300+ international patents) and the development of products that test, prove and continuously enhance the technology portfolio.

V-Nova LCEVC is the industry's first highly optimized library for encoding and decoding enhanced video streams with MPEG-5 Part 2, Low-Complexity Enhancement Video Coding (LCEVC). V-Nova VC-6 is a high-performance AI-powered software library for SMPTE VC-6 (ST-2117-1) which is used primarily for professional production workflows and imaging applications.

V-Nova has developed multiple award-winning software products to kickstart the ecosystems for its technologies and allow their immediate deployment, addressing use cases in TV, media, entertainment, social networks, eCommerce, ad-tech, security, aerospace, defence, automotive and gaming. V-Nova's business model is to monetize its technologies through software licensing, IP royalties and product sales.

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