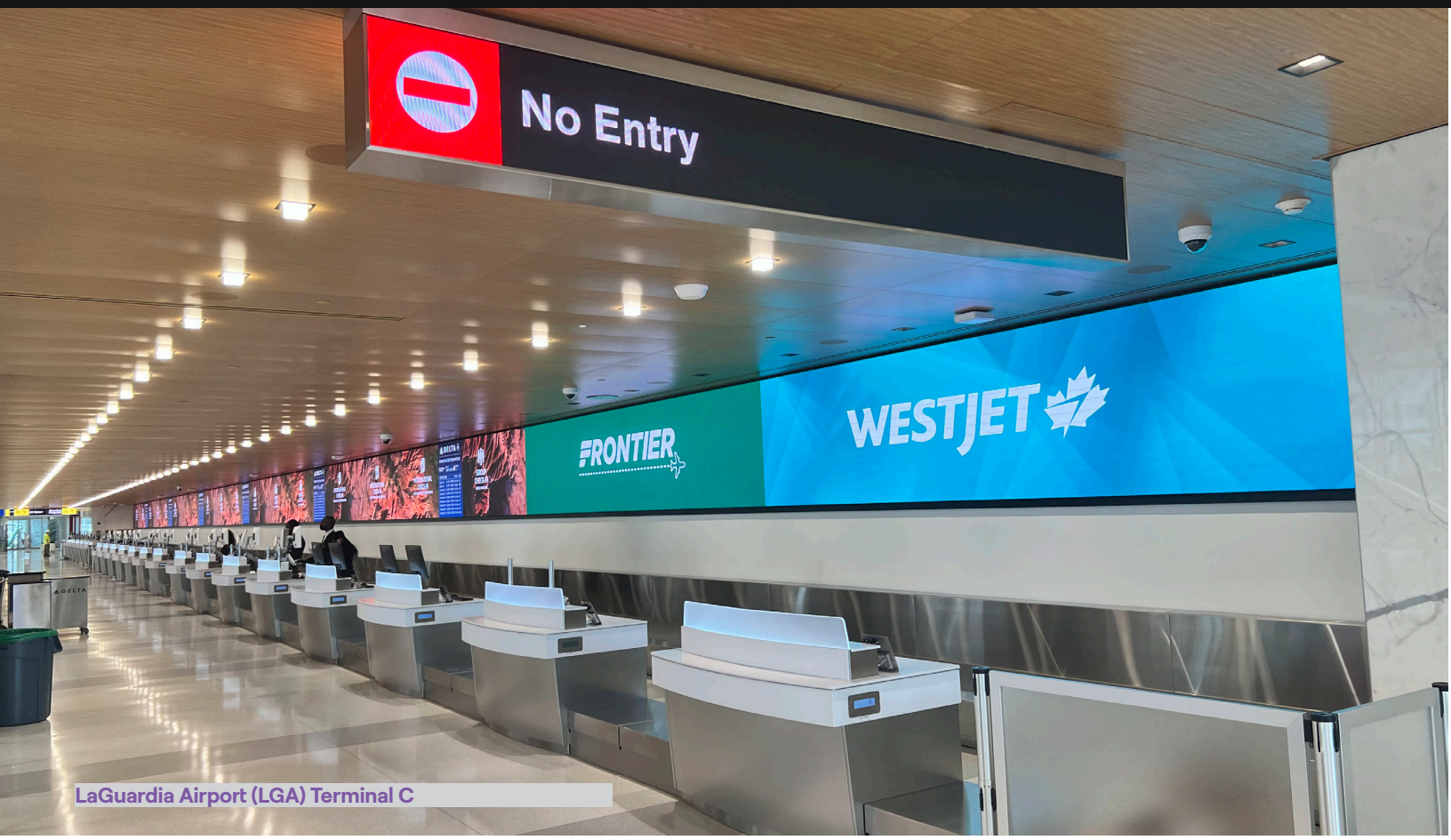
Nanolumens®



LaGuardia Airport (LGA) Terminal C

LED vs LCD: A Comprehensive Guide Between Display Technologies for Airports

By: Todd Alan Green -- Global Manager, Airports and Transportation at Nanolumens

Over the last 10 years, the airport and transportation market has seen a massive increase in the use of dynamic displays. Here, we hope to provide a brief education on current flat panel display technology (LCD) vs the newer direct view LED display (dvLED) systems. With this information, you will be able to understand the difference between these solutions and find where they best fit into typical applications found specifically in airports and transportation facilities worldwide.

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Dynamic Display Evolution

Early dynamic display uses in transportation hubs started out as manually updated chalk boards and then moved to using technology in the form of remotely operated slap flap displays in the early 1900's. In the 1950's-60's, these displays were implemented globally and provided for a nostalgic feel and distinctive sound.

Cathode Ray Tube (CRT) displays were introduced as information display systems (IDS) in the 1970's with mass adoption in the 1980's. By combining multiple displays together into groups, the first "video walls" were created.

