The Technical Case for Network First Design:

What is It and How Does It Make Dimension One Unique?

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Foreword

It's been said, in the context of television broadcasting, that "audio is tougher than video." Anyone who has ever worked in that fast-paced, high-pressure environment can readily explain why that's true. Audio, as compared to video, requires a very different set of processing, routing, and mixing tools. There are also more sources to process, route, and mix. With anywhere from two to eight or more audio sources associated with a single video feed, managing all that data requires considerable processing and mixing power and intuitive controls to keep the audio operator ahead of the game.
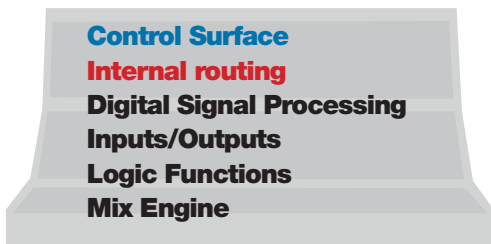
New challenges in the industry have also demanded more from TV audio technology. As in most industries, economic pressures are creating an environment where the same amount of work must be done, but in less space, with less costly hardware, and with a smaller staff.

The growing popularity of 5.1 surround audio has increased audio channel counts and made mixing a more technically demanding process. Control rooms are more automated than ever before, and require audio hardware that is automation-ready.

Networked digital audio technology, a staple for years now in the radio broadcast world, offers answers to many of these demands and more. In this white paper, we'll look at a design philosophy which Wheatstone calls "Network First." Specifically, we'll discuss Dimension One, Wheatstone's most technologically advanced TV audio console which brings high-end features to a mid-market price point and footprint.
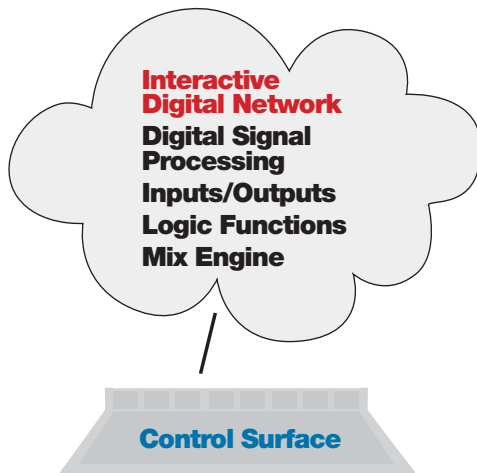
What's different? Architecture.

"In Box" Design

Control Surface
Internal routing
Digital Signal Processing
Inputs/Outputs
Logic Functions
Mix Engine

Dimension One Design

Interactive Digital Network
Digital Signal Processing
Inputs/Outputs
Logic Functions
Mix Engine

