UNDERSTANDING LED SCREENS AND HOW TO SPECIFY THEM

Introduction

Many forward thinking venues and churches are now looking at purchasing LED screens as their main displays. They are an excellent communication tool, ensuring everybody can clearly understand and see what is going on, along with low operating and maintenance costs.

So you've made the decision to buy a new LED screen for your venue. You know that if you're spending a significant amount of money it has to look superb and last for a long time but you're not sure how to interpret all the technical jargon, and work through the myriad of options - from importing directly from China, through to a 'made and designed in the MY' product.

We have specialised in supplying, installing and renting LED screen systems for many years at venues across the MY. We still believe that other technologies (Projection, LCD, etc) have a place for large format displays, but with the latest levels of combined price and performance the LED screen is a serious contender for the ultimate premium display option.

Our ambition for this article is to help you understand the next steps in selecting the best LED screen for your venue.

We hope you will find it valuable!

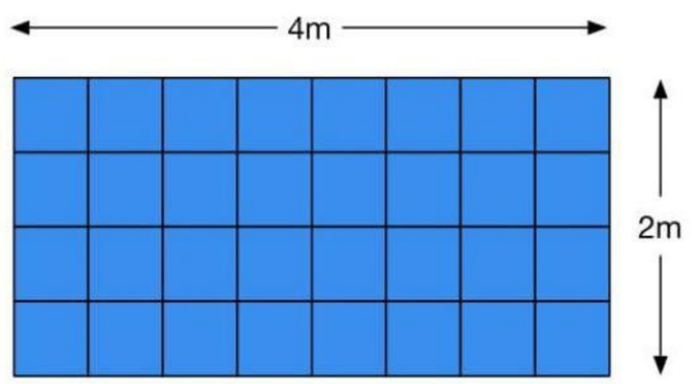
CONTENTS PAGE

What is an LED Screen?

An LED screen is a large format display, where each pixel is made up of a small group of LEDs. These are mounted onto panels in an array and then multiple panels are joined together to create a full image. Each panel is typically 500mm by 500mm but they can come in many different sizes. For example if you wanted a 4m by 2m LED screen you would need 8 panels wide by 4 panels high (32 panels total).

In each panel there's a power supply and a receiver card, which accepts the incoming signal and turns it into the desired image on the LED screen.

Large Format LED Screen
8 panels x 4 panels



Why choose LED screens over other types of large format display?

It's bright! The single biggest advantage is that the technology allows LED screens to be incredibly bright. This is essential in bright rooms and outdoor areas, and really beneficial everywhere else. This brightness is measured in NITS.

It's very dark! When you turn an LED screen off, it actually goes black. If you turn a projector off, it goes white. This simple difference has a huge impact on the contrast ratio, and visual quality.

It's modular. With the panel building blocks you can create LED screens in any shape or size you like.

It's compact. A typical LED screen is less than 100mm thick, regardless of screen width, however a 4m rear projection system, might need 4-5m of depth. This enables versatile installations in interesting places.

It's low maintenance. LED light sources last for a long time. 25,000+ hours of run time is not unusual.

What about the disadvantages?

Price. At first glance, the panels can appear quite expensive but the latest systems are becoming better and better in value, especially when you consider the total cost of ownership and the level of performance. Over a 5 year period an equivalent performance projection system is actually more expensive! So the key question to ask yourself when considering price, is 'am I looking for that level of performance?'

It can be heavy. Again, this element is getting better, but you still can't escape from the fact that typically one sqm of LED screen will weigh 30-35Kg, making LED screen ~8 times heavier than the equivalent projection system. We have many options to ensure that your screen can be rigged safely and in a compact manner, so this doesn't need to be a concern.

What about power? The idea that LED screens use a lot of power is actually a myth. When comparing them to alternative technologies with equivalent brightness displays (projectors, plasma walls, etc,), LED screens are one of the most efficient systems currently available. This is primarily due to their exceptional optical efficiency of the actual LED elements themselves.

