Fiber Optics in the Courtroom

The amount of fiber being deployed in courtrooms around the world continues to grow. This article will highlight some of the courtroom applications where fiber plays an important role to ensure the transport of high quality, secure information.

Fiber optics has a number of inherent advantages over copper-based systems. The courtroom environment takes advantage of many of these to provide a high performance transport system. Several of these key benefits are:

- ***Smaller & Lighter*** - A fiber optic cable is much smaller and lighter in weight than a copper cable
- ***Pack more in existing duct work*** – Because of its small size and bend radius fiber can be more easily installed in existing ducts for system expansion & retrofits. One major consideration when upgrading courtrooms is the availability of space in the existing ductwork. A small fiber cable can carry hundreds of more, and higher bandwidth signals than an equivalent copper cable infrastructure. As more technology is built into the courtrooms, the demand for larger cable ducts increases. Fiber allows this technology to be installed utilizing the existing ductwork without concern for space.
- ***More information than Copper*** – Fiber can carry many more signals and deliver them with greater fidelity than either copper wire or coaxial cable.
- ***Video Quality independent of distance*** – Unlike copper, fiber systems retain their high quality over the entire distance
- ***Higher Data Rates*** - Support much higher data rates, and at greater distances than coaxial cable
- ***No Ground Loops*** – A major problem in audio systems, fiber minimizes or entirely eliminates any potential audio ground loops that would otherwise be a major issue when transporting and routing audio signals to and from courtrooms.
- ***Secure*** – Fiber is ideal for secure communications since it does not radiate signals and is virtually impossible to tap.
- ***Totally immune to interference*** – Fiber can be run inside the same duct as other signal carrying copper cables with no risk of inter-cable interference.
- ***Future Proof Infrastructure*** – Can add more & other types of signals without changing fiber

The courthouse & courtroom environments have various AV applications suited for fiber including *Intra and inter-courtroom video & audio communications, remote arraignment and witness testimony, and media feeds.*

Intra & Inter-courtroom AV – Many courtrooms now have fiber optic AV connections at the judge's bench and attorney's tables, as well as the witness stand, document camera, jury box, gallery and other locations within the courtroom. Each of these locations may have only video while some includes both video & audio. In many applications, these video & audio signals are sent from the courtroom to a central AV room where they are switched or routed to various locations within the courtroom. The control of the signals is generally done by the presiding judge from a control panel on the bench. In order to ensure the highest quality video as it is routed around the courthouse, fiber becomes an obvious choice. In addition, the type of signals being transmitted may vary and fiber, being signal-type agnostic, is a perfect transmission medium for these varied signals.

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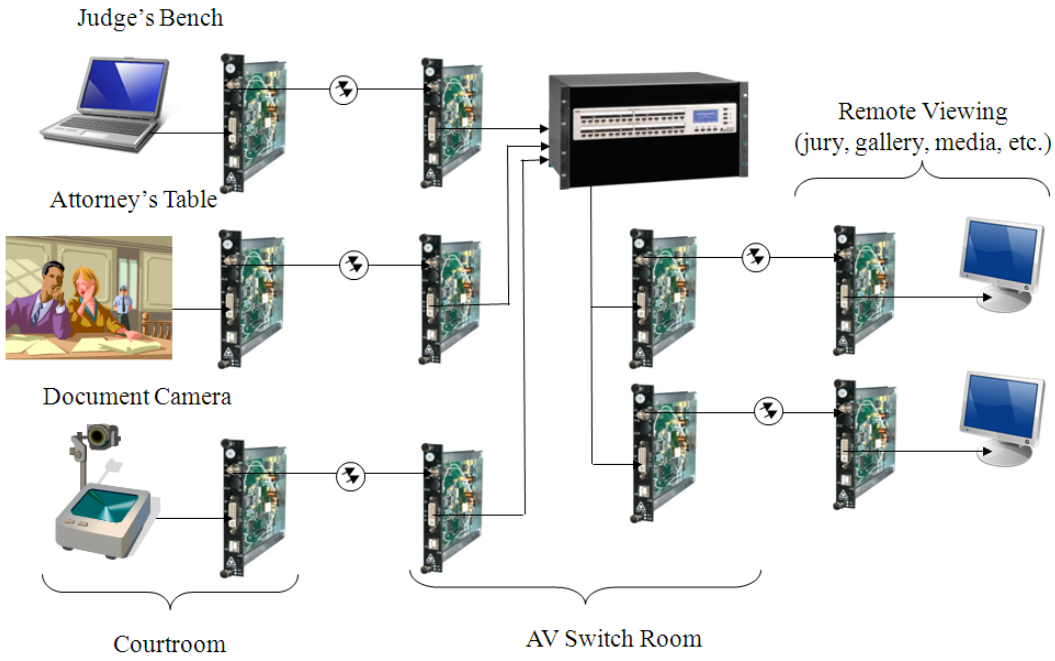
This figure illustrates how such a system may be configured.



