

HDMI Over IP vs. HDMI Matrix Switching using CAT6/STP

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Although TCP/IP networks are typically used for applications such as Data, Voice, and some low quality video, using TCP/IP for high quality HDMI video connectivity has some potential drawbacks which we will outline in this paper. The aim is to compare HDMI over IP connectivity to HDMI over dedicated CAT6 wires. Since HDMI over dedicated CAT6 wires is always uncompressed we will discuss HDMI over IP only from the point of lowest possible compression ratio and highest video quality.

The basic reason for using HDMI over IP is to utilize the same CAT5/6 wiring that is already in place for standard IP Networks such as Ethernet. It certainly sounds appealing to be able to just “borrow” the same already installed CAT5/6 wire used for most TCP/IP installations. TCP/IP wiring however, is always going to or from a central location such as a hub in a star-like distribution structure as shown in Picture 4. However, in the point to point connection HDMI over IP could connect directly without the hub as shown in Picture 2. In addition a TCP/IP network has two flavors: a standard network with data transfer capacity up to 100 Mbps and the so called “Gigabit” network with data transfer capacity up to 1 Gbps. The HDMI signal, with its 12 bit Deep Color and 1080p/60 resolution has a data rate of over 6.69 Gbps. Here are some of the requirements for HDMI over IP system:

- For high quality video IP has to be a Gigabit speed network, not the usual 100 Mbps.
- The HDMI signal has to be compressed before being added to the TCP/IP stream and then expanded at the delivery point. The compression ratio will be higher if 100 Mbps IP network is used.

So let’s find out if we can simply “jump” onto an existing network to distribute HDMI over IP. First of all the Gigabit network uses either fiber or CAT6/7 – not CAT5e as in a regular network, so the cables in the wall *must* change. Below is a comparison of a single connection using HDMI over IP versus a single HDMI over point to point Baluns. However, as I mentioned earlier if more severe compression is a standard hub and standard CAT5e cables can be used.

