



WHITE PAPER

SWITCHING ON SPACES

How to Plan and Deliver Astonishing Visual Experiences with Direct View LED

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Suppose entire walls of a built space could take on whatever look suited the moment, and be active, dynamic and instantly changeable.

The rapid advent and maturation of direct view LED (DV LED) display technology is compelling everyone from commercial property developers to Hollywood filmmakers to reimagine how they do things.

DV LED displays first gained attention as the giant screens used for replays in pro sports mega-stadiums and digital billboards in Times Square. But technology and manufacturing advances have transformed DV LED into a mainstream product that's being used for everything from in-store shopper marketing to casinos and public utility control rooms.

While DV LED is increasingly commonplace across industries, it's a technology that's still new to most end-users, as well as to the architects, designers and engineers who want to make everything from a wall to an entire space visually come to life.

This white paper introduces and explains the technology, outlines its advantages and wide variety of options, and highlights interesting use-cases. Readers will learn the differences between pre-engineered and custom solutions, and they'll finish with a better sense of how to make the right calls for the technology and how to find a solutions partner, like Diversified, who will make ideas happen.



DV LED's Attraction

LCD-based video walls have for many years been the go-to technology when venues want to make a big visual impression, but their appearance has always been compromised by the seams (technically called bezels) between each display unit, which result in noticeable gridlines. DV LED can deliver that same visual footprint with no seams and open a wide range of new possibilities for the shape, scale and orientation of video wall projects.

The technology is both maturing and evolving, and it can be hard even for experts to stay current. But, what never changes is the core importance of having a solid strategy and intent for a DV LED video wall, and content tuned to that plan.

"What is the use-case? What is the intended content? Will people be reading what's on the screen, or is it all about visuals and brand colors? Those are the kinds of things we want to talk about, early, with our clients," says Mitch Mittler, VP of Sales, Design and Technology for Diversified, focusing on the design, build and management of DV LED as well as other digital signage and visual projects.

The Basics

Explaining The "Direct View" Label

In the past decade, consumer televisions have grown thinner and lighter by using arrays of white LED lights in the rear or edges of the screens to illuminate the LCD layer that produces the visuals. Some TV brands, looking for a marketing hook, called them LED TVs.

The same core technology used for those backlights in TVs is what's used for LED displays – the primary differences being that the tiny LED light emitting diodes support rich color and directly generate the changing visuals. With a directly-viewed LED, there is no LCD (or other) layer.

Indoor Versus Outdoor

DV LED technology is used both indoors and outside. While the core idea is the same for both, the engineering is very different by necessity.

Electronics used outdoors have to be ruggedized to handle all potential weather conditions and need to have brightness levels that easily overpower the glare of sunlight. The density of light pixels tends to be far lower with outdoor displays because they're normally fixed on advertising pedestals along roadways, or mounted to building structures, and viewed from considerable distances.

Indoor DV LED doesn't need the same ruggedization, but because average viewing distances might be reduced from 200 feet to 20 feet, the displays pack in far more light emitters to produce visuals that look crisp and rich in the designed space.



3.9

13 ft.

19

6 ft.

10 ft.

1.5

5 ft.

1.2

4 ft.

0.9

3 ft.

Pixel Pitch

LED Pixel Pitch (r

Optimal

7.9

26 ft.

59

20 ft.

Pixel pitch is the measurement of distance between the center of a light emitter chip and the ones surrounding it. The measurement is usually expressed in millimeters and sometimes preceded by the letter P. So, a display can be described as having a 3mm pixel pitch or be referred to as a P3 display.

The simple way to understand pixel pitch is that the smaller or "finer" the pixel pitch, the better the display looks from shorter distances. A fine pitch display rated at 1.5mm has the density of light pixels to look crisp to viewers from just 10-15 feet away. A 6mm or P6 LED display will look crisp to viewers from 50 feet away, but at closer distances, the viewers' eyes will see the individual light emitters and gaps.

