Radio World®
The Newspaper for Radio Managers and Engineers
REPRINTED FROM MAY 21, 2003 WWW.RWONLINE.COM

GUEST COMMENTARY

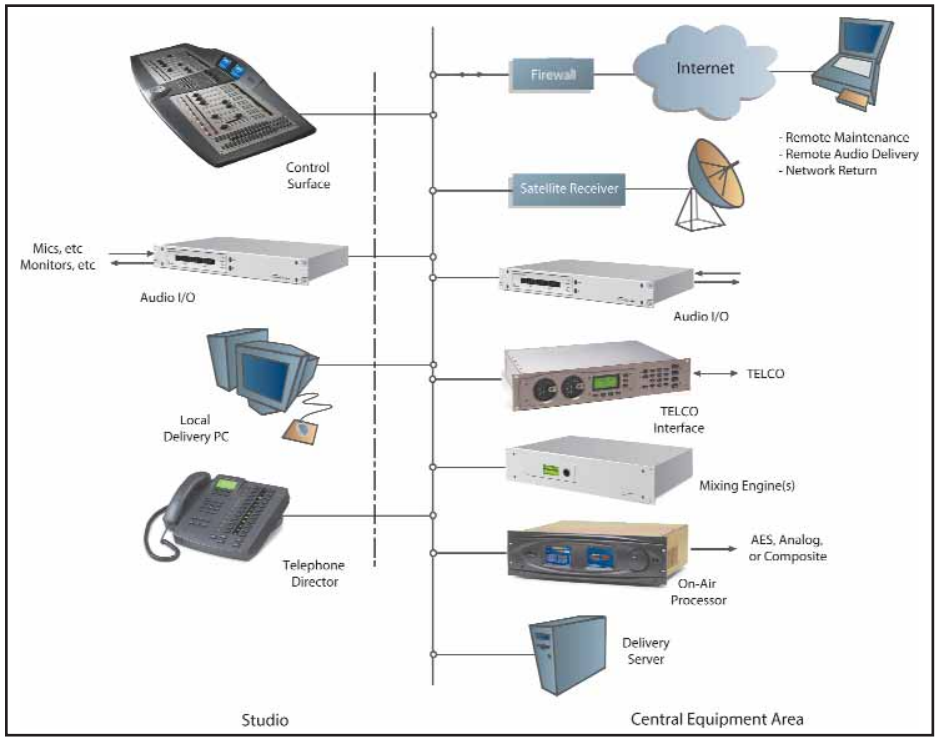
Going Digital? Consider Ethernet

by Steve Church

We've seen a lot of change in broadcast studios these past years. Reel-to-reels have been pushed aside in favor of computer editors. PC delivery systems have replaced CD players and cart machines, which had only a few years earlier replaced turntables. And just now, we are smack in the center of a change to digital for mixing, routing, and processing — a trend certain to accelerate with the arrival of IBOC.

All of this finds us lashing up a mish-mash of analog and digital with XLR, RCA, DB-9, DB-15, 1/4-inch phone, mini phone and RJ-45 connectors. AES-3, MADI, proprietary fiber and copper and network audio file transfer add yet more complication.

We surely need a better way to move audio around studio facilities. With analog soon to be obsolete, we need something digital. AES-3 is the common choice, but this is not a way into the future. It's a 15-year-old scheme that reflects the limitations of its day: one stereo channel, one direction and only a trickle for associated data.



A studio facility linked with Ethernet. All audio, control, phones and data connect over a shared network.

Could this be the way you'll be checking audio wiring?

Audio's future

In contrast, Ethernet is a potentially powerful new medium for studio audio. While Ethernet was not designed with studio interconnection in mind, its capability has recently been improved to make it very attractive for both live audio and data.

The technology side of radio broadcasting is small beans compared to computing and telephony, so we usually borrow and adapt our technologies from those industries. The telephone world looks to be going to Ethernet. Voice over IP is gaining on traditional PBXs, with VoIP gear now taking around 10 percent of new installations.

So let's consider: what would Ethernet do for us as a studio infrastructure?

• Ethernet would be low-cost. Because it leverages R&D and manufacturing scale from the high-volume computer world, cables, plugs, tools, testers and PC network interface cards are standard and off-

the-shelf. With its huge installed base, cost will continue to fall and capability to increase.

• A single Ethernet network could be used for audio, data and telephone.

• A system could scale from very small (two terminals connected to each other) to thousands of channels for the most sophisticated facility.

• A wide variety of wiring infrastructure components could assist installation.

• An Ethernet switch inherently could provide audio routing at no cost additional to the basic infrastructure.

• We would be ready for a radio future that includes synchronized visual and text elements, such as for IBOC.

