Full High Definition (HD) 1080P Video, Audio and PC graphics over IP

INTRODUCTION

This article describes the benefits of sending Full HD 1920 x 1080 Video and PC graphics at 1280 x 1024 over an IP link, compared to traditional analogue cable methods. This paper shows 3 practical examples of sending images either from cameras or PC monitors at very high quality and frame rates over a standard 10/100 ethernet IP Network.
As more and more large or small users of CCTV and PC based security systems wish to integrate , distribute or centralise monitoring, Video over IP appears an ideal solution. Video quality has until recently been limited to VGA or PAL/NTSC which has been inadequate to send todays high graphics content found on Personal Computer screens. PC Video content, high resolution mapping or fast HD graphics require the use of HD encoding . CCTV video at standard PAL/ NTSC resolutions is in many cases insufficient for facial recognition and other fine detail required for identification. The solution to both the PC and video issues is a low cost High Definition server. Using H.264 & AAC codecs to compress the images/audio and supporting various physical inputs like HDMI , DVI, VGA, HD-SDI and composite video.

Full High Definition (HD) 1080P Video Audio and PC graphics over IP

Background: Integrating HD PC graphics and Video over an IP network

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The ability to transfer High quality Video or PC display content over a given distance has been traditionally solved using Coaxial or twisted cable CAT5 networks . Using either pure analogue or non compressed A to D and D to A. Systems were limited to relatively short distances within a building. More recent VGA to Ethernet and KVM to Ethernet systems used some level of compression to transfer images over IP but still required very high bandwidths. These systems relied on Gigabit ethernet to provide high quality SXGA or greater resolutions and higher frame refresh rates over IP.
The case for Video over IP has been more advanced in the Video world using MPEG4 and recently H264 video codecs to compress and transfer Video and audio over IP. Data rates of 1-4 M Bits/second were achievable, although limited to resolutions slightly above VGA (640 x 480) at 30 frames / second.
Recent developments offered High Definition video over IP using H.264 at 1920 x 1080 P30 frames per second at around 4-8 M Bits/second for full frame rate video and audio

The solution to mixing and integrating Both Video and PC content and transferring over an IP network using relatively low data rates has until recently either been impractical or uneconomical. Using broadcast quality equipment to compress Video from an HDMI source and PC images via the DVI output of the graphics card has solved the technical issues. However prices are in excess of several thousand dollars per encode node. A solution to decoding relied on high performance PC based software decode or again highly expensive broadcast quality video decode equipment.

Another issue was the format of video from the PC graphics card was in an RGB format whereas the typical video world would be used to Y Cb Cr.

Solution: A Full HD Video, PC Graphics and Audio Server and Decoder

The solution to these issues is a low cost Video server capable of supporting multiple signal inputs (VGA, DVI, HDIM , HD-SDI, Composite & audio) and able to encode and decode these signal sources over IP using the latest H264 codecs . Supporting Both HDMI inputs and outputs plus audio from separate jacks gives installers flexibility in handling audio. The CCTV industry and IT world still handle Video, graphics and audio as separate outputs.
The other key is use of a high compression codec capable of handling resolutions of up to 1920 x 1080 found in Blue Ray players, HD camcorders and other Full HD equipment . Also the ability to encode both interlaced and progressive video sources at up to 30P or 60i frame rates (30 frames progressive, 60 fields interlaced)

By making the server BOTH encoder or Decoder it provides the system designer with flexibility to use either hardware or software decode at the viewing end. Full HD 1080P decode on a PC , even using multiple core CPUs will use significant PC resources. Many

existing PCs do not have the CPU power to do full HD decode, in this case a hardware decoder may be the solution.

Configuring the HD Server as either an encoder or decoder , changing any of the characteristics like video frame rate, resolution , video format (RGD, Y:Cb:Cr) can all be achieved via a web browser interface over the LAN WAN or Internet.

Finally another important feature of HD servers is the ability to record video via a USB flash or hard drive. In cases of network failure or bandwidth limitations , high quality video/ graphics can be recorded locally via the server USB port. Once the network is reestablished this video can be pulled down the network by the remote viewing end.

