Introduction:

While Distributed Video (a.k.a. Multi-Room Video) is not a new concept, it has become a must have for a multitude of commercial and residential facilities. This is in part due to the advent of high definition video signals, the growing number of video sources, digital signage applications, and the popularity of flat panel displays. However the technology for distributing video in commercial or residential facilities has not changed much over the past 50 years. In this whitepaper we will examine the traditional methods of distributing video, *NetStreams*' use of TCP/IP for video distribution and the advantages of *NetStreams*' IP-Based solution.

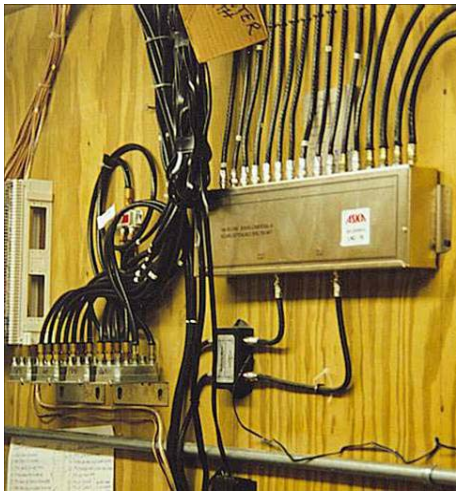
What is Distributed Video?

Distributed Video is a system where all kinds of video (and audio) signals from A/V source components are routed to remote display locations. At the remote locations display devices such as CRT televisions, flat panel displays, projectors, and projection systems are used for viewing the A/V sources at the head end.

A need for distributed video arises when designing a system that utilizes many A/V sources, and/or many display locations and/or the display locations are distant from the A/V sources. Another reason would be for sharing source components such as a DVD changers, digital cable or satellite tuners.

Traditionally video in a commercial or residential installation has been distributed using two methods – Broadband (also known as "Radio Frequency" or "RF"), and Base band analog. Both methods have been in use for the past 50 years, and both have inherent disadvantages.

Broadband ("RF"): This is a system design in which each of the A/V source components are connected to a radio frequency (RF) modulator. The RF Modulator takes the internal RGB, YUV, or composite video and audio signals from the A/V source components and generates a PAL or NTSC broadcast signal that can be fed into the distributed video system. The outputs from the RF modulators are then routed into RF combiners and then into large RF amplifiers.



When designing an RF system the RF amplifier(s) need the ability to boost the PAL/NTSC signal level high enough to make it to the farthest remote display location. In a system design where remote display locations are very distant from the head end, the RF amplifier has to boost the signal very high. The goal would be to have RF amplifier gain to achieve a 0dB signal level at the most distant remote display location. Other remote display locations in this type

of system would need to be attenuated so that the RF signal would not be higher than 0dB. This involves small passive “tap points” or “tap offs in line attenuators installed at each remote display location.

The wiring topology for a system such as this consists of coaxial type cable, with the most common types being RG6 and RG59. In most designs the coaxial cables are in a home run from the head end to each remote display locations; however there are some deployments with more of a “ring” or daisy chain approach.

Disadvantages of Video Distribution over RF:

1. Inconsistent and Poor Video Quality: The largest reason for poor video quality is that RF can only transmit composite video signals. In addition, signal losses caused by the system architecture almost always contribute to the poor video quality of RF systems. In general RF Video Distribution systems can experience 4 types of signal loss – cable loss, splitter loss, insertion loss and isolation loss. Signal loss can range greatly, depending on the size of the install, the length of the cable run. The chart below shows the approximate range of signal loss by type:

Cable Loss	-4 db to -20 db
Splitter Loss	-3db to -8 db
Insertion Loss	-3db to -8db
Isolation Loss	Varies widely

2. Results are unpredictable from system to system: The building environment can also affect the quality of the video signals in an RF system, further adding to the complexity and reducing the consistency of performance from one installation to another (even if the system architecture is exactly the same!). Results can be unpredictable and it can be very tedious to “balance” the RF system out.
3. RF systems are difficult to install: Not only do the RF connectors need to be installed and terminated correctly, but also the correct attenuator must be chosen for each display location. Installers typically have to try multiple attenuators with multiple decibel ratings.
4. RF systems do not provide for the distribution of advanced video signals: RF systems do not allow the distribution of advanced A/V signals such as Component video, HDMI, DVI and digital audio connections. Additionally, RF systems do not provide for the distribution of multi-channel audio, such as Dolby® Digital or DTS® digital audio formats.
5. RF Systems are Expensive: RF Systems can also be very costly, ranging in hundreds to tens of thousands of dollars, since systems with many A/V sources require very high quality digital agile modulators. Even with the best quality digital agile modulator, some signal degradation can occur due to adjacent channel issues and overall bandwidth.

