The Crystal Core Engine

While the demand for larger systems, better quality and lower cost grows exponentially, the professional media industry continues to rely on two decade-old technology, says to Fairlight's STUART DEMARAIS. He says Fairlight has made a breakthrough with new audio and video products incorporating its CC-1 Crystal Core Technology.

FAIRLIGHT'S CRYSTAL CORE Technology (CC-1) processes data in a massive Field Programmable Gate Array (FPGA), architected into what amounts to a purpose-built media processing chip. FPGAs deliver power at price points that will ultimately obsolete the established CPU and DSP/Time-Slice-Bus architectures. With very low processing latency and enough speed to provide smooth analogue-feel tactile response, this technology is fast becoming the bench mark platform for the 21st century. Fairlight's CC-1 is a media-optimised FPGA architecture that harnesses the step change in performance to support improved quality, faster job turnarounds and the development of new creative opportunities for many years to come.

Crystal Core is an aggregation of IP cores, the results of 20+ man-years of development combined with Fairlight's 150+ man-years of experience as a digital audio pioneer.

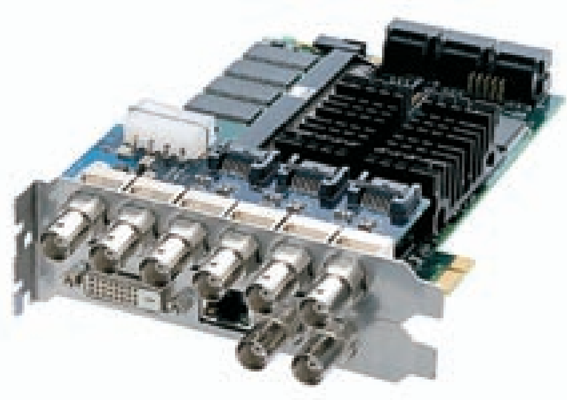
In recent years FPGAs have emerged as the front-running computer engine. They can be programmed so flexibly that, aside from a host PC and some standard memory and 'glue', one chip forms an entire system. And a powerful one — single-chip applications include a 200-plus channel audio recorder/editing/mixer with full I-O and plug-ins; colour-grading for uncompressed HD video; integrated audio/video editing systems; DXD, Super HiDef and emerging 3D audio standards. For larger systems CC-1 uses a wide, fast data highway to interconnect across chips, between computers, or from room to room.

CC-1 introduces a disruptive new technology by delivering improved quality, unparalleled flexibility, scalability, enlarged system scope, and a quantum leap in affordability. And the future looks even brighter — by employing FPGAs, Crystal catches the next upsweep in computer hardware development, transparently inheriting the power increases of each successive generation of silicon, continuing the promise of Moore's Law long after its exhaustion in the microprocessor and DSP technology streams.

The Crystal Core technology platform CC-1, gets its name from the crystalline interconnect scheme used at every level of system architecture. Processing blocks connect in three dimensions to other blocks, forming an extensible lattice that scales as required to meet the volume processing demands of media applications.

The processing blocks themselves are FPGAs, each programmed with the embedded intelligence required to fulfil the demands of the particular product or system being addressed. The flexibility in programming and operation of these chips is crucial in enabling the creation of a universal hardware solution to a great number of media applications. Fairlight's invention (patent pending) defines an architectural arrangement of IP cores supporting real-time audio and video processing systems.

The first products to be released as a result of this invention will support fully featured audio production systems capable of delivering 230 channel paths; each with eight bands of EQ, three-stage dynamics processing, floating insert point with return, on-board HD video, 12 auxiliary sends and upto 72 user definable mix buses: all from a single CC-1 card.

