VIDEOWALL SYSTEMS

DESIGN GUIDE

Extron

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Extron Videowall Systems Design Guide

With the ability to display a multitude of sources across a tiled array of displays, videowalls produce some of the biggest images in the AV industry. First appearing in the late 1980s, videowalls found a home in public spaces such as retail environments and museums. Throughout the following decades, their function shifted from entertainment and advertising to powerful centerpieces in work environments, where visual content could be shared for critical analysis and decision-making.

Extron offers multiple videowall processing solutions with the industry-leading Quantum® Series of processors. They provide scalable solutions for installations ranging from small conference rooms or retail displays up to large, mission-critical command and control facilities, and anything in between. Quantum Ultra II, featuring support for single-path 4K/60 signals, Vector 4K scaling, and the future-ready 500 Gbps HyperLane video bus, is the latest addition to the Quantum product line.

While videowalls continue to grow in popularity, many AV integrators can find themselves new to the task of designing and integrating these unique display systems. By understanding each element of a videowall system, as well as the physical aspects of the environments in which videowalls are used, you can avoid common pitfalls in videowall design.

This Guide will be an invaluable reference to AV professionals who specify videowalls, whether frequently or infrequently. Basic videowall concepts such as operating environments, processor features, and system control are discussed, as well as more complex topics such as room design, font scaling, and readability. Experienced designers will find useful technical references and visual illustrations that will aid in communicating or comprehending technical topics that can be unique to videowall systems. Several real-world designs provide examples of how the sources, videowall processor, displays, and control system all come together to create a powerful visual tool for boardrooms, simulation environments, command and control rooms, and more.

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GLOSSARY

Introduction to Videowalls

Videowalls are used to provide numerous sources of information viewable by everyone in the room.

What is a Videowall?

A videowall is a display and processing system comprising an array of displays that function together as a single, cohesive unit. When compared to a single display, a videowall typically provides a much larger picture size with far greater pixel resolution since multiple screens are combined to form an image. Videowalls are ideal for displaying large images and simultaneously presenting multiple computer or video sources.

As its name implies, a videowall usually dominates a significant portion of a wall. Videowalls can be built with the same aspect ratio as a standard display. They can also be just about any desired shape, orientation, or form factor and comprised of as few as two screens or as many as 100.

How are Videowalls Used?

Videowalls are frequently used to provide numerous sources of visual information for easy viewing by everyone in a room, such as a network operations center or command and control room. They are also commonly used for digital signage to create impact and attract attention through large images in corporate lobbies, transportation hubs, retail locations, and other public environments.

Videowalls have traditionally been implemented by large enterprises with the financial means to justify the substantial integration cost. Advancements in display and video processing technologies, together with the increasing affordability of displays and projectors, have resulted in more videowalls in a wider variety of environments.

What are the Essential Components of a Videowall?

Videowall displays: Videowalls can be comprised of LCD flat panels, projectors, direct-view LED panels, or projection cubes. For many years, projection cubes were the most popular choice for videowalls due to their thin screen bezel that minimized disruption of the image. LCD displays have since become the device of choice thanks to their small physical footprint and technological advances that have greatly reduced screen bezel size to be comparable with projection cubes. Architectural displays are similar to LCD displays or projection cubes. Typically, they are available in compact sizes that lend themselves to creating unique shapes and arrangements. Projectors can be used in front projection, or more commonly, rear projection configurations, often employing edge blending to eliminate image-to-image gap. Direct-view LED displays deliver very high brightness and are ideal for both indoor and outdoor applications.

Videowalls can make a powerful visual statement in a corporate showroom

Videowall processing: Videowall displays sometimes incorporate built-in video processing, with scaling for each individual display unit to create an image across the array. The processing in LCD displays may also include compensation for the bezels, or mullions to make moving images appear more natural.

An outboard, dedicated videowall processor or controller provides greater flexibility for integration than the scalers built into the displays. They can be used to connect many different input sources and signal formats, often from a matrix switcher, and can drive small or large videowalls. These processors have the capacity and bandwidth to process a large number of input sources simultaneously. They also optimize presentation in individual windows. In fact, a videowall processor is absolutely essential for any application that requires the flexibility to window many images on multiple screens.

Videowall processors usually include control software that allows a user to create custom window layouts. It enables placing and sizing windows anywhere on the videowall and then assigning input sources to them. These layouts can be conveniently saved as presets, which the user can recall later from the processor's control software or an AV control system.

What are the Essential Requirements of a Videowall?

Performance and image quality: Because videowalls usually are large and highly visible, their images should always appear bright and sharp. Content must be clear and easy to decipher. The videowall processing must deliver consistent performance regardless of signal load, maintain the original frame rate of high-motion content, and preserve essential image details. This includes text and graphics. A videowall processor also needs to respond to user commands without delay, even while handling a full load of input and output signals.

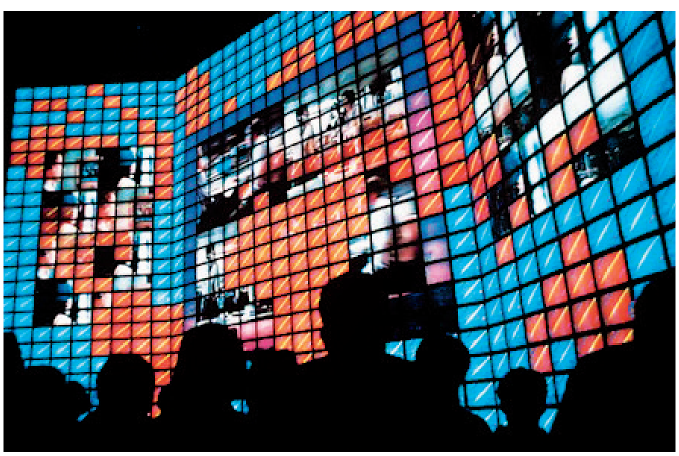
Reliability: A videowall must deliver robust, continuous reliability around the clock when installed in mission-critical environments. Any maintenance, including parts replacement, should not require disabling the entire system.

User accessibility: Videowalls are among the most complex types of AV systems to set up and configure. The end user will likely be a system operator without detailed knowledge of the videowall configuration or functions. An intuitive user interface should be provided, such as a touchpanel with a simple button design that allows the user to easily select presets for window layouts and switch input sources.

Where are Videowalls Used?

Videowalls are a standard fixture in command and control rooms.

Videowalls were first developed in the mid-1980s and found an early home in entertainment and retail environments. The appearance of "a big stack of TVs" producing a single, cohesive video image on CRT screens was a guaranteed showstopper. During the 1990s, CRT-based displays were joined by new imaging technologies. Videowall processors with the capacity to process a variety of input and output signal formats emerged. Together, they were ideal for presenting the high-resolution computer graphic formats that were quickly becoming commonplace, as well as high definition video as it developed throughout the 1990s.



850 CRT Monitor Videowall – Seville EXPO, 1992

By then, videowalls were no longer used exclusively for "eye candy." They found their way into work environments, where large, centrally located videowalls allowed an entire room of personnel to share highly visual information. Today, videowalls can simultaneously present 1080p and 4K video, computer graphic sources and IP streamed content, producing extremely flexible information display systems.

Videowalls are now used in many different ways in public and private sectors. For each of these spaces, there are a vast array of environments, each with unique application needs. The size, features, and performance of a videowall are dictated by the environment, application, and intended viewing experience for the audience.

Work Spaces

Command and Control

Videowalls have become a standard fixture in command and control rooms on military bases and in government facilities run by public safety and intelligence agencies. They are used to provide a large, centralized display, allowing room occupants to share content. These videowalls typically present a wide variety of classified and unclassified sources to aid in information monitoring and decision-making. Camera feeds, satellite news broadcasts, PC signals, digital video, static map files, and other sources are usually displayed on a 12- to 18-screen videowall, managed by a shift supervisor.

LCD flat-panel displays are the display device of choice in command and control rooms, providing large screen sizes with very narrow bezels. Command and control rooms are among the most demanding environments for videowall displays and processors, necessitating the highest quality upscaling and downscaling of mission-critical, high-resolution source content and continuous 24/7 reliability.

Thales Catalyst Center
Simulation

A videowall is effective in providing an overview of all the visual elements in a simulation event.

London Metropolitan Police Service
Security and Traffic Management

Videowalls are commonly used in surveillance and traffic management centers to present camera feeds, maps, and other information.

Situation Rooms

Situation rooms serve functions similar to command and control rooms, though on a smaller scale. A small videowall, six to eight displays, presents updates on emerging situations sourced from satellite feeds, maps, and intelligence data. High-ranking corporate management or government officials meet with staff to monitor and manage a crisis. As with command and control room applications, continuous 24/7 operation is a critical feature for the videowall displays and processor.

Simulation

Government contractors that develop simulation systems utilize videowalls in their facilities to show live or pre-recorded training sessions to an audience, which includes pilots and other participants. With high-resolution video or full-motion computer graphics sourced from real-time “image generators,” these videowalls simultaneously display views from each vehicle in an exercise. The videowall provides a cohesive overview of participant interaction in the simulation.

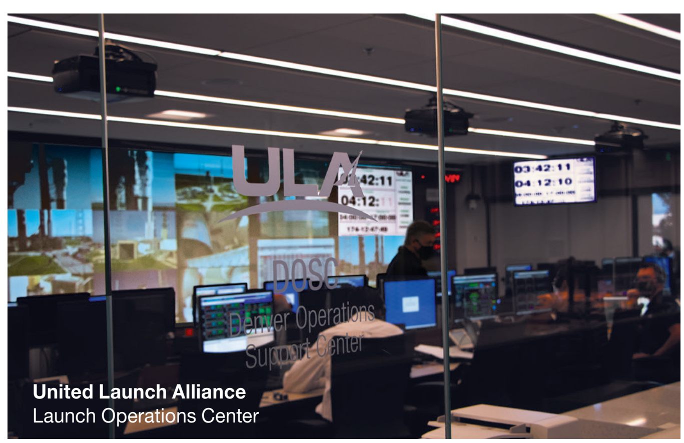
Projectors with edge blending and 4K projectors are the typical display devices of choice. They can present large images with minimal or no seams. Videowall processors in these applications must be capable of maintaining real-time motion for all image sources and provide very high scaling quality to ensure the videowall accurately portrays the visual information from the session.

Security and Traffic Management

Security and traffic management centers may be found in corporate or university campuses, public safety venues, and government agencies. Videowalls in these environments display maps, data screens, and large numbers of video or IP camera feeds. Attention can be drawn to a critical event by magnifying an individual feed as a large, centrally located image on the videowall. Supporting information can surround it. The capability to simultaneously present large quantities of video sources is a crucial feature for these systems.

Emergency Operations Centers

An emergency operations center - EOC is a facility often run by a national or regional government, as well as public safety organizations. Videowalls in an EOC allow staff to monitor critical situations by displaying news broadcasts, graphical maps, and computer sources that provide the location and status of real-time regional or international events. Videowall



United Launch Alliance
Launch Operations Center

Videowalls deliver high-quality, mission-critical content to a team of engineers relying on unwavering accuracy to make critical decisions

Where are Videowalls Used?

Videowalls in Network Operation Centers provide a shared display for monitoring, control, and management of complex networking environments

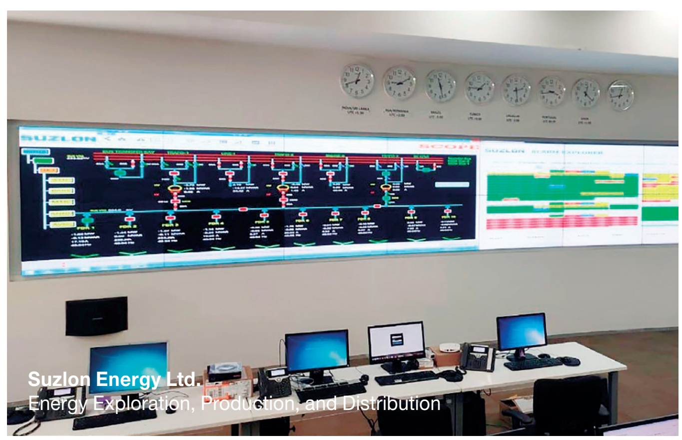
processors used in EOCs must be capable of simultaneously presenting a variety of source formats. These can include standard video, high-resolution video, computer-generated graphics, animation based on probable outcomes, and locally stored images such as maps and building blueprints.

Network Operations Centers

Network operations centers - NOCs perform monitoring, control, and management of complex networking environments for telecommunication companies, business organizations, and government agencies. NOC personnel are responsible for monitoring one to many networks for certain conditions that may require special attention to avoid service degradation. NOC videowalls typically show details of alarms, ongoing incidents, and general performance of the network. They frequently include display systems with thin to no seams, so that the detailed graphical system data is presented clearly as it spans several displays.

Energy Exploration, Production, and Distribution

Private and public utility providers, refineries, and energy exploration organizations employ videowalls for collaborative



Videowalls aid in collaborative analysis of system data

analysis of system data by team members. Operators rely on the videowall display for timely, accurate information to manage, troubleshoot, and track facility, system, and component performance. The videowalls typically display specialized software applications for supervisory control and data acquisition - SCADA systems, presenting data as well as charts, plots, and other graphical information. For example, a solar utility company can use the videowall to compare sites for a new wind farm or discover turbine and windmill

Videowalls in corporate conference rooms enhance presentations that incorporate a mix of diverse sources.

placement to take best advantage of the topography and prevailing breeze.

Corporate Conference Rooms

Videowalls are used in corporate conference rooms to simultaneously display multiple sources of various formats on a small number of displays. They support presentations and training sessions that utilize computer and video sources. Rear-projection systems are sometimes used, configured with two to four projected images and edge-blended into a seamless display.

Public Spaces

Educational Institutions

The collaborative, information-sharing nature of videowalls make them a natural fit in educational institutions. Videowalls can be found in classrooms and labs, allowing teachers to display lesson materials that can include computer, broadcast, and camera feeds on a common visual workspace. Even outside the classroom, schools and universities incorporate videowalls in cafeterias and student union for entertainment and promoting campus activities

The flexibility to display lesson materials and live content in any window arrangement aids instruction and keeps students engaged

and events. They can also present news, weather, and other information relevant to the area.

Corporate Lobbies

The corporate lobby of a technology-based firm is a popular location for a videowall. The stylish video display becomes a reflection of both the creativity and innovation that exists beyond the waiting area. Corporate videos highlighting an organization's products or services, news, and personalized

Where are Videowalls Used?

A corporate lobby is a popular location for a videowall as a stylish video display for welcoming visitors and delivering impact.

images welcoming specific customers are commonly seen on the videowall. Flat-panel LCDs or compact modular tile arrays are popular choices for videowall systems due to their bright images and modern styling. Short viewing distances dictate that the videowall processing delivers very high-quality images, even when the source content is scaled above or below its original resolution.

Cinema and Television

For decades, videowalls have been a mainstay in the television and film industries. This includes their prominent use as local and cable news set pieces that enable news anchors to interact with field reporters or present informational graphics or pre-recorded content. In films, a videowall can fulfill the needs for a vast array of realistic to surreal situations. They can be in the background of a scene or the central focus. For example, a videowall can be behind dancers in a nightclub to add atmosphere or it can be the key element in a command center used by the military to decide how to combat a rampaging monster or an alien attack. More recently, videowalls have replaced physical sets. They provide a full-motion backdrop rendered by powerful real-time graphic engines that eliminate the need for green screen effects. The videowall enables the actors to see and realistically interact with their environment and on-screen objects. They also streamline production and post-production, facilitating more efficient and cost-effective shooting and editing schedules.

Public Signage and Retail

Video-based public signage is used in retail environments and other public venues, including train and subway stations, airports, and other locations where content is visible to large numbers of people. Content is often sourced from solid-state video players, periodically updated across a media network, or from devices that receive IP video streams. Flat-panel LCD displays are popular for these videowalls. The ability to produce a high-quality image is important for videowall processing in public signage applications, as images are magnified to large sizes. Cost efficiency is critical for public signage systems.

Houses of Worship

Videowalls are used by large houses of worship to present media to their congregations. The appearance of these

A videowall in a restaurant or bar provides a convenient, single large display for simultaneous access to several channels of TV programming for customers.

displays is more of a continuous projection display than a tiled system. During services, videowalls typically present camera feeds, video or graphic content supporting the day's teachings, hymn music and lyrics, video of recent events or content streamed from remote worship facilities. The services are similar to other large-scale live events, in that production teams manage audio and video engineering tasks. This includes videowall control. Videowalls in houses of worship usually employ small numbers of front projectors to achieve sufficient image magnification. Videowall processors in these applications must maintain high image quality when sources are scaled for large screen sizes.

Sports Arenas

Videowalls are used in sports arenas in many different ways throughout concourses and public areas. Historically, they have been used in scoreboards to display large video instant replay, as well as computer-generated animations from the facility's production booth. They are increasingly used for digital signage and have become an integral part of the facility experience. LCD panels are often used for indoor displays, while direct-view LED systems are a popular choice for outdoor venues due to their very high brightness. The videowall processor must be capable of delivering high integrity video images, and also respond quickly to user control to keep up with the fast-changing pace of the event.

Bars and Restaurants

In bars and restaurants, videowalls are often used to display multiple high definition video sources. Large numbers of satellite or cable television signals are used as source inputs to the videowall. They are commonly presented in a window layout with a single, large window for the most prominent broadcast and several smaller windows displaying other events. The bartender or manager has the ability to switch the TV channel for any window or recall a different window layout, often using a touchpanel. Flat-panel LCD displays are frequently selected for their capability to display bright images with high contrast. The videowall processor must be cost-effective, but also maintain real-time performance while displaying multiple high-resolution video sources.

Why a Videowall?

A videowall typically requires a significant investment and is often the most expensive line item in a facility's capital outlay for an AV project. While the videowall functions as a single display, it is always important to remember that it is a system.

Videowall processors are a significant component of the videowall in terms of cost. They provide features common to conventional scalers or video signal processors but have greater input, output, and processing capability. The increased number of inputs and outputs creates diverse requirements for processing and image enhancements, providing greater value.

Because of the investment necessary to acquire and install a videowall, an inexperienced designer may be tempted to seek an alternative means of presenting large images or multiple sources simultaneously. This could include increasing picture size from a single projector, using conventional signal switching and distribution in place of a videowall processor or installing independent LCD panels on a wall instead of an integrated videowall array. However, videowalls have several distinct attributes and advantages. The image display capability and flexibility of a videowall simply cannot be duplicated.

