WHITE PAPER

LED video walls

LED video walls are a great way to entertain or share information with many people at the same time. But how do they work? What are the key strengths and advantages of LED technology compared to other methods of producing large images? What features do they offer? This whitepaper will answer these and other questions.

How LEDs and LED video walls work

LEDs are based on the phenomena of electroluminescence. A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Based on this phenomena, electrons moving across a semiconductor change to a lower quantum energy state, and in the process emit photons of a specific wavelength.

An LED video wall typically uses individual standard LEDs in 3 colors for each pixel: red, green and blue. The LEDs can be discrete devices or combined into a surfacemount device (SMD). Each color of LED, which is called a sub-pixel, receives its own drive signal based on video content, which allows for millions of colors to be generated. In addition to standard LED, there are a number of new solutions for packaging smaller-pitch LED. Technologies such as chip-on-board, encapsulation, micro-LED and mini-LED can also accommodate higher resolutions and expanded color gamuts such as DCI-P3, while easily achieving sub-1mm pitches.

Typically, each tile is actually composed of a series of identical LED modules. The modules' circuit boards are electrically connected to ensure each pixel receives its intended and unique RGB drive signals, and power from the tile's power supply. This modularity is an advantage during servicing because if an LED fails, only the module containing that LED needs be replaced.

All of the modules in a tile are typically housed in a cabinet, which also contains a power supply for the tile as well as electronics to control each module and allow connection of a video signal (See Image 1). Some tile designs place the power supply and control electronics in a separate enclosure that attaches to a frame that also holds the LED modules. Now, there are also products with processing functions outside the tile as well.

Best-in-class LED video walls enable full-service from the front to reduce downtime without requiring special third-party mounts, which add project cost and complexity. The best systems use remote video sources, controllers and power supplies to reduce maintenance and disruption at the video wall. Some LED walls are rear-serviceable for specific applications such as entertainment, where servicing from the front is disruptive.

Due to their structure, you can hang LED tiles from an external frame and build large arrays that contain many tiles. Best-in-class LED products come with direct-mount systems

A complete solution

There's more to an LED video wall than just LED tiles. Typically, you need external control units that each control a group of tiles in the wall. Each control unit accepts video signals from source devices and provides a separate video output for each subgroup of tiles. Most solutions include a video processor and universal routing switches, as well as content management and collaboration systems.

allowing them to be installed on flat walls without third-party mount systems, reducing cost and complexity during construction. One or more separate control units, each connected to a given number of tiles, accept video signals from a variety of possible sources, typically over DVI or HDMI, and direct the correct portions of images to each tile (See Image 3).

The mechanical design of the tiles ensures that each accurately aligns to its nearest neighbors, resulting in a seamless composite image that can contain anywhere from several thousand pixels to millions of pixels, depending on how many tiles are used and how many pixels each contains. LED walls can scale to almost any size and be arranged in near-limitless ways, including 90-degree inside or outside corners, concave or convex curves, and even 3-dimensional shapes.

Image 2: Leading-edge LED design - MicroTiles LED

⌄ Exploded view of MicroTiles® LED

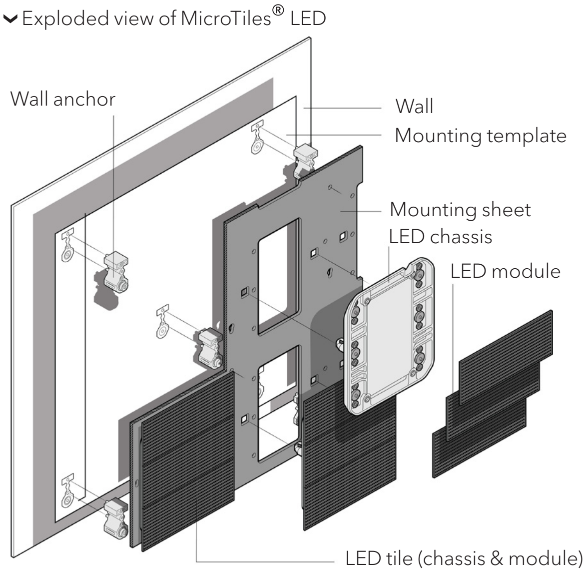
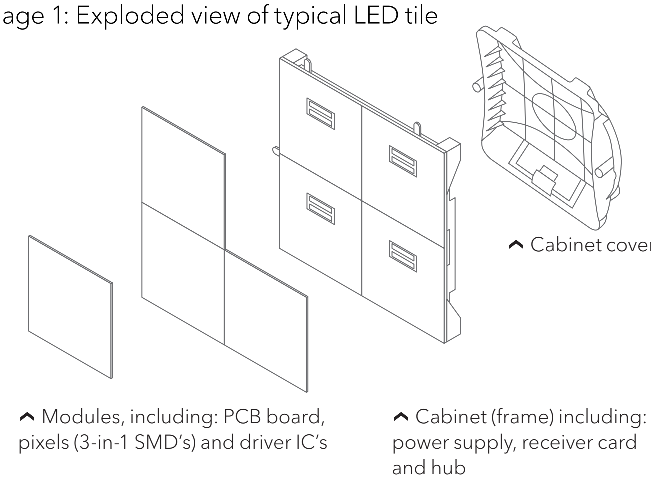