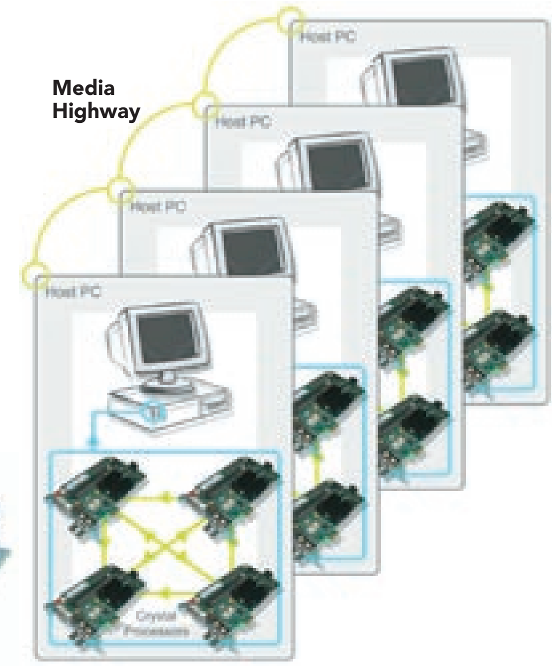


The Crystal architecture is based on the use of high-density FPGAs. Each of these chips contain millions of simple logic parts, that can either statically or dynamically upload a program that configures those parts into complex arrangements for high-speed computer applications. These applications will be used to replace media signal processing hardware that was previously composed of dedicated components or partially-programmable digital hardware.

FPGAs can be programmed to form a great variety of standard logic components and I-O ports that can be built into complex sub-systems. Larger programs can even embed whole processors exactly emulating commonly-used DSPs or CPUs into a part of the chip while other parts function differently. It is thus possible, with the addition of a few extra components such as RAM and some standard computer bus interface chips, to build a complete system using one programmable device.

A chip can upload partial algorithms while in operation, allowing continuous reconfiguration while operating. This is particularly useful in the context of a user controlled system, where tasks change during a session. It is even possible to take a system down and completely reprogram it to change from, say, a large scale audio mixer into a video colour correction device in a matter of seconds.

The Crystal Core architecture has been implemented on a PCI Express card (CC-1), which is connected to a suitable host computer. The smallest configuration capable of delivering 230 channels into 72 mix buses is delivered from a single CC-1 card. Each channel in the system is equipped with eight bands of EQ and 3 stages of dynamics. A medium system providing an increase in the capability (960 channels into 320 buses) is accomplished in a host computer with four CC-1 boards. Larger systems may be assembled by using multiple hosts with each additional CC-1 card delivering a linear increase in the channel capacity. There is no theoretical limit to the number of processors that can be linked.



Large system of multiple hosts connected by Media Highway.

The fundamental operations of a media engine are processing and connectivity. Processing means mathematical and logical operations. Processing is carried out in mathematical sub-units called 'nodes' that are formed within the chip by loading processing algorithms into it. Once a program is loaded, that part of the chip is temporarily dedicated to its processing function, which may be a series of operations designed to achieve any required media processing outcome.

Connectivity means getting the right signals to the right processing node. For example, in an audio system with 200 source channels, there may be more than 1000 actual channels being processed and routed to different destinations, since each channel must be handled before and after each of its multiple stages of processing. This routing requirement consumes a considerable amount of computer resource, so the processing and connectivity requirements must be balanced against each other when designing a media engine.

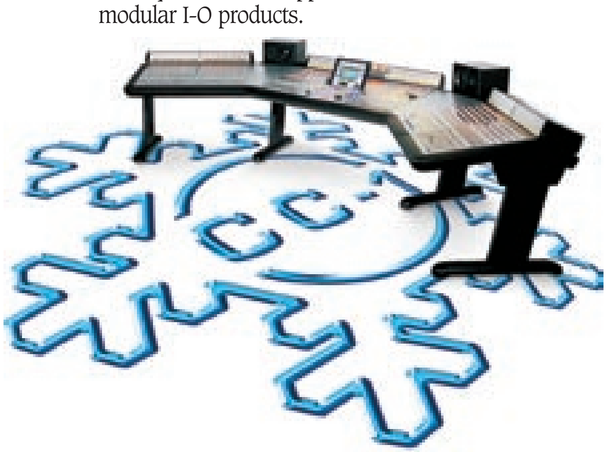
The Crystal Media Engine challenges other systems using acceleration hardware because it can allocate processing and routing resources flexibly to different processing nodes as needed, allowing all its power to be distributed effectively. Each processing node is individually programmed for its specialised function, and the 'size' of the node, or its cost in hardware resources is completely flexible. A simple node performing input and output functions may use a fraction of the resources of a complex node like a multichannel equaliser, and the system will allow precisely the right amount of resources to be allocated to each task. This means that resource usage is optimised, so the maximum possible number of signals can be brought to their appropriate processors and mathematically transformed. By contrast, the architecture of previous systems is locked into standard configurations, where resources are hard-wired to signals that may not need them. This causes waste of resources and thereby increases system cost and reduces flexibility.