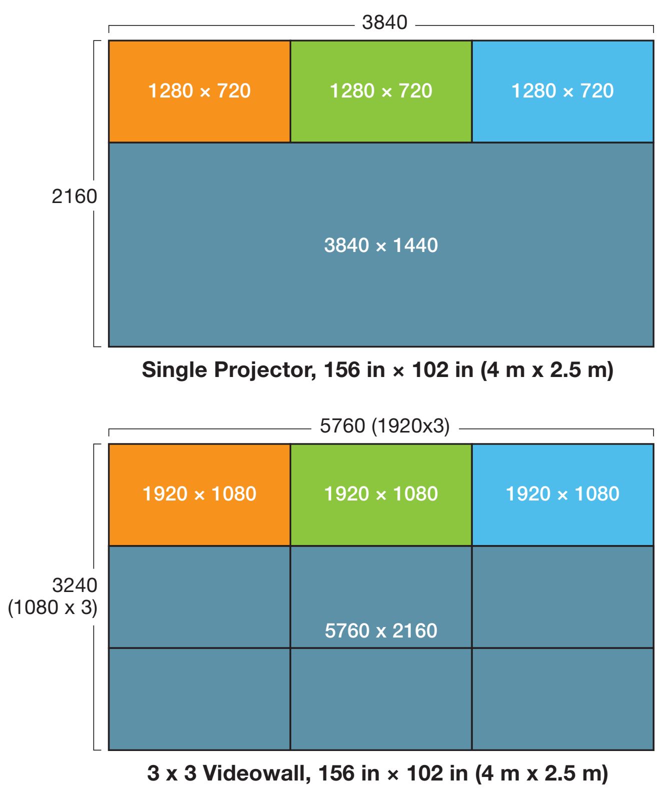


Figure 1-1. Videowall images of identical size, produced by a single projector and a 3x3 array of flat-panel displays

High Pixel Density

Pixel density is the number of pixels per unit area and is determined by the resolution and screen size of a display. When a single projected image is enlarged, pixel density decreases. With a videowall, pixel density is constant regardless of the array size because it is based on the individual display device. Enlarging the array increases the overall resolution of the videowall. A videowall usually delivers much higher pixel density than a projected image of the same size. An image can be upscaled for enlargement on a videowall so that it fills up the array without compromising picture quality. In contrast, significantly enlarging an image from a projector reduces apparent brightness, resolution and image quality.

Images that occupy large viewing areas need sufficient resolution or pixel density in order to present clear and legible content. Figure 1-1 illustrates two images of equal size. One is from a single 4K projector fed by a multi-window processor and the other a 3x3 videowall with 1080p panels via a videowall processor. Both are presenting the same content and layout for displaying multiple high-definition input sources. The videowall presents the sources with twice as many pixels when compared to the single projected image. This increased resolution, resulting from a higher pixel density, enables presentation of a row of three 1080p video sources at full resolution, compared to just 1280x720 per image for the single display.

Creativity with Display Shapes and Sizes

A videowall is created by "tiling" multiple display devices together. By tiling displays, videowalls of any size and aspect ratio can be constructed in very creative ways. Its canvas layout never has to be limited to the standard aspect ratios of single displays. Displays in a videowall can be oriented horizontally, vertically, or even a combination of both, further enhancing the creative possibilities.

Small Footprint

A front projector usually requires significant throw distance to produce an image that fills up a substantial portion of a wall. Practical throw distance may limit the number of allowable participants in the room without blocking the projected image. This is true even when special wide-angle lenses are used. Videowalls comprised of flat panels, LED panels, or projection cubes occupy a compact footprint due to each display's fixed depth. This depth remains constant no matter how large the videowall canvas may be. A display array of any size shares the same depth of a single display device. See Figure 1-2.

Consistent Brightness and Contrast

A bright, clear image is crucial for a video display. Whether being viewed by a workforce interpreting on-screen information or by customers casually glancing at digital signage in a retail environment, images must be sufficiently bright so that content is clear and easy to decipher.

Videowalls present viewers with consistently bright, inviting images, regardless of size. While a single projector loses brightness and contrast as image size increases, there is no reduction in either as more displays are added to a videowall. A videowall with 40 screens is just as bright as a videowall with four screens, with consistent contrast delivering deep, rich blacks even in the highest ambient light environments.

Show More Images on Fewer Displays

Most flat panels have internal scalers that allow a single image to be stretched across a tiled array. This may be suitable for applications that only use videowalls for displaying a single, large image. For applications requiring simultaneous presentation of multiple image sources, a simple solution is to feed sources directly to individual displays in the videowall. A switcher, distribution amplifier, or matrix switcher can be used to provide some flexibility in distributing signals to the displays.

However, with this solution, the number of sources that can be presented is limited by the number of displays in the videowall. For example, a 2x2 videowall with a matrix switcher allows for simultaneous display of only four image sources.

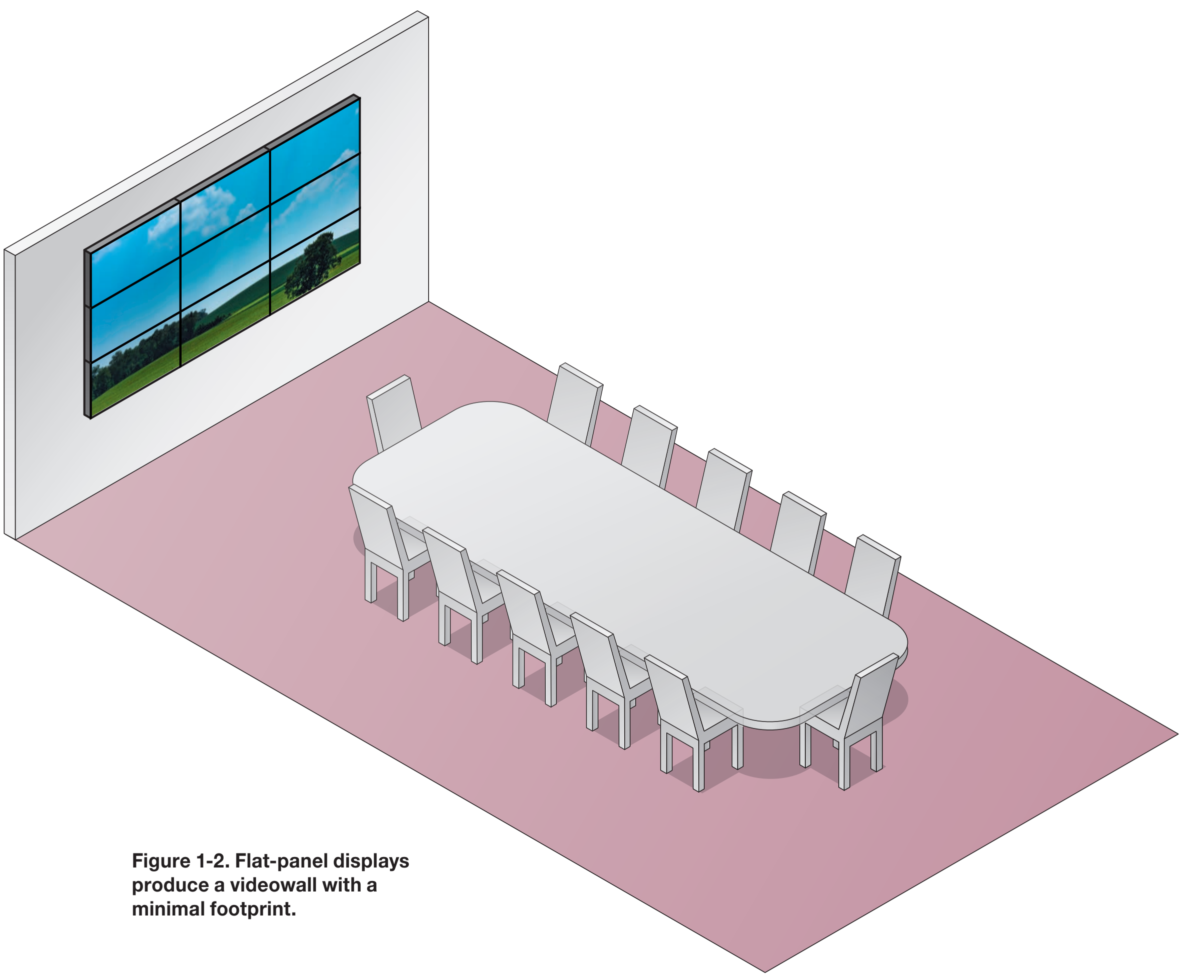
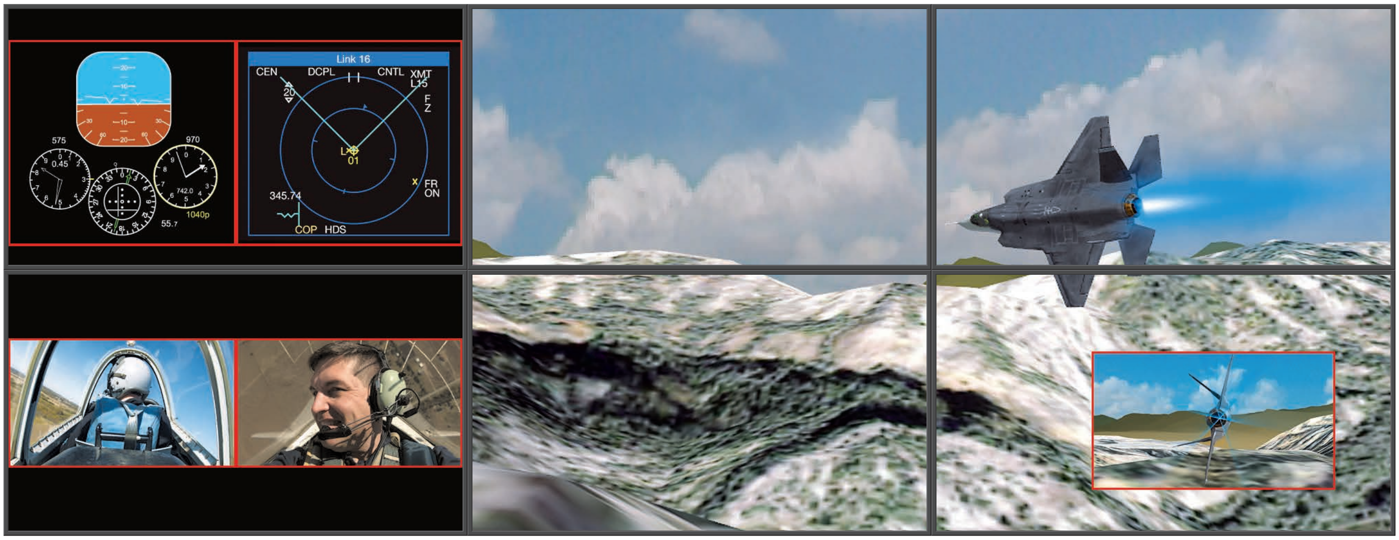


Figure 1-2. Flat-panel displays produce a videowall with a minimal footprint.

Why a Videowall?



Aircraft images from Analytical Graphics, Inc. - www.stk.com

Figure 1-3. Sources of various formats and resolutions can be combined on a videowall.

A videowall processor is a far more versatile and powerful solution. It provides the flexibility to present multiple sources on fewer screens by allowing a user to display multiple source windows on each display. Windows can always be sized and positioned as necessary to accommodate the number of images to be presented.

Mixed Source Resolutions and Formats

A videowall processor accepts and processes multiple signal formats, such as computer graphics and high-resolution video, so they can be displayed simultaneously. Each source can be displayed on any part of the overall canvas, and many different source types can be displayed within a single screen. See Figure 1-3. The ability to "mix and match" signal formats for simultaneous viewing can be a crucial factor for workflows that rely on a variety of visual data sources. Also, a processor provides the flexibility to determine how they should be positioned or grouped together.

Simplified Display Setup

Videowall processors deliver a consistent output signal format, eliminating the need to save unique input adjustments such as size, position, or phase for different signal types on each display. Managing multiple input formats across a common output format simplifies integration. The displays need only be configured for one resolution and refresh rate. Driving the display at its native resolution maintains the best quality image, avoiding inefficient or unnecessary scaling within the display.

High-Quality Image Processing

Videowall processors typically provide better image scaling quality than a display's internal scaler. This can be clearly visible when magnifying images for arrays larger than 2x2 or when high resolution images are downscaled. The latter is particularly important when single-pixel details and lines in graphs, data screens, and camera feeds need to be discernible, despite the smaller image sizes.

Flexibility in Customizing Presentations

A videowall processor provides full flexibility to customize presentations by adding, sizing, and placing windows. It also facilitates assigning input sources to them. Any window can be as small as desired or as large as the entire videowall. Additionally, windows can be layered over each other.

Videowall processing automatically optimizes the input source to the size of the selected window or windows. Many more enhancements are available, including window borders and captions, live backgrounds from a source input, and maps, logos, or other graphics stored on the processor for use as static backgrounds. A videowall processor lets the user precisely define the look and style of the presentation and allows window layouts to be created, saved, and recalled.

Reasons to Learn More

A videowall is ideal for applications requiring presentation of a large image as well as multiple images from multiple sources. They provide flexible image layout options while maintaining the best possible picture quality. However, engineering a videowall can be challenging. A wide range of design factors must be carefully considered, many of which are specific to videowall applications.

Videowalls – More than Just Displays

A common approach to videowall system design is to first specify the display devices and then consider other system components as supporting elements. Unfortunately, this approach can overlook many critical aspects of a successful videowall design. While display devices are important, they only represent a single component of the system.

Extron Videowall Systems Design Guide

This guide is a comprehensive resource for evaluating, planning, and successfully deploying videowall system designs. The sections that follow cover a broad range of considerations, all of which are important to videowalls:

- **Needs assessment:** Any videowall design requires clear knowledge of the application's intended purpose. Selecting the right products requires an understanding of exactly how the videowall will be used.

- **Environmental factors and ergonomics:** Videowall designs should include considerations for human interaction. It is important to account for lighting conditions, seating positions, physical obstructions, and other factors to ensure comfortable viewing and legibility of content.

- **Determining videowall shape, size, and pixel density:** The application, layout of the room, and the type and arrangement of content on the videowall influences its general size and shape. How close viewers will be to the screens dictates pixel density.

- **Videowall display selection:** With knowledge of the videowall size, shape, and pixel density, you can select the display model and technology, finalizing the videowall configuration.

- **Videowall processing:** Videowall processors are equally as important as the displays. However, they vary greatly in features, capabilities, and price. This guide's detailed information helps you decide on the best solution.

- Videowall processor architecture: Videowall processing is available as a single, centralized unit or distributed among modular units connected to sources and displays.

- Videowall processor platforms: Processors can be based on computer technologies, standalone video processing appliances, or a combination of the two.

- Videowall processing features: Scaling performance, window customization options, output rotation, and edge blending for projectors are among the many available features.

- System control: The system must be easy to operate and respond quickly to user commands without being slowed by image processing tasks.

- Supporting system elements: Videowall systems may include matrix switching, signal extension over fiber and twisted pair, streaming content over IP, and more. ■

A successful videowall design accounts for environmental and human factors as well as products and technologies.

Significant Investments

Videowall systems are a significant investment; the cost adds up quickly with displays, videowall processing, control, distribution equipment, and sources. Requirements should be given serious consideration. This is particularly true of the processing system, which can apply unique, sophisticated technology to enable custom multi-window presentations.

For many individuals, videowalls are unfamiliar technology and it can be very easy to become preoccupied with new technology and flashy capabilities. They may dismiss videowalls altogether and focus on simpler, less expensive system designs. The capital investment for AV systems nearly always faces heavy scrutiny, so it is important to identify and validate the videowall system requirements for every project.

The Common Law of Business, credited to the Victorian era poet, art, and social critic John Ruskin, highlights an important point to remember when selecting videowall system elements. It underscores the value of conducting a thorough needs assessment when evaluating any significant technology investment:

"It's unwise to pay too much, but it's worse to pay too little. When you pay too much, you lose a little money — that is all. When you pay too little, you sometimes lose everything because the thing you bought was incapable of doing the thing it was bought to do. The common law of business balance prohibits paying a little and getting a lot — it can't be done. If you deal with the lowest bidder, it is well to add something for the risk you run, and if you do that, you will have enough to pay for something better."

A thorough needs assessment helps clarify core requirements and identifies inadequate or non-essential technology. It can help you avoid paying too little and ending up with a system that is not as effective as intended.

Start with the Basics

When establishing requirements for a videowall with an end user, begin with the fundamental questions:

- What is the name and location of the site?
- What type of environment is this site?
- What is the overall purpose of the videowall?
- What are the intended applications for the videowall within this environment?

As mentioned earlier, different applications and environments have different requirements for videowall capabilities and performance.

Duty Cycle

Inquire about the intended operational schedule for the videowall system. Will it be used for short duration events and periodic presentations, a 40-hour weekly schedule, or a 24/7 operating cycle? This helps define the requirements for system reliability and maintenance.

Scale and Scope

Once the intended use and operating schedule have been established, more technical requirements can be determined by asking the following questions:

- What type of visual information will be presented on the displays? Video productions, live news broadcasts, data screens, complex data visualizations, videoconferencing, security camera feeds, or collaboration data from other enterprise operations or agencies?

- How much information will be presented? Are there tens or hundreds of video, data, and graphic information sources?

- Will there be HD, 4K, or even higher resolution source devices with HDCP-encrypted outputs, such as Blu-ray Disc players and digital cable or satellite receivers?

- How should the information be presented? Will only one or a few images be presented at a time, or must the system be capable of presenting many sources at the same time and in a variety of combinations?

- How much display area is available or envisioned to be used for the videowall?

- What type of display technology may be used in this application – front projection, rear projection, LCD panels, LED, or another technology? The selection of display technology can be driven by the physical space available, the type of information to be displayed, and the sizes at which images must be presented.

- How much space is available in front or at the rear of the display for access and maintenance?

- Will the sources be local to the videowall processor, in a centralized rack, or situated throughout the site? Are there any sources to be integrated from outside the facility?

- Is there an equipment closet or designated location for the videowall processor, sources, and other AV equipment, and what are the anticipated space limitations for installing them?

- What type of user control interface will be required for operating the videowall? Is the operator going to be a trained AV technician or general staff member?

- If the installation is in a government agency or a company contracted with the government, will secure content be presented on the videowall?

- Will copyrighted material be presented in a public area?

Answers to these questions help you determine the most basic system requirements. However, many more environmental and operational considerations can affect the selection of technologies for a videowall. ■

The quantity and layout of source windows will vary depending on the application and environment.

Environmental Considerations & Human Factors

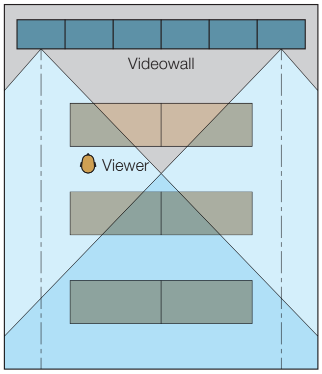
The ability to present clear, high-quality imagery from multiple sources and at large sizes makes videowalls valuable for maintaining situational awareness. Videowalls enable mission-critical information to be presented in working environments, such as a control center. In public spaces, videowalls can deliver visual impact and effective messaging for entertainment and promotional purposes. A videowall should be properly integrated into its physical environment and be engineered for efficient, ergonomic use.

To properly determine which display technology and specifications are best for a given installation, physical and operational dynamics must be considered as part of a complete AV system design. Ignoring the environmental and operational requirements can lead to less-than-optimal results for a high-value videowall, in what could otherwise be an outstanding system design.

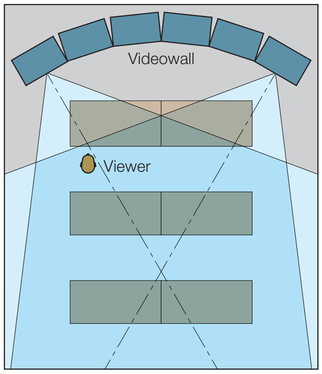
Many environmental and human factors, as well as ergonomic engineering essentials, seem obvious when considered after the fact. Unfortunately, AV designers are often not involved early enough in a project's life cycle to prevent all possible shortcomings regarding these important details. Preparation of two-dimensional plans and section drawings are essential. They allow review of the physical considerations for the environment. Visualizations in 3D, such as in Figure 2-1, can also be valuable for pointing out environmental concerns to end users and project stakeholders with limited experience in videowall applications.

An effectively designed videowall system, with proper consideration for environmental and human factors, ensures viewing comfort and optimal accessibility for everyone in the room. This, in turn, helps to maximize the value and effectiveness of the videowall in conveying visual information.

Figure 2-1. A 3D perspective rendering can be valuable when considering environmental and human factors for a videowall.