Image 1: Exploded view of typical LED tile

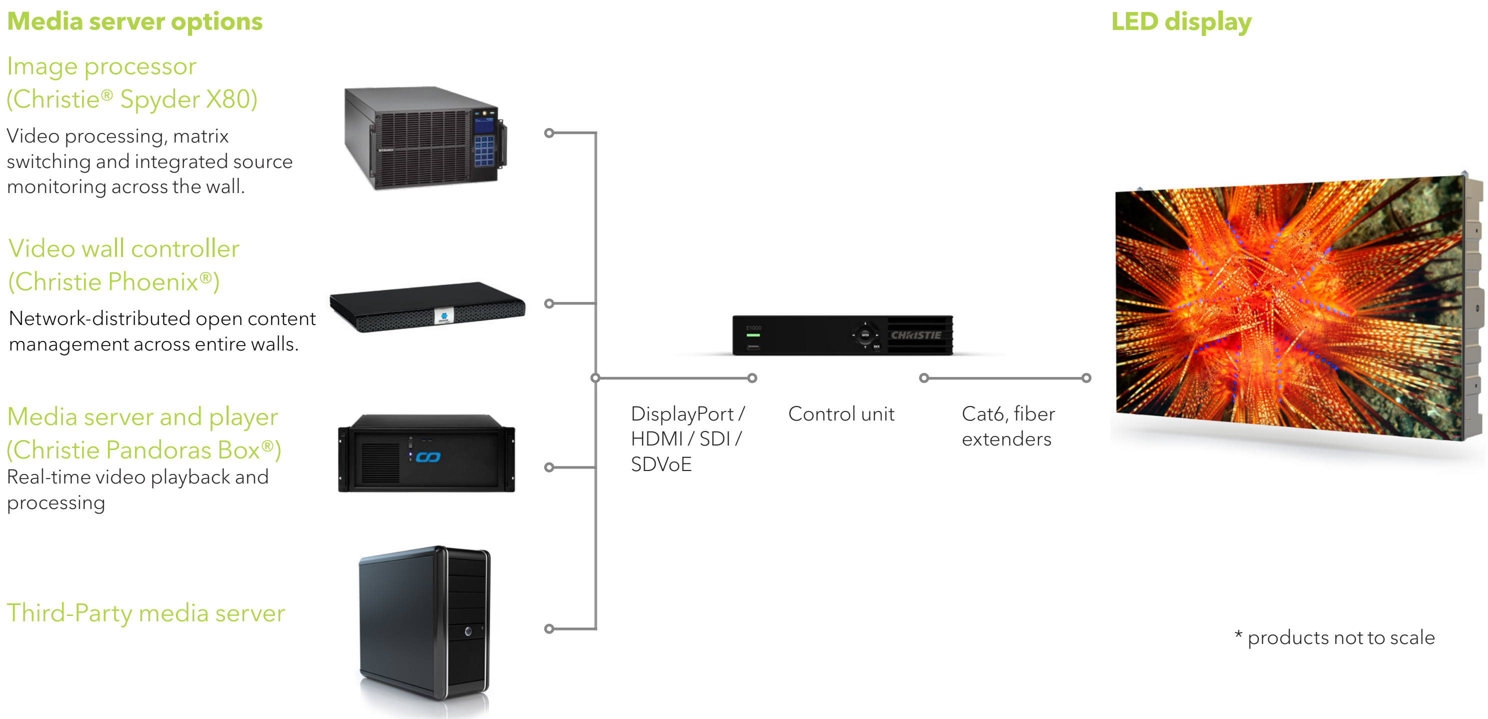


Leading-edge LED design

Christie introduced a new, patented, 'cabinet-free' tile (See Image 2). This 'de-constructed' approach simplifies the solution, making it easier and faster to install and service. It also eliminates many of the challenges that exist with typical cabinet-based products - during both installation and operation. This new design removes the power and most of the processing from the tile, leaving LED modules and a small light chassis unit. The mount system is also a separate unit. MicroTiles LED manage structure, power, and processing separately, which increases design flexibility and makes installation easier and faster.

‹ MicroTiles LED are 'cabinet-free', with processing and power managed outside the unit

Image 3: LED video wall solution components - just add great content



Key strengths and advantages

As a light source, LEDs have a number of exemplary properties.

