MSP Goal

Establish MSP as the Standard for Media Processing

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Media Processor for Programmable Integration

MSP
Multi-Media Signal Processor

sound
telephony
2D/3D graphics
video

email
fax
video phone
answer machine
voice mail
www
modem
Internet

A2 : 7/25/96
Product Applications

- PC
  - Desktop
  - Portable
- Embedded PC
- Software Compatible
- Consumer Devices
  - Games
  - DVD
  - Digital TV
    - DBS
    - Cable
    - Wireless
- PC-Based Set-Top Box; Games
- VRML Web Browser
Product Functionality

• Real-time MPEG1 & MPEG2 decoding
• Real-time AC3 decoding
• Real-time H.324 CODEC
• Wavetable, FM Synthesis, SoundBlaster
• V.34 Modem, V.17 Fax
• Video Processing & Filtering
• PC Telephony (DSVD, Speakerphone, TAM, Caller ID. etc.)
Programming Model

- Fully Programmable Media Processor with conventional 32-bit instruction format
- Dual processor, shared memory architecture based on the ARM RISC Core & Vector Processor
- Dual-threaded programming model to run real-time kernel concurrently with multimedia apps
- Deadline driven preemptive real-time scheduling to meet hard real-time constraints
- Supports both scalar & vector data types
• High performance SIMD instructions with multiple operations per instruction
• Special MPEG Class instructions
• Special instructions for filtering applications (averaging, limit check etc.)
• Instructions to hide IO from programmer
  – 1D and 2D block IO instructions
  – Special Load/Store instructions for Prefetch/Writeback & Circular Buffers
• Macro Library instructions (DCT, CONV, MULM)
Vector Register
Data Type Formats

- **Internal Data Types**
  - Integers: 8-bit, 9-bit, 16-bit, 32-bit
  - Floating Point: 32-bit IEEE 754

<table>
<thead>
<tr>
<th>Type</th>
<th>Bit Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte 9</td>
<td>b31 b1 b0</td>
</tr>
<tr>
<td>Byte</td>
<td>b31 b1 b0</td>
</tr>
<tr>
<td>Half Word</td>
<td>h15 h15 ho h0</td>
</tr>
<tr>
<td>Word</td>
<td>w7 w7 w7 w7  w0 w0 w0 w0</td>
</tr>
</tbody>
</table>
VSHFL Case for shuffling 2 32-byte vectors

Conventional 32-bit Instruction

VSHFL VRc VRd VRa VRb

Shuffles 2 32-byte Vectors

SRC
VRa
287 B31 B1 B0
VRb
287 b31 b1 b0

DEST
VRc
287 B31 b31
VRd
287 36 27 B1 b1 B0 b0
ARM7 Can Initiate the Vector Processor

The Vector Processor Executes in Parallel with ARM7

At Completion, the Vector Processor Returns to ARM7

Case 1:
- ARM7 Forks a Vector Task
  - VP Expects a Join from ARM7
    - ARM7 Initiates an Interrupt to VP
  - VP Joins the Task

Case 2:
- ARM7 Initiates a Vector Task
  - VP Expects a Join from ARM7
  - VP Begins Execution in Parallel with ARM7
  - Upon Completion, VP Returns Control to ARM7

• ARM7 Can Initiate the Vector Processor
• The Vector Processor Executes in Parallel with ARM7
• At Completion, the Vector Processor Returns to ARM7
Multi-Media Software Architecture

Apps

High Level
- GDI
- WinMM/MMSystem
- MSVideo
- ACM

Low Level
- DirectX
  (3D, Draw, Input, MPEG, Play, Sound)
- Active Movie
- Active VRML

HAL/DDI
- DDI
- HAL(s)
- WDM Streaming Media

H/W
- Real-Time Kernel

Hardware
- Multi-tasking
- Multi-threading
- Asymmetric Multi-processing
- Real-time
- Pre-emptable
Software Tools

- MSP Compiler and Debugger
- MSP Assembler and ELF Linker
- MINT Vector Simulator
- MSPSIM Integrated Simulator and Debug monitor
- STAR Cycle-accurate Simulator
Hardware Overview

• Vector Processor (VP) for Digital Signal Processing
• Powerful VP floating-point for very high quality 3D Graphics front-end processing
• Integrated ARM7 32-bit RISC Core for system control & management
• Bitstream processor for syntax & Huffman processing of video data
• Unused 10Kgates for Optional Customization
MSP-1 Micro Architecture

- ARM7 RISC CPU
- 5KB DCache
- 2KB ICache
- 16KB IROM
- Cache Sub-System
- Customer ASIC
- CODEC Interface
- PCI Bus Interface
- Memory Controller
- DMA Controller
- 32-bit PCI Bus
- 32/64-bit Mem. Bus
- Customer Specific Interface
- Video
- Audio
- Phone

- Four Timers
- Full Duplex UART
- Inter. Controller
- Bitstream Processor
- 32-bit
- 64-bit

Multi-Media Signal Processor

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MSP-1 System Architecture

- Pentium
- Cache
- PC Chipset
- Main System Memory & Frame Buffer
- Multimedia Signal Processor
  - MSP-1 (128-pin)
  - Video Decoder
  - Video Encoder
  - EPROM
  - Audio & Telephony Codec
  - DAA
- VGA Feature Connector
- Audio In
- Audio Out
- Video In
- Video Out
- RGB
- PSTN Phone
- DAA
- NTSC, PAL

PC Chipset

Pentium

Cache

Main System Memory & Frame Buffer

Multimedia Signal Processor

MSP-1 (128-pin)

Video Decoder

Video Encoder

EPROM

Audio & Telephony Codec

DAA

PSTN Phone

RGB

NTSC, PAL

Video In

Video Out

Audio In

Audio Out
Physical Specifications

- Based on 0.5/0.35um 3.3v CMOS Technology
- 128-pin Package (without Frame Buffer Memory)
- 256-pin Package (with 32-bit Frame Buffer Memory)
- 4.0 watts Power Dissipation (worst case)
• Operational Speed @100MHz
  – 6.4 BOPS 8-bit Integer
  – 3.2 BOPS 16-bit Integer
  – 1.6 BOPS 32-bit Floating-point
Media CPU for PC-based and consumer products
Integrated Accelerator for DirectX APIs.
Can be standalone solution, but PC content compatible
Open Architecture
  - Comprehensive S/W development tools
  - Initial turnkey solution of MSP H/W and base applications firmware
  - Broad ISV & 3rd Party Community
Highly effective use of silicon => Best “Cost vs. Performance” Solution.
Supported by high process technologies & manufacturing.