Wide viewing angles result in lower display brightness.



Curving displays improves the viewing angle and brightness.

Figure 2-2. Adding curvature to the videowall can help optimize viewing angles.

A great deal of government, academic, and commercial research has been conducted in the area of human factors and ergonomic design for control centers. The ISO has published standard 11064-1:2000 for the ergonomic design of control centers, and the US military has established standards for human engineering that address the use of visual displays.

The human factors and environmental considerations presented here are specific to videowalls for control rooms. However, the same concepts can be applied to a wide variety of other environments.

Viewing Locations

It is essential that all the intended users can easily view the videowall. When evaluating horizontal and vertical viewing angles, ask the following questions:

- Where are the primary viewers situated relative to the videowall?
- Are there any secondary viewing locations for individuals not directly engaged with the display? Examples of secondary viewing locations include viewing galleries or management offices.
- Are there any physical barriers that could obstruct the videowall for some users?

In large rooms, such as a control center, viewing locations vary greatly. It is important to evaluate viewing angles in both the vertical and horizontal planes. If physical barriers are identified,

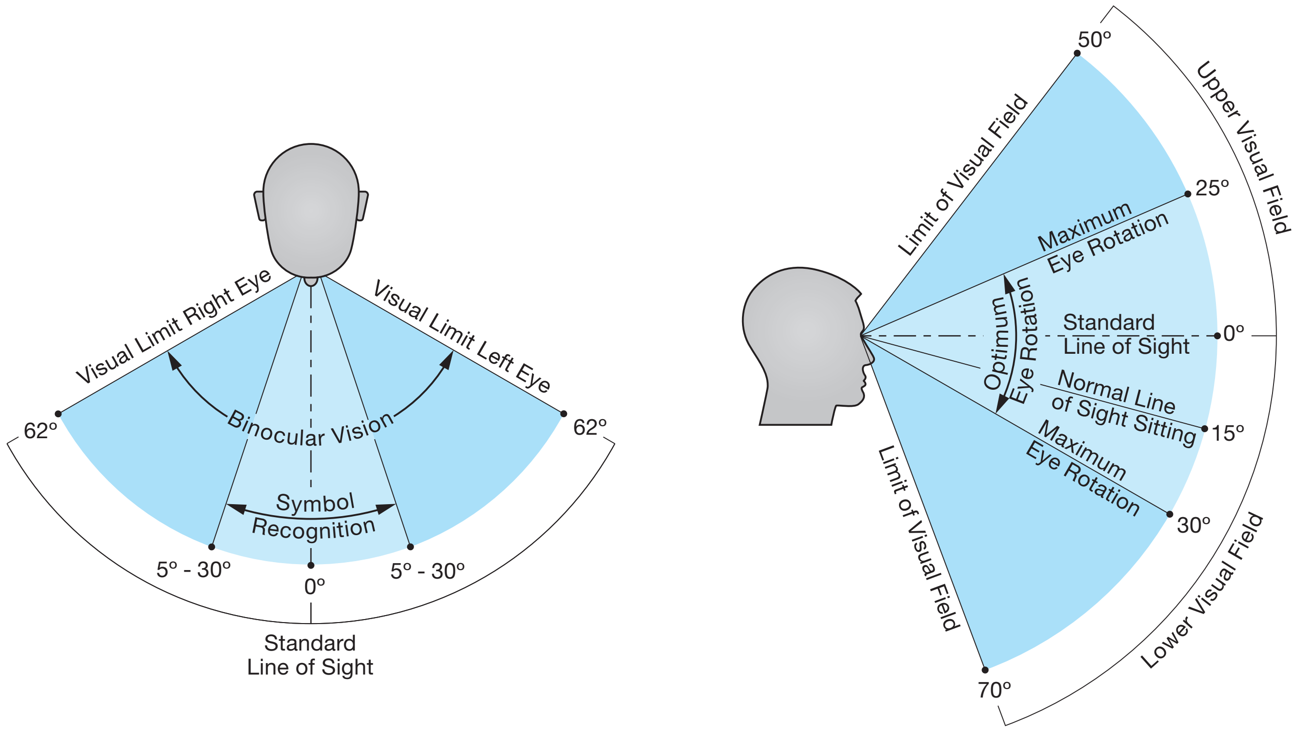


Figure 2-3. Field of vision and recommended head tilt and eye rotation angles

additional displays may be required to expand the videowall. Alternatively, extra localized displays may be necessary. Some environments may require that the videowall be split into smaller systems to sufficiently cover all viewing areas. In other cases, adding curvature to the videowall layout improves viewing coverage, as illustrated in Figure 2-2.

Eye and Head Tilt

In control rooms, operators typically manage tasks using one or more local displays while monitoring content on a videowall positioned beyond their workstation. Eye and head tilt between the workstation and the videowall should be compared against recommended human engineering standards for visual field of view, eye rotation, and head tilt. Proper consideration for eye and head tilt ensures comfortable viewing for users as they alternate between their workstation displays and the videowall. This analysis should always be performed for control rooms, whether information is to be presented on a videowall, individual wall-mounted displays, or a large screen. See Figures 2-3 and 2-4.

A similar field of vision, eye rotation, and head tilt analysis should be applied when a videowall is designed into a public or entertainment venue. Use of personal displays is not a

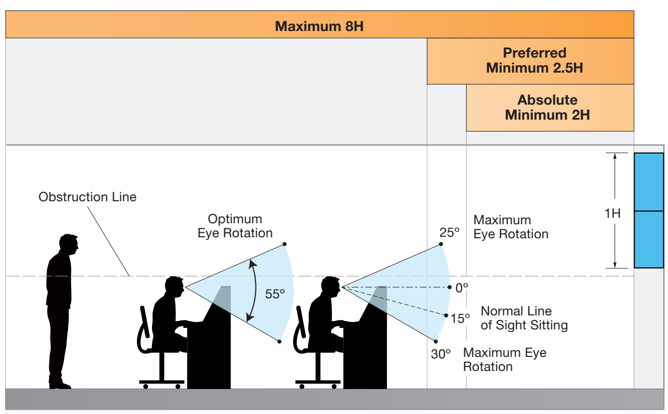


Figure 2-4. Eye and head tilt from workstation to display

consideration in this situation, but the design must offer comfortable viewing from seated or standing positions.

Display Size and Legibility

Viewing distance drives the minimum requirements for display dimensions and the size of individual image windows. It is also critical when considering the display resolution and pixel density of information presented on the displays, as well as the sizes of characters and symbols. Display size and legibility of content are examined further in later sections of this guide.

The Physiology of Color Vision

When preparing content to be presented on a videowall, it is important to have a basic understanding of human vision and the physiology of color. Proper use of color can enhance a viewer's ability to interpret data, while improper use of color can result in eye strain. Text, data, or visual symbols should appear over a background using a complementary color. See Figure 2-5.

Display Brightness

Images produced by videowalls must be sufficiently bright so that they can be clearly visible. Today, many work areas with videowalls employ lighting designs that produce an abundance of ambient light and may include outdoor windows that contribute natural light. Fortunately, advancements in lamps and LED illumination sources have made LCD panels, projection cubes, and high brightness projectors suitable for use in bright ambient-light environments. Direct-view LED panels are also capable of displaying extremely bright images, easily visible in brightly-lit environments, including outdoors.

Display technologies continue to evolve, offering improvements in brightness, resolution, contrast, form factor, power consumption, and cost efficiency. Whatever display technology is under consideration, it is always important to use professional methods for defining display brightness requirements, including under ambient light conditions.

Ambient lighting conditions are determined in terms of illuminance, which is a measurement of all light sources illuminating a point on a surface. Illuminance is measured in lux - lx, equivalent to lumens per square meter - lm/m2. Wherever possible, determine the ambient lighting for a site by referring to the facility's lighting design specifications or personally taking measurements once the lighting has been integrated. Table 2-1 lists typical illuminances for various environments.

Illuminance calculations are regularly prepared when planning front projection systems. The illuminance produced by a projector can be calculated by dividing the projector's ANSI lumens output by the screen's surface area in square meters. The result can then be compared with the ambient light levels in the room. A projector's light output in ANSI lumens is usually listed under "Brightness" in projector specifications.

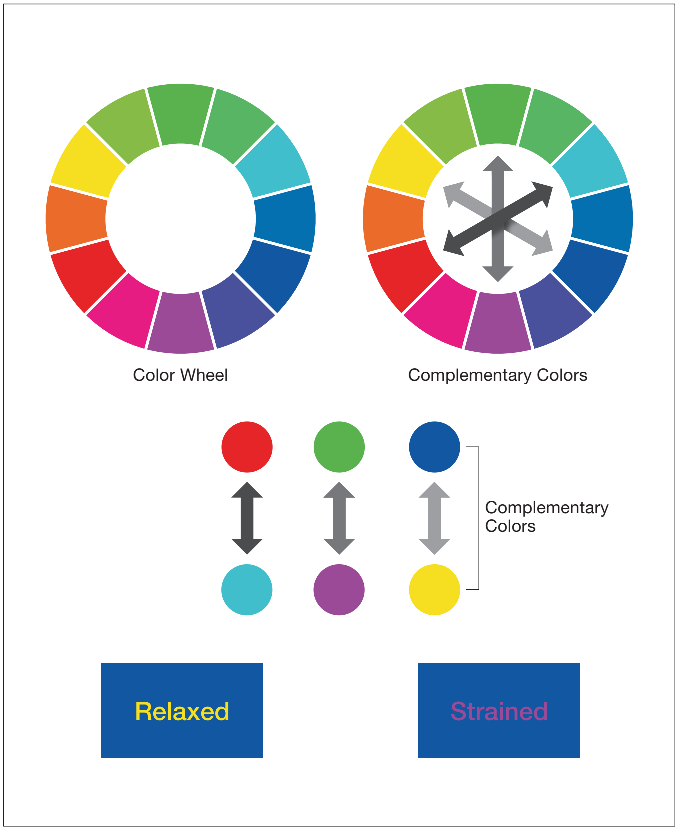


Figure 2-5. The human physiology of color vision requires careful selection of color combinations presented on displays.

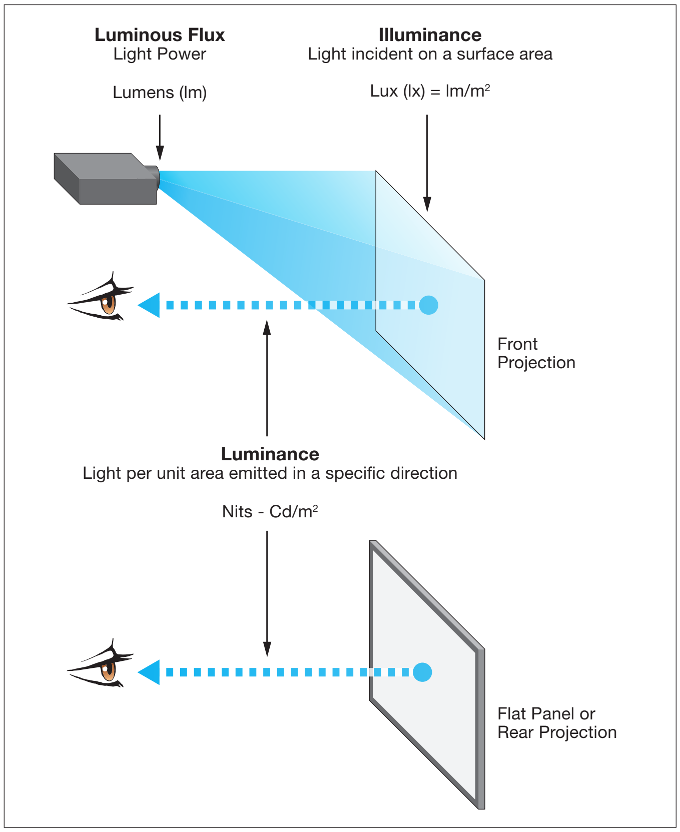


Figure 2-6. Illuminance and luminance

Flat panels, LED panels, and projection cubes also identify luminance values as "Brightness" in their specifications. However, they are quantified as nits or candelas per square meter - cd/m^2. Luminance describes the amount of light leaving a surface in a specific direction. See Figure 2-6. In terms of measurement, one cd/m^2 is the equivalent of one lux at a defined direction. Specifications of brightness or luminance for flat panels or projection cubes identify values that are on-axis or directly perpendicular to the screen. Luminance values between 300 and 1,000 nits provide adequate brightness in control room as well as office environments.

Projection cubes that have been designed with diagonal screen sizes beyond 80 inches (200 cm), or those that have been engineered to offer extended lamp life may have specified luminance values below 300 nits. Use of these displays requires greater attention to ambient light conditions and lighting designs. Table 2-2 lists typical luminance ranges for various display types. On-axis luminance is determined by measuring or calculating the illuminance – projector ANSI lumens divided by screen area, and then multiplying this result by the gain of the projection screen. Projection cube specifications usually identify the horizontal and vertical viewing angles at which the luminance will be one half or a lower percentage relative to the on-axis value.

Rear projection screens with high gain typically yield lower luminance values at off-axis viewing angles. This reduction in brightness helps to illustrate the significance of the direction of light for luminance. For large-screen rear projection, system designs must include proper specifications for projector ANSI lumens, screen size, and screen gain to ensure sufficient luminance within the ambient lighting conditions of the environment.

Some display manufacturers continue to list illuminance and luminance specifications or calculations based on English standard units using square feet rather than square meters. Conversion factors from lux and nits to foot-candles and foot-lamberts are listed in Table 2-3.

Display Contrast

In addition to brightness, videowall displays must offer sufficient contrast, so viewers can easily distinguish text, data, symbols, and visual details in video or graphic images. A

ENVIRONMENT	TYPICAL ILLUMINANCE
Bright sunlight	110,000 lux
Shaded area on a bright day	25,000 lux
Task lighting	1,500 lux
Office lighting	500 - 750 lux
Control room	300 - 750 lux
Theaters	150 lux
Parking lot lighting	10 lux
Moonlight	0.1 lux

Table 2-1. Typical illuminance levels in various environments

DISPLAY	TYPICAL LUMINANCE
LED displays	2000 - 14,000 nits
Rear projection cubes	300 - 1,000 nits
LCD screen	450 - 700 nits
Laptop screen	150 - 250 nits
Cinema screen	40 - 60 nits

Table 2-2. Typical luminance ranges for various display types

MEASUREMENT	METRIC MEASUREMENT	ENGLISH STANDARD MEASUREMENT	METRIC TO ENGLISH	ENGLISH TO METRIC
Illuminance	Lux	Foot-candle (ft-c)	Lux x 10.764	ft-c / 10.764
Luminance	Nit or candela/m^2	Foot-lambert (ft-L)	Nit x 3.426	ft-l / 3.426

Table 2-3. Conversion factors for brightness values derived from metric and English standard measurements

display's contrast ratio describes the dynamic range it offers for presenting imagery, from deep blacks to peak whites. Contrast ratio is a measure of the ratio between the brightest and the darkest luminance values produced by the display. Higher contrast ratios are commonly associated with greater subjective picture quality.

High brightness contributes to a higher contrast ratio by increasing the white measurement. However, producing very high contrast ratios requires even greater attention to reducing dark values. For product specifications, contrast ratio is based on measurements taken in a completely dark room. Unless the display is to be used in a similarly darkened environment, contrast ratio product specifications should not be factored too heavily when comparing products. The standard method for determining contrast ratio is illustrated in Figure 2-7.

Many direct-view flat panels include high contrast surfaces to disperse incident light and reduce reflections on the screen. Content frequently appears better when formatted with bright or white backgrounds and dark characters or symbols. Both types of formatting work well for projection cubes.

Front and rear-projection screens include various coatings or tinting to diffuse incident light and improve contrast. In control rooms with projection systems, contrast is frequently optimized by formatting data and graphic content with dark backgrounds and bright characters or symbols and maintaining low ambient light conditions.

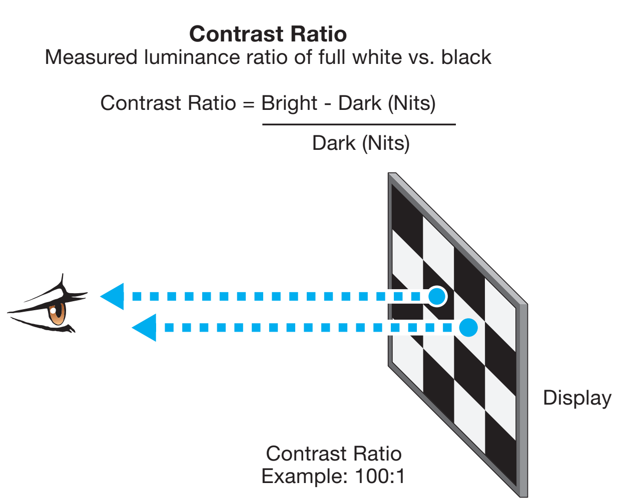


Figure 2-7. Display contrast ratio

In 2011, InfoComm International published the ANSI/INFOCOMM 3M-2011 Projected Image System Contrast Ratio standard for contrast ratios of projected images for different viewing applications. The following recommendations were established: a minimum contrast ratio of 7:1 for images produced purely for informational purposes, at least 15:1 for basic decision-making, 50:1 for critical decision-making, and 80:1 for presentation of full-motion video content.

The introduction of the 15:1 ratio for basic decision-making resulted in notable industry feedback, considering that a contrast ratio of 10:1 had been applied as a rule of thumb by industry professionals for many years. Nevertheless, the economic and environmental factors encountered on every project produces challenges that may or may not support attaining these standards.

Brightness and contrast can be objectively determined with light meters, but in the end, customer satisfaction can be purely subjective. A best practice for visually evaluating a display's brightness and contrast is to go to the actual facility and view content similar to the type and quality to be shown. If this is not possible, view the content under comparable environmental conditions.

Ambient Lighting

Ambient lighting conditions impact the resulting contrast or how images appear under actual lighting conditions. Excessive lighting in a room conflicts with the displays, reducing contrast and making the image appear "washed out" and difficult to view.

The following best practices address the impact of lighting on AV systems in control centers:

- Control ambient brightness throughout the room, minimizing it wherever not essential to human activity.
- Use directional overhead spotlights where possible to keep lighting away from the videowall.
- Incorporate individualized task lighting for workstations, rather than relying on lighting fixtures which apply broad coverage throughout a room.

Figure 2-8. Walls surrounding a videowall should not distract viewers from the display system, clocks, or other status indicators.

Figure 2-9. Furniture and consoles may be customized for specific team workflow or operational requirements.

The following should be avoided:

- Placement of ceiling lights in close proximity to displays; light may spill onto the screen surfaces.

- Untreated windows directly facing a videowall display, particularly those with a southerly exposure.

Note: In northern latitudes, there have been instances of poor planning for ambient lighting conditions. Specifically, these have been for corporate lobby videowall installations that face banks of windows with a southerly exposure. During afternoon hours in winter months, light from the sun can fall directly onto the videowall displays, significantly reducing the effective contrast.

Wall and Room Treatments

Walls surrounding a videowall should be visually neutral to avoid distracting from the information presented on the displays. See Figure 2-8 as an example. Wall surfaces should have matte finishes and be pattern-free, without windows, open doorways, and other visual distractions whenever possible. Similarly, ceilings, floors, and facing walls should have matte or non-reflective finishes. Walls should be void of windows and other reflective surfaces, which can result in light falling onto the videowall displays. Wherever windows cannot be avoided, shades and tinting can be used to reduce the impact of natural light. Acoustic treatments may also be required to control sonic reflections, ensuring a quiet environment for subdued conversations.