First is brightness. Indoor LED display walls today can achieve peak brightness of up to 12,000 nits (cd/m2), although levels for indoor models are typically less than 1,000 nits. While high-brightness is crucial for an outdoor display that needs to compete with direct sunlight, it is also a benefit to an indoor display that needs to be noticed in high ambient light environments such as lobbies, atriums and rooms with floor to ceiling windows.

Other methods of creating large images either can't achieve image brightness levels comparable to LED display walls or can do so only with a considerable increase in system complexity. LCD panels, for example, are typically below 700 nits. For projection displays, where image brightness is almost arbitrary but scales with image size for a given light source, achieving brightness levels that rival LED video walls may require multiple projectors.

The ability of LED video walls to handle high levels of ambient illumination is another strength. This is a consequence not only of the high-brightness typical of LED tiles but of high contrast ratios. The result is an outstanding perceived level of black that results in a high-contrast image even in elevated levels of indoor ambient light.

A further strength of LED displays is a very large achievable color gamut, which is the range and purity of the colors a display can reproduce (See Image 4). The red, green and blue LEDs used in LED video walls all emit a much more narrow range of wavelengths than a broad-spectrum, white-light source like a lamp. This allows LEDs to reproduce a wider range of more deeply saturated color.

Another strength of LED walls is the long life of the LED pixels themselves. The useful lifetime of a display's light source is often defined as the number of hours it takes to reach half of the initial brightness. By this measure LEDs, whether used only as a light source or employed directly as pixels in an LED display, typically last much longer. LED video walls can operate for up to 100,000 hours before they reach half-brightness, when they're typically replaced. 24/7 operation over 365 days per year equates to over 11 years. As most LED video walls are operated at far less capacity, the effective lifetime may exceed 11 years.

All displays consume power and require cooling but not all display technologies are the same in this regard. LED displays consume energy more efficiently than most other display technologies. The improvement in efficiency can be as high 400% or more, depending on which displays which you compare.

This translates into less heat as well as less audible noise resulting from the cooling required to dissipate that heat. In fact, many LED tiles run cool enough to not require fans, provided there is adequate space behind them and appropriate HVAC.

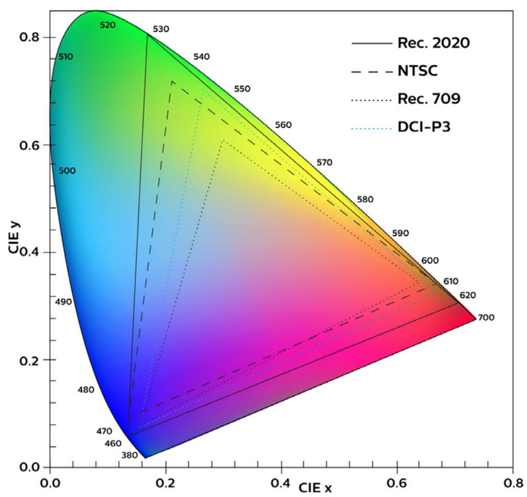
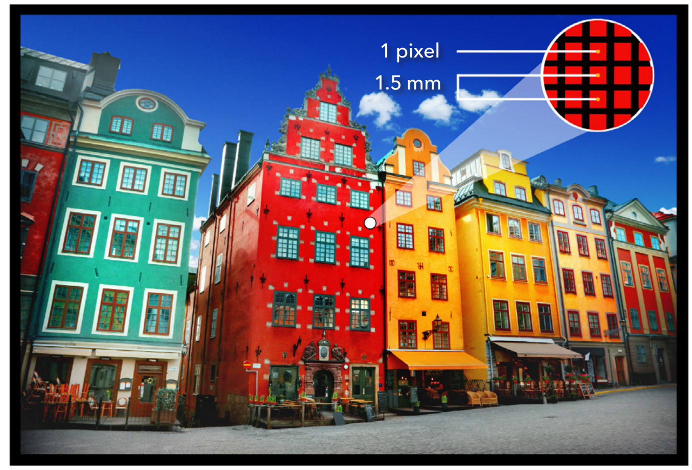


Image 4: Comparison of LED color gamut with standard HG gamut



1.5 pixel pitch (mm)

Image 5: Visual illustration of pixel pitch

An important image parameter for any display is the pitch or distance between its pixels. The lower the number, the closer you can get to an image before you can see its individual pixels. A lower number also means that you can pack more pixels into a smaller area, or conversely that more pixels can be achieved within a given area. However, small pixel pitches aren't right for every application. For very large displays in particular, an overly small pitch may result in many more pixels than are needed for a given application. Fortunately, LED tiles are available in a broad range of pixel pitches, from as large as 20mm to less than 1mm, with the smaller pitches of 2.5mm or less primarily for indoor use.