One way to think about this is with the digital sideline displays used on TV broadcasts of high-level sports. On distant camera shots, the ad messaging will look crisp on the screens by the playing surface. Seen in close-up camera shots, those same images tend to look blotchy.

Pixel pitches can be 8mm and much higher for outdoor displays, while indoor DV LED technology now tends to be 4mm or finer, with some manufacturers producing super-fine pitch displays that are sub 1mm.



Light Emitters

The LED light emitters used for DV LED have a variety of types and descriptions, and the technology is steadily evolving.

Outdoor displays viewed at long distances use "old school" LED lights that look like tiny light bulbs, while finer pitch versions used for premium applications like Times Square advertising boards or sports replay screens may use LEDs that are in tiny packages and surface-mounted to a module.

Those surface mounted devices – known broadly as SMD – are the dominant technology used for indoor DV LED. Versions of these SMD light chip packages contain the light emitter and supporting electronics and, with smaller light packages, more and more of them can be clustered in increasingly fine pitches.

Manufacturing advances have introduced new and different ways of producing these finer pitch displays, like Chip On Board (skipping the LED packaging and wiring light emitters to the display module), and progressively miniaturized light emitters.

There are now mini LED and microLED DV LED displays on the market, with major global manufacturers like LG, Samsung and Sony marketing super-premium video wall products built around tiny lights that enable high contrast and sumptuous visuals, at any scale.

Resolution Rejigged

Most consumers think of resolution as a self-contained designation for a display. With LCD and OLED flat panel displays, an individual display unit – a 55-inch display, for example – might have a resolution of 3840 pixels by 2160 pixels, or 4K.

But with DV LED, cabinets need to be stacked and tiled to realize a target resolution, and its overall dimensions are directly tied to the pixel pitch. Depending on the pitch, it might take 30-40 stacked and tiled cabinets to achieve a 4K resolution. Instead of it being a diminutive 55-inch unit, it might be a 24 foot wide by 16 foot tall video wall.

Here's the math to explain it: If a 1.9mm DV LED cabinet has 400 light emitting pixels horizontally, per unit, it would take 10 tiled in a row to add up to roughly a 4K resolution. If that cabinet is 24 inches wide, that would mean the horizontal width of that 4K video wall would be roughly 24 feet.

The finer the pixel pitch, the higher the pixel density. So, a .9mm DV LED wall using the same cabinet size would have more light pixels in a row, which would reduce the number of cabinets needed to get to 4K and in turn, reduce the physical size.



Evolving Versions

The dominant and most familiar type of DV LED display is an array of precisely aligned light emitters and their circuitry, mounted on something akin to a square wall tile, and grouped in a larger unit called a cabinet. That cabinet is usually a rectangle and roughly the dimensions of a smallish flat panel TV.

Those cabinets are tiled together, stacked, and interconnected, to create an LED video wall that either meets a target size and resolution, or fills a space, like a feature wall in a store or office lobby.

While these cabinet-based systems are the dominant technology deployed today, there is an ever-increasing variety of alternate versions that serve more specialized use cases.

Lightweight and Flexible: Instead of rigid metal or carbon fiber cabinets, some manufacturers have lightweight, super-thin designs that use plastic. This means they can be suspended like tapestries – just using wire – and wrapped around curves, such as structural columns.

Transparent LED: For both indoor and outdoor applications, several manufacturers make displays

that have the light emitters mounted in thin strips on metal grid systems with varying degrees of transparency. Finer pitch versions require the LED strips to be closer to one another, reducing the transparency. The indoor versions are primarily used by retailers in shop windows, while building owners are cladding portions or full sides of their buildings, using versions with sufficient transparency so that windows are not blocked.

The attraction of these mesh displays for outdoors, is they are relatively lightweight and don't typically require costly superstructures or building reinforcements to carry the weight load – something often needed with more conventional outdoor LED.