Clocks and Status Indicators

Control rooms, sales or trading floors, and other working environments with videowalls often use world time-zone clocks or system status indicators, such as those which display security conditions. See Figure 2-8. This information may be presented on the videowall, specialized fixtures, or auxiliary displays.

Furniture and Personal Environment Management

Furniture and consoles used in command and control centers are available in standard designs that support many different workflows. They can be customized, facilitating specific working conditions and environments. See Figure 2-9. Their design may include motorized height settings, highly adjustable seats, task lighting, localized white noise, or local airflow and temperature control for users working in 24/7 operations.

Entry Management and Security

Control rooms and facilities with high-impact displays may have controlled visibility or access for security reasons or to enhance the visitor experience. For example, an executive presentation room may double as a viewing gallery, with motorized shades or controllable privacy glass to expose an adjoining control room. When used for customer demonstrations or promotional applications, a control room may incorporate a special entryway that includes lighting and AV effects to help shape the visitors' state-of-mind before they enter the space. This approach is similar to the use of pre-shows in theme park attractions.

Planning Ahead for Effective Videowalls

All of these human factors and environmental considerations can have a significant impact on the effectiveness of a videowall display system. The earlier an AV designer participates in the facility design, the greater the likelihood these elements are successfully addressed. ■

Choosing the Right Videowall Shape and Size

Deciding how large a videowall should be is more than a matter of determining how many display devices are required to fill the designated space. The manner in which the videowall will be used, the types and quantity of information to be presented, and the size and shape of the room should be considered before selecting the display type and quantity. A videowall in a public setting for digital signage has far different physical requirements than a videowall in a command and control center.

Determining the Shape or Aspect Ratio

When specifying a videowall system, a design engineer has the flexibility to define a specific layout for the displays. Videowalls of two screens high by four screens wide, three screens high by four screens wide, or four screens high by four screens wide are common. However, each of these arrangements results in a different overall aspect ratio. The videowall is defined by the layout of the screens as well as the aspect ratio of the individual display devices. They may also have creative shapes with no defined aspect ratio.

What is the “best” shape or aspect ratio for a videowall? If the objective is to make the videowall as large as possible, then its shape is driven by the layout of the room. A shallow, wide room with a low ceiling necessitates a short, wide videowall. Other room characteristics may result in a videowall shape closer to a square. But room layout is not the only important factor when determining the height and width of a videowall. The size and aspect ratio of the source content and their intended arrangements on the videowall also influence its shape and design.

A good first step is to determine the types and resolutions of the input sources to the videowall, and how many of them

Original source aspect ratios maintained

Original source aspect ratios not maintained – results in image distortion

Figure 2-10. Videowall images may be distorted if content is not presented in its native aspect ratio.

must be displayed together. Discussing this with the end user and deciding together the number of source windows and how they should appear on the videowall helps determine the best overall screen arrangement.

It is beneficial to sketch three or four storyboards with various window layouts. Be sure to maintain each source's original aspect ratio when designing these layouts. While many videowall processors allow images to be stretched, zoomed, or cropped to fill a window of any shape, the end user may find it distracting if content is not represented in its native aspect ratio. See Figure 2-10.

When creating sample window layouts, it is important to consider which sources should be shown at native resolution, which may be downscaled or reduced in size, and what content needs to be upscaled or enlarged. Having an idea of scaling requirements for the source content helps you determine relative sizes for the source windows on the videowall. The nature of the source content dictates how legible it will be when scaled. High-resolution imagery may be reasonably legible when downscaled. Content can often be displayed in small windows as "thumbnails" to save space while being adequately discernible. These can then be upscaled or enlarged upon user control for closer examination.

While videowall processors allow images or graphics to be reduced in size, text or symbols may not remain legible if downscaled or even when shown at native resolution. In this case, upscaling may be necessary. This may require the use of larger window sizes that may require enlarging the videowall. Properly sizing fonts for videowalls is discussed later in detail.

Once you are confident that your sample window layouts meet end user expectations, you can be sure that you have a good idea of the overall shape for the videowall. This is also determined by the layout of the room and the source content to be presented. You should estimate the physical and pixel dimensions for the videowall. Additional considerations, including pixel density and individual display or projected image size, help you finalize the actual dimensions and configuration of the videowall.

Pixel Density

In addition to brightness and contrast, pixel resolution is an important contributing factor to image quality. Viewers tend to perceive images with good resolution as sharp, detailed, and above all, free of visible artifacts. The ability to see pixels on-screen is dependent on the viewing distance from the display, the native resolution of the display, and the content being presented, among other factors. Pixel structure is more likely to be noticeable in content with text, shapes, lines, and fine graphic details than in full-motion video.

The resolution of a videowall can be defined by the total number of horizontal and vertical pixels in the display array or canvas. It can also be described by the pixel density, or the number of pixels per unit area. Pixel density is determined by the individual display unit, in terms of its native resolution as well as screen dimensions. Pixel density remains constant, regardless of the size or layout of the videowall.

The ideal pixel density for a videowall is based on the distance for viewers closest to the screens, so they do not see visible pixel structure. A unit of angular measurement, known as an "arc minute," is used to describe how much of a viewer's vision is occupied by an object. An arc minute is equal to 1/60th of a degree, with 360° comprising a complete circle. The theoretical limit of human visual acuity, or the ability to discriminate an individual object or between objects in space, is approximately one arc minute or 0.0167°. For video, this means that below this limit, a person should not be able to resolve individual pixels. See Figure 2-11.

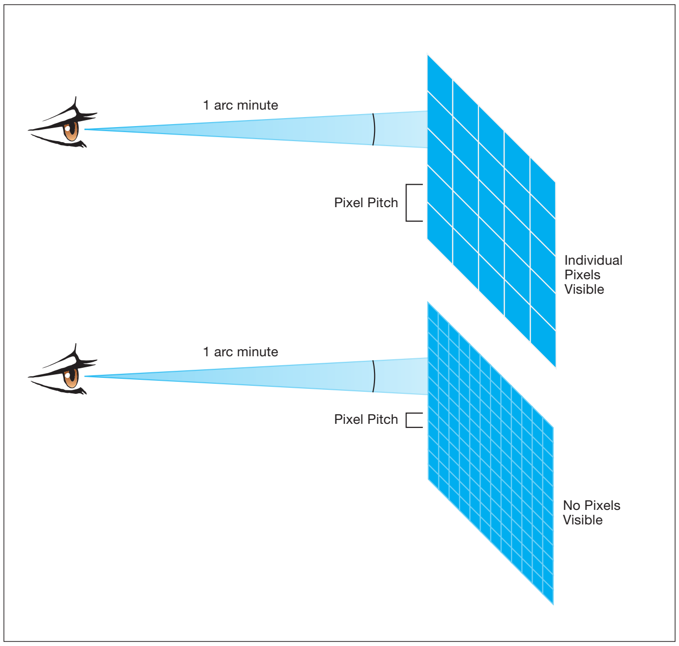


Figure 2-11. Pixel structure will not be noticed if the pixel pitch, or spacing between pixels, forms an angle less than one arc minute in a person's viewing field.

How to Calculate Pixel Density

Calculating Pixel Density Based on Viewing Distance

The minimum pixel density for a videowall, based on the viewing distance and the visual acuity limit of 1 arc minute, can easily be calculated. All that is needed is a tape measure and a scientific calculator, or a mobile device running a scientific calculator app. Ensure the calculator is set to degrees, rather than radians.

Begin by measuring, or estimating the distance from the videowall to the viewing position closest to the wall. Then, this basic trigonometric formula can be used to calculate pixel pitch, or the physical separation between two pixels.

Pixel Pitch = Viewing Distance x tan (1 arc minute / 60 arc minutes per degree)

= Viewing Distance x tan (0.0167°) = Viewing Distance x 0.000291

where the viewing distance and pixel pitch are specified in inches. Pixel density, in PPI or pixels per inch, is then simply the inverse of pixel pitch:

Pixel Density (PPI) = 1 / Pixel Pitch (in)

Example: For a viewing distance of 10 feet (3 m), or 120 inches,
Pixel Pitch = 120 in x tan (0.0167°) = 120 in x 0.000291 = 0.035 in (0.9 mm)
Pixel Density = 1 / 0.035 in = 28 PPI

Calculating Pixel Density for a Display

Pixel density can also easily be calculated for a display, using the equation for the Pythagorean theorem:

Diagonal Pixels $= \sqrt{\text{Horizontal Pixels}^2 + \text{Vertical Pixels}^2}$

Then, dividing the diagonal pixel resolution by the diagonal screen dimension gives you pixel density.

Pixel Density (PPI) = Diagonal Pixels / Diagonal Screen Dimension (in)

Example: For a 52 inch (132 cm) diagonal 1080p LCD panel,
Diagonal Pixels $= \sqrt{1920^2 + 1080^2} = \sqrt{4{,}852{,}800} = 2203$
Pixel Density = 2203 / 52 inches = 42 PPI

The sidebar shown above provides detailed information on calculating pixel density. At a close viewing distance of 10 feet (3 m), the pixel density would need to be at least 28 PPI, or pixels per inch, to avoid visible pixel structure. As points of comparison, a 50" (107-cm) UHD LCD display has a pixel density of 88 PPI, while a 60" (152-cm) WXGA LCD display has a pixel density of 26 PPI. If the end user demands that multiple high-resolution sources be displayed pixel-for-pixel, then it may be necessary to increase the pixel density beyond the minimum. Pixel density is an important consideration when projecting large images. Table 2-4 lists some recommended minimum pixel densities at various viewing distances.

VIEWING DISTANCE	MINIMUM PIXEL DENSITY
5 ft (1.5 m)	57 PPI - pixels per inch
10 ft (3 m)	28 PPI
15 ft (4.5 m)	19 PPI
20 ft (6 m)	14 PPI

Table 2-4. Recommended display pixel density based on the closest viewing distance

Summary

To help determine the best physical shape and size for a videowall, keep the following points in mind:

- The general shape and size of a videowall is frequently determined by the layout of the room and available wall space.
- Drafting window layouts helps both you and the end user better define the shape and dimensions of the videowall. Be sure to account for the following:
  - Types of input sources
  - Aspect ratios and native resolutions of the sources
  - Legibility of content, particularly text and symbols, and the possible need to enlarge them
  - Maximum number of sources to be displayed simultaneously
- Ensure the display devices you select for the videowall have sufficiently high pixel density, so the closest viewer does not see pixel structure.

Together with these suggested guidelines, you ensure that the final videowall design and configuration satisfies eye and head tilt considerations, as discussed previously in this guide. ■

Choosing the Right Display Size and Resolution

The ideal dimensions and resolution of an individual display unit depend on the required pixel density, the desired shape and size of the videowall, and budget. The choice of display technology dictates the available options for screen dimensions and resolutions. Display technologies for videowalls are discussed later in further detail.

For a given display technology, larger displays are typically more expensive than smaller models. However, it may actually cost less to fulfill a desired videowall size with fewer large, more expensive displays than a greater quantity of small, less expensive displays. Fewer displays translate to less expensive videowall processing since they require fewer outputs. On the other hand, smaller displays may deliver higher pixel density for the videowall. Therefore, a videowall design focusing solely on the economics of displays may ignore pixel density considerations.

Figure 2-12 illustrates two videowalls of comparable size. System A comprises three 70" (178 cm) 1080p LCD displays and System B is an array of eight 46" (117 cm) 1080p LCD displays. While the resulting videowalls are close in physical size, there are considerable differences between the two. System A can be less expensive than System B, despite the larger, more expensive 70" displays. System A requires only three displays, while System B requires eight. In addition, the videowall processor for System A only requires three outputs, and System B requires a larger videowall processor with at least eight outputs.

While System A is more cost-effective than System B, the overall pixel density of System B is greater than that of System A. System A comprises 5760x1080 pixels with a pixel density of 31 PPI. System B comprises 7680x2160 pixels and 48 PPI pixel density. Therefore, System B is capable of displaying a higher number of sources at native resolution. Depending on the required pixel density, the desired window layouts, and the resolutions of the input sources, System B may be a more suitable solution than System A despite the higher price. ■

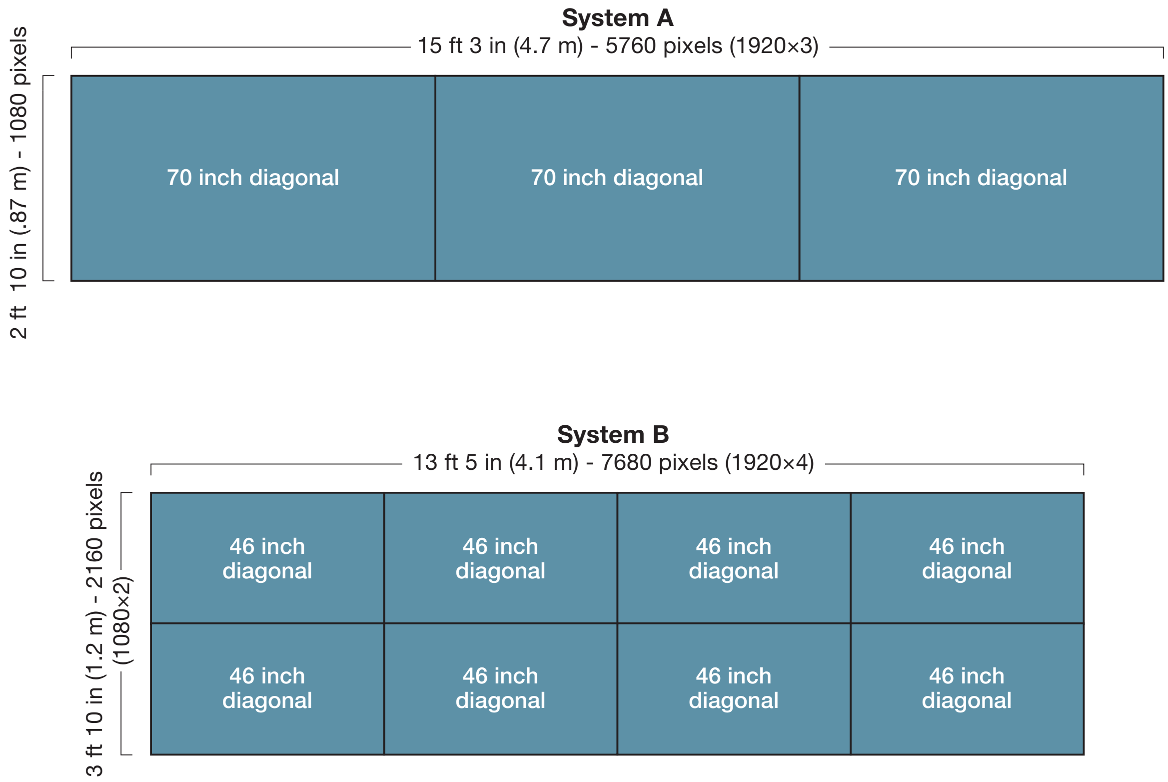


Figure 2-12. A videowall with fewer screens may be more cost-effective, but may not deliver sufficient pixel density for the needs of the application.

Font Size and Legibility

Legibility is very important for any videowall application with sources that include alphanumeric text. Viewers should be able to easily read text at all intended viewing distances without eyestrain. Delivering adequately sized text can be accomplished by scaling up or enlarging the source to make fonts legible. Alternatively, content can be rendered with text at appropriate font sizes.

When considering legibility, it is important to take into account the distance between the farthest viewer and the videowall. Use the "worst case" scenario to determine how large source windows should be or what font size should be specified when creating content. Additional display area may be required to provide adequate space for enlarged windows, which translates to larger displays or extra screens for more rows or columns.

At a minimum, text on a videowall should occupy 10 vertical arc minutes of the viewer's vision to be legible. However, this size may still appear to be too small for many viewers, and eyestrain is likely over long periods of time. A safer rule of thumb is for any displayed text to occupy at least 15 to 20 arc minutes of the furthest viewer's vision.

The example in Figure 2-13 illustrates an environment where the nearest viewer is 15' (4.5 m) from a videowall, and the furthest viewer is 30' (9 m) from the screens. The text is 1" (25 mm) high, which occupies 19 arc minutes of the nearest viewer's vision. While this is acceptable, text read by a viewer 30' from the videowall only occupies 10 arc minutes, which is not acceptable for extended viewing. The sidebar provides more details on calculating arc minutes based on the text size and viewing distance.

To improve legibility for the furthest viewer, text should be rendered at a larger size or source window sizes should be expanded. Figure 2-13 demonstrates that doubling the text height from 1 to 2 inches (25 to 50 mm) improves legibility, since the text now occupies 19 arc minutes for the furthest viewer.

From this illustration, it can be generalized that providing a text height of 1" (25 mm) for every 15' (4.5 m) of the maximum viewing distance ensures legibility for the viewer. This is a good rule of thumb to follow when designing videowalls, especially in environments where critical information is displayed.

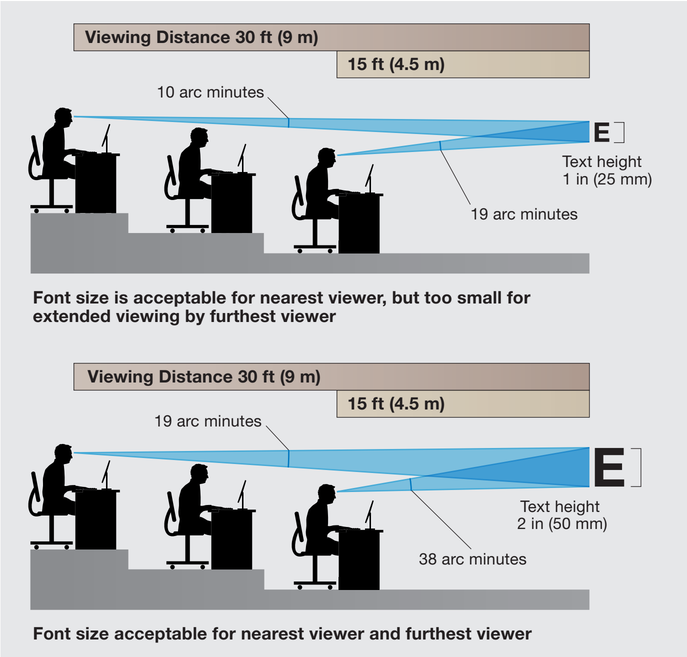


Figure 2-13. Font size vs. viewing distance

How to Calculate Arc Minutes

It is easy to calculate the number of arc minutes that text and characters occupy within a person's viewing field. All you need is a tape measure and a scientific calculator. Scientific calculator apps are available for mobile devices. Make sure the calculator is set to degrees, not radians.

Begin by measuring, or estimating, the distance from the videowall to the furthest viewing location in the room, as well as the height of the text on-screen. Then, this basic trigonometric formula can be used to calculate arc minutes:

Arc Minutes = 60 x arctan (Text Height / Viewing Distance)

where arctan is the arctangent, or inverse tangent, and 60 denotes the number of arc minutes per degree.

Example: For text 1 inch (25 mm) tall, viewed from 15 feet (4.5 m) or 180 inches,

Arc Minutes = 60 x arctan (1 in/180 in) = 60 x arctan (0.0056)
= 60 x 0.3183 = 19

If your calculator does not have an arctangent button, press the "inverse" button and then "tangent."

Pixel Density and Font Size

The pixel density of a display device is another factor that impacts font size. Text rendered at a specific font size appears smaller on a high-resolution display than on a lower resolution display of the same size. This is illustrated in Figure 2-14 for two 55" (140 cm) LCD panels, one at 3840x2160 and the other at 1920x1080.

