XG XTRA

Vol. I • No. 7 • July, 1996

Presented by the YAMAHA® Corporation of America

Special IEEE 1394 Issue!

Visit our WorldWide Web site at:
http://www.ysba.com

Editor: Michael G. D'Amore
Associate Editor: Howard Massey
Production by: *On the Right Wavelength*

Send correspondence via e-mail to news@ysba.com or mgdamore@ysba.com or, via "snail-mail," to:

XG Xtra
Yamaha Corporation of America
Office of Strategic Business Development
P. O. Box 6600
Buena Park, CA 90620
Tel: 714-522-9330

IEEE 1394:

A Glimpse Into The Digital Future

XG developers face a bewildering array of interconnect options—MIDI connections, gamestick port configurations, various types of hard drives and CD-ROM interfaces, and the like. But imagine a world in which all of these devices—in fact, every high-tech device you own—can be interconnected with one single cable, using one single protocol. If you've spent far too many frustrating hours swimming in interface alphabet soup ("OK, now let's connect the SCSI to the IDE, the MIDI to the SMPTE, and the RS232 to the RS422..."), this has to sound like a dream come true. Well, the dream is very nearly reality, thanks to a grouping of four digits you're going to be seeing a lot of in the months ahead: 1394. That's the number assigned by the IEEE (Institute of Electrical and Electronic Engineers) to designate a hardware and software standard for a high-performance serial bus which many believe will one day become the universal interface we've all dreamed of.

1394 is designed to work with pretty much every kind of electronic gear imaginable, including (but not limited to):

- Computers, both desktop and portable
- Consumer electronics products such as set-top boxes, VCRs, camcorders, and digital TVs
- Multimedia products such as digital cameras and stereo/audio equipment

- Electronic publishing products such as printers and scanners

- Data storage and retrieval products such as hard disk drives and CD-ROMs

1394's genesis lay in the "FireWire" technology originally developed by Apple Computer as a desktop LAN. Quickly recognizing its potential in many other applications, the IEEE soon formed both a study group and a trade association. The 1394 Trade Association (http://firewire.org/) includes Yamaha as a charter member, along with industry heavyweights Sony, Intel, Microsoft, Apple, Texas Instruments and many others. Sony's recent release of a line of 1394-equipped Digital Video HandyCams represents the first consumer products to utilize this technology.

A company called Skipstone (http://www.skipstone.com/) has taken a leading role in providing developer toolkits for implementing 1394 capability. They predict that, by 1997, a wide range of consumer electronics and computer manufacturers will offer hardware matched by the inclusion of 1394 into popular operating systems. Microsoft has already announced support of 1394 in future releases of the Windows® family of operating systems and has signed letters of intent with Sony (to develop open device driver interfaces [DDIs], APIs and an open host controller interface for 1394) and with Compaq (to accelerate adoption of 1394 as a standard in the PC industry, including defining an open host controller interface specification). By 1998, gigabit/second 1394 devices are expected to be on the market.

Why is 1394 gaining such immense support amongst manufacturers worldwide? The answer lies in its phenomenal feature set. 1394 is:

- *Fast* - 100 and 200 Mbps data rates are available today, with 400 Mbps and 1 Gbps slated in the near future. This allows real-time data transfer for multimedia applications, including digital audio and video.

- *Reliable* - 1394's isochronous data transport format (a protocol with a continuous guaranteed bandwidth data stream) ensures delivery of multiple time-critical multimedia data for real-time applications.

- *Backward compatible* - 1394's isochronous mechanism operates

transparently on top of a standard asynchronous data transport format (the conventional transmit-acknowledgment protocol) in order to provide connectivity to legacy technology such as printers and modems as well as command and control for new devices. And, even though 1394 is a serial interface, legacy I/O "bridges" allow the attachment of both serial and parallel interfaces.

- *Inexpensive* - 1394 is priced for consumer products, plus its guaranteed delivery of time-critical data reduces costly buffer requirements. In addition, common connectors are used for different devices and applications.

- *Easy to use* - Attaching a 1394 device is as easy as plugging a cord into an electrical outlet. Automatic configuration supports "plug and play," and devices running at different speeds can be mixed on the same system, allowing backward compatibility with devices having slower transport rates. This feature also allows 100 Mbps devices purchased today to operate properly in future bus configurations involving 200 and 400 Mbps devices. Also, there are no separate line terminators required, and no need for device IDs.

