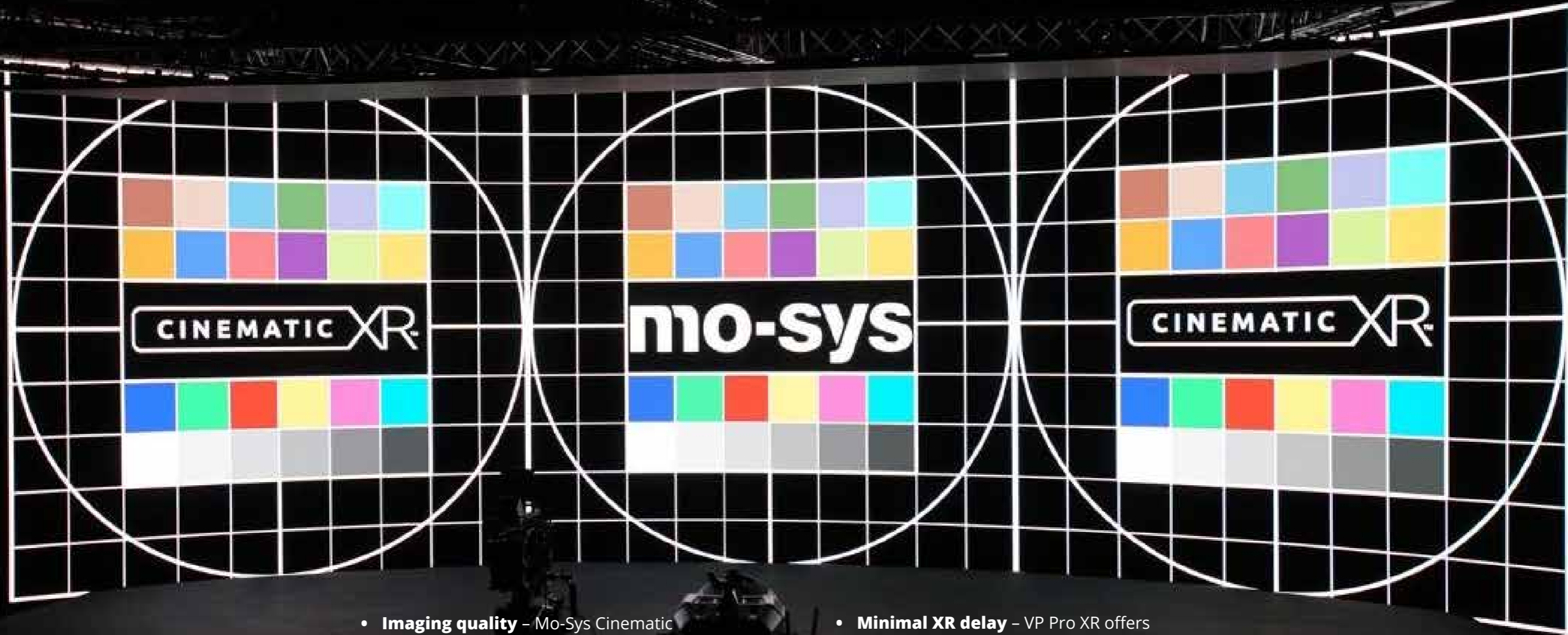


A cinematic XR studio set featuring a city skyline at night and a large illuminated sign that reads 'BRAND'. The scene is lit with blue and white lights, and a camera on a dolly is visible in the foreground.

VP Pro XR

A dedicated
Cinematic XR Server

mo-sys
VISION IN MOTION



- **Dedicated XR server** – purpose-built for Cinematic XR on-set real-time production. A feature rich virtual production tool set designed for your cinematic productions.

- **Imaging quality** – Mo-Sys Cinematic XR Initiative addresses the needs of Cinematographers. VP Pro XR focuses on pixel fidelity and composite image quality within LED volumes and XR Studios. VP Pro XR addresses the needs of Cinematographers.

- **Minimal XR delay** – VP Pro XR offers a 9 frame system delay, compared to the industry standard of between 11 and 16 frames. Reduced delay enables a more accurate perspective view of virtual graphics and faster camera movement.

- **Software only or a complete system** – choose between a complete Mo-Sys VP Pro XR server system or source your own PC hardware to match the unlimited node VP Pro XR software licence.

- **Designed by Cinematic Innovators for XR Creatives** – our patented film and broadcast innovations are backed by 25 years of on-set experience, enabling us to create tuned virtual production solutions knowing the workflows and tool sets required.

- **Non-Destructive Compositing** – the new VP Pro XR compositor workflow preserves photo-realistic fidelity and colour grade thereby delivering cinematic image quality to every pixel. Our cinematic solutions are the answer to your real life production workflow requirements.