It is also important to note that when referring to font size, or point size, a point is not equal to a pixel. In other words, 12-point font is not 12 pixels high, but rather is approximately 16 pixels high. The exact relationship between points and pixels varies by font. As a general rule of thumb, the pixel height of a font is 30% to 35% larger than its point size.

Example: A videowall array comprised of 55" (140 cm) 1920x1080 LCD panels is installed in a control room where the distance to the farthest viewer is 30' (9 m). The videowall has a pixel density of 40 PPI. For a 30' viewing distance, text on the screen should be at least 2" or 80 pixels high. Therefore, when creating content in Microsoft PowerPoint® or any other application, a font size of about 56 points should be applied.

It should be noted that if a source is intended to be magnified across multiple videowall screens, then the font size can be reduced accordingly. For an image spread over a 2x2 array of four screens, for example, the font selected can be one-fourth the size appropriate for viewing on a single screen. This can similarly be applied when a source window is to be enlarged.

Summary

To ensure that alphanumeric text presented on a videowall is legible for all viewers, use the following suggested rules of thumb:

- Apply a minimum text height of 1 inch (25 mm) on the screen for every 15 feet (4.5 m) of distance between the videowall and the furthest viewing position in the room.

- When rendering content for a videowall, the pixel height of a font is 30 to 35 percent larger than its point size. ■

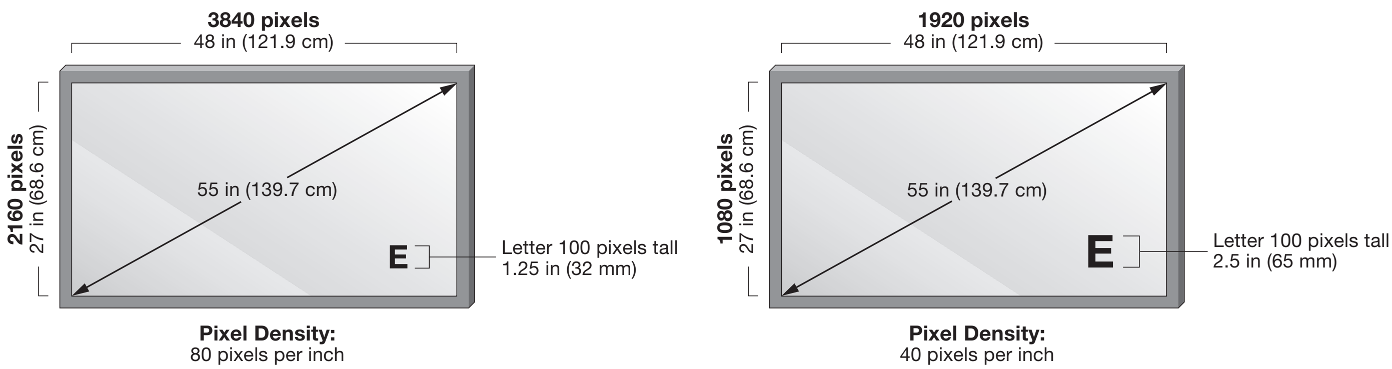


Figure 2-14. Text at a specific font size will appear smaller on a higher resolution display.

Display Devices

With the size, shape, and minimum pixel density of the videowall in mind, the system designer can now consider the necessary display technology and model for the videowall. Several display technologies are available when specifying a videowall design, each with its distinct benefits and drawbacks. The ideal choice is based on several factors, including the following:

- **Specific display technology -** The end user may already have a particular display type in mind for the videowall, such as LCD flat panels.
- **Screen size, shape, and resolution -** Specific screen dimensions and resolutions vary according to the display technology. Considerably large screen sizes may necessitate the use of front or rear projectors.
- **Picture adjustments** - Displays for videowalls feature a range of brightness and color adjustments, controls, and illumination systems that allow the displays to maintain alignment with one another over time.
- **Footprint -** Front and rear projection systems require the greatest consideration for space, while LCD displays and direct-view LED panels consume a minimal footprint in a room.
- **Environmental factors -** Significant ambient light in the room and limited tolerance for mechanical noise may preclude the use of front projectors. Outdoor applications may necessitate a direct view LED display.
- **Budget -** Display technologies vary in terms of the upfront costs for the displays and installation versus ongoing maintenance needs such as lamp replacement. Videowall maintenance is covered in the next section.

Display technologies continue to advance at a rapid pace. This section provides summary technical information and practical considerations relevant to multi-screen videowall applications.

Flat-Panel Displays

LCD displays are currently the most popular choice for videowall applications. They range in size from 40" to 108"

32 in (81 cm) LCD Display with Standard Bezel

42 in (107 cm) LCD Display with Thin Bezel

60 in (152 cm) LCD Display with Ultra-Slim Bezel

Photos Courtesy of Sharp

(102 cm to 274 cm), with a depth of 4" (10 cm) or less. They are ideal for facilities with limited physical space or budgets. LCD panels designed for videowalls are typically available with a 16:9 aspect ratio at resolutions such as 1366x768, 1920x1080, and 3840x2160. LCDs with a 16:10 aspect ratio and 1920x1200 resolution are also available, though these are desktop monitors.

The first displays used in professional video applications were based on plasma technology, which is susceptible to image burn-in. They were not suited for continuous-use applications with the presentation of static content. Early flat-panel videowalls were used in applications that emphasized the artistic value of the bezel, small footprint, and budget, rather than thin mullions. Thin bezels or mullions were not possible with the early flat panels.

The availability of ultra-thin bezel models – less than 10 mm and a minimal footprint – has contributed to LCD displays becoming very popular in a wide variety of videowall applications.

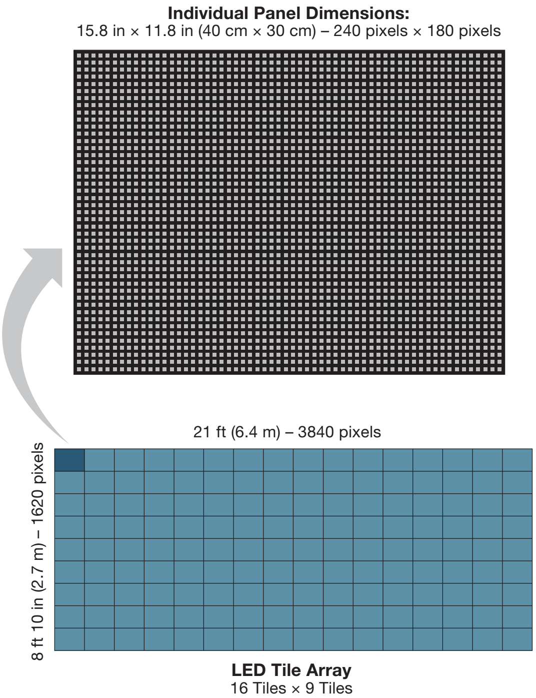


Figure 2-15. A large LED display comprised of 144 individual panels

LED Displays

LED displays produce very high brightness and are frequently used outdoors or in environments with high ambient light conditions. LED display systems comprise several individual panels, each containing an array of LEDs. A single pixel is represented by a discrete surface-mount module incorporating red, green, and blue elements.

An LED panel may have a resolution from 64x64 to 960x540 pixels, depending on the pitch, or spacing of the pixels, and the size of the panel. Selection of the LED pixel pitch is based on the intended use, viewing distance, and budget. LED panels for outdoor use are intended for viewing from great distances, and typically have a pixel pitch of 10 mm to 20 mm.

LED panels for indoor applications are viewed from closer distances and frequently have a tighter pixel pitch, from 1 mm or less to 10 mm. Table 2-5 lists minimum preferred and optimum viewing distances for five popular LED pixel spacings.

Video inputs are distributed to LED panels through one or more signal processors. These processors are typically limited to the magnification of a single image across the canvas. Videowall processors can serve as an input to the LED signal processors, providing advanced scaling, cropping, and multisource windowing features for the entire LED display.

Figure 2-15 illustrates an LED videowall 21 feet (6.4 m) wide and 8 feet 10 inches (2.7 m) tall with a total resolution of

PIXEL PITCH	MINIMUM RECOMMENDED VIEWING DISTANCE	OPTIMUM VIEWING DISTANCE
10 mm	112.7 ft (34.4 m)	187.8 ft (57.2 m)
5 mm	56.4 ft (17.2 m)	94.0 ft (28.7 m)
2.5 mm	28.2 ft (8.6 m)	47.0 ft (14.3 m)
1.5 mm	16.9 ft (5.1 m)	28.2 ft (8.6 m)
0.9 mm	10.1 ft (3.1 m)	16.8 ft (5.1 m)
0.6 mm	6.8 ft (2.1 m)	11.3 ft (3.4 m)

Table 2-5. Minimum and optimum viewing distance for common pixel spacings

3840x1620 pixels. This display comprises 144 individual panels, each 16" (40 cm) wide by 12" (30 cm) high. The modular form factor of the panels provides a great deal of creative latitude when designing the shape and size of an LED display. Because of the low pixel density of LED displays, very large LED displays may have resolutions that only require one or just a few outputs from a videowall processor.

Projection

Multiple projectors may be used in videowall systems instead of self-contained displays. They produce large images. They also offer the opportunity to present source information across fewer displays, resulting in fewer visible mullions.

Front or rear projection can be used. See Figure 2-16. Projector selection is based on a variety of factors relevant to the application. These include resolution, brightness, contrast ratio, lens options, lamp life, picture adjustments, and the capability to maintain color consistency over time. Projectors are available with Ultra-High Performance — UHP lamp, LED, or lasers as the illumination source. Also, they can have various aspect ratios and native resolutions that range from 1280x800 to 1920x1200. Projectors are also available at higher resolutions, including UHD (3840x2160) and 4K (4096x2160). The best choice between front or rear projection for a videowall is determined by the physical attributes of the viewing room and available space.

Front Projection

Front projection videowalls require the use of ceiling-mount systems, floor-level projection cabinets, or isolated projection rooms. Ambient lighting conditions and screen technology must be factored carefully into display brightness and contrast requirements. If projectors are to be situated within the working environment, other considerations are fan noise and floor space. Installing front projection may restrict the usable floor space. The design needs to ensure staff members do not accidentally walk into the projection paths and cast shadows on the screens.

Rear Projection

Rear projection systems place the projector in an enclosure or projection room, isolating it from viewers. To minimize the depth of the projection room, first-surface mirrors are employed to “fold” the projection path.

Rear projection systems eliminate the long-throw distance, ambient light spill, room obstructions, and fan noise that can plague front projection systems. However, they require dedicated space behind the display, and mounting systems with projection mirrors that require greater complexity for setup and maintenance than front projectors.

Videowall applications that incorporate projector arrays employ either edge blending or edge butting techniques. See Figure 2-16. The design objective is to create a single, large display delivering a continuous projected image.

Edge-Blended Projection

Edge blending is ideal for applications that require a large, continuous display area with very high resolution. It is achieved by overlapping the images of adjacent projectors, typically by 20%. Video content projected in the overlap region must be identical between projectors. This requires special image processing that is not a standard feature in some videowall processors.

To match the projected illumination between overlapped and non-overlapped regions, special adjustments for brightness, contrast, and gamma are required. Contrast must be

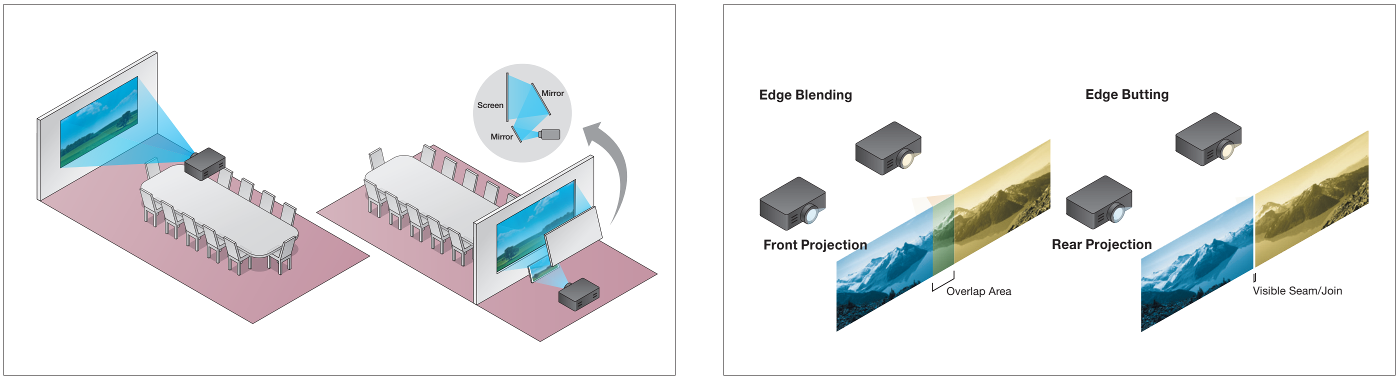


Figure 2-16. Front projection vs. rear projection, and edge blending vs. edge butting

attenuated in the overlapped regions to reduce the level of bright content. Also, the black level must be "notched" up to adjust dark content in the projected areas with no overlap. These image adjustments must be made, either within the projector or by an external image processor.

Windowing various input sources is common on projection videowalls with edge blending. While edge blending produces impressive displays, they are custom by nature. Also, the increased complexity of picture adjustments requires that the owner be prepared to accept higher service and maintenance costs than more conventional display systems.

Edge-Butted Projection

Edge-butted projection displays do not apply an overlap region. Picture adjustments and processing requirements are far simpler than edge-blended displays. With edge-butted displays, set up, alignment, and management are more streamlined. A thin seam may be visible between images, but a virtually seamless appearance is possible with precise image alignment. However, maintaining this appearance over time may require continual adjustments to image positioning.

Projection Cubes

For many years, projection cubes were the display technology of choice for videowall installations. The first projection cubes for videowalls featured CRT projectors housed in enclosures that were four to five feet (1.2 to 1.5 m) deep with 40" (102 cm) diagonal Fresnel and lenticular screens. CRT technology was eventually replaced with LCD, DLP™, and LCoS projection modules with lamp or LED-based illumination systems. They

Projection Cube
Photo Courtesy of Mitsubishi

A 4K projected image can serve as a perfectly seamless videowall for presenting multiple high-resolution image sources.

have been engineered for long life, while maintaining tight tolerances for brightness and color temperature. First, or front,-surface mirrors have been incorporated to reduce the projection path and enclosure footprint.

Current projection cube designs feature DLP projectors, with native resolutions ranging from 1024x768 to 1920x1200. They include LED illumination sources with lifetimes specified between 50,000 and 80,000 hours. Laser illumination sources have lifetimes specified between 60,000 and 100,000 hours.

Projection cubes are available in sizes from 50" to 80" (127 cm to 203 cm) in aspect ratios of 4:3, 5:4, 16:9, or 16:10. They generally require a footprint from 2 feet to 3 feet (0.5 to 1 m). Projection cubes have very thin screen bezels that minimize the appearance of "mullions" in the videowall, making them popular in control room environments where detailed data and graphics may be presented across multiple screens.

Modular Displays

Another class of display products feature a compact, modular display size comparable to LCD and LED panels, with little to no mullions. They are display technologies for creating videowalls with many different shapes and configurations. These displays are not limited to standard aspect ratios and can be a square, a polygon, or some other abstract shape.

Signals are distributed to the displays by one or more proprietary signal processing units. As with LED displays, these units map an image onto an array of modules. A videowall processor can be used to scale, crop, and manage multiple source inputs into this creative display technology. ■

Videowall Maintenance and Cost of Ownership

Videowall systems are high-value investments that require periodic maintenance. They have very high duty cycles, and downtime is unacceptable, especially in mission-critical applications. It is essential that provisions for service, maintenance, and total cost of ownership be considered during the system design phase.

Planning for maintenance as well as operating costs ensures end users remain within their operating budgets. This includes a sufficient stock of consumables and replacement items. Also, scheduling periodic, essential service visits maximizes uptime and image quality. These measures help preserve value in the investment.

Videowall Processors

The selected videowall processor should be capable of delivering failsafe reliability and be fully supported by a manufacturer's warranty policy. For example, Extron videowall processors include a three-year parts and labor warranty.

For applications in which the videowall must absolutely remain operational at all times, the processor should include one or more redundant, hot-swappable power supplies, depending on the size of the installation. In secure environments with restricted access, a spare parts kit might include system controller parts and input and output cards in addition to fans and power supplies.

Videowall Displays

Display selection can have a significant impact on the total cost of ownership. Operating costs for display systems include consumable items, such as air filters and lamps for projectors or projection cubes, plus regularly scheduled cleaning. The brightness and color composition of projection lamps and LED light sources can drift over time, requiring periodic recalibration and balancing across displays. Color balancing of displays is a task best performed by an integrator with experienced, certified technicians. Some projection cube models include automatic color calibration systems that simplify maintenance by minimizing the time required for color balancing.

Extron Quantum Ultra videowall processors feature a three-year parts and labor product warranty. The Everlast power supply carries a seven-year warranty for parts and labor.

Operating costs associated with supplying power and HVAC can vary between different types of displays. They should be considered when comparing display technology options.

Flat-Panel Displays

Flat-panel LCD and OLED displays for videowalls are not intended to be repaired at the component level or with consumable parts. The entire panel is generally replaced when a serious failure occurs or when image brightness becomes unacceptable. LED backlighting for LCD flat panels offers practical lifespans of 50,000 hours or more. OLED technology is self-emissive, meaning no light source is required, with lifespan reported to be anywhere from 50,000 to 100,000 hours.

Flat panels require little or no maintenance. However, when physical access to the displays is required, the location of the videowall and design of the installation and mounting system can impact labor cost by making service access easy or difficult.

Professional flat-panel displays are usually covered by multi-year manufacturer warranties. For mission-critical installations with large numbers of displays, the end user should consider having a spare unit on hand to avoid delays in receiving a replacement from the manufacturer.

Some newer flat panel designs have external, rack-mountable power and video processing modules, simplifying repair. These features also eliminate the need to replace the physical panel in case of a failure.

Manufacturers of flat-panel displays offer varying degrees of advice, warranties, or guarantees concerning image retention for their products. This is a concern with OLED displays more than LCD. Replacement of flat panels can be inconvenient and a surprise expense, so it is advisable to thoroughly examine a manufacturer's specifications and policies regarding image retention on flat panels.

Location and access to the videowall can influence maintenance cost.

Projection Cubes and Projectors

Projection cube designs typically feature an enclosure with a removable screen, a projection module, a light source, a fan, and filter assemblies that make them very serviceable. Projection cubes are available in models offering either rear or front access, which can impact the cost and convenience of maintenance. Where required, the end user should have a stock of spare lamps, screens, and projection modules to minimize downtime in the event of a projector malfunction or accidental screen damage.

Projection cubes initially incorporated UHP lamps as a light source. They have a lifespan of between 6,000 and 10,000 hours. UHP lamps have largely been replaced by LED illumination in projection cubes but are still used in some front and rear projectors. Projectors with UHP lamps installed in 24/7, mission-critical operations reach the 6,000- to 10,000-hour mark much more quickly than systems that are used only during eight-hour work days. Table 2-6 lists annual lamp replacement requirements based on the operating schedule.

In general, videowalls with UHP lamps require annual lamp replacement or at most every two years.

Lamp replacement should be performed by trained technicians. When a new lamp is installed in a projector cube or projector, color balancing is necessary. Therefore, the maintenance budget should include color calibration as part of the labor costs associated with lamp replacement. Projection cubes with self-calibration features or integrated lamp replacement systems require less time and effort for system repair and realignment.

LED-illuminated projection cubes and projectors have lifespans between 50,000 and 80,000 hours. They offer greater stability for brightness and color over time than the once-standard UHP lamps. Lasers are becoming increasingly popular as a light source for projectors and projection cubes and can provide 60,000 to 100,000 hours of use before replacement. These technologies result in lower operating costs, effectively eliminating the cost associated with light source replacement.

