



D7.4 Interim Exploitation Plan



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Table of Contents

1. Executive Summary	4
2. Background	4
3. Technology	4
4. Market	7
5. Exploitation	9
5.1 FilmLight	9
5.2 Brainstorm	12
5.3 Barco	16
5.4 ARRI	18

1. Executive Summary

This document builds on the M6 deliverable D7.2 Initial Market Impact Plan. Now, 2 years into the project, there is a better understanding regarding the opportunities and challenges of HDR as a family of technologies, as well as the specific role of each consortium partner within the HDR market place.

The experience over the last two years has shown that the parallel deployment of HDR and SDR content raises quite a number of technical and artistic challenges. They provide an opportunity to offer special solutions in the market in production, post production and distribution.

At the same time, these challenges are slowing down the deployment of HDR and show that this will be a drawn-out long term process where new solutions can still be developed and new workflows can still be tested. HDR as a technology is far from settled.

The document follows broadly the structure of the earlier document, beginning with an updated overview of the technologies and markets. It then describes in more detail the exploitation activities and plans for the future for each consortium partner in turn. As an Interim Plan, it does not attempt to provide a detailed quantitative forecast, but the commercial opportunities listed give an indication of their significance to each partners' business going forward.

2. Background

To understand the direction HDR technology is taking us, it is worth remembering what was there before. With the first wave of digital display technology, dynamic range was considered the major limitation. LDC monitors struggled to have a contrast ration of 400:1, and the DCI had to settle for 2000:1 as an acceptable target for digital cinema projectors. Peak brightness was a consideration, but not a driving force. After all, the premium format 65/70mm cinemas that could have provided a step-up in brightness weren't a long term commercial success, and in any case emphasised screen size and resolution and weren't deployed on small screens. In fact many screens were run well below the 48nit peak white defined by the standard in an attempt to save bulb life and electricity cost.

While the improvement of contrast turned out to be a long term challenge, new illumination technology, be it LED backlight, OLED or Laser offered brighter pictures without elevated blacks. Not that anybody knew what to do with it. But the side-by-side comparison with the earlier dull screens made an absolutely convincing case for HDR. There is simply no way back. But there is hardly any agreement on the way forward either.

3. Technology

HDR today presents a very confusing picture. On the one hand, it is an established technology, with a substantial amount of content already being available, and more being made. In terms of TV sales, the trend towards larger screen sizes and resolutions of 4k and above continues with strong growth. Virtually all large-format TVs now support some form of HDR, so it has actually become rather difficult to buy a good quality non-HDR TV recently.

On the other hand, the broadcasters have not started live HDR broadcasts in any meaningful way – the transition from an SDR workflow is turning out to be much more complex than anticipated. So the major opportunity to watch HDR content is through streaming services. In turn, this indicates that HDR today is very much a technology associated with drama and storytelling rather than factual programming.

In the cinema, there is an ongoing effort to rebrand premium 100nit "EDR" solutions as part of the HDR development, but proper HDR comparable to home viewing is still some way off. Given

the strong overlap between cinema and streaming content on the one hand, and the vast installed base of SDR TV sets, the problem that spoils the HDR technology success story is the need for at least two versions of each programme.

Consequently, much effort has gone into automatic conversion processes that push this issue away from the content creation process, as well as offering a cheap way of repurposing SDR content. What it doesn't account for however is that even the most sophisticated underlying colour appearance model (CAM) does not capture the Director of Photography's dramatic storytelling intent.

While it is perfectly possible to transform a photographic image to render a faithful reproduction of the original scene using a CAM, it completely misses the point of dramatic visual storytelling. Images serve a dramatic purpose, they are not primarily capturing reality as we see it. Production companies spend a lot of money on the Director of Photography (DoP) and his crew, on the lighting budget and preparation time on set, for the specific purpose to make the images interesting rather than real: beautiful, exciting and unusual, and as close to the edge as possible.



Fig. 1: HDR and SDR side-by-side (Dolby)

This state of affairs opens up opportunities for the consortium, and at a minimum shows that the work done by the consortium so far was necessary and timely. There is a need to generate multiple deliverables for all viewing conditions from a single "scene-referred" HDR master that is more robust and more faithful to the creative intent.

At the same time we need to recognise that with so much popular programme material available already, and only available in SDR, there is a need for peaceful coexistence, especially in the home viewing environment. One relevant issue here that isn't fully appreciated yet is the strong adaptability of our visual system. We watch HDR and immediately see how attractive it looks, above all in direct comparison to a "dull" SDR version. But after a few minutes without a direct reference, we are already used to it. It just looks like you would expect it to look. After all, we see higher dynamic range scenery in the real world all the time (Fig. 1, 2).

