# When AV Meets IT:

## The Evolution of Signal Transmission

*The Challenges of Providing Simple, Reliable Solutions to Transmit Multiple AV and Control Signals with Enough Bandwidth for Ever-increasing Resolutions*

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# 1. Introduction

Ten years ago, AV signals started making the transition from analog to digital. Just as music on cassette tapes had already previously migrated to CDs, and movies to Laserdisc and then DVDs and Blu-ray, industry connector standards also started to change and VGA began to migrate to HDMI. There are clear benefits of migration from analog to digital, and those benefits are that digital signals not only provide better quality but also more possibilities, in terms of both data processing and data transmission.

If you think back to the phone that you had 10 years ago, and then look at your smartphone today, you can clearly see the difference. So you can imagine that the same kind of difference in professional audio video also represents a huge change. After the migration from analog to digital, resolutions started going up very quickly, from VCD, to DVD, then migrating to 720p, and then to 1080p, which is probably the most familiar format of the past 10 years. However, recently, in the past 2 or 3 years, 4K has become the new standard of quality for high definition video across many industries, with the even-wider standard of DCI 4K leading the way for movies. Considering that 4K UHD is 4-times the resolution of 1080p Full HD, this means that 4 times the amount of video data needs to be processed. Furthermore, in addition to the video signal, we also need to account for the transmission of other signals, like audio, control, USB, and Ethernet. And this evolution of AV signals means that today we face a range of challenges when it comes to transmission.

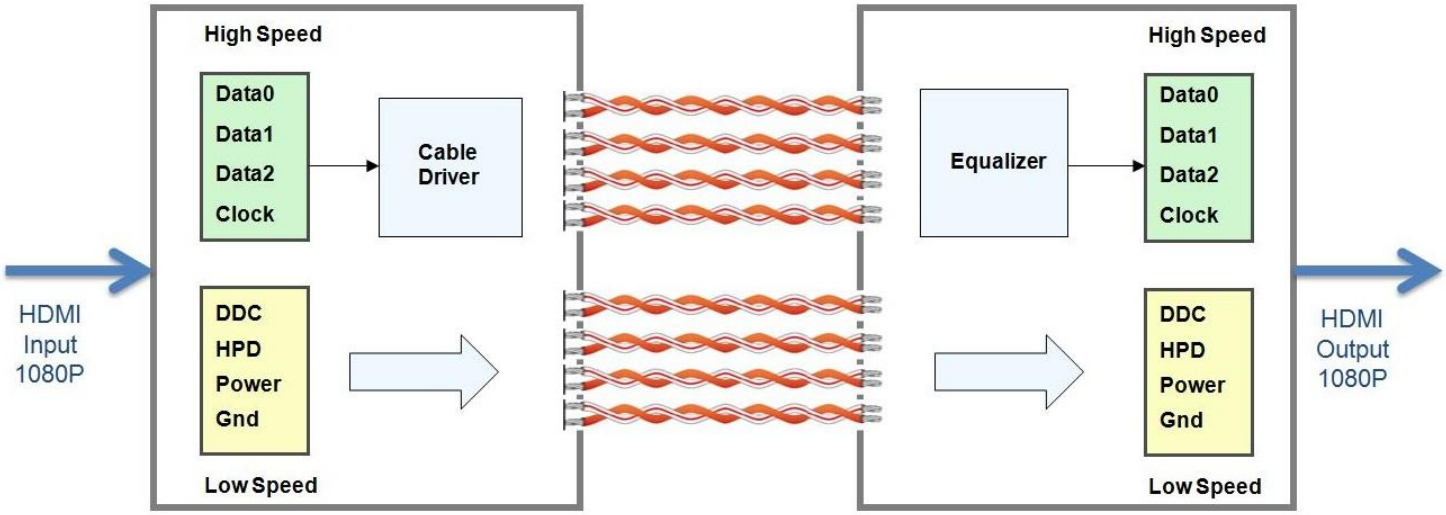
At ATEN, we have given ourselves the task to meet these challenges and to provide simple and reliable solutions to transmit multiple signals, including video, audio, and control signals, with enough bandwidth for ever-increasing resolutions up to 4K@60 or 4K HDR.