- *Hot pluggable* - Users can add or remove 1394 devices without data loss or interruption while the bus is active.

- *Physically small* - The thin serial cable used by 1394 can replace larger and more expensive interfaces.

- *Flexible* - Free-form network topology allows daisy chaining and branching for true peer-to-peer communication without consuming system memory and CPU resources.

- *Non-proprietary* - There is no licensing required to use 1394 in products.

Little wonder that many are proclaiming 1394 as the future "AC plug" of multimedia!

Yamaha is currently developing a proposal for using 1394 for the interconnection of musical

equipment (this proposal is tentatively called the Audio and Music Protocol, or "AMP" for short) as well as participating in a study committee formed by the MIDI Manufacturers Association (MMA) to consider the adoption of 1394 for possible migration of the MIDI protocol. For more information about AMP, see the article on page 6 of this issue of XG Xtra, or click **here**. For more on the MMA's views about 1394, see the article on page 11 of this issue of XG Xtra, or click **here**.

Click on these URLs for more information about IEEE 1394:

- 1394 Trade Association:
  http://firewire.org/
- Skipstone:
  http://www.skipstone.com/
- Sony:
  http://www.sel.sony.com/SEL/consumer/camcorder/dcr_vx1000.html
- Texas Instruments:
  http://www.ti.com/sc/docs/msp/1394/1394.htm

XG publications available from Yamaha

- XG Interactive Online Help
- An Introduction to XG
- XG Guidebook
- XG Music Production Recommendations
- XG Specifications
- XG Voice List and Drum Map
- XG Xtra issues #1 - #6

*All available online (**www.ysba.com**) or in hard copy direct from Yamaha:*

Send requests via e-mail to:
news@ysba.com
or, via "snail-mail," to:
XG Xtra
Yamaha Corporation of America
Office of Strategic Business Development
P. O. Box 6600
Buena Park, CA 90620
Tel: 714-522-9330
Fax: 714-228-3913

The Yamaha Audio and Music Protocol (AMP) Proposal

The IEEE is currently studying a proposal made by Yamaha to incorporate within 1394 a standardized protocol for the interconnection of musical devices—in effect, a kind of MIDI for the future, but one which will handle both music performance data and digital audio data, both down the same wire. As shown in figure 1, the proposal begins by defining the scope of an "mLAN" (musical Local Area Network), in which these time-critical data streams are distributed amongst all the components.

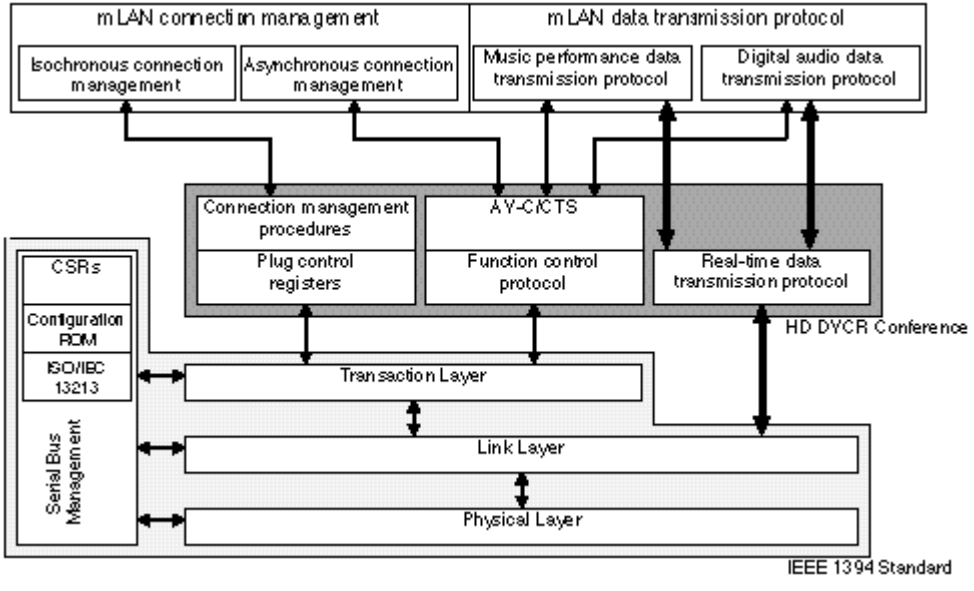

Figure 1

In order to enable usage in live performance environments, onboard connection management (both isochronous and asynchronous) is utilized so that the various instruments in the mLAN can maintain their connection without the need for external devices such as a computer. This is accomplished through both input and output "plug managers" that monitor and control the data flow from both physical 1394 connectors and virtual plugs that may be seen by the receiving instruments as carrying legacy data (such as MIDI). The plug managers' efficiency must be such that even a "worst case" scenario (i.e. maximum number of nodes, with all nodes asserting asynchronous packet transmission) will result in a latency time of no more than 6 milliseconds.