- **Unique cinematic features** – Cinematic XR Focus is the first of our unique patent-pending cinematic technology features to be included with VP Pro XR. Cinematic XR Focus enables seamless focus pulls between real and virtual elements in an LED or XR volume.

- **Highly Scalable** – VP Pro XR supports any size LED volumes, with no additional licence cost - Simply add sufficient PC hardware to address the total pixel count.

- **Precision set extensions** – VP Pro XR offers rapid mesh mapping with precision set extensions, tracking, and colour matching, delivering seamless extended studio sets.

- **Dual use: LED or green screen** – Whether your studio is transitioning from green screen to an LED volume, or because you use both types of screen technology, VP Pro XR can be used with any screen technology.

- **Zero cost software expansion** – no additional VP Pro XR licence is required when you expand your LED volume or change your LED tiles for a finer pixel pitch version. All you need is additional PC hardware.

Key Features

Key Features

The Existing LED/XR Landscape

The Live Event Industry Pivot

On-set real-time virtual production using LED volumes has seen explosive growth since early 2020. However, the use of LED panels in film making has been around since 2004 where it was used on the film "Zodiac" for lighting effects, and later in 2013 for lighting effects and reflections on the film "Gravity" which used Mo-Sys equipment. The current cycle of virtual production growth is fuelled by four key elements coming together:

- real-time photo-realistic rendering and compositing, combined with precision 6 axis camera and lens tracking
- Disney's "The Mandalorian" using LED panels for on-set real-time virtual production
- The live events industry pivoting into virtual production for film and broadcast, as a response to the demise of live events in 2020 brought on by Covid 19
- Covid 19 restrictions on travel and crowds

The nett result is that today, on-set, real-time LED volumes are being launched at an incredible rate driven by the live events industry. But the technology and imaging standards predominantly being used are those from live events, and not from broadcast and film. Whilst shooting on-set, real-time productions in LED volumes is an exciting addition to the film and television industry, there are challenges that need to be resolved to take the technology to the next level – that is to cinematic quality levels.

Technology – today most XR stages use LED tiles, LED processors, and live event media servers from the live events sector, which deliver less fidelity than a VFX film production pipeline. LED tile and processor manufacturers are likely to launch improved cinematic versions of their products over the next 12 months as the demand for

improved image quality from LED volumes increases. But the industry also needs dedicated XR content server solutions that are focussed specifically on film and television, where the live event features are removed (projection mapping, timelining lighting shows, mixed media, and mixed render engine support) and cinematic features and workflows are added (higher pixel fidelity, higher composite image quality, focus pulling, shadows, multi-camera support etc.). Why, because Cinematographers and VFX Supervisors are demanding focussed toolsets that meet their needs, enabling a closer content quality match to traditional post-production compositing quality.

Film Experience – most XR stages have been built by live events companies with little or no experience of the demands of film production and VFX quality levels. Without experience of film and TV workflows, and the key operators involved in each, live event LED/XR studio builders can't know the problems that need solving, and the new features that need innovating.

Image quality – most XR stages today use LED tiles and processors with a pixel resolution and pixel fidelity that can't match the very high quality content from a traditional post-production compositing pipeline. New LED tile technology will help, but there are other factors involved that need addressing (colour matching between virtual and real, off axis colour shifts on the LED wall, improving the virtual graphics quality possible in a real-time environment, matching the virtual scene to the camera) that all need addressing. None of these issues are faced in the live events world, and therefore the solutions to these issues are unlikely to come from the live events market.

Current XR Volume Challenges

Not every on-set real-time LED production requires virtual set extensions (XR capability), but when required it needs to appear seamless to the camera, particularly for moving camera shots. In order to achieve a seamless join between the virtual set extension and the LED volume for moving camera shots, four elements are required:

- **Accurate Mesh Mapping** – this is the process of mapping the position, dimensions, and shape of the LED volume into the virtual 3D scene, so that the real and virtual 3D worlds are aligned. When correct, whatever the camera position or movement, or whatever the lens settings, the set extension should remain locked to the LED wall. However, live event media servers struggle to provide a truly seamless join between the LED wall and the virtual set extension.
- **Accurate colour matching** – this is the process of matching the colour characteristics of the virtual set extension to what's displayed on the LED wall, when viewed through the camera. When correctly setup there should be no discernible join visible to the camera. This isn't a normal requirement of a live event media server, and as such the colour match from these systems whilst close still isn't seamless.
- **Precision Tracking** – in order that the set extension illusion persists when the camera position or the lens settings are changed, precision camera and lens tracking is required. Today's live event media servers do utilise precision tracking but use their own lens distortion model. As such the set extension join is often still visible, and the perspective view of the virtual graphics on the LED wall is impacted by the system delay.