## 2. Challenges and Solutions

### 2.1. Equalizer

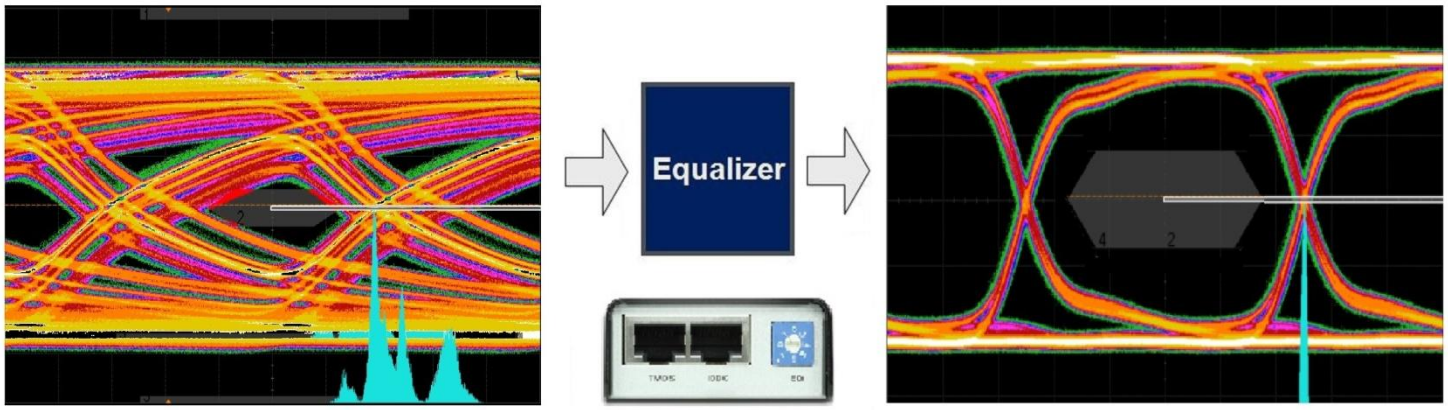
Thus, about 10 years ago, ATEN looked around at the available technologies on the market. The first one was Equalizers. These are the simplest method of signal transmission, and the most cost-effective. Figure 01 shows how equalizers transmit HDMI, using two CATx cables to transmit different parts of the signal – the first cable transmits the high speed signals, and the second cable transmits the low speed signals, such as EDID, HDCP, HPD, audio, IR, and USB. It's not especially difficult, but this kind of technology has limitations – the longest distance for 1080p is only 40 meters, for example.

**Fig. 01: How Cable Equalizers Work**




For high speed digital signals, like DVI and HDMI, there is serious decay after long-distance transmission. This kind of eye diagram (shown in Figure 02) is used to measure priorities and digital video problems – when signals are not received properly, the display may blink, or show no images at all. When the eye is open, the quality is good. However, after 40 meters, this is where the function of the equalizer comes into play. ATEN HDMI extenders use this technology to recover the signal and bring the video quality back to normal and match the original signal.  ATEN models feature a slide switch which allows end-users or SIs to adjust the level of compensation, based on different distances, because the equalizer compensates for signal loss at various frequencies. Higher frequency signals will decay more after long-distance transmission, for example.