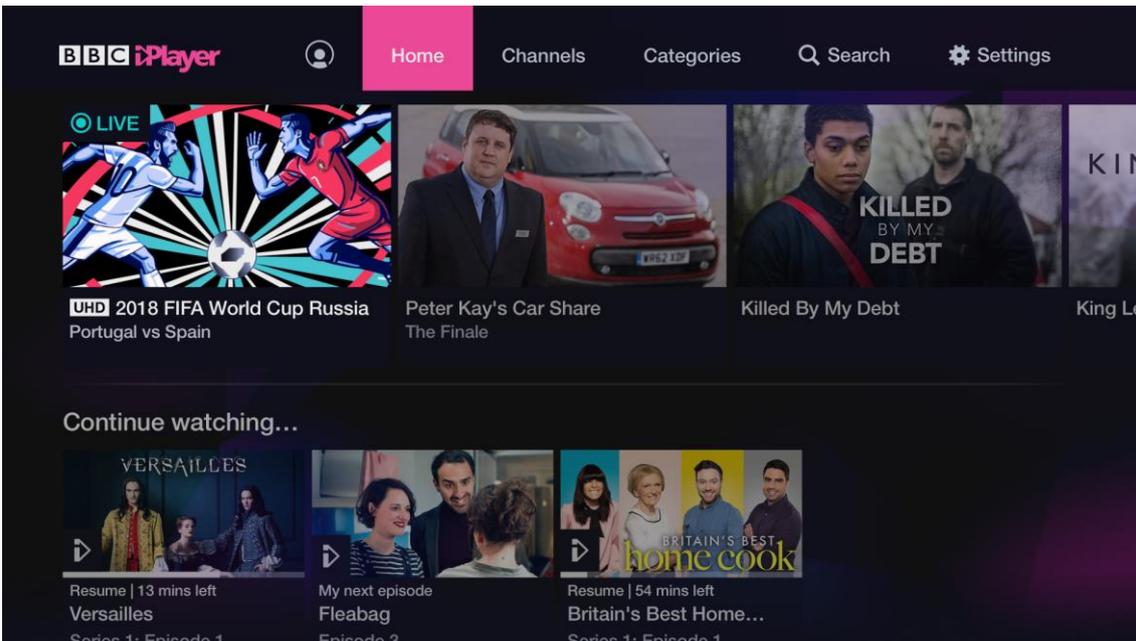


Fig. 2: Mixed HDR and SDR content via streaming app

Conversely, if you go back to an SDR presentation, it initially looks dim and flat, with the loss of a lot of highlight detail. But after a few minutes, we are completely used to it again. After all, we have seen these kinds of images for all our lives without being concerned about the lack of "realism".

What is interesting to note is that even relatively small changes in the viewing environment, what we call Extended Dynamic Range (EDR), require their own approved master. It is generally accepted that any deviation from the standard DCI cinema viewing environment (48nits white, 2000:1 contrast) is not treated as an automatically derived secondary deliverable. Instead, as a premium cinema version it gets at least the same care and attention as the full HDR version for home viewing.

This hand-tuning in an interactive post production process is possible for dramatic content, but not in a live broadcast environment. Live broadcast of HDR has played a role so far primarily for major sports events and is in practice tied to UHD/4k technology, which in turn ties it to streaming services like BBC iplayer and the few satellite based UHD channels in operation.

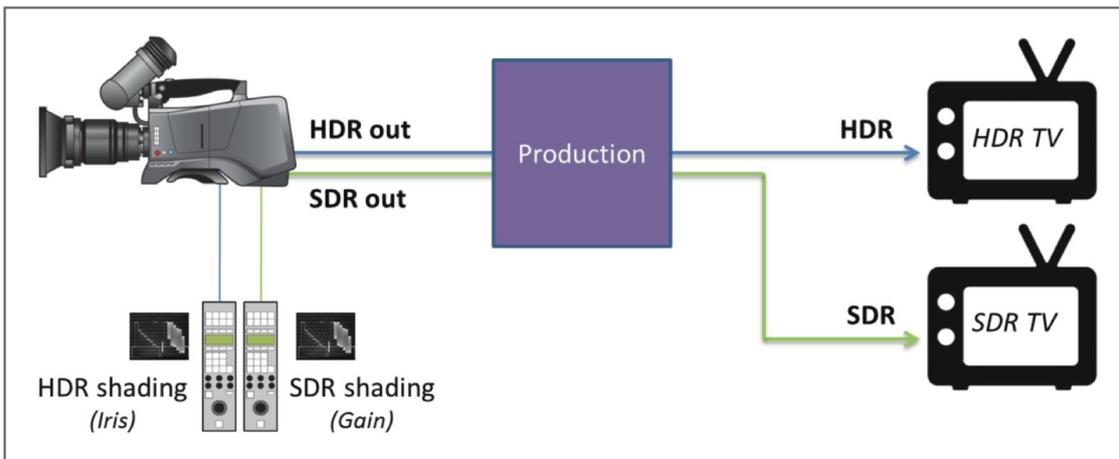


Fig 3: Parallel HDR/SDR live broadcast workflow (Grass Valley)

But to provide a high quality output at HD/SDR, which is still by far the most popular way to view these events, a parallel production workflow was maintained, with the separate camera outputs for UHD/HDR and HD/SDR going parallel but separate, expensive ways (Fig 3). It is only very recently that the promise of HDR/SDR compatible HLG encoding allows a unified production workflow (Fig 4). Unlike dramatic content, the live action content benefits from the extra level of realism provided by HDR, and make the balancing of the camera output if anything easier than before.