Today's Ethernet is not your grandfather's Ethernet. Its near universal acceptance means a huge market for innovation. The result has been extensive R&D, and a dramatic increase in performance. Speed has increased from 10 to 100 to 1000 Mbps. The original bussed coaxial cable has given way to star-configured copper and fiber.

But it was the introduction of switching and full-duplex technology in 1998 that has opened the door widest to live media applications. Just as PCs have grown to be perfectly acceptable audio editing and delivery devices, so has Ethernet's performance grown to be able to support professional audio transmission.

Taking advantage of these developments, Telos has developed a studio audio transport system called *Livewire*. Each Livewire link transports as many as 50 48 kHz/24-bit uncompressed audio channels (25 stereo) in both directions. 1000BASE-T or gigabit fiber can support over 250 stereo channels.

The main challenges to making a packet network like Ethernet work successfully for audio are achieving low delay and solid reliability. Talent must be able to listen to themselves in headphones, so delay must be kept below 10-15 ms.

Livewire uses a distributed clock and small packet length to minimize buffers and keep delay low — less than 1 ms per link, allowing a number of them to be cascaded. Then, we use two simple tools to ensure reliable, drop-free audio. First, we always calculate link capacity and never allow overfilling. Since, with Ethernet switching, each terminal owns its entire link, we know to the bit how much capacity is available. Second, we tag audio packets with high priority so that even when audio and data share a single link, audio flows smoothly.

Livewire uses Multicast (one-to-many) transmissions so that an audio source can be received at any number of locations. Audio terminals advertise their streams to the network so that receivers can build a list of available sources. This includes a numeric ID, characteristics and a text name. Receivers can display these lists to users for selection. Terminals can be placed near where the audio is needed and may be distributed throughout the facility according to convenience.

A unit located within a studio can collect audio from microphones and deliver audio to monitors, while another in the central equipment area can enter network feeds, codecs, telco remotes, etc. into the network. Because of the inherent audio routing function provided by the Ethernet switch, any audio source from whatever location may be received everywhere.

A driver software component is used to get audio to and from Windows PCs. It makes the network look like a sound card, so any audio application such as a delivery system or an editor can be directly connected. No sound card is needed.

With a computer network at the heart of the studio, we can take the next step: use a PC as an audio mixing and processing engine.

PCs offer a lot of power at low cost due to being manufactured in very high-volume. If software is carefully designed, a single PC has plenty of DSP power to do everything a typical radio studio needs.

Telos has developed such an engine based on an off-the-shelf Pentium 4 motherboard and a reduced and real-time modified version of the Linux OS. It is able to support a full-featured 20-channel broadcast on-air control surface, including per-channel EQ, mix-minus sends, talkback, etc. with less than 1 ms throughput delay. Control surfaces connect via Ethernet, of course.

A horse that can count to 10 is a remarkable horse — but not a remarkable mathematician. So, which do we have here? Yes, Ethernet will function as a satisfactory audio transport medium, but should it?

Imagine if you were coming fresh to radio broadcasting from the computer world. Wouldn't RJ-45s suggest themselves immediately? Indeed, are there not vendors selling devices to wire-up analog with RJs already? Well, then, what keeps us from moving on? Make the audio digital, make it bi-directional, allow a bunch of channels on one plug and cable and combine with all the necessary control functions? And while we are at it, why not label each audio channel with a numeric and text ID? And have a way to simplify things so that audio, computer data, and phones share the same infrastructure? Be ready for program-associated data? And let's do all of this cheap by riding on computer industry R&D and volume, and get all the routing we need for nearly free. Doesn't this make a lot of sense?

True, you can't hang a pair of cans on an Ethernet Cat-5 to check for audio. But, with Ethernets everywhere, there are a lot of tools from the computer world that can be used to run down problems. There are cable and plug testers, packet sniffers and more. Switches, terminals, engines and surfaces will all have diagnostics accessible over the network.

Nearly two decades ago, I wrote in the introduction to the Telos 10 manual that DSP applied to broadcast telephony would slam-dunk solve hybrid leakage, a problem that had been around from the beginning of phones and broadcast studios. I predicted that the reaction would be forthcoming in the following order, as with almost all innovation: 1) It would be attacked as "ridiculous" and "impossible" — no chance it will work as the inventor claims. 2) Begrudging acceptance that the technology works, but with the arguments shifting to, "There is no need for change, the new approach is too risky, etc." 3) Imitation. This is almost certain to happen with the suggestion that data network technology be applied to studio audio. If not exactly Livewire, there will surely be a similar network in our future.

Ethernet has the potential to make broadcast engineering a little easier, while delivering all the flexibility we need to take us into the future. It seems somehow fitting that that a network technology with the name *Ether*net finally gets applied to radio broadcasting.