The Integrated Network

Integrating optical and copper transport of A/V and IP signals

A white paper by Riedel Communications

Optical transport has been a mainstay in the broadcast and production industry for decades. The introduction of optical transport made a huge difference sending content over long distances. It solved the challenge of moving content within boundaries of cities, venues and facilities. For field production it solved the issue of degradation over long cable runs. It has reduced the need for amplifiers and maintained signal integrity on long haul delivery. It has become one of the core layers in facility and venue infrastructure.

Where optical is typically used as a problem solver is in overcoming distance limitations in media transport, more and more it is replacing copper as the direct connection for high bandwidth signal transport between devices. However, there are many other layers.

Let's look at all the layers in a broadcast and production environment (see figure 1). Each has its own cable topology and signal requirements. Some travel over the same Ethernet transport — management, files, communication, and command and control. Video and audio can be a separate layers or the audio embedded in the video.

There is a considerable amount routing and distribution required to move these signals around the plant, remote production or in a venue (see figure 2). All of these signals need to be available and accessible at all operations and production positions.

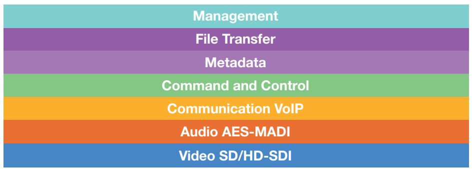

Figure 1. The transport layers in broadcast technical infrastructure.

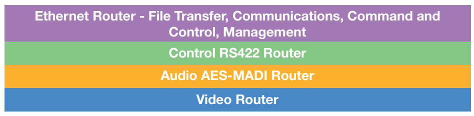

Figure 2. The routing layers.

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Add to that all of the signal processing and management that is required to maintain the integrity of signal quality as it moves throughout the environment or is transported between production and broadcast systems and it begins to get complicated and cumbersome.

The current production environment uses multiple devices for processing, embedding, de-bedding, routing and management. AV routers are now beginning to incorporate some of this signal processing into their core feature sets. The integration of this functionality into the transport processes starts to reduce the number of individual external devices (see figure 3).

There are fiber optic matrix switches similar to AV routers that can route optical carriers. This saves the need to go from optical-to-electrical-to-optical (O/E/O) which is essentially demodulating from one fiber path, route and/or process the signal in its native format and then re-modulate back to fiber for the next leg of the signal's journey to its destination.

While optical transport solves the distance limitation, it is still largely a point-to-point technology. One of the efficiencies in using fiber is the ability to multiplex a number of signals into a single pair of fibers. There are a few different ways to multiplex signals over fiber, the two basic ways are Wave Division Multiplexing (WDM) and Frequency Division Multiplexing (FDM). WDM is the more popular technology. This is accomplished by using different wavelength lasers on a single fiber. There are a few different WDM technologies.

Basic WDM technology enables only a few wavelengths within the allowable transmission band of the lasers. Coarse Division Multiplexing (CWDM) and Dense Wave Division Multiplexing (DWDM) enable more wavelengths by optimizing channel spacing on the fiber therefore enabling more signals to be transmitted over a single fiber.

