

# GeoBox in the LED Wall Signal Chain

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The Open Video Processing Layer Bringing Precision,  
Flexibility, and Creative Freedom to Any LED Display

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## 1 Introduction: Why Today's LED Walls Need an Open Processing Standard

LED walls have become the signature visual element of modern environments — from control rooms and corporate lobbies to immersive art spaces, museums, exhibitions, and large-scale events. Their pixel dimensions and aspect ratios are rarely standard, their content requirements vary widely, and the signal chain must adapt instantly to whatever users connect: media players, laptops, cameras, conferencing systems, or real-time graphics engines.

Despite this growing complexity, most LED systems still rely on closed, brand-specific sender/receiver architectures. These were never designed for flexible, multi-format, multi-source workflows.

This is where **GeoBox** comes in.

**GeoBox is an open, brand-agnostic processing layer for LED, LCD, and projection displays.**

It works with any LED controller, any display technology, and any content source — without requiring changes to your existing LED infrastructure.

By operating as a neutral hardware layer *before* the LED sender, GeoBox ensures:

- Consistent scaling across non-standard canvases
- Reliable BYOD performance
- Multi-window / multi-source layouts
- Cross-technology integration (LED + LCD + projection)
- Professional-grade image processing
- Unified workflows across different brands and display types

This gives integrators a universal standard that brings all display technologies under one umbrella, a capability the LED ecosystem has been missing for years.

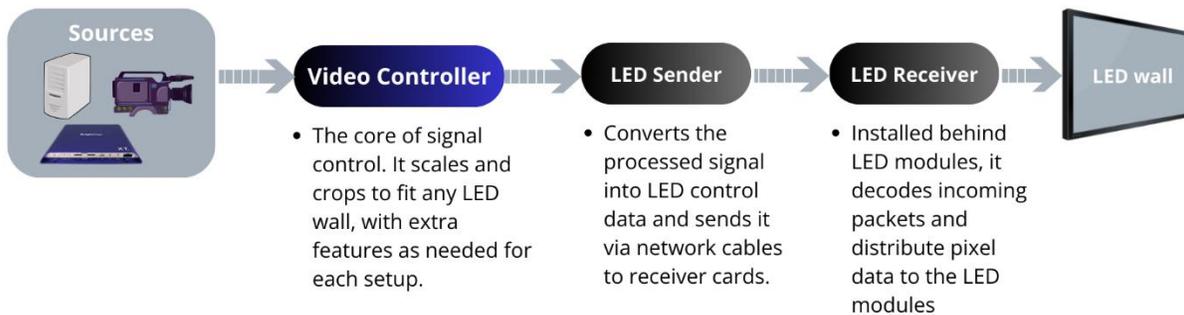
## 2 The LED Wall Signal Chain & Ecosystem Layers

### 2.1 LED wall signal chain

The LED wall signal chain starts with a **video controller**, which prepares incoming sources by scaling, cropping, aligning timing, and performing advanced composition tasks such as multiview layouts and custom output generation.

The processed signal is then passed to the **LED sender**, which converts it into synchronized LED control data.

Finally, the LED **Receiver** decodes this data and drive the LED modules with pixel-level mapping and calibration.

