Networked Digital Audio

Wheatstone Corporation

WHAT IS NETWORKED AUDIO AND HOW DOES IT WORK?

A networked audio system is a collection of components designed to accept audio input signals, manipulate them with processes such as equalization and mixing, and make them available throughout the system. It differs from traditional audio consoles and routers in that a mechanism is provided to transport audio in digital format throughout the system via some sort of high speed interconnects.

This ability to transport audio around without a complex and expensive wiring infrastructure of patch bays, tie lines, punchblocks, distribution amplifiers, and match boxes makes a networked system much easier to design, maintain, expand, and modify.

In a typical networked system, some sort of localized input-output satellite rack or node is located wherever there are audio source or destination devices. The inputs and/or outputs of these audio devices are wired to this local rack with generally short, simple, and standardized cables. The local racks in turn connect together via the high speed interconnects which are usually Cat-5 or -6 cables that may already exist in the facility.

In the Wheatstone system, each one of these Cat-5 cables can carry 128 audio signals and simultaneous logic and control information. One of these cables is usually ample for all of the audio and logic needed in a control room or studio. A system installation becomes mainly mechanical; i.e., mount the equipment into the racks, plug the audio device wiring (which can frequently come with the system) in, and plug in the network cables connecting the rooms together.

In the Wheatstone system, once installed, every audio device, every mix, and every logic function is instantly available throughout the whole system. The long hours of the past spent crawling behind and under consoles to wire up input connectors and logic ports are not needed. And should a cross connection change be required it can be executed in seconds with a mouse click.

A further benefit of a networked system such as the Wheatstone Bridge is that all system configuration and control settings can be managed from one central point via password-protected software. All connections, settings and functions are always available for inspection, activation, or modification. Mapping connections, changing signal names, setting up a logic function, adding more channels, changing a format to surround sound, implementing an intercom, etc., all can be managed in the Wheatstone system on line and while the system is ON AIR. Or if preferred, changes can be made off line (say while on the flight over) and then later uploaded to the system in seconds.

WHAT TYPES OF NETWORKED SYSTEMS ARE THERE?

ROUTER BASED:

A router based system is built using a centralized digital audio router with secondary or satellite router frames in studios and control rooms. Some of these systems have integrated mixing with **control surfaces** [Fig.1] while others use separate consoles, which are then wired to router frames. In either case, once the audio has been brought in to the router, it is distributed to other frames via the high speed interconnects. Because the router handles all of the networked audio a major system constraint is the overall size or capability of the router and the size and capability of the satellite frames and their associated network links. The system capability must be large enough to handle all current and future audio requirements if it is to benefit from the advantages of a networked system. It can be dif ficult ascertaining whether the capabilities of the router are sufficient because in some systems router channels are needed unexpectedly, say to get metering information back to control surfaces, or to bring mixes back into the system, etc. Additionally, some router based systems handle logic functions directly within the system while others require an additional network and maybe even PCs to deal with logic. In larger systems, careful planning and investigation should be made to assure that the router is sufficient for the scope of the project.

For router based systems that use **traditional consoles** [Fig.2] some sort of wiring infrastructure such as punchblocks is generally needed in each location due to the large number of fixed, inflexible connections required to the consoles. Depending on the type of router, a large punchblock system may be required in the TOC as well to provide for cross connects and distribution amplifiers that may be needed to connect the output mixes.

IP BASED:

An **IP based system** [Fig.3] is built using conversion boxes that take analog or digital signals in (or out) and convert them to (or from) Ethernet packets which are then distributed LAN fashion using one or more intelligent Ethernet switches that have been set up to manage the audio distribution. Although this sounds simple on the surface it is a complex process and requires attention to detail and careful planning. The Ethernet protocol was originally designed as a mechanism to distribute short bursts of data non-synchronously in a non-deterministic fashion. The protocol has an elaborate mechanism of collision correction and retries built into it, because the designers knew some packets would not get through. Because audio data is very different in nature (a continuous stream of synchronized, time critical data) special constraints must be placed on the LAN and Ethernet switch to control the “scattered packets” tendency of basic Ethernet. Because these constraints can be inadvertently upset on a general-purpose network, it’s best to run such a system on its own dedicated LAN to avoid problems.