**Fig. 02: The Function of Equalizers**



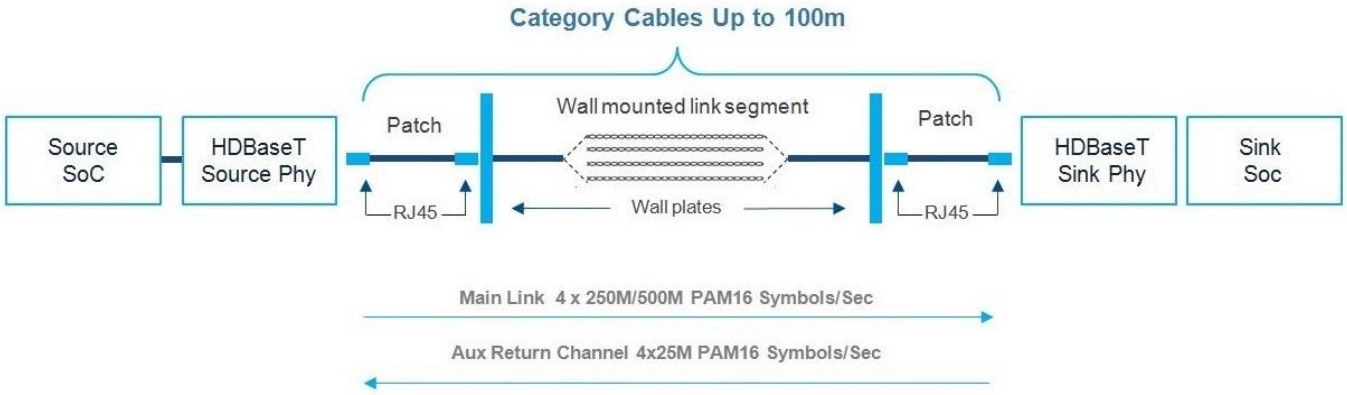

ATEN has a wide range of equalizer-based products that are simple and cost-effective. The key models are the VE807, VE800A, VE803 and VE810. However, the maximum capability is only 40 meters for 1080p signal, which is too limited compared to previous analog signal extension. For reference, ATEN VGA extenders can transmit up to 150 meters. So, how do we deal with this extension limitation?

## 2.2. HDBaseT

The extension limitation of equalizers meant that we had to find another signal transmission solution. We decided to take a look at HDBaseT, which is an open standard that most people are now familiar with and which has become the new standard for digital connectivity. HDBaseT, which can combine all different kinds of signals into a single cable, was founded by Valens in 2010 and now there are about 200 members of the HDBaseT alliance, membership of which is classified into two levels. The first is Contributors; the second one is Adopters. The Adopters use the HDBaseT standard in their products. Contributors actually join in the discussion for the future requirements and specifications of the technology. Originally ATEN was an Adopter, but in July 2017, we made a very big decision and upgraded to become a Contributor member of the alliance. Now we have become busier because the alliance requires active contributions about user cases and technologies. The benefit of this for ATEN customers is that we know more inside information about HDBaseT so we can make better products.

If you consider our first solution, equalizers, with which we need to use two cables and the maximum distance is only 40 meters, it is easy to see the beauty of HDBaseT. With HDBaseT you can extend five different kinds of signals up to 100m: 1) Uncompressed ultra HD video and audio; 2) 100BaseT Ethernet; 3) USB (USB 2.0 for HDBaseT 2.0); 4) Control signals (IR, CEC, RS232); and 5) Power over HDBaseT (up to 100W). To reinforce knowledge of these unique capabilities, HDBaseT created a special term for this special function – 5-Play. So, to share what we have learned from HDBaseT, you can see in Figure 03 the key factors of a suggested cable installation HDBaseT. If you are familiar with Ethernet switches, you will notice that this is similar to 10G Ethernet.

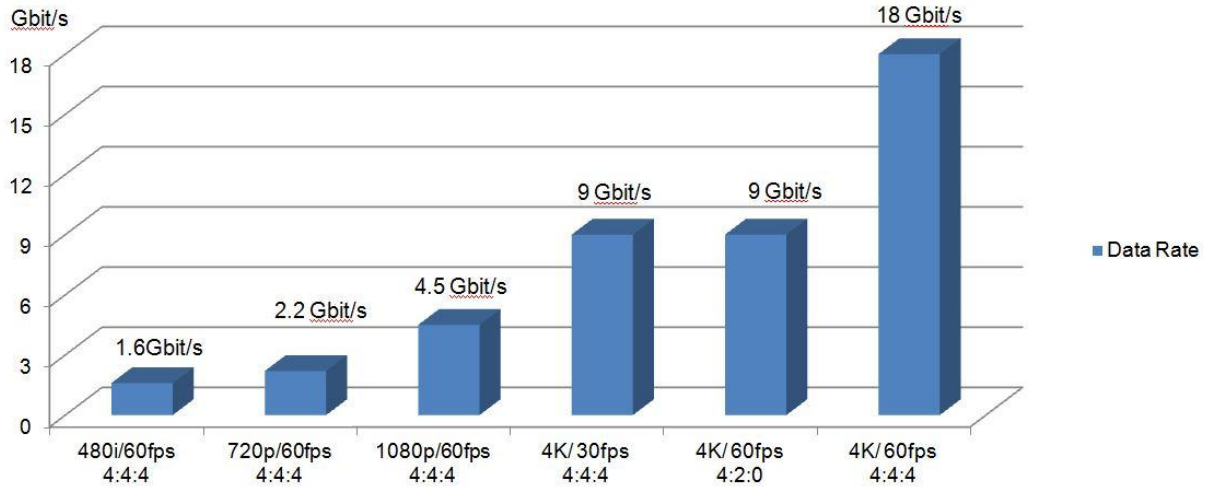
**Fig. 03: Key Factors of HDBaseT Installation**