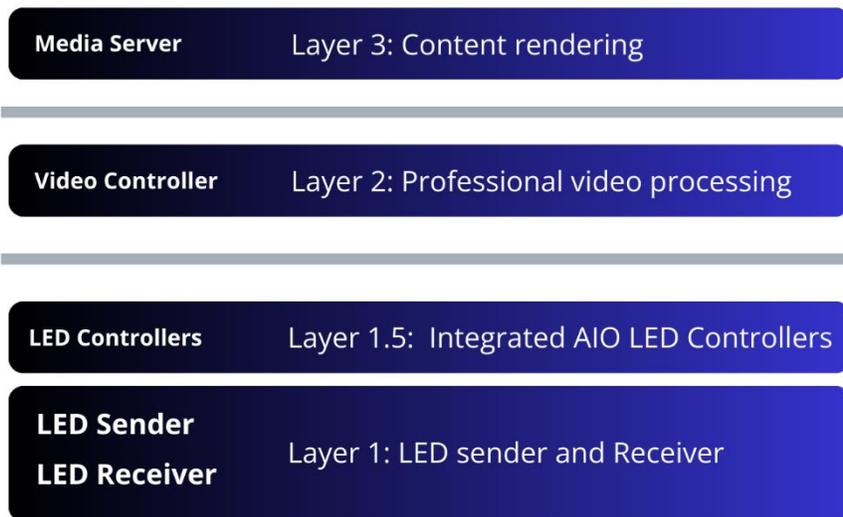


### 2.2 The Four-Layer LED Display Ecosystem

While the LED signal chain shows how video data travels through the LED system, it does not fully explain the distinct technical roles of the devices involved. A clearer way to understand these roles is to view the LED ecosystem as **functional layers**, each responsible for a specific stage of processing or control.

**The following four-layer model provides a structured, technology-based view of the complete LED display ecosystem**

# LED Ecosystem Function Layers



## 2.2.1 Layer 3 — Content Creation & Rendering (Media Servers)

Examples: Disguise, Watchout, and TouchDesigner

High-end media servers generate real-time content, multi-layer compositions, virtual production scenes, and timeline playback. These systems offer exceptional flexibility and creative power, but rely on PC operating systems and GPU rendering, making them less suitable for 24/7 stability-critical environments.

## 2.2.2 Layer 2- Professional Video Processing & Signal Management (GeoBox)

**Examples:** GeoBox G901, S902, G900 Series

This is where source signals are shaped, formatted, synchronized, and prepared for LED systems. This layer handles all **real-time video processing**, including:

Fundamental tasks:

- **Scaling to match LED pixel maps**
- **Cropping to define active regions**
- **Output synchronization to ensure timing stability**

Advanced demands in modern LED installations:

- **Multi-view layouts with multiple simultaneous HDMI/DP sources**
- **Seamless switching without black frames or flicker**

- **Fade / dissolve / wipe transitions**
- **BYOD stability for laptops and conferencing devices**
- **Transparent overlays for logos or real-time data**
- **Custom backgrounds behind active windows**
- **Custom output resolutions, including non-standard canvas sizes (e.g., 5120×1280, 1080×3840)**

These requirements exceed the capabilities of All-in-One (AIO) LED controllers and media servers. GeoBox fulfills this layer with FPGA-based processing, real multi-source compatibility, zero-black switching, and pixel-accurate custom resolution output.

### 2.2.3 Layer 1.5 — Integrated AIO LED Controllers

**Examples:** NovaStar VX Series, Colorlight X Series, VDWall A-Series, Linsn VP Series

AIO LED controllers combine sender functions with basic video processing. They provide simple scaling and layering limited to single source instead of multiple sources. It does not support seamless switching or custom output timing.

Their functional behavior aligns closer to LED sending hardware than to professional processors, therefore they occupy **Layer 1.5**, between processing and sending.

### 2.2.4 LED Sending & Receiving

Sender and receiver hardware (e.g., MCTRL, Tessera, Colorlight) handle pixel routing, synchronization, and panel driving. These devices do not perform advanced video processing and rely entirely on upstream processors.

### 2.2.5 Summary

By clarifying the ecosystem layers, the distinct role of GeoBox becomes clear. Only GeoBox provides all of the following:

- multi-source multiview
- seamless switching
- custom non-standard resolutions
- BYOD stability
- hardware reliability
- cross-brand LED compatibility

These capabilities define GeoBox as the industry's **dedicated hardware video processing layer**, bridging BYOD flexibility and LED display precision.

### 3 Common Challenges

Even integrated LED controller solutions such as Novastar’s VX series, which combine scaling and sending, still leave major gaps for system integrators.

