

# Jupiter Systems

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## PixelNet Overview

The PixelNet™ Approach - Advancing AV Through Network Technology

## Introduction to Jupiter

Jupiter Systems was founded in 1982. As a small, privately held company, Jupiter is one of the major success stories in the AV industry. The company is employee owned, has no outside investors, has no debt, is consistently profitable and invests a substantial portion of revenue into R&D activities each year. The company is ISO 9001:2000 registered and has a global reputation for excellence and innovation with over 6,000 installations world-wide. Our Fusion series of products is the broadest, most feature-rich line of display wall controllers in the industry. Leveraging 25 years of experience in the computer, networking and AV fields, we deliver features based on digital technologies to solve audio/visual problems in unique and powerful ways.

Jupiter prides itself on being independent of any manufacturer of projectors, cubes or other display devices. We let the user choose the best display devices for his particular situation with the size, brightness, resolution and dynamic range he needs. Then we generate the signals to drive those displays in the best and most flexible way possible.



## Introduction to PixelNet™

### What is PixelNet?

PixelNet is a new patent-pending technology developed by Jupiter for interconnecting an arbitrarily large number and variety of video sources to an arbitrarily large number and variety of displays. Using packet-switching technology any source can be shown on any display, as a window on any display, or as a window spanning multiple display devices in a display wall. Any source can be shown at any size on any display or array of displays.

PixelNet uses sophisticated high-bandwidth networking technology developed for data transfer in the computer world and applies it to video switching. But this is not a traditional video switcher. This is video switching on steroids – switching entirely in the digital domain to preserve signal integrity and switching on a pixel-by-pixel basis with built-in up and down-scaling so any rectangle of pixels from any source can be sent to any destination rectangle on any display device.

### Benefits of PixelNet

PixelNet is an all-digital system. Input and output signals can be either digital or analog, to meet the interface requirements of the attached devices. But inside the PixelNet domain signals are always digital and can be transmitted long distances without degradation. All video processing is done in the digital domain including cropping, scaling, de-interlacing and noise reduction.

PixelNet is independent of any operating system or computer architecture.

PixelNet is a modular system. This provides the multiple benefits of ease of configuration, ease of installation, ease of expansion, ease of sparing and ease of maintenance. PixelNet modules include **input nodes** to capture various kinds of video signals and **output nodes** to drive display devices. PixelNet **switches** are used to interconnect the input and output nodes.

PixelNet uses unshielded twisted pair (UTP) cabling which is inexpensive to purchase and install. The same familiar Cat5E or Cat6 cable that is universally used for Gigabit LAN installations today is the same cable used by PixelNet. The familiar RJ45 connectors used for Ethernet connections are used with PixelNet.

A PixelNet installation is easy to expand by adding more input and output nodes and, if necessary, additional switching capacity.

PixelNet provides flexible display capability based on a fundamental paradigm that any rectangle of source pixels can be displayed at any rectangle of destination pixels regardless of size or “connectivity” obstacles. Any source can be shown on any display device. Any portion of a source can be treated as a source and shown anywhere. Each source can be shown occupying an entire individual display, as one window on an individual display that is showing multiple sources, or can be shown as a window extending across multiple screens on a large display wall.

PixelNet provides implicit format conversion. Signals captured as VGA, DVI, SDI, HD-SDI or HD component can be displayed on any DVI or VGA monitor or projector.

PixelNet’s simple yet powerful paradigm provides a broad foundation for a great deal of growth in new features and capabilities.

## **Applications of PixelNet**

PixelNet works well in small and medium-sized configurations and is especially good in large configurations with dozens, and potentially hundreds of inputs and outputs. PixelNet works well in configurations with over 100 inputs, where digital switching is impossible and analog switching and cabling are hugely expensive.

PixelNet provides signal transportation up to 100m. using inexpensive copper cables and much further with fiber optics. PixelNet provides signal aggregation and distribution. PixelNet provides signal conversion among color models (YUV, YCrCb, RGB), among frame rates (24, 25, 29.97, 30, 50, 59.94, 60 Hz), between analog and digital, between interlaced and progressive scan, and among resolutions from QCIF to HD and beyond. Both up-scaling and down-scaling are independent in both horizontal and vertical dimensions so aspect ratios may be maintained or adjusted to suit the requirements of the source signal and the display device.