Advancements in television technology have provided the industry with a considerable path to providing even larger and more colorful display options to share more information and engagement for both passengers and staff. Smaller bezels between the glass panels provide a more seamless look compared to previous CRT displays. Combining these with network-based content management systems (CMS), IDS displays have now become interactive as well as automated and provide the ability to react to real time data triggers (APIs) based on facility conditions and passenger presence.

Today, dvLED displays are the latest evolution in dynamic displays for transportation facilities. This technology started with very large pixel pitches (more on this later in this document) and was primarily designed for outdoor use. Electronic scoreboards at sports stadiums helped lead the way and now fine pixel pitch displays are commonplace, as are indoor dvLED displays. DVLED is direct competition with traditional LCD flat panel displays for uses in commercial environments which tend to require 24x7x365 always on ability. DVLED technology can now be thought of more as a dynamic material or canvas than a traditional "display" in its ability to be formed into multiple shapes and sizes and can be used for many applications in transportation facilities to provide information, entertainment, ambiance, and sense of place.

Welcome to the age of "Digital Drywall."

Daniel K. Inouye International Airport (HNL)

The value of dynamic displays in transportation facilities:

- Flexibility to update as the environment changes.
- Provide immediate, real-time information to passengers and staff.
- Reduce passenger anxiety with dynamic wayfinding, flight updates and engaging experiences.
- Provide support for emergency notifications, health safety and public announcements.
- Advertising and branding opportunities to increase awareness of local landmarks and advertisers.
- Ability to provide information in native languages of arriving passengers.
- Provide placemaking and entertainment opportunities.

Differences in LCD Flat Panel Displays and Direct View LED

Flat Panel Technology and Sizes

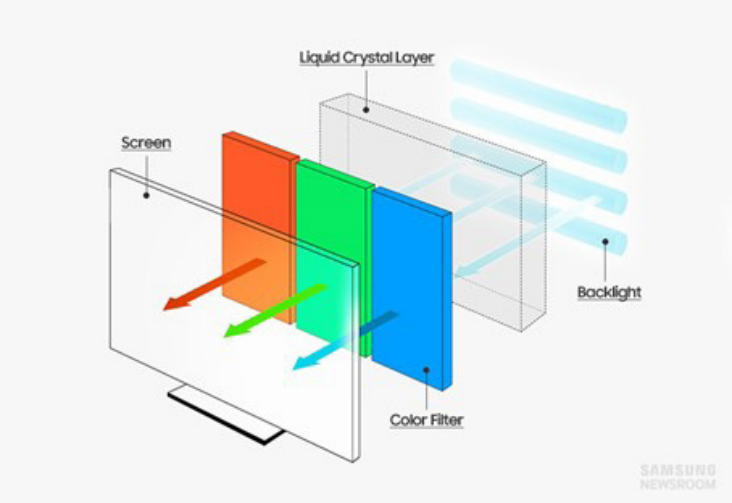
You will typically find two types of flat panels on the market today - Liquid Crystal Displays (LCD) and Organic LED (OLED). To start, all flat panel displays use a glass screen to create a viewable display image. Glass is a requirement of this technology, and it must be protected from possible damage. LCDs utilize liquid crystals that produce an image when light is passed through the display from a backlight. OLED displays generate images by applying electricity to organic materials inside the display. Flat panel displays are limited to the size of the glass that is manufactured. LCD/OLED display sizes can start out at 19" and max out at 108" diagonal.

Flat Panel Illumination – Liquid Crystal Displays (LCD)

As described above, LCD displays require some type of illumination to be able to see the image created by the liquid crystal. This illumination is provided by a backlight. LCD displays, just like the television you have in your living room, are marketed as LED TV's. This is because a Light Emitting Diode (LED) is being used as the "backlight" that provides the illumination that then shines through the LCD glass and provides the images that we see on the display. These diodes are the same as used with your LED lights at home. They are a common cathode device that provides a white light used for illumination.

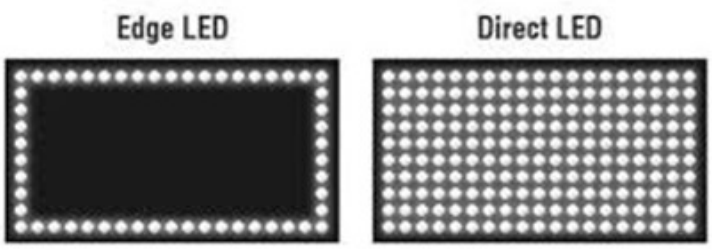
An example of an LCD display is shown below (figure 1). The back light portion of the display is the LED diode creating the light that shines through the other surfaces and thus creating the usable image.

Figure 1



There are two main types of LCD backlights; one is edge lit or edge LED and the other is full/direct lit LED. As shown in figure 2 below, you can see how the edge LED provides illumination, but the use of the LED is just around the edge of the display, this helps provide a great amount of black area which helps to create contrast. This is wonderful for use in home theater viewing applications where you can control ambient light. These displays do not provide a lot of brightness but do provide a lot of contrast in dark images. Direct LED backlights provide a much greater brightness level and are typically used for commercial LCD displays which is why the industry and most people use the term LED display to describe a flat panel display.

