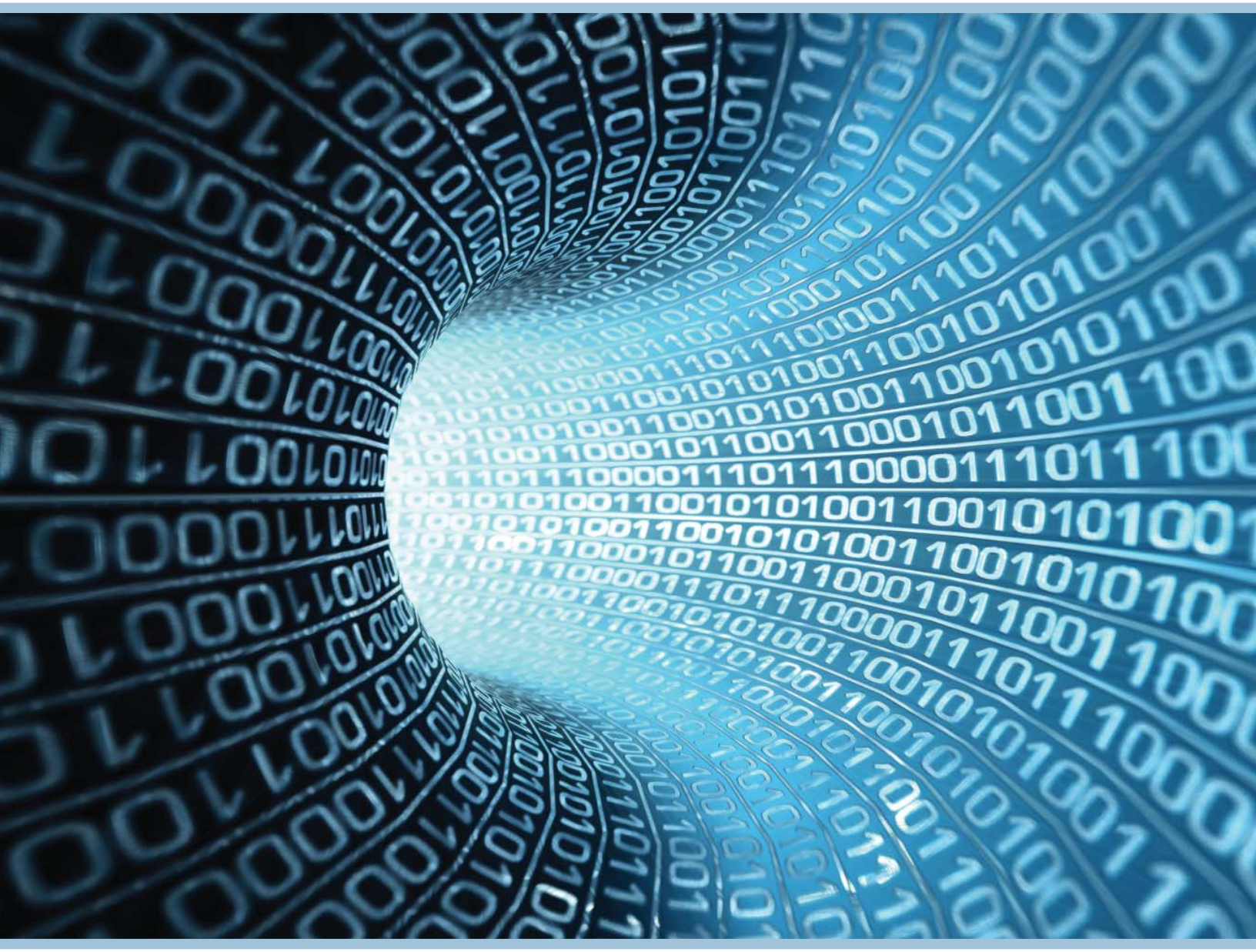
ClearOne®



StreamNet™ Digital Media and System Design Reference Guide

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The purpose of this reference guide is to provide valuable information on digital media technologies for the AV dealer seeking to better understand how to make the transition from analog based media formats and transports, to digital. Though comprehensive in nature we recommend further study if the concepts and terms covered are new. ClearOne's StreamNet solutions are highly capable and scalable, allowing traditional system design concepts to be challenged by offering more flexibility, higher quality and in many cases costs savings.

Introduction

We believe AV systems should no longer be analog.

+ **Sources are digital.** This doesn't mean a modern audio video source won't have analog connectors. But since the program material is rendered digitally, it no longer makes sense to convert the pristine quality of a digital file back to analog. Hence the longer an AV systems designer is able to keep the digital signal intact, the better the sound and picture quality will be.

+ **Displays are digital.** With the advent of digital fixed pixel displays and projectors, the highest quality picture is possible when the content stream remains digital and is not converted to analog. Though a reasonable quality picture is possible to achieve with analog equipment, there are resolution and cabling limitations, which can greatly degrade the end result.

+ **Greater signal lengths without loss or degradation with digital.** By transmitting digital signals over Internet Protocol (IP) rather than analog or RF based distribution methods, signal distances of several miles may be achieved with virtually no image degradation or signal loss. This compared to mere hundreds of feet with analog where image degradation can suddenly become a significant issue.

+ **Mass exposure to HD and 3D program material has greatly raised consumer expectation for AV system performance.** Consumers are presented with ever increasing sound and picture quality in nearly every arena. HDTV products and program material is highly penetrated in the home. OEM automobile sound systems are at the highest performance level they have ever been. Which along with ever improving retail, and commercial AV system quality, means the average consumer has a reasonably good understand of what constitutes good audio and video performance.

+ **Wireless technologies improve installation flexibility.** With new state of the art wireless systems, the digital signal remains intact from the source to the transmitter to the receiver to the speaker or display. This means AV systems designers have choices in infrastructure that can lower or reduce the high cost of cabling or installation difficulty when designing high performance audio video systems.

+ **Cost benefits compared with extensive cabling costs and labor for large installations.** With analog systems, generally a single cable may only carry one signal type. However with IP based AV systems, a single Category 5 cable may carry the load of several dozen audio channels along with multiple video streams and all control signals. This reduces not only cable cost but also installation labor.

It is important to note that there is a difference between a file format and a codec. The job of a digital codec is to perform the encoding and decoding of the raw audio data. While the data itself is stored with a specific audio format in a file. Although most audio file formats support a single type of audio data that is created with an audio coder, a multimedia container format such as MKV or AVI may support multiple types of audio and video data. Interfaces on the other hand commonly define a physical connectivity standard by which various signals may be interconnected. Following are a few of the most common interface types found in audio, video, network and control systems.

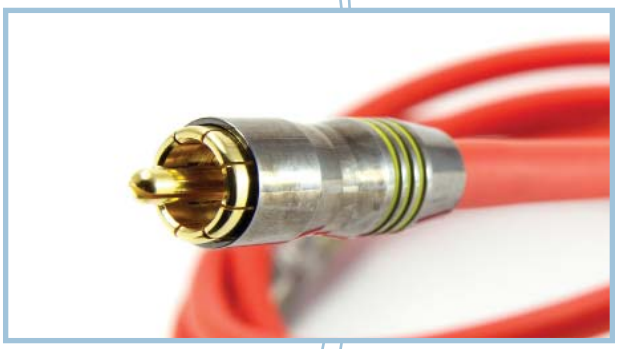
Digital Audio

AES/EBU - The digital audio standard frequently called AES/EBU is officially known as AES3 and is used for carrying digital audio signals between various devices. Several different physical connectors are defined as part of the overall group of standards such as IEC 60958 Type I Balanced – 3-conductor, 110-ohm twisted pair cabling with an XLR connector, used in professional installations (AES3 standard). The IEC 60958 Type II Unbalanced – 2-conductor, 75-ohm coaxial cable with an RCA connector is often used in consumer audio applications. Finally, IEC 60958 Type II Optical – optical fiber, usually plastic but occasionally glass, with an F05 connector, may also be found in consumer audio applications.

S/PDIF - A related system to AES/EBU, S/PDIF was developed as a consumer version using connectors more commonly found in the consumer market such as RCA connectors in the case of 2-conductor 75-ohm coaxial cable. S/PDIF also supports optical fiber termination and is found widely in consumer applications.

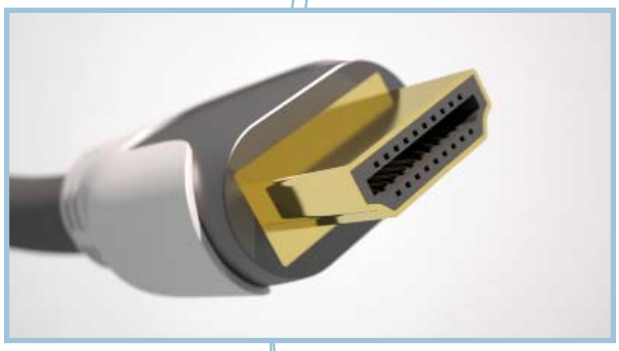
Toslink Optical

XLR



RCA

Digital Video



HDMI

HDMI – High-Definition Multimedia Interface (HDMI) technology is a global standard for connecting high-definition products. With HDMI's uncompressed all-digital interface the viewer receives both dazzling quality and ease of use. Well over 1,000 manufacturers incorporate HDMI connectivity into a growing list of consumer products from HDTVs, Blu-ray Disc Players, Gaming systems, Digital video cameras, Mobile devices and more.

The flexibility of HDMI is in the single cable capable to transmit digital video, digital audio, and control data through a high-speed link.

HDMI offers **enormous bandwidth capacity** of up to 10.2 gigabits per second, more than twice the bandwidth needed to transmit an uncompressed 1080p signal. This enables better looking movies, faster game play, richer audio, 3D movies and gaming. Additional benefits include higher resolution support beyond 1080p such as 1440p or Quad HD, faster refresh rates like 120Hz or beyond and deep color, taking the HDTV display palette from millions to trillions of colors. It should also be noted that HDMI specifies a robust digital rights management scheme (DRM) known as HDCP. For this reason premium content owners allow full HD output typically over HDMI only and not analog interfaces such as component video.

DVI

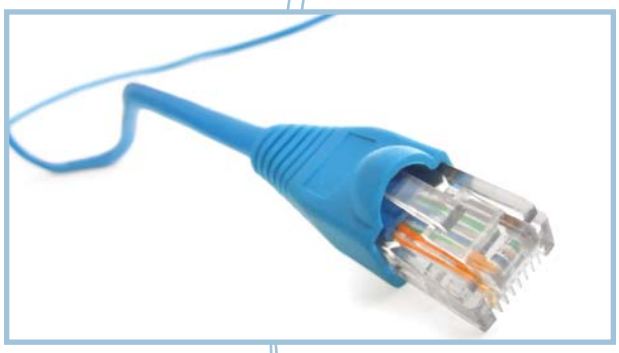
DVI - The Digital Visual Interface (DVI) is a video interface standard designed to provide high quality direct digital connection of source devices to digital display devices such as flat panel LCD computer displays and digital projectors. DVI was developed by an industry consortium, the Digital Display Working Group (DDWG) to replace the "legacy analog technology" VGA connector standard and is designed for carrying uncompressed digital video data to a display. Because it is partially compatible with the High-Definition Multimedia Interface (HDMI) standard in digital mode (DVI-D), and VGA in analog mode (DVI-A) some devices will display a digital signal originating from a DVI connector but terminating to an HDMI port. However, care must be taken in mixing and matching the standards as certain data types and signals are not fully supported by DVI, but may be supported by HDMI.

DisplayPort - DisplayPort is a digital display interface standard put forth by the Video Electronics Standards Association (VESA) which defines a digital audio and video interconnect scheme intended primarily for use between a computer and its display. DisplayPort is designed to replace digital (DVI) and analog component video (VGA) connectors in computer monitors and video cards. As well as replace internal digital LVDS links in computer monitor panels and TV panels. Though DisplayPort can provide the same functionality as HDMI it is not expected to displace HDMI in high-definition consumer electronics devices.

DisplayPort

DisplayPort includes optional DPCP (DisplayPort Content Protection) which is licensed from Philips and uses 128-bit AES encryption. It also features full authentication and session key establishment along with an independent revocation system, something that is considered essential by premium content owners such as Hollywood studios. Later versions of DisplayPort beginning with version 1.1 added support for the industry-standard 56-bit HDCP (High-bandwidth Digital Content Protection) revision 1.3

Network



RG45 Ethernet

Ethernet - Modern Ethernet networks are now able to easily carry data and StreamNet signals simultaneously without difficulty. This fact reduces cost for the AV systems designer choosing IP audio / video systems as separate networks and cabling no longer need to be installed.

Ethernet defines wiring and signaling standards for the Physical Layer of the OSI networking model as well as a common addressing format, and a variety of Medium Access Control procedures at the lower part of the Data Link Layer. Evolutions include higher bandwidth support, improved media access control methods, and changes to the physical medium which has caused Ethernet to evolve into a complex networking technology. Ethernet stations communicate by sending each other data packets, blocks of data that are individually sent and delivered. As with other IEEE 802 LANs, each Ethernet station is given a 48-bit MAC address. MAC addresses are used to specify both the destination and the source of each data packet. Despite the significant changes in Ethernet over the years, all generations of Ethernet (excluding early experimental versions) use the same frame formats (and hence the same interface for higher layers), allowing them to be readily interconnected.

Ethernet network interconnection options:

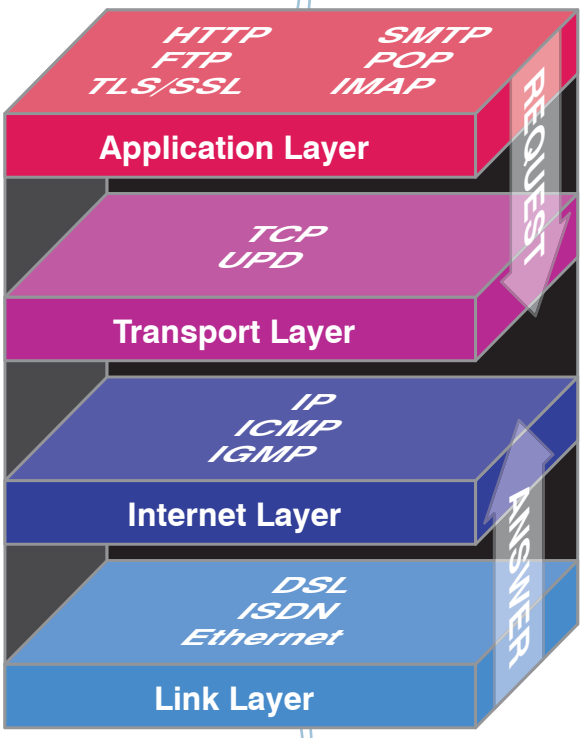
Category 5 / 6 Cable

Category 5 (Cat 5) cable for use in networks is tested for reliable transfer of signal frequencies up to 100 MHz. Category 5 cable is terminated in either the T568A scheme or the T568B scheme. Canada and Australia use the T568A standard, and the U.S. commonly uses T568B scheme. Both schemes work equally well and may be mixed in an installation so long as the same scheme is used on both ends of the cable. An interesting fact regarding Category 5 network cable termination is that 8P8C modular connectors are used but are often incorrectly referred to as "RJ-45". Of the four pairs of wire found in a Category 5 cable, each has differing precise number of twists based on prime numbers so as to minimize crosstalk and improve signal integrity. The pairs are made from 24 gauge (AWG) copper wires within the Cat 5 cable standard. Although, cable assemblies containing 4 pairs are common, Category 5 is not limited to 4 pairs. In fact backbone applications may use up to 100 pairs.

A newer cable standard known as Category 6 (Cat 6), is the cable standard for Gigabit Ethernet and is backward compatible with the Category 5/5e and Category 3 cable standards. Compared with Cat 5 and Cat 5e, Cat 6 features more stringent specifications for crosstalk and system noise reduction. Category 6 provides performance of up to 250 MHz and is suitable for 10BASE-T, 100BASE-TX (Fast Ethernet), 1000BASE-T/1000BASE-TX (Gigabit Ethernet) and 10GBASE-T (10-Gigabit Ethernet).

T568A

T568B



Internet Protocol Suite Layers

TCP/IP – The Internet Protocol Suite is a set of communications protocols used for the Internet. It is also known as TCP/IP named from two of the most important protocols contained in it, the Transmission Control Protocol (TCP) and the Internet Protocol (IP). Modern IP networking represents a synthesis of several developments which evolved in the 1960s, 1970s, and emerged during the 1980s, together with the advent of the World Wide Web in the early 1990s.

The Internet Protocol Suite consists of four layers from the lowest to the highest layer these are the Link Layer, the Internet Layer, the Transport Layer, and the Application Layer. Each layer defines the operational scope or reach of the protocols and are reflected loosely in the layer names. Each layer has functionality which solves a set of problems relevant to its scope.

The Link Layer contains communication technologies for the local network where the host is connected to directly. The Internet Layer describes communication methods between multiple links of a computer and facilitates the interconnection of networks. This layer establishes the Internet and contains primarily the Internet Protocol, which defines the fundamental addressing namespaces. Internet Protocol Version 4 (IPv4) and Internet Protocol Version 6 (IPv6) are used to identify and locate hosts on the network. Direct host-to-host communications are handled in the Transport Layer which provides a general framework to transmit data between hosts using protocols like the Transmission Control Protocol. The highest-level Application Layer contains all protocols defined specifically for the functioning of the vast array of data communications services. This layer handles application-based interactions on a process-to-process level between Internet hosts that are communicating.

MoCA (Multimedia over Coax Alliance)

Using Coaxial cable, MoCA is the only home entertainment networking standard in use by cable, satellite and IPTV operators and equipment providers. The current MoCA specification can support multiple streams of HD video, delivering up to 175 Mbps throughputs while offering unparalleled user experience via parameterized quality of service (PQoS). Though primarily implemented for transportation of digital entertainment files, MoCA fully supports Ethernet and thus is an excellent way to transfer data of any type with no limitations. MoCA is a popular solution in any installation where coaxial cable may be already installed thus negating the need to pull new wire. For AV installers working with residential projects we recommend MoCA as a cost effective way to distribute StreamNet and Ethernet signals. The Multimedia over Coax Alliance (MoCA®) features more than 80 certified products and is the universal standard for home entertainment networking. For information on MoCA and compatible products visit: http://www.mocalliance.org/

HomePlug AV (Powerline Alliance)

The purpose of HomePlug AV (HPAV) is to provide high-quality, multi-stream, entertainment data transfer using Ethernet standards over existing AC wiring. HPAV employs advanced PHY and MAC technologies to provide a 200 Mbps class powerline network for video, audio and data. The Medium Access Control Layer is designed to be highly efficient with AC line cycle synchronization and Quality of Service (QoS) guarantees. HomePlug AV also provides advanced capabilities consistent with new networking standards. HPAV offers tight security based on 128-bit AES and the design allows a station to participate in multiple AV networks. HPAV is backward compatible with HomePlug 1.0 and aims to be the network of choice for the distribution of data and multi-stream entertainment including HDTV, SDTV, and audiophile quality audio throughout the home. It is designed to provide the best connectivity at the highest QoS of the home networking technologies competing for these applications. HomePlug AV enables all devices with a power plug to have network access through HPAV. For information on HomePlug and compatible products visit: www.homeplug.org

Audio Video Bridging (AVB)

ClearOne is a proud member of the AVnu Alliance, an industry forum dedicated to the advancement of professional-quality audio video transport by promoting the adoption of the IEEE 802.1 Audio Video Bridging (AVB), and the related IEEE 1722 and IEEE 1733, standards over various networking link-layers.

An “Audio Video Bridging” network is one that implements a set of protocols being developed by the IEEE 802.1 Audio/Video Bridging Task Group. The four primary differences between the Audio Video Bridging (AVB) architecture and existing 802 architectures are as follows:

1. Precise synchronization of audio and video signals as required by high quality AV systems.
2. Traffic shaping for media streams to ensure ultra low latency and signal integrity.
3. Admission controls.
4. Identification of non-participating devices.

Key to AVB is the fact that it has been specifically designed for AV use and addresses the unique requirements of distributing an audio and video signal in a high quality manner over a standard switch Ethernet network.

To understand why AVB is special, lets look at the requirements for A/V streaming.

First, it must be possible to synchronize multiple streams so they are rendered correctly in time with respect to each other. This might be to ensure lip sync or to keep multiple digital speakers in phase, or it could be to maintain tight time sync of 40 or more microphone channels feeding a live mixing desk in a live sound or studio environment. Regardless of the application, what this means is A/V streams must be synchronized to within approximately one microsecond. Something that is impossible for a standard switched network to achieve using regular 802 architecture.

Furthermore, applications must be able to receive a high level of confidence that the network resources needed are available and will remain available as long as the application needs them.

This is sometimes referred to as a “reservation”, or “admission control”. The intent is for an application to notify the network of the requirements for a stream ahead of time, and have the network lock down the resources needed for that stream and, if they are not available, to notify the application so the stream may be stopped or an error message delivered.

Although delay through a network may on the average be very low, there is little effort made to limit that delay in a traditional IT network. Since there is no concept of "time" in an IT network, there is nothing in the network infrastructure itself that can aid in synchronization. Additionally, the network itself does not prevent network congestion, so data can be lost if buffers are inadequate or link bandwidth insufficient for the offered traffic.

IT networks count on higher level protocols to handle congestion such as TCP which works by throttling transmission and retransmitting dropped packets. This is adequate when long delays are acceptable, but will not work where low deterministic delays are required.

The typical way these last two problems are handled today is with buffering, but excessive buffering can cause delays that are annoying in the consumer environment and completely unacceptable in a professional application.