Challenge	Description
<b>Closed Architecture</b>	The controller, sender/receiver pairs usually come from the same brand. Limits choice.
<b>Fixed Aspect Ratios</b>	Difficult to support ultra-wide, tall, or creative canvases.
<b>Minimal Multiview</b>	Typically only one Picture-in-Picture window.
<b>Poor Cross-Tech Support</b>	Hard to combine the control of LED with LCD or projectors.
<b>Limited Control Integration</b>	Closed ecosystems restrict integration.
<b>Signal Compatibility</b>	EDID failures, mismatched resolutions, refresh conflicts, HDCP issues leading to black screens or signal loss.

#### The Missing Middle Layer in LED Ecosystems

Between basic LED controllers and expensive high-end processors/media servers, integrators lack a flexible, hardware-based middle layer.

GeoBox fills this gap.

It acts as the processing standard that LED controllers alone cannot provide — without replacing them and without locking integrators into brand ecosystems.

### 4 GeoBox: The Open Video Processing Layer

GeoBox is a professional hardware video processor placed before the LED sender. It enhances flexibility, image quality, and creative control without altering existing LED infrastructure.

#### 4.1 Solving Scaling & Aspect Ratio Problems

**Problem:** LED walls rarely match 16:9 or any standard format. Result = stretching, letterboxing, mismatched content.

**GeoBox Solution:**

- Pixel-accurate scaling

- Region-based cropping
- Ensures perfect fit on any LED canvas
- Maintains visual integrity across all content types

## 4.2 Solving Multi-Source & Multiview Limitations

**Problem:** Most LED controllers cannot display multiple high-resolution sources simultaneously.

**GeoBox Solution:**

- Up to four UHD input layers
- Customizable, savable layouts
- True seamless switching (no black frames)
- Professional transitions including dissolve, wipe, and alpha blending
- Custom backgrounds for branding

This transforms any LED wall into a dynamic multi-content platform.

## 4.3 Solving Non-Standard Output & Mixed Display Issues

**Problem:** LED + LCD + projection cannot be driven from one workflow.

**GeoBox Solution:**

- Any custom output resolution
- Mixed landscape/portrait compositions
- Simultaneous output to LED + projection + LCD
- One device, one workflow — regardless of display technology.

## 4.4 Solving BYOD Instability

**Problem:** Laptop sources often fail due to EDID or refresh mismatches.

**GeoBox Solution:**

- Real-time scaling
- Precise EDID management
- All-hardware switching
- Guaranteed compatibility for any user device

## 4.5 Solving Control Integration Limitations

**Problem:** Closed platforms restrict automation and AV control.

**GeoBox Solution:**

- LAN / RS232 / WebUI / IR
- Seamless integration with Crestron, Extron, BrightSign

## 4.6 Solving Reliability and Image Quality Challenges

**Problem:** Software-based or PC-dependent systems risk crashes and latency.

**GeoBox Solution:**

- Pure FPGA hardware
- Mission-critical stability
- 10-bit color, 4:4:4 processing
- Near-zero latency (<1 frame)

## 5 Value for System Integrators

Category	GeoBox Advantage
Technical Flexibility	Works with any LED brand and sender (Novastar, Brompton, Colorlight, etc.).
System Upgrade	Enhances existing LED installations without replacing hardware.
Operational Simplicity	Hardware-based, no drivers or complex software.
Visual Excellence	Perfect scaling, precise mapping, seamless transitions.
Market Differentiation	Key enhancement: SIs can deliver brand-neutral, multi-technology, creative visual systems that LED brands alone cannot provide.