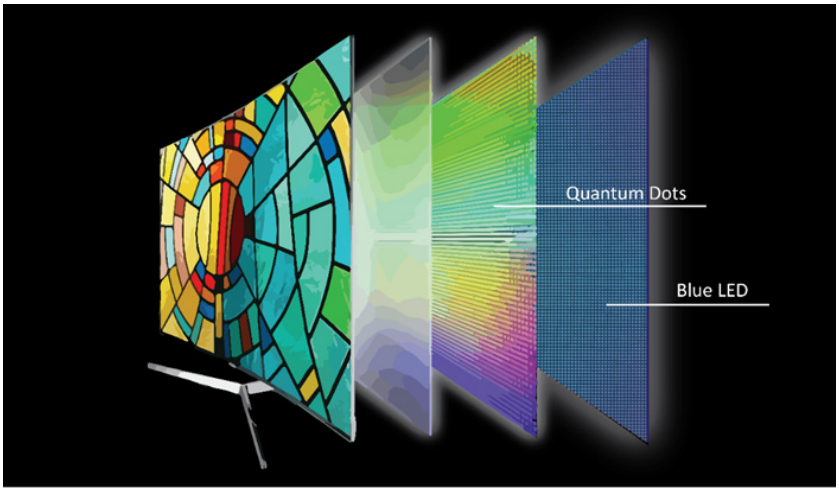
Figure 2



Flat Panel Illumination – Organic Light Emitting Diode (OLED)

OLED is a light-emitting technology created by stacking a series of organic thin films between two conducting components. Illumination is provided when an electrical current is applied across this multi-layered stack. One of the primary differences between LCD and OLEDs is that OLEDs are self-illuminating, so they have no true backlight. This means LCDs can produce brighter images than OLEDs due to their powerful backlights, but OLEDs are thinner and more efficient than LCD based display panels.

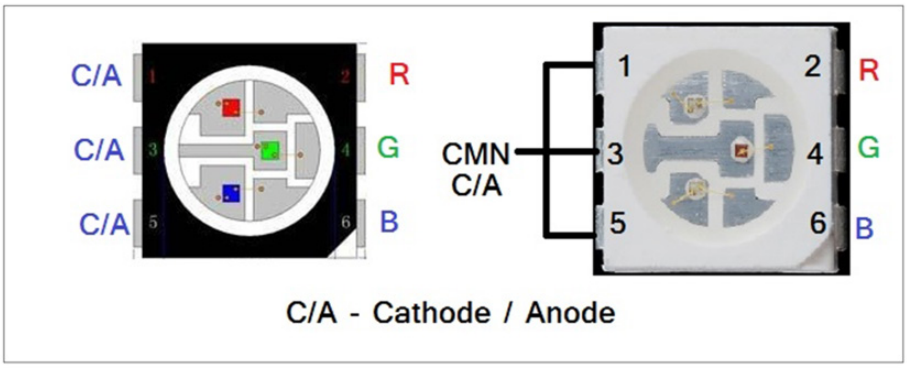
Figure 3



LED Illumination – Direct View Light Emitting Diode (dvLED)

Today's LED displays are called direct view LED because you are viewing the illumination directly. There is no glass or other surface from the illumination device. The illumination of dvLED comes from individual diodes that contain three primary colors—red, green and blue—and then mix all the colors to form white light. (figure 4).

Figure 4



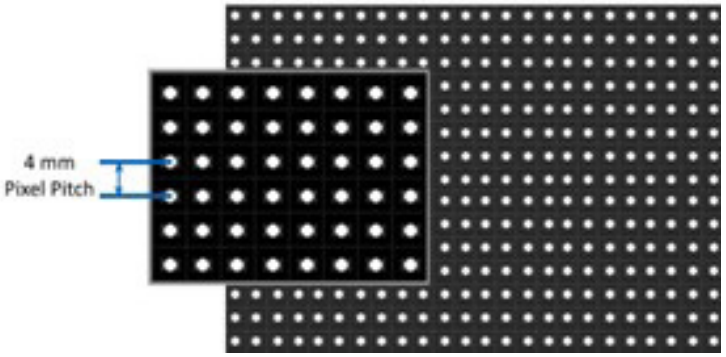
These diodes vary in size and are placed upon an electronic board to create a "module." Modules can vary in shape and size and individually can be removed from the term "display", which is more of a specific size and shape to using of the term "canvas". The number of these diodes on the module will determine the pixel pitch and the resolution of the module. Modules can then be added to a "frame" and combined into "video walls" or canvases of an almost unlimited size and shape (figure 5).

Figure 5

Display Resolution and Pixel Pitch

A display's resolution is equal to the number of "pixels" or individual image dots used in that display. A HD video display is 1920 pixels wide by 1080 pixels high. With flat panel displays, users are limited to three resolutions in today's marketplace; high definition (HD) which is 1920x1080, ultra-high definition (UHD4K) 3840x2160 and (Full 4K) 4096x2160. DVLED displays however, can be provided in almost any resolution needed for any specific application. For dvLED displays the resolution is determined by the choice of "pixel pitch" used for its manufacture. The pixel pitch of a dvLED display is measured by the distance between the middle of one pixel to the middle of the next pixel (figure 6, as shown below).