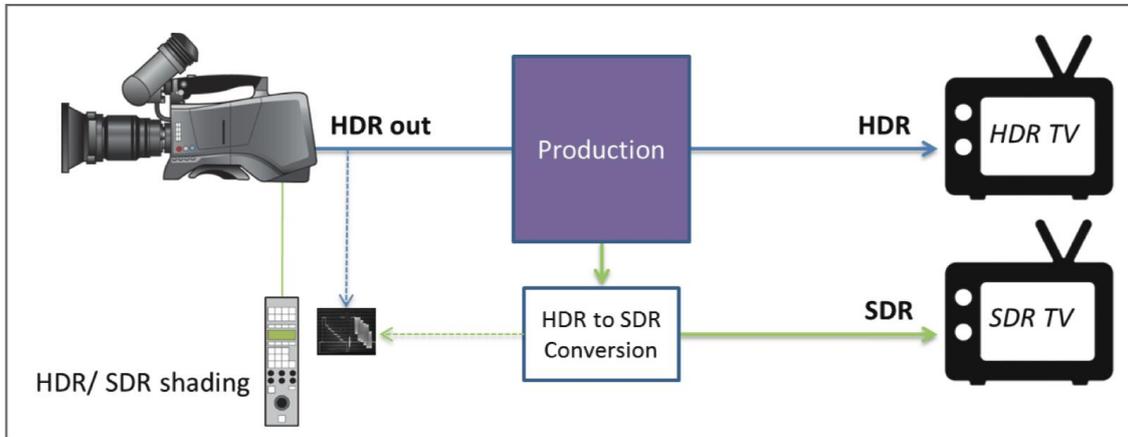


Fig 4: Unified HDR/SDR live broadcast workflow (Grass Valley)

4. Market

The positions of the main players in the HDR market have become clearer over the last couple of years. Dolby Inc. has agreed licensing deals for their premium “Dolby Vision” HDR end-to-end workflow with many studios and TV manufacturers, as well as streaming services and technology companies, notably Netflix and Apple.

In the consumer electronic space, i.e. mobile viewing, Blue Ray players and TV sets, PQ-encoded HDR10 is the dominant solution. However, the various attempts to provide an alternative to the Dolby Vision dynamic metadata encoding solution under the umbrella of HDR10+ have so far gained very little traction.

Among the broadcasters, there is a consensus to adopt HLG as the most compatible route for HDR, but it is entirely unclear if it will ever find its way into the terrestrial broadcast infrastructure, or if it will remain part of the UHD live streaming and VOD services provided by the broadcasters.

In addition to these three major market segments, there are a number of more specialised solutions available. In the Extended Dynamic Range premium cinema space, Dolby offers “Dolby Cinema” (Fig 5), French company Ymagis has Éclaircolor (Fig 6), Imax have a proprietary solution for their vertically integrated cinema business.



Fig. 5: Dolby Cinema commercial roll out (at London’s premier cinema)

While these offerings are not strictly speaking HDR, they provide an important testing ground for delivering content outside the DCI specification.

The DCI has published a draft proposal for HDR cinema in November 2018. It puts forward a 500nit HDR cinema standard very much in line with the previous 48nit standard that has held up for many years but is now being overtaken by improvements in technology. The DCI recognises that there are fundamentally different technologies competing for HDR cinema, namely directly illuminated screens like the ones put forward by Samsung (Onyx) and Sony (Crystal LED) on the one hand, and projection technology like Barco’s light steering technology on the other.



Fig. 6: Eclaircolor EDR process

It is not clear at this point how the substantial differences in texture, sound and perceived black level will ultimately be reconciled. What is clear however from the push towards premium EDR cinema, there is a need to allow competition among cinema operators not just on the comfort of

the seating or the choice of popcorn, but on the quality of the sound and images, too. The constraints of technology as well as the compatibility with conventional film helped define the first generation of digital cinema. Similar constraints for HDR cinema are more difficult to identify.

FilmLight has investigated the blending of two independently mastered versions, one for HDR and one for SDR, and found this to be an astonishingly simple, extremely robust very accurate way of interpolating between different viewing conditions and brightness levels. We have proposed this method, which can be deployed before or during distribution as well as at the point of delivery, to the DCI and various experts in the industry and hope it will gain some traction.