Control Surface

Dimension One's architecture is unlike that of traditional consoles. The old, conventional console design called for everything essential to the console's operation (with the exception, perhaps, of some remote I/O) to be located inside the console's enclosure as shown in the chart. Routing, signal processing, logic, and I/O all resided "in the box." As consoles grew in size and capability, this could become quite a large box! The console was a monolithic beast, and this resulted in certain disadvantages in maintainability, reliability, and flexibility.
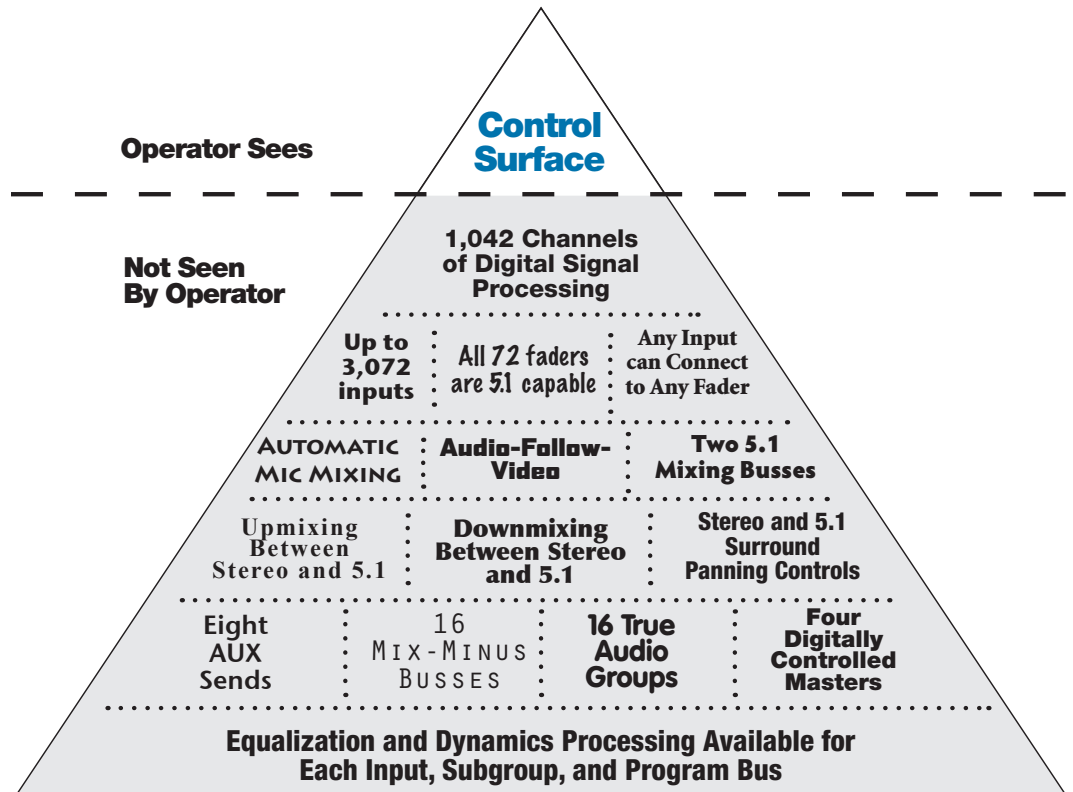
Networked digital audio technology allows us to do things quite differently. First, we build a sophisticated digital audio network with the ability to interconnect a large number of audio inputs and outputs, as well as digital signal processors and control devices. Time Division Multiplexing allows these network resources to be routed to and from each other at will, in real time. Modular I/O allows us to install only the number and type of inputs and outputs that will be needed. To expand, we'll simply add more cards. As shown in the figure at right, all of these items are located "outside the box," in a network represented by a cloud outline.

To this already powerful network, we add a control surface. That surface, itself a networked device, has the ability to control and manipulate the network and access its audio and processing resources, just as the control surface of a more conventional console controls its inner workings. However, this control surface connects to the rest of the network with a single cable, and can be located in any convenient spot, or even in a different room from the rest of the network's hardware.

To the operator of a Network First console, of course, the look and feel of the console are the same as they would be to the operator of a traditional, in-the-box console. The sophisticated, powerful network and DSP technology are all transparent, other than in the way they improve workflow and operator convenience. This is illustrated by the chart below.

Operator Sees

Control Surface

Not Seen By Operator

1,042 Channels of Digital Signal Processing

| Up to 3,072 inputs | All 72 faders are 5.1 capable | Any Input can Connect to Any Fader |

| AUTOMATIC MIC MIXING | Audio-Follow-Video | Two 5.1 Mixing Busses |

| Upmixing Between Stereo and 5.1 | Downmixing Between Stereo and 5.1 | Stereo and 5.1 Surround Panning Controls |

| Eight AUX Sends | 16 MIX-MINUS BUSSES | 16 True Audio Groups | Four Digitally Controlled Masters |

Equalization and Dynamics Processing Available for Each Input, Subgroup, and Program Bus

What does that get us?

Network First design, as implemented in Dimension One, brings us advantages in five primary areas. Increased processing power offers the ability to handle more audio channels, and to do more with them. Total routing flexibility gives us the ability to route any signal wherever it's needed. Operating efficiencies are improved in various and significant ways. Cost of ownership decreases due to the use of networked technology, and overall sound quality is improved.

Processing Power

All of Dimension One's processing work is done by massively powerful Gibraltar DSP engines, which are located within the networked router's card cage. Because they're not located inside the console, the number and configuration of these cards is flexible.

On average, Dimension One offers about twice the signal processing capability of similarly priced products. We can support up to 72 faders, each of which can be assigned mono, stereo, or full 5.1 surround sources. We provide 16 true audio groups (submasters), 16 mix-minuses, 8 aux sends, and 4 Digital Control Masters (DCMs). Each fader also has its own independent bus-minus, further increasing the total number of mix-minus outputs available.

There are two full 5.1 surround mixing busses. Upmix and downmix facilities are available for converting between 5.1 and 2.0 (stereo) signals. Each fader, group, and master can be assigned individual EQ and dynamics processing.