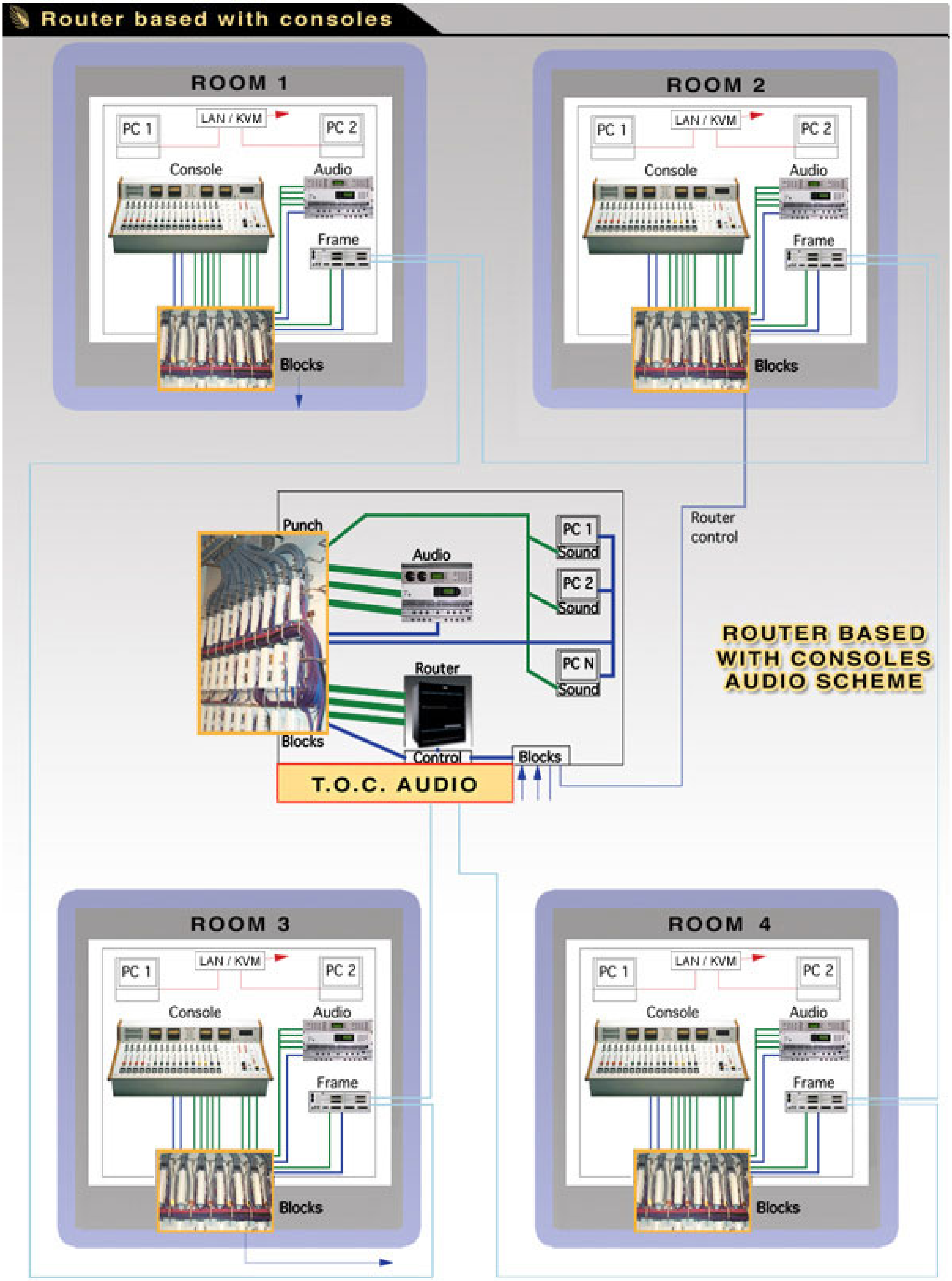
Router based with consoles
ROOM 1
PC 1
LAN / KVM
PC 2
Console
Audio
Frame
Blocks
ROOM 2
PC 1
LAN / KVM
PC 2
Console
Audio
Frame
Blocks
Punch
Audio
PC 1 Sound
PC 2 Sound
PC N Sound
Router
Blocks
Control
Blocks
T.O.C. AUDIO
Router control
ROUTER BASED WITH CONSOLES AUDIO SCHEME
ROOM 3
PC 1
LAN / KVM
PC 2
Console
Audio
Frame
Blocks
ROOM 4
PC 1
LAN / KVM
PC 2
Console
Audio
Frame
Blocks

FIGURE 1

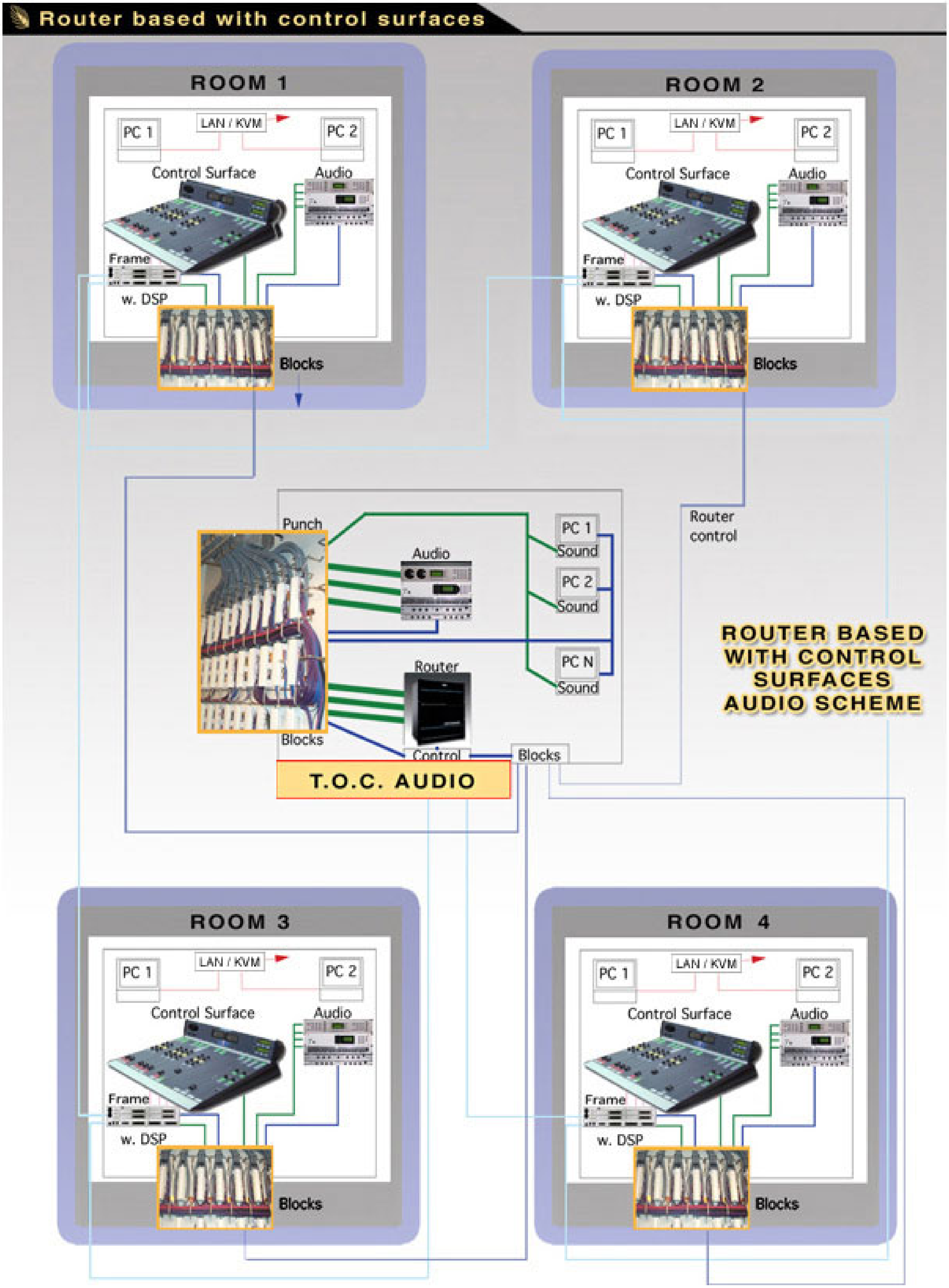
Router based with control surfaces
ROOM 1
PC 1
LAN / KVM
PC 2
Control Surface
Audio
Frame
w. DSP
Blocks
ROOM 2
PC 1
LAN / KVM
PC 2
Control Surface
Audio
Frame
w. DSP
Blocks
Punch
Audio
PC 1
Sound
PC 2
Sound
PC N
Sound
Router
Blocks
Control
Blocks
T.O.C. AUDIO
Router
control
ROUTER BASED
WITH CONTROL
SURFACES
AUDIO SCHEME
ROOM 3
PC 1
LAN / KVM
PC 2
Control Surface
Audio
Frame
w. DSP
Blocks
ROOM 4
PC 1
LAN / KVM
PC 2
Control Surface
Audio
Frame
w. DSP
Blocks