- **Minimal delay** – the delay between the virtual graphics engine receiving the camera and lens tracking data and delivering the correct camera perspective of the virtual scene to the LED wall, is critical. Live event media servers typically have a delay of between 11-16 frames, meaning that the tracked camera can't be moved quickly because the correct perspective of the virtual graphic can't be rendered quickly enough to keep up. As such, dynamic creative shooting is severely limited.
- **Using multiple cameras in an LED volume** – for a green screen shoot, each camera's virtual graphic perspective is rendered by a computer connected to the camera's tracking output. Switching between cameras is simply a case of switching between the composited video outputs of the cameras. In an LED volume, a single computer stack renders the virtual graphic perspective of a single camera to the LED volume. If a second camera is added and pointed at the LED wall, there needs to be orchestration of the LED volume virtual graphics, as only one camera's perspective can be displayed at any one time. Currently, switching between two cameras results in the second camera seeing approximately 5-6 frames of the first camera's graphics perspective, before the LED volume updates with the correct perspective graphics. This is a problem for live production.

Cinematic XR Required

On-set real-time LED shoots offer distinct advantages (real-time VFX visualisation, scene lighting, scene reflections, post-production cost savings etc.) but they also present challenges that have yet to be solved (e.g. pulling focus between real and virtual, using multiple cameras, creation of shadows, reduction of moiré patterning etc.). All these challenges need to be resolved to encourage greater adoption of on-set, real-time shooting using XR volumes, and to provide Cinematographers and creatives with the tools and techniques they're used to on a standard VFX shoot. However, these challenges can only be solved by manufacturers who understand the cinematic and broadcast workflows intimately enough to drive the innovation of new features for final pixel LED volume production.

On-Set Real Time XR vs Green Screen

The euphoria of on-set real-time production using LED volumes with or without AR set extensions, has driven the rollout of new LED volumes around the world. But this doesn't mean green screen shooting has been superseded. Both technologies will be required going forwards as each is suited to a particular type of shot. Green screen is the right option when fine detail VFX shots are required, LED is the right option for shots that require scene lighting on the talent or involve reflective surfaces.

It's entirely likely that VFX studios will contain both an LED volume and a green screen, and the tracked camera being used is simply rotated to use each screen technology dependent on the shot. However, today, companies investing in on-set real-time studios have to choose between a content server for an XR studio or a green screen studio, which isn't ideal.

LED/XR Server Costs

For companies who decide an LED volume is correct for their needs, and who therefore need a content server, they will naturally be looking at a live event media server, because that's what's been used to date. However, going down this route has significant cost implications, in particular the cost of expansion.

If a company with an LED volume wants to enlarge it, add an LED ceiling or an LED floor, or swap the LED tiles for finer pixel pitch versions, additional rendering nodes will be required for the live event media server. These rendering nodes are only supplied by the media server manufacturer and cost significantly more than the PC hardware they run on. The ideal scenario is to be able to leverage the cost of standard PC hardware, but this isn't currently an option with a live event media server.

LED/XR Workflow Innovation

Lastly, the virtual production space is still new, and the rate of product and feature innovation is rapid. Whilst each manufacturer will naturally innovate its own single point product, what the market needs is **workflow innovation** where the new capabilities are synchronised across multiple elements of the combined system. Currently this isn't happening.

The development of a comprehensive ecosystem, a Cinematic XR initiative focused on virtual production, is what we at Mo-Sys are committed to. Please read on to find out more.



The Existing LED/XR Landscape

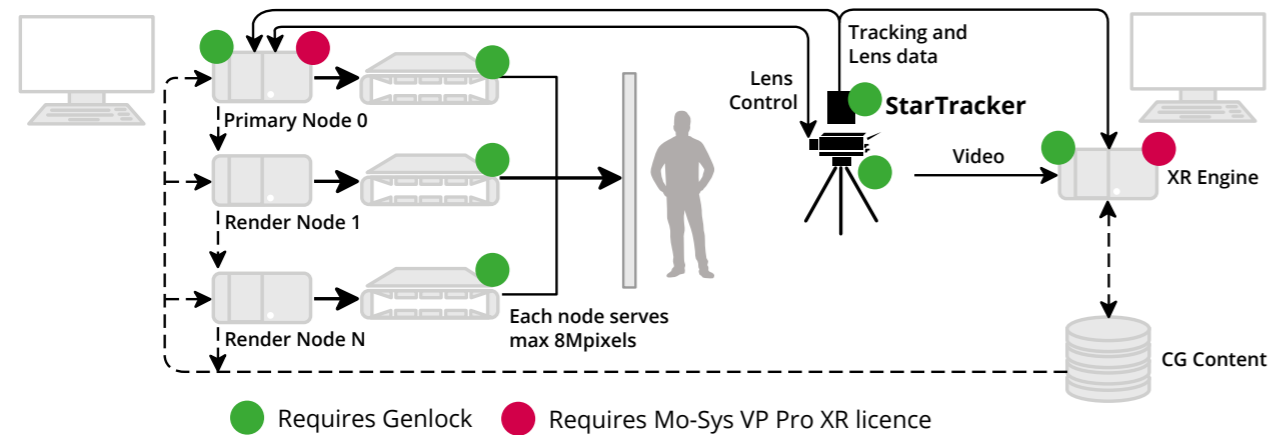
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The Existing LED/XR Landscape

