Harrison Consoles Introduces Full-Function Native DSP System

White Paper
December 2006

Full-Function Digital Signal Processing
Commodity Hardware Components
Future-Proof Expandability
Open-Source Computing

Xrange Introduction

Harrison Consoles, an industry-renowned manufacturer of digital and analog audio mixing consoles, is introducing the **X**range digital signal processing (DSP) system to support its comprehensive line of digital console surfaces. The **X**range line is comprised of components that are engineered to use native-based processing *and* audio-over-Ethernet to provide a totally expandable DSP solution for recording, broadcast, live venue, and motion picture applications. The system combines these two technologies to bring the highest level of audio performance with a much lower customer investment in equipment and infrastructure. The **X**range system delivers an impressive list of cost, performance, and scalability benefits to the professional audio arena.

The introduction of the **X**range system represents a major paradigm shift in the design of the DSP back-end for small, medium, and large format console systems. The **X**range system is comprised of modular components that unlock the power of off-the-shelf industrial computer hardware running the open-source Linux operating system to accomplish state-of-the-art console DSP. **X**range delivers the sonic purity and headroom of a true 64-bit, floating-point digital audio path *and* the numerous benefits of audio-over-Ethernet connectivity. For cost-constrained applications, **X**range can also operate at a 32-bit audio depth.

By implementing a native-based platform, Harrison Consoles can leverage the aggressive performance-to-price competition in today's computing hardware, data processing, and network communications markets. Additionally, customers do not have to wait through a complete redesign cycle when a more powerful DSP chip set comes to market.

Background

The traditional approach to console design has been based around high-speed, proprietary, application-specific integrated circuits (ASICs) or field programmable gate arrays (FPGAs)—and more commonly, dedicated digital signal processors such as the tried-and-true Motorola 56000. More recently, the Analog Devices SHARC processor delivered floating point capability that improved the sonic quality of digital audio.

Harrison's approach to the market has been to meet the audio industry's needs for both small and large systems. To meet the calling for a massive DSP system that provided a large number of audio channels to handle new surround formats as well as large-scale film post-production, Harrison introduced the SHARC-based digital.engine DSP system in 1999. The digital.engine offered a system that was capable of expanding to 768 channels of fully resourced audio, with each channel processed using 40-bit precision. The digital.engine

was constructed using “building block” modular components that combined to create a large-expansion system offering superior sonic quality.

When Harrison embarked on the transition to native (host processor-based) processing, the same “building block” philosophy was applied to the **X**range DSP system. Additionally, Harrison successfully achieved numerous key design objectives in engineering the **X**range system:

- Minimize the number of proprietary hardware devices
- Utilize off-the shelf processing hardware to optimize system costs and enable scalability
- Utilize the Linux operating system and Harrison DSP software to enable scalability without the upgrading limitations or “next release wait time” of proprietary software
- Utilize 64-bit, floating-point precision to further optimize sonic quality and headroom
- Utilize the cost and simplicity benefits of audio-over-Ethernet as the signal transfer protocol

Xrange System Overview

Harrison now offers a full line of components required to create a customized digital back-end that meets the audio requirements of any customer application. The Harrison **X**range system consists of the following:

- One or more Harrison **X**engine processing computers
- The Harrison **X**router digital router, which integrates the functionality provided by Harrison’s older-generation router core and router master
- Harrison **X**link Ethernet connection protocol
- Optional Harrison standard or premium I/O devices that can accommodate conversion of multiple audio formats including AES and analog

Every part of the DSP path—from full-featured channel processing (including EQ, dynamics, fader, trim, delay, phase, panning, and bus assignments), to full surround monitoring functions for music and film applications, to specialized audio tools like de-essing and multiband compression—is processed on a standard (but specially configured) **X**engine processing computer equipped with high-capacity multiple AMD Opteron processors.

Each device in the **X**range line of components is connected using standard Cat6 cabling. Using Harrison’s **X**link audio-over-gigabit Ethernet transfer protocol, Harrison consoles can route any signal to anywhere within the console system.