Each device in the mLAN may have up to 31 output plugs and/or up to 31 input plugs, with each plug referred to by an integer number from 0 to 30. A connection is regarded as a combination of an output plug that has a broadcast-out connection and an input plug that has a broadcast-in connection. In this type of "broadcast connection," multiple input plugs can be added without any modification to the output plug.

When an mLAN includes a computer, software may be used to manage all the connections on the bus. This type of connection management is called "concentrated connection management." An application that wants to establish a connection should set an output plug and an input plug to enable sending or receiving of an isochronous flow, and should then maintain the connection information, such as which channel is used for the isochronous flow, which input plug receives the flow, and which output plug sends the flow. Also, since the actual transmitter and receiver may not "know" each other, when a power reset occurs, the application that established the connection should resume the connection.

When no computer is present to provide such a concentrated connection management, a transmitter and a receiver should still be capable of managing the connection established on their plugs. This environment is regarded as "distributed connection management". In distributed connection management, connections are persistent across a power reset or bus reset. This persistency is necessary because the concept of

mLAN connection is an analogy of the actual cabling system of the existing audio, MIDI, and power supply. Here, a plug manager is introduced so that each device can maintain and restore connection, with each device submitting requests to the plug manager to establish a connection. The transmitter is responsible for transmitting an isochronous stream on a specified isochronous flow, while receivers are responsible for receiving the isochronous flow from the specified transmitter.

Registration of either end point of a connection is simply called "plug registration." For example, a registration might inform the output plug manager that output plug #5 will be used for 2-channel raw audio at a 44.1 kHz sampling rate, or might request that the input plug manager prepare to receive data from output plug #2 of a node with a particular Node_Unique_ID. A plug registration does not, however, cause an actual data flow.

After a bus reset, the output plug manager will resume the transmission on the registered output plug, while the input plug manager will check if the source of the incoming flow is identical to the registered input plug. The registration will be non-volatile for the connection restoration so that, after a power reset, although the isochronous flow is not resumed, the connection information maintained before the power reset remains.

Attribute lists are used to specify the capabilities and functions of each device in the mLAN. Music performance data will be transferred utilizing both isochronous and asynchronous methods, with MIDI channel messages (which are time-critical and must be available to multiple devices) using the former method and MIDI system messages (which often require responses from receiving devices) using the latter. As always, the MIDI data stream can contain timing and control information such as MTC (MIDI Time Code) and MMC (MIDI Machine Control). Buffers are used to ensure real-time transmission and response.

Digital audio data, on the other hand, will utilize bidirectional isochronous data transmission, as shown in figure 2 on the following page.

The mLAN will be able to handle raw audio data and AES/EBU (professional) format audio—and can distribute both simultaneously, if required. Up to 64 channels of