Videowall Maintenance and Cost of Ownership

Cleaning

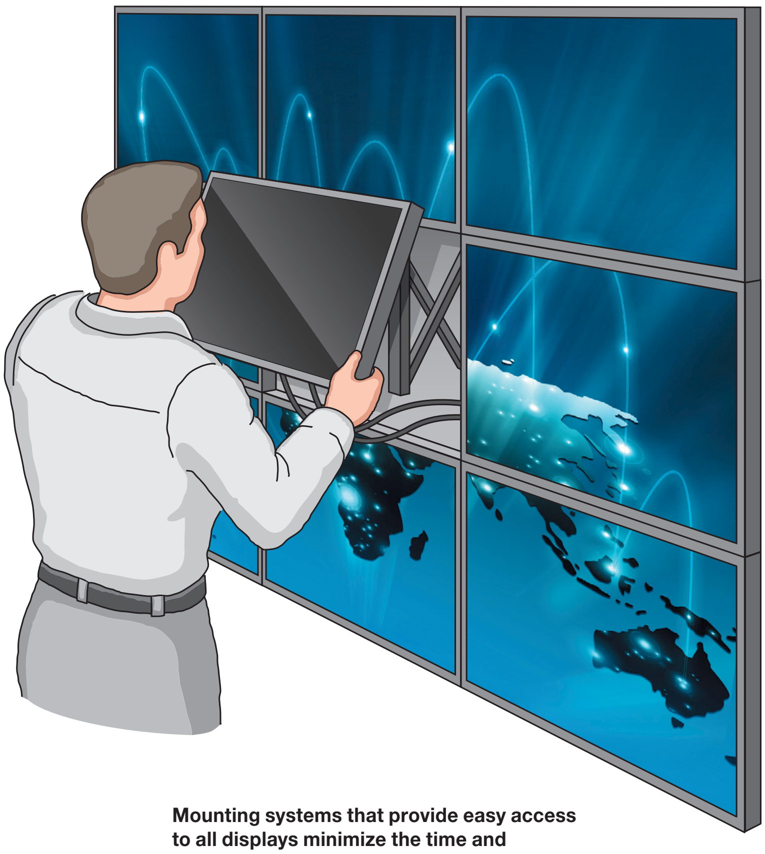
Displays with intake filters, as well as videowall processors, should be kept clean and free of dust and dirt. Clogged filters and excessive dust accumulation inside the equipment may cause it to overheat, and in some cases, shut down until temperatures drop to normal operating levels. Projection brightness is reduced when dust builds up on lenses. Unplanned outages and sub-optimal display quality can be prevented by including cleaning as part of the regularly scheduled maintenance. Furthermore, consistently maintaining normal operating temperatures helps maximize product lifespan.

Preventive Maintenance Agreements

Preventive maintenance agreements help keep videowalls looking and performing their best and can prevent problems before they occur. Agreements can be billed at a flat quarterly or yearly rate or at a fixed rate per visit. These service contracts may include the cost of spares, lamps, and quarterly or bi-annual visits for cleaning, color adjustments, and lamp replacements. Alternatively, they may be based on time and materials needed. A number of emergency on-site visits for repairs may also be included in a service contract.

HOURS PER DAY	DAYS PER WEEK	LAMP HOURS PER YEAR
8	5	2,080
8	7	2,920
12	5	3,120
12	7	4,380
24	7	8,760

Table 2-6. Typical operating schedules for videowalls and the resulting UHP lamp usage



Mounting systems that provide easy access to all displays minimize the time and costs associated with servicing flat-panel videowalls.

Input Sources for Videowalls

In addition to presenting large, windowed images, a videowall offers unique value in its capability to display a variety of digital and analog video formats and signals. Some also decode networked video streams. The specific signals a videowall processor supports vary from manufacturer to manufacturer, and from model to model.

Videowall processors are often targeted towards specific applications. For example, a processor used in traffic management or security applications typically supports a large number of IP camera feeds. Command and control systems must support computer-video signals that may be digital, streamed, or in some cases, legacy analog signals and even combinations of these types of sources. In order to select the right videowall processor for your application, you need to identify the primary signal types to be used.

Standard Definition Video

Standard definition video sources are defined as full motion video with resolutions of 720×480 or less, with frame rates of either 30 frames per second progressive or 60 fields per second interlaced. Standard definition video signals require less bandwidth and processing resources on a videowall processor than high definition, 4K and computer graphic signals, because they are lower resolution and contain less information. However, standard definition video is becoming a far less common requirement for videowalls.

High Definition Video

High definition video signals carry full-motion imagery, with parameters defined by the Advanced Television Systems Committee - ATSC standard at 1280x720 or 1920x1080 resolutions. The bandwidth of a high definition signal is at least five times that of standard definition video.

UHD and 4K Video

UHD (3840x2160) and 4K (4096x2160) signals are gaining popularity, while continuing along an evolving path. New features such as expanded color gamut and high dynamic range further increase the realism of 4K video presentations. But, it places increased demands on the bandwidth required by videowall processors to manage these signals. For more information on UHD and 4K signals, refer to the Extron white paper “Hitting the Moving Target of 4K”, available at www.extron.com/4kpaper.

Computer Graphics

Computer graphics refers to imagery produced on computers that typically, but not always, are at high resolutions. Computer-video resolutions frequently range from 1024x768 to 1920x1200. It can also be as low as 640x480 and as high as 3840x2160 and beyond. Computer graphic signals carry information for a 4:4:4, RGB color space. A computer-video signal with a 1920x1200 resolution uses over ten times the bandwidth required for a standard definition signal. A 3840x2160 signal uses almost four times the bandwidth of a 1920x1200 signal.

Analog Signal Formats

Analog video and computer-video signals are a diminishing entity. Today, end users select digital source devices for new projects, but analog sources may still be encountered at some sites. Videowall processors must support analog signals or incorporate external signal convertors when expanding existing display systems. Table 3-1 lists common analog signal formats for standard-definition, high-definition, and computer video.

Digital Signal Formats

Offering superior image quality and resolution, as well as support for ancillary audio and control data, current consumer and professional video sources and computers incorporate digital signal interfaces. Digital signals such as HDMI and DisplayPort offer advanced signal management features for EDID and High-bandwidth Digital Content Protection - HDCP.

DVI and SDI digital formats were popular in commercial and broadcast applications for over a decade. However, HDMI is now the most popular digital signal format for AV systems, including videowall systems.

Videowalls are often installed in environments where considerable distances can separate the video sources, displays, or processing equipment. For spans longer than 35 feet (11 m), copper digital video cables are often unable to transmit signals reliably, especially higher resolutions such as 4K. Videowall processors are incorporating digital technology that delivers and receives video signals across long distances using CATx twisted pair cable terminated with RJ-45 connectors. This facilitates easy integration of long signal runs across low cost, industry-standard cables.

Input Sources for Videowalls

Format	Connection	Maximum Supported Format	Typical Source Devices
Composite Video	 or 	525 or 625 line interlaced video, 25 Hz - 30 Hz	Consumer video products
S-Video / Y/C	 or 	525 or 625 line interlaced video, 25 Hz - 30 Hz	High-end consumer video products, prosumer video editing systems
Component / YPbPr	 or 	HDTV 720p or 1080i @ 60 Hz	Cable or satellite set-top boxes, DVD players
RGB	 or 	1920x1200 @ 60 Hz	Computers, video processors, scalers

Table 3-1. Analog video signal formats

Format	Connection	Maximum Resolution	HDCP Support	Typical Source Devices
Single-Link DVI		1920x1200 @ 60 Hz, 2048x1080 @ 60 Hz	Yes (Optional)	Computers, video processors, scalers
Dual-Link DVI		2560x1600 @ 60 Hz	Yes (Optional)	Application-specific computers for medical, production, and design
HDMI		4096x2160 @ 60 Hz	Yes	Blu-ray players, cable and satellite set-top boxes, video games, computers
DisplayPort		3840x2160 @ 60 Hz	Yes	Graphics cards, laptops
IP Network Streaming		Hardware dependent	Hardware dependent	Hardware encoders PCs (software encoders)
IP Network Streaming	Fiber (Various)	Hardware dependent	Hardware dependent	Hardware encoders PCs (software encoders)
Extron DTP **Extron XTP** **HDBaseT** **(Twisted Pair)**		4096x2160 @ 60 Hz	Yes	External transmitter required to convert each source to appropriate twisted pair format
SDI **HD-SDI** **3G-SDI**		**SDI:** Standard definition interlaced Video **HD-SDI:** HDTV 720p or 1080i @ 60 Hz, HDTV 1080p @ 30 Hz **3G-SDI:** HDTV 1080p @ 60 Hz **12G-SDI:** 2160p @ 60 Hz	No	Broadcast Signal Processing and Management

Table 3-2. Digital video signal formats

Table 3-2 summarizes the common digital signal formats. Specifications for digital signals will continue to advance with the need to accommodate higher resolutions and more capabilities for professional and consumer applications.

HDCP Compliance

HDMI signals can include HDCP, a digital rights management scheme to prevent unauthorized copying of digital content. Some DVI connections also support HDCP. Proper display of HDCP-encrypted content by a videowall processor requires that it support HDCP at both the input and output connections, and that HDCP-compliant display devices are used. Note that HD and 4K content incorporate different versions of HDCP. For compatibility with UHD/4K signals, a minimum of HDCP version 2.1 is required for all devices in the signal chain.

For more information on digital video, consult the Extron Digital Design Guide, available at www.extron.com/ddg.

Local and Client Applications

Some videowall processors operate like computers, with the videowall displaying a large, active desktop. This offers the flexibility to install and operate software applications or software clients directly on the videowall system. Many of these applications produce ultra-high resolution material presented natively across multiple screens. This capability is frequently required for videowalls in utility and network operations centers.

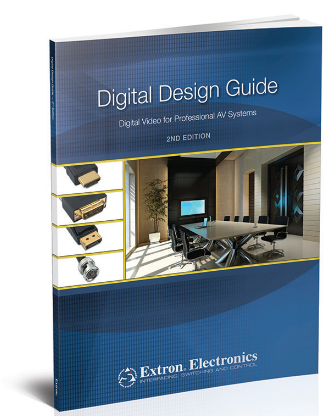
Software applications such as Virtual Network Computing - VNC may be used to share imagery from a computer desktop with a videowall processor. This method of delivering a computer image is effective for presenting static or low-motion imagery. However, it can be overloaded at the client or server end if the content contains full-motion video, high-motion visualizations, or animations. The result can be imagery that does not update at speeds expected by the user or undesired processing loads for the source computer or videowall processor.

Streamed Content

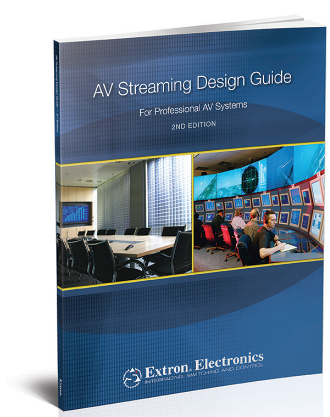
There is a growing need for videowall processors to decode video sources that have been streamed over networks. Sources may be streamed over a local area network - LAN, which provides a cost-effective, scalable delivery infrastructure. Video may also be delivered from distant locations across a wide area network - WAN.

A variety of methods are available for decoding streamed content. Scalability and performance requirements for a videowall may influence the decision to use the decoder built into the videowall processor or external hardware for decoding streamed sources.

For more information on video streaming technology, refer to the Extron AV Streaming Design Guide, available at https://www.extron.com/article/avstreamingdgad. ■



The Extron Digital Design Guide provides a reference for AV system designers seeking to understand emerging digital technologies, with a practical approach to integrating these technologies in new and legacy presentation systems.



The Extron AV Streaming Design Guide provides reference data, information on important technical topics, and real-world application examples demonstrating practical uses of Extron streaming technologies.

Videowall Processor Architecture

The most effective videowall designs apply equal importance to video signal processing and display technology. For applications that only require one large image, displays with built-in processing can scale the image across the array. But whenever there is a need to present multiple images in windows on the screens, dedicated videowall processing is a must. It is critical that the end user's intended application for the videowall be clearly identified during the needs assessment.

The traditional videowall processor architecture is a unit with inputs, outputs, and specialized built-in processing. This was originally based on a card-cage platform with input and output cards and an internal bus to handle signal transfer within the unit. Processing is also available as a system of modules, with signal processing distributed or shared between them. Other videowall processing solutions combine elements of these two architectures.

The first important design consideration for videowall processing is to determine the appropriate architecture, or hardware form factor, for the application and environment. There are several important aspects to take into account, all of which arise from a detailed assessment of the end user's desired outcome. Requirements include:

- Quantity of input sources
- Locations of the input sources, whether local to the videowall processor, dispersed throughout the facility, or both
- Number of displays in the videowall
- Possible need for the videowall to be scalable, so it can be expanded over time with new sources or additional displays without replacing the processor
- Available space and locations for AV equipment, including videowall processing

Centralized Videowall Processing

Centralized videowall processing, with input and output signals handled within a single unit, is ideal for applications in which the sources and displays are local to the processor. See Figure 3-1. If long signal runs are required for source or display connectivity, twisted pair or fiber optic signal extension solutions are available, either externally or partially integrated into the cards. Centralized video processors are available in a large variety of sizes and formats, from just a few inputs and outputs, to dozens of device connections.

Some processors feature a fixed input and output configuration in a 2U or 3U chassis. Other processors are card-cage designs, populated with different types of input and output cards that vary depending on the source and display types used. These systems are typically customized and configured at the factory on a built-to-order basis, and typically have from eight to 16 card slots or more. Most offer the ability to display multiple sources per screen, and some offer advanced features such as internally generate clocks that can be display in multiple time zones, window borders, window titles, and dynamic text windows.

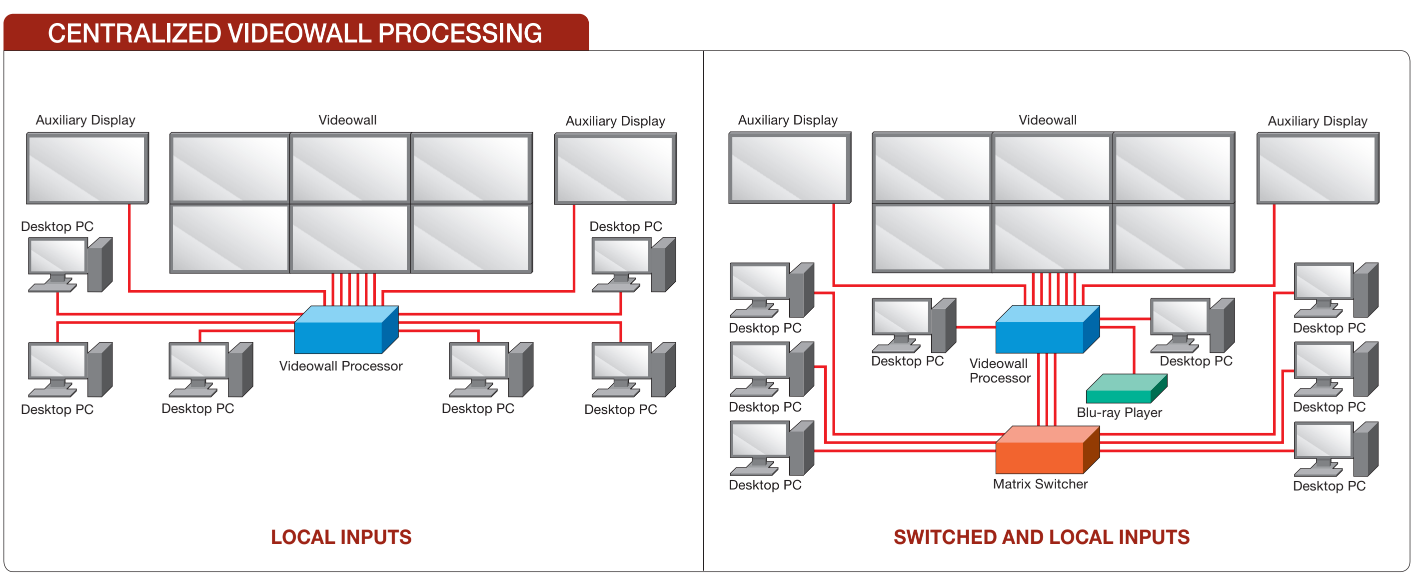


Figure 3-1. Videowall systems with a centralized videowall processor

Card-cage processors provide scalability, especially when configured with vacant card slots. This allows the addition of more input or output cards over time. Cards can also be swapped out for system upgrades or maintenance. Including a matrix switcher also adds input scalability to a videowall system, as shown in Figure 3-1.

An advantage of a centralized videowall processor is that it can be installed, configured, and serviced in a single location as a single unit. This makes a centralized processor potentially simpler to configure and manage than videowall processing architectures comprised of many separate devices.

Distributed Videowall Processing

In a distributed videowall processing architecture, input and output connections as well as signal processing are distributed among modules. Two common forms of distributed videowall processing are illustrated in Figure 3-2. For the system on the left, each display in the videowall is fed by a videowall processing module. A matrix switcher is used to distribute signals from the input sources into the modules. The matrix switcher and modules function together as a single processing system, controlled by a computer or control system over Ethernet.

For the second system in Figure 3-2, sources are connected into input modules that convert signals for distribution over a network. The streams are received by output processing modules connected directly to the videowall displays. Again, a computer or control system is used to manage the modules as a system.

A distributed videowall processing architecture has some potential advantages, including system scalability. The videowall can be easily expanded with additional displays or new sources by adding modules to the system. A distributed videowall processing system with network-based modules is ideal for installations where input sources are not central to an AV equipment rack, but rather are located throughout a room or facility. Additionally, distributed videowall processing can reduce the need for AV rack space when the modules are localized to the sources or displays.

There are some installations in which videowall processing capabilities are incorporated within the displays themselves, either as a built-in feature or processing cards. They may receive source signals distributed over a network from input modules local to the sources or directly from a matrix switcher with the sources connected to the inputs.

Hybrid Videowall Processing

Some videowall processing systems combine centralized and distributed processing architectures. One example is shown in Figure 3-3, in which the input sources are connected to modules that stream their content over the network to a centralized videowall processor. This system is ideal for installations with some sources remotely located throughout the facility and others local to the videowall processor.