So why would you want a 64-bit audio path?

Well, this is one situation where less is not more. With 16-bit systems, if you did too many operations—even functions as basic as level changes—round-off errors would occur due to the limited "numeric dynamic range" of a 16-bit system. Accumulate enough round-off errors, and the sound quality suffered. The 32-bit floating point was a major improvement, but 64 bits gives just that much more headroom and dynamic range. The improvement is particularly noticeable with material like reverb tails that decay into nothing, even when you really turn up the volume at the end. Those "fizzing" decays of low-res systems are gone forever.

The other big difference occurs when you're running projects with lots of tracks, plug-ins and soft synths. That's a lot of calculations going on at once, and 64-bits of resolution can handle it without you having to worry too much about clipping and other issues that relate to limited calculation abilities.

And, of course, we like to put all this in perspective, so . . . is 64 bits a huge step forward? For audio, there's no doubt that it removes the limitations of the not-very-limited-in-the-first-place 32-bit floating-point format. As there are still passionate arguments about whether mixing "inside the box" produces satisfactory audio results, 64-bit resolution should help people feel better about living in the digital domain.

As to 64-bit hardware and operating systems, although 64-bit systems aren't necessarily twice as fast as 32-bit systems, they are indeed faster and as far as I'm concerned, faster = better. After all, playing or recording music is — or at least, should be — a real-time experience, and your tools should help facilitate that."

Craig Anderton, "64-Bit Buzzword Is Shorthand For Something Deeper", ProSound News, December 30, 2005
www.prosoundnews.com/articles/article_2979.shtml

The **X**router component is designed to accept (up to 8 input and 8 output) standard MADI signals for interfacing to any standard MADI device. The **X**router allows full, arbitrary signal routing of any microphone, line, or AES3 input to any channel. The **X**router has up to 4 gigabit Ethernet ports to connect to up to 4 **X**engine processing computers.

Xlink Ethernet Connectivity

Harrison's exclusive **X**link connection protocol provides a sustained bandwidth of 256 signals at 64 bits at 48kHz (128 signals at 96kHz). **X**link uses standard gigabit Ethernet and off-the-shelf network adapter cards. Although this method places large demands on the computer infrastructure, Harrison is committed to using commodity components in order to truly leverage market forces. Sustained throughput at nearly full capacity is a daunting challenge; however, Harrison has successfully engineered fully qualified gigabit Ethernet cards to maximize packet throughput.

The Xengine Processor

Harrison's prime commitment is to sonic quality. Consequently, Harrison has employed native processing to offer an industry-best processing depth of 64 bits. Each **X**engine employed in an **X**range system is powered by multiple AMD Opteron 64-bit processors. Each **X**engine can process 48 fully resourced channels of audio at 48kHz and 64 bits. This performance is achieved using a moderate speed-grade dual processor configuration, and will increase over time as faster and higher-capacity processor performance comes to market.

Because AMD's Opteron processors are 64 bits wide, they easily accommodate the processing of many audio channels at 64 bits. Each audio channel features 8 bands of EQ (each band with selectable EQ type), a full dynamics section including compressor and gate, and comprehensive bussing and panning. A width of 64 bits, which currently is a Harrison exclusive, extends mantissa from 23 bits to 52 bits. The exponent moves from 8 bits to 11 bits. With 64 bits, the dynamic range and resolution of audio are simply beyond question.

The Harrison Xengine processor

There is a trade-off between sampling rate or bit depth and the number of channels that can be accommodated by a single **X**range processor. The maximum number of channels for 48kHz is approximately twice the number for 96kHz. The maximum number of channels for 32 bits is approximately twice the number at 64 bits.

A hard real-time Linux kernel provides low latency (10 samples) and high reliability. **X**link provides for up to 256-signal input and output for each **X**engine.