5. Exploitation

5.1 FilmLight

FilmLight as a provider of colour grading systems for the post production market sees a number of possibilities to offer solutions in this market. For the last two years, we have run a wide range of seminars and workshops around the world to strengthen and enhance our reputation as leading industry experts in colour management and specifically HDR.

Some of these events have been joint presentations with some of the consortium partners, namely Barco and ARRI. For example, a workshop for DoP's held jointly with ARRI at Camerimage in 2017 and again for a masterclass in San Sebastian in 2018. Or the HDR panel at an event organised by the French DoP's (AFC) in Paris, involving Barco, ARRI and FilmLight (Fig. 7-9).



Fig. 7: Camerimage workshop with ARRI and FilmLight



Fig. 8: HDR Masterclass during Film Festival in San Sebastian



Fig. 9: HDR Panel during AFC conference in Paris

FilmLight continues to organise and sponsor “Colour Days” during industry trade shows as well as publishing educational videos and giving advanced training courses (Fig. 10). These events have directly contributed to additional business.



Fig. 10: IBC 2018 FilmLight colour day with Maxine Gervais

The main focus of FilmLight's HDR exploitation is the improvement and widening of the HDR toolset within the Baselight application. Over the last 2 years, we have

- added Base Grade as a completely new scene-referred HDR-optimised grading operator (Fig. 11)
- added support for Dolby Vision, including support for dynamic metadata
- added support for HLG and HDR10
- introduced "DRT-families" to optimise production of multiple deliverables for different viewing conditions
- added flexible and robust tone mapping and inverse tone mapping tools (Fig. 12)
- added tools for local tone mapping and texture modifiers to improve the natural appearance of HDR images

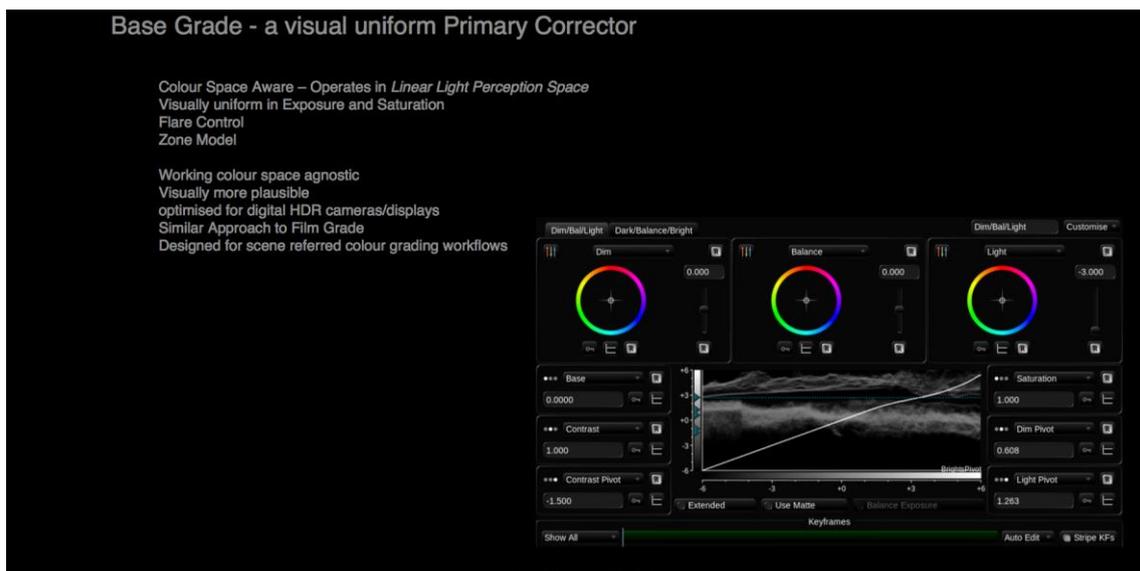


Fig. 11: Base Grade colour grading tool optimised for HDR

Further HDR related tools are in development and will continue to ensure that Baselight will remain the industry-leading toolset for mastering HDR content and for related SDR and EDR versions.

