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A Digital Transformation

Inside Whirlwind's E SNAKE

(Adapted from an article that originally appeared in **LiveSound! International**, March 2004.)

by Al Keltz, Whirlwind Technical Support

It's been said that soon after the mid 1960s (and mostly unheard) performance by the Beatles at Shea Stadium in New York City, an enterprising sound person moved some of the audio gear into the audience area, bundled a few microphone cables together, and voila! The first "snake" was born.

Pro audio folklore aside, in 1975 Whirlwind became the first commercial manufacturer of snakes with the debut of the Medusa. A lot of change and evolution has happened in the nearly 30 years since, and now, digital has found its way to our world of snakes and interconnects, with the goal of improving functionality and performance.

Several factors led us down the digital path. A digital system employing lightweight CAT-5 or fiber optic cable would provide the opportunity to fly cable overhead, around obstacles or trenched below ground. Digital splits could be accomplished with standard networking hardware, eliminating the need for costly transformers and interconnects.

Audio networks would also allow dynamic routing – more flexible than dedicated point-to-point analog connections. And digital snakes can run much longer distances and are far less prone to interference and ground loops. Until a few years ago, the cost of developing the hardware, software – and especially – a protocol to handle multi-channel audio made developing a digital snake out of the question for any small manufacturer in a niche market like live sound. However, this changed with the introduction of CobraNet, a real-time, multi-channel digital audio networking protocol.

With this impediment now out of the way, Whirlwind signed on as a CobraNet licensee in the late 1990s and then went about the business of designing its first digital audio snake system.

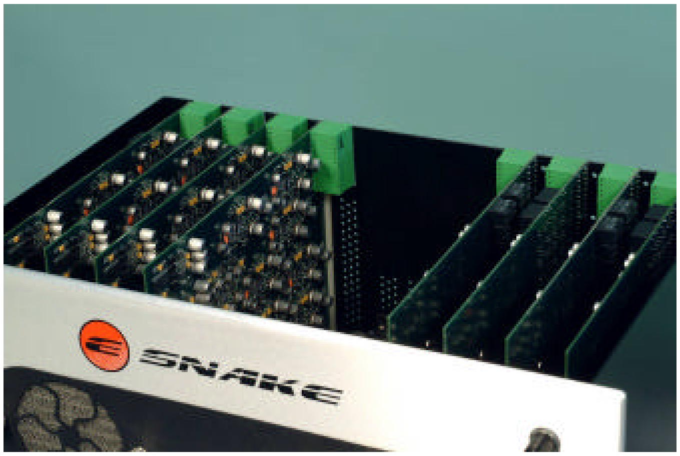
COMMON TRANSPORT STANDARD

The CobraNet protocol involves transporting uncompressed multi-channel digital audio and control over standard Ethernet hardware, and currently, there are some 40-plus manufacturers signed up as licensees of this technology. Because licensees conform to a common standard for transporting digital audio data, the various devices developed by these manufacturers can communicate with one another, similar to an Ethernet computer data network. CobraNet facilitates the transport of up to 64 channels in each direction between two points on a switched 100Mbs full duplex network. (However, actual network topology can allow for many more channels within the network and using gigabit hardware dramatically increases channel count.)

Addressing of CobraNet data allows channels to be routed to specific destinations anywhere on the network or across LANs (local area networks) – it's not restricted to a closed point-to-point structure. The routing provided in network switches can allow CobraNet to be transported on existing networks along with regular Ethernet data. And, quite notably, this protocol allows employment of standard off-the-shelf Ethernet hardware that is readily available, and at a relatively low cost.

CobraNet has become the de facto standard and is used extensively in installs, as well as some live audio applications such as drive snakes. With all of these advantages and market acceptance, we decided to use CobraNet as the basis for our digital snake, which we now unveil as the E SNAKE.

The heart of CobraNet is the CM-1 module, which has the capability of handling up to 32 audio channels in each direction between two points. For this reason, it was decided to configure E SNAKE as a hardware frame and motherboard with a CM-1 module mounted on the motherboard.



This motherboard contains eight slots for accepting up to four input and four output "daughter boards". Each daughter board can handle eight channels of audio, giving each frame the capability of 32 inputs and 32 outputs when fully loaded.