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VP Pro XR - The Solution

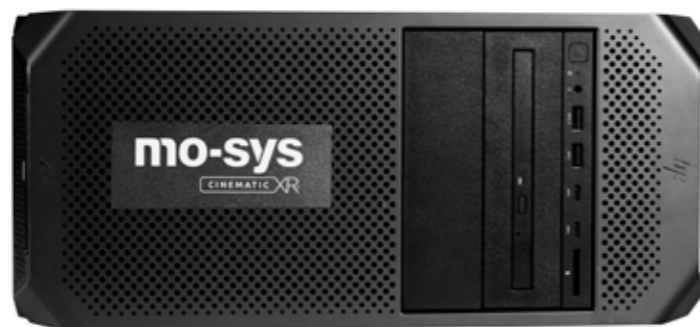


Expertise: Film/Broadcast vs Live Event

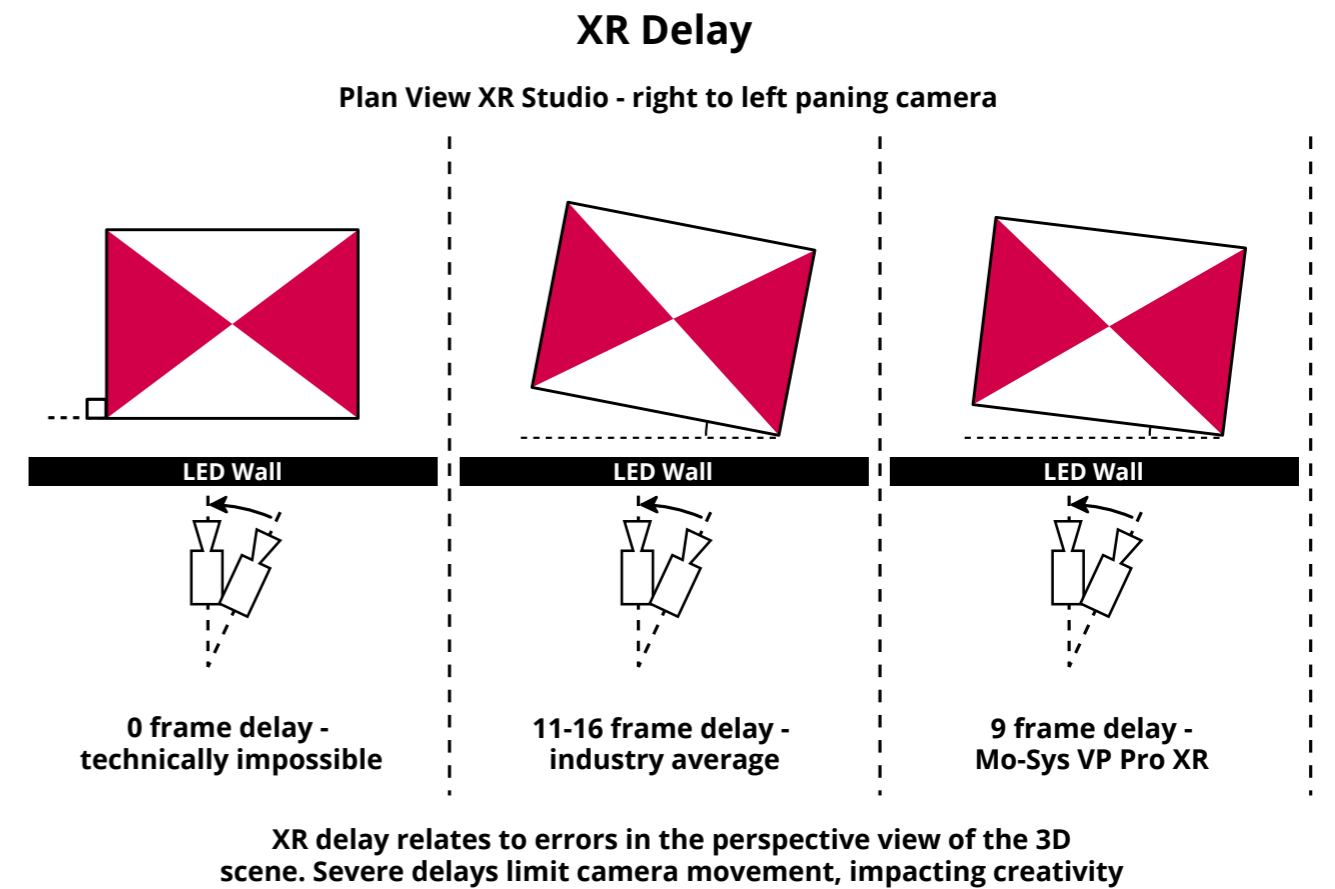
To address the issues relating to broadcast and film currently using live event LED technology for on-set real-time virtual production, Mo-Sys has released VP Pro XR, the industry's first dedicated XR server.