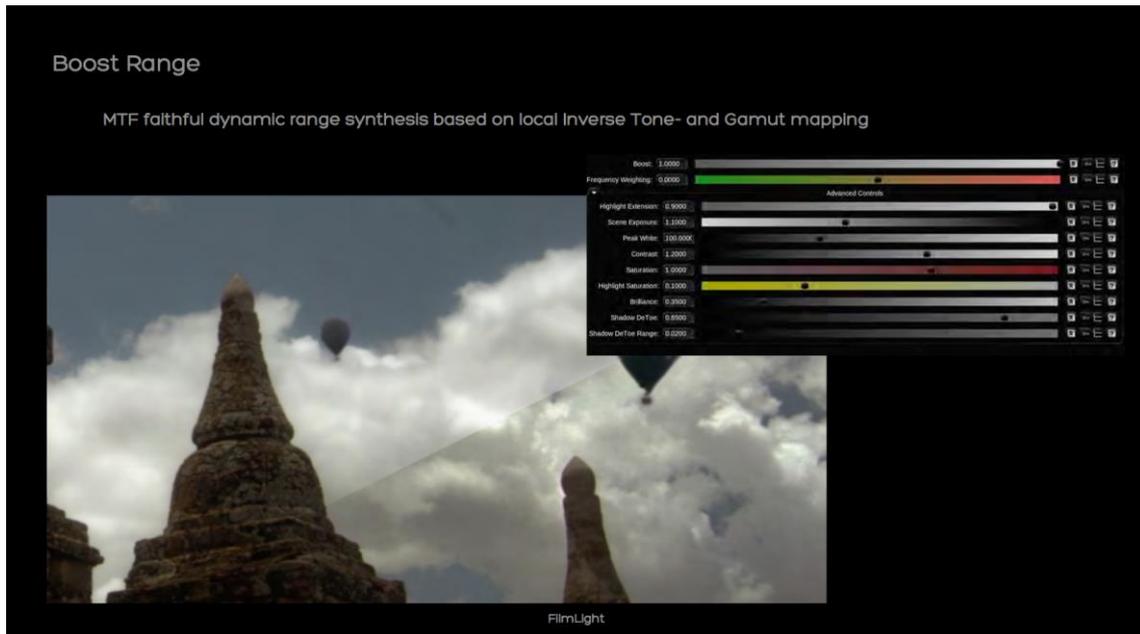


Fig. 12: Boost Range inverse tone mapping tool for SDR to HDR conversion

5.2 Brainstorm

Brainstorm has seen a significant increase in competitive pressure over the past 10 years. The company believes that profitable growth will only come through innovation. As such, Brainstorm is looking to respond to current trends in the market by innovating existing product offerings through strategic partnerships. The HDR4EU initiative is an important part of this strategy.

Brainstorm is a leading company in providing real-time 3D graphics solutions for the broadcasting industry.

Today, using Brainstorm’s patented technologies, companies are able to offer a high degree of realism in their productions. In terms of realism, never is it enough for virtual reality graphics. Customers are constantly demanding of higher quality and realism for the graphics for television, especially in virtual studios (Fig. 13).

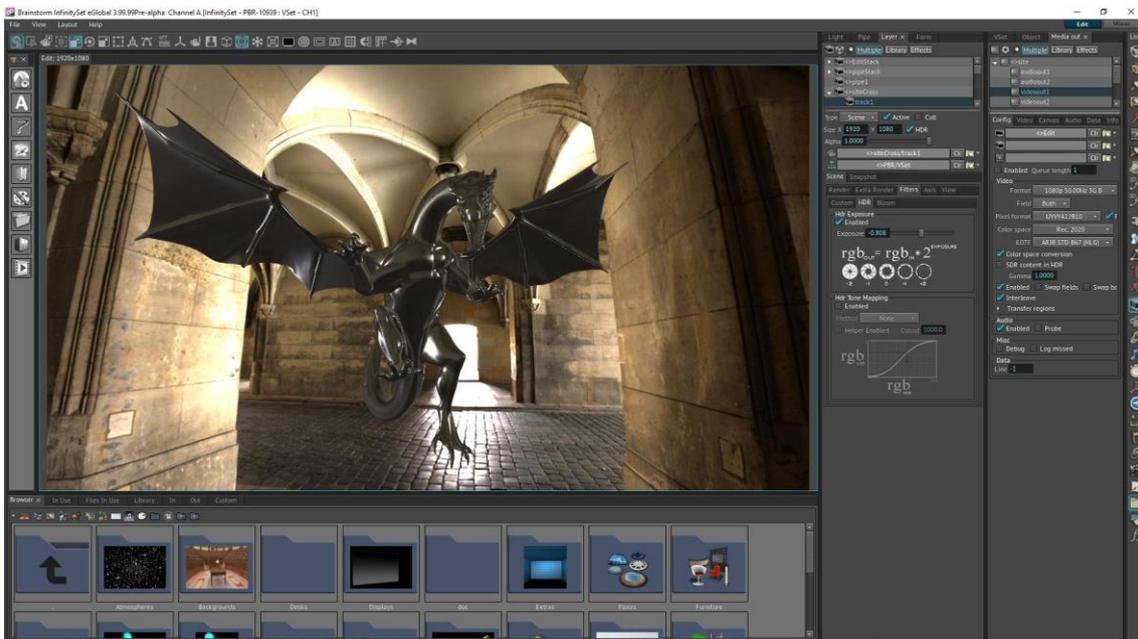


Fig. 13: Brainstorm Virtual Studio Application

Thanks to HDR4EU’s developments, Brainstorm will be able to integrate HDR in its engine and therefore in its own main products, offering an outstanding quality of 3D graphics in virtual scenarios. Far from being considered just a competitive advantage, HDR in real time 3D graphics for broadcasting industry is a must. From now on, those graphic providers not having their engines ready for HDR will be simply left out of the market. That is why, HDR4EU is so suitable for Brainstorm, achieving to get its engine updated and prepared for HDR technologies. This will ensure to retain customers around the world and increase its current market share.