System examples: Sending HD Video and HD PC graphics over IP

Example 1: Monitoring multiple computer screens and Video sources in a central location over any distance via IP .

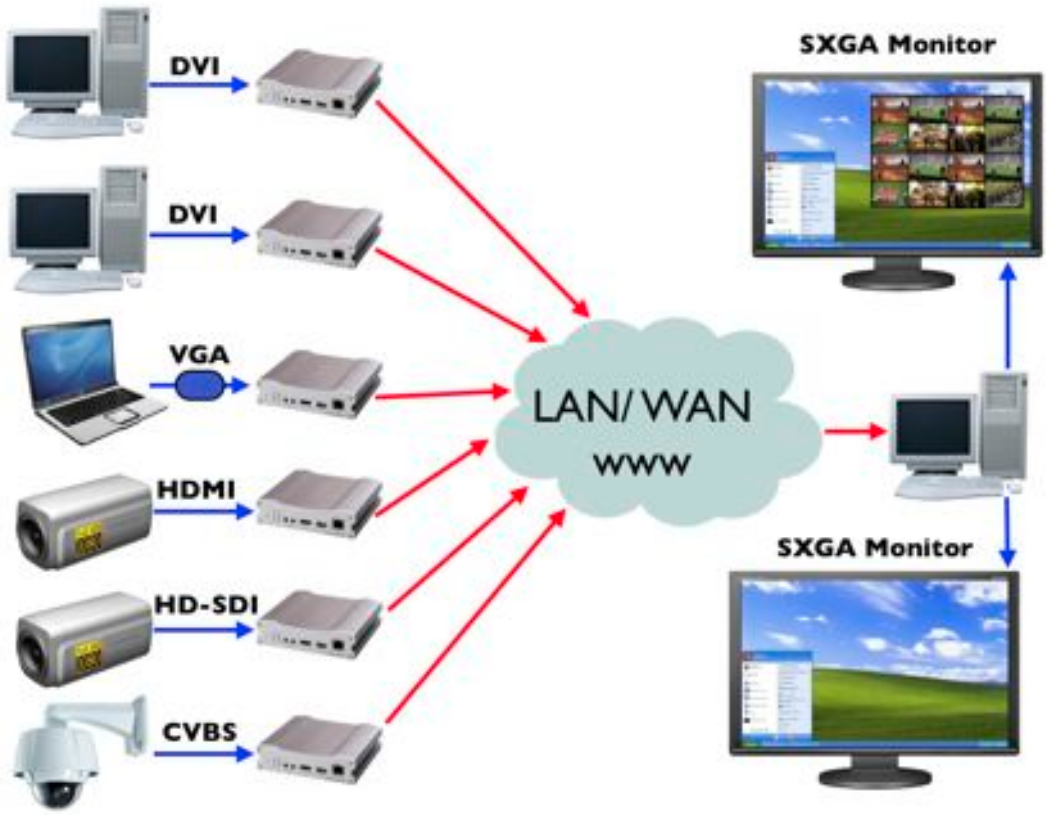

Figure 1: Multiple PC and Video HD encode

The resulting bit stream data rates over ethernet will vary over the ethernet connection depending on the amount of motion in the video/ PC screen. High quality desktop images can be sent using as little as 2M bits/ second at full frame rate and high motion video or graphics can be between 4 and 8 MBits/ second. Data rates can also be significantly reduced if frame rate or resolution is reduced. High quality PC desktop images at SXGA resolution can be sent over IP at under 1Mbit/second if frame rates are reduced to 10 frames per second, perfectly acceptable for desktop applications.

Applications Deployment of Command centers in Fire, Ambulance and Police applications. Remote training with two way audio and HD computer graphics coupled with video monitoring. Remote monitoring of multiple video and graphic monitors in Industrial or production environments.

Example 2: Setting up a High Definition (HD) video link over IP and decoding back to video, without any PC or software required.