VP Pro XR has been designed specifically for the film and broadcast markets, and to address (along with Mo-Sys' Cinematic XR initiative), the concerns of Cinematographers, Focus Pullers, Colourists and VFX Supervisors.

Mo-Sys has 25 years of broadcast and film innovation, with team members who have been involved in virtual production since its inception more than 20 years ago. Mo-Sys has been involved in LED panel use in film production since its technology was used in the film "Gravity" in 2013. Mo-Sys' Cinematic XR initiative is focussed on pixel fidelity and composite image quality from LED volume and XR studios, and as such is directly in tune with what Cinematographers require.



Solving Current XR Volume Challenges



For those on-set real-time LED productions that require AR set extensions, VP Pro XR comes with tools specifically designed to provide a seamless extension to the LED wall, and is aided by being an embedded toolset inside the Unreal Engine interface, rather than a layer on top of the Unreal Engine as most live event media servers are today.

VP Pro XR offers rapid automated precision mesh mapping, enabling the LED wall's physical shape and position to be precisely mapped into the virtual scene. It's colour matching toolset and calibration charts enable set extensions to be accurately colour matched, delivering seamless extended studio sets.

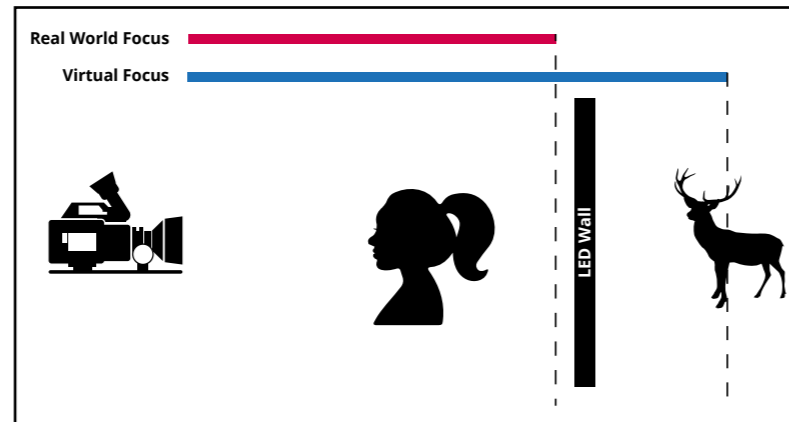
VP Pro XR operates with just a 9-frame system delay because it is embedded in the Unreal Engine interface. In comparison, a live event media server typically produces a delay of between 11-16 frames. VP Pro XR's 9 frame delay enables it to deliver a more accurate perspective view of the virtual graphics relative to the camera position and lens settings, providing greater creative freedom with moving camera shots.

The Solution - VP Pro XR

Cinematic XR Focus

Mo-Sys' proven track record designing innovation solutions for the film and broadcasting markets, combined with being able to offer both a Cinematic XR solution (VP Pro XR) and the leading camera and lens tracking solution on the market today (StarTracker), puts the company in the unique position of being able to deliver new innovations in on-set real-time production and solve today's existing LED/XR challenges.