Figure 6



Example of 4mm Pixel Pitch

When it comes to resolution and commercially available flat panels, most discrete, stand-alone flat panels come in UHD resolution while most "video wall" flat panels are HD resolution displays. This is because it's cheaper to provide a video wall solution in which you combine displays to form a video wall to create a larger resolution. It is also much easier for content creators to provide the resolution outputs necessary to use the full video wall canvas. The larger the resolution video wall you have, the more horsepower and the more complicated the content playout solution needs to be. Also, when it comes to resolution in a commercial use case, the more resolution, the closer the viewer must be to the display for them to read any sort of fine text content. For most commercial spaces, it's highly recommended to select HD displays so the content can be seen by the greatest number of viewers from a comfortable distance from the display.

So, why are resolution and pixel pitch important to understand? Because those two factors determine what size your display should be. You need a larger pixel pitch and lower resolution the farther out the viewer is from the screen. A great example of this is at a sports arena (see figure 7 on next page). When fans are sitting in the stands viewing the information from 500ft (152m) or more away, the font and text in the signage needs to be large to view it from that distance. Conversely, if those fans are now in the food court and viewing the menu boards, (figure 8), the pixel pitch will be much smaller, and the resolution will be higher because you are much closer to the display.

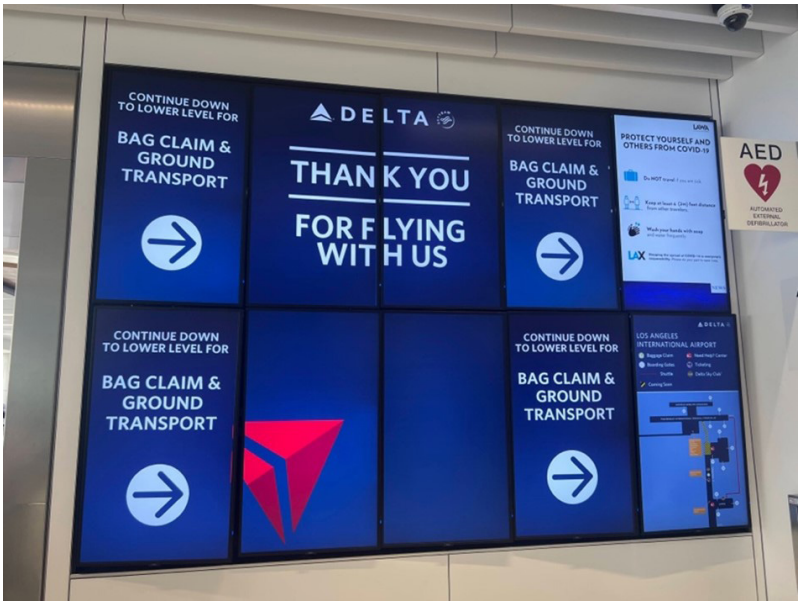
Figure 7

Figure 8

Bezel Size

Now let's discuss bezels. Bezels are the trim or edge around a flat panel display that create a gap between panels and can range from 3.5mm (Ultra Narrow Bezel), to 1.7mm (Extreme Narrow Bezel), and .88mm (Razor Narrow Bezel). Some manufacturers even claim to have displays with no-bezel. At the end of the day, ALL flat panel displays when used as a video wall are required to have some level of gap between them to provide heat dissipation as well as to prevent damage to the glass of the flat panel, from pressure exerted from the other displays surrounding them. When using flat panel displays together to create a larger video wall, the bezels become much more of a user experience issue that needs to be considered (figure 9). The larger the bezel the more "lines or breaks" you see in your video wall content. Most designers tend to look at using a much smaller or no-bezel display solution. The smaller the bezel, the more fragile and more expensive the displays become.

Figure 9



Mounting System

Flat panel video wall installation can be a time-consuming process and require some type of precise mounting solution that allows for the proper alignment of each display. for successful installation. Care must be taken to make sure that the mounting system chosen allows for precise control of the X, Y and Z-axis. Another thing to consider is how you are going to remove and service panels located in the center of the video wall. Special tools and access are required to precisely adjust align each panel. It is common for flat panel wall displays to shift out of alignment over time and it's difficult to provide this needed level of precision without spending a considerable amount on a custom mounting solution.

DVLED displays remove the need for this precision because they have either a cabinet or frame that properly aligns panels to each other, as long as they have been properly leveled and off wall adjusted. DVLED displays can be installed once and typically do not need other mounting adjustments over time, unlike flat panel mounting systems which tend to require constant tweeking in order to stay flush.

Image Retention and Display Uniformity

Flat panel displays do have some inherent flaws in their technology. Most of these are not apparent until being used over time. Some of the problems that must be considered include image retention (screen burn) and color uniformity.

Image retention is when the same content image has been on a display for an extended period, and this image is now saved or "burned" into the display itself. No matter what other content you use, there will tend to be a "ghost" of the image that was there prior over the current image. This issue has become much less of an issue with advancements of flat panel technology, but unless the display has been properly set up with image retention technology turned on, or even within your own content being moved and changed, this can be a real issue as the display gets older in its provided lifespan.