Brainstorm intends to integrate HDR4EU’s exploitable results in its own engine and therefore, commercialise its own portfolio including HDR. The increase in Brainstorm’s market share after this upgrade is foreseen to be of at least 10%. Hitherto, just a few companies have managed to offer HDR in their solutions. Being the first in offering these features would make a real difference for Brainstorm. On top of that, the involvement in such a prestigious EC funded project, will contribute to lend extra reliability to Brainstorm’s 3D applications.

According to the European Audio-visual Observatory, the current size of the biggest European broadcast media market in terms of number of large scale, regional and local television channels available is as follows:

Concentration of TV channels established in the EU28 (2017)

Country	Total national	% share of EU total	Cumulative %
UK	1 197	31%	31%
FR	306	8%	39%
IT	264	7%	46%
DE	253	7%	53%
NL	219	6%	59%
ES	182	5%	64%
CZ	167	4%	68%
BG	127	3%	71%
RO	110	3%	74%
PL	103	3%	77%
SE	89	2%	79%
AT	87	2%	81%
HR	85	2%	84%
LU	85	2%	86%
GR	71	2%	88%
PT	61	2%	89%
FI	57	1%	91%
SI	54	1%	92%
BE (VLG)	42	1%	93%
SK	34	1%	94%
CY	30	1%	95%
HU	28	1%	96%
MT	28	1%	97%
BE (CFB)	26	1%	97%
LV	26	1%	98%
EE	24	1%	99%
DK	20	1%	99%
IE	20	1%	100%
LT	15	0%	100%
BE (DGB)	2	0%	100%
Total EU 28	3 812	100%	100%

Source: European Audiovisual Observatory

Fig. 14: European Broadcast Media Market

Other markets around the European environment have less than four channels each. Some countries such as Spain, France, Italy, Poland and the UK, where satellite TV penetration is high, there is also a bigger range of HDTV channels available. Satellite TV is also a growing sector in Hungary, Germany and Russia. Of the total number of channels available in the European market, 60% are regional or local broadcasters whilst the remaining 40% account for national and international broadcast networks.

The potential market for HDR4EU outcome in Europe is huge and this will be the initial focus for the business plan in the short term. Although, the plan will target broadcasters in first instance, Brainstorm is confident that the potential customer base will extend beyond this in the medium to long term. Currently customers can be categorised as follows:

1. Large scale broadcasters – these are usually players who are well established in their national markets but have also become significant players with substantial global audiences.
2. Medium scale broadcasters – comprise well established players in the regional to national market.
3. Small-scale broadcasters – operating on a local level.

For Brainstorm, as mentioned above, we expect to increase our market share in the first three years after the end of HDR4EU. HDR4EU will make the difference in realism and this differentiation factor will be essential in the final decision of acquiring our system for large and realistic virtual studios facilities. HDR4EU results will be incorporated into our engine as an important improvement of the realism of the graphics generated with it.

Sales are expected to rise due to this upgrade in our graphic engine and results will be incorporated to our standard demo presentations and proof of concepts to our clients.

Plan of Execution

During the Project

- Testing with TVE (Spain) and NHK (Japan) – New improvements in HDR are going to be tested by this broadcaster getting feedback during the process. This valuable feedback will be essential for the adequate implementation of HDR on Brainstorm’s graphics engine and different market solutions.
- Different demos to customers will be performed during the two major Broadcasting Trade fairs Brainstorm is present at, that are NAB (Las Vegas, US) and IBC (Amsterdam, The Netherlands).

After the Project:

Brainstorm will commercialise the resulting product making use of our own international network of resellers as well as other channels cited below:

Network of Resellers: Brainstorm’s commercial operations, led by a Commercial Director, is organised by geographical regions with sales and business development teams for each region. In some regions the company has dedicated operations on the ground and where this is not the case, Brainstorm operates through a network of authorised dealers. The commercial operations are also supported by a technical support team and a marketing function. In most cases, with some notable exceptions in markets where the company has a leading position, the company has single authorised dealers in each country in which it operates.

Advertisement: advertising must be predominantly online, as mentioned above. Some of the potential media to advertise could be:

- Online media.
 - Europe. Panorama Audiovisual, InBroadcast.
 - Latinamerica. Prensario, Newline Report.
 - APAC. C+T
 - USA. Produ.com, Newcast Studio.
- Offline media.
 - Europe. TM Broadcast.
 - Latinamerica. Prensario.
 - USA. SVG Magazine.

Broadcast Fairs

This is the list of international events that Brainstorm usually attends on a yearly basis and where live demo are performed. Some of these will be the perfect scenario to showcase the resulting product.