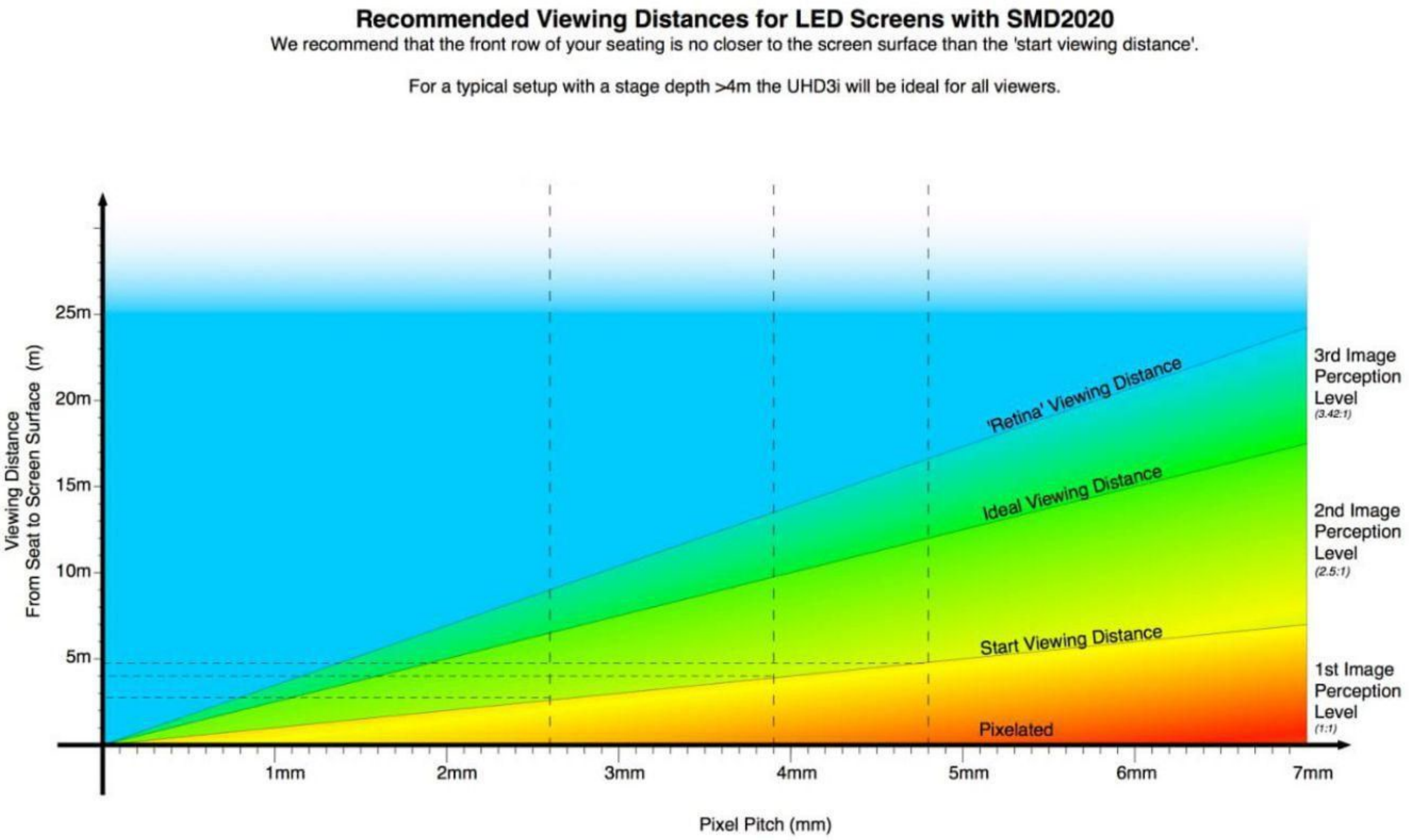
Jargon Buster: Understanding the detailed specifications

When comparing one screen with another we recommend that you ask for specifications in a per square metre format. This helps to simplify comparisons between different panel sizes.