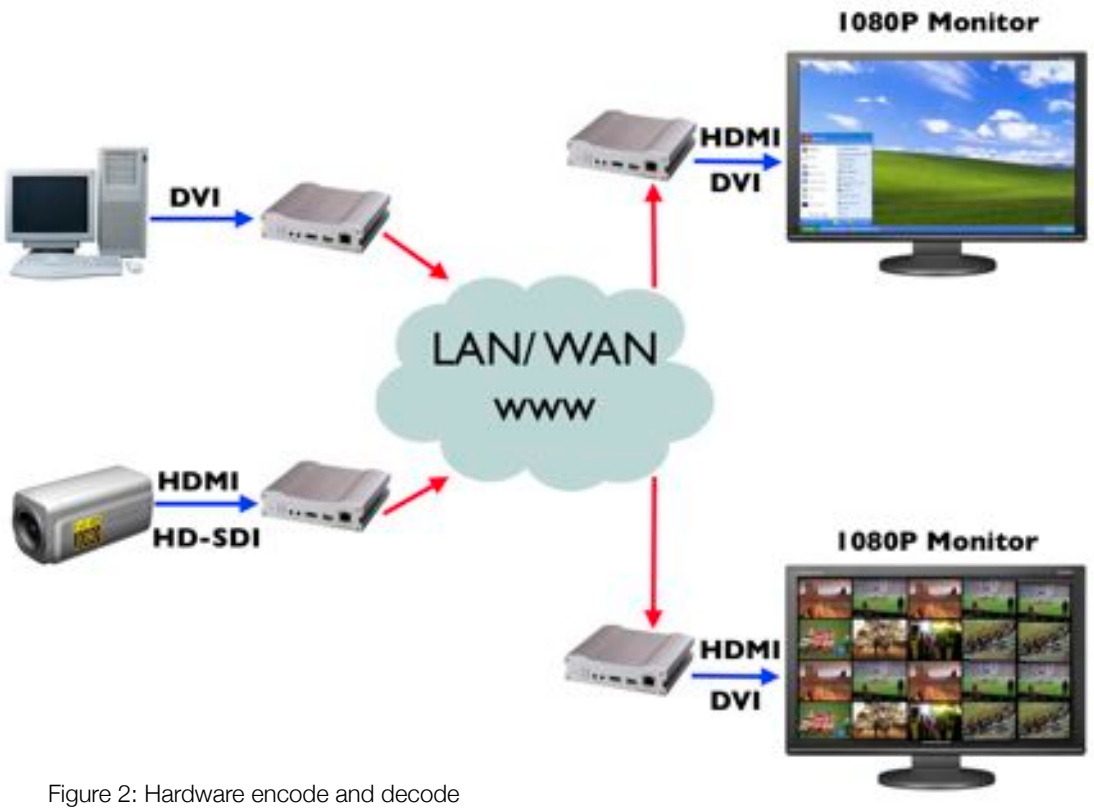

Figure 2: Hardware encode and decode

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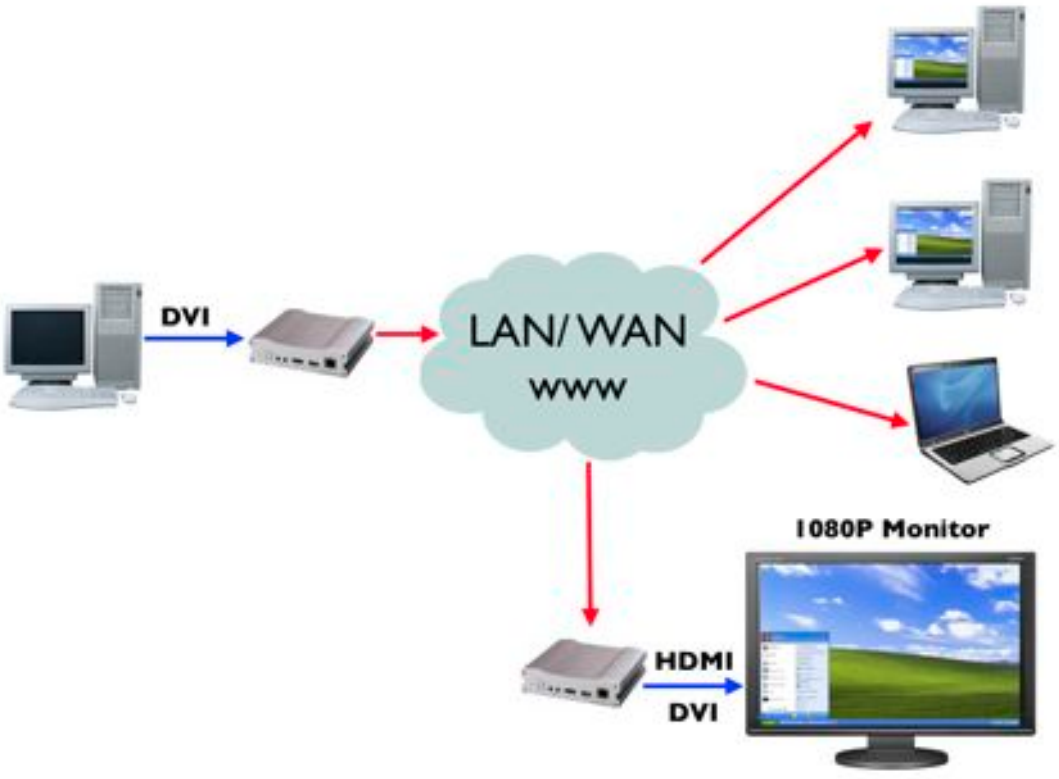
are configure as decoders. (HD Servers are capable of either encode or decode and software configured over IP)
The decoders are configured to look for the specific IP address of the HD Encoder they are expecting to decode. Once the decoder locates the encoder on the network they decode the incoming IP stream , decompress video and audio and output via HDMI and the Audio jack. This effectively creates an HDMI + Audio over IP and back to HDMI + Audio link. Audio is two way if required as a back channel is useful for communicating with the server end either during installation or more generally.

The benefit of this approach is that a link can be achieved over IP over any distance with only two HD servers , removing the need for software decoding via a PC.
Applications: A simple example would be an unmanned reception desk remotely located to the monitor plus two way audio communication. Factory machine monitoring of both Video and PC content , general control rooms, Weather stations , Electricity plants etc.

Example 3: Viewing a single High definition Camera or Computer screen over the Internet using multiple methods of viewing



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In th... eople viev... n be ... or PC

Figure 3: Multiple methods of decoding from a single source

content to many hundreds of viewers.

In this example both PC based decoding and an HD server configured as a decoder, with no PC involved is being used.