Each **X**engine has two Ethernet ports. The control port is used to receive control from the Harrison IKIS™ Control and Automation Platform. The **X**link audio port (copper or optical) provides audio I/O for 256 64-bit bidirectional signals. Each signal within the channel processing is available to travel to and from the Ethernet port. Each channel has A & B inputs, a patch point which can be located anywhere within the fully flexible signal flow, a direct out, and bus outputs.

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Each **X**engine is connected to an **X**router router via the **X**link Ethernet connection. No word clock input is necessary on the **X**engine. The **X**engine operates as a slaved device and gets its clocking information from the Harrison Xrouter.

Each **X**engine is housed in a sturdy, brushed aluminum 4RU chassis with attractive badging. A redundant power supply option is also available.

	Xengine Specifications
Configuration	48 channels per **X**engine computer (typical), full processing on all channels (96kHz)
Bus Architecture	Up to 48 Main, 16 Aux and 16 Mix/Reassign
Digital Signal Processing	Native, dual AMD Opteron processors
Channel Functions	Compressor/Limiter with Side Chain Insert, Expander/Gate, Input Select, Flexible 8-band EQ w/notch, bell, HP and LP Filter, Channel Delay, 16 Aux Sends, 8-wide Panning (optional 16-wide Panning), Programmable Insert Point, Main Fader
Internal Processing	64 bit floating (or optional 32 bit)
Sample Rate	48kHz, 96kHz, or 192kHz
Vari-Speed Sample Rates	+/– 12.5% (38.5kHz to 54kHz, 77.2kHz to 108kHz, 154.4kHz to 216kHz)
Audio Input/Output	**X**link – standard Gigabit Ethernet
Size	4RU (7 inches); 2RU (3.5 inches) option available
Power Supply	Internal, fused PSU; optional redundant PSU available
Cables	Cat6

The Xrouter Router

The **X**router is Harrison's new MADI and Ethernet audio-based router that is capable of 1536 x 1536 routing. Harrison can easily scale a console surface from a 48-channel system to over 500 channels. These very large systems are accomplished by strapping multiple **X**routers together in a large configuration. The connections between each **X**router maintain Harrison's ultra high-resolution 64-bit depth, with no degradation in audio quality.

The Harrison Xrouter router

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The **X**router has 8 MADI inputs and 8 MADI outputs to connect to Harrison's high-quality premium I/O or to any MADI-equipped converter or device. Additionally, the **X**router has 4 **X**link Ethernet ports to connect to other **X**router units or to the Harrison **X**engine. Each **X**router can be cascaded in a tree structure to achieve truly massive system channel counts. When a MADI signal is routed to a MADI output, the signal passes through unaltered. When a MADI signal is routed to an **X**link output, it is converted to 64-bit floating point. Any **X**link-to-**X**link route is kept at 64 bits. When an **X**link is routed to a MADI output, the signal is dithered and truncated. Independent output dithering is available at 16-, 20-, or 24-bit.

Harrison truly employs an "anything to anywhere" philosophy. All points within the console (patch points, direct outs, channel A & B inputs, bus outputs, and the inputs and outputs of Harrison's suite of Digital Audio Tools) are available and visible to the **X**router and thus to the system. One-to-one, one-to-many, and many-to-many routes can be assigned simply and quickly via the IKIS router control screen. Also, the **X**router has partitioned summing nodes, which allow systems to have both multi-user busses and per-user busses. It is important to note that the multi-router busses can be summed across an entire **X**range system, even if the system is comprised of a large number of **X**engines.

The **X**range incorporates a "hot spare" (N + 1) method of redundancy. The system will automatically detect any **X**engine processor that has failed. When the system is fitted with a redundant (hot spare) **X**engine, the **X**router will automatically switch in the hot spare **X**engine in the event of processor failure.

The **X**router is housed in a sturdy, brushed aluminum 2RU chassis with attractive badging. The front face of the **X**router integrates a panel of user-convenient LED performance indicators. A redundant power supply option is also available.