Color uniformity is a much more common issue with flat panel displays. The LEDs that make up the backlight are created in "bin or batches". Each LED batch's color profile is just a bit different than the previous batch. If you look at these batches side-by-side, you will notice a difference in the color performance of each. This is similar to the way paint shades differ when they are mixed separately. If you paint one wall with one can of paint and need to use a new can of the exact same color on another wall, the shades of that color could be slightly off because they were mixed separately.

As with flat panels, dvLED display technology faces the same issue with manufacturing different bins and batches. DVLED manufacturers make up for this uniformity issue by producing their dvLED display using the same bin/batch diodes for all modules in the display, including spare parts so each spare identically matches the others in case of repair.

Field Service Ability

Once a flat panel display has any damage such as a cracked display, bad input port, bad power supply or any internal cabling issues, the only solution to resolve this is to replace the panel with another panel of the same make and model. Keeping spare panels from the same make and model are critical to long term success. In most cases, cracked glass is not covered under warranty or during shipping. If a panel's glass gets damaged, the only solution is to buy and replace it with another panel. The damaged panel needs to be boxed and sent back to the manufacture for hopeful repair. Access, removing, replacing, and re-adjusting for just a single display can take a full day of service time and video wall downtime.

DVLED manufacturers provide at least 3-10% spare parts for most or all system components, allowing the display to be immediately fixed. Power supplies, cables, and even LED modules can be quickly replaced in the field providing for minimal downtime. Damaged components can be sent back to the manufacturer for repair, and these can be returned to the customer site to be available for any other repair need in the future. Usually, video wall repairs can happen in minutes, with the hardest part of the operation getting to the display location, should it require a lift or ladder.

Lifespan

Product lifespan is the most obvious advantage of a dvLED display solution. Flat panel displays are provided using technology commercially rated for up to 50,000 hours (5+ years) of 24x7 use. The panel will start to noticeably degrade quickly once the display(s) reach about ½ of their expected lifespans.

DVLED displays provide a 100,000 lifespan (11+ years) of 24x7 use and this is to the ½ life of the product, meaning after 100,000 hours the product will have reached half of its use. In normal use conditions it would be expected that a dvLED solution would be able to provide 15 to 20 years of life in a "normal" operating environment

Warranty

Standard commercial warranties for flat panel technologies are provided with 2-to-3-year max offerings. Most of Nanolumens' dvLED solutions provide a 6-year, extendable to 10-year warranty, further providing support for a display solution designed for a long, continuous life of use.

Image Reproduction and Visualization

Flat panel solutions have come a long way from their initial beginnings with high-definition resolutions (1920x1080). Now with 4K and approaching 8K resolutions, flat panels can provide a very high-resolution image in a very small display or video wall footprint.

Color reproduction and contrast is still lacking over dvLED solutions, and glare from the glass surface is still a common pitfall of flat panel solutions. DVLED, however, currently provides one of the best viewer experiences on the market and is in high demand by brands seeking to keep their specific color schemes in line with specific pantone shades and gamut. DVLED displays can provide NTSC, REC 709, DCI-P3 and REC2020 color reproduction using specific and controlled pixel diode bins where flat panels are limited to 100% NTSC color spaces.

Virtual Technology Shootout

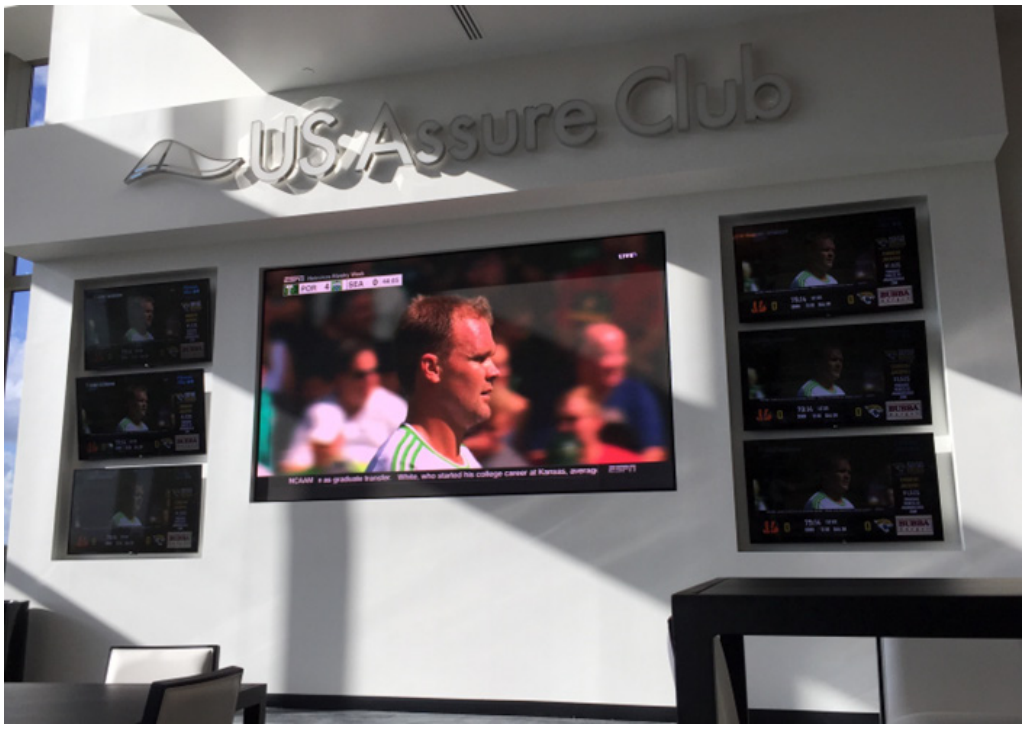
Below is an image of a 5x3 LCD video wall made up of a series of 49” panels with a 3.5mm combined bezel. Below is a direct replacement for this video wall using a 2.5mm pixel pitch dvLED in approximately the same size footprint. This LCD video wall was provided with a 3-year commercial warranty and will be really seeing its age around the start of the 3rd year of use. The different panels have lost their color uniformity resulting in each panel having a slight difference in color and brightness.