In a move that mirrors the convergence of AV and IT, HDBaseT leveraged 10G Ethernet technology from the IT industry to create an ultra-high bandwidth channel for AV, which is enough for 4K30Hz @4:4:4 or 4K60Hz @4:2:0. Because the data rate for both of these is about 9Gbps, HDBaseT cleverly uses 10Gbps to transmit ultra HD signals. And, it's not only video but also audio, control, Ethernet, USB – all signals are converted to data packets during transmission to provide excellent flexibility. An interesting point to note here is that even though this concept is not unique, HDBaseT has been doing really well over the past few years, primarily because Valens invested heavily in their ASIC to provide affordable pricing.

But what does this mean for new standards, such as HDMI 2.0? For this, the resolution is still 4K60Hz but the color sampling should be 4:4:4. This requires a data rate of up to 18Gbps and, as you can see from Figure 04, this bandwidth exceeds the limitations of HDBaseT.

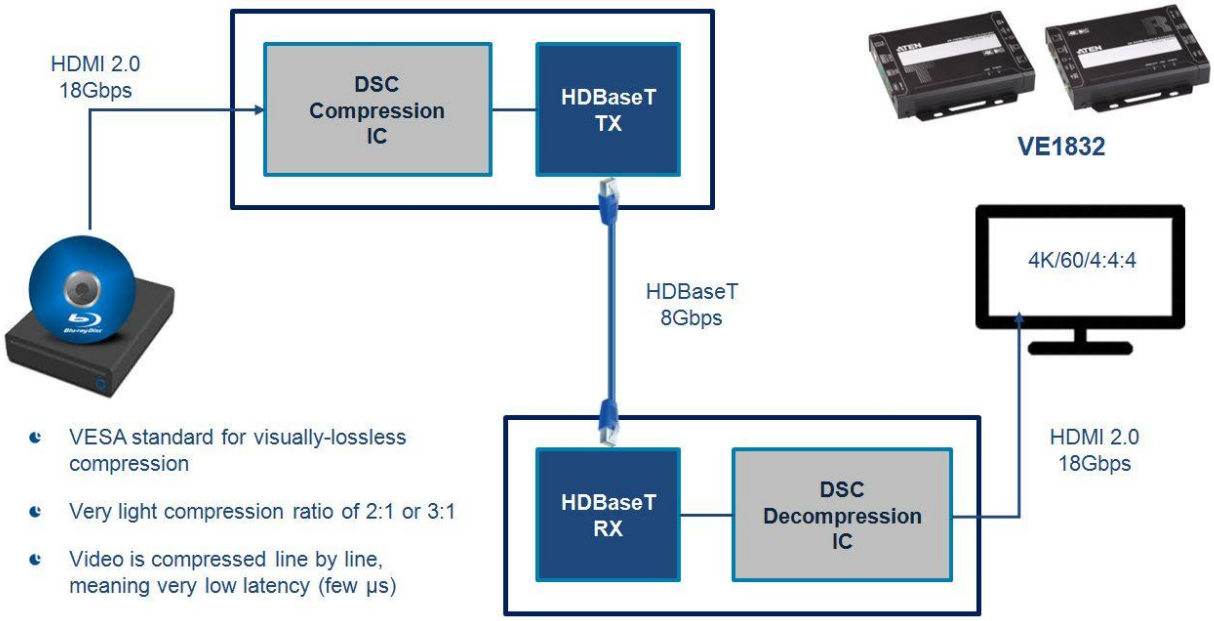
**Fig. 04: HDBaseT can provide up to 10Gbps bandwidth for 4K30 @4:4:4 and 4K60 @4:2:0, but the bandwidth is not enough to transmit 4K60 @4:4:4, which needs a data rate up to 18Gbps.**



HDBaseT met this challenge by investigating the available technologies on the market. It was fortunate to discover a special kind of compression from VESA, another alliance that is in charge of definitions for display resolutions. VESA stands for the Video Electronics Standards Association and it is an international non-profit organization that supports and sets industry-wide interface standards for the PC, workstation, and consumer electronics industries. When you hear about things like XGA, UXGA and EDID, all of these things are defined by VESA and are common standards. HDBaseT found out about a new technology from VESA called DSC (Display Stream Compression).