Fair name	Venue
NAB	Las Vegas
IBC	Amsterdam
BVE	London
Telemundo	Mexico DF
BES	Mombai
SET	Sao Paulo
GV Expo	Washington
CABSAT MENA	Dubai

Broadcast India	Mumbai
INTERBEE	Tokyo
BIRTV	Beijing
BITAM	Madrid

PR: Public Relations are essential to raise awareness about the product and how it relates to Brainstorm existing technology:

- Press Communications. Articles and Press Releases will be sent to the relevant media, talking about the product itself and also related to events and other actions. Relevant PR will lead interested users to the website or directly to the product page.
- Branded content. We will explore the possibilities of placing branded content in relevant media to explain our technology and the benefits it will provide to customers.
- Social Media. delivering information about the product and related events, and will also follow relevant accounts related to the product and its features. Users, institutions and other stakeholders will be followed and informed. Also, and more importantly, they will be amplifying the Press Releases and branded content placed in other media.

The different elements that will be required to achieve the above strategy are the following:

- Website: This is the main hub, the contact point that provides the information about the products, the company and relevant events.
- Email Marketing: Main output for delivering further information to the market (meaning contacts and leads), keeping the audience aware of the developments and updated on the product. They will be sent to the customer list plus the contacts and leads in the CRM in the form of newsletters or emailing's, providing:
 - Updated information about the product, features, training, etc.
 - Updated information the company and forthcoming events.
- Brochures: required at events and presentations to deliver key information to potential customers.

5.3 Barco

Background:

The first wave of digitization in the cinema industry was a full digitization of the complete ecosystem: Digital Cinema Package (replacing the chemical film), server (content player), projector, distribution strategy (hard disks replacing reels) and strong security to protect the cinema assets in the digital world (KDM). The digitization of the market raised significantly the quality of the presentation and at the same time allowed for a lighter/eco-friendly (and money saving) distribution scheme. With this overall enhanced quality of presentation, the premium experience in cinema took mainly the direction of giant screens, to offer an immersive experience. Later immersive sound complemented this experience before arriving in mainstream screens. The cinema market is undergoing its second wave due to the needed replacement of the old first generation equipment. Since the transition from analog to digital, as an industry effort, already happened, there are no programs offering subsidies anymore. Therefore this second wave is focused on a cost-effective reengineering of digital cinema equipment with target to help exhibitors sustaining their business in a highly competitive market: out of home entertainment.

The competition with home entertainment, mainly television, has strengthened dramatically since the first digitization time of cinema, and TV manufacturers are now offering image and sound quality that sometimes exceed the quality of cinema presentation. Besides, the streaming revolution in the TV and internet world, offers tailored content in very high quality with an easy

and personalized access (Netflix, Amazon, OCS..). HDR arrived in television as a consequence of that quest for better experience based on image quality. Very strong standardization competition initially did slow down its penetration but compromised down to acceptable level for TV manufacturers (DolbyVision, HDR10), allowing most of the available HDR content to be viewable on any HDR capable TV (OLED, QLED TVs).

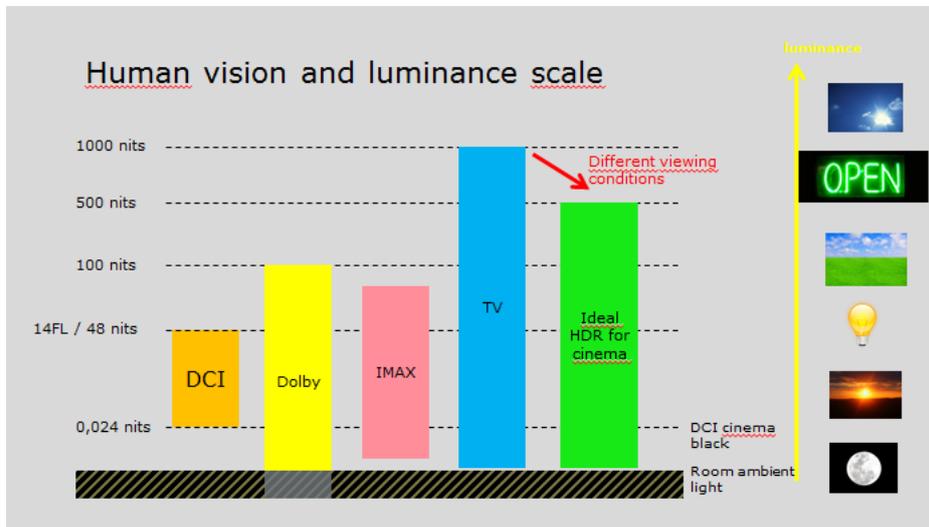


Fig. 15: Cinema effective dynamic Range

Digital Cinema did also invest in innovation in order to bring a higher theatrical experience with 4K, HFR, laser source and some branded Premium Large Format started offering novel visual experience based on extended dynamic range (IMAX, DolbyCinema) but nothing equivalent to what the TV work was already offering. The Premium experience still being based on the large immersive screen setup... not exclusive anymore to branded premium chains (c.f Barco DP4K60L).

