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Situational Awareness in Control Rooms?**



# Do Video Display Walls Improve Situational Awareness in Control Rooms?

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## Introduction

In the past several years, many organizations have made significant investments in their control room infrastructure, with the goal of improved situational awareness for control room staff. The most significant projects often include large video display walls. Many of these projects have been extremely successful; operators have access to new information that supports rapid decision-making in changing situations. Unfortunately, other projects have fallen short of their objectives. This article investigates how one might ensure that a display wall project will be successful. We'll start investigating this by reviewing what situational awareness is.

diverse sources; monitoring the health of critical systems to understand the quality of available data, and receiving timely notifications of important information.

## How do various types of display walls contribute to situational awareness?

Display walls are common in control rooms. Current display walls range from large paper drawings and maps, metal or mosaic tile walls (with or without indicator lights), LCD or plasma panels, front projectors, and rear projection displays. Hybrid solutions that combine several of these methods are also available.

When considering the potential approaches from the situational awareness perspective, we categorize them as 1) Static display walls, 2) Static display walls, augmented with dynamic content, and 3) Video display walls. Each is explored in the following paragraphs.

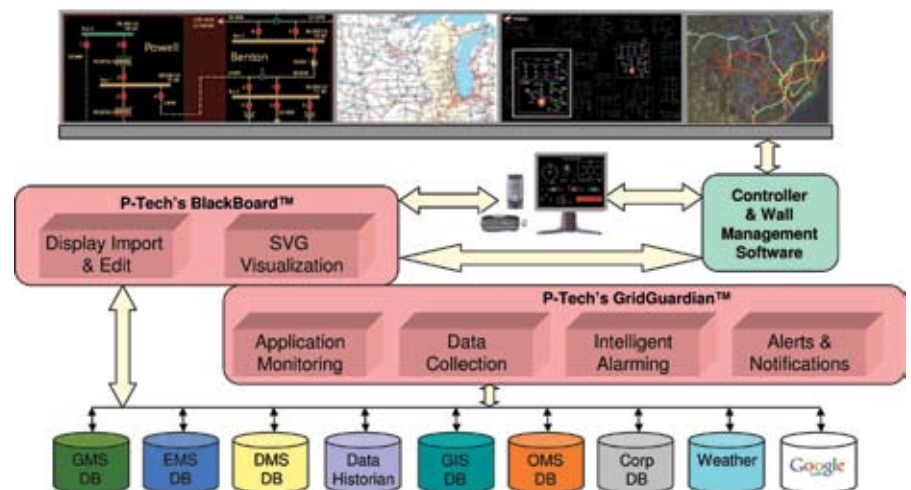
Static display walls include paper, metal, and mosaic walls. They are much less expensive than their dynamic counterparts and typically present a schematic view of the user's service territory. It is beneficial to have a comprehensive view of the electric system, and their comparatively low cost is attractive; however, they make only a marginal improvement to situational awareness. Operators must capture an understanding of the real-time conditions

## What is Situational Awareness?

Situational awareness, as defined by Wikipedia, is the knowledge and understanding of the environment that is critical to those who need to make decisions in complex areas. The definition continues by saying, "...situation awareness (SA) involves being aware of what is happening around you to understand how information, events, and your own actions will impact your goals and objectives, both now and in the near future. Lacking SA or having inadequate SA has been identified as one of the primary factors in accidents attributed to human error."

Clearly, control room operators must have a thorough understanding of what is happening to support complex decision making. We believe they accomplish this by assimilating information from

## Data Visualization for Display Walls



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™Google Earth mapping service is a trademark of Google Inc.

of the system from one source, and then mentally transpose that image to the view on the display wall. The control room staff retains the burden of gathering the data from disparate sources and aggregating the information in their minds.

Static display walls are often augmented with dynamic content. This includes the static walls described above, supplemented with LED lights or digital displays. Walls in this category can begin to improve situational awareness. With the addition of dynamic content, the control room staff has a schematic view as described above, combined with indications of the current condition of the electric system. This provides operators with integrated information that gives them a better understanding of the current condition of the entire system. However, there are several drawbacks. First, a very small percentage of the surface area is dynamic, and the dynamic elements often serve a rigid, pre-defined purpose. Operators cannot alter their view of the system as conditions change. Additionally, with many of the hybrid solutions, your staff is still forced to mentally combine the video content with the information on the static display wall. Based upon the design of the hybrid, some significant steps toward improving situational awareness can be achieved.

The final category is display walls built entirely of video displays. Studies show that visual representations can accelerate insight into complex data by taking advantage of the human eye's high-bandwidth pathway into the brain, allowing operators to see, analyze, and understand large volumes of information quickly. Given this, video display walls seem like the perfect technology for a control room. Video display walls can present a comprehensive view to operators and allow them to discriminate between important and unimportant situations. These displays are typically built with front projection or rear projection systems, but may also include tiled LCD or plasma panels. Video display walls are a great

approach for viewing different displays, viewing a schematic or geographic view of the service territory, and swapping between the schematic and geographic views. With the right software, video displays can integrate data from different sources, and the content may be changed or sectionalized for independent operator viewing. The major drawback is cost, as video display walls are the most expensive solution discussed.