DSC is the VESA standard for visually lossless compression. It is a very light compression ratio of 2:1 or 3:1, and the video is compressed line by line, meaning a very low latency (just a few µs). This means that via the DSC compression IC in the HDBaseT transmitter, the 18Gbps HDMI 2.0 signal can be reduced to within the limitations of HDBaseT in order to be transmitted up to 100m where it can be decompressed at the receiver side and recovered back to 18Gbps. See Figure 05. This means that by using DSC, HDBaseT can perfectly transmit True 4K up to 100m. ATEN has a new product that utilizes these technologies, the VE1832, which is a True 4K HDMI/USB HDBaseT 2.0 Extender.

**Fig. 05: DSC (Display Stream Compression)**



Many people are concerned that compression will decrease video quality, but DSC is an ultra-light compression method that provides visually lossless streaming, and it is very difficult for the naked eye to tell the difference between the original and the compressed images. It is very important for HDBaseT to maintain video quality for end-users and so this is why they use this special technology.

In summary, since the data rate of HDBaseT can be up to 10G bps, it is very important that care is taken with installation and cabling. ATEN has a range of HDBaseT products, and to help the market understand more about HDBaseT, ATEN has prepared an HDBaseT Installation Guide. So please be sure to read this [see *Further Resources,* below]. We also recommend the use of certified HDBaseT cable in your installations, such as the type ATEN supplies. One final, important point is that while HDBaseT is based on technology similar to Ethernet, HDBaseT signals cannot go through a standard Ethernet switch, so do not directly connect HDBaseT cables to an Ethernet switch, as that will not work.

### 2.3. Over IP

ATEN's over IP solutions have been developed based on Gigabit Ethernet network architecture, which is commonly used in the IT industry, to provide better flexibility and scalability than is offered by HDBaseT. For many solutions, HDBaseT is excellent, but for certain applications, its flexibility and scalability is somewhat limited. ATEN's over IP solution is very simple – it consists of a transmitter, a receiver, and a standard Gigabit Ethernet network switch. Note that many of ATEN's connection diagrams show a Netgear switch, because we have done comprehensive testing with this brand and Netgear is always compatible with ATEN over IP products.

The first clear benefit of over IP products is flexibility. From simple extender and splitter setups to matrix switch and video walls, we can use similar transmitter and receiver setups in conjunction with different numbers of ports on a Gigabit switch to provide a solution for most applications. However, we need to consider the data rate. ATEN chose 1Gbps because this provides much better flexibility, better total cost, and has better anti-interference capabilities than 10Gbps. But even 1080p has a data rate of more than 1Gbps. So for over IP products, compression is a must.