Pixel Pitch (and viewing distance)

Pixel pitch Is the distance in mm from the centre of one pixel to the next. For example a 3.9mm pixel pitch panel measuring 500mm x 500mm can hold 128x128 pixels (giving a total of 16,384 pixels per panel). If you lower the pixel pitch to 2.6mm, on the same size panel, you can fit more pixels on the panel. For example a 500x500mm panel with a 2.6mm pixel pitch holds 192 x192 pixels (giving a total of 36,834 pixels per panel).

It's a common misconception that pixel pitch defines the screen resolution, but this isn't true. We actually need to consider both the pixel pitch and the screen size. For example a 7.5m wide screen with a 3.9mm pixel pitch, has the same resolution as a 5m wide screen with a 2.6mm pixel pitch.



A diagram showing ideal viewing distances compared to pixel pitch

So how do we choose the right pixel pitch? This all depends on one key factor - how far away the viewer will be from the LED screen (and don't forget that camera shots need to be included too!). This is important because our eyes have a limited resolution and like Apple's "retina displays" (where individual pixels become imperceptible) the same thing happens with LED screens. Imagine you are stood 2cm away from an LED screen (you might want to turn the brightness down!). When you open your eyes you will just see a bunch of dots, with no image at all. This is the first image perception level (IPL).

As you walk backwards the image will start to form, eventually it will merge into a continuous image. At this point you're at the second image perception level, often referred to as the 'viewing distance'. As you keep walking backwards, the level of detail will apparently increase until the observed resolution nears your retina resolution. This is the 3rd image perception level.

When you walk further back from this point the level of detail will appear to decrease, as your eyes are unable to resolve the image (just like looking at a tree a long long distance away, it will look less detailed than when you are up close).

The best possible viewing distance for an LED screen is at the 3rd perception level and further away. In other words, this is the point where reducing the pixel pitch won't increase the amount of detail the viewer can see. We would suggest that your front row of seating is positioned at a minimum distance of the 'recommended minimum viewing distance'. (i.e. 2.6mm >3m, 3.91mm >4m, 4.8mm >5m)

There's also one other factor to consider, which is the SMD size. This doesn't affect the 3rd image perception level but it does affect the 1st and 2nd (we'll look at that in more detail later).

To see the 3 IPL distances for different pixel pitches with a SMD 2020 chip please see the diagram.

LED encapsulation mode

This covers a group of parameters, all to do with the physical build of the LED. The two most significant aspects are 'how big the LED is' and what colour it is when you switch it off.

Why is the physical colour important? When you switch the LED screen off, it should be very black. This black is the darkest colour your screen can reproduce. If you imagine your LED case, face & PCB were all bright silver, this would have a big negative impact on the image quality. All the black colours would have a washed out appearance (because they are now light grey). The best technology uses a black case, face & PCB.

SMD Size

What about the SMD size? The SMD (surface mount device) is the actual LED itself. Typically each pixel (SMD) is actually 3 LEDs (1x red, 1x blue, 1x green (RGB)) all packaged together in one tiny box. The SMD is followed by two numbers, often 20 20, or 35 20, or 10 10. These describe the height and width of the LED in tenths of a millimetre. For example a SMD 2020 is cased in a box 2mm wide and 2mm high. Generally speaking a bigger LED looks better when you're close to the screen but at a distance it doesn't make much difference.

Resolution

This is the number of physical pixels in your complete screen and is expressed in a horizontal and vertical count i.e. 1920x1080 (WxH). If you see a value like 128x128 it will be referring to how many pixels are on one panel/module, rather than your total screen resolution.

The total screen resolution is directly related to the final total screen size and pixel pitch.

Driver IC

The LED driver chip is really important. This is a big factor in determining image quality/colour calibration, reliability, flicker, refresh rate and many other elements. The industry standard is the MBI5124. This is the base level driver chip and should be considered a minimum for any professional product. The next step up is the MBI5153 and MBI5252. The key differences for the end user are fault tolerance, image quality and refresh rate.

It is really worth the extra money for the MBI5252 even if it's just for the refresh rate improvement.

Refresh Rate

The refresh rate is how many times the LED flashes it's colour in a second (measured in Hz). If it flashed it's colour only once a second you would see the screen flickering very badly. At 25 times per second (25Hz), the human brain starts to perceive the flashing as a continuous colour. At around 400Hz the flicker is undetectable to the human eye.