LED in Film and Glass: Miniaturization of the LED light chips and the wiring that provides power and signal have allowed manufacturers to put programmable LED video wall technology into thin, see-through films that can be applied to window glass, and even into commercial building glass. The pixel pitches tend to be much coarser than conventional DV LED displays, and are used for ambient visuals and branding, as opposed to detailed information.

Super-premium: Mainstream manufacturing methods for LED have reduced the pixel pitch on tiled, stackable DV LED video wall products to a mere .8mm, with select trade show demos as fine as .6mm.

Although the super-premium side of DV LED emphasizes microLED displays, the real story is the near-microscopic size of their light emitters. Conventional SMD and related manufacturing align tiny lights in grid arrays. When packed in particularly fine pitches, gaps become imperceptible.

This reduces visibility of the dark background between the lights, negatively impacting contrast in dark scenes. With microLED, the tiny lights sit in a relative sea of black, enhancing contrast levels and visual quality.

Since large format microLED displays are still relatively new, manufacturing methods are still evolving, production volumes are low and costs are substantially higher than mainstream products. However, these are expected to decrease over time.

How DV LED is Sold

DV LED video wall projects, both indoors and outside, have tended to be sold as custom jobs, in which the cabinets and supporting technologies are aggregated to fill a targeted visual space. Variables like viewing distance, target resolution, configuration, serviceability and budget may all influence what's done and how it's built.

For seasoned pro AV solution providers such as Diversified, who has completed countless large format indoor and outdoor DV LED projects, designing and delivering custom jobs is second-nature.

But for much of the AV, IT and building/store design ecosystems, DV LED is unfamiliar and more than a little dizzying in terms of how video walls are specified and built. That's why numerous manufacturers have, in the past two years, introduced bundled, pre-engineered solutions – with DV LED walls sold in fixed sizes.

LG, for example, has 25 different versions of turnkey DV LED video wall options that meet a variety of sizes, pitches and price points.

The argument for these bundles is that for relatively small, well-defined jobs like putting a 150-inch fixed-size display in a large conference room, bundles simplify the selling and installation process.

"Those have been tremendous," adds Mittler, "because they take the guesswork out of projects. There's no engineering to do. It's an all-in package."

The counter-argument is that bundles constrain creativity. In simple terms, it's the difference between putting a big display on a wall and turning a big wall into an active display canvas. The former is functional, the latter **is experiential**.



Established and Emerging Use Cases

The first large format LED displays on the market were used for applications like video replay boards in sports venues, backdrops for touring performers, and digitized highway billboards.

But as the technology has matured and manufacturing advances have boosted the visual quality for indoors and close proximity viewing, the variety of usecases has exploded.

Here's a sampling of interesting applications:

Commercial Property: Building owners are cladding parts of the facades of high-profile buildings with outdoor DV LED to brand the building, support tenants and be part of larger digital advertising networks, notably in scenarios such as Times Square. Inside, property owners are using wall-filling digital installations in main lobbies as signature visuals designed to attract and retain tenants.

Broadcast and Film: Green screen backdrops on broadcast and film production sets are being supplanted by seamless DV LED video walls. Movie producers, for example, can bring a location to a studio set at a fraction of the cost of bringing a crew to a remote location. For movies using a lot of computer-generated visual effects, actors can react to scenes and characters on the video wall in front of them, instead of a blank sea of green fabric.

Control Rooms: Pitches on DV LED video wall products are tight enough to allow control rooms and operations centers to replace tiled LCDs or projection systems with seamless DV LED systems that are unaffected by ambient light. So, the lights can come up and window blinds opened, because LED displays have brightness levels that overpower glare.

Design Material: DV LED technology is increasingly a design consideration as a building material for physical spaces, both inside and outside. While



conventional flat panel displays are engineered to mount vertically or as a tabletop surface, DV LED can be used as walls, wrapped around corners, set in curves and function as floors, ceilings and canopies. Professionals who design physical spaces can make the feature walls of lobbies and concourses big, dynamic canvases that are changeable with a few keystrokes. Premium retailers have started converting store facades in high profile locations like airports to DV LED, reinforcing their brands, attracting attention, and drawing in shoppers.