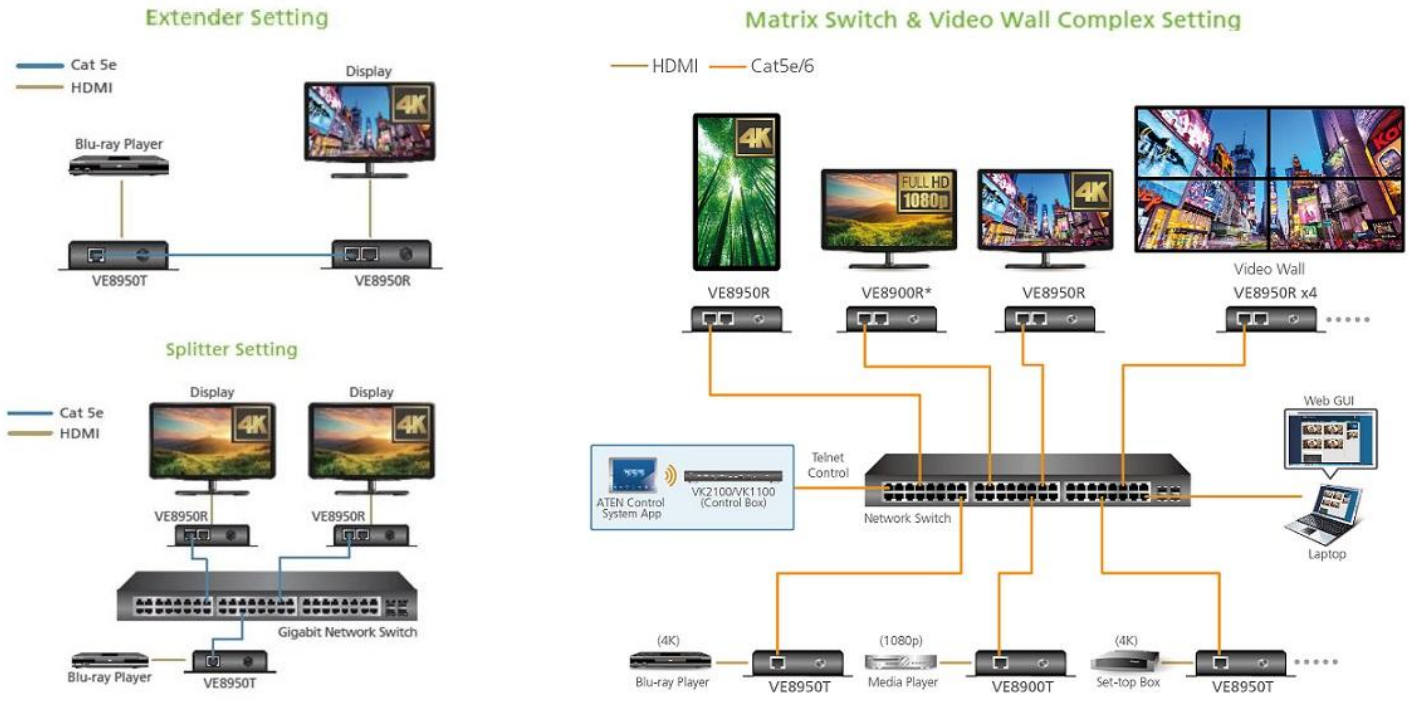
Due to the fact that we must use compression, there are two topics that need to be considered. The first one is video quality. Compression will definitely cause the loss of some image data, and different kinds of compression will cause different levels of data loss. Based on the level of image data lost, compression methods can be classified into three levels: "Lossless", which means no data loss; "Visually Lossless", which means the loss of quality will not usually be noticed; and "Lossy", which means that the difference is clear. So, to find the perfect balance between quality and flexibility, ATEN VE89xx over IP products use the "Visually Lossless" compression method.

The second important factor to consider when compressing video is latency. During our market research, we discovered the levels of latency that are acceptable to most people in certain situations.

For example, in medical monitoring for applications that are critical to human life, no latency is acceptable. Second, for HIDs, such as keyboards and mice that require an extremely quick response, the level of acceptable latency should be less than 50ms. Equipment control devices for control and access, such as touch panels, can have a slightly longer acceptable latency, but it should still be less than 100ms. Considering the main target applications of our customers involve both HIDs and touch panels, at ATEN we decided that our acceptable latency should therefore be less than 100ms. So our lab test results ensure latency for the ATEN KE69/89 and VE89 series of 32ms / 2 Frames for both the transmitters and the receivers.

Networking is often unfamiliar to pro AV professionals and can be difficult, so our ATEN HDMI over IP Video Extender System Implementation Guide [See *Further Resources,* below] is a good place to start to get a grounding in the important issues. The core concern is that since the main purpose of a network switch is for data communication, this means that HDMI over IP applications are quite challenging. Therefore, selection and configuration of the network switch is critical for the whole project, and inside the implementation guide we have listed some models that we have tested with our over IP products that we can recommend. On the other hand, cabling is not as critical as it is for HDBaseT products since the over IP data rate is only 1G.

**Fig. 06: Multi-functionality in extender, splitter, matrix switch, video wall, and daisy chain applications.**



## 3. Selecting a Solution Based on the Application

So how can we choose between the different technologies to meet the challenges of different applications? The conclusion so far is that equalizers are the most cost-effective solution; HDBaseT can provide the most outstanding video quality; and over IP has the most flexible architecture. But what about some more specific cases? Here are a few examples that should be useful. (Links to the full-detailed individual case studies, where available, can be found under *Further Resources*, below).

### 3.1. Restaurant Chain, Italy

The first application example is in a restaurant chain in Italy. The customer required a simple and effective solution to distribute STB signal to a few monitors within the restaurant. The distance from the source to the monitors needed to reach up to 40 meters, and the required resolution was only FHD. Most importantly, it was to be a budget-friendly solution since the total number of restaurants is more than 100. So, of course, equalizer technology was the best fit for this case.