GeoBox gives integrators **unique value proposition:**

- A single processing platform for LED + LCD + projection
- The ability to solve BYOD and multi-view challenges effortlessly
- A way to offer creative, architectural layouts without high-end media servers
- Independence from current closed LED brand ecosystems

**This enables integrators to win projects not by panel price, but by superior system design.**

## 6 Enhanced Visual Capability Through GeoBox

Large LED canvases that require multiple live sources often exceed the processing capabilities of standard LED controllers. By combining the GeoBox S902 UHD Multi-Viewer

with the G900 series UHD image controllers, system integrators gain a flexible, hardware-based solution that enables true multi-window performance across any LED wall.

**What GeoBox Enables:**

- Multi-layer UHD windows
- Pixel-accurate image slicing
- Custom aspect ratios and creative layouts
- Dedicated monitoring outputs
- Easy expansion for larger or more complex canvases

**Key Advantages:**

- Real-time, all-hardware processing
- Perfect pixel-mapped output for every LED section
- Dual-output monitoring for technical supervision
- Scalable architecture for future growth
- 100% hardware reliability without PC dependencies

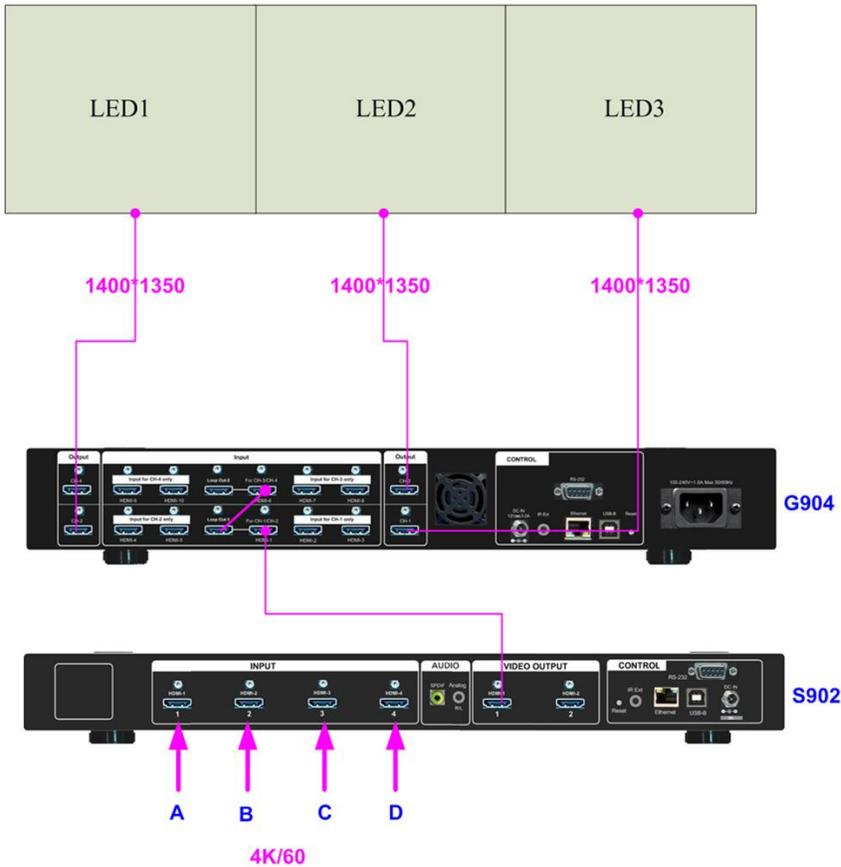
GeoBox transforms any LED wall into a fully managed, multi-source visual platform designed for professional environments.

## 6.1 System Reference

**Goal:**

Display multiple 4K sources across a large LED wall as independent, dynamically controlled windows — all synchronized and pixel-accurate.

**Solution Architecture:**



## 6.2 System Components and Functions

### GeoBox S902 — UHD Multi-Viewer

- Display up to **four independent image layers** from four 4K input sources simultaneously.
- Support **customizable layouts** and user-defined presets.
- Allow **saving three 4K full color images as background**.
- Provides **dual UHD outputs**: One feeds the main LED wall (via G902), one can be used for **live monitoring** in the technical control room.