Video cameras are much more sensitive to this and a 400Hz refresh rate will have lots of visible flicker, especially if the cameras frame rate isn't synced to it (via a method called genlock). The point of imperceptible flicker on a video camera is around 3,000Hz refresh rate.

If a screen is using a MBI5124 chip (basic chipset), and the input signal is at 60Hz, it's maximum refresh rate will be 1,920Hz, which is flicker free for the human eye but is easily seen on camera. If the input signal is 50Hz then the maximum refresh rate then drop to only 1,600Hz which is even worse.

The MBI5252 chipset operates at double the refresh rate of the MBI5124, giving 3,840Hz (p60-framerate) and 3,200Hz (p50-framerate) respectively. So you can see the differences have a look at the video clip on our website.

Frame rate

This is the number of times a new signal is sent to the processor. You could also say it's how many times the image changes per second. However, this is different from the refresh rate and is normally user selectable. It's typically 24/25/30/50/59.94/60 frames per second.

Grey Scale

This is the bit depth of the grey scale dynamic range. In other words it shows you how many colours the LED screen is capable of reproducing. Typically a high quality screen has a 16bit capability for each colour (R, G & B) giving a 48bit colour depth in total. This results in it being able to reproduce 281 trillion different colours!

Viewing Angle

This is simply the maximum horizontal angle (180 degrees would be completely sideways) that you can still see a clear and bright picture. When you go beyond this angle the colours will start to shift towards two of the 3 RGB components, and you will get a yellow or purple 'hue' across the screen. Beyond that the shader (plastic front protection cover) will block the light completely.

Brightness

This is simply a measure of how bright the screen can go at max 'white'. It's measured in nits

An uncalibrated screen will have some pixels which shine brighter than others, this will give you an artificially high brightness figure, but poor uniformity. Once a screen has been calibrated then these 'over bright' pixels will have been turned down to match with their slightly darker neighbours. This will reduce the overall brightness, but increase the uniformity. The more expensive LED screens will use a better mix of LED brightness in the first place, and require less calibration.

For an indoor screen in dark & atmospheric lighting conditions normally 800 nits would be an ideal brightness. In a bright room then 1,300 nits would be excellent, and for a very bright sunny day outdoors then 5,000-7,000 nits would be best.

Contrast Ratio

This is an often misunderstood measurement, primarily because manufacturers measure it in so many different ways. The Contrast ratio is the difference between the brightest and darkest parts of an image, and is normally measured with a 4x4 checkerboard black and white pattern. With an LED screen, black is normally the absence of light, and in a laboratory condition where there is no ambient or reflected light, then black will actually be 0 nits, now if you compare this to the brightest section of the image, which may measure ~1,500 nits. Because we are comparing the max to the min, and our base is 1 (for a ratio) it will actually give us a contrast ratio of ∞:1, which is obviously not much use to compare! So it is normally best to ignore this statistic unless there are very clear indicators as to how the measurement has been made, which would allow for a fair comparison. Instead, we recommend actually looking at an image on-screen for yourself and checking the contrast.

LED Lifetime

There are normally two figures quoted here:

> **LED lifetime**, which is the predicted number of hours each LED will remain within 70% of it's original brightness (also called L70)
>
> **MTBF** (or Mean Time Between Failure). This is the anticipated number of hours between a component failure.

It's important to watch for where these figures come from. Typically the LED RGB manufacturers predict the life expectancy of the LEDs based on them running within their ideal operating conditions (good heat dissipation, regulated current flow, etc.). Unfortunately, to achieve extra brightness at low cost, the LEDs can be overdriven, significantly reducing the real world life expectancy. To test for this we make sure all of the LED screens that we recommend undergo our long period testing before we allow our customers to purchase them. (we leave a sample panel on max white continuous 24/7 for years!). Based on typical venue usage figures (~35hrs wk) we expect the LED screens that we recommend to last in excess of 8 years, and potentially many more.

Power Supply and Draw

To start with you will need a power supply with the right voltage range and frequency for your country. Then after that it's down to how much power each panel will consume.