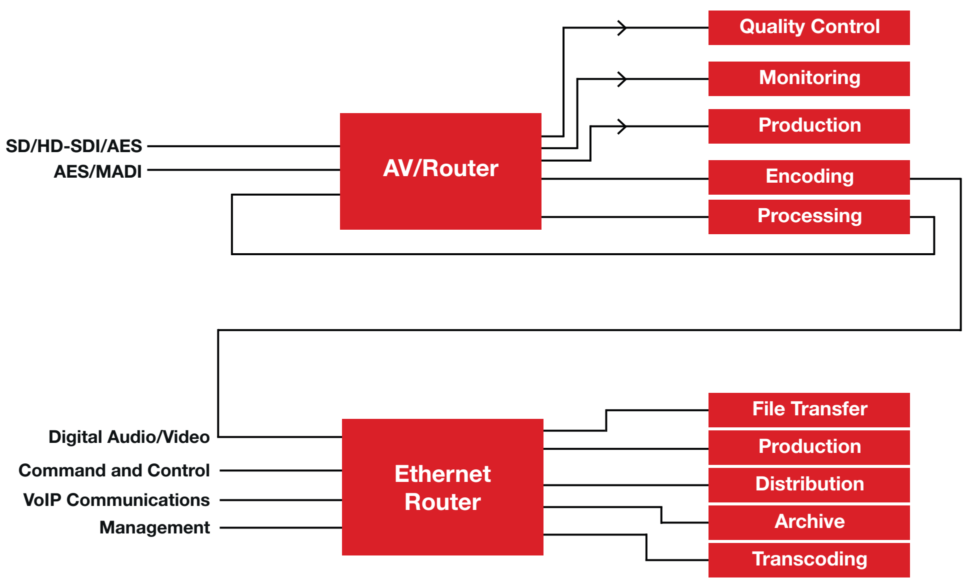

Figure 3. The current production environment uses multiple devices for processing, embedding, de-bedding, routing and management.

WDM, DWDM and CWDM use a similar concept of putting multiple wavelengths of light onto a single fiber. Where they differ is how they space the wavelengths on the fiber, which determines how many channels can be transmitted and the ability to amplify the multiplexed signals within the optical carrier. CWDM is the more cost efficient of these technologies and the one that has been adopted in the broadcast industry.

Figure 4. Coarse wave division multiplexing carries many circuits over a single mode fiber.

The next evolution in signal transport, management and processing is an integrated network based on a multiplexed fiber optic topology. Using Coarse Wavelength Division Multiplexing (CWDM) technology enables multiple signals to be layered together over fewer fibers and then add in a higher level of integration combined with processing, routing and management will provide a number of efficiencies to a production (see figure 4).

Let's get back to the processing and management discussion. There is signal processing at all points of the media workflow. Beginning with acquisition, media is processed and managed using a variety of tools. Router manufacturers have realized that some of the processes need to be incorporated within the router technology. This gives the router much greater power by reducing the number of external devices and providing a single user interface to manage and control signal quality. Routers have become layered devices that integrate audio, video and control and now Ethernet to support the management layer. The routing of each signal from source to destination still largely uses XY matrices. The individual signals are transported over copper and fiber.

Historically, the same processing devices sit in front of and on the receiving side of the transmission systems. The signal is then output to the A/V router, DAs and the Ethernet router. There are frame stores, frame synchronizers, processing amplifiers, conversion, embedders and de-embedders in the signal chain assuring the quality and integrity of the signal is maintained. A critical component of the signal path is to monitor these processes for quality assurance.

The distribution and transmission chain is typically an asynchronous process within the media workflow. By this we mean that within the broadcast environment there are multiple layers of house sync. However, it is typical that the transmission devices are not locked to house sync.

One of the challenges in moving signals around a facility, a remote production, or a venue is maintaining signal quality and sync. While fiber optics is used to move signals over long distances to avoid loss, it is still a point-to-point technology. If there are six production positions in a venue, then six fiber bundles are run from the truck to each one. In the truck there are specific transceivers for each signal type. Using fiber within the broadcast center solves the distance issues associated with copper but requires the same amount of fiber and adds more equipment.

The Riedel Approach

Riedel has taken a new approach to optimizing the efficiencies of using fiber with MediorNet. The next generation in facility infrastructure is an integrated network enabling all signal formats to be transported simultaneously over a pair of single mode fibers. There are dramatic cost savings and efficiencies with this topology.

The first stage of the integrated network is the topology. The core of this new system is based on the flexibility of the network both in the topology and with the number of different wavelengths/channels that can be modulated onto a single pair of fibers while maintaining the full 3Gb/s bandwidth per channel. Instead of the typical point-to-point configuration, the integrated network can be configured in any common network topology: ring, daisy-chain and star.