Each video & audio source location (Judge, attorney, document camera, etc.) sends its respective video & audio over fiber to the main AV room. Note that this may be either a direct connection to the AV room or it may go through intermediate video/audio switches where they may be routed to remote viewing rooms or other courtrooms for inter-courtroom conferencing. Once in the main AV switch room, the signals can be viewed or listened to locally to verify operation and quality, recorded and then routed back to the courtroom for viewing by the jury, gallery, etc. This main AV switch can also bring in video and audio from other locations such as remote testimony and arraignment locations. A future article will deal with methods of switching fiber signals including optical-to-electrical and all-optical switches. These switches play a key role in efficiently routing the video and audio signals to and from courtrooms and other court-related facilities.

Fiber provides the perfect infrastructure for transmitting these various signals and, with the proper equipment, allows video format conversion (e.g., RGBHV to DVI) directly in the fiber transmission equipment giving further flexibility and future-proofing to the fiber network.

This application is one of the main uses of fiber in the courtroom and illustrates one of the many ways to configure the primary courtroom AV system. As the need and demand for higher quality courtroom video continues to grow, fiber will take a major role in transporting these signals with quality far beyond any available copper-based system.

Remote Arraignment - Fiber optics plays a key role in implementing a remote arraignment system due to its large signal carrying capacity, flexibility in type and quantity of signal content, its long distance transmission capability and high quality video and audio signal transmission characteristics.

Fiber optic video arraignment systems provide an efficient, affordable and secure means to have the accused make appearances without leaving the jail or holding facility before a judge in a remote courtroom. With the costs for arraignment on the rise, overbooked courtroom dockets, and increased security risks, it is important to explore alternative methods for arraigning persons quickly, efficiently and at lower costs to taxpayers. Remote video arraignment over fiber offers a number of features and capabilities that will provide these features.

Generally, remote arraignment activities will take place at a holding facility or jail where the accused and prisoners are housed. There may be several different rooms where simultaneous arraignments may take place. It may also be advantageous to have other remote communications, access control or surveillance networks from the jail back to the courthouse to ensure that the attending courtroom has full control over the proceedings. A dedicated fiber system is an ideal candidate for such a network topology. In general, the communications nerve center for the courtrooms and detention centers is located in a dedicated area in the courthouse. The fiber network from each of the remote locations will terminate in this control room and be routed to a video/audio switch where each of the incoming & outgoing signals can be switched as needed to the appropriate courtroom and arraignment room in the remote holding facility.

A single fiber connection between the courtroom and holding or detention facility can provide the following functions:

1. Remote arraignment (video & audio) to and from one or more arraignment rooms
2. Security monitoring of the entire facility or specific areas
3. Data communications (camera PTZ control as well as access control)

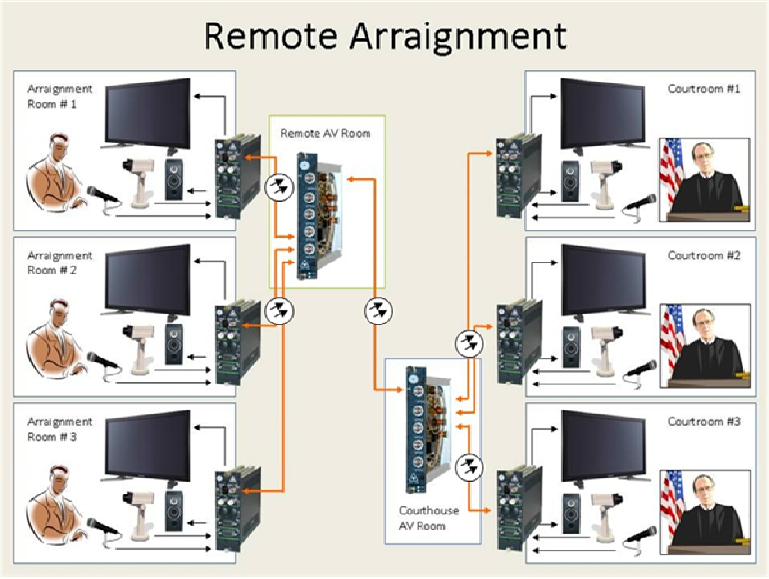
Several key benefits and features associated with a dedicated fiber transmission system include the following:

1. Secure video & audio transmission to and from the courtroom and holding location. A dedicated fiber transmission system ensures that the signals cannot be compromised, altered or tapped in any way. System security is becoming more and more important as the profile of the cases being tried continues to increase. Video and audio over an IP network always stands a chance of having the signals intercepted and compromised. Regardless of how secure the network is, there are always ways to somehow compromise the system by disrupting the communication link or by intercepting the various video/audio signals on the network. Again, as the profile of the cases being tried continues to increase and more interest and emphasis is placed on terrorist activities, network security is extremely important. Every effort should be made to ensure the integrity of the transmission network.

   Point to point dedicated fiber transmission systems provide the network security needed in this type of high profile system. Since the system uses a dedicated fiber path from end to end, the security and integrity of the system is guaranteed. An IP based system, where the video & audio signals are sent across a network, is inherently more vulnerable to such conditions as network failures, temporary drop outs, latency issues, video quality and tampering. These short-comings of IP based systems make them definitely less desirable than dedicated fiber systems for these high profile applications.
2. Real-time, high quality video transmission over fiber – One of the key advantages of a dedicated fiber video transmission system is that the video is transmitted in both directions in real time and at or near-broadcast quality. Network cameras have lower quality video and, when used with pan-tilt-zoom (PTZ) cameras, may also have some latency – further compromising the quality of the system.
3. Future-Proofing - As more cameras are added to a standard IP network, the quality of the video transmission comes into question. Network bandwidth continues to be used by these cameras and other signals on the network. As the network's bandwidth demand continues to increase, eventually the video quality and latency will become affected to the point where the overall system's performance will be compromised. On the contrary, a well-designed fiber system can provide for almost unlimited growth. Using state-of-the-art wavelength multiplexing technologies, over 64 cameras, associated audio and data channels can all be transmitted in real-time over a single fiber. This type of design allows for significant system growth as the demand increases.

Once the video signals are brought back to the main control & recording room, video & audio switches are used to route the appropriate signals to and from the selected courtrooms, recorders, and the remote holding facility. The bandwidth of singlemode fiber is large enough to support any number of simultaneous arraignment or other video/audio conferencing sessions as well as security monitoring and access control.

This figure illustrates how multiple arraignments between a courthouse and remote arraignment facility can be simultaneously held using a single fiber. Each of the bi-directional video & audio signals from the courtroom & arraignment rooms is transmitted to its main AV room where it is then multiplexed optically multiplexed over a single fiber and transported to the other facility. Once at the remote location they are then separated into signals and routed to the corresponding rooms over fiber.