### How do you ensure that your video display wall project will be successful?

Many pitfalls could prevent you from having a successful display wall project. A successful project requires an educated buyer, good architects and design engineers, audio-visual experts, and knowledgeable software engineers. Many times an unprepared buyer faces budget overruns due to surprises with the complexity of the process, the mistaken belief that a display wall is a commodity purchase, or limited experience in the specific requirements for control rooms that operate 24 hours a day, 7 days a week. Recognizing the complexity, and keeping in mind the ultimate purpose, can result in a significant improvement to control room operations.

We'll continue by looking at the primary components of the display wall: hardware, display wall management software, and data visualization. The effective interoperation of these components provides an ideal environment for fast and effective decision-making.

#### Hardware

Some utilities consider tiling many commodity LCD or plasma panels together to create a large video wall, which is far less expensive than a front-projection or rear-projection system. However, commodity panels are not necessarily built for 24x7 operations, which can result in frequent replacement. Additionally, if the content on the panel is of a display that is relatively static, such as an overview of a portion of the system or an alarm

summary, the panel is subject to shadows from the continuous concentration of the same data and color at the same location – a condition frequently (if imprecisely) called “burn-in.” Another drawback is that the distance from the operators' consoles to the panel may reduce the readability of the panels, making them an ineffective investment. Additionally, this approach leads to disturbances in the visualization of graphics due to the mullions between panels; a mental leap is needed to view a single line that is separated by space.

Front projectors similar to those commonly used in conference rooms may not be an attractive alternative. Front projectors are a great solution for viewing different displays, viewing a schematic or geographic view of the service territory, swapping between the schematic and geographic views, and taking advantage of updates that are made to systems without the mess of tape and scissors. Front projectors may be “tiled” together to provide a somewhat scalable display wall size. As with commodity panels, not all front projectors are rated for 24x7 operations. The constant cooling fan noise can become annoying, especially during stressful conditions. Front projectors are not a bad option, if several are tiled together and the fan noise is tolerable.

A true display wall consists of a set of video cubes tiled together. A diverse set of manufacturers offer a wide range of features, but most offer a solution for light and color management; reduction in seam widths between cubes, expansion to accommodate the addition of new audio visual equipment; and the inclusion of live video feeds for security cameras, news, and weather. Without a doubt, video display walls are the most expensive hardware alternative, but provide a nearly ideal solution for improving situational awareness.

#### Display Wall Management Software

The first type of software required for video display walls is wall management software. It is part of the controller for

the display wall and supports the content being displayed.

Wall management software is typically provided by the display wall controller manufacturers. Standard features include the ability to place content on the video display wall. Wall management software has to interoperate with sources of content. Additionally, wall management software also controls the location of feeds from cameras and other sources. Optional features may include the ability to assign areas of the display wall to specific operator consoles, perform screen scraping of displays on other systems, or allow notes to be written upon a wall and captured in print. Good wall management software will have a well defined application program interface (API) to allow the user or other parties to send information to the wall management software for display on the wall using standardized programming techniques.

Choosing the wall management software that best fits the team's needs is a critical part of improving situational awareness with a display wall.

### Data Visualization

Although hardware and wall management software are important, it is the data visualization, that is, the content, that helps operators make decisions. This is the primary factor in determining if a display wall improves situational awareness. Significant improvements in situational awareness are made possible when the data visualization software, combined with the wall management software, is inter-operable; thus, eliminating mundane operator interactions with the video walls and providing more effective ways to review critical conditions.

As anyone who has upgraded home video equipment will understand, it takes more than a great hardware infrastructure to deliver spectacular results. A large format, high definition television is a good start, but it needs to be fed with high quality content to provide the desired image. The same is true with a control room. The investment in a video display wall cannot be justified if the same content available on the desktop is merely scaled up to fill a larger display surface. Given that, many organizations elect to build an overview display specifically for the display wall. This can be a good approach, but the customer needs to determine if the control

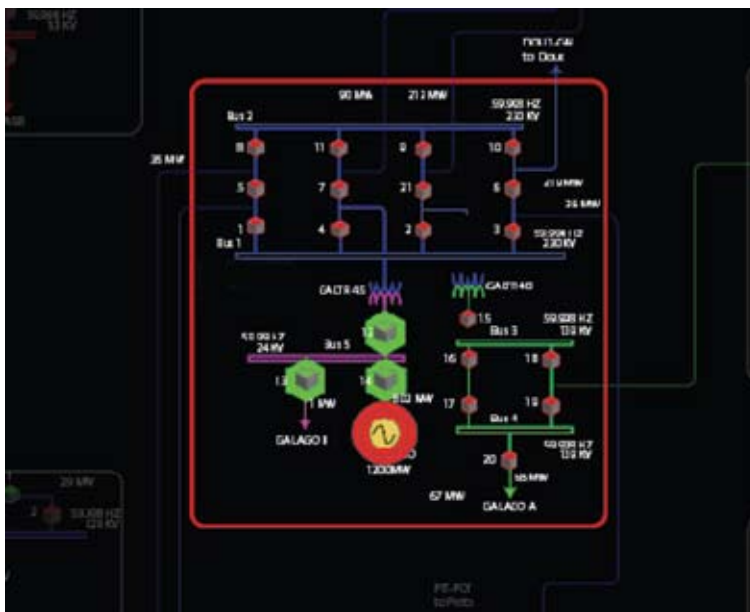


The data visualization above reflects data automatically built from GIS data and shows real-time updates from the SCADA system in KML files overlaying Google Earth.