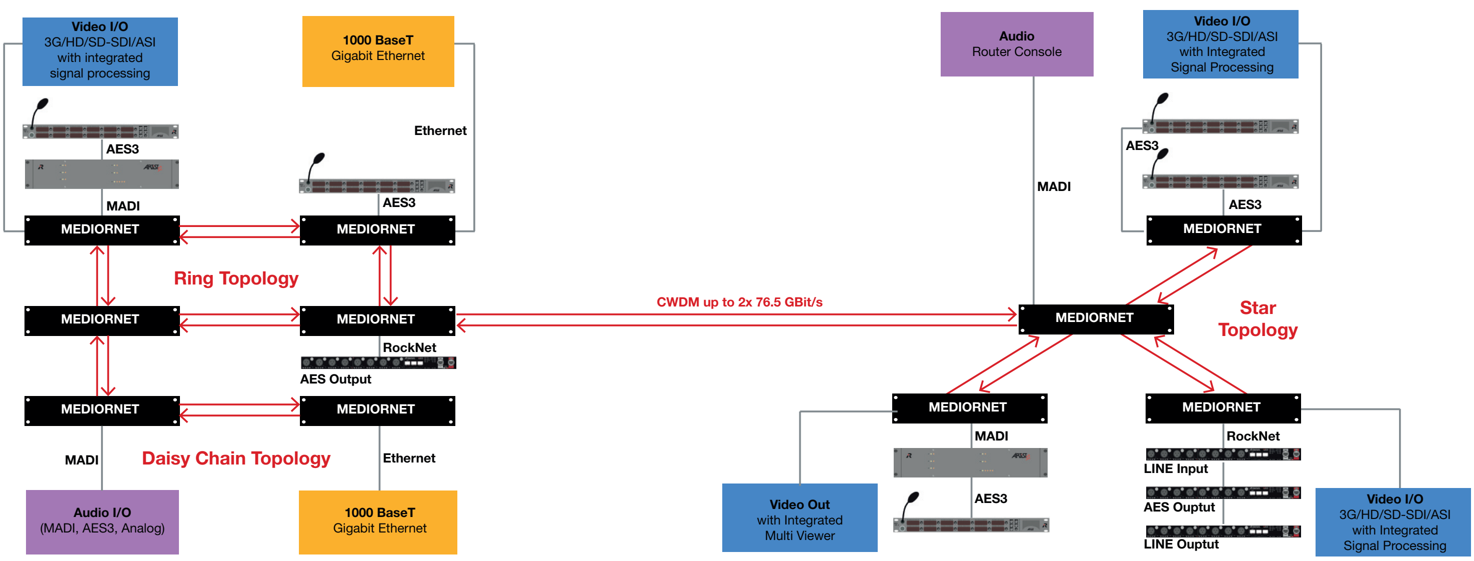

Figure 5. MediorNet topologies include daisy-chain, ring and start.

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MediorNet can be configured in a mixed of topologies which adds a considerable amount of flexibility (see figure 5). The benefit of this level of flexibility is it overcomes constraints due to physical locations. Instead of home runs to each location, ring topology can be used to connect production locations on the same building floor or venue level, then a single pair interconnects the rings in a daisy chain until it connects to the main equipment location in a star topology. This reduces the amount of fiber and consolidates the transport management. This has a positive impact on the cost of a fiber backbone, reducing the amount of fiber required and the other costs associated with dedicated fiber runs.

The signal flow within the network can be easily managed from any endpoint, directing any source to any destination over the fiber backbone.

The integrated network uses a node for each end point. The nodes are modular frames allowing different signal formats to share a common network. At their core each node functions as an optical switch with the ability to access any signal on any channel within the network and route them independently. One of the immediate efficiencies of the integrated network is the ability to maintain the transport on fiber so there is no loss as a result of the E-O-E (electrical to Optical to Electrical) process to route the signals. The network can be managed from any one of the nodes using the integrated dashboard that shows the network configuration and services in use. Each node can be configured for inputs, outputs and duplex.

This minimizes the number of E-O or O-E devices at each location on the network. One of the common issues in transmission is latency and all transmission systems have delay compensation devices at the destination to resolve the system induced latency. One of the components in the integrated network is delay compensation. This protects the integrity of the signal as it is output from the transmission environment back into the production or broadcast environment.

Integrated Signal Processing

This brings us to the second stage of the integrated network, integrated signal processing. Similar to the direction SD/HD-SDI routers have taken, the integrated network includes the functionality of frame synchronizers, conversion, embedding and de-embedding. There are a number of processes before and after a signal is transported within a production environment. Typically the transport is more than just media movement, it is moving media between systems and devices for different production or broadcast operations.

In the integrated network, the nodes can provide these processes and have different profiles at each node. This creates not only efficiencies in handling and processing the media but also cost efficiencies by reducing the number of outboard devices with command and control requirements and automation necessary to manage all these devices. By having these processes as an integrated component to the transport network, it allows an operator to manage the actual signal delivered to the destination in a different format from the signal format on the source side. This supports the production media cycle from acquisition to distribution.