Retail: DV LED video walls have supplanted printed fabric lightboxes in large and flagship stores, enabling marketers to cycle through multiple visual messages and target promotions and incentives by shopper profiles that can change by the time of day and week. DV LED is being used for everything from directories and wayfinding in large stores, to full-motion promotional ribbons at the shelf-edge in store aisles. Retailers that normally need large footprint spaces – such as auto dealers – are using DV LEDs to showcase product at life-size in small footprint micro-stores in shopping malls and in downtown settings.

Making the Right Call

What are you trying to accomplish with a DV LED wall?

Being able to readily address that question grounds a video wall project and helps ensure end-users and their solutions partners make the right choices for the display technology and the supporting components.

Many variables can influence selection, including:

Location: Environmental challenges are far greater with outdoor displays – notably diverse weather conditions and pollution – than they are inside, but even displays used in controlled indoor settings need careful thinking.

Every display project should consider sightlines and distance to optimize viewability but also control costs. A DV LED wall should be tuned to the normal minimum distance of viewers, matching up the pixel pitch. If the pitch is too coarse for the distance, the visuals will be unsatisfactory. Likewise, there is no visual benefit to using premium fine pitch displays if viewers are too far to see the difference.

Think of it this way: if viewers are typically 40 feet away from a video wall, a 15mm LED video wall will look broken up and rough because viewers will see the individual lights and gaps between them, while a 12mm pitch version will deliver tight visuals at that distance. Video walls with tighter pitches will also look great, but viewers won't discern the difference. Tighter pitches mean more LEDs are needed, and capital costs climb rapidly as that millimeter number drops.

The building's conditions and set-up should also be considered. Does the physical space that will house the video wall have the structural design to carry the weight load of a large video wall? Will all those LED lights on a fine pitch video wall overheat a room? What's the impact on energy loads and billing? Are humidity or static electricity potential problems? Is power accessible? Can power supplies and servers be located nearby?

Human Factors: Conventional SMD-based LED video displays can have millions of light chips micro-soldered to their substrates. They're brittle and easily damaged during install and ongoing operations.

Most outdoor displays are elevated and inaccessible, minimizing damage risks. But indoors – in scenarios like retail and mass transport hubs – people

are often within easy reach of the displays. Damage happens, accidentally and willfully.

The low-tech answer is to incorporate set-backs in the video wall design, even things like floor railings that prevent roller bags and carts from brushing the display.

The high-tech answer is engineered coatings – sometimes referred to as Glue On Board – that bathe the modules in an epoxy coating, hardening and protecting the electronics from impacts, static and water spills. The technology is still just emerging, and while AV pros appreciate the idea, there are still questions about what that coating does to the visual quality, including how it can amplify reflections from lights and windows

Serviceability: One of the big hidden costs with operating video walls is the potential field costs of servicing, maintenance and repair. Most but not all DV LED video wall products now support front access servicing – enabling technicians to access, remove and replace modules or cabinets from the visual side of the screen. That speeds repair times but, more importantly, wins back valuable square footage in the venue by eliminating the need for rear access space. Also important: hardware and software tools associated with the electronics that allow remote, internet-based monitoring and troubleshooting.

Price: As always, price is often a determining factor in product selection. Many things influence final costs – the biggest ones being the type of technology used, the pixel pitch (more light emitters means more cost) and the quality of the components. When two LED options have the same pixel pitch, the lower cost versions likely use cheaper metal work, connectors and wiring, as well as cheaper light emitters that have variable color and brightness capabilities.

Price can also correlate with operating life in cases where competing options have similar visual performance. Due to the high cost of installation and management, outdoor media companies are looking for displays that will last upwards of ten years, while control room operators may only expect five to seven years. Retailers may do store design refreshes every five years and will settle for a display expected to last for the same time window.

A display expected to last five years will typically cost less than one rated for 10+ years of consistent duty.