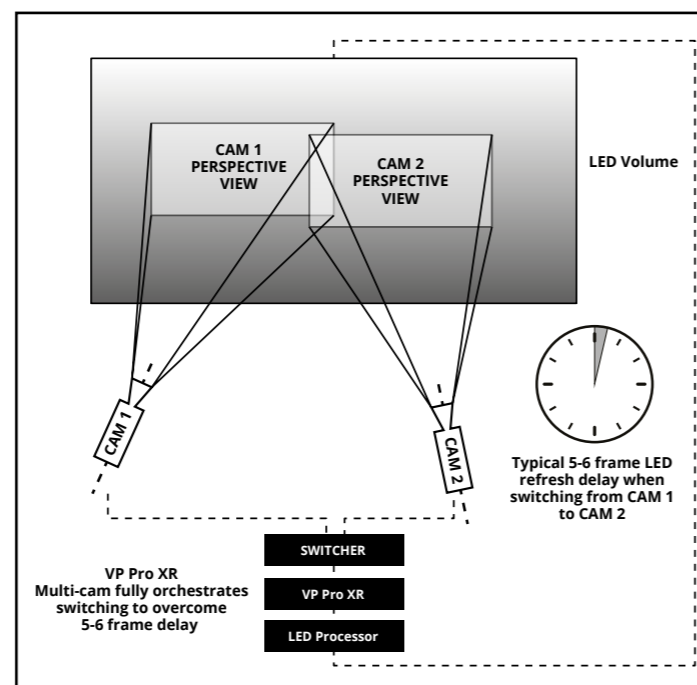
A great example of a VP Pro XR feature that achieves both is Cinematic XR Focus®, delivering the ability to pull focus between real and virtual elements in an on-set real-time shoot. This patent-pending technology invented at Mo-Sys is a major creative story telling solution when using an on-set real-time LED volume.



Cinematic XR Focus is the first truly innovative cinematic tool for LED/XR volumes, and Mo-Sys is well positioned to deliver more cinematic features in the near future.

Multi-Cam Switching

Mo-Sys' Multi-Cam Switching solution for VP Pro XR orchestrates the 5-6 frame delay between switching two or more cameras and updating the LED volume with the new camera's correct perspective graphics. Importantly, it allows switching at full resolution up to UHD4K. The solution requires a simple video switcher being added to a VP Pro XR system, and a few settings adjusted in the latest VP Pro XR software. With Multi-Cam Switching enabled, a live multi-camera LED virtual production shoot is possible, and without the virtual graphic switch-over artefacts.



The Solution - VP Pro XR



On-Set Real-Time Shoots: LED and Green Screen

VP Pro XR has been designed to operate with both LED/XR studios and green screen studios. This is a major advantage, even for those companies only planning just an LED/XR studio, since virtual production technologies and techniques used today are likely to change over the next 18 months.

A good example of this is how the industry is quickly realising that on-set real-time LED production won't replace green screen, instead both technologies will co-exist going forwards, and for entirely logical reasons.

On-set real-time LED production, in requiring real-time graphics to be delivered to a large LED wall, places a limit on the quality of virtual graphics that can be rendered whilst maintaining real-time playback frame rates. Green screen doesn't have the same limitation since the virtual graphics only have to be rendered for the camera resolution (e.g. 4K). This means that on-set real-time LED can be used for close-up shots or where reflections are important, and on-set real-time green screen can be used for wide shots or where higher scene detail is required.

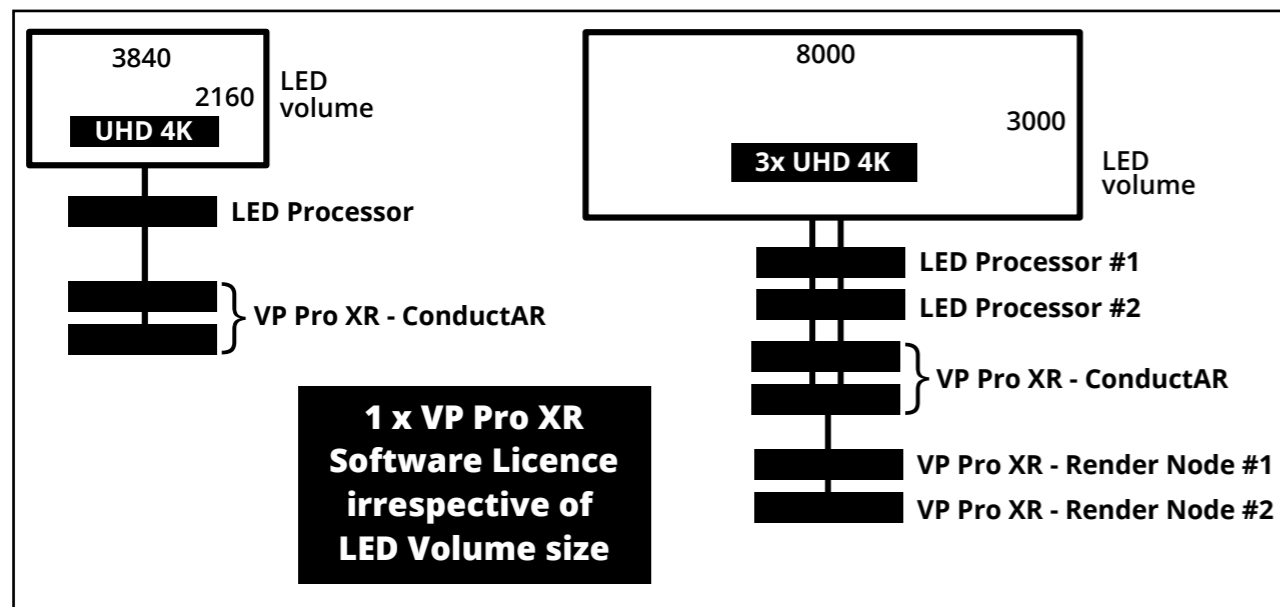
Future VFX studios are likely to contain both LED volumes and a green screen where the same tracked camera can be used with both screen technologies.