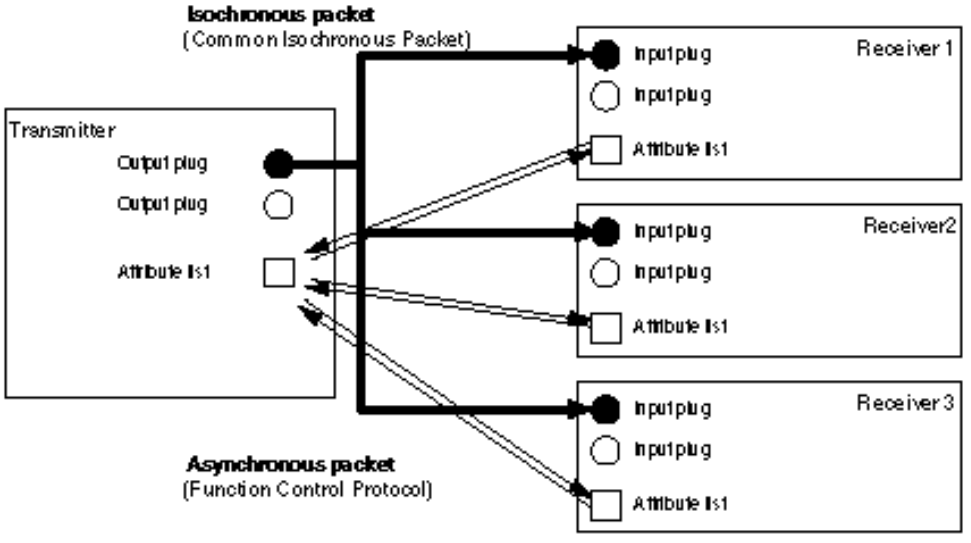

Figure 2

variable bit-length (up to 128 bits) and variable sampling rate (up to 128 kHz) audio can be transmitted over a single cable. Provision is also made for timing conversion, sample rate conversion and drift/jitter compensation. As shown in figure 3 (on the next page), both the audio data and sampling clock will be transmitted simultaneously over the one bus through the use of an embedded time stamp that carries word clock in order to synchronize the transmitter and receiver.

Direct word clock I/O will also be available at every node within the mLAN, as shown in figure 4 on the next page.

(text continues on page 11)

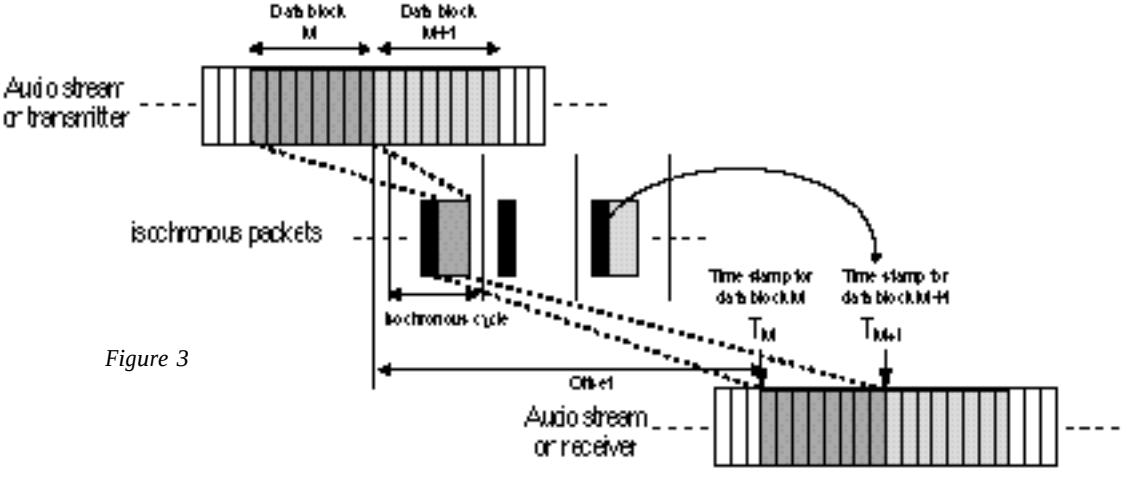

Figure 3

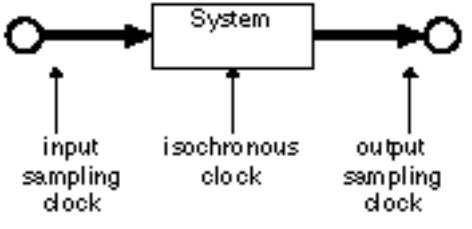

Figure 4

(Yamaha AMP, continued from page 9)

As with the original MIDI specification, there is plenty of room in the AMP proposal for future expansion. Subunit ID addresses are used to access specific video functionality such as that found in digital VCRs and digital TV tuners. And several of these addresses are reserved for future use—these may define functionality we may not have even thought of yet! This will enable the future integration of digital video signal—and other kinds of digital signals, perhaps not even yet defined—along with the digital audio and music performance (MIDI) data that the mLAN is distributing.

For those of you who want to get into the real technical nuts and bolts of mLAN, the complete current AMP proposal is posted on our Web site (http://www.ysba.com)—click **here** to download it.

