Applications of the Processor Enhanced Memory Module for Music Signal Processing

Steven Trautmann(1), steve@trdc.ti.com, Ngai-Man Cheung(1), cheung@trdc.ti.com, Christopher Poletto(2), cpoletto@loomshuttle.com

(1) Tsukuba R&D Center, Texas Instruments
(2) Loomshuttle Inc.

Abstract
The Processor Enhanced Memory Module (PEMM) is a new world wide standard endorsed by EIAJ and JEDEC. This standard allows control of a processor located on a standard DIMM module. The main benefits of this architecture for music signal processing are high bandwidth, a large amount of shared memory between the CPU and local DSP, and easily expandable parallel processing. The bandwidth to memory can be high because system memory bus has four times the bandwidth of the PCI bus (66MHz by 64 bits vsr 33 MHz by 32 bits). In addition, the DSP has its own private memory bus which causes no contention with the system memory bus. This is in contrast to the PCI bus which does contend with the system memory bus. Each DIMM slot in a PC can be populated with a separate PEMM, allowing massive parallel processing to occur. This is important to achieve high polyphony with processing intensive synthesis techniques such as physical or spectral modeling as well as 3-D audio, audio compression, decompression and effects.

1 Introduction
Many signal processing applications including those pertaining to music require high bandwidth to memory, a large amount of memory and high speed parallel computation. The Processor Enhanced Memory Module (PEMM) was designed with these requirements in mind. As a result, many musical applications can receive performance benefits and achieve real-time performance at relatively low cost.

2 Hardware
The current PEMM design (shown in Fig. 1) consists of two 32 MB memory banks, one of which is shared with an on board Texas Instruments C6x DSP. The DSP uses an independent memory bus to allow access to two sub-banks of 16 MB each. Sharing memory with the host CPU in this way reduces cost, and facilitates the streaming of large amounts of audio as well as memory intensive music synthesis techniques, such as those using large sets of sampled data. The current PEMM is just over 2 inches high.

The processor used on the PEMM is a TMS320C6201 (C6201) DSP, a high performance general-purpose fixed-point DSP. Based on a Very-Long Instruction Word (VLIW) architecture, it can execute up to eight instructions every clock cycle and achieve a peak 1600 MIPS computation performance at 200 MHz.

The block diagram for the PEMM is shown in Fig 2. The host system memory bus, located at the card edge is connected to the Shared Bus via crossbars which are used to isolate the PC's memory bus from this bank of the module when the DSP is accessing the shared DRAM. These crossbars may be located internal or external to the Bus Controller IC. A secondary bus, the DSP Local Bus, is also present on the module. This bus is completely de-coupled from the CPU bus, allowing the DSP to access the shared memory without being in contention with the host on the system memory bus. The local SRAM is optional. It is included for additional performance.
4 Other Application Issues

Since the PEMM has no connection to the outside world, any real-time application requires additional hardware. For audio, any sound card can be used. The audio data can be transferred to and from the PEMM using the OS and the PEMM driver’s application programmer’s interface (API).

The dual bank nature of the PEMM requires that any constant data which cannot fit on-chip or in SRAM be placed on both 16MB banks. Only in this way the DSP is always able to access this data. The DSP can only access one bank at a time and is completely cut off from the other bank. A similar issue arises in streaming data which requires memory of a previous state. This data must be copied either on-chip, to SRAM or to the other 16MB bank before a bank switch takes place. Despite this issue, streaming media applications can be successfully executed on the PEMM when there is time to copy the needed data between banks.

5 Conclusion

The PEMM is novel DSP device architecture which offers advantages for many music processing applications which can benefit from a large memory, with parallel and pipelined operations.

References