Another strength of LED walls is the perceptually seamless nature of the images. The tiles of an LED display wall are designed in such a way that they touch each other without increasing the distance between the pixels from one tile to the next. Moreover, the nature of the area surrounding the LEDs in a typical tile makes it difficult from a normal viewing distance to see where the tiles join.

Configuration options

A wide variety of LED tiles are available in the market. These are fundamentally divided into indoor and outdoor models. Pixel pitch, discussed above, is a further point of differentiation. What all of these products have in common is extreme modularity. The small form factor of typical LED tiles make it easy to create a video wall of any size, aspect ratio and shape.

LED tiles are typically quite thin, often with a depth of less than 10cm. One intriguing consequence is the ability to mount the tiles along a curve. Depending on the radius of curvature and the model of tile, you can create both convex and concave curves. The small sizes typical of LED tiles offers considerable flexibility in the size and the shape of a video wall.

One of the most important choices when purchasing an LED display is the pixel pitch (See Image 5). The best pixel pitch depends on both the desired pixel count in the final image and the expected distance of viewers. As an example, Image 6 illustrates the wall sizes required to achieve a full HD (1920 x 1080) image for a range of pixel pitches. To achieve a UHD image (3840 x 2160) – sometimes called "4K" – simply double each linear dimension in the diagram. Other aspect ratios and final image resolutions are, of course, possible.

With respect to the optimal viewing distances for different pixel pitches there are no hard and fast rules. Table 1 lists some recommendations. The right pixel pitch achieves maximum impact when it's difficult to see individual pixels from the typical viewing distance and intended resolution, yet fills the viewer's field of vision with brilliant light and color.

Image 6: Display size to achieve 1920 x 1080 resolution
(estimate to be used as a guideline only)

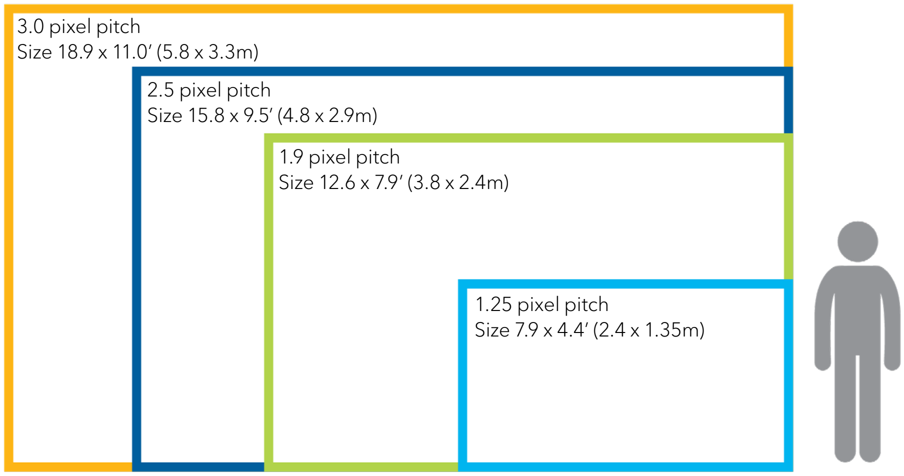


Table 1: Suggested optimal viewing distances

LED display pixel pitch (mm	**Optimal viewing distance (Pixel pitch x 8)***	**Minimum viewing distance (Pixel pitch x 3.28)***
0.8 mm	0.8 x 8 = 6.4 feet	0.8 x 3.28 = 2.6 feet
1 mm	1 x 8 = 8 feet	1 x 3.28 = 3.3 feet
1.25 mm	1.25 x 8 = 10 feet	1.25 x 3.28 = 4.1 feet
1.5 mm	1.5 x 8 = 12 feet	1.5 x 3.28 = 4.9 feet
1.9 mm	1.9 x 8 = 15.2 feet	1.9 x 3.28 = 6.2 feet
2.5 mm	2.5 x 8 = 20 feet	2.5 x 3.28 = 8.2 feet
3 mm	3 x 8 = 24 feet	3 x 3.28 = 9.8 feet

*To calculate optimal viewing distance in meters instead of feet, the formula is pixel pitch x 2.5 in feet and pixel pitch x 1 for meters. (Estimate to be used as a guideline only)

Conclusion

Compared to other image-display technologies, LED video walls enjoy a number of advantages with respect to brightness, color gamut, service life, power consumption and form factor. They are also uniquely adaptable to a wide variety of applications with differing requirements for size, shape, viewing distance and environment.

As an image-display technology, LED walls are one of the newer kids on the block but they're obviously here to stay. The future of LED displays? It's brilliant!

For the most current specification information, please visit christiedigital.com

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