Using a broadcast center as an example, in the studio audio and video are separate, whereas for recording and monitoring the audio Is embedded. Craft editing de-embeds the audio, and then re-embeds it when the product is complete. In the craft processes audio and video signals are monitored separately.

There is production communication throughout the plant with automation sending command and control requests to all systems and devices. These production activities are not in adjacent spaces and not all the equipment is in the core equipment center. The integrated network moves the signals between systems, embedding and de-embedding as needed, possibly moving between SD & HD, while changing HD formats. Using the integrated network, all this can be done on a single pair of fibers within a single modular frame. One of the consistent challenges in all broadcast configurations is maintaining sync or reference. In today's technology architecture many layers of reference are used. These are analog black & burst, tri-Level sync and word clock to name a few. Different devices have different sync pulse requirements. The integrated network can transport these reference signals and maintain sync across the transmission architecture. In addition it will transport timecode and has the ability to display it onscreen.

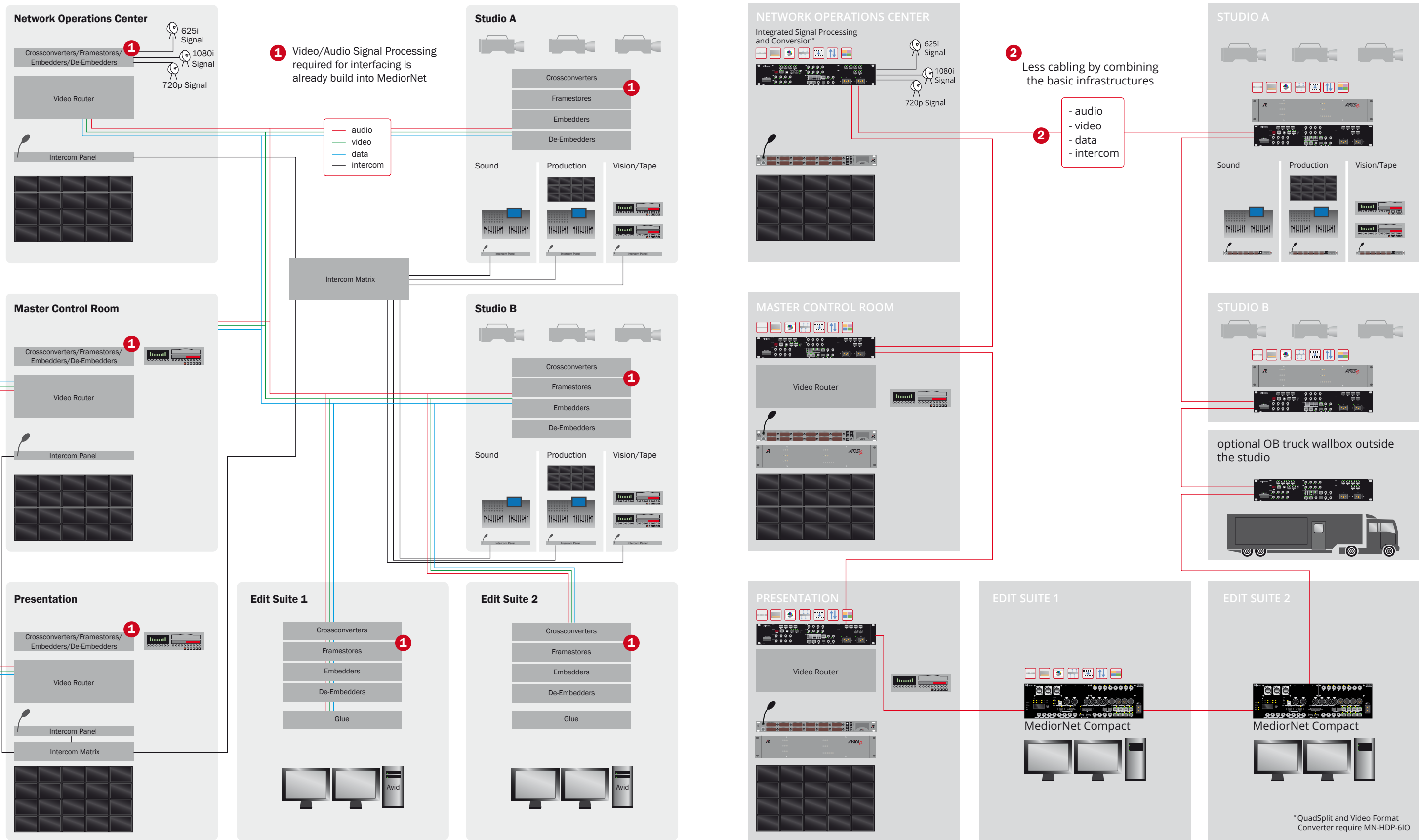

Figure 6. Creating larger production venues with Riedel decentralized systems.