One way to allow existing IT-oriented networks to be used for A/V streams is to "manage" the network at a higher layer or to impose strictly defined, inflexible configurations. For example, in the professional market, there are a few systems in place that can provide adequate delays and guaranteed bandwidth, but they require a single proprietary solution, and need to be reconfigured every time a new device is added. CobraNet is an example of this kind of architecture.

How AVB came to exist.

An effort was started within the IEEE 802.3 (Ethernet) working group to define a “Residential Ethernet” which would directly address the challenges of A/V streaming. However this work quickly moved over to the IEEE 802.1 working group. In particular, the group wanted to ensure the technology was scalable from consumer applications in the home and car, all the way up to high professional standards.

As explained previously, there is nothing more important than time synchronization when distributing audio and video signals. To achieve this AVB devices periodically exchange timing information. This precise synchronization has two purposes:

1. To allow synchronization of multiple streams.
2. To provide a common time base for sampling and receiving data streams at a source device, and presenting those streams at the destination device with the same relative timing.

The protocol used for maintaining timing synchronization is specified in IEEE 802.1AS, which is a tightly constrained subset of another IEEE standard (IEEE 1588), with extensions to support IEEE 802.11 and also generic “coordinated shared networks” (examples include some wireless, coaxial cable, and power line technologies).

How audio and video signals stay in sync with AVB.

An 802.1AS network timing domain is formed when all devices follow the requirements of the 802.1AS standard and communicate with each other using the IEEE 802.1AS protocol. Within the timing domain there is a single device that provides a master timing signal called the “Grand Master Clock”. All other devices synchronize their clocks with this master.

The device acting as Grand Master may be auto selected or specifically assigned. Example: If the network is used in a professional environment that needs “house clock” for audio, or “genlock” for video. Or if a specific timing hierarchy is needed for other reasons.

AVB devices typically exchange capability information after physical link establishment. If peer devices on a link are network synchronization capable they will start to exchange clock synchronization frames. If not, then an AVB timing domain boundary is determined.

Traffic shaping is yet another way AVB ensures tight timing and synchronization of signals is achieved. Traffic shaping is the process of smoothing out the traffic for a stream so the packets making up the stream are evenly distributed in time. If traffic shaping is not done at sources and bridges, then the packets tend to “bunch-up” into bursts of traffic that may overwhelm buffers in subsequent bridges, switches or other network infrastructure devices.

The AVB architecture implements traffic shaping using existing 802.1Q forwarding and priority mechanisms and also defines a particular relationship between priority tags and frame forwarding behavior at endpoints and bridges.

The vision of AVB is to realize a standard that will allow “no-compromise” streaming of AV signals over modern networks. Since the same could be said of StreamNet products, you may look to ClearOne to take a leadership position with respect to implementing AVB support across our line.

Control

IR – Infrared Control (IR) is the most ubiquitous control method and format. Though every manufacturer uses a slightly different standard, IR is so ubiquitous that near Universal Remote Controls are available to operate nearly any consumer electronics device known.

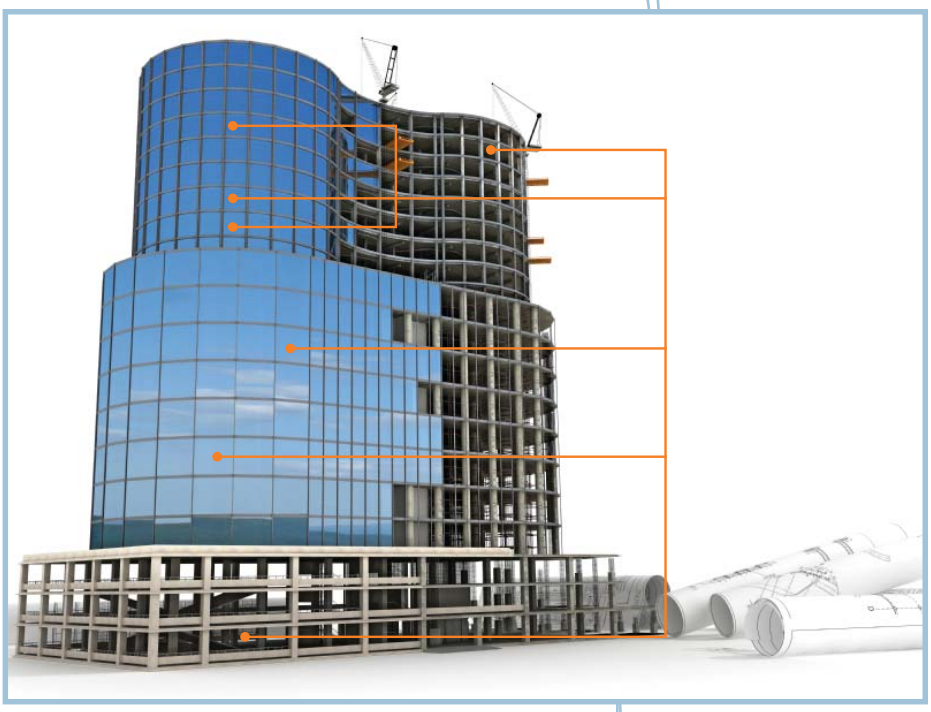
IP – Internet Protocol is the preferred way to control any device as it eliminates issues with IR interference and limited command sets. Using IP some manufacturers define a great number of parameters that are not typically available on an IR remote.

Serial – Serial control otherwise known as RS-232 is the most common and widely used standard for control of modern systems, after IR. Advantages of RS-232 include its wide support and inclusion in many products. However, with RS-232, cable distance limitations and the aging protocol are just a few of the reasons it is being rapidly replaced by IP which offers much greater flexibility, reduced cabling and infrastructure requirements, and overall greater reliability.

HDMI® HIGH-DEFINITION MULTIMEDIA INTERFACE

CEC – Consumer Electronics Control (CEC) provides for integrated, "one-touch" commands across multiple linked components. When enabled CEC allows system-wide behaviors such as one-touch play or one-touch record, where pressing a single button launches a series of coordinated commands greatly streamlining the user experience. CEC is enabled courtesy of HDMI because of the "smart" two-way connection protocols, which allow devices to communicate and interact with each other using EDID information and other mechanisms. Devices connected with HDMI have the ability to scan the other devices capabilities to automatically configure certain settings. Though few consumer electronics devices today take advantage of CEC, it is a capability all audio video professionals should be aware of if and when it begins to show up in devices.

By utilizing standardized Ethernet TCP/IP protocols to distribute audio and video streams over LANs, StreamNet offers a scalable system enabling virtually unlimited zones, and sources. Using standard TCP/IP, StreamNet has the most advanced integration capabilities available in distributed audio and video. With StreamNet, seamless communication with other systems such as lighting control systems, automation systems, and security systems is easily achieved. StreamNet's open architecture allows those systems to feed information for display and control in real-time, eliminating need for keypads to control each subsystem, or intensive programming required by integrated all-in-one control solutions. In addition to selecting sources from the TouchLinX keypads, users can browse digital media metadata via a color LCD or any web enabled device.

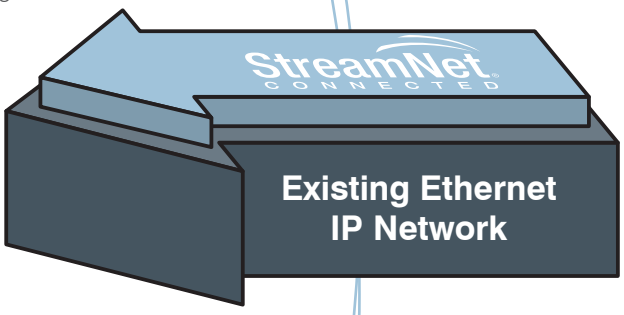


What is StreamNet?

StreamNet is a family of products designed to distribute digital entertainment using standard networking technology which by embracing open standards, has allowed ClearOne to develop a system that leverages the reliability, expandability and cost-effectiveness of traditional computer networking solutions. StreamNet provides the following advantages over traditional distributed audio systems:

+ Unparalleled Scalability: 1,800,000 sources may be distributed to up to 1,800,000 zones
+ Compatible with both digital and analog sources and displays
+ High quality audio and video playback capabilities, supports high bit-rate codecs
+ Little to no programming required, since the system is IP-based, it requires little to no programming
+ Easy to install and control with a rich user experience including animated screens

Because StreamNet was designed for real world applications, it does not require a dedicated network. Instead, AV devices peacefully coexist with data services or other applications on the same network. In order to place content on the network, StreamNet multi-media encoders convert audio, video and control signals into streaming data which is transmitted across any Ethernet based network using Internet Protocol (IP). For playback, StreamNet multi-media decoders convert the IP stream back into audio, video and control signals for playback on display devices and audio systems.



Furthermore with StreamNet, you may mix and match sources, such as Blu-ray players, digital media players, satellite and cable boxes, video cameras or computers, allowing virtually any audio, video or data source to be used with a StreamNet solution. Additional capabilities of StreamNet include an interactive network technology where audio channels are sent back over the network such as to contact a help-desk or security office while simultaneously allowing the overhead speaker system to play the audio track for the video display. StreamNet also provides GPIO at the network edge, or in other words on the endpoints. This allows dealers to perform complex room automation without any additional boxes, wiring or power supplies.

Why TCP/IP for Distributed Video?

NetStreams' vision for distributed video is one that consistently distributes high definition video (up to 1080p) in an all digital format using TCP/IP on any standard switched Ethernet network. This is the backbone of StreamNet. By distributing video over TCP/IP, drastic improvements in flexibility, scalability, and price / performance are achieved over traditional video distribution methods. In addition, the incorporation of a distributed architecture and distributed intelligence allows for flexibility and easy expansion, since A/V sources may still be located at the head end (like RF and Baseband systems), OR located anywhere on the network.

Since TCP/IP was primarily developed for data transmission across a network, ClearOne had to solve fundamental challenges with using the protocol to distribute video. For example Network bandwidth is a constraint to quality as packets may be lost if the network is not managed correctly. Additionally synchronization of signal distribution is essential and backwards / forwards compatibility with legacy and newer sources always presents issues.

Only ClearOne has been able to solve all of these issues and distribute the highest quality (1080p), uncompressed video, point to point, and point to multipoint over TCP/IP on an Ethernet network. NetStreams' IP-Based system is the most advanced and expandable distributed video system ever built.

RF (the old way)

max resolution 480 lines

IP

full 1080P HD resolution

Advantages of StreamNet IP-Based video distribution:

1. StreamNet delivers the highest quality uncompressed video over TCP/IP on a network to multiple displays. With StreamNet, NetStreams is the first to deliver uncompressed video over TCP/IP as most digital solutions for distributing video employ artifact introducing compression prior to distribution, due to bandwidth issues.

2. StreamNet can distribute multiple resolution formats of high definition and standard definition video signals.

3. StreamNet technology insures precise synchronization of audio and video signals for point to point, and point to multi-point distribution, delivering the highest quality audio and video performance with the lowest latency, allowing audio and video signals to be delivered and played back simultaneously at all display locations without perceptible dissonance. Additionally, audio and video signals distributed to multiple display locations are fully synchronized across the network using TCP/IP and eliminating lip sync problems. In addition signals are automatically synchronized over the entire network for point to multipoint distribution, with a total latency of just 30 milliseconds.

StreamNet's suite of communication capabilities enables easy system configuration and concrete network reliability. StreamNet incorporates a suite of communications conventions which reduce system configuration time and increases overall network reliability. StreamNet services are known as Service Discovery, Message Routing, and Status reporting.

Service Discovery - Every feature or function of the StreamNet IP-Based Multi-Zone Audio and Control system is provided by a "service." There are many types of services – audio renderers, audio sources, general purpose inputs and outputs (GPIO), user interface, media server proxy, to name a few. These services 'advertise' their existence to the network, broadcasting their name, type, IP-Address(es) and other important information. When StreamNet-enabled devices are plugged into the network, they immediately advertise their capabilities in effect auto discovering and configuring, reducing the need to program the entire system from scratch.

Message Routing - ASCII messages provide the primary method of control and status reporting for StreamNet. Every service has a name and optionally belongs to a zone and / or some number of "groups". Messages may be addressed to the service name, room name or group name. Messages may be sent multicast (UDP) or unicast (UDP or TCP) to any or all StreamNet-enabled devices. If required, StreamNet devices will forward messages to ensure delivery to the service(s) addressed.

Status Reporting - StreamNet services output unsolicited reports of their state and changes in state. Reports are in a flexible format that resembles XML. Each report is a list of "variable=value" pairs. Status reports may be sent unicast or multicast. In addition, a TCP client may "register" for status from one or more services and the StreamNet device will aggregate the reports onto the one TCP connection.

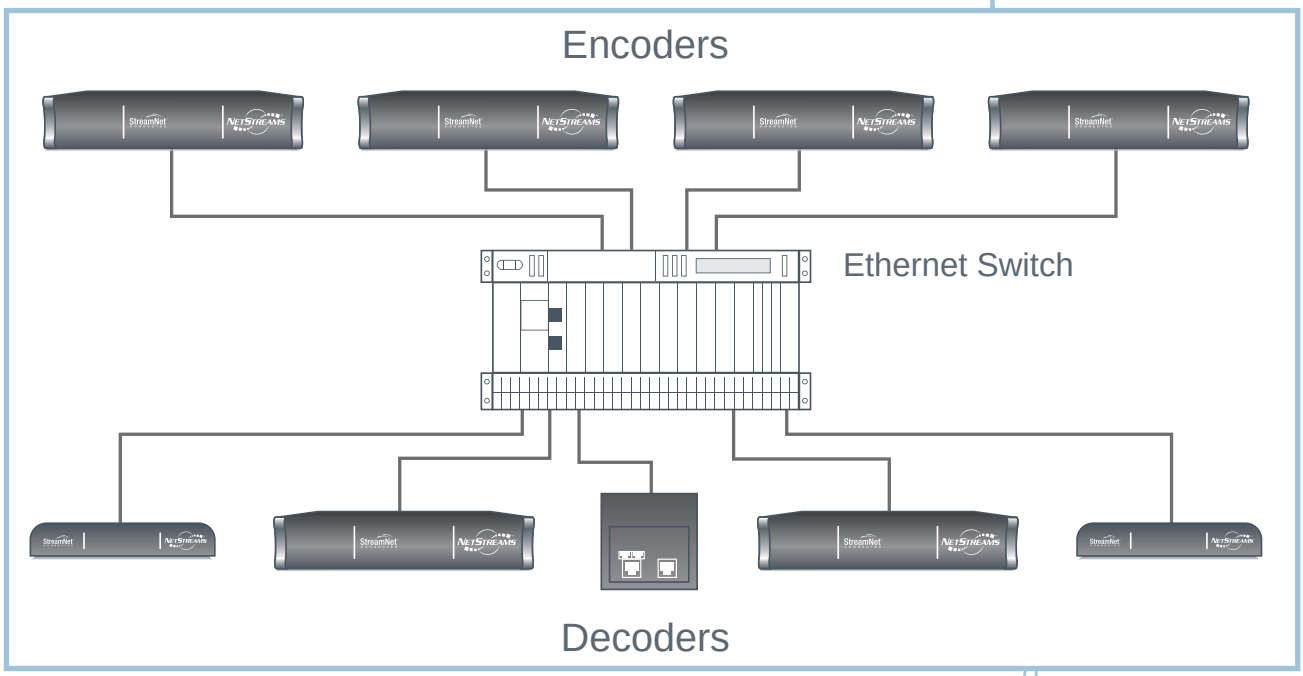
4. StreamNet PerfectPixel technology faithfully replicates video over the network to ensure the highest quality is achieved regardless of distance from the video source. Packet loss can always occur when distributing a video signal (even a compressed one) over an Ethernet network which may cause the picture to appear blotchy, color shifted, or chunks of the picture to be missing all together. PerfectPixel technology solves this issue with both compressed and uncompressed signals over the network and is a combination of ClearOne's proprietary algorithms for packet delivery optimization and error concealment algorithm, insuring reliable delivery of video data and eliminating dropped content across the network. The result is pixel-for-pixel, high definition video distribution with consistency of high quality images across the network, regardless of distance.

5. StreamNet can also distribute and deliver bit-for-bit, high performance audio including the use of Dolby Digital® and DTS® multi channel formats for decoding by a Display, A/V Receiver or surround sound processor.

6. TCP/IP, the language of the internet, was developed to support an almost infinite number of nodes. NetStreams' StreamNet offers support for a nearly unlimited number of sources and zones, on any packet switched network. StreamNet incorporates a state-of-the-art network architecture in which each product on the network has its own IP address and network intelligence, eliminating the need for costly matrix switches and central controllers. In addition, audio and video streams are multicast to provide scalability. StreamNet technology is incorporated in the ClearOne MediaLinX products and automatically converts audio and video in real time so it may be streamed using TCP/IP for playback.

7. The StreamNet IP-Based distributed video system is future upgradeable. ClearOne has insured the firmware in all new distributed video products (just as the audio products) is upgradeable so additional features and CODECs may be added without costly hardware upgrades.

8. StreamNet is easy to install and setup. Because StreamNet is completely IP-Based, it does not require complex Matrix switches or external control systems with the massive custom programming. Sources and displays are automatically discovered over the network and a variety of easy to use graphical user interface skins are available, which means programming time may be reduced by as much as 80% over a traditional video distribution system.



Automatic Synchronization of Streams (Time Sync)

A fundamental problem with using TCP/IP to distribute digital audio to multiple zones in a home or commercial environment is synchronization of playback. Without synchronization, audio can sputter, cut out, or have strong echo effects from zone to zone, sometimes playing several seconds apart.

Simply incorporating a buffer to attempt to synchronize the audio is not enough. ClearOne's StreamNet technology provides the solution by removing the effect of network delays. This is achieved by StreamNet assigning a "master" which is dynamically chosen to serve as the time reference, thereby allowing all devices to share the same concept of time and stay fully synchronized.

The sample rate is synchronized using a VCXO for low jitter. As a result, the maximum delay between any two speakers is reduced to just 1 millisecond which is considerably below the audible threshold. StreamNet allows audio in all zones to be synchronized when playing the same source throughout the system, solving the problem of distributing audio over TCP/IP packet-switched streams.

StreamNet is compatible with traditional audio sources because MediaLinX automatically converts audio in real time so it may be streamed over TCP/IP for playback in any zone including IR commands packetized for easy control of the source.

Internet Protocol (IP-Based) enables pristine audio to be delivered digitally using state-of-the-art meshed network architecture in which each product on the network has its own IP address and network intelligence, eliminating the need for costly matrix switches and central controllers. In addition, audio streams are multicast to provide scalability. With StreamNet there is virtually no limit to the number of sources or zones you can have in the system, so no matter the size or scale of your project, ClearOne's StreamNet system will deliver the performance you require.

Choose Between Uncompressed, Full Bandwidth Audio and MP3. The StreamNet Multi-Zone Audio / Video and Control system can handle a wide range of audio sources simultaneously, from uncompressed, full bandwidth audio to MP3 songs compressed at any sample rate.

StreamNet enables a pure digital signal all the way to the speakers. Digital provides the highest quality audio since it represents a perfect copy of the original studio recording. However, at the amplifier, the digital signal is converted to analog so it can be heard. A fundamental principle in audio is the longer the speaker wire, the more compromised the audio signal becomes, as losses can occur due to speaker wire resistance (regardless of the gauge). Besides losses due to cable resistance, longer cables begin to exhibit a significant reactive component of capacitance and inductance regardless of the wire gauge. When an AV professional designs a multi-zone audio system with long cable lengths, the signal quality is compromised even more. Using StreamNet it is now possible to maintain the quality of the signal by allowing the power amplifiers to be located at the speaker or in close proximity significantly reducing the length of the speaker wire required and keeping the signal in the digital domain for as long as possible.

Defining DRM

DRM stands for Digital Rights Management and refers to a collection of systems used to protect electronic media such as music, movies, images or any digital content where the publisher wishes to ensure their data “bits” are not available to be freely swapped or shared without proper compensation. DRM systems can vary widely but most frequently include two primary pieces, encryption and access control.

Encryption as the name implies is designed to limit the free exchange of content so it cannot be played outside the intended ecosystem, whereas access control is intended to limit the number of plays or authorized devices available for playback. For example, Apple iTunes uses a DRM system to limit the number of Apple devices iTunes files may be played on.

Digital Rights Management (DRM) is important to publishers of electronic media to ensure they receive the appropriate revenue. By controlling the trading, protection, and access to digital media, DRM helps publishers limit the illegal propagation of copyrighted works and maximize revenue in the case of premium “paid” content.

The history of DRM technologies extends well before digital or electronic media existed where copyright holders, content producers, or other financially or artistically interested parties had certain business and legal objections to copying technologies. As early as the player piano rolls in the 20th century copying technology represented a disruptive technology to the live player who suddenly was no longer needed for the piano to be played. Thus debates about the need for DRM are really not all that new. In fact we can thank a successful outcome from the famous Sony “Betamax case” in the U.S. as paving the way for the video tape recorder being made available for mass consumer use. Copying technology in any form has and always will represent disruptive technology.

The advent of digital media and their associated conversion technologies, especially those that usable on mass-market general-purpose personal computers, has vastly increased the concerns of copyright-dependent individuals and organizations, especially within the movie business. For this reason it is incumbent that all audio video professionals have some understanding of DRM technologies as they can play a key role in a systems design, or in certain equipment and cabling choices that otherwise would not be a factor.

Though certain copy protection schemes exist for analog, such as Macrovision, because digital media files may be duplicated an unlimited number of times, with no degradation in quality, DRM technologies are used by publishers to enforce access policies that not only disallow copyright infringements, but also prevent lawful fair use of copyrighted works.

DRM can even be used to implement use constraints on non-copyrighted works, examples include the placement of DRM on certain public-domain or open-licensed e-books, or DRM included in consumer electronic devices that time-shift both copyrighted and non-copyrighted works.