FIGURE 2

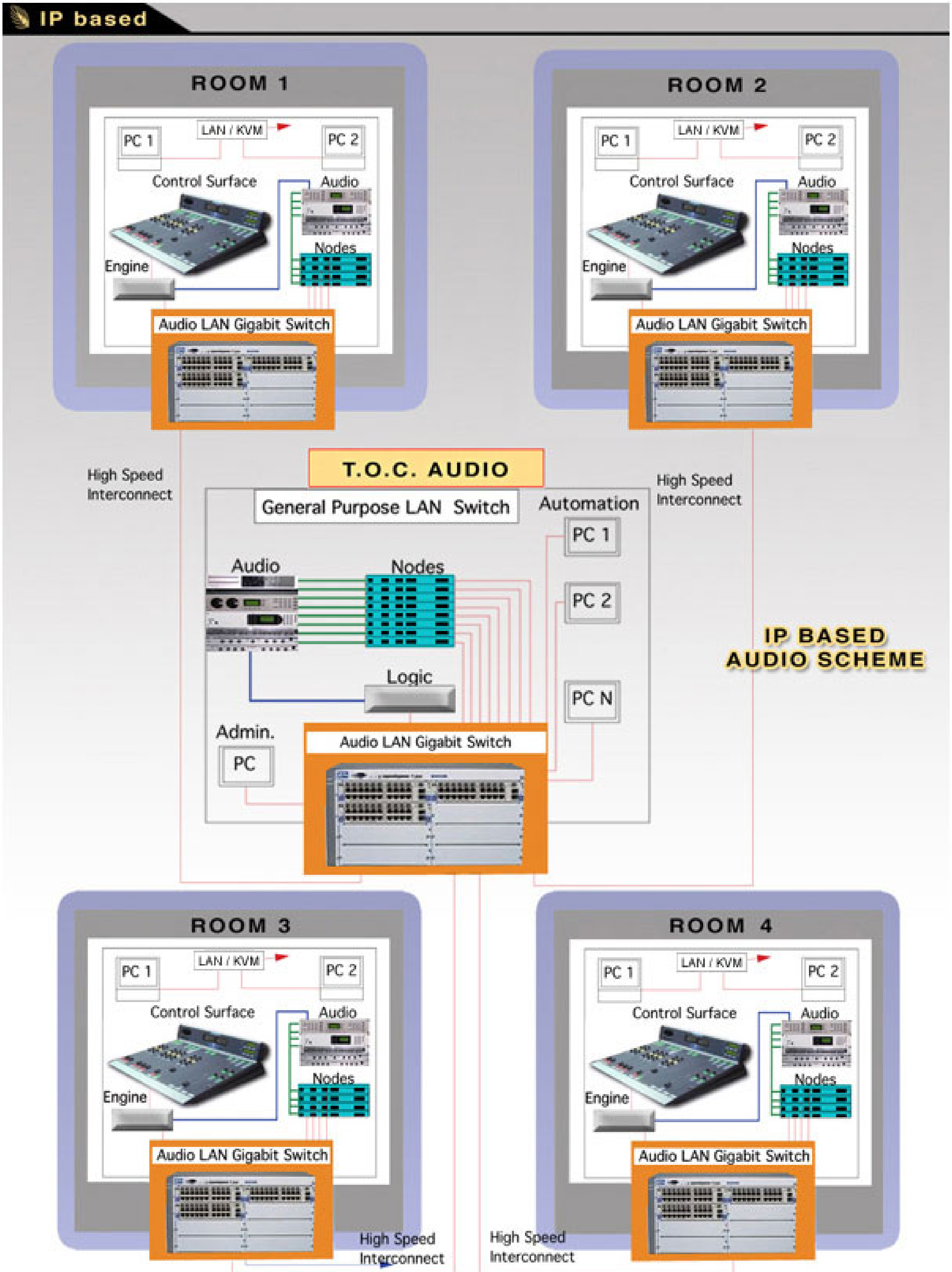
IP based
ROOM 1
PC 1
LAN / KVM
PC 2
Control Surface
Audio
Nodes
Engine
Audio LAN Gigabit Switch
ROOM 2
PC 1
LAN / KVM
PC 2
Control Surface
Audio
Nodes
Engine
Audio LAN Gigabit Switch
High Speed
Interconnect
T.O.C. AUDIO
General Purpose LAN Switch
Automation
PC 1
PC 2
PC N
High Speed
Interconnect
Audio
Nodes
Logic
Admin.
PC
Audio LAN Gigabit Switch
IP BASED
AUDIO SCHEME
ROOM 3
PC 1
LAN / KVM
PC 2
Control Surface
Audio
Nodes
Engine
Audio LAN Gigabit Switch
ROOM 4
PC 1
LAN / KVM
PC 2
Control Surface
Audio
Nodes
Engine
Audio LAN Gigabit Switch
High Speed
Interconnect
High Speed
Interconnect

FIGURE 3

These systems purport to save money by eliminating the need for a dedicated central router frame and by using an off-the-shelf Ethernet switch; in reality a central frame or equivalent nodes are needed anyway to pull audio in and out of the system in the TOC. The costs associated with the Ethernet switches and extra cabling due to the inherent lower audio density plus the expense of the control software and PC total up to an amount that can exceed the costs of a controller card in a router based system. A typical IP system will actually have a large number of low density CAT-5 cables, I/O dongles, and power adapters to get it all wired in. On the other hand, for applications where the audio is either developed on or distributed to a PC, IP based systems allow you to connect directly with the LAN and avoid using audio I/O ports in the system and sound cards in the PCs, which can be a potential cost savings (depending on software driver costs, additional switch ports consumed, etc.). Another sometimes unexpected cost is the time required to set up, configure and administrate these network devices; in a good sized system this can become quite significant.