**Fig. 07: The restaurant chain required an equalizer solution.**

## 3.2. Hospital MRI Extension, UK

The next application case is in a hospital in the UK. The customer was implementing a new, cutting-edge MRI-guided radiation therapy as part of their ongoing development of leading treatments for cancer and brain disorders. They therefore required a reliable MRI extension solution with outstanding video quality and accuracy that would meet the high demands of such critical medical and healthcare applications and to help them to meet their goals of improving patient health. For this case, HDBaseT technology was the obvious choice, and they used the ATEN VE813A with HDMI and USB signal extension up to 100m.

**Fig. 08: HDBaseT was the obvious choice for MRI extension.**

## 3.3. Training Center, Turkey / Digital Courtroom, Europe / Live Event, UK

The next three cases are over IP solutions. ATEN's VE89xx series has recently collected a variety of project wins since its launch at the end of 2016. One is a training center in Turkey that required a digital signage/online classroom solution across 8 floors; another is a digital courtroom in Europe where they required multiple displays to share a lot of content; the third one was for a live event that happened in the UK that used 4K signals on huge screens. They required a reliable extension solution that would not be affected by the environment, so they selected the ATEN VE8950.

**Fig. 09: Over IP solutions were selected for these cases.**

## 3.4. Public Surveillance, Italy

Now, the next case is very unique. The State Police in Turin, Italy, required a new public surveillance control room to monitor crowd behavior and detect incidents during large public events. With the help of ErreElle Net, an industry specialist, several video walls and flexible workstations were set up using ATEN's KVM and AV signal distribution hardware. For this case, a combination of HDBaseT and KVM over IP technologies were used, making it an interesting AV Meets IT case that perfectly illustrates the tangible advantages of ATEN's focus on AV/IT connectivity.

**Fig. 10: State Police in Turin used a combination of HDBaseT and KVM over IP technologies for their control room.**


## 3.5. Sports Bar, USA

Next is another interesting case from the United States. A large sports bar complex wanted to create a unique experience to attract customers. They required 4 video walls. Originally, they used our VM3200 modular matrix solution and HDBaseT receivers because that was the most up-to-date solution that we had to meet their requirements (Figure 11), but they decided to implement our over IP solution (Figure 12) when they realized they needed much more flexibility in their new store for a much wider variety of displays.