Boards currently available include Mic/Line Input (MLI) and Mic/Line Output (MLO). Future releases are planned for Line Only Input, Transformered Mic Input, AES/EBU I/O and Voltage Control I/O versions.

MANAGE VARIOUS CONTROLS

A pair of E SNAKE Frames (ESF), connected to each other through an Ethernet switch, along with the presence of a personal computer (PC) on the network, replaces the traditional analog snake. The PC is necessary to run E SNAKE Control software that allows the operator to manage the various controls and operating parameters of the system.

If splits are desired, they may be easily accomplished by using additional ports on the Ethernet switch. However, most short run splits, such as providing for a monitor mix, will probably continue to be accomplished by traditional analog means.

The original concept was to design a point-to-point replacement for the analog snake. However, it quickly became obvious that any number of individual ESFs (again, E SNAKE Frames) could be used in any CobraNet system as nodes capable of being a high performance access point for multiple channels of inputs and outputs, mic or line level. (More about this a bit later.)

In order to optimize performance, it was necessary to incorporate mic preamplifiers and remote control into the MLI (input) cards. For this digital snake system to be accepted by professionals using high-end mixing consoles, the mic preamps would have to be of the highest quality possible.

Therefore, it was decided that they would be based around a new chip from Analog Devices that is designed specifically for high-end mic preamp circuits. The same considerations applied for the A/D (analog to digital) and D/A (digital to analog) converters - expensive but necessary for optimum performance.

The MLO (output) cards receive CobraNet digital data and convert it back to analog audio at the same level that was input to the MLI – mic level in means mic level out. This way, the operator continues to use the mic preamps in the analog console and receives the same performance, sonic characteristics and “feel” as if using an analog snake.

However, it’s necessary to provide remote gain adjustment in the MLI to optimize input to the A/D converter. At the same time, it’s also necessary to prevent those adjustments from upsetting the gain structure at the analog console. This is accomplished by utilizing a scheme we call “Gain Tracking.”