Equally, for broadcasters undecided about switching from green screen to LED wall virtual studios, VP Pro XR offers a solution that means the broadcaster can transition to LED when they want to, or can use VP Pro XR in multiple studios irrespective of the screen technology in each studio.

The Solution - VP Pro XR

Free Software Expansion: reducing LED/XR Server Costs

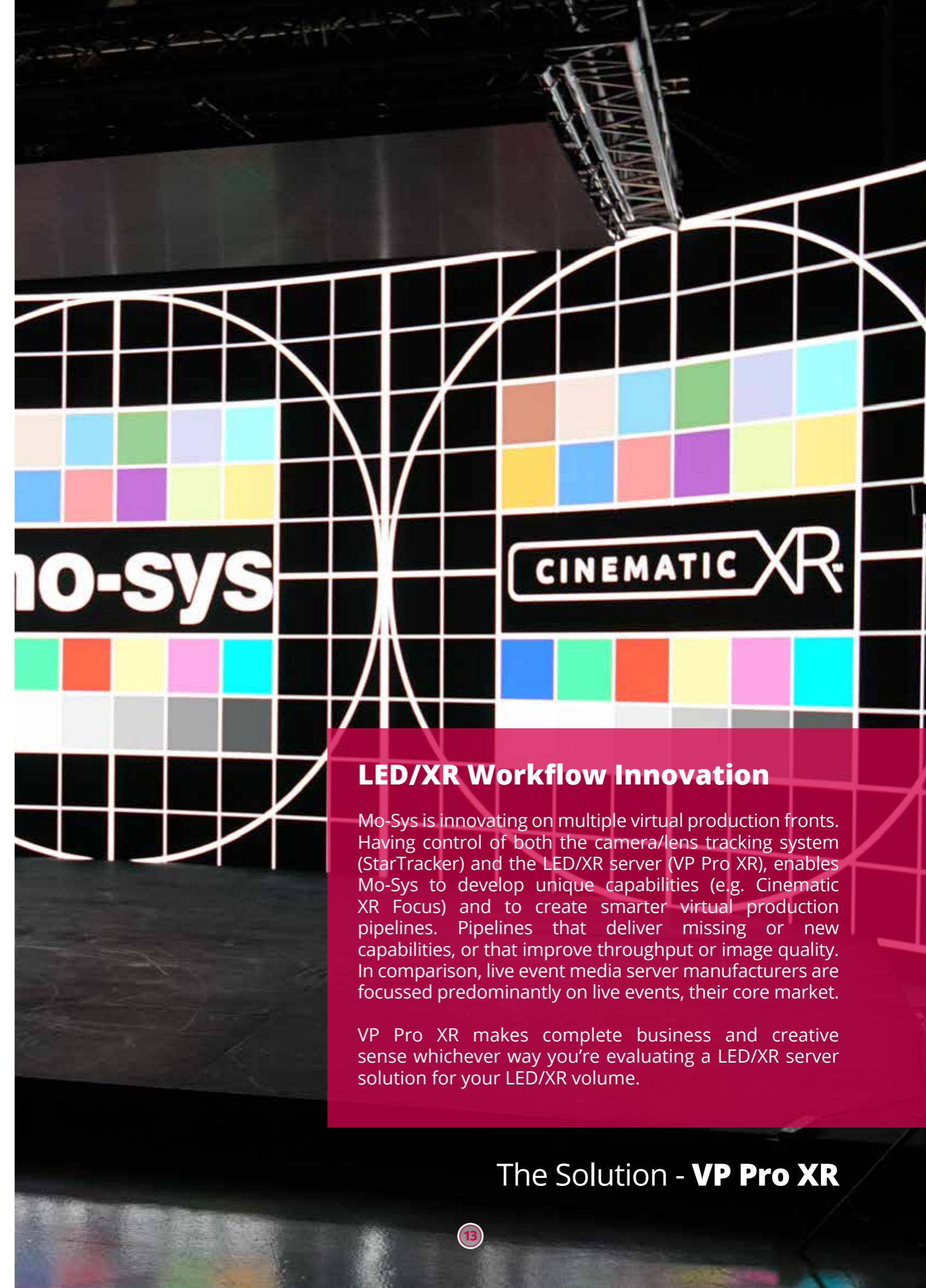
Whilst most live event media servers are bespoke systems, VP Pro XR's architecture has been designed for the future of final pixel virtual production, knowing that finer pixel pitch LED tiles are coming, and that LED/XR volume expansion (ceilings, floors, side panels) is likely. VP Pro XR consists of two components; a dual PC Controller (**ConductAR**) that drives a UHD 4K output, with one PC providing XR capability, and the other providing AR capability and Cinematic XR Focus. In addition, render nodes, each delivering an additional UHD 4K output, are used to create an LED/XR system that can address any size LED wall.