### GeoBox G904 — UHD Image Slicer

- Receives the 4K signal from S902 and **splits it into multiple sections** according to the LED wall's pixel dimensions.
- Each output can be **scaled, cropped or rotated** to match custom resolutions or aspect ratios.
- The **overlap adjustment function** allows fine-tuning of image ratios and edge alignment between LED panels, that's also possible for creating asymmetric LED wall.

## 7 Market applications

### 7.1 Exhibition & Experience Spaces

Museums, galleries, trade shows, and retail flagships benefit from GeoBox’s ability to merge live video, branding, and motion graphics into one synchronized canvas. Creative layouts—panoramic, vertical, or mixed-aspect—are easily managed, with presets enabling rapid scene changes across different display devices.

### 7.2 Hospitality & Events

In hotel lobbies, conference halls, and event stages, GeoBox handles multiple live sources with seamless transitions. Instant preset recall streamlines session changes and reduces operator workload during live productions.

### 7.3 Broadcast, Simulation & Training

TV studios, XR environments, and simulators require low-latency, frame-accurate synchronization. GeoBox’s FPGA architecture ensures real-time switching and precise alignment for camera tracking and multi-feed training setups.

### 7.4 Immersive & Artistic Installations

For media art, façades, and interactive environments, GeoBox turns LED walls into multi-layer digital canvases. S902 + G900 workflows enable complex compositions—live video, animation, and data—without heavy media servers, keeping installations stable and easy to maintain.

## 8 Conclusion: From “Lighting Up” to “Bringing Life”

Novastar makes LEDs light up.

**GeoBox makes the content come alive.**

By integrating GeoBox into the signal chain, system integrators gain:

- A unified processing standard for all display technologies
- Precise control over content, scaling, and creative compositions
- Independence from closed LED ecosystems
- Differentiation that strengthens commercial competitiveness

To support your projects, we invite you to:

- Request **sample schematics** tailored to your LED configuration
- Submit your upcoming project for a **free design review**
- Schedule a **live online demo** of S902/G900 performance
- Ask for **reference diagrams** for tender and proposal use

**GeoBox is not just an add-on.**

**It is the missing processing layer that modern LED systems have long needed.**

# APPENDIX: Glossary of Technical Terms

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## Video Signal & Processing Terms

Term	Definition
<b>Scaling</b>	Adjusting the size of an input image to match the LED wall's pixel resolution.
<b>Cropping</b>	Selecting only a defined region of the input signal for display on the LED canvas.
<b>Aspect Ratio</b>	The proportional width-to-height relationship of a display (e.g., 16:9, 21:9).
<b>Custom Output Resolution</b>	A non-standard output resolution designed to match unique LED pixel maps (e.g., 5120×1280).
<b>Pixel Mapping / Pixel-Perfect Mapping</b>	Ensuring every content pixel aligns precisely with the LED panel's physical pixel grid.
<b>Seamless Switching</b>	Switching between inputs without black frames, flicker, or visual interruption.
<b>Transition Effects</b>	Professional visual effects such as fade, dissolve, or wipe used between content sources.
<b>Multi-View / Multi-Window</b>	Displaying multiple simultaneous input sources on the same LED wall.
<b>Alpha Blending</b>	Combining images using transparency for overlays such as logos or data layers.

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## Display Technology & Hardware Terms

Term	Definition
<b>LED Sender</b>	Converts the processed video signal into LED-specific data and transmits it to receiver cards.

<b>Term</b>	<b>Definition</b>
<b>LED Receiver Card</b>	Installed behind LED modules; decodes sender data and drives pixels with correct color and brightness.
<b>Sender / Receiver Architecture</b>	Closed LED ecosystem requiring matched-brand sender and receiver components.
<b>UHD (Ultra High Definition)</b>	High-resolution format (3840×2160) used for premium content and multi-window applications.
<b>Frame Sync (Frame Synchronization)</b>	Ensures multiple outputs refresh simultaneously for smooth multi-screen playback.
<b>PIP (Picture-in-Picture)</b>	Displaying a smaller secondary window within a main image; typically limited on basic LED controllers.