The dvLED solution is brighter, uniform, bezel-less and uses less energy to provide a better viewing experience.

LCD - Before

DVLED - After

In the example below, the individual LCD panels on either side of this dvLED display are completely washed out and basically un-viewable in direct sunlight. The dvLED display in the middle is big, bold and bright and is also not reflecting the direct sunlight and creating glare.



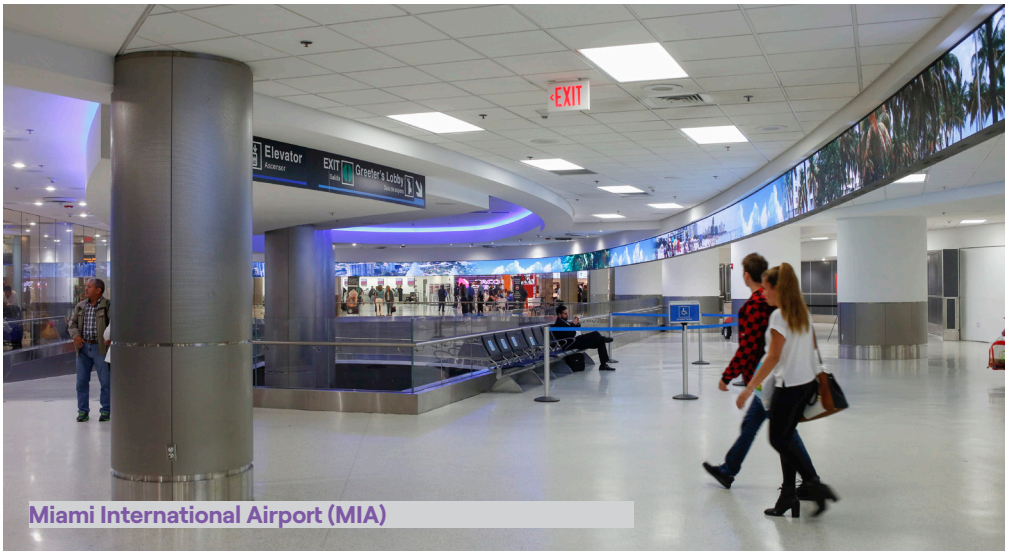
Higher Visibility, In Any Situation

With brightness levels easily controlled and adjusted, Nanolumens LED displays are more effective because the content on screen can be more useful, more legible, and provide more WOW resulting in an improved passenger experience. Nanolumens LED displays can be seen from further distances, which helps provide even better customer communications and can help with passenger flow.

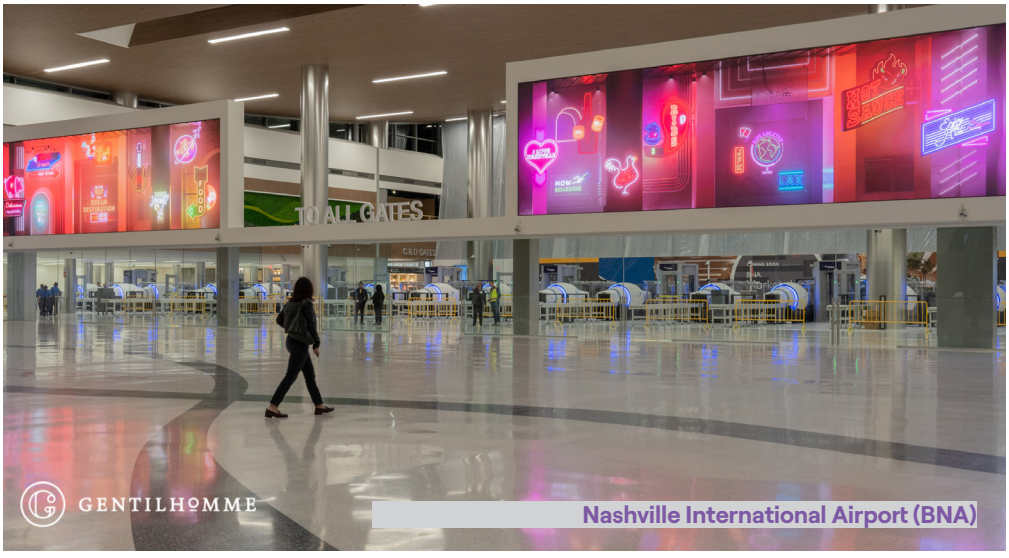
Head-to-Head Comparison (30% - 60% Power Savings)