VP Pro XR can be ordered as a (unlimited node) software licence, where the customer sources and configures the PC hardware, or as a system where Mo-Sys supplies and configures the PC hardware for the LED wall dimensions required.

Importantly, with VP Pro XR, expanding your LED volume or changing your LED tiles for a finer pixel pitch version, only requires adding additional PC hardware. No additional VP Pro XR licence is required.

The Solution - **VP Pro XR**



LED/XR Workflow Innovation

Mo-Sys is innovating on multiple virtual production fronts. Having control of both the camera/lens tracking system (StarTracker) and the LED/XR server (VP Pro XR), enables Mo-Sys to develop unique capabilities (e.g. Cinematic XR Focus) and to create smarter virtual production pipelines. Pipelines that deliver missing or new capabilities, or that improve throughput or image quality. In comparison, live event media server manufacturers are focussed predominantly on live events, their core market.

VP Pro XR makes complete business and creative sense whichever way you're evaluating a LED/XR server solution for your LED/XR volume.

The Solution - **VP Pro XR**

Technical Specifications

VP Pro XR – ConductAR (hardware)

- **Dual PC base unit**
- **Delivers 1x UHD 4K output** (3840 x 2160)
- **Offers simultaneous AR and XR**
- **Enables Cinematic XR Focus** (customer sourced Preston wireless hand unit and motor controller required)
- **NearTime rendering enabled** (for green screen use only)

PC Specification

1x Lenovo P620 AMD Threadripper Pro 3955WX 16 Core Processor, NVIDIA RTX 3090 16GB GPU 32GB RAM 512GB SSD, M.2 2280, PCIe NVMe Gen3x4, TLC, Opal 2.0 2TB SSD, M.2 2280, PCIe NVMe Gen3x4, TLC, Opal 2.0 AMD Integrated controller Windows 10 Pro 64 1000w PSU

Plus

1x Lenovo P620 AMD Threadripper Pro 3955WX 16 Core Processor, NVIDIA A6000 16GB GPU, NVIDIA Quadro Sync II, 32GB RAM 512GB SSD, M.2 2280, PCIe NVMe Gen3x4, TLC, Opal 2.0 2TB SSD, M.2 2280, PCIe NVMe Gen3x4, TLC, Opal 2.0 AMD Integrated controller Windows 10 Pro 64 1000w PSU

or

1x HP Z4 Intel i9-10980XE 18 core, NVIDIA RTX 3090 16GB GPU 32GB RAM 512GB SSD

Plus

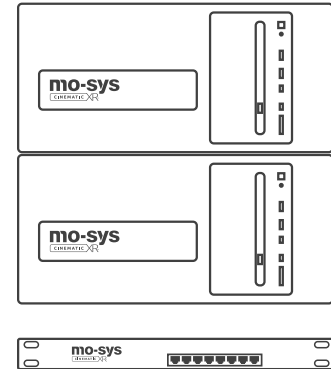
1x HP Z4 Intel i9-10980XE 18 core, NVIDIA A6000 16GB GPU 32GB RAM 512GB SSD, NVIDIA Quadro Sync II

or

PC equivalent hardware, with identical GPU and Sync2 cards to above specifications

1x GigE Network Switch

1x 8-port or greater Gigabit Ethernet switch



VP Pro XR – Render Node (hardware)

- **Single PC unit**
- **Delivers 1x UHD 4K output** (3840 x 2160)
- **Offers render expansion for VP Pro XR ConductAR**, for LED walls that require greater than a single UHD 4K output

PC Specification

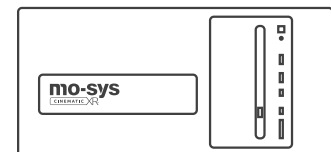
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PC equivalent hardware, with identical GPU and Sync II cards to above specifications



For more information

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