Although it might seem that IP based systems are immune from sizing constraints, that is not the case. Because of the extra addressing and timing baggage the packets require to "herd the cats", IP based systems typically run their high speed interconnects with lower density (typically one fourth as many channels), resulting in many more cables being required. The bandwidth of the central Ethernet switch must also be sufficient for the number of streams required.

COMPOSITE:

The Wheatstone Bridge system is a **composite system** [Fig.4]**.** The system has a scalable audio structure that distributes and manipulates audio data synchronously and coherently for low latency and true audio fidelity. The system size constraints are very generous; the hardware can support over 24,000 simultaneous audio channels within the card racks of which over 3000 channels can be distributed across the network at once. The network interconnects use standard Cat-5 cable (or fiber), and because the audio distribution is deterministic the signal density is very high, with 128 channels of audio, plus logic and control signals, available on every cable. Because this audio core is not Ethernet based and uses embedded control, it is immune from accidental or even deliberate network disruptions.

For those cases such as Automation, where audio data plays from storage on a PC, the Bridge system can have Ethernet portals that allow direct connections to a LAN. Using the Wheatstone AoIP driver, any Windows based PC or device can send and receive multiple audio channels (up to 8 stereo each way) via its NIC card. These ET portals convert IP based audio into the proprietary protocol of the Wheatstone audio structure. They are scalable, and systems can be built with multiple portals, each supporting 64 audio streams.

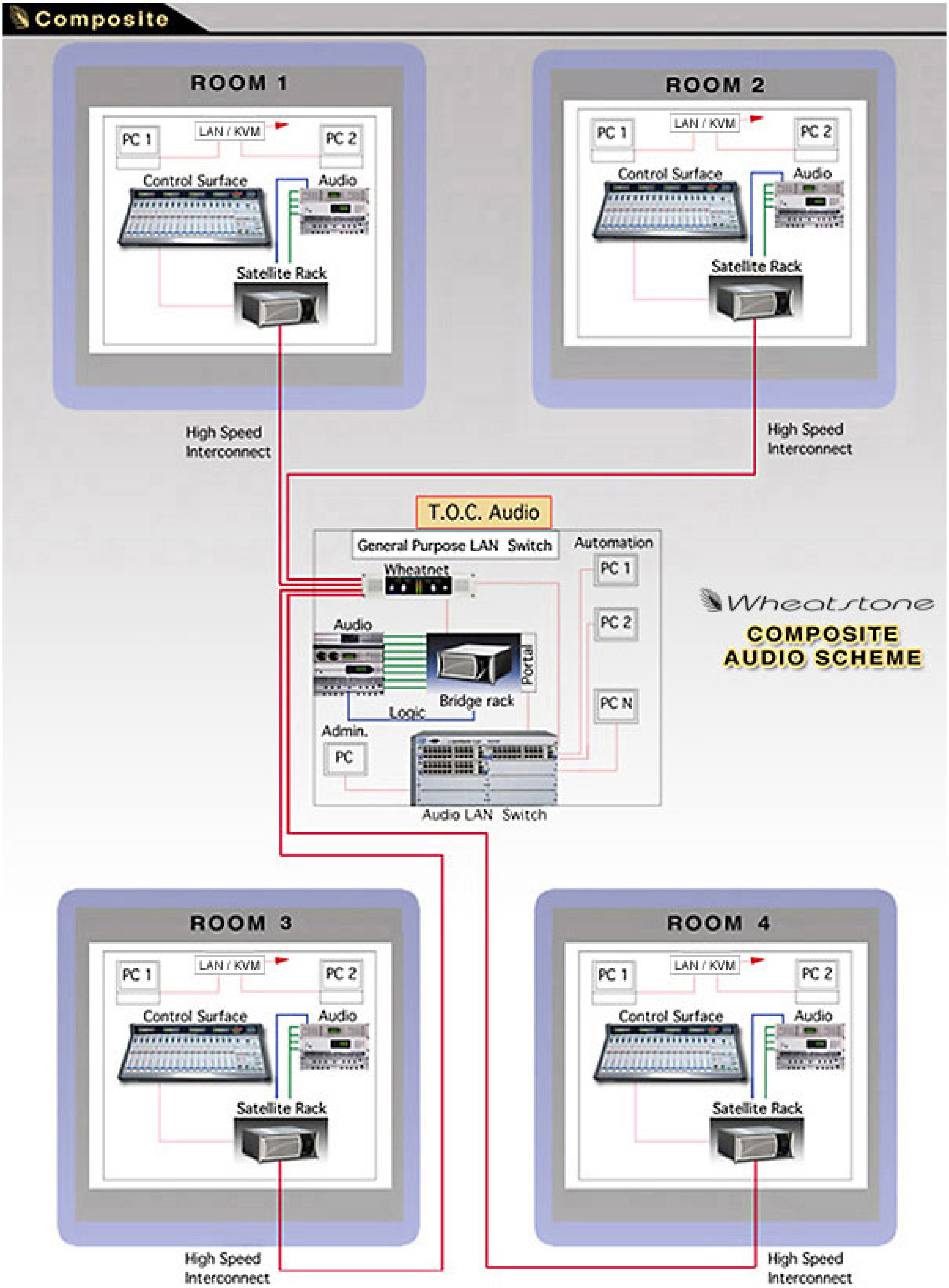
Composite
ROOM 1
PC 1
LAN / KVM
PC 2
Control Surface
Audio
Satellite Rack
ROOM 2
PC 1
LAN / KVM
PC 2
Control Surface
Audio
Satellite Rack
High Speed Interconnect
High Speed Interconnect
T.O.C. Audio
General Purpose LAN Switch
Automation
Wheatnet
PC 1
PC 2
PC N
Audio
Portal
Bridge rack
Logic
Admin.
PC
Audio LAN Switch
Wheatstone
COMPOSITE AUDIO SCHEME
ROOM 3
PC 1
LAN / KVM
PC 2
Control Surface
Audio
Satellite Rack
ROOM 4
PC 1
LAN / KVM
PC 2
Control Surface
Audio
Satellite Rack
High Speed Interconnect
High Speed Interconnect