Xrouter Specifications	
Input/Output	8 MADI inputs, 8 MADI outputs 4 **X**link Gigabit Ethernet ports – 64 bits, 256 channels
Sample Rate	48kHz, 96kHz, or 192kHz
Vari-Speed Sample Rates	+/–12% (56 channel MADI) up to –12% (64 channel MADI)
Signal Capacity	1536 inputs and 1536 outputs
Power Supply	Internal, fused PSU; optional redundant PSU available
Connection Types	MADI/Copper: 75 ohm coax with BNC connection MADI/Fiber: 62.5/125µm multi-mode with SC connection Ethernet/Fiber: 62.5/125µm multi-mode with SC connection Ethernet/Copper: Cat5e or Cat6 / RJ45
Word Clock Input	AES3 and TTL
Size	2RU (3.5 inches)
Latency	10 samples

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Benefits of Harrison's Open-Source, Industrial Computer-Based, Audio-over-Ethernet DSP

When considered in total, the benefits of Harrison's unique approach to DSP back-end design are numerous — and quite compelling:

- Industrial computers are commodity items. Upgrades and repairs cost less due to high market competition, high demands, and high production volumes.
- An upgrade is as easy as installing a new computer. As the hardware industry introduces innovations, Harrison implements them into its DSP.
- Diagnosis and repair of computer problems can be performed by local professionals at reasonable cost.
- Software is the dominant factor in system design and scalability, with many of the hardware restrictions removed.
- The DSP system, and the number of channels it can support, is expanded easily by adding more computers and/or routers.
- Space and noise are reduced due to a small computer footprint.
- Utilization of audio-over-Ethernet dramatically reduces cable clutter and streamlines the installation process.
- Full floating-point interconnects between processing units mean no truncation and no clipping. The clipping indicators that are necessary between processes on competing products are not needed, resulting in greater simplicity.
- 64-bit, floating-point processing delivers improved precision over a fixed point 48-bit system. Plus, it provides a much greater dynamic range than any current fixed point system.
- With 10-gigabit Ethernet availability coming soon, future expansion is ensured, with easier resultant changeover to higher bandwidth processing.

Xrange Application Versatility

Three **X**range application diagrams are shown on the following pages. These diagrams illustrate the application versatility, configuration options, and scalability of the **X**range system.

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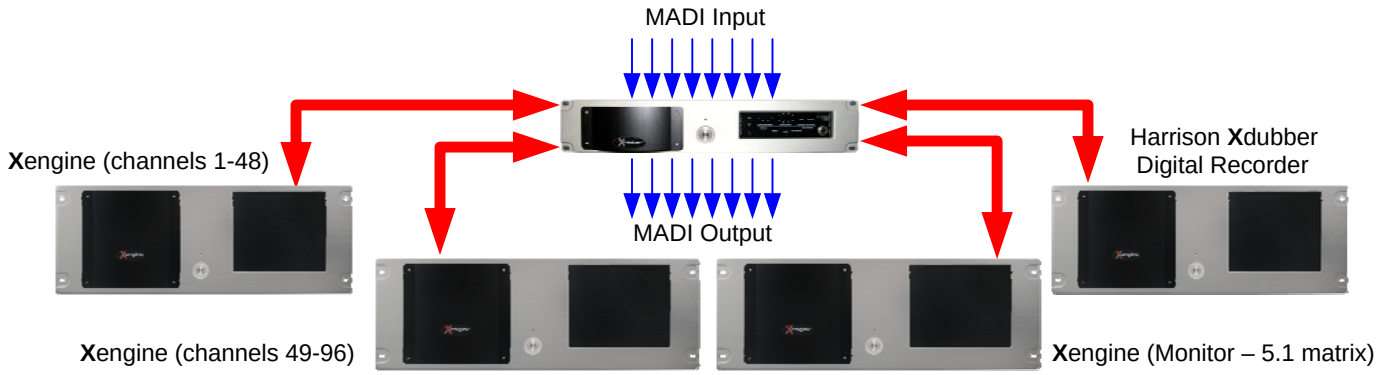
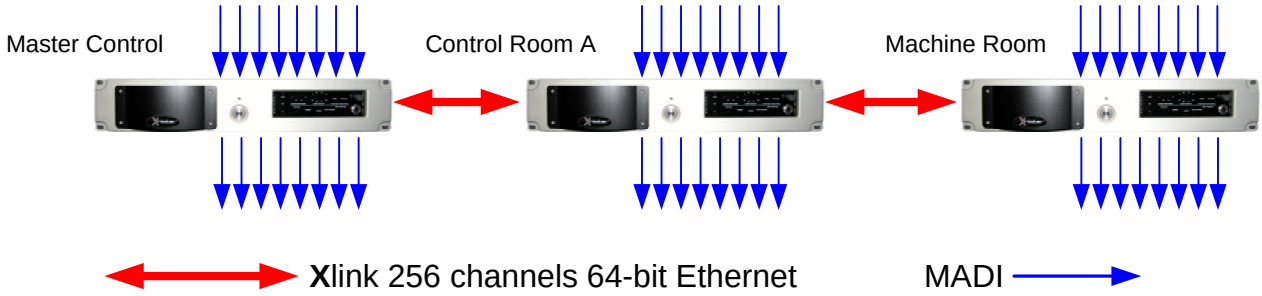
Application #1: Single Xrange System with Xrouter, 3 Xengine Processors, and Xdubber Recorder