Now that we understand the various display technologies, let's look closer at their advantages and disadvantages specific to airports and other transportation facilities. On the next page, we've put together a chart of Pros and Cons for each technology.

DVLED display technology provides many cost benefits, but one that sets it apart is its reduced power consumption. On average, you should see 30-60% less power usage from a similar size flat panel video wall solution with similar brightness capabilities. This reduced power can help facilities towards their carbon reduction goals as well as identifiable cost savings. Nanolumens dvLED displays can also be designed to work within specific power limitations further helping to provide even more project value.



Miami International Airport (MIA)



Nashville International Airport (BNA)

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	Pros	Cons
LCD	Cost - Inexpensive initial purchase price	Power - High power consumption compared to other display technologies such as OLED and dvLED.
	Resolution per Ft^2/Meter - High resolution ability within a small space	Bezels - Display frames distract from the viewability and user experience. Gaps will be necessary.
		Maintenance – No in-field repair. Requires full display replacement.
		Color Uniformity – LCD displays' color level balance will shift over time, requiring annual calibration.
		Brightness Reduction – LCDs lose brightness as they age and displays in a video wall will reduce their brightness based on the lowest performing unit.
		Glare – LCDs' glass surfaces have glare and ambient lighting conditions will need to be considered.
		Limited Color – LCD displays provide a limited color reproduction ability compared to other display technologies such as OLED and dvLED.
		Limited Contrast – LCD displays provide a more limited contrast ratio compared to other display technologies such as dvLED.
		Model Changes – LCD displays go through frequent model changes resulting in the need to stock full displays as spare parts. Most manufacturers change LCD display models every 6 to 12 months.
		Lifespan – Commercial LCD displays provide 50,000 hours of usable lifespan solution.
		Warranty – Typically limited to 3 years with a max of 5 years.
		Mounting – A mounting system must be provided requiring precise alignment to provide a flat, professional look.
DVLED	Lifespan – DVLED displays provide a 100,000+ lifespan.	Cost – DVLED solutions require a higher capital expense compared to flat panel displays, however the lifespan of this technology provides a higher return on investment and lower total cost of ownership.
	Power – DVLED displays provide 30% to 60% energy savings over the same size LCD video wall / display.	
	Custom Resolutions – DVLED displays can be provided with smaller sub-HD resolutions which allow for easier reading of displays from a distance.	Resolution per Ft^2/Meter – Higher cost per sq ft/m of resolution compared to flat panels.
	Glare – LED displays do not require a glass surface that produces glare.	
	High Contrast – DVLED solutions provide a high contrast ratio providing for blacker blacks and whiter whites.	
	Color Uniformity – DVLED solutions will maintain their white level throughout the display for the life of the product.	
	Color Reproduction – DVLED solutions provide the highest color palette of all display technologies on the market today.	
	Higher Viewing Angle - Allows more viewers to see images from a wider range of angles.	
	Brightness - DVLED displays provide high brightness solutions allowing for a greater range of applications, including outdoor direct sunlight.	
	Range of Resolution Options - Flat panel displays have 2 resolution choices, HD or UHD. DVLED can provide a full range of display resolutions that allow for the display to be designed to help move viewers around a given area. The closer or further away from the display, decides how to best fit the application needs.	
	Reduced Heat – DVLED displays are more efficient at converting electricity into light thus generating less heat.	
	Warranty – Nanolumens LED displays provide an industry leading 6-year warranty, extendable up to 10-years.	
	Mounting – Nanolumens LED displays provide a custom mounting solution in the cost of the display	

While flat panels have a lower initial capital expense, dvLED makes up the return on investment with savings over the life of the technology. Within 3-5 years of use at an airport or transportation facility, dvLED displays are about as cost effective as an LCD purchase. After the 3-5 years of time however, dvLED displays are still looking like new and not needing a technology refresh while also still providing power, maintenance and infrastructure cost savings.

DVLED Uses in Airports and Transit Facilities

The 2020's have seen a tremendous uptick in the use of LED displays over flat panel displays for many of the reasons listed above. Transportation facilities tend to have very large capital investments in the beginning of a project but need to have those investments perform at their highest over the 15 to 20+ year lifespan of the designed facility. DVLED solutions fit the needs of these public facilities with their advantages and long lifespan providing substantial return on investment.