PixelNet is modular, compact, expandable, inherently fault-tolerant, easy to spare and service and has long-term viability. PixelNet can simplify an installation while providing more flexibility, performance and potential for

growth. PixelNet also reduces ancillary costs such as design, cabling, installation and maintenance.

### **System Expansion**

As a modular system PixelNet can be easily expanded. The key consideration is switch capacity for inputs and for outputs. If switch capacity is available then it's a simple matter of cabling and connecting new input and output nodes. The control system will automatically accommodate additional nodes as they are plugged into PixelNet.

### **Control of PixelNet**

PixelNet installations are controlled by an operator using a Windows PC with PixelNet Domain Controller (PDC) software featuring an intuitive graphical user interface providing access to all domain resources and simple drag-and-drop operations to effect changes on the PixelNet displays. The PDC client can control any number and type of input devices and can control output nodes operated as discrete displays or as tiles in a display wall. PDC also provides a command-line-oriented network control protocol for users wanting to write their own control programs or use touch-panel control.

### **Sample Configurations**

A small system might have a dozen input nodes and six output nodes, plus the required PDC, all connected via a standalone switch. The user can select which inputs to view at any given time on the attached monitors. Individual signals can be viewed on each monitor or multi-window layouts can be created for viewing multiple signals at once.

A large system with say, 100 inputs and three display walls each containing 12 projectors, plus another six discrete display monitors might require six stackable switches with a 10G backbone switch. Control would be similar to the smaller configuration described above, using a PC with the PDC software, but the three display walls would each be treated as a single large display device making it easy to select input signals for viewing and moving/resizing windows to create an attractive and functional display.

Because of PixelNet's modularity virtually any system imaginable can be easily configured. All the systems above envision user control of the system operation. Another kind of application is a fixed function that always does the same thing

and dynamic control is not needed. In this case the PixelNet nodes can be setup in the desired mode and programmed to boot up always in that mode so no operator intervention is required, even in the event of power failures, loss of input signals, disconnection of display devices, or other disturbances.

With PixelNet any individual display device can be used to show a single source, to show multiple sources in windows with complete PIP/POP/PBP flexibility, or to show a portion of a source in concert with adjacent tiled displays. Tiled arrays of displays can be treated as one large display wall or can be dynamically re-assigned as multiple smaller independent walls.

**PixelNet Display Capabilities**

1:1	one-to-one	Single source on a single display
M:1	many-to-one	Multiple sources on a single display (multiviewer capability)
1:N	one-to-many	One source distributed across many displays (simple display wall)
M:N	many-to-many	Display wall showing multiple windowed sources

## PixelNet Components

Physically PixelNet is composed of input nodes, output nodes, controllers, switches and cables. Input nodes capture video signals and convert them to a universal format that can be received by PixelNet output nodes. Output nodes receive signals in the universal format and convert them to the desired display format (native resolution) of the attached display. All PixelNet nodes are connected through a switch which directs traffic from sources to destinations.

PixelNet nodes are small devices with a footprint of about 9x6 inches and just 1.5" thick. Input nodes are intended to be located near the source of the signal they are capturing and output nodes should be located close to the display device they are driving. This is especially true with digital DVI signals which can't be transported very far without expensive cables or fiber optic extenders.

If desired, two nodes can be mounted side-by-side in a tray in a 1RU space in a standard 19" equipment rack.

## Switches

PixelNet switches come in a variety of sizes. Small configurations are handled using either a 24 or 48-port standalone switch. Medium-sized configurations are handled using “stackable” switches (which have 48 PixelNet ports and dual 10G uplink ports) with a daisy-chain interconnect. Two or three stackable switches can be interconnected to provide 96 or 144 ports. Large configurations requiring more than 144 ports are handled with stackable switches and a 10G backbone switch for interconnect. With a large backbone switch systems can be configured with capacity to handle over 1,000 input nodes and 1,000 output nodes.



## Input Node

PixelNet input nodes are designed for the specific type of signal that needs to be captured. Currently offered are input nodes for

- computer DVI-I signals (analog or digital);
- standard and high definition SDI signals;
- high definition component (YUV) video signals.

Input nodes perform several key functions on each captured frame: digitize the signal if it is analog; de-interlace the signal if it is interlaced; crop and down-scale the signal if the full resolution will not be used at the destination; segment the signal if parts are to be shown on multiple displays; and finally, packetize the segments and transmit to the destination(s) without exceeding the destination’s input bandwidth.