Total Routing Flexibility

Because the heart of the system's design is a digital audio network, we are afforded tremendous flexibility in the type and number of inputs we can bring into the console, as well as how we manipulate them.

Of the 3,072 possible inputs that can be configured on Dimension One's network, we can select any source to be assigned to any fader. Sources can be configured as mono, stereo, or 5.1 surround. Each fader can also be assigned any type of source, to include analog mic, analog line, AES digital, MADI, and SDI.

Logic (GPIO) can be configured and routed right alongside its associated audio, so that any needed machine start/stop or animation controls can follow their audio sources.

Operational Efficiencies

Console maintenance is significantly easier. Rack-mounted network components can be accessed with no disassembly of the control surface. In fact, many components such as I/O and DSP cards are hot-swappable, enabling troubleshooting and repair even while the console is in use. There is no need to pull the console away from the wall or out of the furniture to make repairs. This can be a more important consideration than one immediately realizes, until the day repairs need to be made inside a cramped control booth or one that's in active use.

Because the control surface is simply a control element that is part of a network, adding another control surface is a relatively simple task. A new control surface can instantly gain access to all of the audio sources available on the network.

Expansion is simpler than ever. If more faders are needed, the control surface can readily be expanded, and as necessary, new DSP and I/O cards can be added to support the additional channels.

The modular nature of a networked system also means that adding redundant components allows a degree of fault-tolerance to be built into the system. In effect, redundant components in the system to eliminate single-point failures can actually take the place of a second, backup audio console.

Lower Cost of Ownership

A networked digital audio console is far less expensive to build than the equivalent conventional console plus an equivalent digital router. Because the console itself is inherently a router, the additional expense of this complex and costly system is eliminated. In addition, Dimension One's Gibraltar DSP engine provides enough processing power to significantly reduce or even eliminate the need for outboard processing equipment, saving you money, wiring expense, and power.

Sound Quality

The Network First design of Dimension One results in a cleaner and simpler design and workflow than that associated with more conventional consoles. With a smaller set of components and fewer points of interconnection, the signal path is streamlined and provides minimal opportunities for degradation. On-board processing power provided by the Gibraltar engine reduces the need for outboard processing gear, which also positively impacts audio quality.

Special Features

The DSP power and intelligence behind Dimension One's design have enabled us to include features that have never before been seen in a product in this price class. These features, normally seen only on high-end TV audio consoles, afford operator convenience as well as impressive automation capabilities.

Automatic Microphone Mixing

When airing a panel discussion, forum, or other program where many microphones are located close together, an audio operator has his work cut out for him. Simply leaving all the mics open all the time will result in an ugly, comb-filtering effect that will make the room sound hollow. The operator must constantly pay attention to the discussion in progress, and keep unused mics pulled down. There are many opportunities for errors which are obvious to the audience.

Automatic Microphone Mixing takes this difficult task out of the hands of the operator. By engaging the feature on each of the microphones, the operator allows the console to monitor the level coming from each microphone and automatically bring up only those that are being spoken into. The rest are kept pulled down to low levels until they become active.

Audio Follow Video (AFV)

Audio Follow Video works in conjunction with the video production switcher or production automation system. When engaged, the audio console will automatically crossfade between inputs as the switcher or automation system cuts or dissolves between video sources. This feature can either supplement the work of an audio operator, allowing him to concentrate on sweetening and other tasks, or in some cases it can stand in for the audio operator during simple operations such as integrating remote broadcasts with a local anchor.

Spill

Usually, it's extremely convenient to be able to control the level of an entire 5.1 surround source package with a single fader. Sometimes, however, it is necessary to individually trim the levels within that package. For example, we might need to knock down the subwoofer level, or increase the center channel gain slightly. On the Dimension One, this is easy. Just press the "Spill" button on the fader. Instantly, the six signals of the 5.1 source will be spread across six separate faders and labeled for you, and the motorized faders will snap to the current levels. Make your adjustment, turn spill off, and everything switches back to normal.

Redundancy and Fault Tolerance

The power of a networked console, which can handle a very large number of inputs and route them flexibly, creates many opportunities for redundancy and fault tolerance. Redundant sources, redundant components, and redundant power are all easily implemented.