- 48 fully resourced channels at 64-bit
- Optimized performace-to-cost
- Large expandability capacity using additional Xrouters / Xengines



Application #2: Production Facility Routing and Distribution

- Full facility router connectivity
- Full audio-over-Ethernet infrastructure over large distances
- Centralized or distributed control of production environment



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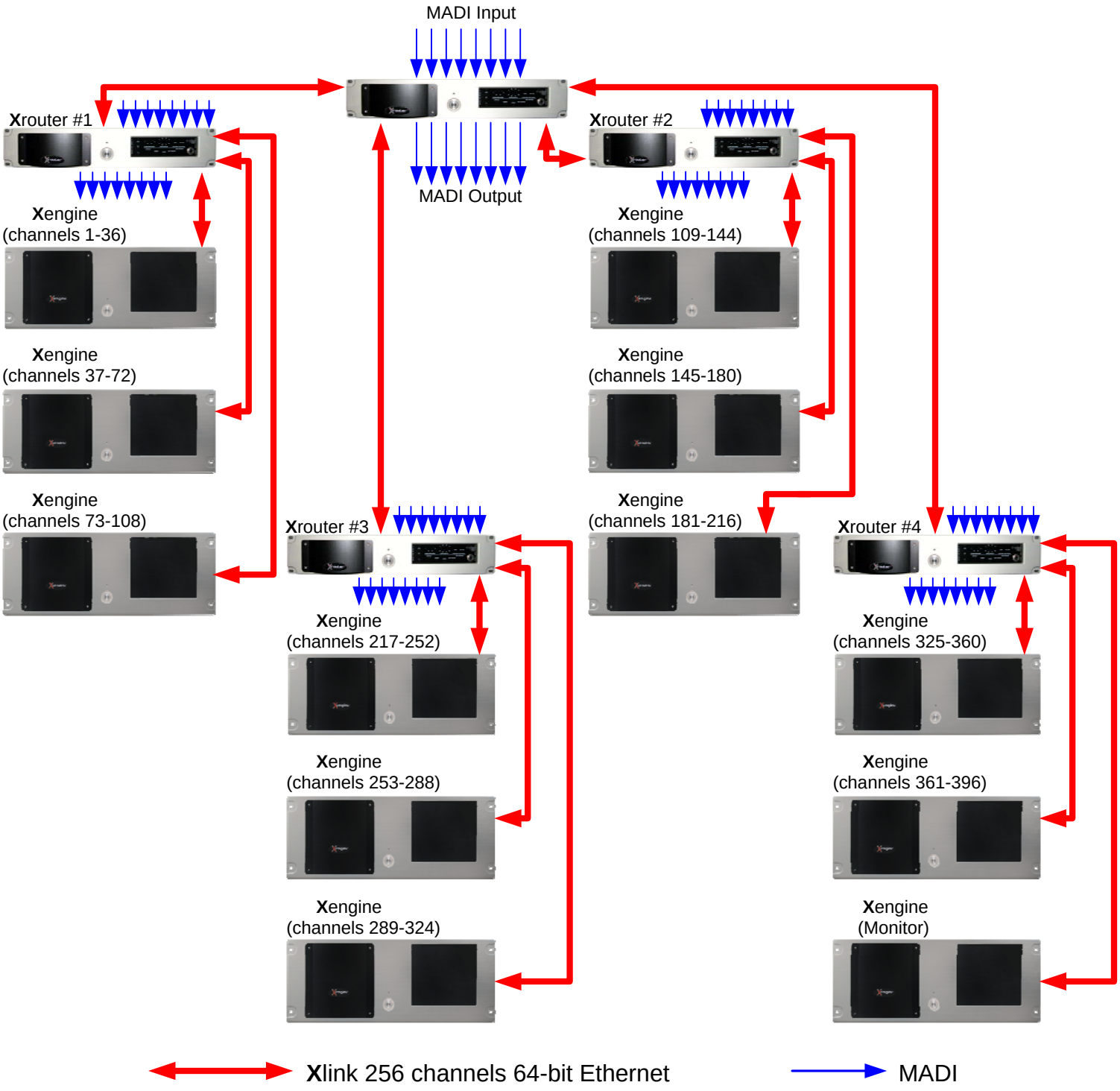
Application #3: Large-Scale Multichannel Configuration with Xrouter as Master Router