DVI and SDI input nodes provide loop-through so distribution amps are not needed. DVI input nodes have an option for KVM (Keyboard-Video-Mouse) capability providing the user with the ability to control the keyboard and mouse inputs to the computer generating the source signal.

All input nodes have two PixelNet ports. For highest performance it is recommended that both links be used, thus requiring two ports on the switch for each node. In large configurations it may be desirable to use only a single PixelNet connection to minimize switch cost at the expense of some performance.

### **Output Node (TeamMate)**

PixelNet output nodes generate both analog RGB and digital DVI signals on a single-link DVI-I output connector.

Output nodes are referred to as TeamMates™ because of their ability to work cooperatively in a tiled array. But TeamMates are versatile and can be used in three different modes:

- As a solo display – receive a single signal from an input node and show that signal, and only that signal, on the attached display;
- As a MultiViewer – receive one or more signals simultaneously from multiple input nodes and show these signals in their entirety in windows on the attached display.
- As one tile in a tiled array – receive one or more signals or parts of one or more signals and composite these signals into frames which are shown on one display in a tiled array of displays (display wall). TeamMate also has the ability to synchronize its output signal with a master reference clock. Thus all the screens in a display wall can be synchronized with each other to eliminate “frame tearing” between tiles.

An output node always reads the EDID information of the attached monitor (if available) and from that determines its native resolution. The output node always generates its output in the attached monitor’s native resolution to avoid scaling in the monitor. All common VESA display formats can be handled.

All DVI output nodes have two PixelNet ports built in. For output nodes driving low resolution output devices (below XGA resolution) high performance can be achieved using a single link, thus requiring only one port on the switch. Output nodes driving XGA and higher resolution displays may be connected by one or two links. Using a single link allows more nodes to be connected to a switch but for highest performance it is recommended that both links be used, thus requiring two ports on the switch for each node.

### **Note**

PixelNet is a separate networking environment from your LAN. PixelNet uses proprietary protocols and is not compatible with TCP/IP and other common data-networking protocols. There must be no cross-connection of PixelNet nodes into the LAN or data connections into PixelNet. There is no danger of electrical damage from such a cross-connection but the high data rates of PixelNet streams would interfere with LAN traffic.

### **Limitations**

Despite its flexibility PixelNet does have limitations. Areas of concern may include the following:

- HDCP and other digital content protection schemes are not supported.
- Capture nodes handling high resolution signals can only transmit one signal at a time at full refresh rate.
- No transitions or other special effects are supported at this time.
- “Framelock” capability provided by PixelNet TeamMate output nodes to synchronize the projectors in a display wall achieves vertical synchronization within one line-time but may not be accurate enough for studio genlock.
- As a network-based system PixelNet does have bandwidth limits. In general PixelNet can achieve 30 frames/second update rates in the vast majority of situations. In many of those situations an update rate of 60 frames/second can be achieved. Contact the Jupiter factory if the 30 vs. 60 fps update rate is a key issue for your application.

### **Future Enhancements**

PixelNet is an open system built with modules which provide specific functionality and communicate using established protocols over well-known physical links. As such new functionality can be added with relative ease, compared to re-engineering a closed system-level product. Over the next few months Jupiter will be adding new input and output nodes to the catalog of PixelNet modules along with totally new functions such as the ability to record and playback signals, or to transfer captured signals over the user’s LAN (or externally over a WAN or the Internet) from one PixelNet domain to another.

### **Reliability/Maintainability/Support**

**MTBF**

All PixelNet nodes have MTBFs in excess of 120,000 hours. Every node is an independent entity and will not cause failures of other nodes so any failures that occur will be isolated, random and infrequent occurrences.

**MTTR**

All PixelNet nodes of a given type are interchangeable. Any DVI input node can be substituted for any other DVI input node and any TeamMate output node may be substituted for any other TeamMate output node. Every node is assigned a logical name which is used in communicating with it (as opposed to the hardware MAC address). If a node fails, a spare unit must be setup with the logical name of the failed unit. Then the spare can be swapped in to replace the failed unit. Such a replacement should take no more than 15 minutes if spare units are kept handy and installed units are readily accessible.

**Warranty**

A two-year limited warranty applies to all Jupiter PixelNet nodes and switches.