For the AV professional the most relevant discussion around DRM is to define transfer stream DRM as compared with DRM encryption for digital files. Example: High-bandwidth Digital Content Protection (HDCP) compared with Microsoft PlayReady DRM.

High-bandwidth Digital Content Protection (HDCP) is a form of digital copy protection developed by Intel Corporation and is used to prevent copying of digital audio and video content as it moves across DisplayPort, Digital Visual Interface (DVI), High-Definition Multimedia Interface (HDMI), Gigabit Video Interface (GVIF), or Unified Display Interface (UDI) connections.

HDCP does not allow copying permitted by fair use laws, rather the system is meant to stop HDCP-encrypted content from being played on devices that do not support HDCP or have been modified to copy HDCP content. The HDCP system works as follows. Before sending data, a transmitting device verifies that the receiver is authorized to receive it, and if so, the transmitter then encrypts the data as it flows to the receiver. This is an example of a transport stream DRM which is primarily what the average AV professional will come in contact with. However, a complete understanding of digital file encryption is also required, lest a file be attempted to play and the user presented with a dreaded, “file not authorized” error message.

In contrast, Microsoft PlayReady DRM is one example of a system which protects digital files and enables content services and device manufacturers to make more content available to consumers without fear of losing control and revenue of their high value digital assets. PlayReady fully supports domains and embedded licenses, making it simpler for consumers to transfer and play content on a wider range of devices. Microsoft’s PlayReady technology supports a wide range of audio and video formats, including Windows Media Audio (WMA), Windows Media Video (WMV), Advanced Audio Coding (AAC), AAC+, enhanced AAC+, and the H.263, and H.264 video codecs. It also moves beyond audio and video to support games, images, and ringtones. In addition, it supports many business models for content, including purchased downloads, subscription, rental, preview, and pay-per-view which have now all become an essential part of premium service offerings gaining mainstream consumer adoption.

Why transport stream DRM is problematic in multi-source systems.

As is often the case with complex digital systems, particularly when DRM or digital encryption technologies are involved, what should "just work" rarely does as promised which is why a complete understanding of the pitfalls and challenges of multi-source and multi-display video distribution must be understood.

To begin we need to define key elements contained within HDMI starting with the Data Display Channel (DDC). The DDC is a two-way communications interface that sits between the source and associated downstream repeater (or display device). The purpose of this channel is to communicate device capability information encoded in a structure known as Extended Display Identification Data (EDID). HDMI devices use EDID to broadcast to receiving devices the audio and video formats supported. It should also be noted that the DDC interface is used to set up and maintain HDCP encryption.

Adjacent to DDC is Hot Plug Detect (HPD), which broadcasts to downstream devices, indicating its presence to the source. HPD allows each device to know when a cable has been connected and automatically triggers authentication including EDID information about a display to a source conveying its resolution capabilities.

Initially developed for computers and monitors, EDID is now found in most all consumer electronic devices that support HDMI. As an example, a television may use EDID to indicate support for the standard HD resolutions in addition to 1080p and Deep Color while another TV may not support higher than 720p / 1080i resolution. All information regarding the audio and video capabilities of each device is stored in its EDID.

The challenge AV professionals face in simple installations is minimal. In fact one could argue HDMI greatly eases set-up and compatibility issues when dealing with simple consumer systems comprising a single source and a single display. However, it is our assumption the reader of this guide is commonly dealing with system designs of a much more complex nature such as multi-room and multi-source, with perhaps dozens of displays needing to be switched reliably. And for these system design applications, StreamNet was developed.

Because HDMI and the EDID specification were not originally conceived to be used for multi-point installations or applications, problems may be introduced in systems typical of what AV professionals design, install or maintain, where display devices will not show content. Since HDMI switches are required for large multi-source and multi-display systems, and these same switches are responsible for collecting the display's EDID and providing a unified version to the source, it must be noted neither the HDMI nor EDID specifications suggest how to do this task reliably. Which is why different HDMI switches and repeaters often behave in unpredictable ways as each manufacturer implements the standards differently.

As illustration, consider the following system.

Your client wishes to connect a 1080p projector with a surround sound processor in the media room or home theater, and a 720p / 1080i display in the master bedroom using the internal speakers for audio. So the question is how should the HDMI switch combine the EDID information so each display shows the optimum image, or in some cases shows any image at all, and audio is correctly passed to each environment?

It is our experience that certain devices on the market solve this problem by simply copying the EDID from the first output. However in our scenario this would mean1080p video and surround sound audio is sent to the family room which neither supports1080p or surround sound audio.

Another approach some HDMI switches take is to create a merged EDID that limits the content to only what both rooms can support. Unfortunately this means our media room / home theater is now artificially limited to 720p video and stereo audio. Once we expand this scenario to multi-point installations with multiple rooms, source devices and displays it is easy to see why HDMI in many systems is problematic and why many AV professionals have "defaulted" back to analog interconnection schemes. After all with analog you are ensured to have picture and sound on every screen in every room. Of course never mind the quality our customers paid for is never fully realized. At least it is nearly guaranteed to work every time or so is the rationalization of this approach. However with ClearOne's StreamNet digital media solution there is now a way to not only provide your customers the very best picture and sound, and do so reliably.

HIGH-DEFINITION MULTIMEDIA INTERFACE

Another complicating factor with many HDMI connected multi-source / multi-display systems is HDCP encryption.

There are two parts to HDCP, which must be discussed to better understand why solving the EDID problem alone does not guarantee reliable interconnection in advanced systems using HDMI. The first is HDCP authentication and the second is HDCP encryption to prevent interception during transmission. Using HDCP authentication ensures all devices receiving content over the HDMI link are licensed and authorized. Only after successful authentication may the display output audio and video streams received from the HDMI link.

Every HDMI device contains a unique ID known as KSV (Key Selection Vector), which must be passed to the source. Devices that re-transmit HDCP content will inform the source of all downstream connections in the system. The source must then verify each device before it transmits content. It is this authentication process that frequently causes delays when switching between devices as the source and display(s) must negotiate their KSV's to ensure content is only delivered to authorized devices.

The HDMI standard imposes a hard limit on the number of displays that can be connected. Due to a limit in the number of KSVs available, the HDCP specification calls for only up to 127 devices. However sources usually support considerable less than 127 and in fact most consumer products only support ten devices at most. What this means is if a repeater presents a source with too many KSVs, the source will cease transmitting content. Unfortunately for the AV professional KSV limits are not an advertised feature as HDMI was really designed for point to point communications where even ten KSVs was thought to be "more than enough" by the manufacturer of the HDMI silicon chipsets.

When KSV values are exceeded, the viewer will not realize a problem until they try to route an additional source to an extra display and audio / video begins to drop out inexplicably. To make matters worse, this can occur without so much as an error message.

ClearOne's StreamNet solution solves these problems because of the innovative application of encoders and decoders in its architecture. Since every source in a StreamNet system is connected to what is known as an encoder, the source is able to easily negotiate EDID and KSV values with the connected encoder, keeping the original design intent of HDMI's point to point architecture intact. In the case of StreamNet decoders, these devices connect to each display and in-turn are able to easily return the EDID and KSV information an HDMI connected source requires. The StreamNet solution also informs the user of potential HDCP limits and issues, for example if you try to connect to a source that has already exceeded its KSV limit, we will instruct you on screen or on the touch panel of your options, and how to remedy the issue. Since we store all information on each unit, we can also switch sources very quickly, greatly improving the overall user experience.

HIGH-DEFINITION MULTIMEDIA INTERFACE

Q. What is HDCP?

High-bandwidth Digital Content Protection (HDCP) is a technology developed by Digital Content Protection, LLC (a subsidiary of Intel) to protect digital entertainment content. HDCP has been implemented across both DVI and HDMI interfaces. The HDCP specification provides a cost-effective and transparent method for transmitting and receiving the highest quality digital entertainment content to DVI / HDMI-compliant digital displays.

Q. Is HDCP an option to implement in any device with an HDMI connection?

While HDCP is optional in the HDMI specification, nearly every device intended to transmit or receive protected content such as movies has incorporated HDCP. Manufacturers typically do not call out HDCP support as the only devices that do not regularly include HDCP are those not designed to transmit or receive protected content, such as consumer camcorders and digital still cameras.

Q. If my display doesn't have an HDCP compatible connection will I be able to view HD DVD and Blu-ray content in high definition?

Content owners (i.e., any movie studio releasing a title on optical disc format or digital streaming / download) decide which technologies they will require to be used to protect their content against unauthorized copying. Movie studios fearing high-definition versions of their titles will be pirated, almost universally use HDCP when releasing high-definition versions of their movies. Note, there are specific requirements on HDCP usage mandated by the U.S. Federal Communications Commission and by industry bodies in Europe and Asia. With certain exceptions, nearly all HDMI devices on the market today include HDCP support. DVI devices, in particular earlier versions of DVI intended for computer applications, are less likely to support HDCP.

Q. Is AACS (Advanced Access Content System) an alternative to HDCP?

No, AACS is the content protection for video on Blu-ray discs and HDCP is the content protection for all video carried over the HDMI link between an HDMI enabled source and the display featuring an HDMI connector enabled with HDCP. AACS is a stronger replacement for the current content protection on today's standard-definition DVDs known as CSS or copy scramble system. The way AACS and HDCP work in tandem is as follows. The video player will decrypt the AACS-encrypted content coming off the disc and then send the content over the protected HDMI link (using HDCP) to the HDTV. Of course both the source and display must be HDCP enabled for the content to be decrypted and played back.

HDCP Quick FAQ

HIGH-DEFINITION MULTIMEDIA INTERFACE

Q. Can HDMI cables contribute to devices not working properly together?

The vast majority of image quality or interoperability issues with HDMI devices are related to the software (firmware) used for device communication and content protection (HDCP), and have nothing to do with the HDMI cable. These issues are often caused by the software related to HDCP handshaking, or from devices improperly handling the device capability information read through HDMI (EDID is incorrect). It is fairly uncommon for the cable to be the cause of HDMI compatibility problems, generally the issues are HDCP related when a source will not properly talk to a display.

Q: Is it possible for a source to connect to more sink devices (displays) then it supports?

The answer to this question is “No”. It is not possible to achieve this unless a product is infringing on the HDCP license due to improper implementation. This is a question of great confusion for dealers due to a few well-known HDMI matrix switcher products not properly implementing HDCP.

The reason this is not possible is because HDCP is a technology designed for point to point content protection to ensure high value data transmitted digitally from a source to a display is fully protected and not easily hijacked or stolen in route.

HDCP works by allowing every source device to accept a fixed number of keys that allow it to support one or more display devices or “sinks” based on the number of keys the source product supports. As an example, there are several popular cable set-top-boxes that only support a single display device. For the A/V systems design professional and installer this can be problematic where the client may desire the source be simultaneously displayed on a projector and flat panel display. This is not possible if the number of display devices exceeds the key count contained in the source.

To ensure your projects do not run afoul of HDCP licensing and implementation rules all StreamNet products implement HDCP as specified in the Digital CP agreement. We encourage you to not submit your company or client to legal scrutiny by using products which do not fully or properly implement HDCP.

Q: How can a dealer identify products which may not properly implement HDCP?

Unfortunately HDCP was largely designed for consumer applications where point to point is the normal connection protocol and 1 to n signal distribution, such as found in HDMI matrix switches, is almost nonexistent. ClearOne will never attempt to label products as "conforming" or "nonconforming". However, in the interest of protecting our dealers from making an innocent mistake and selecting products which could have a disastrous legal result, we suggest you be cautious and seek written assurances if a manufacturer claims any of the following.

1. If a manufacturer says they have a special HDCP bypass or "lawyer" button, steer clear as this is expressly prohibited by the HDCP robustness rules and is a clear violation of their agreement with the Digital CP.

2. If a manufacturer claims they can support more simultaneous displays than the connected source has keys, steer clear as the only way to do this is to work around the KSV limitation by regenerating keys or some other trick, all of which are expressly prohibited.

3. If a manufacturer claims they can support more than 127 connected devices. The upper limit for the number of connected displays to a source is 127. Any claim beyond this is a clear sign the manufacturer is not properly implementing HDCP.

4. If a manufacturer suggests there is a consumer implementation of HDCP and a professional implementation which is designed for the unique requirements of matrix switched HDMI systems. At the moment of this writing there are not two different implementation specifications. Furthermore, the content providers are the ones who ultimately specify how their content is protected. This means even if a professional version where to be introduced, if the leading content providers do not authorize it their content will fail to play over your systems.

HDCP Quick FAQ

HDMI®
HIGH-DEFINITION MULTIMEDIA INTERFACE

Q: What are the risks to a dealer if installing non-conforming HDCP products?

Note: it is not the purpose of this FAQ to provide legal advise which is why ClearOne suggests any dealer with legal questions consult an experienced Attorney on the subject of DRM and specifically HDCP.

HDCP is licensed by the Digital Content Protection LLC (DCP) http://digital-cp.com/ which means every licensee agrees to explicit terms of use and implementation. For this reason, and given the serious view content owners rightfully take on protecting their valuable intellectual property (movies), any licensee found to be improperly implementing the technology will likely face legal action. Though this may not affect a dealer directly, what could affect a dealer is if the vendors products were rendered useless because of key revocation.

One of the attractive features of HDCP is the ability to revoke access on certain devices should the master keys be compromised. This allows content providers a method to prevent further content access on infringing devices, while allowing unimpeded support on devices which have not been compromised. This means a potential risk for any dealer selling products not conforming to HDCP fully is at some point content from certain studios may no longer play. If this were to happen, you can imagine how difficult it would be to explain to a client why the system works with some content but not others.

It is not ClearOne's purpose to predict what the studios will do, but instead educate dealers on the issues. We encourage every dealer with concerns to first not take them lightly, and second, consult appropriate legal advice, as the facts and application around every project will be different.

Licensing bodies, why public performance matters, who is BMI, ASCAP, etc? Because most all commercial music and video is licensed for home use only it is important to understand when a use may become public performance so you can properly advise your client of the unique requirements for this application. Our objective is to provide the user with general information about licensing procedures and provide answers to the most frequently asked questions that may be faced. Content licensing is a highly specialized area of entertainment law and as such we recommend you consult an attorney or content licensing rights consultant if you have any questions around this topic.

ClearOne is a responsible citizen in the copyright community and we believe wholeheartedly in the protection of copyright. We support the philosophy that film makers, songwriters and artists deserve to be compensated for their labors, an art which enhances the lives and experience of every one of us.

What is "public performance"?

To perform or display a work "publicly" means two main things:

+ *to perform or display it at a place open to the public or at any place where a substantial number of persons outside of a normal circle of a family and its social acquaintances is gathered;*

+ *to transmit or otherwise communicate a performance or display of the work to a place specified by clause (1) or to the public, by means of any device or process, whether the members of the public capable of receiving the performance or display receive it in the same place or in separate places and at the same time or at different times.*
(Title 17, U.S.C., Copyrights, Section 101, Definitions)

What does "home use only" mean?

In the case of motion pictures, including video recordings, and other audiovisual works (music), one of the exclusive rights of the copyright owner is to perform or display the work publicly. Unless video recordings are sold or rented with public performance rights or are licensed for public performance, they should be considered "home use only" and should be restricted to private showings in the home to a "normal circle of a family and its social acquaintances." The only exception to this is the "face-to-face teaching exemption."

What is the "face-to-face teaching exemption"?

United States copyright law contains an exception which allows the lawful use of "home use only" video recordings for public performance or display without the permission of the copyright owner. Section 110 (1) of the law appears to allow the classroom use of video programs that have not been cleared for public performance if, and only if, all of the conditions set forth by the law are met.

Notwithstanding the provisions of section 106, the following is not an infringement of copyright: (1) performance or display of a work by instructors or pupils in the course of face-to-face teaching activities of a nonprofit educational institution, in a classroom or similar place devoted to instruction, unless, in the case of a motion picture or other audiovisual work, the performance, or the display of individual images, is given by means of a copy that was not lawfully made under this title, and that the person responsible for the performance knew or had reason to believe was not lawfully made;...

(Title 17, U.S.C., Copyrights, Section 110 (1), Limitations on exclusive rights: Exemption of certain performances and displays)

Does the face-to-face teaching exemption apply to distance education?

No, the Technology, Education and Copyright Harmonization (TEACH) Act provides a more limited right to use copyrighted material in distance education by accredited nonprofit institutions providing certain conditions have been met. The law permits the performance of nondramatic literary and musical works and "reasonable and limited portions" of dramatic and audiovisual works "in an amount comparable to that which is typically displayed in the course of a live session." Educational materials marketed as "mediated instructional activities transmitted via digital network" may not be used.

In order to take advantage of these exemptions there are many requirements including: 1) Access must be limited to enrolled students within class sessions; 2) Technological protection measures must be put in place to prevent recipients from further distributing the works; and 3) Institutions must institute copyright policies, provide information on copyright compliance, and provide "notice to students that materials used in connection with the course may be subject to copyright protection."

The TEACH Act was enacted in October, 2002, and is a completely revised version of Section 110(2) of the U.S. Copyright Act.

It should be noted that the TEACH Act does not restrict the law of fair use, which may allow performances beyond those allowed by the TEACH Act.

Video specific Copyright information

Since there are specific uses where copyright material may be viewed in a public performance setting it is important to consult an attorney for expert legal advise before proceeding with your project. What follows is designed to provide an overview of copyright issues in public performance situations.

A copyrighted video recording is a property right that gives the copyright owner of an original work a bundle of exclusive rights. Which include the right to authorize or prohibit reproduction, derivative works, distribution, and public performance or display of that work.

Under present law, copyright exists automatically from the moment a work is fixed in a tangible medium of expression. The work may be published or unpublished and it is not necessary for the copyright to be registered with the Copyright Office. As of March 1, 1989, a notice of copyright on the work is optional and its absence does not necessarily mean that the work is in the public domain. In short the rights of copyright apply to video recordings as well as to other works and it is best to assume all recordings are protected by copyright (unless verified otherwise by the original creator of the creative work).

What are some of the ways to find out if a video recording has public performance rights or home use rights?

+ Determine what rights are attached to a video recording at the time it is purchased or acquired, and document that information. Know that the video recording is a legal copy and know if the source of purchase or acquisition has the right to grant or convey public performance rights or not. NOTE: It is the responsibility of the person displaying a video recording to ensure they have legal right to do so in the situation they plan to use it in. Do not assume showing a home use licensed movie in a church is the same as a school or the same as a retail store. Consult an attorney if you have any questions or concerns about whether your application could be infringing or not.

+ Look for rights information on the video label, container, or on the screen. Video recordings with "home use only" rights usually, but not always, have statements indicating home use. Do not assume a video recording has public performance rights if "home use" or wording to that effect is not indicated. For example, video recordings with public performance rights rarely have that information specifically stated.

+ Contact the copyright owner or the owner's authorized representative for rights information. If the rights cannot be determined, in order to avoid infringing activity, it is advisable to assume a video recording does not have public performance rights.

When might schools or libraries consider obtaining licensing in order to use "home use only" video recordings for public performance?

Organizations should consider purchasing a license for public performance such as when a public library desires to show video recordings in any situation outside of the definition of "home-use-only" or, in the case of schools, outside of the definition of the "face-to-face teaching exemption." As example, a public library would need public performance rights to show a video recording to staff in an in-service workshop, to children during story hour, or to a community group meeting. A school would need public performance rights for a video recording to be shown for entertainment in place of recess on a rainy day, or for after-school programs, or as a reward.

How can schools and libraries obtain a license to use home use video recordings for public performance? One way is to contact the copyright holder directly, or the distributor if the distributor has the authority from the copyright owner to grant licenses, to purchase public performance rights or to request permission for a particular public performance use. Another way to obtain a license, particularly in the case of feature films, is to contact the licensing service representing the particular studio or title. Services vary in the types of licensing offered and the scope of materials represented and are listed below.

Criterion Pictures USA, Inc. 8238-40 LehighMorton Grove, IL 60053-2615 1-800-890-9494 or 1-847-470-8164 Fax: 1-847-470-8194 http://www.criterionpicusa.com

Kino International Corp. 333 W. 39th Street, Ste. 503 New York, N.Y. 10018 1-800-562-3330 or 1-212-629-6880 Fax: 1-212-714-0871 Email: contact@kino.com http://www.kino.com

Milestone Film & Video P.O. Box 128Harrington Park, NJ 07640-0128 1-800-603-1104 Fax: 1-201-767-3035 Email: milefilms@gmail.com http://www.milestonefilms.com

Motion Picture Licensing Corporation (MPLC)5455 Centinela AvenueLos Angeles, CA 90066-6970 1-800-462-8855 Fax 1-310-822-4440 Email: info@mplc.com http://www.mplc.com

Movie Licensing USAA division of Swank Motion Pictures, Inc.Schools: 10795 Watson RoadSt. Louis, MO 63127-1012 Schools: 1-877-321-1300 Libraries: 1-888-267-2658 Other organizations: 1-800-876-5577 Fax:1-877-876-9873 (Schools & Libraries) Email: mail@movlic.com or mail@swank.com http://www.swank.com

Churches should contact Christian Copyright Licensing International at http://www.cvli.com/ for blanket licenses and full information on how to use copyrighted video licensed originally for home use only in a public setting such as a religious service.

Music-Specific Copyright Information

RECORD RIGHTS

The copyrights for master recordings reproduced for use in our digital distribution equipment are held by either the record companies or the artists themselves. The Digital Millenium Copyright Act provides the owner of the master recording the right to receive a royalty from any public performance of sound recordings. Because of this we wish to ensure that all StreamNet distribution systems are not used in any way that would violate this agreement. Any installation of our distribution system into a facility which is designated as a public place almost always requires the payment of royalties to an appropriate licensing body (see information on this at the end of the section). Thus it is important all public venues, store fronts, performance stages, etc secure licenses for the reproduction rights and performance rights in the recordings to be distributed (played) whether performed live or reproduced electronically.