This will be listed something like '150W Max, 75W Average, per panel'.

When a panel is on all white and flashing rapidly it will consume the most amount of power. In normal video use it will consume around half of this, and with white text on a black screen it will use practically nothing! So what power supply do you need?

When you switch the screen on, it will use its maximum power for a short time (less than a second). This surge of every panel switching on at once will be the single highest moment of power demand so, this is the maximum that we need to cater for.

Bearing the ‘switch on’ moment in mind, we take the maximum power requirement (typically 150W) and add 20%. Then we join 2,800W worth of panels together on a single cable/supply, (which is normally around ~16 panels). We then use a 16A type ‘C’ breaker for each supply, along with a high current switch. This will give you a long service life and no problems when switching on & off.

If your electrician asks you for a diversity calculation, then please contact us to help.

How do you control an LED screen?

To start this section it's important to understand the different parts that make up the control system. You can compare an LED screen to a giant TV, you can send it your signal (say a DVD player or computer) and it will show it on screen for you. To do this it needs to:

1) Match the incoming signal to the display
2) Prepare the pixel information and get it ready for the LCD screen.

The LED screen is exactly the same, the difference is that the TV has these two processors built-in, where as the LED screen has them as separate units. In fact the separate LED panels can't do any kind of processing by themselves. If a screen is very large it may even require more than one of each processor type to do the job properly.

The first of these two processors is the scaler.