Previous systems achieved expansion through a linear connection bus that allocates a specific number of channels to each discrete processor. The speed of the bus also limited the total system size. In general these systems were hampered by having limited processing power per block, which dictates and constrains the algorithms that can be run, and having a fixed architecture, which commits resources to processes even when they are not needed. The Crystal architecture connects in three dimensions, allowing almost limitless expansion. It can connect multiple circuit boards within a single computer, or multiple computers, fusing them into a single system of immense power. In addition, its reprogrammable allocation of channel connections to processing nodes ensures the flexibility to make full use of the processing power.

Unlike the technology it replaces, which is based on interconnected circuit boards using dedicated DSPs, the Crystal Media Engine will be a complete architecture on a single chip, with the option of seamlessly linking other chips to the first when extra capacity is required.

Using FPGA technology has allowed Fairlight to further increase the quality of audio manipulation by implementing a new processing paradigm known as Dynamic Resolution Optimisation (DRO). The DRO architecture enables the optimal precision needed for a specific task to be used within each of its Nodes. This design means that ultra-precise 72-bit fixed point can be used in CC-1's EQ node, while optimal 36-bit floating point can be used in the mixing node. In areas where extreme precision is not required, CC-1 adjusts the precision accordingly. For example, audio metering is more than adequately specified at 16-bit fixed point. DRO is unique, and is patented by Fairlight worldwide.

The CC-1 media engines powers the Dream II product family. These products form a range of audio production tools for recording, editing and mixing applications. All initial product outcomes will be delivered from a single CC-1 card that will connect with any of the four available surface technologies (SatelliteAV, StationPlus, Constellation-XT and Anthem). The end user's physical I-O requirement is supported with the SX-48 or SX-20 modular I-O products.



Anthem 230-channel large format mixing powered by a single CC-1 card.

Each CC-1 engine includes a 1U SX-20 Sync and I-O unit that provides analogue and digital I-Os together with machine control and sync capabilities. In addition, each CC-1 card can support up-to seven multiplexed data connections. These may be used in the form of 64-channel BNC MADI connections or as SDI video data streams. If MADI is employed this equates to 448 physical inputs and outputs per CC-1 card. These MADI ports can be connected to Fairlight's SX-48 modular remote I-O or any other third party MADI-equipped I-O platform.

The initial Dream II products provide the capability to connect up to 4 x SX-48s delivering up to 192 physical inputs and outputs.

Fairlight's SX 20 is a versatile 'Sync I-O Toolbox', and is a required component of any base CC-1 system. The SX-20 includes two mic/instrument preamps plus two additional balanced analogue inputs, 12 balanced analogue outputs, four digital inputs and eight digital outputs. In addition, SX-20 includes powerful simultaneous independent multimachine 9-pin control. The SX-20 provides for sync at any frame rate including HD trilevel sync, video sync, Word clock, AES and LTC. The unit also generates LTC at any standard rate. When combined with CC-1, SX-20 provides all the capabilities required for a wide variety of audio production and postproduction tasks.

Fairlight's SX-48 Signal Exchange extends the CC-1 platform with flexible and cost-effective I-O. Up to four SX-48 units can be connected to a single CC-1 card via MADI providing up to 192 channels of discrete I-O per engine. SX-48 is designed to accommodate all standard sampling frequencies from 44.1kHz to 192kHz. Fairlight's I-O can be installed in 8-channel modular blocks, allowing combinations of up to six cards of analogue and/or digital I-O to be mixed together in each SX-48 unit or added later if required. SX-48 locks to external sync at any frame rate and accepts HD trilevel sync, video sync, Word clock or AES as references. Fairlight's Total Studio Connectivity Protocol (TSCP) allows intelligent management of all SX-48 I-O resources on the TSCP network. ■