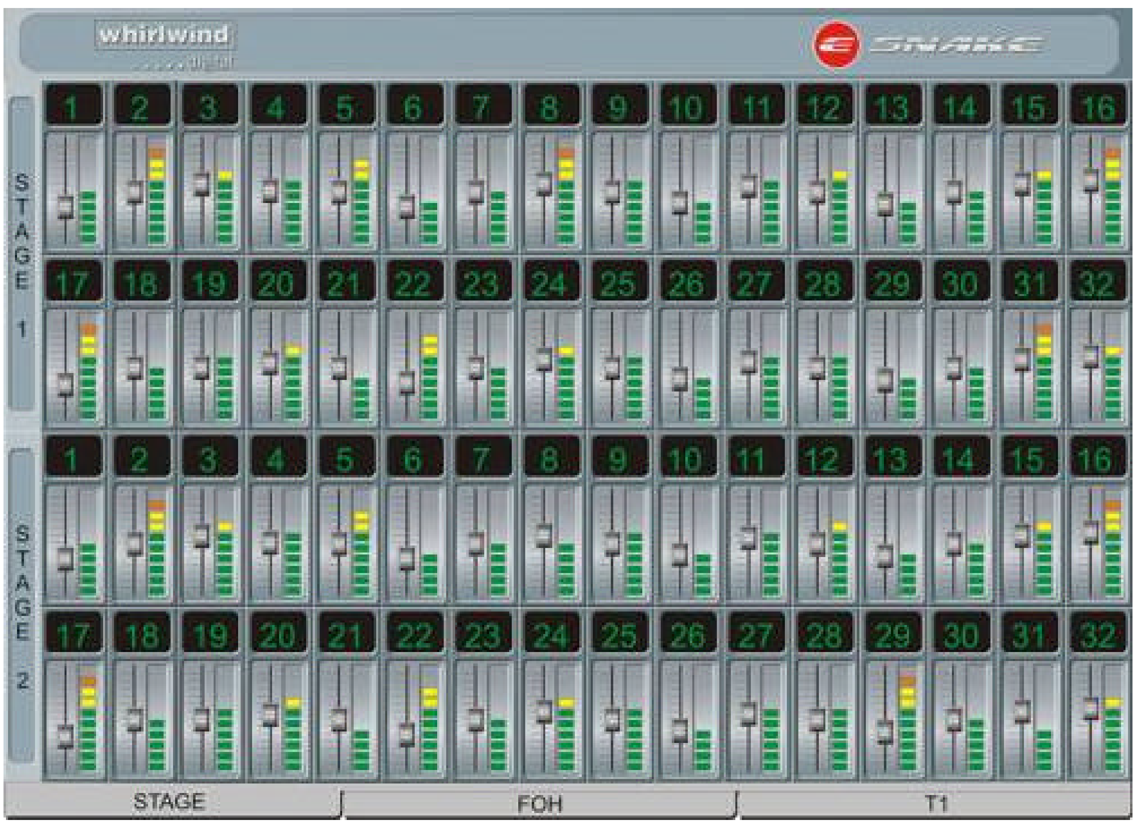
A VIRTUAL WIRE

The E SNAKE Control application provides A/D converter input gain control by highlighting a channel (clicking on it) and moving its on-screen fader with the mouse. However, if adjustments were made without compensation in the corresponding output channel on the MLO side, the analog audio level presented to the console would change too. This would require an additional step of re-adjusting the console's analog input gain.

The E SNAKE "Gain Tracking" function monitors adjustments to the MLI and automatically compensates at the MLO by changing the output level by the same amount – but in the opposite direction. The result is that the analog audio level remains constant making E SNAKE a "virtual wire."

It's important to note that this only applies when connecting ESFs to each other. Other devices on the network that are being sent CobraNet audio by ESFs will experience a change in level when adjustments are made to input gain.

Utilizing a CobraNet network allows for a system that could contain multiple ESFs. We realized that the interface needed to be designed to give the operator an overview of the entire system and also provide full control over each input channel. This led to development of "Channel Arrays" to display groups of inputs and "Channel Page Tabs" as a way of organizing the inputs when controlling multiple ESFs.



In this example, the 64 visible channels represent the inputs for a pair of ESFs located on stage that are providing 32 inputs each to the system. The user has labeled this tab "Stage" and the ESFs are divided into upper and lower halves labeled "Stage 1" and "Stage 2."

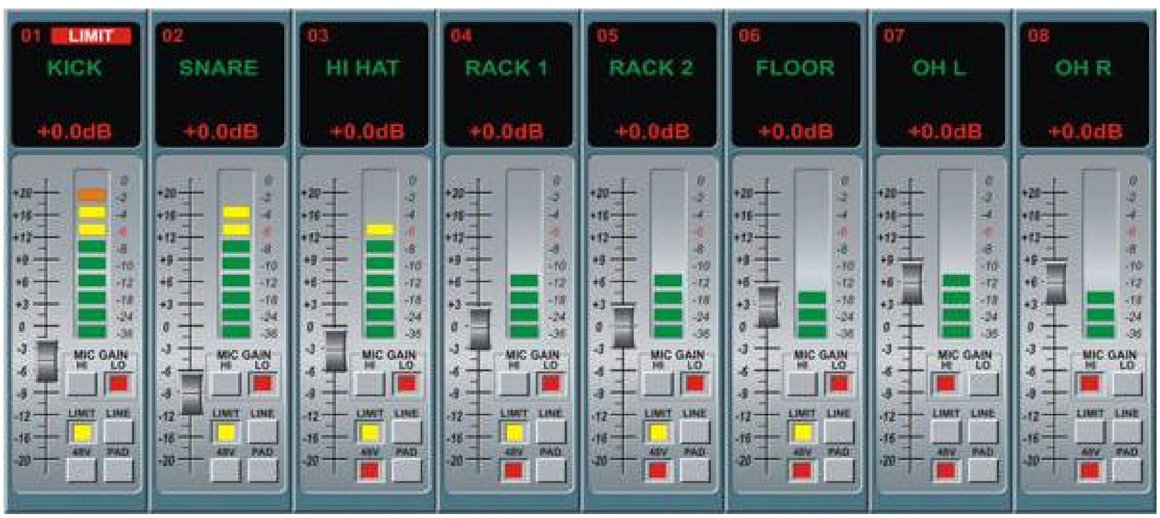
Any one or two ESFs on the network can be user designated as the ones visible on a tab and if either ESF were short loaded, the display would adjust accordingly to show a reduced number of input channels. Output channels are not visible in the software since all controls only pertain to channel inputs.