## Control, Compatibility & Reliability Terms

<b>Term</b>	<b>Definition</b>
<b>EDID (Extended Display Identification Data)</b>	Communication protocol that tells a source device which resolutions/formats the display supports. Instability causes black screens or scaling issues.
<b>BYOD (Bring Your Own Device)</b>	Scenario where users connect personal devices (laptops, tablets); often causes mismatched resolutions or EDID conflicts.
<b>FPGA (Field-Programmable Gate Array)</b>	High-reliability hardware chipset enabling ultra-low-latency video processing without software or OS dependencies.
<b>Control Integration (LAN/RS232/Web UI)</b>	Methods for linking GeoBox with control systems like Crestron, Extron, or BrightSign for automation.
<b>Hardware-Based Processing</b>	Processing that does not rely on PCs or operating systems, ensuring stability, low latency, and crash-free performance.

<b>Feature / Aspect</b>	<b>1. Basic AIO LED Controller</b>	<b>2. GeoBox + Basic LED Sender</b>	<b>3. High-End Media Server + LED Sender</b>
<b>Architecture</b>	All-in-one (video processor + sender in one)	Modular two-layer system (GeoBox as processor, sender for transmission)	Software-based media engine with separate sender
<b>Signal Input Flexibility</b>	Limited to a few HDMI/DVI inputs	Multiple HDMI/DP inputs, BYOD-friendly	Virtually unlimited via capture cards or NDI
<b>Output Resolution Control</b>	Fixed presets (1080p, 4K)	Fully programmable custom timing and aspect ratio	Fully flexible via GPU and software
<b>Scaling &amp; Cropping</b>	Basic, limited precision	Hardware-grade scaling, cropping, rotation	Software-based, depends on GPU performance
<b>Seamless Switching</b>	Often causes short black frames	True zero-black switching via hardware	Smooth transitions but may have latency or sync drift
<b>Multi-View / Picture-in-Picture</b>	Basic (2 layers typical)	Up to 4K quad-view or multiview layouts (S902)	Unlimited, software-dependent
<b>Custom LED Wall Matching</b>	Limited, depends on LED controller brand	Pixel-to-pixel custom output	Fully flexible, but requires configuration and GPU tuning
<b>Reliability / Stability</b>	High (stand-alone hardware)	High (stand-alone hardware, 24/7 use)	Lower (Windows-based, requires maintenance)
<b>Latency</b>	Low	Extremely low (<1 frame)	Variable (1–3 frames typical)
<b>Ease of Setup</b>	Simple plug-and-play	Moderate (processor + sender setup)	Complex (software installation, mapping)

<b>Feature / Aspect</b>	<b>1. Basic AIO LED Controller</b>	<b>2. GeoBox + Basic LED Sender</b>	<b>3. High-End Media Server + LED Sender</b>
<b>Control Method</b>	Front panel / web UI	Front panel / web UI / Ethernet	Software interface with scripting or timeline
<b>Cost Level (indicative)</b>	Low (≈ €1,000–3,000)	Mid-range (≈ €2,500–5,000 including sender)	High (≈ €10,000–50,000+)
<b>Target Applications</b>	Retail, signage, small LED screens	Control rooms, museums, corporate walls, immersive exhibits	Concerts, live shows, creative installations, large-scale mapping
<b>Key Strength</b>	Simple, integrated, low cost	Precise, brand-neutral, professional-grade hardware	Ultimate flexibility, creative effects, large capacity
<b>Key Limitation</b>	Limited flexibility, brand-locked	No timeline or 3D content engine	Complex setup, higher cost, lower stability