PUBLISHING RIGHTS

The music publisher is the entity that holds the copyright in a song. That is, the piece of music itself not the paper on which it is printed or the recording on which it is performed.

Anyone who wishes to record a song, perform a song or synchronize a song in a motion picture film or television program (for example), must secure a license from the music publisher and pay either a statutory royalty or a negotiated fee or royalty, whichever the case may be.

PUBLIC PERFORMANCE RIGHTS

In the United States of America nearly all public performances of music are licensed through ASCAP, BMI or SESAC. For the most part, all "professional" American songwriters belong to one or the other of these societies. Since the societies and the music publishers derive their rights exclusively from their affiliated writers, virtually all music publishers have companies belonging to all three societies. Membership is these societies are open to anyone who has had a musical composition commercially recorded and/or published.

The Copyright Act as amended in 1976 granted the copyright owner (songwriter or music publisher as the case may be) the exclusive right to license the performance of a musical composition in public, whether or not for profit.

CONSUMER TECHNOLOGY BILL OF RIGHTS

On October 17th, 2002 Congress introduced legislation designed to recognize the rights of consumers to use copyright protected works, and for other purposes. Which effectively stated that it is the Sense of the Congress that United States copyright law should not prohibit a consumer of information or entertainment content distributed via electronic media from engaging in the reasonable, personal, and noncommercial exercise of the six rights described in the next section with respect to works that the consumer has legally acquired.

THE SIX CONSUMER RIGHTS

1. The right to record legally acquired video or audio for later viewing or listening (popularly referred to as `time-shifting').
2. The right to use legally acquired content in different places (popularly referred to as `space-shifting').
3. The right to archive or make backup copies of legally acquired content for use in the event that the original copies are destroyed.

4. The right to use legally acquired content on the electronic platform or device of the consumer's choice.

5. The right to translate legally acquired content into comparable formats.

6. The right to use technology in order to achieve these rights.

USING TECHNOLOGY "Properly"

ClearOne is the manufacturer of equipment designed to distribute information or entertainment content via electronic media for the sole purpose of engaging in the reasonable, personal, and noncommercial performance of copyrighted works that the consumer has legally acquired. ClearOne StreamNet equipment is designed and intended for installation within a single private facility and is not designed nor intended to be installed in a way that would provide a means to publicly perform copyrighted music without the express prior permission of the copyright owner or their agents.

COPYRIGHT ORGANIZATIONS

If an individual or group wishes to utilize StreamNet equipment in a way which could infringe on copyrights, they must first contact the following organizations and make arrangements to avoid being in violation of the law.

ASCAP (American Society of Composers, Authors and Publishers) http://www.ascap.com/ Established since 1914, ASCAP has over 30,000 members and is owned, and run, by its membership.

BMI (Broadcast Music, Inc.) http://www.bmi.com/ Established in 1940 and has a membership of about 65,000 songwriters and publishers who are referred to as Affiliates. BMI is owned by 500 radio and television stations

SESAC (SESAC, Inc) http://www.sesac.com/ SESAC is a privately held organization the smallest of the three performing rights societies.

Churches should contact Christian Copyright Licensing International at http://www.ccli.com/ for license and information on how to compensate song writers for music performed in religious services.

Network

StreamNet works optimally on a Gigabit packet switched Ethernet network, though StreamNet does not require a dedicated network and peacefully coexists on any data network provided it is properly installed and configured. To ensure optimum performance is achieved NetStreams SwitchLinX switches auto detect 10/100/1000 Mbps speed, full/half duplex mode and MDI/MDI-X connections. This feature provides the user a simple way to complete the network connection with the switch. The SwitchLinX gigabit models are certified and preconfigured for the NetStreams DigiLinX IP Audio/Video distribution system for easy, plug and play installation, eliminating time required to configure and setup the switch for the DigiLinX system.

Network Switch example: SwitchLinX SW1148

Sources

With a StreamNet Encoder literally any source with analog connectors may be made available for distributon on the StreamNet network. StreamNet uses a distributed architecture that allows the hardware and the processing power to be spread out across a TCP/IP network. This leverages many of the advantages of using TCP/IP over traditional analog systems. Traditionally, sources are located near the head end controller or additional cabling is used remotely locate the audio/video source in a conference room or hotel suite.

MediaLinX is not constrained by traditional limitations and can be located anywhere, only requiring a network connection. Each MediaLinX Encoder is designed to support a single source so integrators need only to specify the exact number required and can easily add MediaLinX as the project evolves.

MediaLinX allows for unlimited Audio/Video Sources. Using TCP/IP as a distribution method also renders limits on the number of audio/video sources obsolete. StreamNet treats each source as just as another device on the network and using TCP/IP multicast protocol StreamNet easily manages the network traffic. Each MediaLinX device handles the audio and video signal encoding, IP stream output, and source control. Beyond a MediaLinX encoder no additional hardware is required to add a source to the system.

MediaLinX is a versatile audio encoder. Each MediaLinX encoder will accept analog (Line level or balanced) or digital audio (S/P-DIF) signals. The audio is converted using a Burr Brown 24-bit/96kHz analog to digital converter. The integrator can adjust the signal output strength to insure that it is consistent with other sources on the system. Then using StreamNet™ technology the audio is converted into an uncompressed stream of TCP/IP packets and made available to the system.

MediaLinX is an ideal SD / HD video encoder. The MediaLinX A/V can encode, in real-time, both SD and HD video signals into either a compressed (MotionXT) or uncompressed stream of TCP/IP packets, depending on the speed of the network switch. Using BNC connectors the MediaLinX accepts H Sync, V Sync, Y/G/CVBS, Pb/B/C and Pr/R signals allowing a variety of source types to work with MediaLinX A/V. Converting to TCP/IP will insure the audio and video signal does not degrade on its way to the display, even when cable distances are hundreds or thousands of feet.

MediaLinX offers source control. The MediaLinX A/V not only manages audio encoding, but also handles control of the source. Each device is capable of using IR, RS-232, or IP to control the source. RS-232 and IP protocols provide the MediaLinX A/V the capacity for two-way control of the source allowing the MediaLinX A/V to gather metadata and feedback. Many sources are already available that take advantage of RS-232 and IP, others can be created using StreamNet Agents written in LUA, a readily available open-source scripting language. By including the source control at the MediaLinX A/V, means not having to install additional hardware for source control.

MediaLinX Encoder example: MediaLinX MLA9300-CS

Displays

Using a StreamNet Decoder enables IP content distributed over the StreamNet network to be played from any audio or video system. StreamNet decoders are compatible with any modern display device and even legacy displays.

StreamNet uses a distributed architecture which allows the hardware and the processing power to be spread out across a TCP/IP network. This leverages many of the advantages of using TCP/IP over traditional analog systems. Traditionally, a video signal is transmitted over long cables runs that degrade the quality of the signal and can increase the project costs by requiring multiple cable runs per display. Using a decentralized IP based system preserves the HD quality of the signal and saves money by requiring only one CAT5 cable for audio, video, and control of the display.

ViewLinX Decoders fully support compressed and uncompressed video. Video may be distributed in both compressed and uncompressed forms. Sending video uncompressed allows the HD quality to be preserved during distribution on a gigabit network. For installations without a gigabit network or those with many simultaneous streams, ViewLinX fully supports compressed formats using NetStreams proprietary MotionXT™ Video Compression. If at a later date video quality needs change, ViewLinX can be easily re-configured to use uncompressed video.

ViewLinX supports unlimited number of displays. Using TCP/IP as a distribution method also renders limitations on the number of display devices obsolete. TCP/IP treats each ViewLinX as just another device on the network. By using TCP/IP multicast protocol StreamNet easily manages all network traffic to ensure full motion and resolution is preserved with minimal artifacts. Additionally, StreamNet technology keeps each zone synchronized so all zones play within 500 microseconds of each other, ensuring audio and video is always kept in sync.

ViewLinX supports both SD and HD video decoding. Each ViewLinX Decoder converts an IP stream (compressed or uncompressed) back into SD or HD and outputs the program material into the appropriate signal output type. All ViewLinX Decoders can output H Sync, Vsync, Y/G/CVBS, Pb/B/C, and Pr/R signals through BNC connectors and include an HD 15 connector for VGA signals.

ViewLinX DualDrive technology can automatically determine which signal type is being used and route the signal to the appropriate connector. This is ideal for situations where a display must display VGA and video signals in the case of a DVD player and PC connected such as in a corporate board room application. Dual Drive also allows both BNC and DB-15 connectors to be connected. The ViewLinX can also be programmed to switch the displays input based on the source signal. With a ViewLinX Decoder the AV designer has maximum

flexibility to design the system as a user would actually use it versus create a use case around the operating mode of the equipment.

ViewLinX Audio Decoder. In addition to outputting video all ViewLinX Decoders are capable of outputting analog (line level and balanced) audio and digital (S/PDIF) audio.

Additional features of ViewLinX include XVO (extended Video Output) which allows the display to plug into a 2 gang multimedia port that is connected up to 50 meters from a ViewLinX providing a very clean installation. The multimedia port and ViewLinX output can both be connected enabling a single ViewLinX Decoder to drive up to 3 displays with the same source content. ViewLinX Decoders also include two macro controlled contact closures to trigger projector screens and an input sense which can trigger a custom macro ideal for use in museums or kiosks that require content to be started when motion is detected, for example.

ViewLinX Decoder example: ViewLinX VL9100-CS

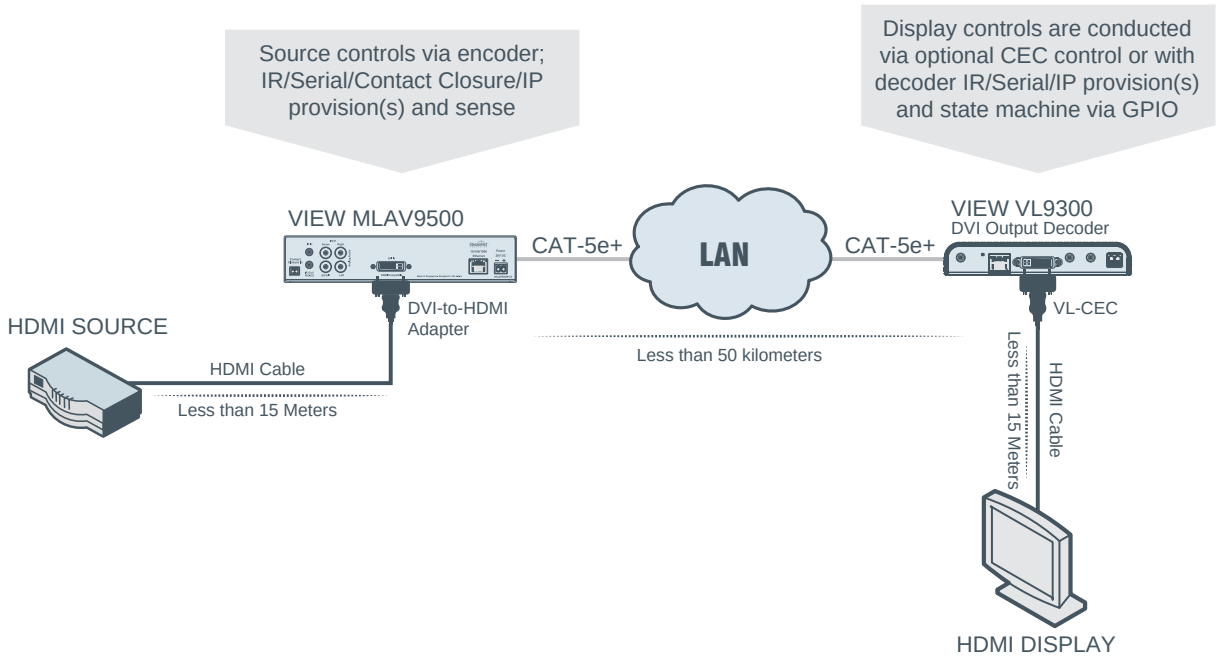
Control

With Netstreams TouchLinX control you now are in full command of your lighting, HVAC, Security, Audio and Video from anywhere in your home, or from anywhere on the Internet. Using StreamNet not only can all audio and video signals be distributed, but the system fully integrates with all leading brands of audio and video components and control products. Plus StreamNet allows you to view IP security camera's remotely from your iOS device.

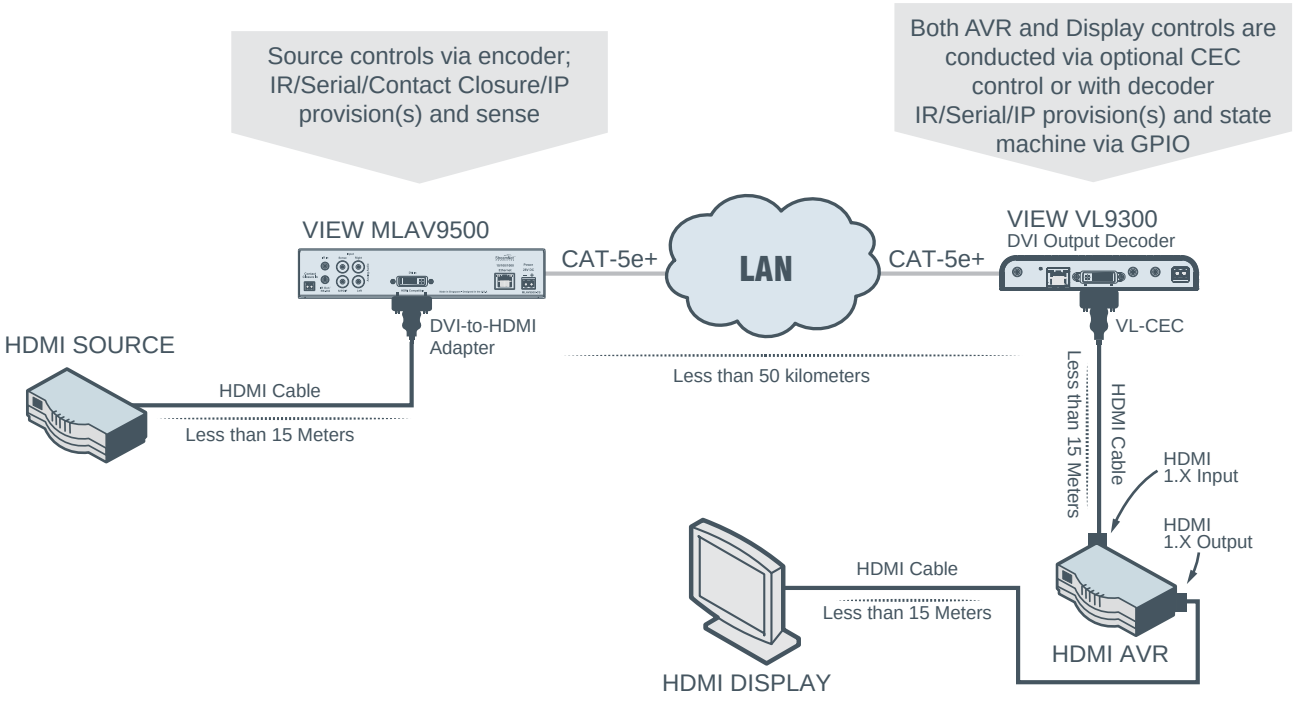
TouchLinX Control examle: TL700

HDMI source to destination AV flow and control scenarios

Scenario 1: HDMI source to HDMI display and StreamNet Control

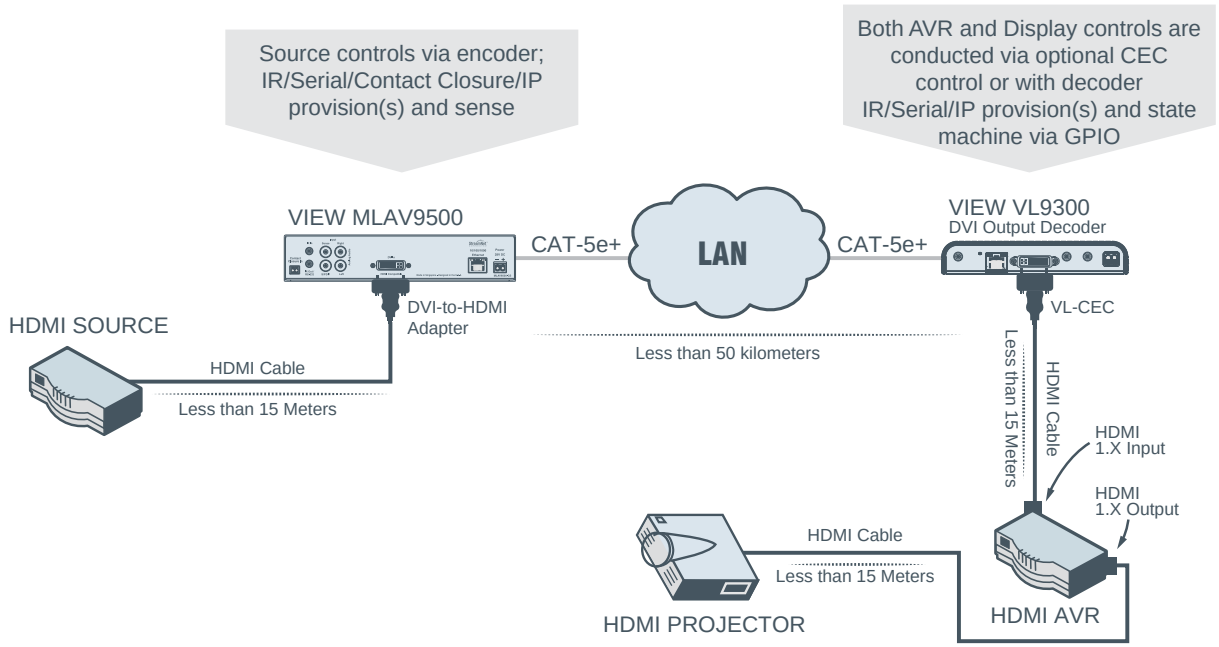


Scenario 2: HDMI source to HDMI display via HDMI repeater (AVR) and StreamNet Control

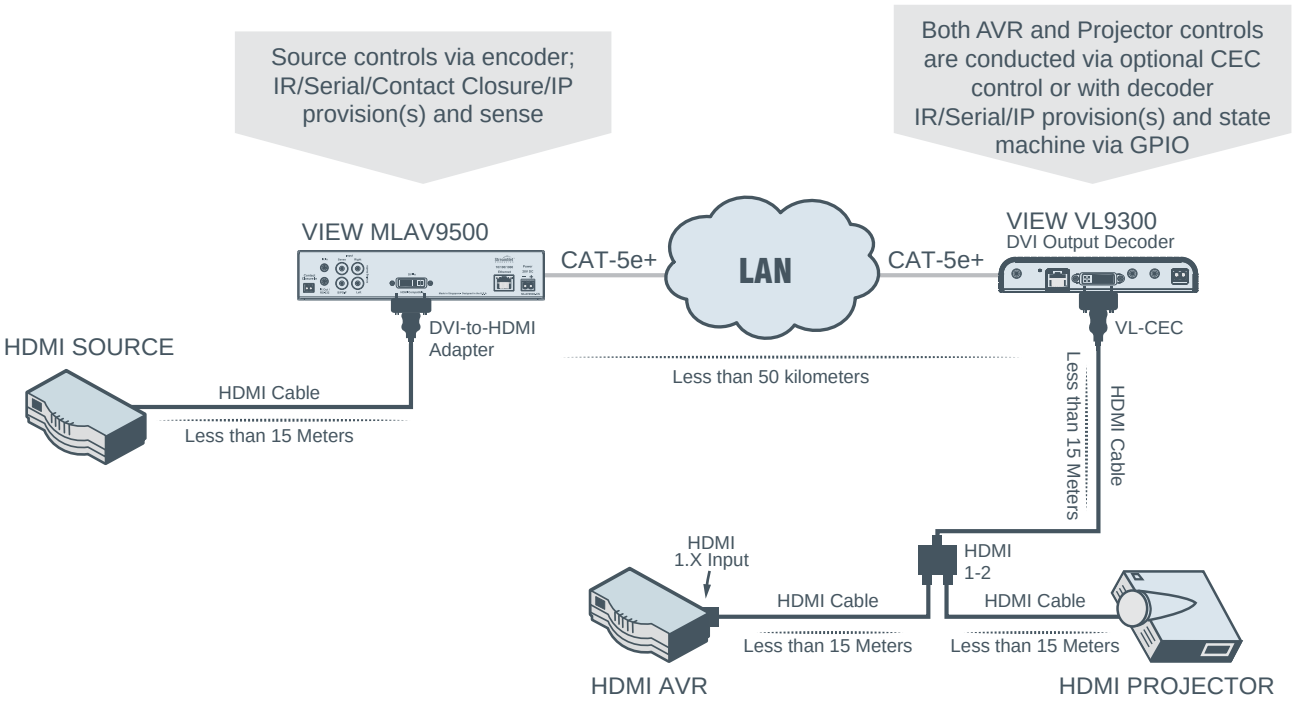


HDMI source to destination AV flow and control scenarios

Scenario 3: HDMI source to HDMI projector via HDMI repeater (AVR) and StreamNet Control