Base Band: The design of a Base band video distribution system is one in which all the A/V source components are connected to matrix switch(s). The inputs on the matrix switch takes the internal RGB, YUV, or composite video and audio signals from the A/V source components and switches them to be routed to matrix outputs. The outputs from the matrix switch are then routed via wiring circuits to each remote display location. When designing a baseband system each type of video and audio signals need a separate set of wiring circuits to be homerun to each remote display location. In baseband system designs, the remote display devices are configured as monitor states only. This means that if every remote display location needs to have cable or terrestrial television feeds including HDTV, a separate tuner would be needed for each remote location. Matrix switches are simple yet expensive products and need to be configured based on what signal inputs are routed to what signal outputs. This usually means an external controller is required with extensive programming to make it work.

Disadvantages of Video Distribution over Base Band:

1. Results can be unpredictable: Because Baseband has many termination points and requires large amounts of wiring topology for each source type; it can be very difficult to predict the results at each remote display location. Cabling losses such as attenuation, reflection, and roll off of high frequencies negatively impact image quality. Long cable runs can pick up environmental noise.
2. Base band systems have a limited number of sources & displays: Baseband systems have a fixed amount of input and output connections, limiting the scalability of the system. In cases where hundreds of displays are necessary, it is mandatory that separate systems be created and matrix switches be paralleled, greatly increasing the complexity of the job. To increase the number of sources beyond that handled by a single matrix switch requires daisy-chaining or cascading the switches (connecting them in series) which greatly complicates the programming of the system. Also, there is a limit to the number of switches that a given source can drive without the addition of a booster amplifier. Usually a source may only drive one or two inputs without buffering.
3. It is difficult to add on new sources or displays after the installation is complete: It is difficult to accommodate the addition of sources and displays after the installation unless multiple phases of the construction and future additions are planned in advance. Most matrix switches have a finite capacity for cascading, and additional cable runs have to be made to accommodate each source and video format.
4. Base band systems are difficult to install: Multiple runs of cables are required, increasing the complexity of the system prewire. In addition matrix switches require extensive programming and matrix switch daisy chaining for larger systems can be complex, not to mention time consuming.
5. Base band systems are expensive: For high quality and or many signal types the cost of matrix switches can be very high. Baseband video distribution systems can also be

very costly, with systems ranging from a few thousand to hundreds of thousands of dollars.

Why TCP/IP for Distributed Video?

With the growth of high definition sources and displays, customer acceptance of video quality has shifted dramatically. Yet traditional methods of distributing video have not kept up with these changing expectations, be it in a commercial or residential environment.

NetStreams' vision for distributed video is one that consistently distributes high definition video (up to 1080p) in an all digital format over TCP/IP on an Ethernet network. 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 can be located at head end (like RF and Baseband systems), OR can be located anywhere on the network. Another advantage easily realized is the reduction of installation and maintenance costs, since an IP-Based distributed entertainment system (one that can distribute both content and control signals) can be integrated into a segmented section of a standard network.

Of course, since TCP/IP was primarily developed for data transmission across a network, there are some fundamental challenges with using that protocol to distribute video. Network bandwidth can become a constraint to quality, packets can be lost if the network is not managed correctly, synchronization of signal distribution can be a challenge and backwards / forwards compatibility with legacy and new sources also presents an issue.

Only *NetStreams* 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 a TCP/IP on an Ethernet network. *NetStreams*' IP-Based distributed video solution integrates with our *DigiLin*X IP-Based distributed audio and control solution, making the *DigiLin*X line of products a complete IP-Based distributed entertainment and control solution.

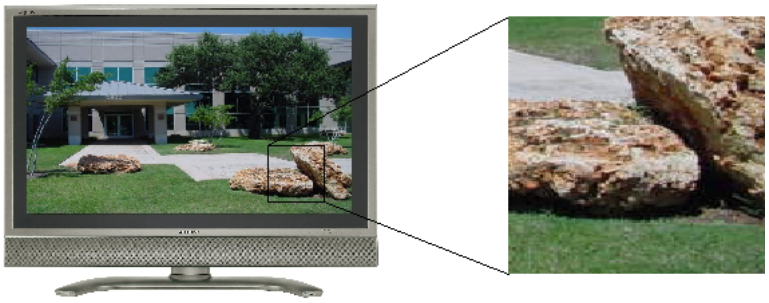
NetStreams' *DigiLin*X IP-Based system is the most advanced and expandable distributed video system ever built.

Advantages of the *NetStreams DigiLin*X IP-Based Video distribution system:

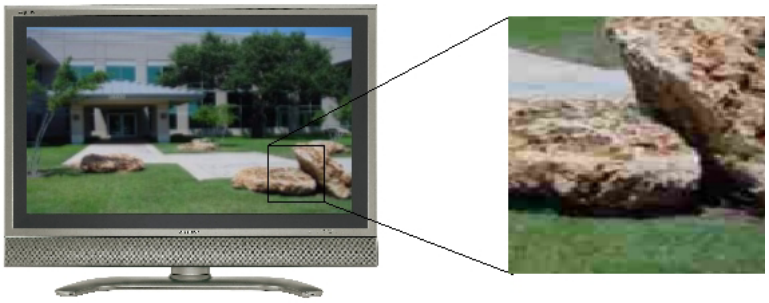
1. *NetStreams* IP-Based distributed video solution delivers the highest quality uncompressed video over TCP/IP on a gigabit network to multiple displays. *NetStreams* is the first to be able to deliver uncompressed video over TCP/IP. With video, there is a visually discernable difference between an uncompressed and a

compressed video signal. Most solutions for distributing video need to employ some sort of compression prior to distribution due to bandwidth issues. Compression causes signal degradation, which may cause poor chroma sharpness and poor frequency response (horizontal, vertical and diagonal), making the picture appear fuzzy. *NetStreams*' solution manages and optimizes the bandwidth of the network, eliminating the need for compression of the video signal prior to distributing it over the network.