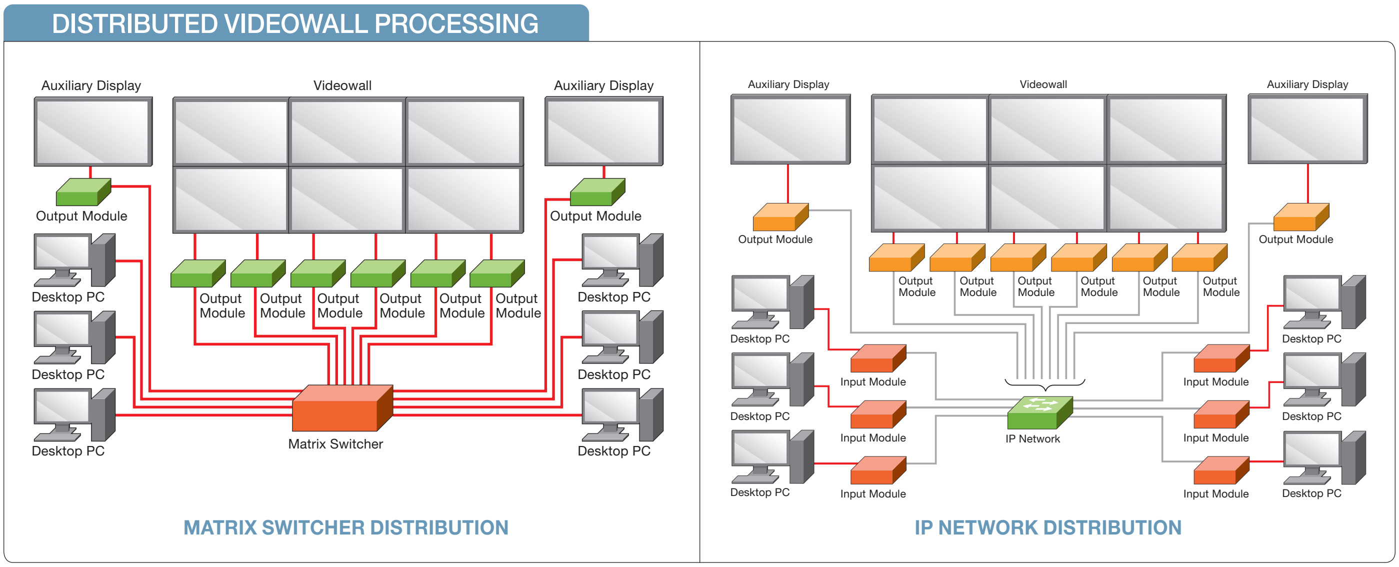


Figure 3-2. Videowall systems with distributed videowall processing modules

Videowall Processor Architecture

Centralized videowall processors can be expanded by connecting to external modules with additional inputs and outputs or by cascading additional processors that work together as a single processor. This solution is somewhat similar to a distributed videowall processing system where signal and processing loads are shared among the units.

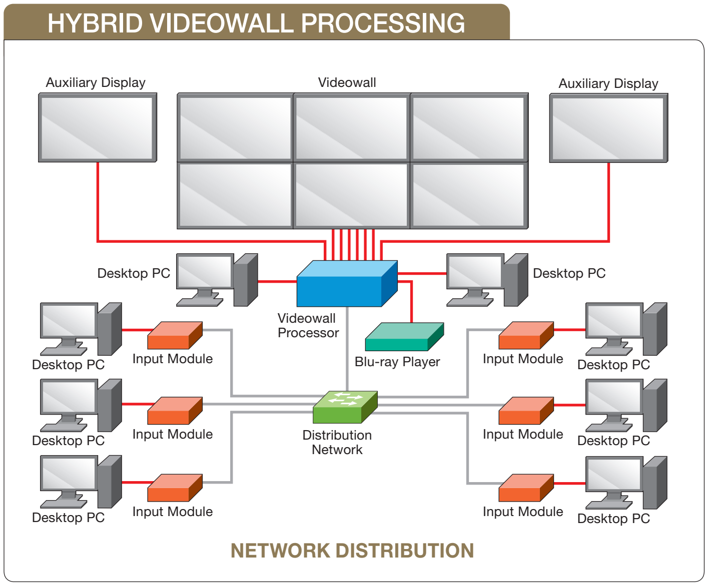


Figure 3-3. Videowall system with centralized videowall processing plus distributed modules at the input sources.

Extron NAV provides a pro AV over IP solution for networked switching and display of signals with distributed Videowall processing capabilities.

Videowall Processor Hardware Platforms

Centralized videowall processors are based on one of two hardware platforms. Purpose-designed, real-time video processors, similar to basic AV scalers and multi-window processors. Others apply PC architecture as the foundation. Some processors incorporate a combination of these platforms.

Each platform has distinct advantages for meeting-specific applications. The best videowall processor satisfies end user input and output interfacing needs and fulfills reliability and performance expectations for presenting sources with high image quality. Ideally, all images should display at their original frame rates and be free of any stuttering, image tearing, and other visible artifacts caused by signal or processing overload.

Furthermore, the videowall processor should respond to user or control system commands in real-time. Any noticeable latency is an indication that the system's processing capability has been exceeded. In 24/7, mission-critical applications, the processor must also deliver continuous, failsafe reliability.

History

Introduced in the mid-1980s, videowall processing platforms were based on a card frame. A control processor and a data bus transported video from input cards to output cards. See Figure 3-4. They provided advanced video memory and high-speed bus technologies that made high-speed, high-volume calculations possible for real-time video image scaling and enabled fast delivery of video between the cards.

Manufacturers have pursued a variety of evolving design platforms. They capitalized on advancements in high-speed data bus technology, commercially available off-the-shelf PCBs or computer components, and network transport methods. These technologies have resulted in higher image quality, real-time performance, scalability, or cost targets.

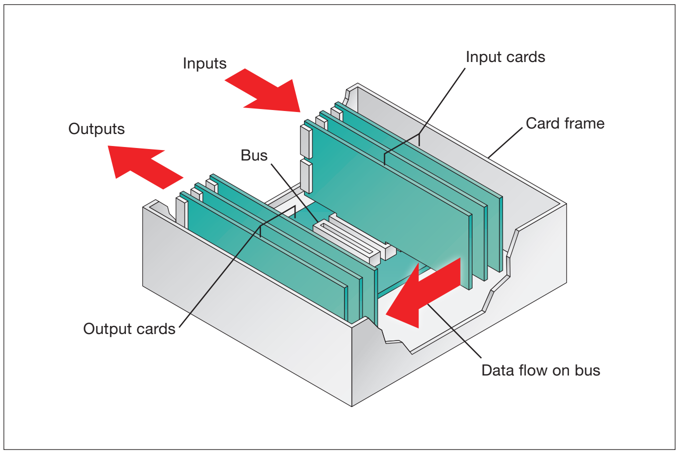


Figure 3-4. Historical videowall processing architecture

Appliance-Based Videowall Processors

Appliance-based videowall processors are built on a proprietary hardware platform, designed with a custom controller, high-speed video bus, and a tailored operating system. These processors are designed to provide predictable, real-time video processing and device control in a stable operating environment.

Appliance designs can have a fixed input/output configuration or a card frame architecture. Fixed I/O processors have a defined number of inputs and outputs, with the video signal formats predetermined. Card frame processors are flexible, supporting specified input and output requirements.

Appliance-type processors typically have a custom operating system and fast boot times of less than one minute. They are generally purpose-built to handle all of the videowall processing requirements, delivering reliable, high-quality images to the displays. The stability and robustness of the operating system and video-specific hardware make these devices ideal for continuous 24/7 environments.

Computer-Based Videowall Processors

Computer-based videowall processing designs integrate components, technologies, and architectures. These include a motherboard or single-board computer, power supply, PCIe - PCI Express bus, and hard drives running a Microsoft Windows or Linux operating system.

This platform emerged in the 1990s to support new graphics cards with multiple outputs. They enable computers to span multiple screens. Today, input capture cards and output cards developed for use in videowall applications can be installed in off-the-shelf industrial computer frames.

Computer-based videowall processors are capable of displaying a large extended computer desktop on the videowall, as well as multi-source windows. They offer capabilities common to computer functions, such as running software applications while presenting external input sources.

Some computer-based processors incorporate proprietary input and output cards into purpose designed card frames.

Videowall Processor Hardware Platforms

Although they offer superior processing performance when compared to off-the-shelf computers, there are disadvantages when implementing such technologies in real-time videowall production.

In particular, the PCIe data bus frequently applied in these processors must perform double duty. They have to manage interrupts from system resources such as the CPU, storage, or network port, while transporting video from input cards to output cards. Mixing inter-system communications and video transport on this PCIe bus makes the video performance difficult to predict. Real-time performance also degrades significantly as video-source loading increases on the bus.

Videowall processors based on computer technology may provide performance that is "good enough" for simple video and static graphical data. It may not be satisfactory when applied to continuous use, mission-critical environments that require real-time device control and presenting many video and motion graphic sources. Additionally, they can experience extended shutdown and boot times.

Combined PC and Appliance Platforms

As the videowall market has matured, products have emerged that incorporate both hardware appliance and computer-based technology. These system designs capitalize on the benefits of each platform. These include the operational familiarity of a computer-based processor and the high performance and reliability of a hardware appliance processor. Compared to computer-based processors, they offer the stability and performance of a standard AV appliance.

Quantum Ultra Connect, Quantum Ultra, and Quantum Ultra II are Extron videowall processors that combine computer and appliance platforms. They use a customized operating system based on a "pruned down" variation of a standard Windows operating system. This solution requires fewer system resources, dramatically reducing boot time and improving system stability. All processors in the Quantum Ultra family have solid-state storage drives, which further optimizes boot time and system reliability.

Quantum Ultra processors feature proprietary input and output cards, with on-board, high performance video processing and scaling. They also incorporate a high-speed, high-capacity data bus dedicated to transporting real-time video from input to output cards. It is physically separate from inter-system communication on the PCI bus.

See Figure 3-5. The input cards, output cards, and bus are engineered to operate as a system, much like a hardware appliance, and requires minimal loads on the CPU. This ensures predictable, real-time performance with high-quality images delivered to the videowall. Additionally, with minimal loading on system resources, these processors respond to user or control system commands in real-time and without the latency associated with heavy signal processing tasks.

Summary

The ideal videowall processor fully satisfies the installation requirements, as well as general end user expectations for reliable operation and very high-quality images on the canvas. System performance, dependability, the capability to run computer applications on the videowall, and budget are some of the important factors in selecting a videowall processor. Additional considerations include image processing and other functions. These are explored further in the next section. ■

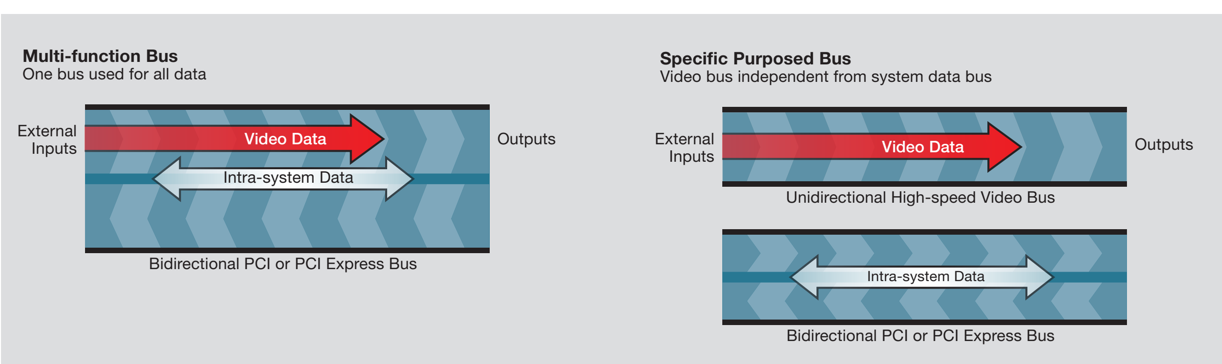


Figure 3-5. Shared bus vs. dedicated video and data buses

Videowall Processor Features

Videowall processors are available with a wide range of features and capabilities. Many of them relate to system performance, image quality, and reliability, while others help streamline system design and meet integration needs. These are targeted at specific vertical markets and applications and vary by manufacturer and model.

When selecting a videowall processor, it is important to understand more than just which source formats and how many input and output channels must be supported. Assessing the environment and application for the videowall helps identify the most critical features the processor must support. When comparing processors, be aware that manufacturer claims of capabilities or performance may be generalized or represented by inaccurate or misleading specifications in the brochure and on web pages.

Dedicated Video Bus

Centralized videowall processors use a data bus to transport video from their inputs to their outputs. Some systems incorporate a dedicated bus for this purpose, while other systems use a common bus for transferring video as well as other inter-system communication. Use of a dedicated video bus ensures that the transfer of video data is not impeded by other activity. It provides more reliable, stutter-free video playback and ensures the processor responds to user commands in real-time.

Scalability

Some end users will want to add more input or output channels over time. This may be part of a phased installation or an unforeseen upgrade. While some processors are easily expandable, some have a “fixed configuration” that cannot be changed after leaving the factory. Other videowall processors are upgradeable but may require on-site support from the manufacturer to change the hardware configuration.

Redundancy & Accessibility Features

For videowall processors used in mission-critical or 24/7 environments, redundant and hot-swappable components are essential. Redundant, hot-swappable power supplies keep processors running during a failure of the facility’s power grid and facilitate replacement without powering down the unit. Hot-swappable fans can also be quickly and easily be replaced if necessary. The capability to replace these components without removing the videowall processor from the rack minimizes downtime.

Data Storage

Hard drives are one of the first points of failure for a computer. Videowall processors with hard drives can become inoperable if a failure occurs. To reduce this risk, some videowall processors use RAID or removable solid-state storage for their operating systems. Solid-state storage virtually eliminates the possibility of hard drive failure while adding the benefit of reduced boot time.

4K Support

Support for 4K/60 signals is an important feature for videowall processors. Many processors support multipath 4K/60, accepting or outputting two or four signals that are stitched together to form a cohesive single image. This method also requires source equipment or displays that can process 4K as four separate signals. Supporting 4K/60 signals on a single connection is more efficient, but this feature is currently only available on a few processors.

4K sources place a heavy load on a videowall processor’s video bus. This is because of the format’s high pixel count. As a result, some processors may be limited in the number of full-resolution 4K sources that can be displayed at any one time. Bus capacity and bus management capabilities are important when the system includes a large number of connected 4K sources.

Upscaling and Downscaling Quality

Maintaining image quality is crucial for videowall processors, which often display large images at high resolution, or downsized images as smaller windows. Poor scaling can produce artifacts, rendering imagery ineffective for applications requiring critical analysis of content.

Figure 3-6 shows how visual information is preserved or lost when high- or low-quality downscaling is applied. Since image quality frequently must be judged subjectively, the best way to assess scaling performance is to see a videowall processor in operation at a site. Another option is to view a demonstration where the system is displaying content similar to what will be presented in the intended application.

Full Color-Depth Processing

Full color-depth processing is required to preserve the quality of 24-bit or 30-bit video and graphics without introducing color banding. Some videowall processors reduce the color depth of incoming source signals to reduce bandwidth on their video bus. While this helps preserve real-time performance, color reproduction can be compromised. Figure 3-7 illustrates the color banding artifact. This bit reduction may not be noticeable on simple content, such as computer desktops or data screens, but may be noticeable with high-resolution video, animation, and rendered graphic visualizations.

Accurate Input Detection

Incoming source signals can vary widely in signal format and resolution. Quick, accurate input detection and configuration of input sources is ideal. Slow auto-detection can produce blank windows that are presented for an undesirable length of time. Inaccurate input signal detection can result in image distortion or no image being displayed.

Proper detection of legacy analog sources can be especially challenging. Manual programming to correct these issues for each input can add weeks of programming that can be avoided with the support of quick and accurate input detection. This capability also simplifies the integration of new sources and temporary sources, such as guest laptops.

Custom Input Management

When a videowall processor detects an analog input signal, it typically compares it to a list of known formats and selects the closest match to determine the signal parameters. Another technique is to examine certain elements of the signal. These can include sync polarity and line timing. The processor then performs a source capture based on VESA standard CVT - Coordinated Video Timing or GTF - Generalized Timing Formula calculations for the signal parameters.

Incorrect format detection can occur if there are non-standard signal formats or if the sources are altered by upstream signal processing or signal extenders. To correct this issue, a videowall processor should allow customization of input signal parameters. This permits manual adjustment of input source sampling to ensure proper source display. Some processors allow custom source profiles to be created for each input, while others allow the custom profile to be created just once and then shared across inputs. Profile proliferation reduces integration time and complexity.

Custom signals from digital sources are more easily accommodated since information about the signal, such as the resolution and timing, is embedded within the data stream. This simplifies the processor's task of properly decoding and displaying the image. Check the detection speed and supported formats, which vary from processor to processor.

Custom Output Modes

Some videowall processors allow customization of the output resolutions. This is useful if the system's display devices are of a non-standard resolution, or when the display device's resolution is not included in the processor's default output mode table.

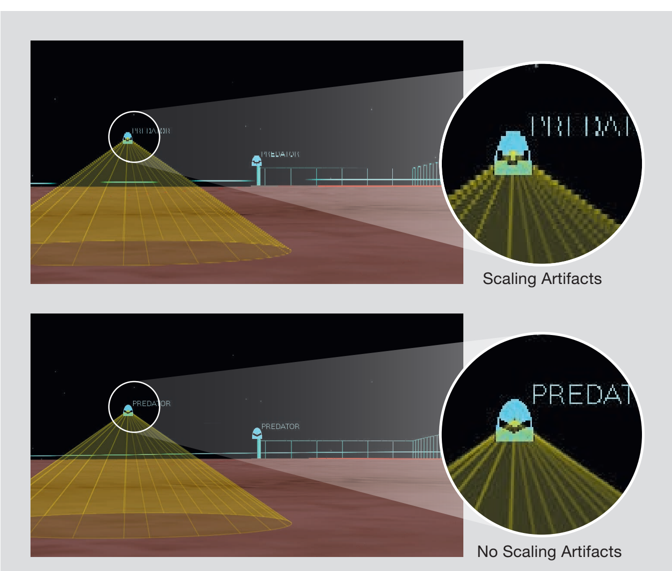


Figure 3-6. High quality scaling maintains critical image details when content is downscaled.

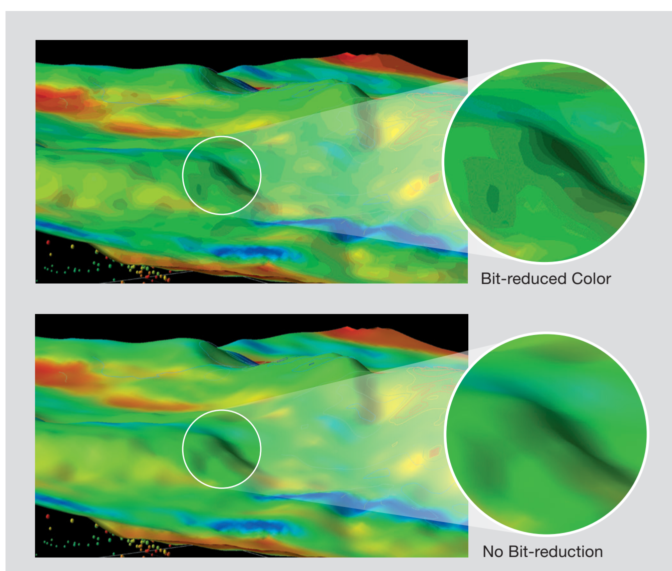


Figure 3-7. Full color depth processing avoids color banding artifacts associated with a reduction in color resolution.

Mullion/Bezel Compensation

When projectors and projection cubes are stacked next to each other, there is no appreciable image-to-image gap between the displays. However, flat-panel displays have a physical bezel around the active picture area. The active picture area stops at the inner edge of the bezel. Therefore, when they are stacked together to form a tiled display, there can be screen-to-screen gaps across panels.

If a videowall processor does not account for the gap between displays, the result looks unnatural. A processor can compensate for this effect by clipping away a small percentage of the image which should physically be positioned behind the bezel. See Figure 3-8. The sidebar details the calculations to determine the horizontal and vertical mullion pixel sizes necessary for proper mullion/bezel compensation.