Redundant sources can be configured effortlessly due to the A/B source selector provided on each Dimension One fader. An operator might assign the primary audio feed from a remote to the "A" source on a fader, and the backup feed to the "B" source on the same fader. These sources can be switched instantly. If the primary feed goes silent, he need only reach up and press the "B" source selector to recover audio. Because the system supports such a vast number of inputs, there's room to provide these redundancies without the need for patching or external switching.

Redundant power is equally simple to arrange. The control surface itself, which carries no audio, can have redundant power supplies; these are external, rack-mounted, modular units that can be quickly replaced while the console continues to operate. Each of the network components can also be redundantly powered.

Redundant components can also be provided to make the system more fault tolerant. I/O cards can be doubled up, and a hot-spare DSP card can be provided with automatic failover in the event of a problem with the primary engine. Because any source can be assigned to any fader, even catastrophic damage to a fader module on the console (as from a drink spill or falling object) only means that the damaged faders are out of action. The sources can be rerouted to other faders, and the show goes on.

Maintenance

A networked digital audio system means greatly simplified maintenance. Components are easier to physically access, and most are hot-swappable.

Rather than pulling a console out from the wall, disassembling it, powering it down, or crawling underneath, the engineer is able to access the audio hardware from the rack front. Modular power supplies, I/O cards, CPU cards, and even DSP engines can be hot-swapped while the console is powered up and in operation. Concerned that an I/O card might have a fault? Swap it with its neighbor and see if the problem moves, all without powering down.

Cost-Effective Upgrades

Dimension One is modular, from its control surface to its networked I/O. This is an architecture designed to be future-proof.

It's easy to design an expandable control surface. Simply specify a console frame of larger size than you expect you will need, and "short-load" it with the number of faders you need now. When the time comes to expand, just drop in the additional faders.

Expanding I/O is equally effortless. Simply add additional I/O cards to the network frame, and those resources will be available to the existing network. Need more I/O than will fit into a single I/O cage? Add another and connect it to the network.

How can this improve my programming?

Dimension One can streamline your workflow and simplify your infrastructure.

The sophisticated features of Dimension One are designed to make the audio operator's work as simple and straightforward as possible. The design of the networked control surface is intended to place the most frequently used controls within easy reach of the operator. Bright and intuitive source name displays and TFT monitors put all important information right before his eyes. Special features like Audio Follow Video and Automatic Mic Mixing automate tedious and repetitive tasks, allowing him to direct his attention to details. The ability to route any source to any fader allows him to set up the console for the way he works and for the particular production he's working on. Extensive DSP power reduces the need for patching in and adjusting outboard equipment.

Networked digital audio simplifies your infrastructure. The link between the control surface and the rest of the network is a single cable, eliminating the usual rat's nest of wiring behind the console. Audio can be routed and distributed within the network, so there's never a need for patchbays or jackfields. Distribution amplifiers, once an integral part of any complex audio installation, are now also relics of the past. Up to 128 individual signals can be carried on a single piece of Cat-5 cable, replacing up to five 26-pair mult cables. Think conduits or thin raceway, not cable trays.

What can I do with Dimension One?

Here are five things you can do with Dimension One that you can't do with similarly-priced consoles of conventional architecture.

1. Assign any source of any type to any fader.

2. Hot-swap components without powering down or disassembling.

3. Add additional control surfaces which share the same I/O

4. Run automation, even without a physical control surface.

5. Switch live, on the fly, between air and protect sources on the same fader.

How does it stack up against the competition?

Network First design gives definite advantages. Let's compare Dimension One with a conventional, "In-the-box" console in the same price class:

TV Audio Console Comparison		
Feature	**Conventional**	**Dimension One**
Max Inputs	258	**3072**
DSP Channels	700	**1024**
Redundant DSP	No	**YES**
Networked I/O	No	**YES**
Any source, any fader	No	**YES**
Hot-swappable components	No	**YES**
Redundant A/B Sources	No	**YES**
Easy access for maintenance	No	**YES**
All faders 5.1 capable	No	**YES**
Sources can be any type	No	**YES**
Share I/O without add'l hardware	No	**YES**
Audio Follow Video	YES	**YES**
"Spill" for 5.1 & Stereo Sources	No	**YES**
Auto Mic Mixing	YES	**YES**
Upgrade control surface only	No	**YES**

Conclusion

Dimension One's "Network First" design philosophy, along with its superior DSP power and advanced, intuitive design features, gives it numerous advantages over conventional console designs. It places high-end console features and impressive flexibility in a control surface that can be priced for the mid-market due to the economy of networked digital audio.