**Fig. 11: Original HDBaseT solution for sports bar.**

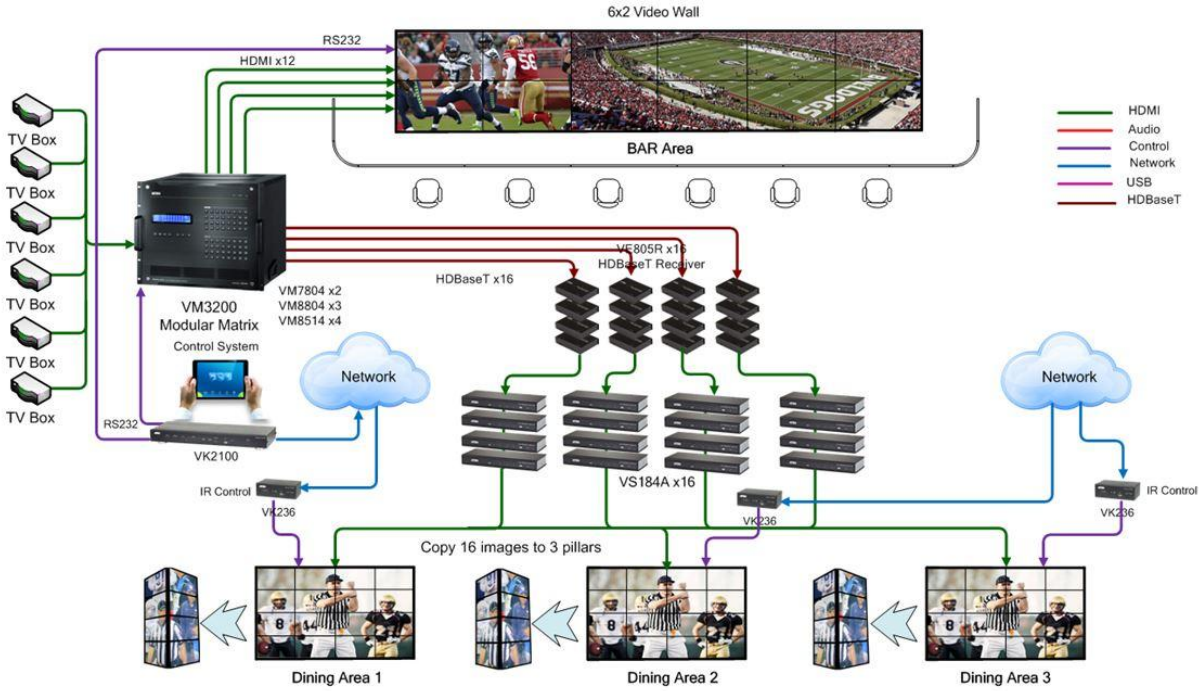
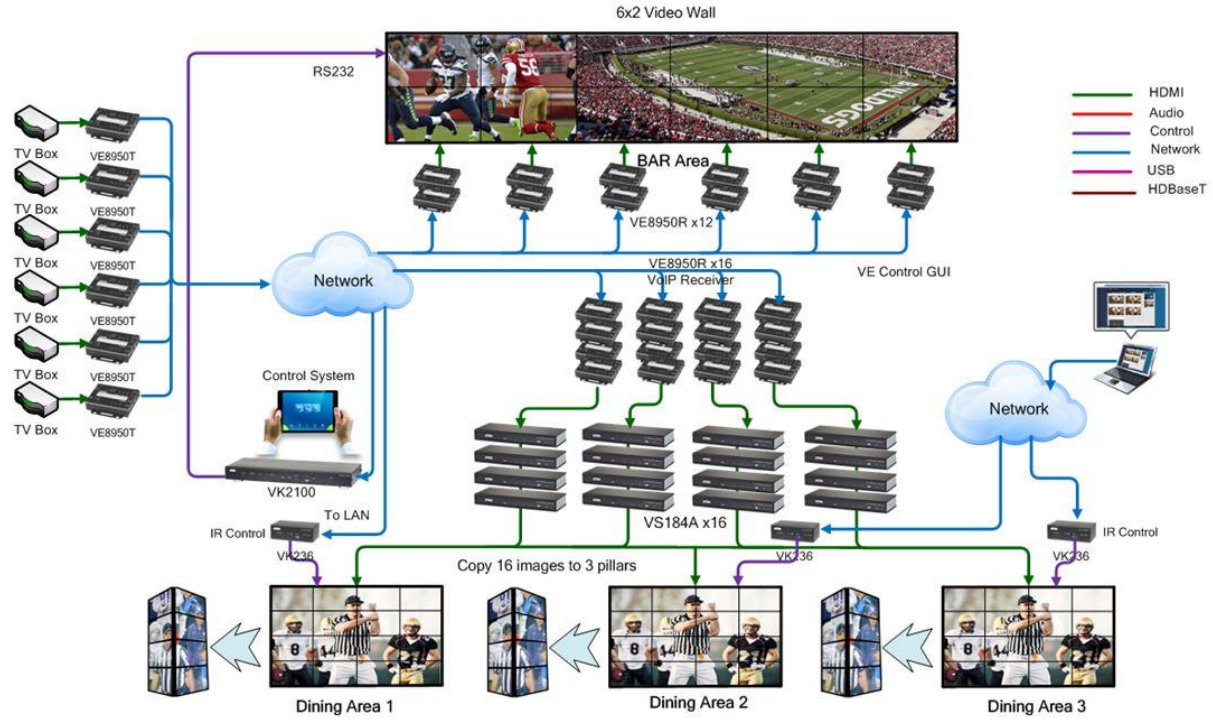



**Fig. 12: Updated over IP solution for same sports bar.**



## 4. Conclusion

In conclusion, we can see that AV is already meeting IT, and our methods for AV signal transmission at ATEN have already evolved to account for this continuing convergence. We began with equalizers, using the available technologies on the market, and the traditional way to send AV signal transmissions using just cables. We then migrated to HDBaseT, still using cables but also using packet technology of the Ethernet backbone for transmissions. And now we are leveraging more IP, using Ethernet switches to come out with more over IP solutions, which demonstrates that in an AV/IT integrated world, ATEN solutions can meet market demands.


## 5. Further Resources

- ATEN  HDBaseT Installation Guide
  https://assets.aten.com/resource/epublication/ATEN_HDBaseT_InstallationGuide.pdf
- ATEN HDMI Over IP Video Extender System Implementation Guide
  https://assets.aten.com/product/manual/Implementation_Guide.pdf
- ATEN Case Studies
  https://www.aten.com/global/en/market-and-solutions/success-stories/