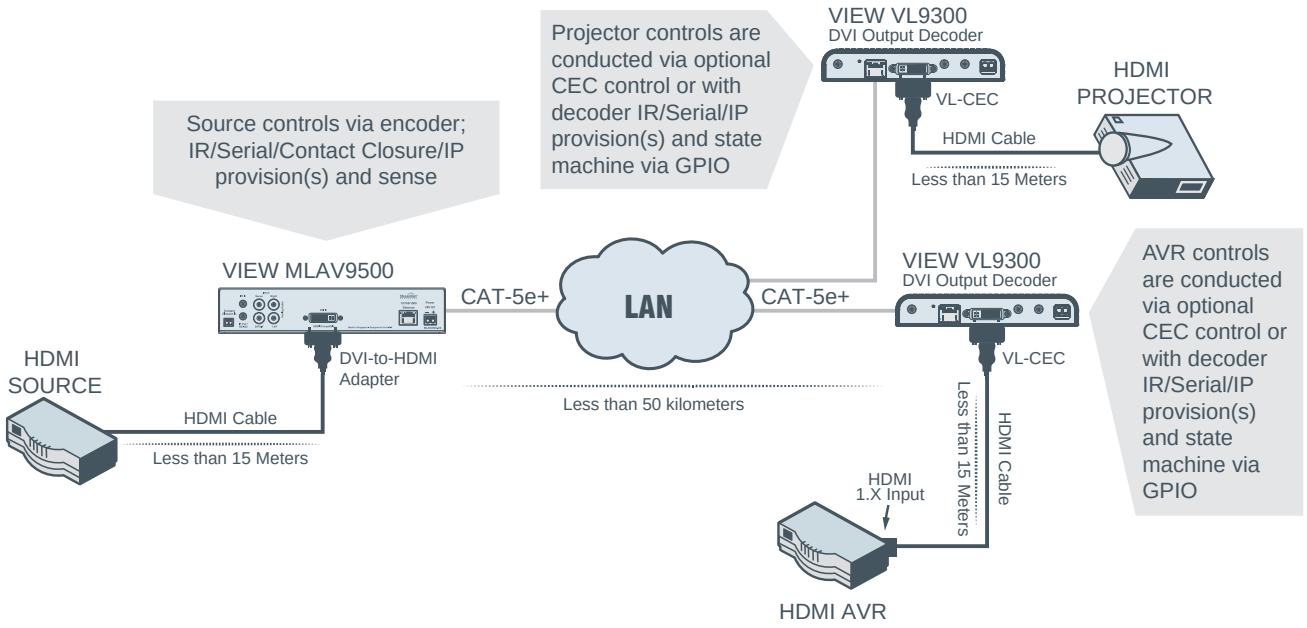


Scenario 4: HDMI source to HDMI projector and HDMI (AVR) via HDMI repeater and StreamNet Control

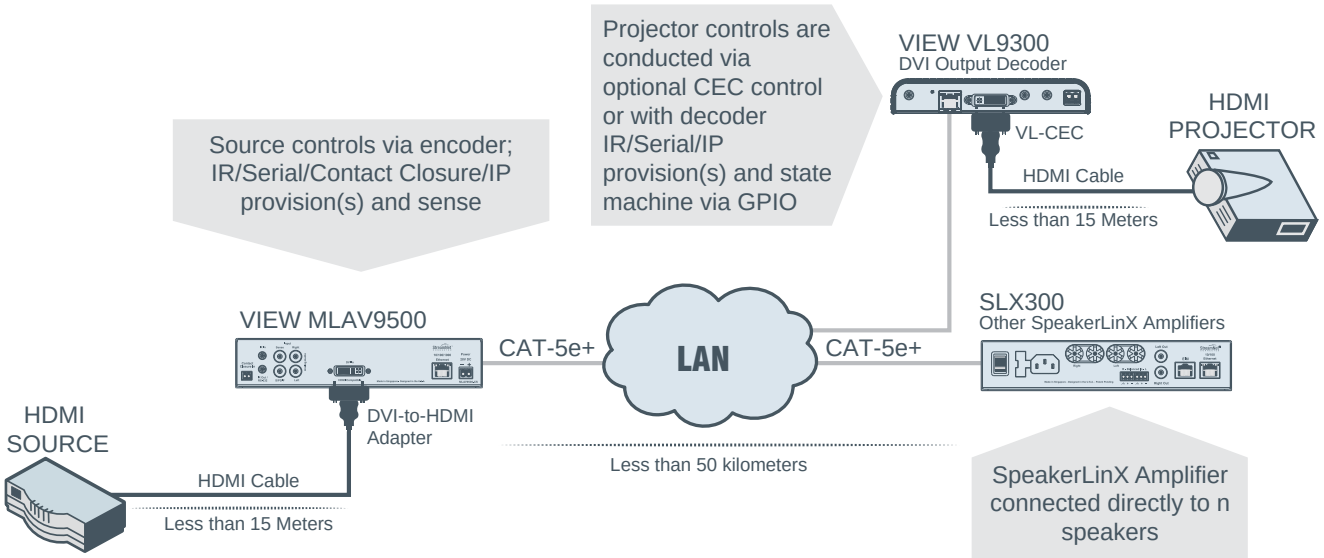


HDMI source to destination AV flow and control scenarios

Scenario 5: HDMI source to HDMI display and HDMI (AVR) and StreamNet Control

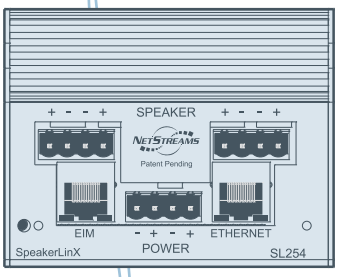


Scenario 6: HDMI source to HDMI display and StreamNet Audio, and Control

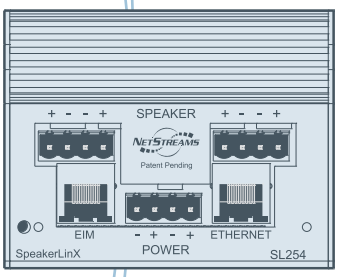


SpeakerLinX

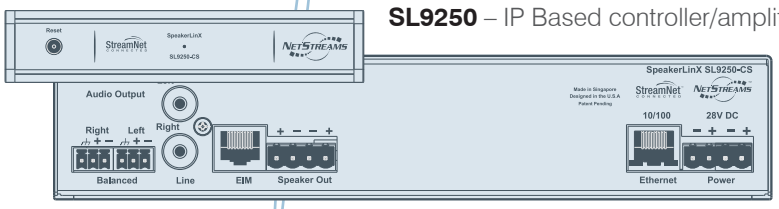
Is a family of IP amplifiers designed to mount on or adjacent to a speaker or in the room / zone where the speakers are located. A SpeakerLinX module contains not only the IP controlled amplifiers, but also a web server for complete control from any computing or display device that hosts a web browser. SpeakerLi SLSL220 contantt Class-D amplifier with the footprint the size of a credit card. By locating the amplifier right at the speaker, power and damping losses are minimized, yielding impressive clarity and definition typically only heard with expensive audiophile component systems.



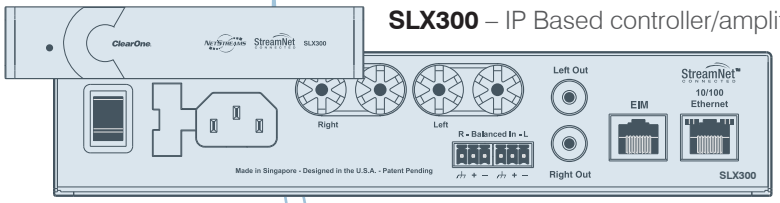
SL254 – IP Based controller/4x25 watt Amplifier-SpeakerLinX functions both the amplifier and a room controller. The SL254 SpeakerLinX includes a 4 Channel, 25 watts per channel amplifier and a built-in web server that uses an Adobe® Flash interface to control the system. The SL254 also includes an EIM interface that allows it to use peripheral devices like the KeyLinX, IRLinX, Audio Port and EIM enabled external amplifiers. The SL254 provides the digital crossover for IP Ready speakers.



SL251 – IP Based controller/amplifier - an IP-Based controller/amplifier designed to mount on or adjacent to a speaker. An Adobe® Flash® enabled SpeakerLinX SL251 module that contains the IP-controlled amplifiers and a web server for complete control from any computing or display device that hosts a web browser.



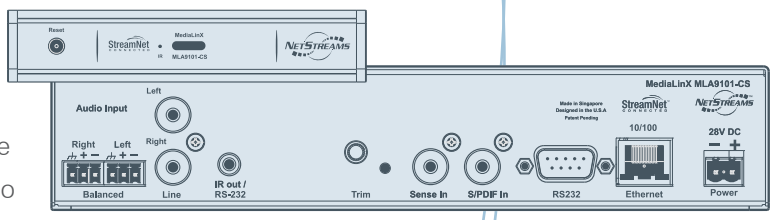
SL9250 – IP Based controller/amplifier – 2 x 50 watts amplifier and controller with a built in webserver using Adobe® Flash to control the system. The unit comes in half rack width and 1U high enclosure. Digital crossover for IP ready speakers. Includes balanced and single ended outputs.



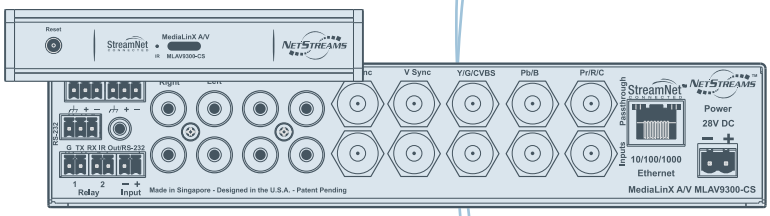
SLX300 – IP Based controller/amplifier – 2x150 watts amplifier and controller with built-in webserver in half rack width and 1U high enclosure included digital crossover for IP ready speakers and balanced and single ended outputs.

MediaLinX

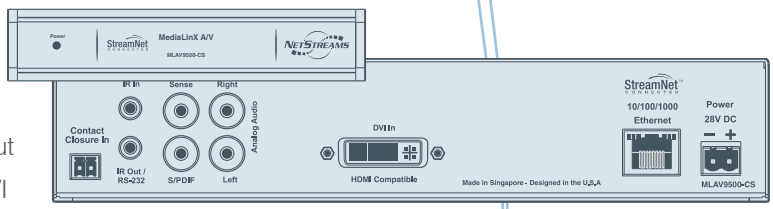
Converts analog audio or PCM digital signals into streaming TCP/IP 24-bit/96kHz audio streams in real time. MediaLinX also converts analog video signals into streaming TCP/IP up to 1080p and controls legacy sources with stored IR (Infrared) commands, offering IR pass-through and power status sensing of attached components.



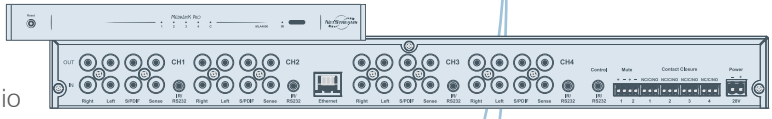
MLA9101 – IP Audio encoder-Newer native IP Based sources can output the audio directly onto the network through the Ethernet connection. Older legacy sources that output the audio over a line level connection need a device to convert the audio to an IP stream. For each legacy source the MediaLinX encodes and prepares the audio for distribution across the DigiLinX network. In addition to encoding, MediaLinX also provides a mechanism for one-way and two-way control, gathering metadata and power management of the source.



MLAV9300 – IP Video/audio encoder-gateway for audio and SD/HD quality video to flow into the DigiLinX network. For each source a MLAV9300 encodes and prepares the audio and video for distribution across the TCP/IP netowrk. Provides a mechanism for on way and two way control of the source and can ensure that the source stays power on.



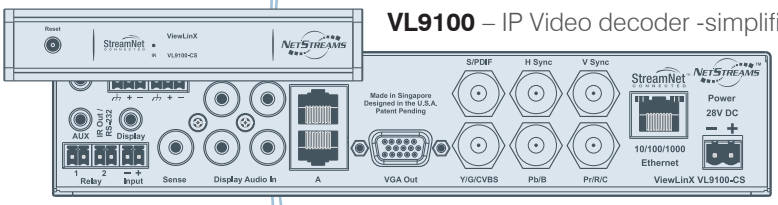
MLAV9500 – IP-Based A/V Encoder. DVI-D (HDMI compatible/HDCP Compliant). Supports 1080p and multichannel digital audio as well as analog two channel audio in. IR input, IR/Serial RS232 output in a 1U half rack width enclosure. Includes HDMI/DVI adapter.



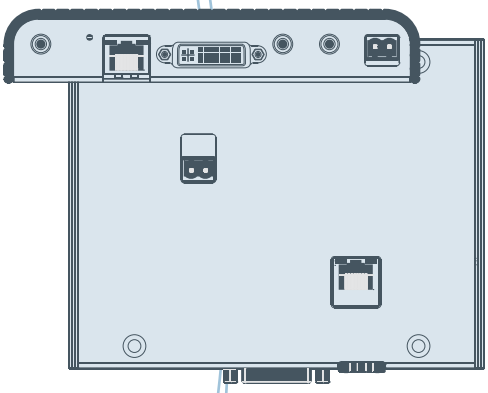
MediaLinXPro MLA4000 – IP Based 4-source MediaLiNX component that combines digital conversion of up to four Legacy analog or digital audio sources and control of third party sub-systems such as HVAC, lighting and security.

ViewLinX

TCP/IP Video component that provides real time decoding of an uncompressed A/V stream from a standard Gigabit TCP/IP network into an analog or S/PDIF audio signal and a component, composite, S-Video or VGA video signal for output to a display.



VL9100 – IP Video decoder -simplifies the design and installation of large multi-zone audio/video distribution systems. HD and SD quality multimedia can be distributed to virtually unlimited number of displays by placing a ViewLinX at each display, There is also no need to include separate components for controlling the display, its all included in the ViewLinX.

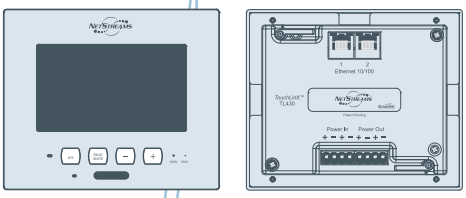


VL9300 – IP Based video decoder – HDCP compliant output. Included HDMI-DVI adapter and VESA mount. Optional Power over Ethernet.

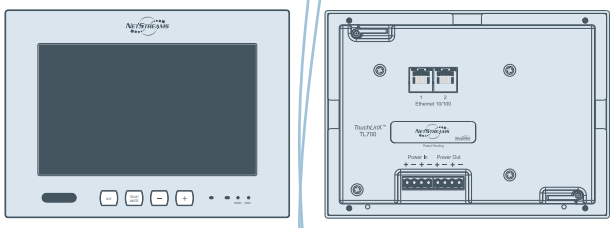
TouchLinX

TouchlinX is an elegant IP-based touch-screen designed to mount in a wall (standard two gang footprint size). The 3.8-inch, 320x240 resolution color touch-screen can display the meta-data and transport controls available for each audio source or SpeakerLinX module. TouchLinX's simplicity and intuitive design allows users to access their favorite songs, artists, play lists, or stations easily and quickly. Each room can have customized bass, treble, balance and loudness contours. TouchLinX's functionality will expand, through downloadable upgrades, to include zone-to-zone or whole-system intercom or messaging, programmable alarms and more.

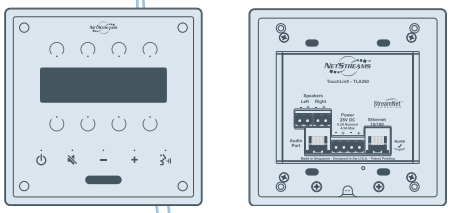
TL430 – 4.3 inch IP-Based in-wall touch screen controller-IP-Based in-wall LCS touch screen features a 4.3 inch, high resolution, TFT color LCD ouch panel, which displays the meta-data (artist, album, song, cover art) and transport controls available for each audio/video source or SpeakerLinX module.



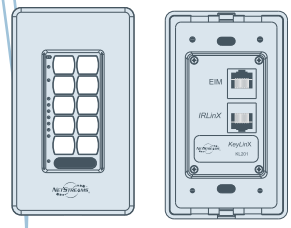
TL700 – 7.0 inch IP-Based in-wall touch screen controller-IP-Based in-wall LCS touch screen features a 7 inch, high resolution, TFT color LCD ouch panel, which displays the meta-data (artist, album, song, cover art) and transport controls available for each audio/video source or SpeakerLinX module.



NS-TLA250 – Amplified Touchpad/room controller - The TouchLinX TLA250 is ideal for zones requiring exceptional audio quality, but do not need a full color touchscreen. The text based OLED screen provides metadata, control of the zone, and IP intercom for the zone.

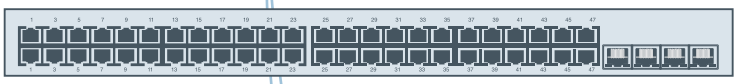


NS-KL201 – 10-button KeyLinX Keypad with IP-Intercom - The KL201 KeyLinX keypad is a 10-button single-gang in-wall keypad with intercom, microphone and monitoring capabilities that works perfectly for applications or audio zones where basic control of audio is all that is required.

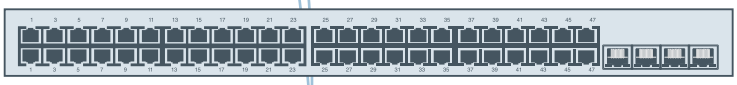


SwitchLinX

SwitchLinX is a family of IGMP (Internet Group Message Protocol) enabled, multicasting, non-blocking Ethernet switches designed specifically for handling the high demands of networked audio/video distribution and control products. Multiple SwitchLinX's allow virtually unlimited numbers of networked audio sources or other networking or control products. The NS-SW224 SwitchLinX is designed to fit in a rack or mounted set top style, while the NS-SW208 is small enough to be mounted anywhere.



SW1124 – 24-port IGMP (Internet Group Message Protocol) enabled, multicasting, non-blocking Gigabit Ethernet switches designed specifically for handling the high demands of networked audio/video distribution products. Additional SwitchLinX modules can be employed to expand the network video inputs.



SW1148 – 48-port IGMP (Internet Group Message Protocol) enabled, multicasting, non-blocking Gigabit Ethernet switche designed specifically for handling the high demands of networked audio/video distribution products. Additional SwitchLinX modules can be employed to expand the network video inputs.

AVoIP Video Encoder Feature Comparison Matrix

Encoder Features	Note 1	Note 2	Note 3	MLAV 300	MLAV 9300-CS	MLAV 9500-CS
Composite [YUV] Input	(1) F-RCA Connector		Green	✓		
Composite [YUV] Input	(1) F-BNC Connector	75 Ohm	Green		✓	
Composite [YUV] Pass-Through	(1) F-RCA Connector		Green	✓		
Composite [YUV] Pass-Through	(1) F-BNC Connector	75 Ohm	Green		✓	
S-Video [Y/C] Input	(1) F-Mini-DIN [4 pin]			✓		
S-Video [Y/C] Input	(2) F-BNC Connectors	75 Ohm	Green [Y], and Red [C]		✓	
S-Video [Y/C] Pass-Through	(1) F-Mini-DIN [4 pin]			✓		
S-Video [Y/C] Pass-Through	(2) F-BNC Connectors	75 Ohm	Green [Y], and Red [C]		✓	
Component [YPrPb] Input	(3) F-RCA Connectors		Green [Y], Red [Pr], & Blue [Pb]	✓		
Component [YPrPb] Input	(3) F-BNC Connectors	75 Ohm	Green [Y], Red [Pr], & Blue [Pb]		✓	
Component [YPrPb] Pass-Through	(3) F-RCA Connectors		Green [Y], Red [Pr], & Blue [Pb]	✓		
Component [YPrPb] Pass-Through	(3) F-BNC Connectors	75 Ohm	Green [Y], Red [Pr], & Blue [Pb]		✓	
VGA Input via DB15HD to DB15HD	(1) DE-15F Connector		(2) F-JackScrews	✓		
VGA Input via DB15HD to 5 BNC	(5) F-BNC Connectors	75 Ohm	Green [Y], Red [Pr], Blue [Pb], Grey [H], & Black [V]		✓	
Digital Visual Interface [DVI-D] Input	(1) F-DVI-D					✓
Analog Stereo Audio Inputs	(2) F-RCA Connectors	Single Ended	White [Left/Mono], & Red [Right]	✓	✓	✓
Analog Stereo Audio Inputs	(2) Removable Screw Down Euro blocks	Balanced 3.5mm (3) position	Green / Ground, Positive, Negative			✓
S/PDIF Input	(1) F-RCA Connector	75 Ohm	Orange	✓	✓	✓
S/PDIF Pass-Through	(1) F-RCA Connector	75 Ohm	Orange	✓	✓	✓
Sync Pulse Sense [YUV]	(1) F-RCA Connector		Yellow	✓	✓	
Sync Pulse Sense [YUV] Pass-Through	(1) F-RCA Connector		Yellow	✓	✓	
Contact Closure Input	(1) Removable Screw Down Euro blocks	3.5mm (2) position	Green / Ground, & Positive	✓	✓	✓
Contact Closure Outputs	(2) Removable Screw Down Euro blocks	3.5mm (2) position	Green / Ground, & Positive	✓	✓	✓
Infrared / RS-232 Input Port [TSR]	(1) 3.5mm Stereo TSR		TX, RX, GND	✓	✓	✓
Infrared / RS-232 Output Port [TSR]	(1) 3.5mm Stereo TSR		TX, RX, GND	✓		
Infrared / RS-232 Output Port [TSR]	(1) Removable Screw Down Euro blocks	3.5mm (3) position	TX, RX, GND		✓	✓
10/100/1000 Auto Sense Ethernet Port	(1) RJ45-F	TIA/EIA-568-A	Green Link, Yellow Activity	✓	✓	✓
DC Power Input Port	(1) Removable Screw Down Euro blocks	5.5mm (2) position	Green / Ground, & Positive 10-30vDC	✓	✓	✓
Front Mounted Reset Button				✓	✓	
Front Mounted IR Status indicator				✓	✓	
Front Mounted Infrared Reciever				✓	✓	
Rack Mount Enclosure				✓	✓	✓
Front Mounted Power LED				✓	✓	
StreamNet DV Lossless CODEC				✓	✓	✓
StreamNet MotionXT CODEC				✓	✓	✓