- 448 x 448 inputs/outputs
- 396 fully resourced channels at 64-bit
- Console-wide bus summing
- Large channel capacity for film post-production or multiple stems



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IKIS Automation and Control

Each **X**engine and **X**router in the configuration is controlled by the Harrison IKIS Control and Automation Platform as one large system network. IKIS administers all console configuration and setup functions, provides both Snapshot and Scene List Recall for broadcast and live venue applications, and provides Dynamic Mixing Automation for post-production and music mixing. IKIS administers all customized, high-resolution graphics displays available to operators via TFT monitors that complement the Harrison console surface. All signal processing and routing parameters, signal levels, and meters for each channel within the system are viewable on a dedicated IKIS TFT display. IKIS also provides many levels of console configuration and displays of all console parameters that are not normally utilized in real-time operations.

Integration with Harrison Console Surfaces

Xrange is a totally expandable audio processing back-end that complements the comprehensive line of Harrison console control surfaces, including:

- the MPC4D™ console for large-scale film and television post-production
- the Trion™ console for music recording/scoring, broadcast, post-production and live venues
- the value-engineered Air 24/7™ broadcast console for studio and mobile applications

Harrison consoles deliver several features that are a perfect complement to the scalability and versatility of the **X**range DSP system. All Harrison consoles can be expanded in multiple 8-fader sections, and each fader group is supported by a dedicated set of channel strip displays displayed on a TFT monitor mounted above the fader section.

Summary

Harrison Consoles now offers the **X**range line of native components required to create a customized DSP back-end that meets the audio requirements of any customer application. Any size of console is attainable using the **X**range processing elements, from large to small and any size in between.

Execution speed, reliability, and sonic quality have always been the key attributes of Harrison console systems. The **X**range DSP system truly realizes these attributes for the world of recording on the digital console, while delivering future-proof channel expandability and processing scalability.

Delivering over-the-top resolution, low latency, and virtually boundless expandability, the **X**range DSP system offers an impressive performance-to-price ratio for any and all professional audio applications.

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