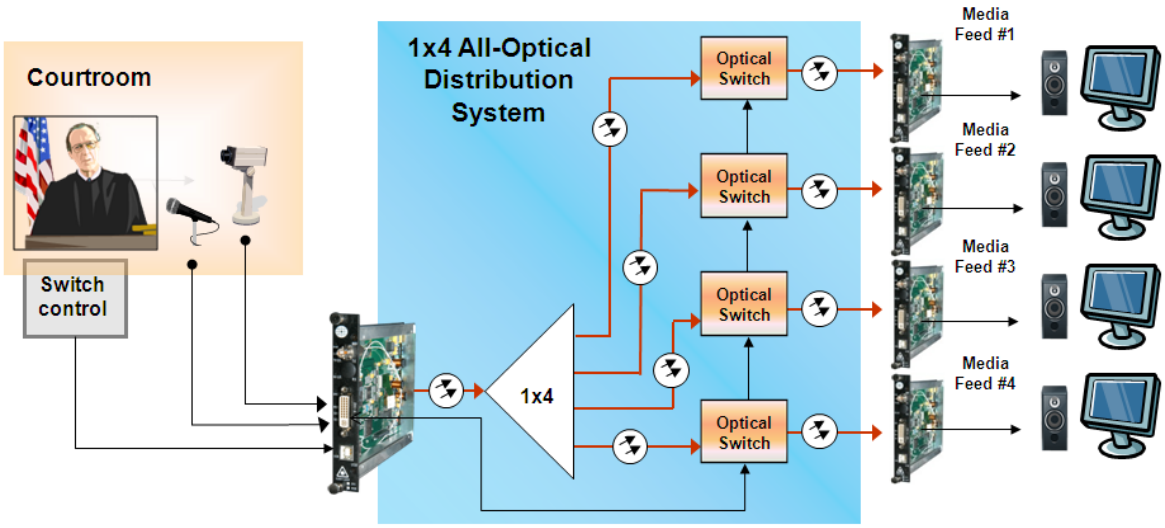


A combination of electrical signal and optical multiplexing (Coarse Wavelength Division Multiplexing - CWDM) provides a very efficient method for combining many varied signals onto one fiber – all being transmitted in realtime. A single fiber transmitter/receiver pair can combine a number of video, audio and data signals into one data stream while optical wavelength multiplexing can combine a number of these data streams from different transmitters (arraignment or courtrooms) onto a single fiber for transmission over very long distances. This wavelength multiplexing technology also allows the user to add more remote arraignment or witness locations on the same fiber without the concern for being either bandwidth or capacity limited. Obviously, other functions such as audio echo-canceling, audio conditioning, etc. need to be included in a complete system. The intent here is to provide information about how fiber can be used to efficiently implement these signal transport requirements.

Media feeds – Another important application for fiber in the courthouse environment is for remote audio/video media feeds. More and more television stations are now broadcasting their signals in high definition (HD). HD media feeds from the courthouse are starting to become more commonplace and will transmit the highest quality video available. Because of its high bandwidth, fiber is a perfect medium for transmitting these HD video signals including SDI, HDSDI, HD component video and 3G signals – all of which require significant bandwidth on the fiber – far more bandwidth than capable over traditional copper transport solutions. Fiber will also support all of the various video sources. Therefore, as video sources change from one courtroom to another or are upgraded, the same fiber infrastructure can be used without concern for video and audio quality.

An added benefit to fiber is that multiple remote media pedestals can be fed from a single video/audio transmitter with no loss of signal quality or concern for impedance issues as you would have with coaxial systems. A simple optical splitter can be used to split the optical signal from the transmitter into multiple paths, each feeding a separate media pedestal or other receiving location. Because fiber is signal-type agnostic, any type and number of signals can be transmitted over the same, individual fiber with no loss of quality or fidelity. In this way, the video feeds can be varied depending on the court agenda using the same fiber.

This figure illustrates how a single video & audio feed can be easily distributed and switched to a number of remote media pedestals or other receiving locations. The fiber transmitter from the AV room transmits both video and audio over one or more fibers to the optical splitter/switch. This splitter then distributes the optical signal to four different switched media pedestals for use by the various news sources or others monitoring the courtroom activity. The active optical switch is used to switch each output of the splitter to the specified remote location. These individual optical output ports can be selected either by the AV engineer or by the presiding judge simply by selecting the appropriate output channel via a touch panel control system. This active switch gives the judge control over what information becomes available to the onlookers and to whom it is distributed.



All-optical routing and switching adds capabilities to the transport and routing system not presently available in copper-based systems. By keeping the signals in the optical domain, the quality of the signals (video & audio) is maintained since conversion to and from the electrical domain is done primarily at the end points of the system.

These examples of courtroom applications illustrate the broad flexibility and capabilities of fiber and how it can integrate seamlessly into the courtroom environment. Clearly there are other courtroom and criminal justice applications that can benefit from fiber. These represent one fiber approach for the applications highlighted. Future-proofing is inherent in fiber and, properly implementing wavelength multiplexing and optical switching/routing ensures that the system is designed to take into account the ever growing demand for more bandwidth and real-time signal transport as well as evolving technologies.

Our next topic will focus on the various types of optical connectors available. There are numerous types of single channel, multiple channel and hybrid connectors in the marketplace. We will try to give a brief overview of several of these and how they play in the AV space. If you have any questions or if you have any particular topic on fiber optics you would like to know more about, please send an email to me at emiskovic@meridian-tech.com.