AVoIP Video Decoder Feature Comparison Matrix

Decoder Features	Note 1	Note 2	Note 3	VL 100	VL 9100	VL 9300
Composite [YUV] Output	(1) F-RCA Connector		Green	✓		
Composite [YUV] Output	(1) F-BNC Connector	75 Ohm	Green		✓	
S-Video [Y/C] Output	(1) F-Mini-DIN [4 pin]			✓		
S-Video [Y/C] Output	(2) F-BNC Connectors	75 Ohm	Green [Y], and Red [C]		✓	
Component [YPrPb] Output	(3) F-RCA Connectors		Green [Y], Red [Pr], & Blue [Pb]	✓		
Component [YPrPb] Output	(3) F-BNC Connectors	75 Ohm	Green [Y], Red [Pr], & Blue [Pb]		✓	
VGA Output via DB15HD to DB15HD	(1) DE-15F Connector		(2) F-JackScrews	✓	✓	
VGA Output via DB15HD to 5 BNC	(5) F-BNC Connectors	75 Ohm	Green [Y], Red [Pr], Blue [Pb], Grey [H], & Black [V]		✓	
XVO Output	(2) RJ45-F	TIA/EIA-568-A	A, & B		✓	
Digital Visual Interface [DVI-D] Output	(1) F-DVI-D					✓
Analog Stereo Audio Outputs	(2) F-RCA Connectors	Single Ended	White [Left/Mono], & Red [Right]	✓	✓	
Analog Stereo Audio Inputs	(2) F-RCA Connectors	Single Ended	White [Left/Mono], & Red [Right]	✓	✓	
Analog Stereo Audio Outputs	(2) Removable Screw Down Euro blocks	Bal. 3.5mm (3) position	Green / Ground, Positive, Negative		✓	
Analog Stereo Audio Input/Output	(1) 3.5mm Stereo TSR-F	Single Ended	White [Left/Mono], & Red [Right]			✓
S/PDIF Output	(1) F-RCA Connector	75 Ohm	Orange	✓		
S/PDIF Output	(1) F-BNC Connector	75 Ohm	Orange		✓	
Sync Pulse Sense [YUV]	(1) F-RCA Connector		Yellow	✓	✓	
Contact Closure Inputs	(4) Removable Screw Down Euro blocks	3.5mm (2) position	w/ VLCOM Green / Ground, & Positive			✓
Contact Closure Input	(1) Removable Screw Down Euro blocks	3.5mm (2) position	Green / Ground, & Positive	✓	✓	
Contact Closure Outputs	(2) Removable Screw Down Euro blocks	3.5mm (2) position	Green / Ground, & Positive		✓	
Contact Closure Output	(1) Removable Screw Down Euro blocks	3.5mm (2) position	Green / Ground, & Positive	✓		
Contact Closure Outputs	(4) Removable Screw Down Euro blocks	3.5mm (2) position	w/ VLCOM Green / Ground, & Positive			✓
Infrared / RS-232 Input Port [TSR]	(1) 3.5mm Stereo TSR-F		TX, RX, GND	✓	✓	✓
Infrared / RS-232 Output Port [TSR]	(1) 3.5mm Stereo TSR-F		TX, RX, GND	✓		
Infrared / RS-232 AUX Output Port [TSR]	(1) Removable Screw Down Euro blocks	3.5mm (3) position	TX, RX, GND	✓	✓	
10/100/1000 Auto Sense Ethernet Port	(1) RJ45-F	TIA/EIA-568-A	Green Link, Yellow Activity	✓	✓	
10/100 Auto Sense Ethernet Port	(2) RJ45-F	TIA/EIA-568-A	Green Link, Yellow Activity			✓
DC Power Input Port	(1) Removable Screw Down Euro blocks	5.5mm (2) position	Green / Ground, & Positive 10-30vDC	✓	✓	✓
DC Power Input Port	(2) Removable Screw Down Euro blocks	5.5mm (2) position	Red / Ground, & Positive 10-30vDC			✓
Front Mounted Reset Button				✓	✓	
Front Mounted IR Status indicator				✓	✓	
Front Mounted Infrared Reciever				✓	✓	
Rack Mount Enclosure				✓	✓	
VESA Mount Enclosure						✓
Front Mounted Power LED			VL 9300-CS LED is located on Rear	✓	✓	✓
StreamNet DV Lossless CODEC				✓	✓	
StreamNet MotionXT CODEC				✓	✓	✓

View Decoder Comparison Chart

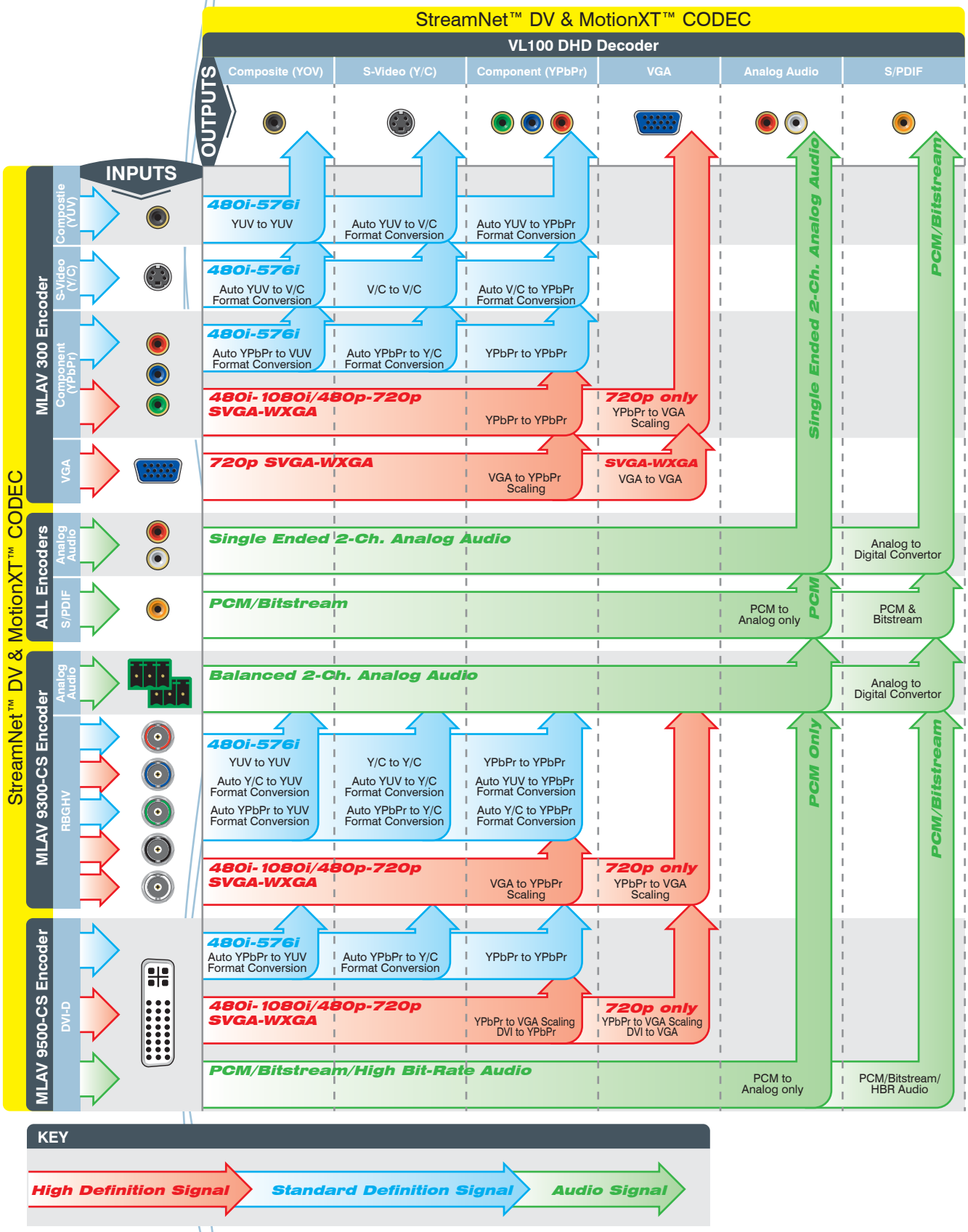
	VL100	VL9100	VL9300
Composite Output	Yes	Yes (1 xBNC)	
S-Video Output	Yes	Yes (2 xBNC)	
Component Output	Yes	Yes (3 xBNC)	
DB15 (VGA) Output	Yes	Yes (5 xBNC)	
RGBHV Outputs		Yes	
DVI Output			Yes
HDMI Output			Yes (w/a)
HDCP Support			Yes
Compressed Video (Motion XT Technology)	15/30/45/60Mb	15/30/45/60Mb	15/30/45/60Mb
Uncompressed Video	Yes	Yes	
Unbalanced Audio Input Port	Yes (Stereo RCA)	Yes (Stereo RCA)	Yes 3.5mm
Unbalanced Audio Output Port	Yes (Stereo RCA)	Yes (Stereo RCA)	Yes 3.5mm
Balanced Audio Output Port		Yes (Eruoblock)	
Digital Audio Output Port	Yes	Yes	
IR Input Port	Yes	Yes	Yes
Display Control Port	Yes	Yes	Yes
AUX Control Port	Yes	Yes	
Sense Input Port	Yes	Yes	
Contact Closures	Yes	Yes	Yes (w/a)
Relays	Yes	Yes	Yes (w/a)
XVO Audio/Video/Control Exp. Ports		Yes (2-RJ45)	
Ethernet Ports (RJ45)	10/100/1000	10/100/1000	10/100
Phoenix Connections for Power	Yes	Yes	Yes
Mounting Options (Wall, Rack and Vesa)	Wall/Rack	Wall/Rack	VESA/Wall

Codec Selection vs. Primary use case or Application

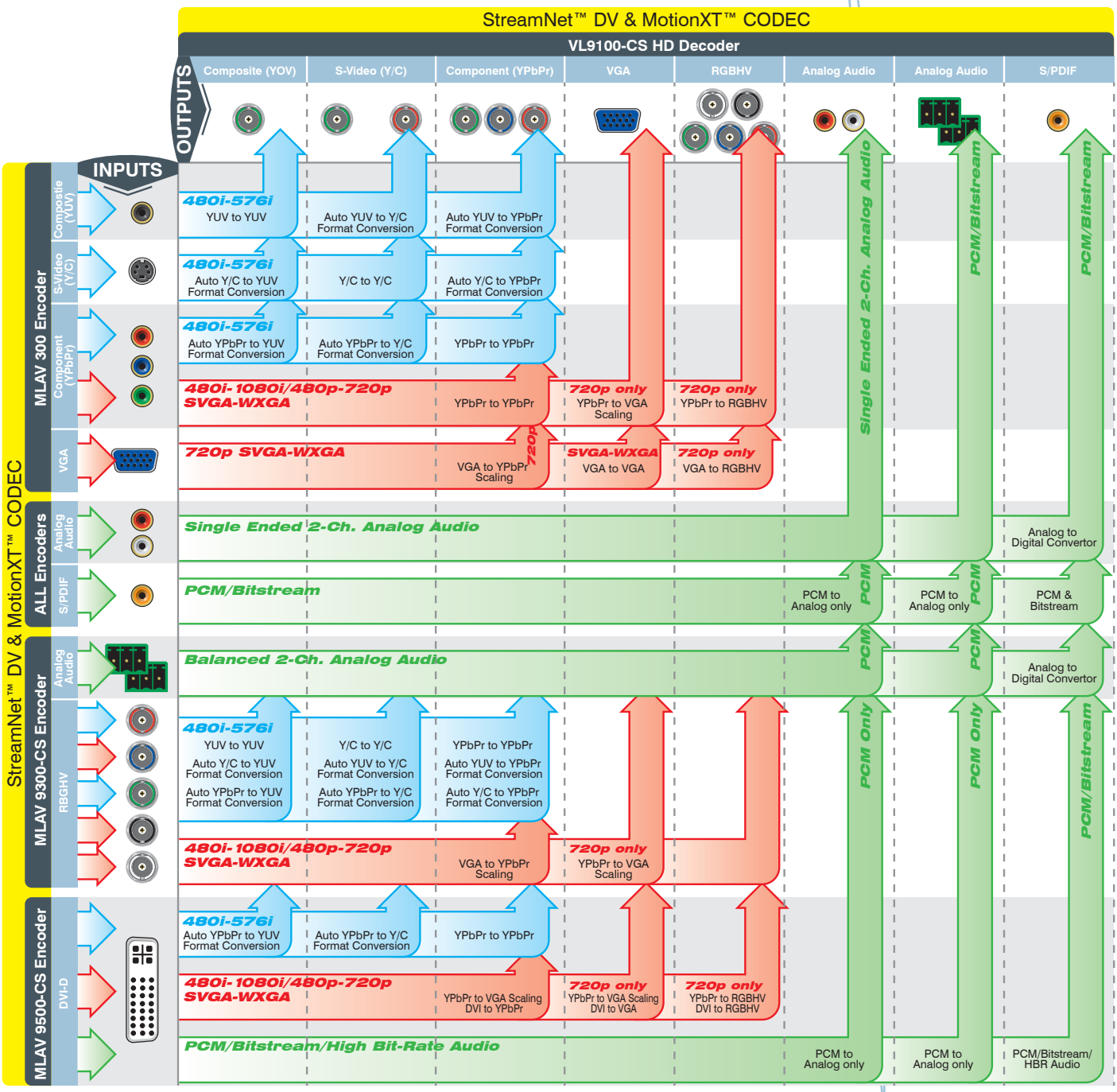
Primary Use Case/ Application	Res/.Size	StreamNet DV	Motion XT®							
			Cinema				Live Action			
			60mb	45mb	30mb	15mb	60mb	45mb	30mb	15mb
Bandwidth Limited			ANY Motion XT®							
Bandwidth NOT Limited		ANY CODEC								
Sports/News		480i-1080p[1]					480i-1080p[2]	480i-1080p[2]		
Live Sports		480i-1080p[1]					480i-1080p[2]			
Security Camera Feed		480i	480i				480i			
Movie Content HD		480i-720p	480i-720p							
Hi Def Blu Ray		480i-1080p[1]	480i-1080p[2]							
Display Size	<24"	ANY CODEC								
Display Size	25-42"			Motion XT®				Motion XT®		
Display Size	42-65"	StreamNet DV	Motion XT®				Motion XT®			
Display Size	65-120"	StreamNet DV								
Display Size	>120"	StreamNet DV								
Digital Signage - Static (DB)	480i-720p				Motion XT®				Motion XT®	
Digital Signage - Motion	480i-1080p[1]	StreamNet DV	Motion XT®				Motion XT®			

[1]StreamNet DV CODEC with 1080p output requires MLAV9500 encoder and VL9500 decoder
[2]StreamNet Motion XT® CODEC with 1080p output requires MLAV9500 encoder and VL9500 or VL9300 decoder

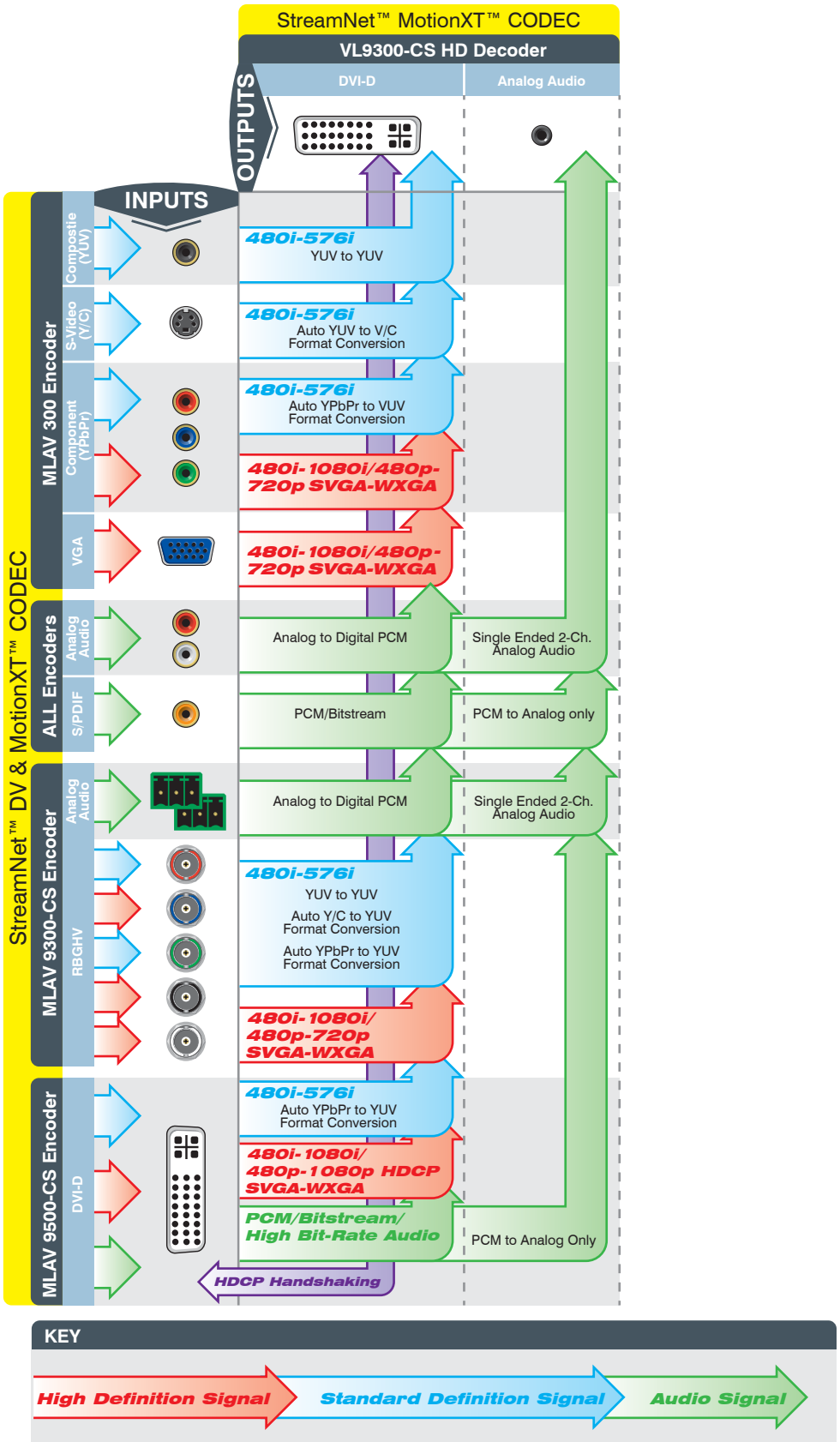
Encoders vs. VL100 Decoder Compatibility Matrix



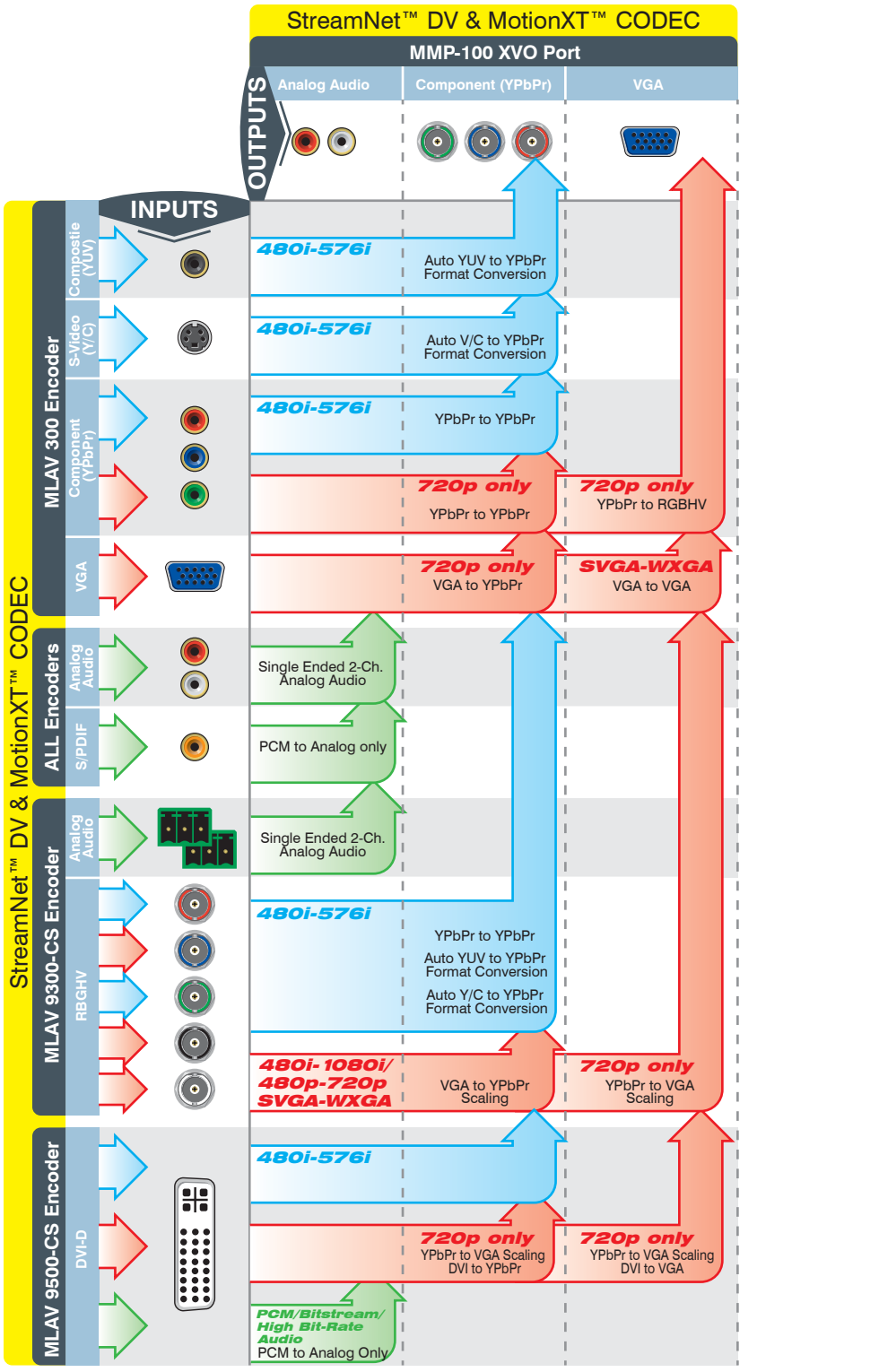
Encoders vs. VL9100 Decoder Compatibility Matrix