Management and Monitoring

The next stage is management and monitoring. This layer of the integrated network provides the tools necessary to assure that the signal transport and processing performing optimally. These tools include a test signal generator, video and audio monitor ports, even the ability to quad split signals as an efficient way to monitor multiple signals without the need for external multiviewers.

There is an integrated management dashboard interface that controls the signal flow and all of the signal processing (see figure 7).

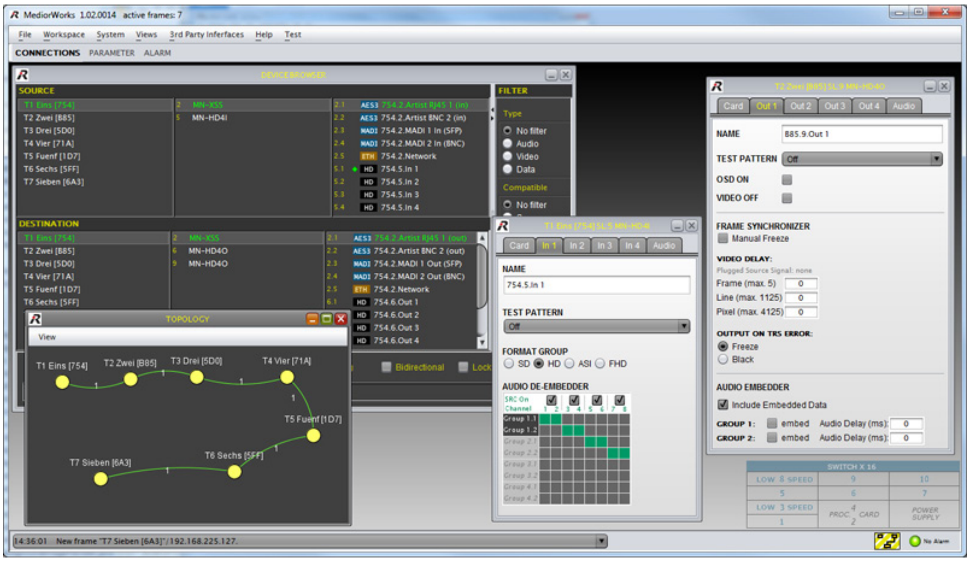

Figure 7. MediorWorks user interface.

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In any multilayered network, monitoring and signal flow management is critical to provide a high quality signal throughout the broadcast environment. The dashboard interface controls the routing of signals over the network and assign processing components to a signal path. The dashboard provides the controls to adjust any of the processing parameters and distribute the profile across the network to any of the connected nodes. The dashboard is accessible anywhere on the network. This assures the integrity of the signal as it travels within the Mediornet Integrated Network architecture.

One of the main considerations when designing a facility or implementing new technology is total cost of ownership. This is where the benefits of an Integrated Network provide the greatest return. The modular architecture provides flexibility with cost efficiency. One is the ability to change modules without changing an entire device. Since the network runs over fewer fibers, it is easier to have spare fiber capacity for protections and expansion. Another benefit is the ability to provide full redundancy within a single frame as well as lower cost for full redundancy. The device footprint is smaller; this makes having a full second frame easier. The smaller footprint needs less space, uses less power and lowers the amount of climate conditioning.

Summary

Moving to an Integrated Network that can carry audio, video, communications, command and control and management over a single pair of fibers in a mixed topology is very efficient. This provides benefit in difficult remote production environments where it reduces the number of cables and fibers and in a fixed broadcast environment where distances between production spaces can create restrictions or limitation that are overcome by fiber and a lot of external processing equipment. The integration of processing and signal management with the transmission system and having the ability to route signals, more than just transport adds flexibility and workflow economies in a cost effective way.