This view allows the user to monitor levels and adjust each gain setting. The active channel becomes highlighted when selected with a mouse click.

If necessary, additional tabs can be user defined to represent other combinations of ESFs and any ESF can be represented on more than one tab. Also in Figure 1, there are additional tabs labeled “FOH” and “T1.”

“FOH” may have an input card(s) to provide for returns to the stage, “T1” might be a broadcast truck where its ESF contains inputs for tie lines. Clicking the mouse on either tab switches views and brings those channels to the front.

AN ENLARGED VIEW
If the operator requires a closer look and more control, it’s a matter of double-clicking on a channel and a larger view of eight channels pops up as a “Channel Detail Page.” (Figure 2) This enlarged view gives the operator access to all functions: mic/line switching, 48-volt phantom power, pad, limiter, gain control and metering.



These functions are currently available on the MLI board; other input boards such as Line Only Input or AES/EBU will have their own set of appropriate controls. In addition, a pop-up channel text editor is also available for customizing text labels and colors for each channel. (Figure 3)

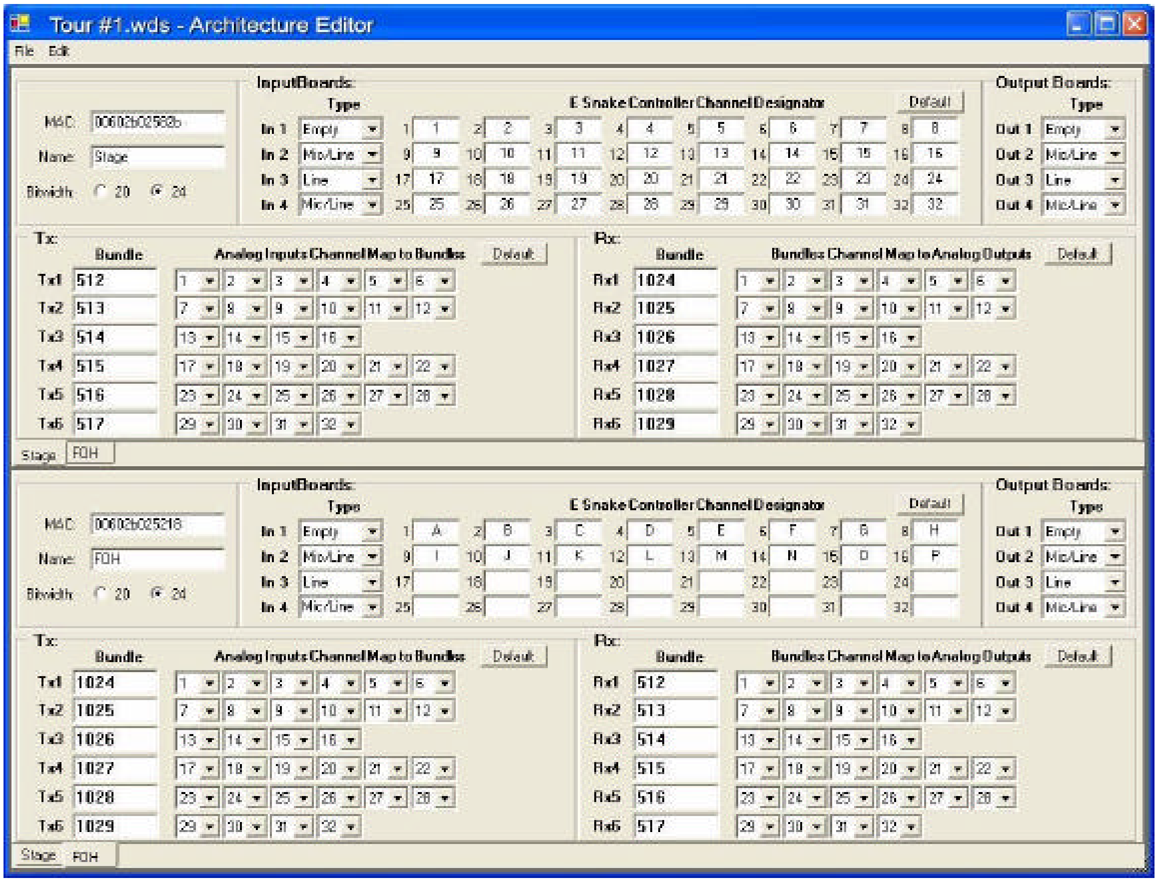
The E SNAKE system utilizes a set of parameters called “System Architecture” to define the configuration in any given system. This architecture is stored on the PC in a file and allows the E SNAKE Control software to supervise the system and notify the operator if any I/O boards or entire ESFs are missing.