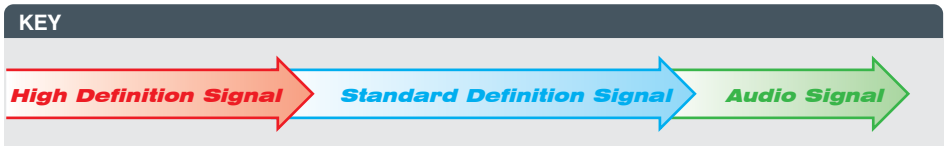


Encoders vs. VL9300 Decoder Compatibility Matrix



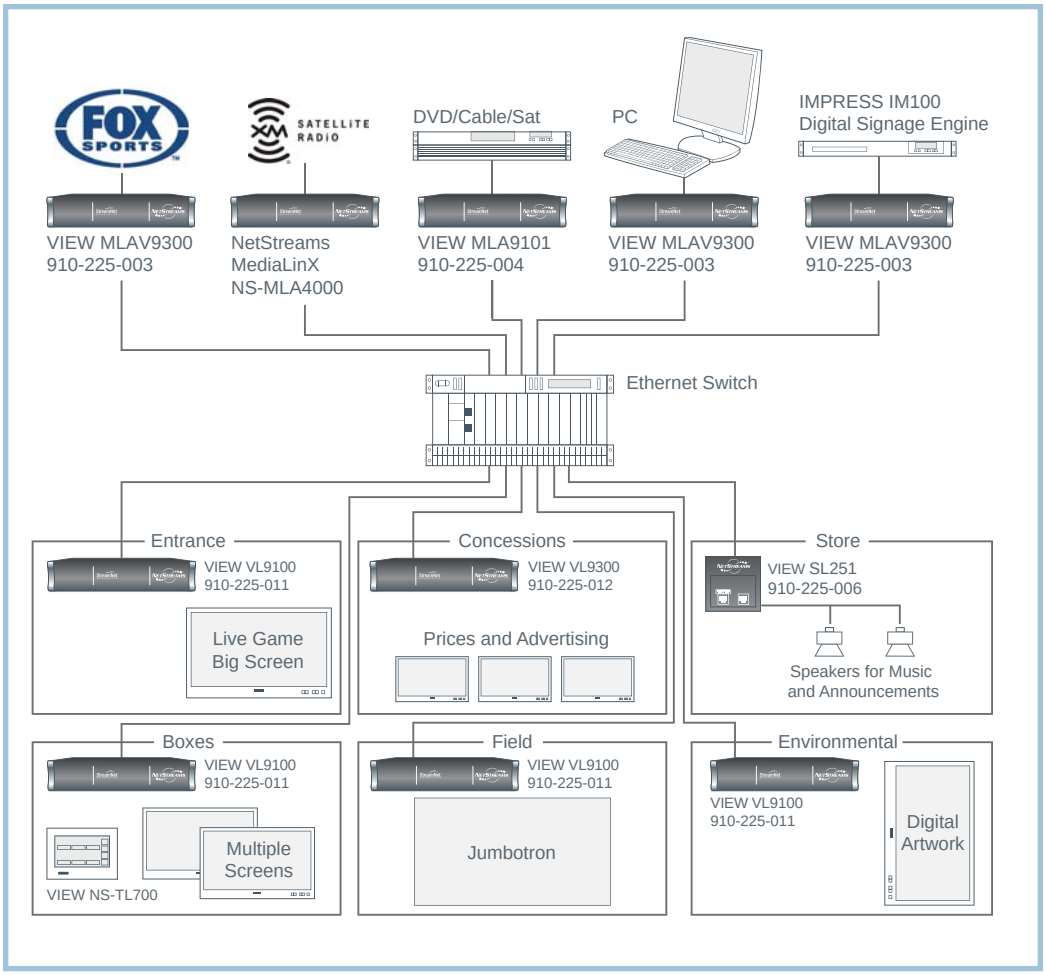
Encoders vs. MMP-100 Decoder Compatibility Matrix





Example StreamNet System Design

Football Stadium Wiring Diagram



Football Stadium Equipment List

Encoders:
VIEW MLAV9300 - 910-225-003
NetStreams® MediaLinX NS-MLA4000
VIEW MLA9101 - 910-225-004

Decoders:
VIEW VL9100 - 910-225-011
VIEW VL9300 - 910-225-012

Amplifiers:
VIEW SL9250 - 910-225-008

Gigabit Ethernet Switches:
VIEW NS-SW1148

User Interfaces:
VIEW NS-TL700

Power Supplies:
VIEW PL960 - 910-225-005

Digital Signage Engine:
IMPRESS IM100

StreamNet FAQ

1. How many zones can StreamNet distribute audio to?
2. How many sources can I connect to a StreamNet system?
3. How good is the quality of networked audio with StreamNet?
4. What cable should I use for Pre-Wiring for the StreamNet System?
5. Why don't you power the amplifiers via CAT5 like other systems?
6. Will StreamNet integrate with other AV systems?
7. How do I program a StreamNet system?
8. I'm working on a project now, what do I need to know?
9. How do I control the music with StreamNet?
10. Can I stream music from my PC to the StreamNet system?
11. Can I listen to Internet Radio Stations on a StreamNet system?
12. How is StreamNet different from other systems that distribute uncompressed (WAV) or MP3 files?
13. What compression ratios of MP3 does StreamNet support?
14. What is TCP/IP?
15. What does ClearOne recommend for sources?
16. Can I use a different remote control?
17. What is the Expansion Interface module (EIM) used for?
18. If I am transferring files or browsing the Web, will it interfere with the music?
19. How far can I run the wires for StreamNet?
20. Can I program the music to turn on and off and specific times?
21. Why should I locate the amplifiers at the speakers?
22. Can I mount the amplifiers in another location?
23. How loud will the music play?
24. Does StreamNet distribute digital (SP/DIF) audio?
25. Can I use SpeakerLinX with any speaker?

StreamNet FAQ

1. **How many zones can StreamNet distribute audio to?**

   A StreamNet system can be almost infinitely expanded, just like a computer network (the distribution is based on computer network technology). There is currently a hypothetical limit of around 1,800,000 rooms, but we're working on that…

2. **How many sources can I connect to a StreamNet system?**

   Essentially, as many as you want. Connect supported Audio Request® music servers directly to SpeakerLinX using the Ethernet connection. Legacy Audio Sources (such as CD, Cassette player) each can be connected to the network using the MediaLinX IP-based Media Converter/ Controller via analog or coaxial digital connection.

3. **How good is the quality of networked audio with StreamNet?**

   How good is your source? StreamNet is designed to never degrade the sound quality. Since the network is digital, the audio signal is always kept intact, full bandwidth and resolution. StreamNet devices also incorporates Burr-Brown® 96 kHz / 24-bit D/A and A/D converters to maximize sound quality. StreamNet will perfectly reproduce the source, even from hundreds of feet away!

4. **What cable should I use for Pre-Wiring for the StreamNet System?**

   The StreamNet system utilizes Siamese Ethernet + 14 or 16 gauge speaker wire -- the new industry standard for audio distribution. This allows for many different types of installations and applications. Ethernet insures maximum bandwidth for audio distribution and the 14 or 16 gauge speaker wire is used for the power connection.

5. **Why don't you power the amplifiers via CAT5 like other systems?**

   We found we could not get small amplifiers to run properly off the limited current capacity a CAT5 cable and RJ45 connector is able to support. The amplifiers in the StreamNet system are supplied 28 volts from dedicated power supplies via thicker 14 or 16 gauge "speaker wire". This means we can have a much more powerful amplifier resulting in fuller, richer sounding audio. StreamNet is a professional audio distribution system with wide frequency, SPL and extended headroom support.

6. **Will StreamNet integrate with other AV systems?**

   There are several ways to integrate StreamNet with a wide variety of home subsystems (lighting, security, telephones, doorbells, air conditioning etc). Most advanced systems are migrating to IP networked control. StreamNet will also integrate via RS-232 commands sent over Ethernet, and IR commands.

7. How do I program a StreamNet system?

Normally a StreamNet system is installed and setup by an Authorized trained professional installer. A Dealer setup program that runs on a standard web browser is used to configure the system and IR.

8. I'm working on a project now, what do I need to know?

The wiring infrastructure is quite simple. Ideally run CAT5e plus a 4 conductor speaker wire from the location where your sources will be out to each room. Drop a service loop in a location where you would install a control keypad (typically near a door entrance or by a desk) and then continue the wire (including the CAT5e) up to the speaker locations. If you anticipate installing an Audio Port, which can export the networked audio into a local system, adding a sub woofer, or inputting a local source in the system, the run another CAT5e from the control keypad to that source.

9. How do I control the music with StreamNet?

There are many ways to select and control what you listen to in a StreamNet system. TouchLinX keypad, which offer a 3.8 color LCD and touch-screen, mount in the wall, at any desired location. These keypads generate a rich user interface and can control the audio and sources in any room. The system can also be controlled via KeyLinX button keypads, a wireless equipped PDA, a computer, or any web enabled device.

10. Can I stream music from my PC to the StreamNet system?

Yes, but the meta-data (song title, track title, artist name) available on the PC can not be distributed at this time. This will change in the near future when ClearOne makes available software that will allow your PC to stream its music, meta-data and control functions.

11. Can I listen to Internet Radio Stations on a StreamNet system?

Yes, but the Internet Radio source must be IR controlled and you must use a MediaLinX to proxy this source onto the network. This will change in the future when ClearOne makes available a networked Internet Radio, which in addition to streaming its audio, it will also stream its meta-data, and control.

12. How is StreamNet different from other systems that distribute uncompressed (WAV) or MP3 files?

While StreamNet makes it very easy to listen to MP3 audio files, its capabilities are not nearly that limited. StreamNet gives you access to far more then just MP3 files. The system can distribute any source, including CD's, AM, FM, TV sound, even your old 8 track tapes! All of your music is easily accessed and controlled. Systems that are designed primarily to distribute MP3 files do not allow you to listen to you CD's, without a CD player in your room and the hassle of finding the CD wherever in the house it

may be. StreamNet also offers far superior sound quality. Unlike MP3 files, which compress the sound by literally discarding 70% of the musical information, StreamNet can distribute your music collection in full, uncompressed fidelity. Should you decide to listen to MP3 files, StreamNet offers complete control over your music library so that you can browse and sort by artist, album genre or song title. And StreamNet allows you to play different music in each room or the same music in all rooms, simultaneously; beautifully synchronized (other systems simply cannot perform this important function).

13. What compression ratios of MP3 does StreamNet support?

The StreamNet system supports the following compression ratios of MP3 files, VBR (variable bit rate) 64 to 320 kbps. Support for additional Codec's will be added in the future, and may be downloaded directly.

14. What is TCP/IP?

TCP/IP stands for Transmission Control Protocol/Internet Protocol. This is the basic communication language for computers on the Internet (also on intranets and extranets).

15. What does ClearOne recommend for sources?

You can use any sources you wish, analog, digital or networked. StreamNet can handle everything from the newest hard disc based audio servers to old 8 track players.

16. Can I use a different remote control?

There are many different types of remote control options. Any learning remote can control sources on a StreamNet system. You can also use any device equipped with a web browser.

17. What is the Expansion Interface module (EIM) used for?

There are many different uses for it. You can use analog wall mounted input plates, Bluetooth Digital Interfaces, External amplifiers, Keypads, and more.

18. If I am transferring files or browsing the Web, will it interfere with the music?

No. The StreamNet system uses a very sophisticated network technology to ensure complete integrity of all StreamNet and data traffic on the network is maintained.

19. How far can I run the wires for StreamNet?

For maximum quality and reliability, ClearOne always recommends adherence to the guidelines for networking practices of the IEEE 802.3 standard. Nominally that means runs up to 100 meters are fine, beyond that, a repeater or other devices can be installed to extend the range to whatever you require. For very long runs, you may wish to use a local power supply.

20. Can I program the music to turn on and off and specific times?

Not yet, but in the near future, you will be able to this. Since the firmware for the system can be upgraded via the internet. Users will be able to set wake alarms and sleep alarms for each room via their TouchLinX touch-screens.

21. Why should I locate the amplifiers at the speakers?

There are lots of very significant advantages to locating the amplifiers as close to the speaker as possible. The foremost advantage is that it helps the system sound great. The closer the amplifier is to the speaker, the better the power transfer and control. This design also protects your investment in your entertainment system. Many other systems place all the amplifiers in on unit, where they may generate a tremendous amount of heat, dramatically reducing the lifespan of the other electronics. Additionally, in the unlikely event of an amplifier failure, only one room is disturbed and a replacement can be simply plugged in. If all the amplifiers are in one unit, losing just one channel means the entire system must be shut down until the amplifier can be repaired and returned. This typically takes weeks. ClearOne' design would have you back up and running in minutes (and all the rest of the system would operate perfectly the entire time.

22. Can I mount the amplifiers in another location?

Yes. SpeakerLinX intelligent amplifier modules can be mounted to a truss or a beam, inside a wall (decorative cover plate sold separately), or rack mounted (up to 4 on each rack mount plate (also sold separately).

23. How loud will the music play?

That will depend on the speaker and the room, but it's safe to say loud enough for just about anything. Having a powerful amplifier located right at the speaker maximizes the efficiency of the amplifier/speaker combination. And if you want even more power, an additional amplifier (or amplified subwoofer) can be easily added to the room where the speakers are located.

24. Does StreamNet distribute digital (SP/DIF) audio?

StreamNet can distribute analog, digital or compressed (MP3, WMA) files with no loss. The audio is transmitted via TCP/IP, overcoming the normal limitations of analog or digital audio distribution.

25. Can I use SpeakerLinX with any speaker?

Yes you can. Your system designer can help select the proper SpeakerLinX module for optimum performance. SpeakerLinX modules can be mounted on or near the speaker, in the room or even in the main equipment rack. Wherever it is located, the module will turn your speaker into an IP enabled device.

Why AV designers must “conquer” HDMI

Hollywood studios and major television networks require that devices supporting (transmitting) HD video do so only to protected outputs that use HDCP. The Blu-ray Disc Association (BDA) delayed activation of the image constraint token (content protection flag) to help minimize transition issues. However, after December 31, 2010 all new BD players must limit analog video output of Blu-ray disc content to interlaced standard definition (480i). And in fact, the BDA has set December 31, 2013 as the expiration date for analog video on a BD player, stating that no player passing “Decrypted AACS Content” to analog video outputs may be manufactured or sold after this date. This means future HD movies will not be viewable at HD resolutions over analog or other unprotected interfaces, making any AV distribution system designed solely around analog or unprotected signals suddenly obsolete. Furthermore it is important to note that a similar situation exists with premium cable and satellite TV, in which the Motion Picture Association of America (MPAA) is petitioning the FCC to restrict HD transmission to protected outputs.

Unfortunately for the modern AV systems designer, HDMI can be challenging as it was never intended for multi-point distribution applications making system designs all that more challenging in all but the smallest of applications. However, for those designers using StreamNet products and solutions, common HDMI problems and issues are all but eliminated.

HDCP Keys

HDMI with HDCP was created as a consumer technology to enable point to point secure transfer or transmission of high quality digital content such as HD, and it was never intended to be used in large multi-source and multi-display (zone) applications required by modern residential or commercial AV projects. This means, too many devices in a signal path is destined to create problems with the display of audio and video content.

HDMI source devices all have a limit to the number of downstream devices they support. This limit is determined by the number of available HDCP keys in the device. All HDMI sources that utilize HDCP limit the number of devices which may be connected at one time. For this reason an important aspect of HDCP for all AV designers and installation professionals is the use of “keys” which HDCP utilizes to manage handshaking between devices.

The HDCP specification states the maximum depth (number) of devices between source and display is six (6). This means connecting too many displays or video devices will cause the source to stop outputting a signal without warning in most HDMI switching systems. However, a unique feature of StreamNet is that the system actually provides user guidance to the user of options available in an extended condition and provides choices, compared to simply shutting off the stream without warning or explanation as most other HDMI switching or digital transmission solutions would do.

HDCP Keys continued

Following is a more technical description of HDCP, beginning with two primary parts:

1. Authentication

2. Encryption

Using HDCP, authentication ensures all HDMI connected devices receive only content that is licensed and authorized. Only after successful authentication will the display device output a stream.

In a multi-point AV system, HDCP encrypts each segment of an AV transmission, and HDCP authenticates every device via the source. Devices that re-transmit HDCP content inform the source of all the downstream connections. This means every HDCP device has a unique ID, known as a Key Selection Vector or KSV. The KSV must be passed to the source, which then verifies every device before beginning to transmit content. In large systems, it is this authentication process that frequently creates extended switch times when a new source is selected. With StreamNet, because of its persistent architecture and method of handling keys, switch time is nearly eliminated leading to a vastly improved user experience.

It is important to note that all sources have a predetermined limit on the number of display's which may be connected. This limit is caused by the number of KSV's the source is able to accept. Though HDCP allows for up to 127 devices, sources generally support as few as ten and we have even found some which only support a single display.

The reason this can be a problem is when a repeater presents a source with too many KSV's, the source will stop transmitting content with no explanation. For this reason installers must be aware of KSV limits in any HDMI installation involving more than one display. We highly suggest testing devices in the field before completing a system design to ensure your intended system results and performance may be achieved.

Manufacturer Model HDCP Key Count Chart

Manufacturer	Device Type	Model Name	HDCP Keys
Advanced Digital Broadcast	IPTV STB	ADB-3800W	16
Anchor Bay	Digital Video Processor	Edge 101	8
Apple	Digital Media Player	Apple TV (gen 1)	16
Crestron	Digital Media Player	ADMS	16
Denon	BD Player	BDP-1610	16
DirecTV	Satellite STB	HR21	N/A
Dish Network	Satellite STB	ViP-211	16
DVICO	Digital Media Player	TViX HD M-6500A	none
EchoStar Europe	Satellite STB	Vi P211	16
Echostar STB	Satellite STB	VIP-222	16
Enseo	Tuner	HD2000	16
Insignia	BD Player	NS-2BRDVD	13
Integra	BD Player	DBS 30.1	3
Integra	BD Player	DBS 6.9	3
LG	BD Player	BD-270	10
LG	BD Player	LG-BD370	10
LG	BD Player	LG-BD390	16
LG	BD Player	Super Multi-Blue	16
Marantz	BD Player	BD-7003	3
Marantz	BD Player	BD-7004	3
Marantz	BD Player	DV4001	9
Microsoft	Game Console	XBOX 360	16
Motorola	Cable STB	DCH-3416	1
Motorola	Cable STB	DCT-3200	1
Motorola	Cable STB	DCT-3412	1
Motorola	Cable STB	DCT-6412	1
Motorola	Cable STB	DCT-6416	1
Motorola	Cable STB	VIP 1200	16
Panasonic	BD Player	DMP-BD30	3
Panasonic	BD Player	DMP-BD35	3
Panasonic	BD Player	DMP-BD60	3
Panasonic	BD Player	DMP-BD80	3
Philips	BD Player	BDP 7200	16
Philips	DVD Player	DVP5990/12	9
Pioneer	BD Player	BD-LX80	16
Pioneer	BD Player	BD-LX91	16
Pioneer	BD Player	BDP-6000	16
Pioneer Elite	BD Player	BDP-05FD	16
Roku	Digital Media Player	N1000	16
Samsung	BD Player	BD-P1000	16
Samsung	BD Player	BD-P1500	7
Samsung	BD Player	BD-P-1600	7
Samsung	BD Player	BD-P-3600	16
Samsung	BD Player	BD-T3600	16
Samsung	BD Player	BD-UP5000	10
Samsung	BD Player	DBD-P1500	16
Scientific Atlanta	Cable STB	Explorer 4250HD	16
Scientific Atlanta	Cable STB	Explorer 8300HD	16
Sharp	BD Player	BD-HP20	16
Sharp	BD Player	BD-HP21U	3
Sharp	BD Player	BD-HP22	3
Sharp	BD Player	BD-HP50	3
Sky	Satellite STB	Sky HD	16
Sony	BD Player	BDP-S2000ES	16
Sony	BD Player	BDPS301	16
Sony	BD Player	BDP-S350	8
Sony	BD Player	BDP-S360	8
Sony	BD Player	BDP-S5000ES	16
Sony	BD Player	BDP-S550	10
Sony	BD Player	BDZ-X100	8
Sony	BD Player	DVD-P DPX - 2380	9
Sony	DVD Player	DVP-NS71HP	16
Sony	DVD Player	DVP-NS72HP	9
Sony	Game Console	PS3	16
TiVoHD	DVR STB	TiVoHD	16
Toshiba	HD-DVD Player	HD-A20	10
Toshiba	HD-DVD Player	HD-A3	16
Toshiba	HD-DVD Player	HD-A30	16
Toshiba	HD-DVD Player	HD-A35	16
Toshiba	HD-DVD Player	HD-D3	16
Toshiba	HD-DVD Player	HD-E1	10
Vudu	Digital Media Player	VUDUBX100	16
Western Digital	Digital Media Player	WDTV	N/A

This information has been deemed accurate based on HDCP key data found on chip set data sheets and other Internet sources including StreamNet receivers which capture and log all HDCP information of the connected source unit(s).