Market opportunity for HDR projection in cinema:

With the first Digital Cinema wave achieving a high image quality with the digitization of the screens, cinemas have little differentiation opportunities other than large screens and immersive sound (or bright 3D, on the decline). Besides, there is very high competition with the entertainment at home. There is therefore a large appetite from cinema exhibitors to offer a different experience to moviegoers in an appealing offer. This is the premise that HDR offers to cinema.

HDR can be delivered by LED technology or by unique Barco LightSteering technology. The LightSteering technology is a projection technology which can replace an existing projector in a pre-existing cinema environment, reusing the booth, the full sound system, the screen... Besides this technology is a factor cheaper than what can offer the LED walls. Barco believes that the LightSteering HDR projection systems are perfectly fit for bringing the enhanced experience needed by the exhibitors differentiation, coexisting next to LED walls.



Fig. 16: Barco HDR projector prototype

The Barco HDR projector can perfectly play Standard Dynamic Range movies without altering the artistic intent, which allows for an easy replacement of existing SDR equipment while building up

capabilities for HDR premium exhibition. Barco will start introducing HDR in Premium auditoriums (large or medium) where it is most needed and where the business models allow purchase of such high-end equipment. Then a second generation of HDR Lightsteering projectors will be developed to address the mainstream screens, democratizing HDR for the masses, as the ultimate image quality for the Digital Cinema experience.

Prototype Lightsteering HDR projectors and pre-series projectors will be used to demonstrate the experience of HDR in cinema environment to the moviegoers and some specific installations will allow exhibitors to run some trial sessions in their own theatres.

Challenges:

The economy of cinema distribution and post-production shows that there is no room for a multitude of movie master deliverables anymore (2D, 3D, HDR, bright 3D, localized content etc...). Therefore the introduction of this new movie version needs to first aim at an interoperable master that can play on all HDR technologies available for cinema (LED, LightSteering) and secondly find synergy between cinema HDR master and the TV HDR master (which is already part of Studios workflow but it done 6 months later than traditional SDR cinema work). The changes in Post-Production process (minimizing the cost of HDR post-production) and the synergy with TV master (managing an SDR and HDR dual workflow) are major challenges that will need to be tackled by the industry.

In order to standardize on an interoperable master for cinema, there needs to be consensus on a standard. Recently, the Digital Cinema Initiative offered to design such a standard and Barco is actively participating in that effort, which will benefit the whole industry.

Risks:

The major risks around HDR in cinema is the availability of content. As previously mentioned there is a need for an interoperable standard but also a synergy with BluRay/streaming master in order to lower the cost of HDR production, which will eventually be part of a standard workflow and naturally covered by production company/studio, as currently done with HDR for home. The availability of post-production tools that comprehend this synergy and are optimized for SDR/HDR dual workflows is critical to lowering the cost of HDR post-production and then unlocking content.

5.4 ARRI

A high dynamic range has been a key feature of all digital cameras released by ARRI since the introduction of the ALEXA in 2010. While there is no method to objectively measure the dynamic range of a camera that is generally agreed on, many users regard the cameras of ARRI as leading in this regard. This advantage becomes even more significant when the programme is mastered and distributed in HDR. ARRI has been advocating HDR since many years and regularly demonstrates the output of its cameras in HDR on trade-shows and similar venues. Some of these events have been organized in collaboration with Barco and Filmlight.

The service branch of the ARRI Group operates the only HDR cinema grading suites outside of Los Angeles in a cooperation with Dolby. One motivation for this enterprise was to facilitate the introduction of HDR in the European movie industry.



Fig. 17: The HDR (Dolby Vision) grading theatre of ARRI.

Beside the traditional application in dramatic productions, HDR enables ARRI to introduce its cameras to new markets. In the broadcast industry the interest for HDR is growing. Traditional broadcast cameras, however, have a limited dynamic range (because of smaller sensors and therefore smaller photocells).

At NAB 2019, a great deal of ARRI's available booth space was allocated to the ARRI Broadcast Studio where we were able to demonstrate our latest camera and lighting products. In particular ARRI's Cinematic Multicam setup in a broadcast atmosphere complete with HDR workflow solutions was on display.



Fig. 18: The NAB 2019 booth of ARRI.

In all applications the dual monitoring of SDR and HDR will remain an important feature. The performance of new micro OLED displays allows ARRI to introduce an HDR preview in its viewfinder. The OLED display does not, however, reach the required minimum luminance of 1000 cd/m². Therefore, we will work with partners in the HDR4EU project to investigate different tone-mapping approaches.



Fig. 19: New generation of viewfinders for ARRI cameras.

The new viewfinders are already introduced with the ALEXA LF and will be shipped with the announced ALEXA Mini LF. The HDR preview features is scheduled for 2020. The same technology will be used for new camera systems.