A diagram showing the comparison between the way a TV and LED Screen work

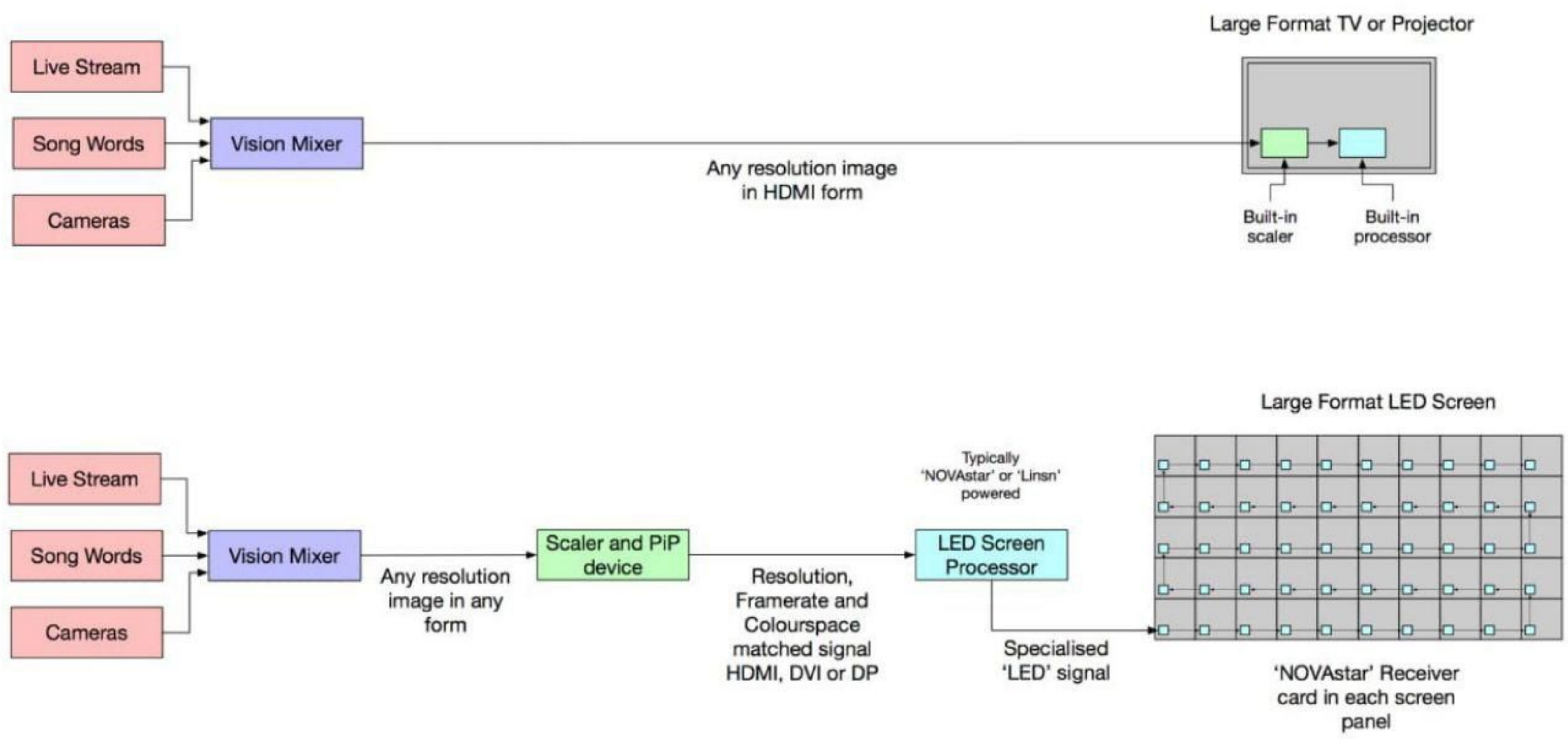


Diagram showing a comparison between the different control aspects of a TV & LED screen

Scaler, Switcher and PiP device

A scaler takes the incoming signal at a given resolution and matches the pixels on the input signal to the pixels on the display. It also adjusts the frame-rate, colour space and interlacing method when necessary. This process is called up/down/cross conversion. For example: your input signal may be 1080i50 and your LED screen panels might be 720p60. The scaler would down convert, de-interlace and increase frame-rate to match the two together.

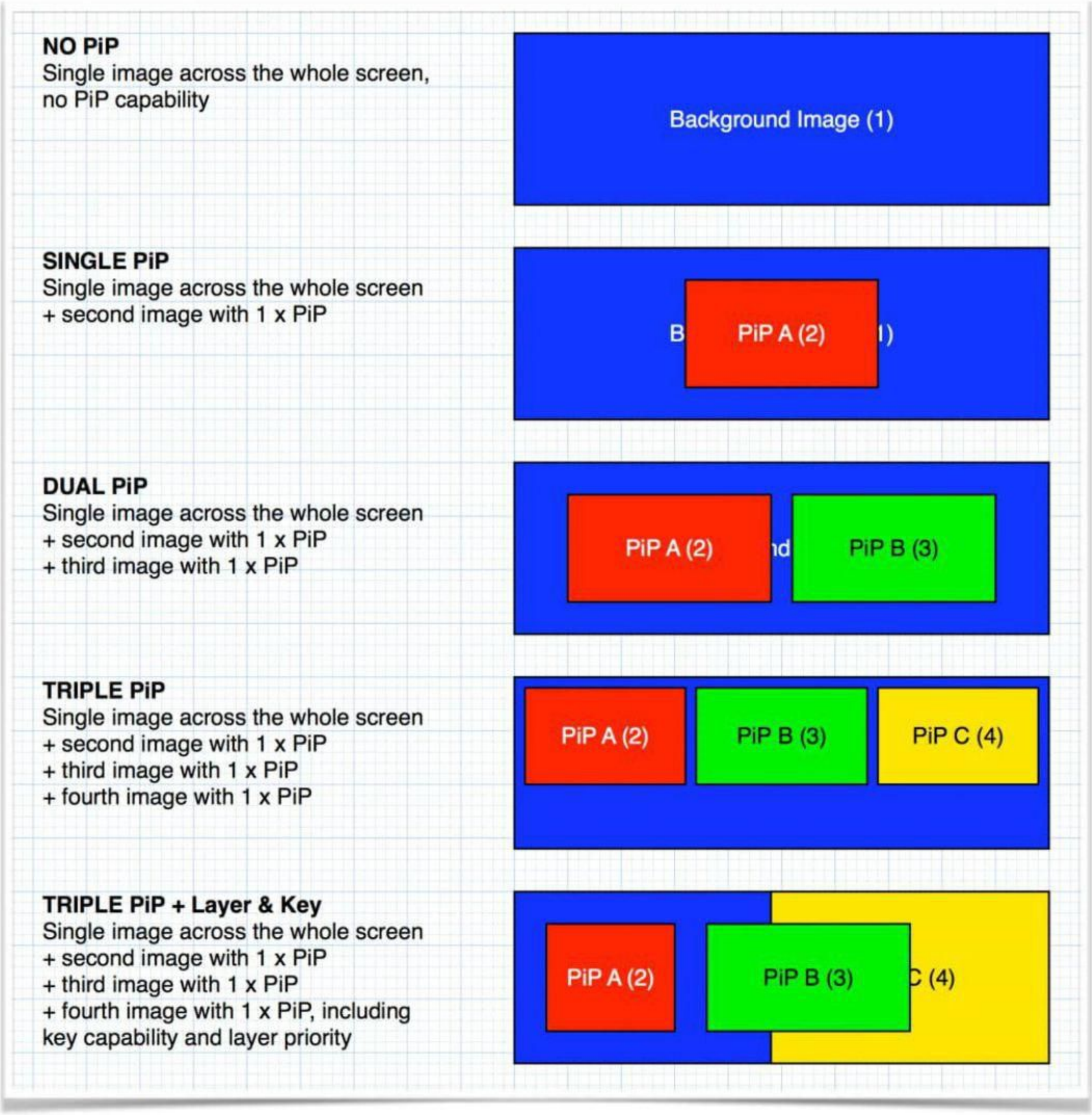
Scaler PiP:

As well as this it can normally do a few other things. The powerful systems have the ability to zoom, stretch and position the video on screen, along with adding & mixing other video sources in at the same time. This type of processing is called 'Picture in Picture'.

The simplest option would be a single PiP capability (often described as dual image). This is where one video feed is put as a background image with the second put into a 'window' and placed on the top in a size and position chosen by the operator.

The position, size and signal source of the window can be adjusted and different presets can be saved so that the operator can quickly recall the different scenes. The more sophisticated systems add extra PiPs and also add the ability to 'key' sections of the image creating transparent sections.

The kind of thing you can do with a multiple PiP system would be to layer a live video feed over the top of a widescreen animated background with the sermon message displayed at the same time.



A diagram showing the different types of PiP system commonly found in scalers (most only have single PiP capability)

Scaler Resolution:

It's also very important to remember to match the resolution of your final screen with the capability of your scaler and LED processor. The images below show what happens if you have a high resolution screen, say 8K pixels wide (capable of the detailed image on the left), but only use a 1080p or 4K scaler system. This results in a lot of loss of quality and detail, creating a 'pixelated' and soft image. At a very long distance away (outside perhaps) this will be manageable. But for all normal indoor uses it will look very poor. To achieve super high resolutions we make use of a deployment system called mosaic, which allows us to handle full resolution content with screens upto 16K pixels wide, ultra low latency, and triple PiP capability!

*Scaler & Screen with a **matched resolution***

***8K Scaler, 8K LED Screen**(total pixel width)*

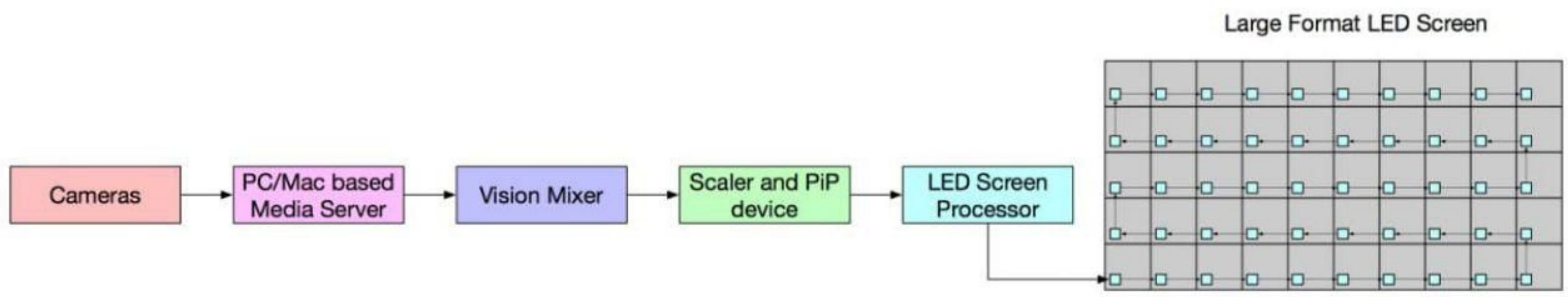
*Scaler & Screen with an **unmatched resolution***