Figure 1: Single connection of HDMI over IP using a hub

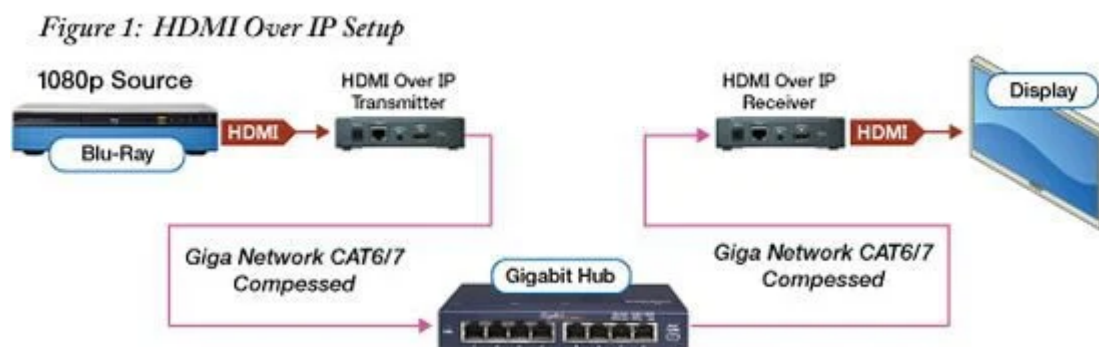


Figure 2: Single connection of HDMI over IP direct without a hub

Figure 2: HDMI Over IP Setup

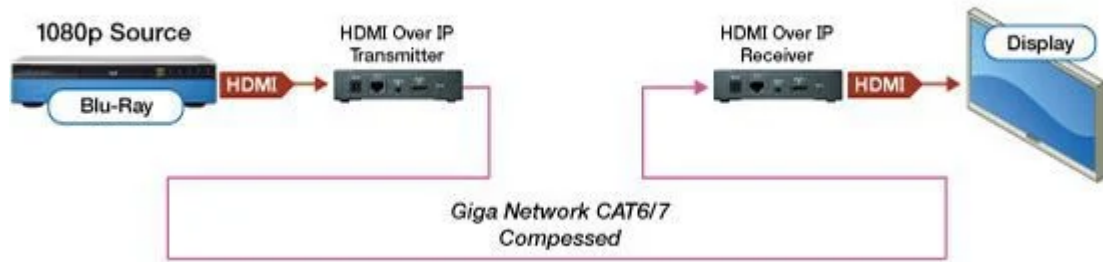
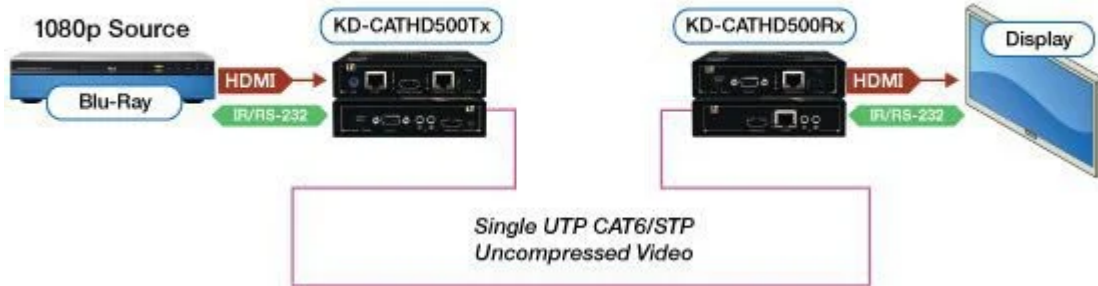


Figure 3: Typical single connection of HDMI through extender balun

Figure 3: HDMI Over Baluns Setup



In this simple example HDMI over IP versus HDMI over Baluns clearly differ in two ways:

1. The quality of the HDMI signal has to be compressed by a factor of 6 (or more) to be able to travel over a Gigabit network so you must consider the limitations of this compromised video quality over that of the uncompressed, full quality signals.
2. The Gigabit hub needs a power source and has to be located somewhere in between the source and the display. With an existing network in place this may be impractical if not impossible.

The quality of the compressed video signal is basically determined by the type of compression scheme and the quality of the compression hardware. Low cost compression hardware will deteriorate picture quality more than the higher cost hardware typical of the type used in broadcast applications.

Any IP Hub, including a Gigabit Hub, will not always keep connectivity priority for an HDMI stream. A simple printing job or even Internet access initiated on the same network, may interrupt the HDMI stream for a fraction of a second creating a visible glitch on the screen. You can of course limit these interruptions by not allowing anything but a single HDMI stream on that network, but that removes the advantage of running HDMI over an existing network.

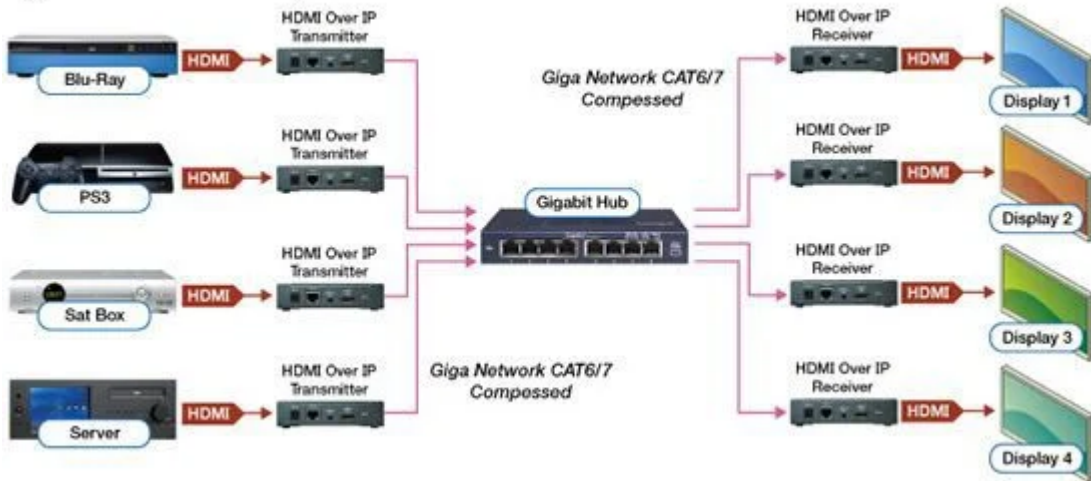
Sending more than one HDMI signal over one IP has even larger problems: the same limited bandwidth of Gigabit will further decrease each HDMI streams compression quality. In addition, the hub may arbitrarily assign a secondary priority to one of the main HDMI streams that will make the interruptions of that stream more frequent.

