A System for Multiple Channel Mixing and Processing of Digital Audio

Mark Rudolph
GOTHAM Signal Arts Corporation
New York, New York

I. Abstract

The GOTHAM Signal Arts Sigma-DSP3[1] is an integrated environment for mixing, equalization and dynamics processing of up to 60 digital audio channels and is intended for use in professional music and post production studios. The system design and application software grew from preliminary multi-processor music synthesis work at AT&T Bell Laboratories and continued at GOTHAM Signal Arts Corporation. The system consists of a custom version of the DSP3 ([1], [2]), a massively parallel multi-processor developed at AT&T Bell Laboratories, a high fidelity digital interface to multi-track digital tape machines, an Ethernet connector allowing control information to be sent from existing scanned "moving fader" mixing consoles or computer "virtual" consoles, and a secondary processor for spectral analysis and display. The DSP3 is an array of up to 128 processing nodes, each node consisting of an AT&T DSP32C floating point processor, 256 Kbytes of zero wait state static RAM and a special communications ASIC also developed at AT&T Bell Laboratories. A custom operating system and processing software have been developed for the DSP3 by GOTHAM Signal Arts to allow the necessary communication bandwidth and processing power to handle up to 60 channels of digital audio.

II. Introduction

The Sigma-DSP3 can be thought of as a massively parallel Ethernet device with special audio interface capability (Figures 1 and 2). The system consists of an optional Sun 3 workstation as a software development platform and supports the use of the Sun Network File System for loading of executable files. Also connecting the Sun to the Sigma-DSP3 is a serial connector so that information about the boot-up can be monitored in a Sunview window. The architecture is based around the VME bus and there are spaces for six 6U VME cards of which two are standard, an Excellan Ethernet card and a Plessey 68030 "realtime host" (RTH) card. A second "VSB" bus connects the parallel ports of all DSP32C processors and allows the RTH to read and write directly to and from local DSP32C memory via parallel DMA. A large hard disk is used for storing start-up and application code and allows the Sigma-DSP3 to operate as a "turnkey" system without the Sun. The processor boards are 9U VME cards and each contains 16 nodes. A node consists of one AT&T DSP32C floating point processor, 256 Kbytes of zero wait state RAM and a special communications ASIC. A system uses 3 to 5 processor boards depending on whether it is a 32, 44 or 60 channel version. There is also one 9U "IOS" board which handles packet communications between the RTH board and the processor boards. Finally, the left and right monitor channels are sent via digital interface to a DSP32C card in a a PC with a high resolution VGA monitor. This subsystem does realtime 8K FFT analysis at 10 frames per second and displays the results using log frequency and log amplitude scaling in either 2D or 3D.

The networking capability of the Sigma-DSP3 is based on its ability to create TCP/IP sockets capable of servicing one or more clients such as a processor located in a scanned mixing console or computer virtual console. The system is controlled by messages conforming to a special four byte protocol. The control philosophy adopted is that all of the digital processing and mixing be controllable from familiar analog mixing consoles and that any console capable of connecting to a pre-existing TCP/IP socket be able to control the Sigma-DSP3 by use of a standard message protocol.

The audio interface allows connection to multi-track digital tape machines of up to 48 channels. Also provided is a user specified array of output interface modules allowing communications with processing units or master recorders using analog or any available digital format such as AES/EBU, SDIF, S/PDIF, PRODIGI, JVC format or Yamaha format. The internal data format is 32-bit floating point which provides an internal numerical dynamic range of 1500dB. At the output the master mix and monitor mix are redithered to 16-20 integer bits by dithering modules.

The internal communications scheme of the system is orthogonal and consists of an Ethernet control stream, serial audio input and output directly to and from each node, and packet communications from node to node on a 160 Mbyte/sec. "NPI" bus formed by the current

1 *Sigma-DSP3 is a Trademark [™] of GOTHAM Signal Arts Corporation*