FIGURE 4

The Bridge system also integrates logic and control. Physical logic I/O cards can be installed in any rack, making it convenient to do control wiring at the location of the controlled device (no more multiwire trunks pulled between rooms!) and logic functionality is fully associated with the audio signals. If an audio device is routed to a different control surface channel or even a different surface, the logic functionality can route simultaneously with no user interaction. Finally, Wheatstone has created and made available a sophisticated Ethernet control protocol for the Bridge system. Many of the Automation providers now have direct control integration between the Bridge and their own systems via Ethernet; no hardwired logic connections are required.

Because the Wheatstone Bridge has the flexibility to internally route and distribute all audio and logic, including all mixes, no expensive wiring infrastructure or punchblock system is required. Each device can be wired directly to the system at its physical location with simple standardized cables. Wheatstone provides a number of I/O connector options to facilitate this. No expensive dongles or distribution amplifiers are needed, and all cross connects can be managed within the system via the provided GUI based administrative software. Lastly, every system comes tested and preconfigured by the factory to the specifics of the project, so it is truly “plug and play”. A large multi-station system will run right out of the box with no user involvement at all other than to unpack the components and plug in the power and CAT-5 cables.

WHEATSTONE IN MORE DETAIL...

AUDIO INFRASTRUCTURE

Wheatstone Bridge audio systems are configured uniquely to match customer requirements. Systems are built up with combinations of Wheatnet central switch, 22 slot Bridge racks, 11 slot Satellite racks, Generation series control surfaces, various input, output, logic, DSP and network cards, control panels, and software packages. WheatstoneBridge systems use TDM technology to structure and control audio transmission. Each rack has 32 signal conduits, or busses, common to all card slots. Each one of these busses is clocked at 100Mhz, fast enough to contain 16 channels of 24 bit audio data within one audio sample period. These busses create an audio infrastructure of 16 x 32 = 512 available channels of audio per rack. Each audio channel brought into the rack can be mapped to any one of these 512 available signal positions. Wheatstone uses embedded control to coordinate the mapping of audio onto the 512 signal slots. At system start up the system CPU assigns each audio input to a unique position in the 512 signal structure. It does this by assigning each input card (which has 16 channels of audio) to one of the 32 busses. Once this assignment has been made, the input cards continue to synchronously place their 16 channels of audio data in order on their assigned bus for as long as power is applied to the rack.

Likewise on the output side, anytime an input-to-output connection is made, the affected output channel is told which of the 16 channels on a particular bus to capture and send on to the output. Similarly it will continue to do this for as long as power is applied to the rack unless instructed otherwise, i.e., told to “make a different connection”.

The entire process of mapping the audio structure and connecting inputs to outputs is called “configuring the cards” and takes place for a couple of seconds while the system is powering up. The system CPU retains a complete system description or “configuration” in its solid state flash memory, and conveys this configuration to all system cards and components at start up time. Anytime the system is changed in any way, the system CPU updates its configuration information in flash memory, so anytime the system is powered up it will be configured with the latest information.

This system of embedded control makes the Wheatstone system extremely robust because once audio connections are established no intervention by the system CPU is needed to maintain the flow of audio. In fact, the CPU can be frozen, switched, or restarted—all without interfering with the flow of audio.

In order to utilize this TDM audio infrastructure, all input signals must first be digitized (if analog) and then up converted to the high-speed format required for the TDM busses.

This is done for analog signals via A/D converters on analog input cards. Each card has circuits for 16 mono (8 stereo) analog channels. Each analog channel is digitized and up converted at a very low latency, and then directed to the appropriate time slot on the particular bus as determined by the system configuration. Analog input cards are available in two versions: either 8 stereo (16 mono) analog line level inputs, or 8 mono mic level inputs.

For digital input signals the process is the same, except that the digital inputs use sample rate converters in lieu of A/D converters. Digital input cards are available in two types: an 8 stereo (16 mono) AES digital input card, or a dual density 16 stereo (32 mono) AES digital input card.

Once the input signals are available on the TDM busses, they can be picked up by output cards, DSP cards, AoIP cards, or network cards for transmission to other places in the system.

For the output, or destination side of the Wheatstone system, the process is reversed. Any output channel that has been “connected” (by software, hardware controllers, control surfaces, salvos, etc.) to an input channel simply pulls in the high speed TDM data from the correct time slot on the correct TDM bus and down converts it to data at the system master sample rate. For analog outputs a D/A converter produces the analog output. Analog output cards are available with 8 stereo (16 mono) analog line level outputs.

Likewise for digital outputs the process is similar except that AES transmitters format the audio data into AES streams at the system master sample rate. Digital output cards are available with 8 stereo (16 mono) AES digital outputs. There is also a dual density version with 16 stereo (32 mono) AES digital outputs.

Some important features become apparent once this technology is understood. First, no intervention by any CPU, processor, DSP, or other controller is necessary for audio integrity. Once the connection paths have been communicated to the hardware, audio will flow continuously. This makes the Wheatstone Bridge system very robust, fault tolerant, and most importantly, maintenance friendly. The system can be expanded, parts moved, reconfigured, control surfaces added, racks and cards added, software updated, etc., all without interrupting the critical flow of audio.

Second, there is nothing in the system design to prevent more than one output channel from gathering the TDM data from the same input. In fact, all of the output channels in the system could be connected to the same input, acting as one huge distribution amplifier. This ability greatly simplifies the system wiring: provide inputs where there are source devices and outputs where there are destinations and make cross connections as needed within the Wheatstone Bridge. If you need PGM audio in three places, connect each destination to an output and assign PGM to all three.