***1080p Scaler, 8K LED Screen**(total pixel width)*

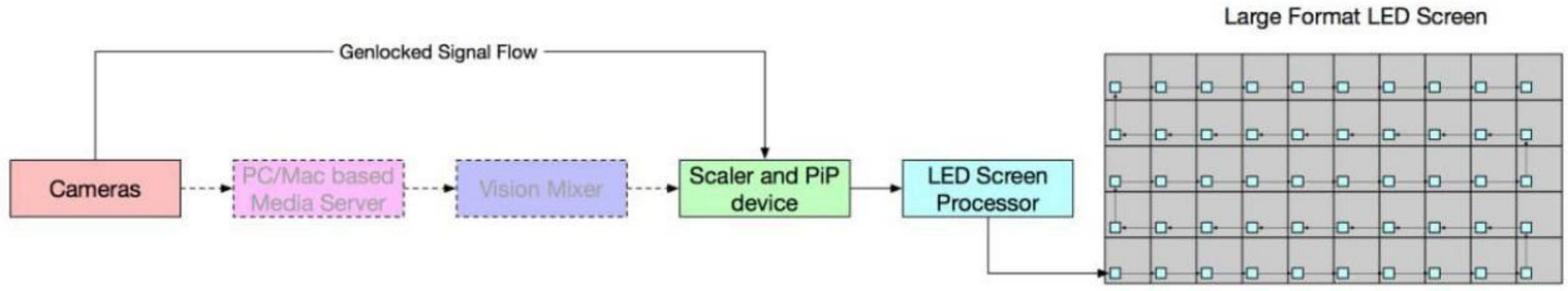
Scaler Signal Delay:

To do all of these aspects well we will need to make sure we use a hardware controller, as the software based scaling/mixing options (like Pro-presenter, Hippotizer & Resolumé for example) have a high level of signal delay. This is fine for video presentation and animated backgrounds, but it makes live on-screen camera footage look terrible! Our hardware options normally deliver a maximum total signal delay (this is called latency) of 100ms from camera capture to display. Typical software solutions are around 300-400ms.

A diagram showing the quickest & slowest path for Live Video to reach an LED Screen



Option 1. Slow - high latency



Option 2. Fast - low latency

A diagram showing the 'quickest path' for live video on screen

The next processor in the signal chain, is controlling the actual pixels on the display. To do this we need to take our 'scaled' signal, look at each pixel in turn and send the right information to the correct place on the display screen. This is called the 'LED Screen processor', typically the LED screen processors can't do the scaling bit, so do make sure you have both!

LED Screen Processor

The LED screen processor is a vital item. This converts a digital display signal (HDMI, DVI, etc) into a LED Screen ready stream, separating out each pixel individually and sending the right information with colours and brightness, and panel order etc.
Some of these have nice user interfaces whilst others are 'black boxes' with USB or ethernet control only. Once your screen is setup then you won't normally have to adjust these again.

The signal is normally sent over ethernet (cat5) and can typically run for ~100m before it will encounter a problem.

Inside the processor there are normally a few different chipsets used (a bit like 'Intel inside' a PC).
We recommend NOVAstar, but Linsn and many others also provide good options.

The key problem with the LED screen processors is that they don't have any scaling capability, i.e. change the image in anyway. They basically will just take the top left pixel of the incoming signal, and put it onto the top left pixel on your led screen rather than making sure it will fit.

We can provide training on how to set these up, and will commission and optimise the process as part of an installation.

Conclusion

We do hope this document has been helpful. If you should have any queries or questions please don't hesitate to contact us. We wish you every success with your LED screen.

A very special thanks to Rock-Tech Projects Ltd, a UK based company, who is the originator of this document.