Uncompressed Video



Compressed Video



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

Resolution	Frames per Second	Bandwidth Required
1080p	24 fps	850 Mbps
1080i	30 fps	800 Mbps
720p	60 fps	935 Mbps
480p	60 fps	500 Mbps
480i	30 fps	270 Mbps

*Note: the bandwidth required denoted in the above table includes approximately 50Mbps for supporting traffic, such as audio, status, thumbnails, etc.

3. *NetStreams*' proprietary *StreamNet* technology insures the synchronization of audio and video signals for point to point, and point to multi-point distribution, delivering the highest quality with the lowest latency at data rates of up to 1Mbps.This is important on two levels. Audio and video signals must be delivered and played back simultaneously at the display location to avoid any perceptible dissonance. Additionally, audio and video signals distributed to multiple display locations must also be synchronized across the network. First the audio and video signals are automatically synchronized over TCP/IP, eliminating lip sync effects. Secondly, the signals are automatically synchronized over the entire network for point to multipoint distribution, with a latency of approximately 30 milliseconds.

   Additionally, *StreamNet*'s suite of communication capabilities enable easy system configuration & concrete network reliability. *StreamNet* incorporates a suite of communications conventions which reduce the system configuration time required and increase the overall reliability of the network. This section covers Service Discovery, Message Routing, and Status reporting.

   Service Discovery
   Every feature or function of the NetStreams DigiLinX IP-Based Multi-Room Audio & Control system is provided by a "service." There are many types of services – audio renderers, audio sources, general purpose input & outputs (GPIO), user interface, media server proxy, just 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, 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 "room" 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. *NetStreams PerfectPixel Technology* insures faithful replication of video over the *DigiLin*X network, regardless of distance from the video source. Packet loss can occur when distributing a video signal (even a compressed one) over an Ethernet network, causing the picture to appear blotchy, color to be lost, or chunks of the picture to be gone all together. *NetStreams*' *PerfectPixel* technology solves this issue with both compressed and uncompressed signals over the network. *PerfectPixel* is a combination of *NetStreams*' 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.

Packet Loss with a compressed signal being distributed over the network, causes blurry areas in the picture.

Packet Loss (with an uncompressed signal being distributed over the network), causes color blotches.

NetStreams' *PerfectPixel* technology optimizes pack delivery, insuring no lost content of uncompressed or compressed video over the network.

5. *NetStreams* 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 an A/V Receiver or surround sound processor at the display location. For those installations where surround sound is desired (such as multiple rooms in a bar or club, multiple home theaters etc), the *NetStreams DigiLinX* solution is the most reliable solution for distributing the best quality audio and video over a standard gigabit network.
6. *DigiLinX* IP-Based distributed video allows an unlimited number of sources and zones. TCP/IP, the same language as the internet, was developed to support an almost infinite number of nodes on the network. The *DigiLinX* system 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. *DigiLinX* virtually has no limit on the number of sources or number of rooms you can have in the system, so no matter the size or scale of your project, *DigiLinX* can deliver the performance you require.
7. The system is compatible with all traditional video sources. Your *DigiLinX* Distributed Entertainment & Control system is also compatible with more traditional video sources (Satellite video receiver, over the air video tuner, cable set top box, Blu-Ray / HD-DVD player, standard DVD player, VHS player). The *StreamNet* technology incorporated in the *NetStreams MediaLinX*™ A/V automatically converts the audio and video in real time so that it can be streamed over TCP/IP for playback in any room of your *DigiLinX* system and learns and packetizes its IR commands to be sent over TCP/IP for easy control of the source.
8. *DigiLinX* IP-Based distributed video system is future upgradeable. *NetStreams* has insured that the firmware in all of the new *DigiLinX* distributed video products (just as the audio products) is upgradeable so that additional features and CODECs can be added without changing out the hardware.
9. The system will be compatible with new IP-Based video sources, such as IPTV. More and more people are beginning to leverage the internet as a source for entertainment. Services like CinemaNow & Movielink have begun to deliver movies on demand, while telecom companies are experimenting with triple play offerings of IPTV. Since *DigiLinX* uses the same language to distribute audio and video content throughout the network, it is compatible with these future entertainment sources, and more to come!
10. *DigiLinX* is easy to install and setup. Because *DigiLinX* is completely IP-Based, it does not require complex Matrix switches or external control systems with the massive custom programming. The PC-based *DigiLinX* dealer setup program is very intuitive and easy to use. Because sources and displays are automatically discovered over the network and a variety of easy to use graphical user interface skins are available, programming time can be reduced by as much as 80% over a traditional video distribution system.