Also, if an ESF should appear on the network that isn't part of the specified architecture, E SNAKE Control will take the appropriate steps to avoid conflicts and notify the operator. When E SNAKE Control software is first started, it opens a preset History List and File Browser. (Also Figure 3) This prompts the user to select a preset architecture file.

E SNAKE Control then loads and verifies all of the system architecture: hardware configuration, MAC addresses, CobraNet bundle assignments and channel array definitions. Individual channel settings such as initial gain, colors, text, switch settings, etc. are also loaded.

Once the system is setup, adjusted and running, the operator can choose to "Save" the current settings and overwrite the loaded file or choose "Save As" and create a new architecture file. This is useful for loading repeating setups where input data can be saved and recalled as presets.

An Architecture Editor application is also included with the E SNAKE Control software package that allows the user to customize the system architecture.



The editor allows the user to architect systems of multiple ESFs, specify what types of I/O cards are loaded into each frame and setup CobraNet bundle assignments and channel mapping. This can be invaluable if a provider has multiple ESFs and I/O card types in stock and needs to configure systems with varying capabilities, depending on the application.

And it can be especially useful when certain mic channels are not meant for the front-of-house (FOH) system but need to be routed to a recording truck. Or, if an ESF is to be introduced into an existing CobraNet installation, bundle assignments in the ESF can be customized to produce the expected results.

Figures 5 - 8 provide examples of how various systems can be configured by the user with the architecture editor.

REDUNDANT BACKUP

E SNAKE Control automatically recognizes when an adjustment has been made to any of the system's settings. When changes are detected, all settings are saved to a temporary file on the PC every 60 seconds. This backup also alternates between two separate files.

This insures that one good backup file will always be present, even if the PC experiences a crash or loses network communication during the writing of the other backup. Should this occur, the ESFs will continue to operate indefinitely with the settings that were in effect at the time of the interruption and the show goes on. As soon as the PC comes back online, E SNAKE Control loads the latest backed up settings and the PC and ESFs are automatically synchronized.

A redundant backup feature allows the operator to specify that an additional backup copy automatically be created to a separate storage device such as a 3.5-inch floppy, CD-R, zip drive, network share, etc. In the event of a total PC failure, the file can be moved over to a backup PC.

Many issues arose during the almost two years of actual design of the E SNAKE that are beyond the scope of this article. Let's just say that if we really knew what we were getting into, we might have decided to go into another business!

For example, although the CobraNet CM-1 board was designed to be controllable over the network, we had to work extensively to further design and implement proprietary firmware and software to accomplish all of the control necessary for a snake.

Also, existing CobraNet systems are running primarily at 20-bit samples with a 48kHz sample rate. We needed to be compatible with 20-bit systems but also wanted to step up to 24-bit operation for more critical applications. Therefore, E SNAKE had to be designed to operate in either mode.

Other details, even seemingly minor ones like "which knobs go on the drawer" and "what's displayed on the LCD" (and even "simply" deciding on a name!) make it tough to ever say, "it's finished, put it to bed." Suffice to say that it all made for lively discussions at our weekly meetings.