Third, this TDM structure is the basis of the entire mixing system as well. In the Wheatstone Bridge, DSP cards have been designed to connect to the TDM structure such that their mixes become available as sources and their mixer inputs become available as destinations. In the Wheatstone system, all DSP functions are always fully enabled; the system always has enough DSP resources available to fully provide all possible mixes and signal processing on all control surface channels simultaneously. In this manner, any audio that is present in the TDM structure can be assigned to a mix, even other mixes! And because every mix is available as a source, it can be routed to any and all destinations where it is needed. System wiring remains simple: source devices are wired to input cards, audio destinations are wired to output cards, and mixer/control surfaces don't get audio wiring at all. Furthermore the inherent robustness of the embedded TDM structure applies to the mixers as well. Once the mix parameters (channel assignments, fader positions, ON/OFF status, etc.) have been communicated to the hardware, the control surfaces can be unplugged and even turned off without affecting the mixes. The following scenario illustrates how useful this can be:

Scenario: Morning drive and the Talent has just spilled a large mug of coffee into the ON-AIR control surface:

(A) AN EMPTY STUDIO IS AVAILABLE. Board operator moves to empty control room and brings up Guest mics, automation channels, Callers, etc., on the control surface. PGM feed is switched to the output of the new control surface. The result: the show goes on uninterrupted with the board operator in the empty control room. This process could be even easier if a salvo had been created ahead of time to switch the show to the second studio. The damaged control surface is turned off waiting for the engineer to service/repair. Rewiring done to get through the emergency: none.

(B) AN EMPTY STUDIO IS NOT AVAILABLE. Control surface is unplugged and turned off. Guest's talk or automation plays and audio continues. Module(s) are removed from control surface and spill blotted up. Drenched areas are dosed with water and blotted up again. Module(s) are reinstalled in control surface. Surface is powered back up and reconnected. The result: the show goes on uninterrupted and if the spill was caught quickly and cleaned up, the control surface will continue to operate until it can be taken OFF the AIR for more thorough servicing. Rewiring done to get through the emergency: none.

NETWORK INFRASTRUCTURE

The Wheatstone Bridge TDM audio infrastructure [Fig.5] described so far allows for up to 512 mono audio signals available in a single card rack. For larger systems, Wheatstone has an intercage linking system that allows connecting many separate 512 signal card racks together into an integrated system that functions as a true audio network. Wheatstone uses the same "star" networking topology that has been so successful in computer networks. "Star" network topology is characterized by a central point from which individual branches extend out to each node of the system. Traffic from any node in the system to any other node follows the branch from the originating node to the central point and then from the central point out the destination branch to the destination node. The advantages of a "star" topology have been well proven in the computer industry: individual branches affect only one node and branches can be added or removed without affecting the operation of rest of the network. Another advantage is that each branch need only have bandwidth or capacity for its individual node, rather than the whole network as some other topologies require.

Wheatstone uses a proprietary protocol for distributing audio signals between card racks to create audio networks. Similar to the TDM architecture used on the backplane of the card racks themselves, Wheatstone uses a TDM structure with embedded control over Cat-5/6 cables (or optionally optical fibers) to connect card racks together. Each one of these connections, or links between cages, is capable of 64 simultaneous bi-directional (64 channels out and 64 channels back) audio signals, as well as logic and control information. Each card rack in a networked system will have a Wheatstone network card whose function is to pick up the 512 signal audio architecture from the rack it is resident in and make the 512 signals available via these link or branch connections to other card racks in the networked system, and vice versa. Wheatstone network cards are available with capacities of as many as 256 audio signals in and 256 audio signals out simultaneously, and multiple network cards can be installed in a card rack for even more capacity. Also important is that each of these network cards has built in switching capability, so it can select any of the 512 signals available in the card rack to switch onto the high speed interconnects. One single Cat-5 interconnect capable of carrying 64 signals can therefore carry any of the 512 available signals; the interconnect is treated as a dynamic resource of 64 signals that the network card calls up and utilizes as needed to transport audio between racks. As with the other cards in the system, the network cards use embedded control and will continue to transport audio as long as power is supplied regardless of the CPU status.