- Wall-filling scale
- True seamlessness
- **DV LED** Glare-conquering brightness
 - Flexibility, diversity of design and technology options
 - Image uniformity
 - Price, still 1/3rd to 1/5th the cost of DV LED for the same footprint
 - HD, 4K & higher in single display units
 - Touchscreens are normal add-ons for LCD, but not for DV LED
 - More standards for things such as mounting hardware

Custom Considerations

Mounts

Bundled, turnkey DV LED solutions typically come with mounting systems designed or at least factored in, but custom video wall projects geared to the dimensions of a space may require custom metal work, particularly if the display surface is curved or turns a corner. While mount systems are universal for LCD displays, there are a few standards for cabinet sizes and mounting plans across the major LED vendors.

Video Wall Processing

Simple video walls, particularly bundles with fixed sizes and resolutions, may run off an external or included digital signage media player. But for large projects with unusual dimensions and resolutions, that put a big premium on visual quality, third party video wall processing systems (software and server) may be needed.

Creative

Visually interesting, relevant and refreshed content is critical for almost every DV LED video wall project, but it is often an after-thought – a decision made after the video wall starts going up. In the early planning stages, project owners should be thinking about what will be on the screen and why, how often the creative needs to be refreshed, who will do that, and what the initial and ongoing creative costs will be. One tactic for controlling costs is to design creative content that is updated, shaped and triggered by data from other systems. For example, a video wall in the corporate lobby of a logistics business could visualize the real-time state of operations, from numbers of packages handled to locations of trucks across the U.S.

Finding Help

Pre-engineered bundles are a great option for simple jobs – like putting a bigger and much brighter DV LED screen to replace the LCD or projection system in a main meeting room. But for larger, more involved projects, finding a trusted, experienced solutions partner is critical.

Look for a company that has deep, diverse experience designing, specifying, installing and managing these kinds of projects. Diversified has many years of direct experience working on high-profile indoor and outdoor projects, including the design and operation of a landmark advertising display one industry writer jokingly labeled the "Billboard That Ate Times Square."

Find a solutions partner that can assess the need and recommend the ideal solution from a variety

of trusted manufacturers, instead of a single vendor who may have a need to sell a specific, possibly underperforming product. "We're not a manufacturer," says Mittler, "we're going to recommend the right product for the job."

Finally, ask the solutions partner or vendor how they will work with you after delivery and installation. "How will the company support you? Where do they go from the install?" Mittler asks, noting that finding someone to install a display is one part of the puzzle, but the real need is for a solutions partner that has the customer's back once the screen is live.

Mittler: "Can they maintain you? And do they have the resources in place? Do they have a services team? What about creative services for ever-fresh content? Do they have those relationships with manufacturers if they need that extra level support? How are they going to manage spare components? What are their service level agreements? What are their fallback plans if there is an outage? It all matters."

DV LED video walls are often big, high profile investments for brands like retailers, and if a screen starts to degrade and look bad, or the visual performance was compromised by budget-trimming or flawed sourcing, it can damage the brand's core identity.

"We've always tried to be really conscious of the brand identity," says Mittler, "and when we're working with customers, we have to support and protect that brand like it's our own."

CLIENT I VORNADO-MARRIOTT

About Diversified

Diversified designs, specifies, builds and manages DV LED solutions for customers around the globe. Our expert teams have delivered signature projects in Times Square, major museums, corporate lobbies and flagship retail locations. We're supplier agnostic, tailoring the technology options to the job.

Diversified is a leading global technology solutions provider delivering a comprehensive suite of solutions to help a diverse clientele achieve the highest performance levels, enhance their operations, increase productivity and drive ROI. Our mission is to enable a digital future—connecting people, technology and experiences, where and when it matters most. Our solutions are experienced by millions every day.

Founded in 1993, we're a global organization serving local needs with 2,000+ employees in 50+ locations worldwide. Learn more at onediversified.com/ digital-media.