Uses of dvLED systems in airports

- Flight Information Displays (FIDS)
- Gate Information Displays (GIDS)
- Lobby Information Displays (LIDS)
- Ramp Information Displays (RIDS)
- Pilot Information Displays (PIDS)
- Baggage Information Display (BIDS)
- Security Information Displays (SIDS)
- Security Queuing Information Displays (SQuIDS)
- Airport Operations Control Center (AOCC)
- Ticketing & Bag Drop Back Walls
- Dynamic Wayfinding
- Digital-Out-Of-Home (DOOH) Advertising
- Branding and Placemaking
- Airline Lounges and Clubs
- Welcome / Transit Centers
- Retail and Duty-Free Shops and Concessions
- Smart Parking Garage Displays
- Roadside / Curbside Wayfinding & Signage
- Cell Phone Lot Displays
- Rental Car Facility Displays
- Art and Entertainment Displays

In Summary

As you can see, there are several reasons why selecting a dvLED video display will be more advantageous to your organization in the long run but below we've highlighted some of the key takeaways to keep in mind when evaluating your next new building structure or information display upgrade. To all facilities looking to implement flat panel video walls, the 2000's called and they want their video screens back. Don't look dated before you even open your newly renovated facility. Using direct view LED as a building material can greatly help to reduce operational costs and provide an improved customer experience while also reducing maintenance and support needs.

Save Money!

LED Displays provide a substantial return on investment (ROI) over the standard 3-year lifespan of a similar LCD display video wall. You typically would need to replace an LCD display 2 to 4 times to reach a similar lifespan of LED.

Save the Planet!

30% - 60% power and heat savings over LCD is substantial to help with carbon off-set goals and LEED requirements.

More WOW Factor

High brightness, freedom to incorporate motion-based advertisements, and vibrant color clarity all attract the eyes of people on their feet or in vehicles in ways that are not possible with static, printed billboards and posters.

Increase Dwell Time

Multiple airport studies have shown that even creating one extra minute of dwell time in your facility equates to additional revenue. If customers are comfortable, knowledgeable, and less stressed, they will stick around and plan to arrive sooner so they can enjoy the airport services and experiences, resulting in increased spending and direct airport revenues for concessions and retail.

Do More with Less!

The in-field repair and on-going maintenance of LED is substantially less than with LCD resulting in much lower labor requirements.

Reduce Infrastructure Needs!

DVLED solutions require less content hardware, less power and less data infrastructure needs leading to less failure points.

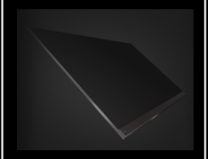
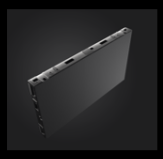
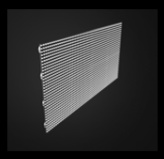
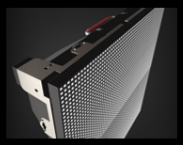
Peace of Mind!

Nanolumens provides an industry-leading 6-year standard warranty on most products, with an option to extend the warranty to a full 10-years, helping to reduce sleepless hours.

Higher ROI Per Square Foot

The flexibility of having multiple ads on a single LED display with higher clarity, and higher customer engagement contribute to making the positive Return on Investment case for LED over static advertising.

Product Family Overview

	Captivate	Engage & NXT	Nixel	CLRVU	Performance
					
Environment	Indoor	Indoor	Indoor/Outdoor	Outdoor	Outdoor
Format	All-In-One Display	Cabinet	Engineered	Engineered Mesh	Cabinet or Eng.
Pitch Range	1.3 - 1.7mm	0.9 - 2.5mm	1.2 – 9mm	10 – 30mm	3.1 – 10mm
Processing Options	Proprietary	MPVR/Nova	MPVR/Nova	Novastar	Novastar

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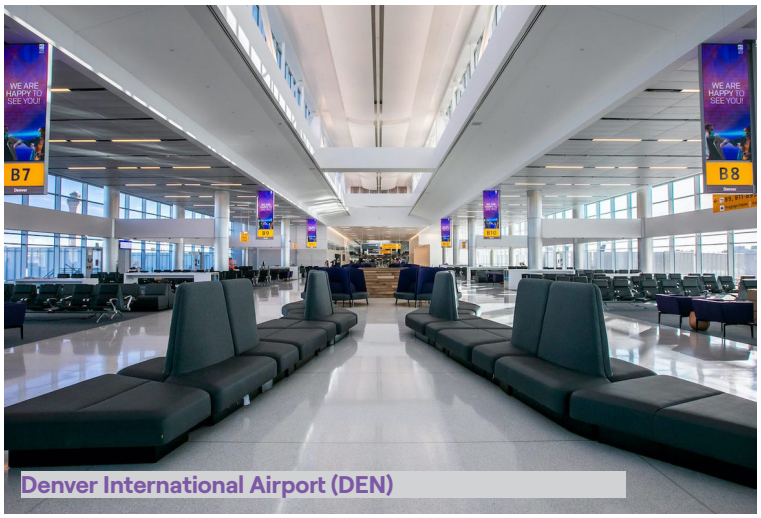

Denver International Airport (DEN)

Minneapolis International Airport (MSP)

To learn more about Nanolumens' products, use the QR code here.

nanolumens.com