Wheatstone Bridge

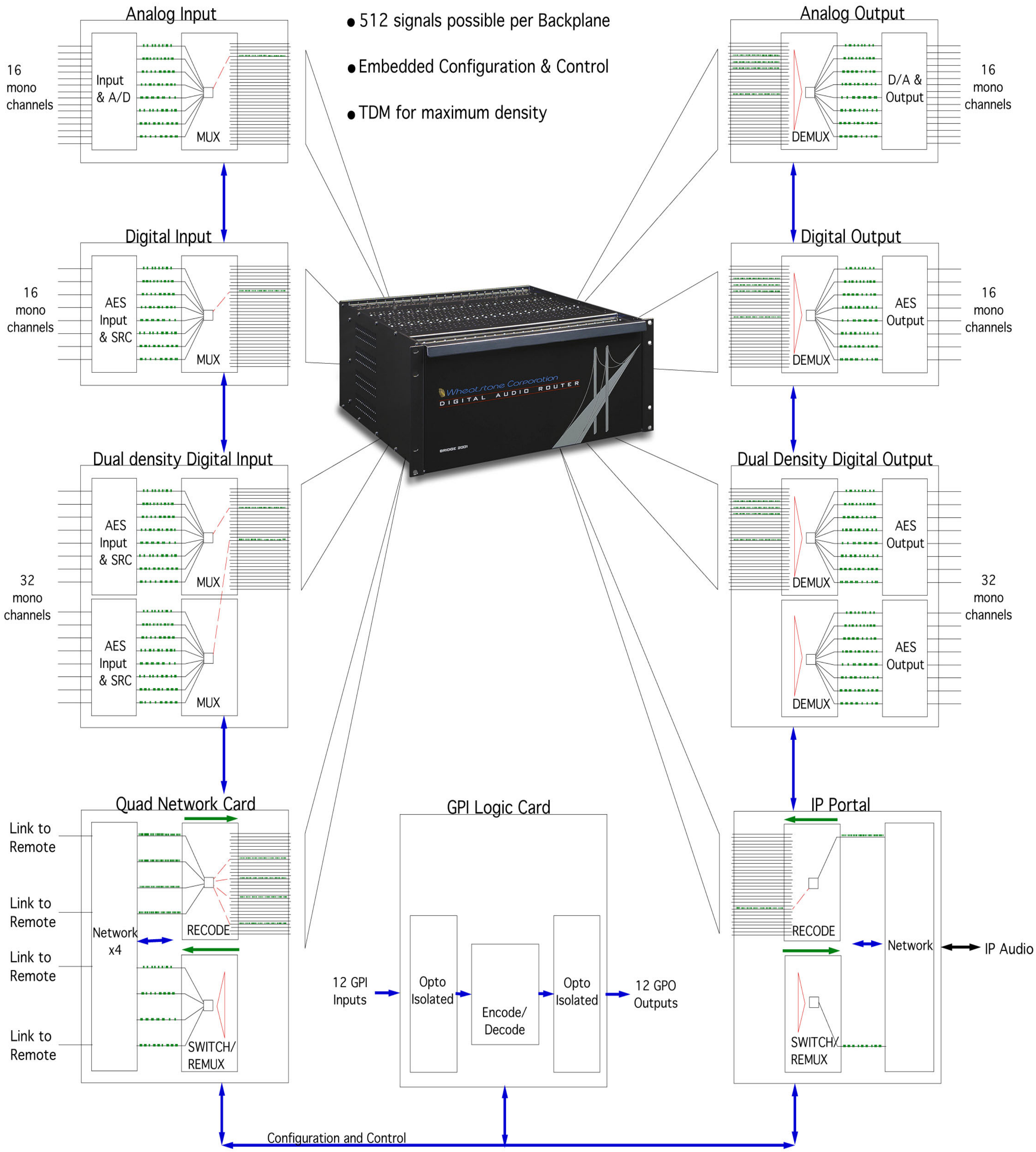

FIGURE 5

A further extension of networking capability is provided by the Wheatstone ET networking cards and AoIP software drivers. With this technology, translation portals can be provided into the Wheatstone Bridge audio infrastructure that allow full fidelity full bandwidth audio to be transferred over standard Ethernet connections between the Wheatstone Bridge system and other devices, including Windows PCs. This AoIP technology is especially handy for distributing audio into business and sales offices via LAN connections while maintaining an effective barrier or firewall between the LAN and the audio infrastructure. It can also be used as a method of directly connecting audio/automation servers into the Wheatstone Bridge audio infrastructure without using sound cards on the servers or audio input cards in the Wheatstone Bridge. Each ET networking card provides up to 32 simultaneous bi-directional mono channels of audio capability.

In a "star" based system there must be a central point or focus of the network. In computer networks this point is commonly called the central switch, and all network traffic flows through this central switch. Likewise for the Wheatstone Bridge system, there must also be a central point. The difference with the Wheatstone system is that only audio signals that originate in one card rack and are needed in a different card rack flow through the central point. This is an important distinction; by allowing direct transfer of audio signals within a card rack when those audio signals are not needed in other card racks, the bandwidth requirement of both the central point and the connecting links is relaxed.

Wheatstone has developed two different solutions for the central point in the "star" based Wheatstone Bridge networked audio system. For moderately sized systems a standard 22-slot card rack can be used as the central point. Network cards are installed as needed to connect to the remote card racks that complete the networked system. This central point, or "hub" rack is typically installed in a central engineering, or TOC area and will likely have audio cards in it as well for those audio devices that are usually located in a TOC area. This approach minimizes the cost impact of the central "hub" because the card rack is needed anyway to house the audio cards for the devices in the TOC. When constructed in this manner, any source in the entire system is available at any destination in the entire system by using the TDM structure of the "hub" rack as the network central point. This allows for complete simultaneous connectivity between sources and destinations within card racks but restricts simultaneous inter-rack connections to a maximum of 512 mono audio signals. Another way of saying it is that any input in the system can be connected to any output, but at any one point in time, only 512 inputs can be connected to outputs in different racks.

For truly massive systems where the above restriction may be too confining, Wheatstone has developed an alternate solution for the central point or "hub" of the "star" network. The Wheatnet™ central point [Fig.6] allows standard 22 slot and 11 slot card racks with standard Wheatstone network cards to be connected to a device capable of supporting up to a maximum of 3072 simultaneous intercage audio connections. In addition to the greatly increased central capacity, Wheatnet devices also include a built in X-Y controller with metering capability and stereo speakers to allow