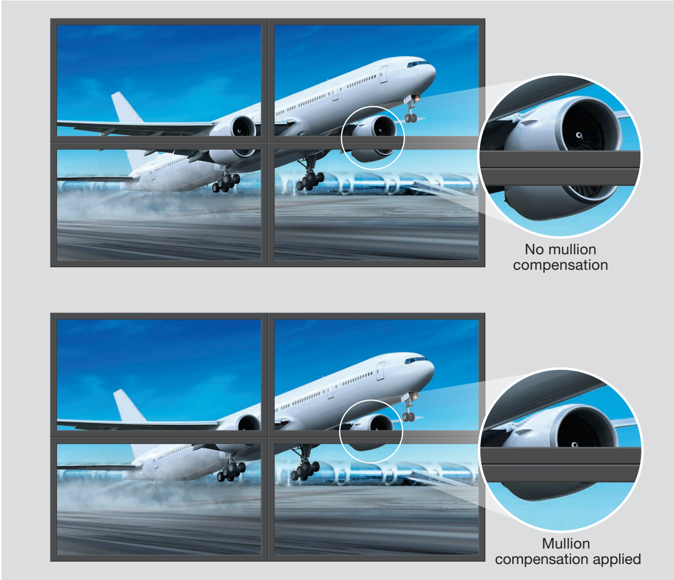


Figure 3-8. With mullion compensation, images appear more natural on a videowall.

HDCP Support

High-bandwidth Digital Content Protection, or HDCP, is an encryption system widely used for content delivered by Blu-ray Disc players, satellite and cable TV receivers, and computers. To properly display encrypted content, all devices in the signal chain must be HDCP-compliant. The use of digital video sources has made HDCP compliance a requirement for videowall processors. Updates to HDCP standards have included accommodations for high-value 4K content. HDCP versions 1.x provide support for standard-definition and high-definition content, while HDCP 2.1 or higher is required for support of encrypted content at 4K and above.

Edge Blending Support

Some videowall displays comprise multiple projectors that overlap with each other to create one large, seamless image on a front or rear projection screen. In these systems, the canvas has to be duplicated between outputs in the overlapped region. Also, brightness, contrast, and special color adjustments must be available in zones to balance brightness and color across the blended and unblended regions.

Duplicating the imagery required for edge blending is a feature that may not be available on every processor. Some videowall processors may support zoned brightness and

How to Calculate Mullion Compensation

Determining the number of pixels a mullion occupies is a simple task. Applying this calculation can save time that will otherwise be wasted by guessing or “eyeballing” the adjustment.

The following example calculation is based on a 52 inch (132 cm) 1080p LCD panel with an active viewing area of 45.375 x 25.5 inches (115 x 65 cm). The top and bottom mullions each measure 0.83 inch (21 mm), and the left and right mullions each measure 1 inch (25 mm).

Determine the horizontal pixels per inch - PPI by dividing the number of active horizontal pixels by the width of the active display area:

1920/45.375 in = 44.26 Horizontal PPI

Determine the vertical PPI by dividing the number of active vertical pixels by the height of the active picture area:

1080/25.5 in = 42.35 Vertical PPI

Calculate the necessary mullion compensation for the left mullion by multiplying the width of the left mullion by the horizontal PPI:

Left Mullion Compensation = 1 in x 44.26 PPI = 44.26 pixels

Repeat the calculation for the right mullion:

Right Mullion Compensation = 1 in x 44.26 PPI = 44.26 pixels

Add the two values to arrive at the total horizontal mullion compensation:

Total Horizontal Mullion Compensation = 44.26 + 44.26 = 88.52 or 89 pixels

Calculate the vertical mullion compensation using the same approach:

Top Mullion Compensation = 0.83 in x 42.35 PPI = 35.15 pixels

Bottom Mullion Compensation = 0.83 in x 42.35 PPI = 35.15 pixels

Total Vertical Mullion Compensation = 35.15 + 35.15 = 70.3 or 70 pixels

In the videowall configuration utility, enter a value of 89 pixels for the horizontal mullion compensation, and 70 pixels for the vertical mullion compensation.

Figure 3-9. Videowall presentations can be enhanced with window borders and titles, as well as clocks.

color adjustments, but this capability can also be supported by many projector models. When designing an edge-blended system, carefully evaluate the projector adjustment and videowall processor capabilities.

Flexible Source Placement

A videowall processor's capability to display source windows varies greatly from manufacturer to manufacturer. Some processors allow up to four source windows to be displayed on a single screen, while other models enable dozens of windows to be presented per screen. Displaying the same source in multiple windows or multiple outputs at different sizes can be beneficial for very wide videowalls servicing segmented workgroups in a large room. The greater the source placement and windowing capabilities of the processor, the more flexibility there is to create the window layouts that satisfy application requirements.

Multiple Output Resolutions

Some videowall processors can output multiple signal formats simultaneously. This is useful for systems that incorporate displays of various resolutions, such as a videowall comprised of large 1920x1080 projection cubes flanked by 3840x2160 flat panels as auxiliary displays. Processors limited to one output format should feed a signal at the native resolution of the videowall displays. For auxiliary displays, signals from the processor may be upscaled or downscaled to match their native resolutions.

Window Borders, Titles, and Clocks

A videowall processor's capability to add colored borders and text to source windows can be a powerful feature in many environments. Colored borders can denote the status of the content in a command and control room, such as green for unclassified data and orange for top-secret data. In a traffic monitoring environment, a red border can help highlight an accident. Overlay text can be used to provide information about the source, such as the location of a reporter. Clocks displaying the time for different regions or time zones can be generated by many processors, allowing an integrator to streamline system designs by avoiding the need for external clocks or status displays.

Remote Control Protocol

Some applications may require a touch panel, controller, or use of a customized application for videowall control. In these systems, the videowall processor must support Ethernet or RS-232 remote control. Control options vary from manufacturer to manufacturer, so it is important to make certain that all required control capabilities are supported. Videowall control is discussed further in a later section.

Portrait Output Orientation

Display devices in a videowall are usually arranged in landscape orientation. However, a system designer may favor displays in portrait orientation or an asymmetrical layout to meet creative or technical objectives for a project. Figure 3-10 illustrates a comparison between videowalls with landscape and portrait-oriented panels. It shows that the use of vertical displays may produce a more compelling presentation of images and objects.

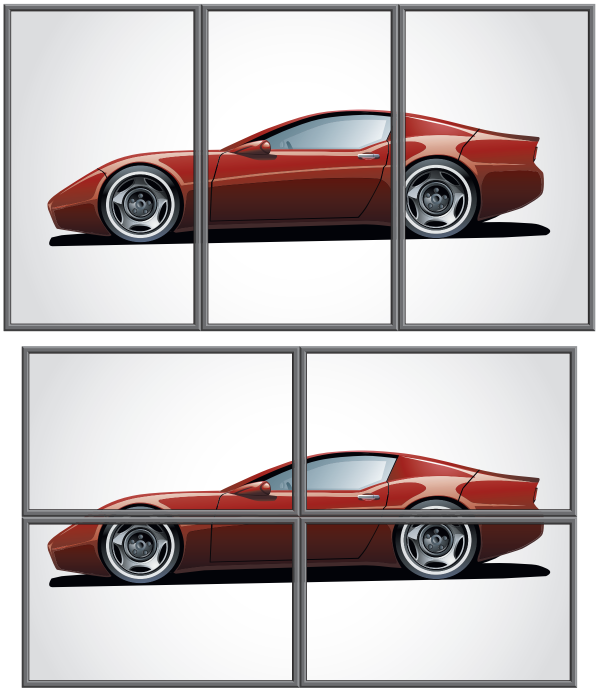


Figure 3-10. Orienting displays in portrait mode may allow for a more compelling presentation.

A videowall processor that has the capability to rotate its outputs can easily accommodate portrait displays. However, this is not a common feature and is only supported by a few models. Make sure the processor selected for the system can handle this requirement if it is crucial to the project's success.

IP Decoding

The security and traffic management industries have migrated from analog, standard-definition video cameras to IP-based cameras which produce high-resolution H.264, MJPEG, or other digital video streams. These streams can be decoded by a computer or outboard processor and delivered to a videowall processor as HDMI/DVI, SDI, or another format. Some videowall processors have the capability to directly accept an IP stream and decode it internally, eliminating the need for external decoding. Overlaying embedded Metadata on the video signal is a popular feature that aids the system operator in identifying the images they are seeing.

Virtual Network Computing – VNC is a desktop-sharing system that consists of a server application running on a computer that is sharing its desktop and a client application that decodes the stream. Some videowall processors have an integrated VNC client application that allows one or more shared desktops to be displayed. Because the image generally refreshes only a few times per second, VNC works best for desktop sources with minimal motion, such as data screens.

Application Control

Videowalls in data-driven environments such as utilities and network centers often require the capability to manage applications presented on the videowall using a keyboard and mouse. This can be accommodated by installing and operating applications directly on some videowall processors, much like a computer. Other solutions integrate hardware or networked software switching systems to manage keyboard and mouse control on the source machines. Software solutions mandate compliance with operating systems and network security requirements, while hardware solutions require additional cabling and control integration.

3D Support

Visualization or simulation applications may necessitate presentation of 3D content. Few videowall processors currently support this feature since 3D imaging is a specialty application. Additionally, the system's source devices and displays must be compatible with 3D content and signals. Note that there are two different types of 3D presentation, passive and active. Viewing passive 3D entails wearing polarized glasses. Active 3D requires electronically shuttered glasses that receive timing information from a transmitted synchronization signal.

Preview Output

Some organizations want a smaller representation of the videowall available for viewing elsewhere in a facility, on one or two screens, or streamed to another location. This allows other staff to see an overview of the videowall, without requiring the use of a large number of display devices. Some processors provide a preview output of the videowall within the control software or one that can be sent to an output. Other processors allow preview layouts to be programmed and presented on additional outputs.

Low Throughput Latency

Video processors introduce a degree of throughput latency, resulting in the processed output being slightly delayed when compared to the original input source. The amount of latency varies from a few milliseconds to several hundred milliseconds. This delay also depends on the amount of processing being performed and how efficiently the processor is executing its tasks.

Throughput delay may have a negligible impact for most videowall applications. However, it can be a concern when the videowall is displaying camera feeds for a live event, or when an operator using a mouse to work with a computer source presented on the videowall. When calculating throughput latency, one must include any other devices in the signal chain that could introduce delay, such as signal extenders, additional scalers or video processors, and displays.

Conclusion

No single videowall processor offers every feature and capability presented in this guide. When designing a system, focus on fulfilling the installation's most critical features and functions. Ensure the videowall processor you select satisfies the application requirements. Where specifications and marketing information are not obvious, insist that the manufacturer's support staff be able to clearly verify that your requirements are supported. A videowall processor that was extremely successful on one project may not be the best choice for the next project. ■

Videowall System Control

Videowalls are among the most complex types of AV systems to set up and configure. Most of the operational complexity is within the videowall processor and its many functions, features, and capabilities. Working with a videowall processor will be greatly simplified if an intuitive, user-friendly interface is available for system configuration and creating window layouts. The more intuitive the interface, the more streamlined the setup and configuration process will be.

Videowall system designs should include consideration for the end user interface, in terms of how staff will operate the videowall. Videowall control should streamline the user's workflow. This may be accomplished by providing a touchpanel with simple button selections for window presets or input sources, or by tying these functions into control room system management software.

Basic Control

Small, simple videowall processors can be configured and operated from a front-panel interface that provides access to all of its setup and control functions. Some processors can also be configured through their internal Web server, accessed by a client Web browser over the network or the Internet.

Control Application Software

Most videowall processors require the use of specialized application software for setup and configuration. For a computer-based processor, the application can usually be run on the unit itself, while for other processors, a computer runs the software and connects to the processor as a client. See Figure 3-11.

The application software aids in navigating through the many functions and features for videowall processing. It includes a GUI and usually groups controls and functions into a logical organization of essential tasks, such as configuring the inputs for incoming source signal formats, defining the videowall configuration and setting up the displays, and creating and saving window layouts. The application software includes a virtual canvas that lets you visualize the window layout as it is being created and drag-and-drop windows onto or off the canvas.

Remote System Control

Videowall processors can be controlled using the application software, or a control system through the RS-232 or Ethernet control ports.

While the application software can be used for system control, the user interface usually includes far more functions and options than necessary for a staff member or system operator, who often lacks detailed technical knowledge of the system. Rather than making the application software available to end users, it is usually preferred to create a simplified control interface with a series of button selections, so a user only needs to control the most common or essential functions on a videowall – selecting an input source or a pre-programmed window preset. This can be provided through a custom GUI from a touchpanel or custom software interface created by the application software or other third-party software managing control over other processes. See Figure 3-12.

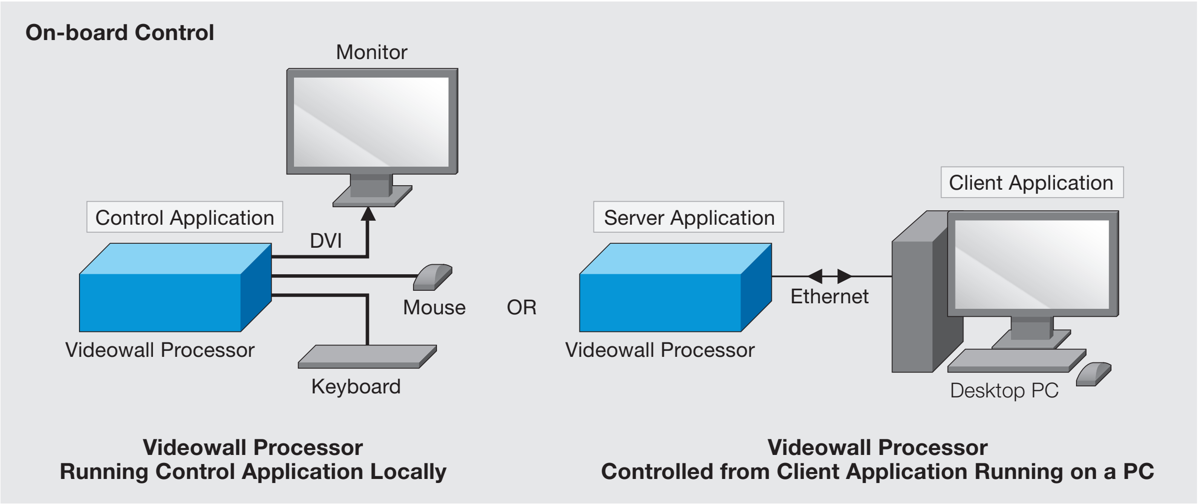


Figure 3-11. Control application software can run on the videowall processor, or a computer connected as a client.

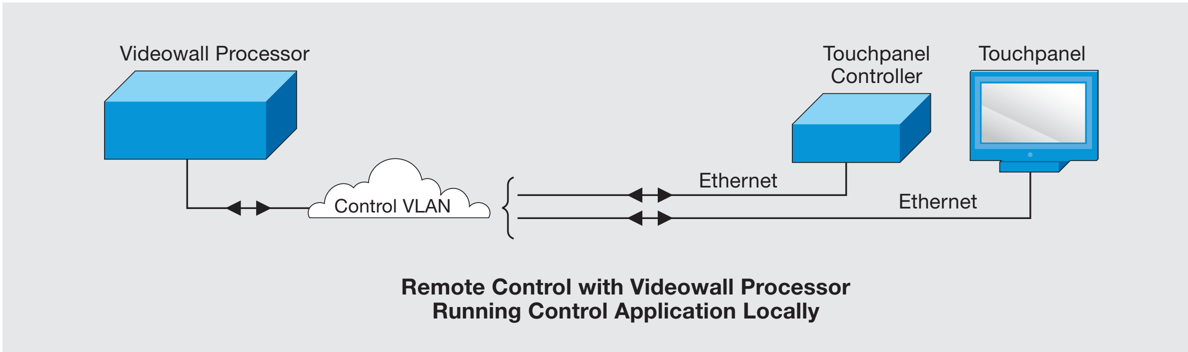


Figure 3-12. A user can access select videowall controls through a touchpanel for a control system, or an application GUI on a computer.

Large Facility Control

Many large facilities, such as command and control rooms require that management of all communications including AV be centrally integrated into a single control system. This allows multiple room operations to be performed from a common GUI. The system can be programmed to incorporate videowall window layout and input source selection, with buttons provided in the user interface alongside other communications functions. Videowall-specific controls may also be provided separately on a touchpanel for an AV control system.

On-Demand vs. Show Control

For most videowalls in working environments such as presentation rooms and control rooms, simple user controls will suffice for staff or a system operator to manage the display. However, entertainment-oriented applications call for elaborately timed, dynamic presentations, which may require a system operator to be trained in the use of show control software that provides access to a wide, free-flowing set of time-based effects. The ideal control method will depend on the environment and application requirements defined by the end user.

On-Demand Control

In work environments or live entertainment applications, changes to the videowall typically are triggered “on-the-fly” by an operator or end user. Recalling window presets and changing source window content are the most frequent actions performed on the videowall for work environments. End users may state they want the ability to place any image anywhere, and control “everything,” but are often unaware of exactly how complex this can make system management. In most cases, five to ten pre-defined window layouts, plus the ability to change source window inputs, provides sufficient flexibility.

Live entertainment applications may require more flexible on-demand control, such as changing source window size and position. A control system that allows multiple actions to be stored and released as a single event may be necessary to produce a clean execution of these layout changes.

Show Control

Videowalls used in retail stores, museums, or other public spaces often include specially created productions that include the presentation of looped video content, with creative visual effects timed to video edit points or events in the content. To coordinate videowall actions with the content, an audible SMPTE or EBU timecode signal is recorded onto one of the audio tracks for the content. This is supplied to a computer running a show control application to provide the time reference for initiating commands, as well as a reference for actions on other show control devices. The show control computer releases control commands to the videowall processor or its control computer, triggered by the incoming timecode signal. ■

Extron TouchLink® Pro touchpanels can be used to provide a simple user interface to manage selection of videowall display layouts and sources.

Additional Videowall System Elements

Due to their large size, videowalls may be the focal point of a room, but they are often just one element of a larger system. System control, signal distribution and extension, audio, and more all play an important role in managing signals and sources. When dovetailed, content can be controlled, seen, and heard.

System Control

A well-designed control system allows a user to effortlessly manage each element of an AV system. Switcher control, videowall window layout and source selection, tuner channel selection, audio control, and room lighting should be accessible from an intuitive interface that makes controlling the system as easy, if not easier, than turning on a TV and watching a movie at home.

SYSTEM CONTROL

Extron TLP Pro 1525TG
Touchpanel

Designing such a system can be as much art as science. In addition to technical elements that can include managing device drivers, data strings, and conditional logic to connect and manipulate devices, there are visual and operational elements, such as the look and feel of the interface. While the system may be complex, the user interface should make it easy to operate. The way to accomplish this is with a logical workflow, easy-to-identify icons and indicators, quick response to button presses, and positive feedback indicating when requests have been initiated and performed.

SWITCHING

Extron XTP II CrossPoint® 1600
Matrix Switcher

Switching

Switching systems deliver source signals to videowall processor inputs, scalers and video processors, standalone displays, streaming encoders, or other system devices. Matrix switchers can simultaneously send a single input to multiple destinations and perform video routing for multi-room facilities. This allows any input to be sent to any destination. Some matrix switchers route audio and multiple video signal formats, providing complete signal management.

A matrix switcher can be a cost-effective videowall source management solution. It can be used to dynamically route only the sources to be displayed in the current window preset, reducing the required number of videowall processor input channels.

Signal Extension

Very long signal runs are often necessary when equipment rooms are located at considerable distances from source devices or display systems. Conventional coaxial or digital video cable may be sufficient up to about 75 feet (23 m), but longer runs require signal extenders to ensure signal integrity. Installation of a transmitter at the source device and a receiver at the far end device, connected by twisted pair or fiber optic cable, facilitates very long video, audio, and control signal runs. A twisted pair extender can provide signal

SIGNAL EXTENSION

Extron DTP3 T 202 & DTP3 R 201
Twisted Pair Transmitter and Receiver