At the same time, (in case we didn't think of everything), the firmware and PC Control software will be upgradeable through the Whirlwind website (www.whirlwindusa.com) allowing users to conveniently access upgrades as new features become available. We're starting a "wish list" and are definitely open to your feedback!¦

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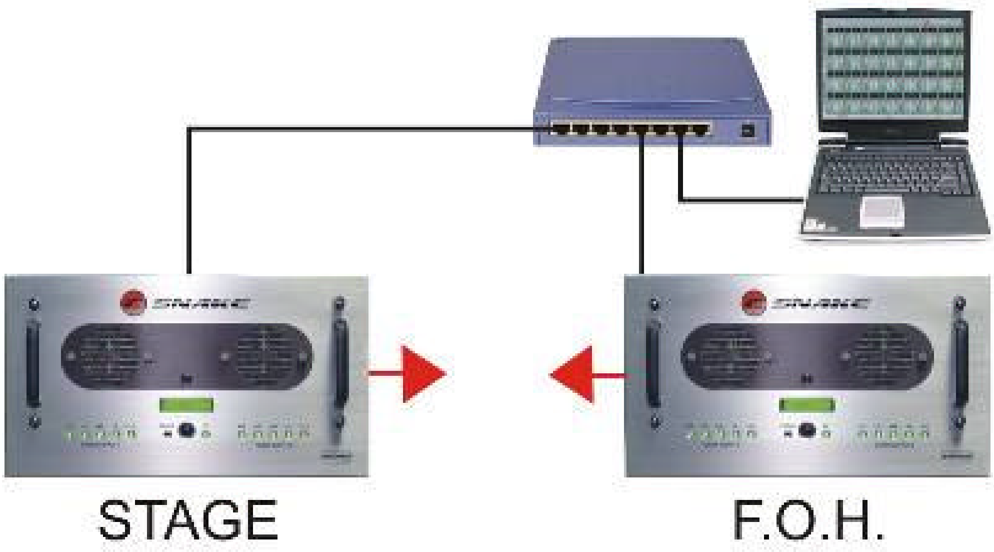
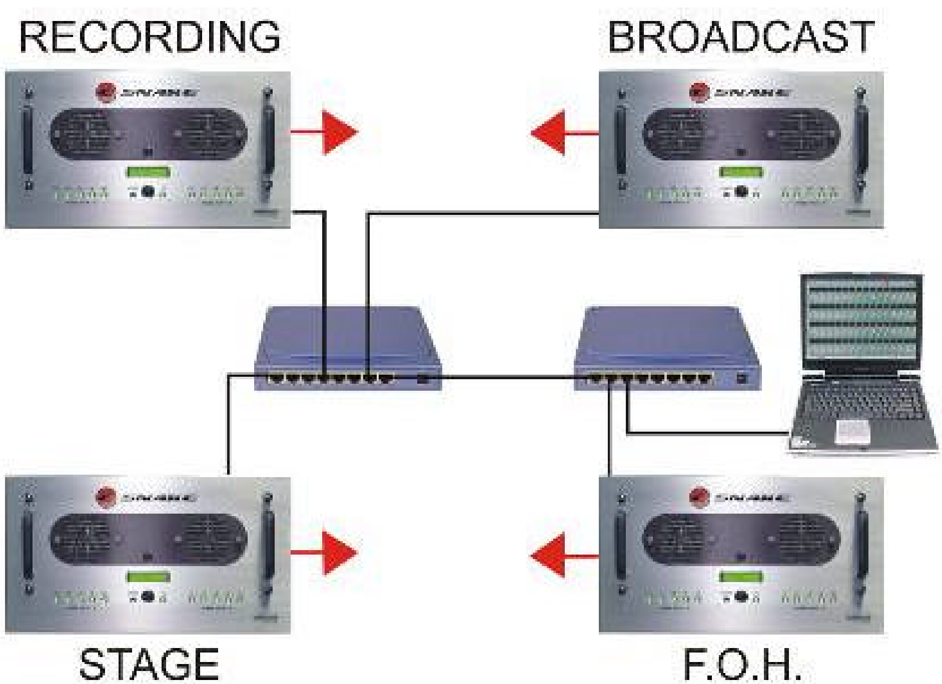
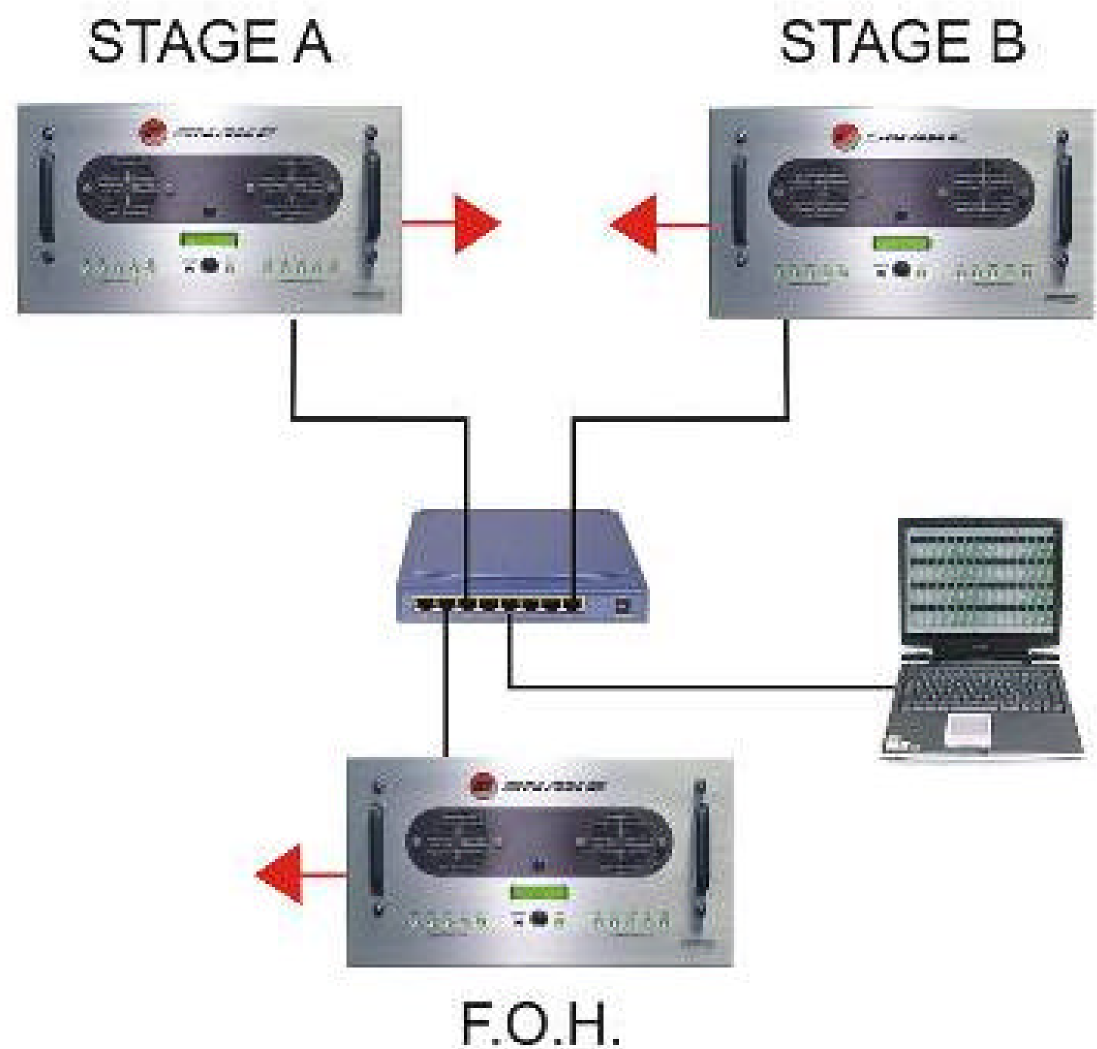


A basic 2 ESF system with hardwired analog split at stage (monitors) and analog out at FOH (to console), represented by the red arrows.



4 ESFs configured for additional broadcast and recording feeds with hardwired splits or analog outputs (red arrows).

Single ESF used as CobraNet multi-channel I/O access point.



Festival setup with 2 stage ESFs alternating feeds to a single FOH unit. Presets may be stored to switch instantly between the two stage boxes at changeover. Stage uses analog splits for monitors, FOH has analog output to console (red arrows).