To remove coexistence issues between regular IP network and IP network dedicated to HDMI traffic - these two networks has to be kept physically separated from each other. In this case the HDMI over IP network need to use dedicated wires and hubs. In case of dedicated HDMI over IP network the basic advantage of utilizing existing IP network for HDMI is removed.

Let's compare a 4x4 HDMI matrix switching application using point to point Baluns with an HDMI over IP system. Below is an example of an HDMI over IP system - *Figure 4*. Some of the points that can characterize this system are:

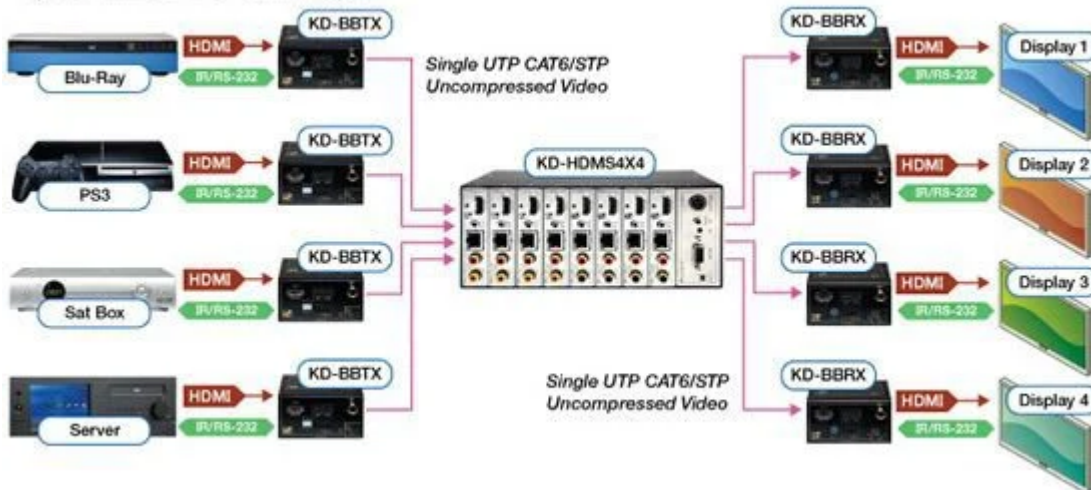
- Let's say we have 4 HDMI sources being sent over a network. A 1 Gbps Gigabit networks bandwidth would need to be shared between those four HDMI sources and as well as other auxiliary traffic such as printers and Internet access points. With an initial data rate of 6.69Gbps for 12 bit Deep Color and 1080p/60 resolution, the HDMI signal would have to have a compression ratio of 7x for each HDMI signal.
- The Networks priority in case of an interruption can affect any of the four streams arbitrarily and cause problems. This is in case of HDMI and regular IP network share same wires and hub.
- The cost per system is proportional as compression encoder and decoder boxes are added to the system for expansion.

Figure 4: HDMI Over IP Setup



In comparison let's take a look at a 4x4 matrix system connected by point to point Baluns and a 4x4 HDMI matrix switcher:

Figure 5: HDMI Over Baluns Setup



We can characterize this system as follows:

- **There is no bandwidth restriction for an HDMI signal with 12 bit Deep Color and 1080p/60 resolution and data rate of 6.69 Gbps. The image and sound go through the system without any degradation.**
- **There are no network priority issues with an HDMI matrix system. Switching is done without any effect from one source or display to another.**
- **The cost is proportional to each input and output added to the system**
- **Further expansion of the system to 8x8, 16x16 or beyond does not change the quality of the video and audio displayed.**

Conclusions:

- **a. HDMI over IP represents lower video quality because compression is needed.**
- **b. For HDMI over IP customers will likely have an unreliable connection with possible interruptions caused by traffic on the network. Separate dedicated HDMI over IP network need to be created to mitigate this problem.**
- **c. HDMI over IP compression devices could be more expensive than HDMI baluns.**
- **d. HDMI baluns and HDMI matrix switching is better suited for high quality residential and commercial HDMI installations.**