system is capable of rendering a single display with the quantity and quality of dynamic content that is required for a truly informative system-wide display. Careful analysis may provide insight that the control system must have user interface refresh rates significantly lower than data scan rates on the telemetry to support a large video wall. Also, one does not want to inhibit the performance of control applications with heavy network loading that may be imposed when the data visualization solution resides on the same network as the control system. Control systems are complex and run intensive applications that must take precedence over data visualization; however, slower data visualization significantly inhibits situational awareness for operations. Optimal situational awareness demands dynamic content that is separate from that of the control system.

An overlooked issue is that display walls are often smaller than the tile mapboard they replace. Advanced visualization techniques are required to put an equal or greater amount of content on a display wall with less real estate than the original tiled mapboard.

Installation of a video display wall as part of a control room renovation is a complex project. Work will occur in the confines of a mission critical facility, so new equipment must be introduced without jeopardizing the operator's ability to control the electric grid. Operators must be trained to use new technologies



The data visualization above shows a portion of a schematic overview diagram using shading and brightness (high opacity) to indicate areas of a system that are in abnormal and alarm situations.

as effectively as they use the legacy equipment, the instant that it is deployed. Like the static wall that often precedes it, a video display wall must be reliable. In fact, an up-to-date visual representation of the electric system on the display wall is arguably most critical when the complementary control system has failed. This is a particularly critical concern when both systems reside on a common technology platform. As previously stated, the data visualization solution delivers the best value and reliability when implemented on a hardware platform that is completely independent from that of the control system itself.

While searching for a data visualization solution, be sure it provides interoperability with the wall management software and that it can integrate data from all relevant control room data sources, including all the quality and tagging information from the control systems. For operators to make the best decisions and reach the best conclusions, all information relevant to the decision needs to be immediately available, so it's important that the visualization solution elegantly provide a single real-time view of all field and processing equipment, the real-time values of all telemetered data, the quality of all information, the location of personnel that may be impacted by any decisions, weather and weather impacts, etc. This requires the integration of information from multiple systems and sources into one display.

Another important criterion in the search for a suitable visualization solution is ease of maintenance. The staff that supports the control center is often overloaded, and only rarely has access to additional staff to support new projects. Although maintaining tile mapboards and other legacy display walls is often labor-intensive, the level of effort is known and can be worked into the staff's routine schedule. By contrast, the level of effort required to properly support a new video wall is initially unknown and should be researched in advance.

The visualization solution should include a standard or customizable interfaces to many different systems and data sources (EMS, DMS, OMS, etc.), including redundant sources of similar data (when available).

The visualization solution should integrate the data into a single real-time repository. Additionally, the solution should be able to monitor the status of operational equipment (servers, communication equipment, field devices, etc.) in order to quickly detect any failures or questionable data sources. When concerns arise, the data visualization solution should be able to generate personalized notifications (i.e., text messages, text to voice, email, etc.) for management and support organizations, while also annotating the data with any quality or integrity concerns.

A visualization solution should provide robust calculation tools that allow sophisticated processing of data. This will allow for better animation to be deployed on the video wall enhancing operators' awareness of potential or pending situations, especially those resulting from the integration of information from multiple and sometimes variable sources. This should also provide some form of enhanced alarm management for operators. The solution should provide the highest quality text, symbols, and graphics available. Virtually every aspect of the solution should be dynamically controllable, including color, scaling, opacity, and animation, while retaining connectivity and aspect ratio with all the devices and symbols on the displays. The results should provide visually appealing, eye-catching, and informative displays.

Lastly, to reduce maintenance impacts while also improving situational awareness, the data visualization solution should support the efficient extraction of display information, not just from the existing control systems, but also from many of the most prominent systems used in control rooms.

## Conclusion

Control rooms are very critical to retaining reliability of the grid. Due to the risks of blackouts, cyber threats, and terrorist activities, there are many recommendations and requirements that are being driven by public service commissions, NERC and FERC to improve situational awareness. The introduction of a video display wall with flexible wall management software running on a dedicated platform, and a high-quality data visualization solution can substantially improve the operators' ability to assimilate large volumes of information; thus, allowing them to focus on interpreting and acting on the information rather than having to tediously navigate through large amounts of data before appropriate control actions can be taken.

## About Primate Technologies

P-Tech is a privately held company headquartered in Melbourne, FL, providing enterprise visualization solutions that epitomize the concepts discussed in this article. More information is available at [www.primate-tech.com](http://www.primate-tech.com). ■

## About the Authors

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