EDID and DDC

EDID stands for Extended Display Information Data. This is the data contained on each DVI display or HDMI sink and there may be as many as one EDID per DVI or HDMI input. The source device checks the display's DVI or HDMI port for the presence of an EDID prom and uses the information to optimize the output video and / or audio format. All sink devices compliant to the DVI or HDMI specification must implement EDID.

EDID was formed as a standard to help PC monitors report their capabilities whereas E-EDID is an extension of the EDID specification used traditionally by consumer electronic devices to illustrate more advanced features. For example, PC monitors generally do not support audio, so a traditional EDID structure would not account for this, whereas an E-EDID would.

Before we discuss the role of EDID it's important to understand the role of the DDC (Display Data Channel) in the HDMI specification. In a video system, the vast majority of information flow occurs from a source to a sink (display) where the video and / or audio travels. DDC provides a back channel from the sink to the source to indicate events like hot-plug when a new device is suddenly connected to the system or HDMI chain. The sink communicates its display output capabilities back to the originating source device using DDC. Without this feature, devices like DVD players would have to guess at what video / audio formats any given display is optimized for.

An EDID PROM is used only in sink devices where this PROM sits on the DDC channel and uses a 2-wire I2C bus (part of the DDC specification from www.vesa.org) to communicate from the sink to the source. The EDID PROM contains information about the sink it resides in. Its job is to communicate the preferred (or supported) video and audio formats and resolutions to the originating source.

As an example, when a DVD player is powered on, it reads the EDID from an attached HDTV. The HDTV will have in its EDID data pertaining to the size and type of display along with native resolution, all supported resolutions including video connection capabilities, and audio support. A connected source would compare this information with what it can put out of its HDMI port, and automatically set itself up to send the best video and audio format appropriate for the display.

Repeaters

One limitation of HDMI is that traditional cables are general only certified for use up to 10 meters in length. However, HDMI technology has been designed to allow standard copper cable construction at longer lengths but requires the use of a repeater to extend beyond 10 meters. In order to allow cable manufacturers to improve their products through the use of new technologies, HDMI specifies the required performance of a cable but not maximum cable length. NOTE: It is not only the cable that factors into how long a cable can successfully carry an HDMI signal but also the receiver chip inside the display which also plays a factor. Receiver chips that include cable equalization are able to compensate for weaker signals, thereby extending the potential length of any cable used with that device.

It is important to be aware of both active and passive solutions when it comes to HDMI cables. Whereas a repeater by definition must be active and therefore power supplied to the device in some manner. Any HDMI device that has active electronics should have a provision for external power in order to be compliant. Some active devices, such as actively powered HDMI cables or in-line signal extender boxes, will by default attempt to power their electronics by taking power from the 5V line (+5V power) available on the HDMI connector. The HDMI specification requires all source devices to provide at least 55mA (milliamps) on the 5V line for the purpose of reading the EDID of a display.

While 55mA is not enough current to operate most HDMI accessory devices (which typically require about 100 to 150mA), most source devices on the market today provide significantly more current on the 5V line than the HDMI specification requires. As a result, the vast majority of accessory devices can operate when interfaced with a source device that provides more than the required current (i.e. over 100-150mA) on the 5V line. However, it should never be assumed that the source device will provide enough power, and manufacturers should make a provision for their powered HDMI accessory devices to obtain external power.

For the AV systems installer and designer, what this means is that failure of video output when a Repeater is used can often be attributed to a simple lack of adequate power. Just because a device says it doesn't need an external power supply, it is advisable to not use it and select one where you can be assured the product will always have adequate power regardless of the source that is connected.

The truth about matrix switches and HDCP

Many HDMI switches are nothing more than “muxers” providing digital cross connection between multiple sets of HDMI inputs and HDMI outputs. For this reason, issues with HDCP key exchange and EDID / DDC channel integrity where displays will suddenly stop working or intermittent blanking occurs. It is not ClearOne’s purpose to identify products that do not comply with HDCP licensing rules, however it is our objective to help dealers not fall into the marketing hype of companies with potentially infringing products.

It has been reported that several well known manufacturers are making claims both public and private about capabilities of their products which should the claims be true are in clear violation of the Digital CP (HDCP) licensing agreement. We suggest if you have specific applications or questions around HDCP that you speak with the vendor company and consult a DRM licensing Attorney. To help navigate the marketing hype of these potentially infringing vendors, dealers should pay close attention to any vendor making the following claims.

1. Claim to have a special HDCP bypass or “lawyer” button.
2. Claim they can support more simultaneous displays than the connected source supports. We suggest you consult ClearOne’s key count chart found in this guide.
3. Claim they can support more than 127 connected display devices.
4. Claim there is a consumer implementation of HDCP and a professional implementation designed for the unique requirements of matrix switched HDMI systems.
5. Claim they have any “special” agreement with content providers.
6. Claim content providers don’t care because the professional and custom electronics A/V channels are so small.
7. Claim they can sell you additional keys to support more devices.

Troubleshooting matrix switch connectivity problems

When troubleshooting display problems with a matrix switch begin by taking the source to within a standard HDMI cable length of the display (less than 10 meters) to test if syncing between the source and display is possible.

Assuming the test is successful and you obtain a picture, work backwards from the display, carefully accounting for every device in the signal chain. Simply go to the nearest upstream device from the display and plug the source in to see if a picture may be obtained. By repeating this process you can quickly determine where the signal is failing to pass.

Once the device not passing the video signal is identified, try physically switching inputs as it is not always the case that HDMI Input 1 travels through the same silicon path as HDMI Input 3, for example. Though better quality displays will offer the signal path regardless of Input, we have seen examples where varying silicon parts are used which can lead to sporadic performance across different displays.

Also, do not assume all HDMI cables are created equal. Furthermore, we encourage you not to assume the more expensive a cable, the better it is! There are some well known cases where the technical performance of a lower cost cable was actually better than the more expensive interconnect. This is not to say there is no performance advantage to higher end cables. As always don't buy based on marketing hype, do your homework. And when you find a good quality reliable cable, keep using them. Cables matter in every point of an A/V system, but they really matter when dealing with HDMI.

One of the major advantages to StreamNet is the elimination of an HDMI matrix switcher, which reduces overall system cost while improving system performance and reliability.

How StreamNet reduces HDMI switching time and improves system stability

Sync time between an HDMI connected source and display is typically around 2 seconds. This can cause confusion with any user who selects a program source, fails to see a picture and begins making other source selections. Source switching time is compounded in large systems as every additional matrix switch, video processor or other HDMI connected device in the chain increases the overall handshake and key exchange time.

Since StreamNet is not a matrix switched topology, switching between sources occurs nearly instantaneously as the source is always in sync with the StreamNet encoder, and the display is always in sync with the StreamNet decoder.

This means in practical application, a user on a StreamNet system experiences the speed and reliability of analog, but with the picture quality, resolution and performance of digital.

StreamNet system architecture is point to point, exactly how the HDMI interface was conceived to operate. With StreamNet, system stability is improved due to the elimination of multiple levels of devices leading to fewer key exchanges, improving the odds of a display not blanking.

Video Resolutions

Interlaced Scanning
Interlaced scanning displays (TV's) show odd-numbered lines in succession, followed by the remaining even-numbered lines. This method is more prone to artifacts and was required for older cathode ray tube (CRT) video technology but is not needed for modern digital TV's (DTV). However, much source material is still formatted in an interlaced format so all DTV's will display interlaced video.

480i
480i where the "i" refers to the term interlaced is a form of standard definition digital television (SDTV). All analog and digital video outputs support this lowest level of video resolution.

Progressive Scan
Progressive scanning is a way of displaying images and video where all lines of every frame are drawn in sequence so the eye sees the entire picture at once as compared to interlaced video where the odd lines are alternated with even. For video with scenes of fast motion, progressive scanning provides the best visual presentation with the absence of visual artifacts such as interline twitter. Other benefits include better quality scaling to higher resolutions since scaling works with full frames.

480p
480p where the "p" refers to the term "progressive scan", a form of standard definition digital television (SDTV) comparable to VGA computer displays. For reference, native resolution of DVD is 480p. However that resolution can be seen only if a DVD player outputs a progressive scan signal and the Digital TV accepts a progressive scan or component video input. It is also known as EDTV.

720p
720p where the "p" refers to the term progressive scan is one of two currently used formats designated as high definition television in the ATSC DTV standard. This technology comprises 720 vertical pixels and 1,280 horizontal pixels. 720p is not inferior to 1080i though 720p has fewer lines of resolution it has the advantage of providing progressive scanning and a constant vertical resolution of 720 lines, making it ideally suited to handle video with a high degree of motion.

1080i
HDTV standard that specifies an interlaced resolution of 1920 x 1080. Only analog component video and digital video outputs such as HDMI are able to support full 1080i video.

1080p
1080p is the highest resolution in the HDTV standard and refers to an image size that is 1920x1080, it is also often called progressive scan. Only digital video outputs such as HDMI are capable of supporting 1080p video. Be sure to check with your source and display manufacturers to ensure the HDMI connectors on your equipment support 1080p as not all do.

Deep Color
Color depth standard associated with the HDMI 1.3 standard. Deep Color supports 10-bit, 12-bit and 16-bit color depths, an increase from 8-bit. Benefits of increased color bit depth include finer gradations between different shades of the same color meaning the viewer will experience smoother gradients and reduced color banding. Deep Color also enables the potential for a supported TV to display billions of colors. To view this improvement the entire video production chain must support Deep Color from the camera, editing software, video format, player, and display.

Video Scaling
In DTV because of the myriad of formats and resolutions possible, scaling is the process a display device (TV) must use to map the source to the actual capabilities of the display. For example, the conversion from a higher resolution input signal to a lower one.

Aspect Ratio
The ratio of width to height in a video display window. Traditional U.S. TV broadcasts and computer monitors featured a 4 by 3 aspect ratio whereas HDTV broadcasts typically feature a 16 by 9 width to height ratio.

16:9
Sometimes expressed as 16 by 9, 16 x 9 or 16:9 (also known as 1.78:1 in the film world). 16 by 9 is the standard DTV widescreen television standard which is 16 units wide by nine units high, as compared to a standard TV aspect ratio of 4 by 3.

4:3
Standard NTSC TV screen size measured by four units wide by three units high and often expressed as 4 x 3 or 4 by 3. In the film world 4:3 is also expressed as 1.33:1.

Anamorphic
Adopted from the film technique of shooting a widescreen image on a square 35mm frame, anamorphic is the process of compressing widescreen images to fit into the squarer standard 4:3 television signal. The images are then expanded for viewing in their original format on a widescreen display device. Widescreen or letterboxed DVDs that are not anamorphic have less detail when projected on a widescreen monitor because fewer lines are used to draw the image on the display and thus full resolution is not achieved. A non-anamorphic widescreen DVD is designed to be shown letter boxed on a standard "square" TV but appears with a black box all around the image when shown on a larger 16:9 widescreen TV. To fill a 16:9 screen, a non-anamorphic DVD has to be stretched, resulting in loss of resolution and detail. Whereas an anamorphic DVD that has been enhanced for 16:9 displays delivers 33 percent more resolution than regular letterboxed transfers.

Signal types and video formats

Component video
The electrical elements that comprise a video signal, consisting of luminance and two separate chrominance signals. These are expressed as either Y R-Y B-Y or Y Pb Pr. Component video is the highest quality analog format for HD video up to 1080i.

DisplayPort
A digital display interface proposed by the Video Electronics Standards Association (VESA) that defines a new license-free, royalty-free, digital audio and video interconnect method intended to be used primarily between a computer and display monitor or computer and home theater system. A newer version known as DisplayPort Multimode may be converted to HDMI, DVI or RGBHV. Today nearly all DisplayPort sources implement DisplayPort Multimode.

DVI
Digital Visual Interface; a digital interface specification created by an industry consortium, the Digital Display Working Group. This universal standard for connecting flat panel monitors is also used for data projectors, plasma displays, and digital TVs. Using a DVI connector and port, a digital signal sent to an analog device is converted into an analog signal (if the device is digital, such as a flat panel monitor, no conversion is necessary). There are three different DVI configurations: DVI-A for analog signals, DVI-D for digital signals, and DVI-I (integrated) for both analog and digital signals.

DTV
Digital television is a generic term that refers to all digital television formats, including high definition television (HDTV) and standard definition television (SDTV).

HDMI
High Definition Multimedia Interface. USB-like digital video connectivity standard designed as a successor to DVI. Transmits both digital audio and video signals and incorporates HDCP digital copy protection.

SDTV
Standard definition television. Digital television format that includes 480-line resolution in both interlaced (480i) and progres- sively scanned (480p) formats; offers discernible improvement over conventional analog NTSC picture resolution, with less noise; similar to DVD or satellite TV quality but not considered high definition.

Widescreen
An image with an aspect ratio greater than 1.33:1, or a picture wider and narrower than a traditional television image. Typi- cally refers to TVs in the 16:9 aspect ratio.
Y Pb Pr (Component Video)
Y Pb Pr (also known as component video) is specified as luminance, and two chrominance channels of blue minus luminance and red minus luminance. This can also be written as Y Cb Cr (or Y R-Y B-Y).

DRM and Security

Authentication
Authentication ensures digital data transmissions are delivered to the intended receiver, and also guarantees integrity of the data and its source. The simplest form of authentication requires a username and a password but authentication protocols may also be based on secret key encryption, such as DES, or on public key systems using digital signatures. Modern DRM (digital rights management) systems all use more advanced key encryption schemes.

DRM
Digital Rights Management is any secure technology which enables the copyright owner to control access to their intellectual property (such as a music, video, or text file) and to specify what a user may do with it. For example, DRM can both encrypt a file so it cannot be easily played outside the intended playback environment, and DRM can control access such as with a 48 hour rental window.

HDCP specific terms:

Authorized Device
An HDCP Device that is permitted access to HDCP Content is referred to as an Authorized Device. An HDCP Transmitter may test if a connected HDCP Receiver is an Authorized Device by successfully completing the following stages of the authentication protocol – Authentication and Key Exchange (AKE) and Locality check. If the authentication protocol successfully results in establishing authentication, then the other device is considered by the HDCP Transmitter to be an Authorized Device.

Content Stream
Content Stream consists of Audiovisual Content received from an Upstream Content Control Function that is to be encrypted and Audiovisual Content received from an Upstream Content Control Function that is encrypted by the HDCP System.

Device Key Set
An HDCP Receiver has a Device Key Set, which consists of its corresponding Device Secret Keys along with the associated Public Key Certificate.

Device Secret Keys
For an HDCP Transmitter, Device Secret Key consists of the secret Global Constant. For an HDCP Receiver, Device Secret Keys consists of the secret Global Constant and the RSA private key. The Device Secret Keys are to be protected from exposure outside of the HDCP Device.

Downstream
The term, downstream, is used as an adjective to refer to being towards the sink of the HDCP Content. For example, when an HDCP Transmitter and an HDCP Receiver are connected over an HDCP-protected Interface, the HDCP Receiver can be referred to as the downstream HDCP Device in this connection. For another example, on an HDCP Repeater, the HDCP-protected Interface Port(s) which can emit HDCP Content can be referred to as its downstream HDCP-protected Interface Port(s). See also, upstream.

Global Constant
A 128-bit random, secret constant provided only to HDCP adopters and used during HDCP Content encryption or decryption

HDCP Content
HDCP Content consists of Audiovisual Content that is protected by the HDCP System. HDCP Content includes the Audiovisual Content in encrypted form as it is transferred from an HDCP Transmitter to an HDCP Receiver over an HDCP-protected Interface, as well as any translations of the same content, or portions thereof. For avoidance of doubt, Audiovisual Content that is never encrypted by the HDCP System is not HDCP Content.

HDCP Device
Any device that contains one or more HDCP-protected Interface Port and is designed in adherence to HDCP is referred to as an HDCP Device.

HDCP Encryption
HDCP Encryption is the encryption technology of HDCP when applied to the protection of HDCP Content in an HDCP System.

HDCP Receiver
An HDCP Device that can receive and decrypt HDCP Content through one or more of its HDCP-protected Interface Ports is referred to as an HDCP Receiver.

HDCP Repeater
An HDCP Device that can receive and decrypt HDCP Content through one or more of its HDCP-protected Interface Ports, and can also re-encrypt and emit said HDCP Content through one or more of its HDCP-protected Interface Ports, is referred to as an HDCP Repeater. An HDCP Repeater may also be referred to as either an HDCP Receiver or an HDCP Transmitter when referring to either the upstream side or the downstream side, respectively.

HDCP Session
An HDCP Session is established between an HDCP Transmitter and HDCP Receiver with the transmission or reception of rtx as part of the authentication initiation message, AKE_Init. The established HDCP Session remains valid until it is aborted by the HDCP Transmitter or a new HDCP Session is established, which invalidates the HDCP Session that was previously established, by the transmission or reception of a new rtx as part of the AKE_Init message.

HDCP System
An HDCP System consists of an HDCP Transmitter, zero or more HDCP Repeaters and one or more HDCP Receivers connected through their HDCP-protected interfaces in a tree topology; whereas the said HDCP Transmitter is the HDCP Device most upstream, and receives the Audiovisual Content from one or more Upstream Content Control Functions. All HDCP Devices connected to other HDCP Devices in an HDCP System over HDCP-protected Interfaces are part of the HDCP System.

HDCP Transmitter
An HDCP Device that can encrypt and emit HDCP Content through one or more of its HDCP-protected Interface Ports is referred to as an HDCP Transmitter.

HDCP
HDCP is an acronym for High-bandwidth Digital Content Protection. This term refers to this content protection system as described by any revision of this specification and its errata.

HDCP-protected Interface Port
A logical connection point on an HDCP Device that supports an HDCP-protected Interface is referred to as an HDCP-protected Interface Port. A single connection can be made over an HDCP-protected interface port.

HDCP-protected Interface
An interface for which HDCP applies is described as an HDCP- protected Interface.

Master Key
A 128-bit random, secret cryptographic key negotiated between the HDCP Transmitter and the HDCP Receiver during Authentication and Key Exchange and used to pair the HDCP Transmitter with the HDCP Receiver.

Public Key Certificate
Each HDCP Receiver is issued a Public Key Certificate signed by DCP LLC, and contains the Receiver ID and RSA public key corresponding to the HDCP Receiver.

Receiver Connected Indication
An indication to the HDCP Transmitter that an active receiver has been connected to it. The format of the indication or the method used by the HDCP Transmitter to connect to or disconnect from a receiver is outside the scope of this specification.

Receiver Disconnected Indication
An indication to the HDCP Transmitter that the receiver has been disconnected from it. The format of the indication or the method used by the HDCP Transmitter to connect to or disconnect from a receiver is outside the scope of this specification.

Receiver ID
A 40-bit value that uniquely identifies the HDCP Receiver. It has the same format as an HDCP 1.x KSV i.e. it contains 20 ones and 20 zeroes.

Session Key
A 128-bit random, secret cryptographic key negotiated between the HDCP Transmitter and the HDCP Receiver during Session Key exchange and used during HDCP Content encryption or decryption.

Upstream Content Control Function
The HDCP Transmitter most upstream in the HDCP System receives Audiovisual Content to be protected from the Upstream Content Control Function. The Upstream Content Control Function is not part of the HDCP System, and the methods used, if any, by the Upstream Content Control Function to determine for itself the HDCP System is correctly authenticated or permitted to receive the Audiovisual Content, or to transfer the Audiovisual Content to the HDCP System, are beyond the scope of this specification. On a personal computer platform, an example of an Upstream Content Control Function may be software designed to emit Audiovisual Content to a display or other presentation device that requires HDCP.

Upstream
The term, upstream, is used as an adjective to refer to being towards the source of the HDCP Content. For example, when an HDCP Transmitter and an HDCP Receiver are connected over an HDCP-protected Interface, the HDCP Transmitter can be referred to as the upstream HDCP Device in this connection. For another example, on an HDCP Repeater, the HDCP- protected Interface Port(s) which can receive HDCP Content can be referred to as its upstream HDCP-protected Interface Port(s). See also, downstream.

StreamNet™ Digital Media and System Design Reference Guide

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About ClearOne

ClearOne is a global communications solutions company that develops and sells conferencing, collaboration, streaming media and connectivity systems for audio, video, and web applications. The reliability, flexibility and performance of our advanced comprehensive solutions enhance the quality of life through better communication, education, and entertainment.

NetStreams delivers the ultimate IP A/V experience by distributing high definition audio and video over TCP/IP networks. NetStreams' products offer unprecedented levels of performance, functionality, simplicity, reliability, and expandability. By combining audio/video content, meta-data and control signals into one stream incorporating industry standards, NetStreams' newly patented StreamNet® solutions are a smart investment, enabling the Power of AV over IP™ - today.

NetStreams' StreamNet technology provides elegant solutions for streaming media & control applications such as digital signage, distribution of HD video and audio, LAN Cloud Matrix Switching™, and audio paging over data networks.