The MMA Studies IEEE 1394

The 1996 Winter NAMM show may have had relatively little in the way of major new product announcements, but there sure was plenty going on behind the scenes. Perhaps the most significant event was a presentation made at the annual MMA meeting by Gary Hoffman of Skipstone, giving many members their first look at the power of IEEE 1394 and piquing interest in the possibility of actually using it to launch the next generation of MIDI. Shortly thereafter, the MMA Executive Board made a decision to appoint a committee (which includes representatives from Yamaha, Mackie, IBM, Roland, Microsoft and Ensoniq) to study the IEEE 1394 specification for possible migration of the MIDI protocol. The committee will be responsible for proposing the basic requirements and recommending a course of action for further study and progress. XG Xtra spoke with Tom White, President and CEO of the MMA, and with David Oren, chairman of the MMA's 1394 Steering Committee, to get their views on the subject.

Although it is the job of the committee to evaluate 1394 fully, it's fair to say that both White and Oren are already strong proponents. "I think it's an excellent idea, for several different reasons," White states, "the most significant of which is that it can serve to end the segmentation of the marketplace. For example, there are, for all practical purposes, currently several kinds of MIDI, from low-end GM applications to high-end uses such as sample dump. There are also currently two kinds of music data—MIDI, which contains performance information, and digital audio, which contains data describing the sounds themselves. One of the best things about 1394 is that it will allow both kinds of data to converge into one, so that we'll simply have music data, period. After all, if you think about it, the only difference between MIDI and digital audio sounds is their length and where they are stored (in sound card ROM, for example, or on a hard disk). 1394 has the potential to dramatically change the whole paradigm of working with audio." Oren adds, "1394 appears to be a specification that will carry us well into the next century. There is a strong feeling of consensus in the industry, a feeling of wanting to move forward, and everyone I've talked to is very positive about the future it points to."

The main objective of the Steering Committee chaired by Oren is to generate awareness of 1394 among MMA members and to then work towards defining what the migration path will be from MIDI to 1394. "1394 appears to allow all we had previously discussed for a newer, 'high-speed' MIDI, and a whole lot more," he says. The steering committee is currently studying Yamaha's AMP proposal (described on page 6 of this issue of XG Xtra) and hopes to have a 'recommended practice' document regarding 1394 published by the fall of 1996.

Oren points out the inroads 1394 has made in the consumer industry already, observing that digital video is really the enabling technology. "1394 has already been announced as the digital I/O standard for DVC (Digital Video Cassette) and indications are that it will probably also be the I/O standard for DVD, which is going to be launched in a big way in the coming year." He adds, "Because there are several different companies gearing up to produce 1394 chips, 1394 won't have the single-supplier problem that led to the VHS vs. Beta wars." Both Oren and White also see 1394 as being inevitable: "The thing is,"

says White, "it *will* happen in the computer and consumer electronics industries, whether we're there or not—future devices will have 1394 ports and future operating systems will support the protocol. We have a golden opportunity here to bring MIDI into the mainstream." "Unofficially," summarizes Oren, "1394 is already a *fait accompli*."

One of the most impressive statistics given at the NAMM presentation was that a single 1394 cable operating at the current rate of 200 Mbps (and this is expected to rise to 1 Gbps by 1998) is capable of carrying the content of 640 MIDI cables (a staggering 10,240 channels of data) or 140 CD-quality audio channels. This, of course, assumes the use of the current MIDI feature set at the current transmission rate, but White is quick to point out that 1394 will allow MIDI to be greatly expanded upon. "Logjam has been a problem up until now in certain circumstances, but 1394 will not only pretty much eliminate that, it will allow us to add all the things to MIDI that people have been asking about for years—more channels, greater resolution, more controller numbers, a greatly extended system exclusive command set, new kinds of events, and so on." Tied in with the rise of higher-density storage devices (such as DVD), this will not only give game developers much greater control over audio content, but also extend that control to the end user. "Game developers will be able to tap into a whole new set of tools for fashioning sounds, such as digital mixing and customized DSP, and end users will also be able to interactively alter the sounds in many new and exciting ways." Oren agrees, adding that "1394 would appear to be the ideal medium for the consumer market, providing, as it does, a single-connector solution for creating a simple in-home network that is nonetheless enormously powerful."

It is perhaps for developers of interactive multimedia content that White sees the greatest rewards: "It used to be that computers had no audio, then there was some audio, but it's always been kind of an afterthought," he observes. "1394 will allow us to do things with audio we've never done before. It will, at long last, enable developers to not only work with state-of-the-art audio, but to deliver it in a pristine form to end users."

For further information, contact the MMA at P.O. Box 3173, La Habra, CA 90632-3173 (phone 310-947-8689 or e-mail MMA@earthlink.net).