Applications: Hospital Endscopy, MRI and CT scans plus other PC based graphics can be sent over the IP network. Two way audio and full HD Video opens up possibilities of consultant surgeons advising theatre surgeons remotely. Training of students showing live situations in the field whilst students are located remotely are possible, HD content allows them to see what the trainer sees.

Typical Performance figures: Full HD & SXGA content over IP

a) Video at 1920 x1080 at 60 fields per second plus AAC audio at best quality will use around 6-8 Mbits per second with high motion video
b) Video at 1920 x1080 at 10 Fields per second plus AAC audio can use under 1 M Bit per second of bandwidth on the IP network

c) 1280 x 1024 SXGA PC desktop content plus AAC audio with no video will use approximately 2Mbits per second. Video content or fast changing graphics will increase this figure closer to 4-6 Mbits/second

d) 1280 x 1024 SXGA PC desktop with a refresh rate of 5 times per second will use between 500kBits/ second and 1Mb/s with video content and static desktop graphics.

This shows that systems with upwards of 10 PCs or HD video systems can be easily supported on a standard 10/100 ethernet network and significantly more depending on the video or PC content. Gigabit ethernet will obviously significantly increase the system size.

It should be noted that data rates quoted are average throughput rates and that peak data rates, during I frames for example, will be higher than the average.

Summary:
Full HD content or SXGA PC desktop content can now be integrated in a single system using a single product , the HD Video and PC graphics server. High quality two way audio and other control signals such as RS232/485 can be seamlessly integrated into a total HD Video and Graphics over IP network.