WHEATSTONE BRIDGE SYSTEM WITH ***WHEATNET 4864***

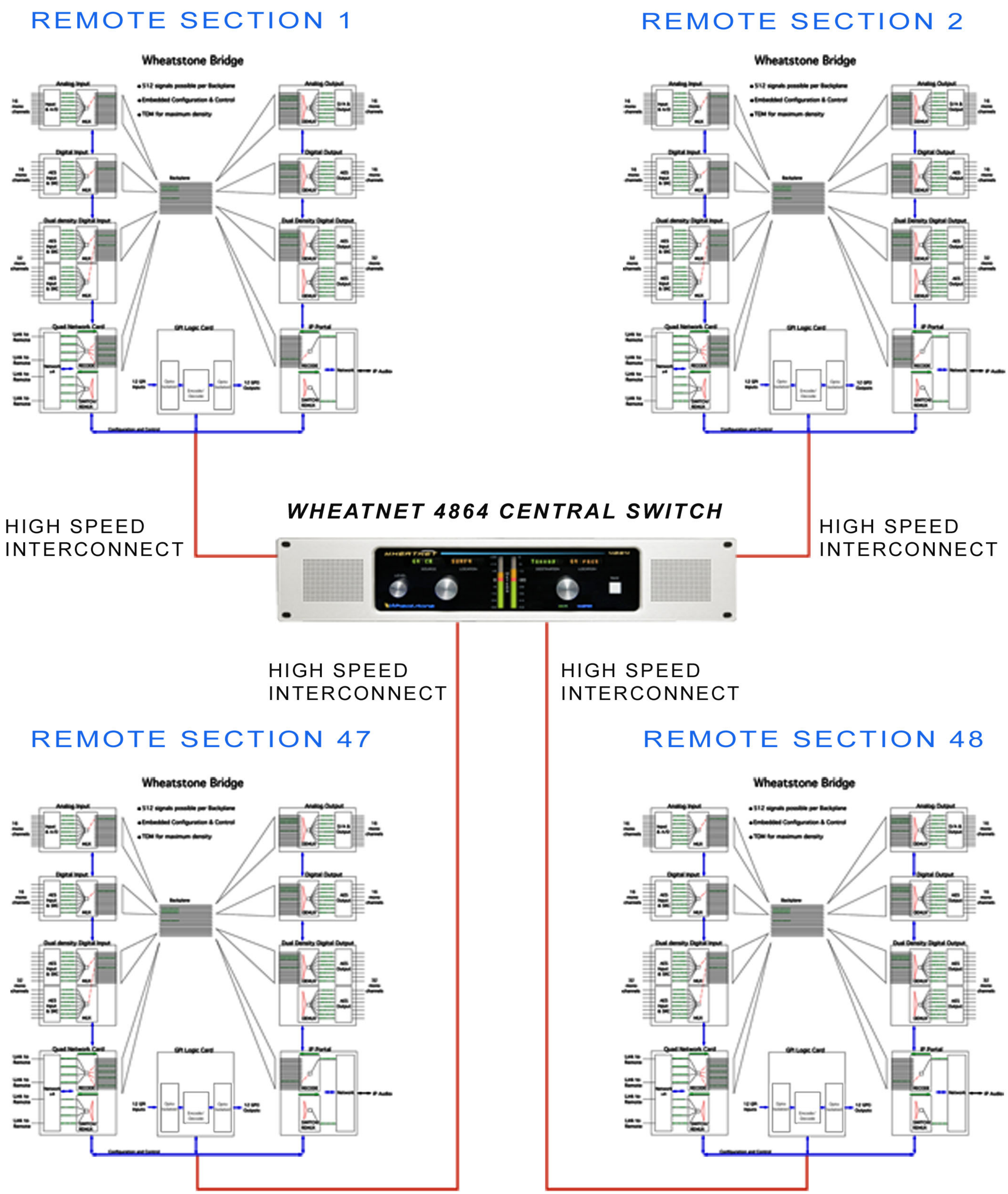

FIGURE 6

direct monitoring of any source in the entire system. Finally, two Wheatnet devices can be connected into a system with duplicate intercage links to allow full automatic failover of the entire audio network. Wheatnet devices are available in 16, 24, 32, and 48 port versions, with each port providing 64 simultaneous bi-directional audio signal capabilities.

CONFIGURATION SOFTWARE

A system as large and complex as the Wheatstone Bridge can obviously be put together in many different ways. Some mechanism must exist therefore for the system components to know how they are supposed to work together. Wheatstone has developed the “Xpoint” software that runs on a Windows PC and communicates via Ethernet with the Bridge, providing a Graphical User Interface. This GUI provides password protected administrative control of all aspects of the Bridge system. Rack, card, and control surface configuration is mapped here; signals are defined and named, levels trimmed, resources set, network connections specified, logic functions detailed, and system behavior analyzed and logged all with the Xpoint GUI. These system functions can be monitored and manipulated remotely if internet access is provided to the GUI PC. At no time however is this Xpoint software required for the Bridge system to function; it will run happily without the administrative PC connected to the system at all. Xpoint is needed only to make administrative changes in the system.

The Xpoint GUI has three main sections: set-up, control, and diagnostics. The set up functions include system addressing for racks and surfaces, GUI rack and card layout, and GUI control surface layout. This part of the software is used primarily by the factory to lay out the system in accordance with customer requirements, but is available to the system administrator to move or add cards, rename signals, etc., after installation. All of this important information is stored both on the hardware and the PC in configuration files that can be archived.

The system administrator heavily uses the control section at installation time to specify logic functions and control surface modes of operation. The Bridge system has many functions and modes of operation that can be changed to suit user preferences. While each system is assembled and tested as a complete system at the factory, users generally find they need a little run time on the system before deciding on some of these functions. Her e you would set which channels mute the Control Room speakers, or does pulling the fader down automatically put the channel in CUE, etc. This section also provides the mechanism to associate functions with the programmable buttons on the control surfaces and any hardwired switches and indicators located throughout the facility.

The diagnostics part of the Xpoint GUI software is used mainly after the system is installed and running to monitor system performance. All system network connections are continuously monitored and displayed graphically on a “system health” display. All system message traffic is displayed in logs, and all system hardware components queried and logged along with their associated software version numbers. Any questionable conditions will automatically show alerts on the Xpoint GUI screen.

AUXILIARY SOFTWARE AND DEVICES

A true fully featured networked audio system must have methods of control other than the control surfaces. Wheatstone has available for the Bridge system a full family of Ethernet based hardware X-Y and hot button styled controllers for making connections and firing salvos from locations such as the TOC where there are no control surfaces. There are button panels and guest turrets that allow users to control their own mics and headphones or change surface presets and fire salvos to change set ups for different shows.

On the software side Wheatstone has the PC-XY application that can be run on any PC to control system crosspoints, the Event Scheduler software that allows for automatic switching of audio and logic connections based on time of day, the WS Timeserver application that synchronizes all control surface time-of-day clock displays, the Button Prog application that provides for sophisticated system control (including conditionals) with an auxiliary panel via Ethernet, and the Utility Mixer application that runs on a Windows PC and provides the capability of using any of the system audio sources to create mixes directly without tying up either a control surface or its DSP mix engines. These programs have all been developed by Wheatstone to assure both system functionality and system compatibility.

Finally, for those applications such as Automation, where users may wish for some other device to control the system, Wheatstone has built a fully featured external control protocol into every control surface and Bridge system. A single Ethernet connection is all that is required to alter crosspoints, turn channels ON or OFF, adjust fader levels, make channel assignments, and effect a wide range of other functions and controls. Using this protocol Automation systems are controlling Bridge systems today over Ethernet, and there is even a company that has developed voice based control of a Generation surface for blind operators.

With the Wheatstone Bridge system a true “star” topology audio network system exists. By using embedded hardware control and proprietary TDM architecture Wheatstone has provided a truly robust and practical solution, where the costs savings of installation are compounded with the benefits of easy on-line expansion, alteration and reconfiguration of a “star” based networked audio system. And by providing IP audio portals into this secure infrastructure, the capability is here to employ both current and future IP audio based functionality in the comprehensive and user-friendly GUI environment of the Wheatstone Bridge system.