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Richard A. Brunner is a senior staff engineer and manager of Workstation Graphics Architecture in Intel's Workstation Products Group. He has extensive programming experience with new Intel instruction sets and how they relate to Workstation Graphics. Rich is also the author of an AGP memory manager for NT 4.0. Rich has broad computer architecture experience starting with his work on the VAX, VAX Vector, and Alpha architectures at DEC. Upon joining Intel, Rich took over as technical lead for the i960 architecture group and led a number of architecture and microcode implementations including the i960JX. Rich has a number of patents granted or pending. He holds a BSEE degree from CWRU and a MSCE degree from RPI.

Course Syllabus

Introduction (Rost - 10 minutes)

Welcome
Speaker introduction and background
Course outline and schedule

3DNow! Technology Overview (Kaplowitz - 1 hour)

3DNow! instruction set overview
Arithmetic instructions
Reciprocal and reciprocal square root
Prefetch
FEMMS
Other
Key coding optimization rules
Decode related optimization
Execution latencies
Scheduling
Resource constraints
RISC-like coding style
Predecode tweaking
Alignment
Prefetch
FEMMS
Branches
Addressing modes to avoid
3DNow! code example
System issues
Optimization strategies

Streaming SIMD Extensions Technology Overview (Brunner - 1 hour)

Architecture review

- Data types
- New registers
- Speed up for OpenGL
- Data movement instructions
 - MOV instructions
 - UNPCK instructions
 - SHUF instructions
 - Alignment issues
- Arithmetic instructions
 - ADD, SUB
 - MUL, DIV
 - MIN, MAX
 - Reciprocal and reciprocal square root
- Compares and logical ops
 - AND, OR, XOR
 - CMP
 - Flags and masks
- Prefetch instructions and cache issues
 - PrefetchT0/T1/T2
 - PrefetchNTA
 - Write-back caching
 - Write combining
 - Streaming store
- AOS vs. SO paradigm
 - Array of structures
 - Structure of arrays

Developing High-Performance Software with 3DNow! and SSE (Rost - 55 minutes)

- Comparing 3DNow! and SSE
 - 3DNow! features
 - SSE features
 - 3DNow! advantages
 - SSE advantages
 - 3DNow! disadvantages
 - SSE disadvantages
- Software optimization process
 - Collect necessary documentation
 - Decide on your tools
 - Identify good candidates for optimization
 - Consider your coding options
 - Adjust your attitude
 - Write the code
 - Analyze performance
 - Hedge for the future
- Performance results on 3Dlabs' drivers
 - 3DNow! results
 - SSE results
- Industry support
 - 3DNow! support
 - SSE support

Wrap-up and Questions (all - 10 minutes)

Summary Statement

CPU developers have taken the next step in the evolution of CPU design with the inclusion of SIMD floating point instructions on mainstream CPU's. This course provides an overview of the two main CPU extension sets aimed at accelerating 3D graphics and video: 3DNow!™ and Streaming SIMD Extensions™ (SSE). A general overview of both technologies and a discussion of the documents, tools, and example code that is available will prepare course attendees to make their own plans for software development and optimization.

Prerequisites

This course assumes some familiarity with CPU architecture, including concepts such as processor cache, instruction fetch, instruction decode, execution units, arithmetic/logic unit (ALU), branch prediction logic, cycle counts, latency, throughput, single-instruction/multiple data (SIMD) instructions, and the like. The ability to read C code is recommended, as C code fragments may be presented. Programming experience with assembly language (particularly x86 assembly language) would be very helpful.

Topics Beyond the Prerequisites

This course will provide a general overview of both 3DNow! and Streaming SIMD Extensions technology. The feature sets and performance of both sets of CPU extensions will be discussed. Software development tools and techniques for optimization will also be covered.

Course Objectives

Course attendees will leave this course with the following:

- A general understanding of the capabilities of AMD's 3DNow! technology
- A general understanding of the performance benefits of 3DNow! technology on currently shipping processors from AMD and others
- A general understanding of the capabilities of Intel's Streaming SIMD Extensions (SSE) technology
- A general understanding of the performance benefits of SSE technology on currently shipping processors from Intel
- Knowledge of documents, tools, and methods for incorporating 3DNow! and/or SSE capabilities in their own software

Intended Audience

This course is intended for application programmers and people developing high performance software for 3D graphics or video applications. This includes people who write interactive 3D graphics or video applications; people developing display drivers for graphics or video hardware; people developing toolkits or middleware for 3D graphics or video; and people interested in using SIMD floating point instructions to support computationally challenging tasks such as sophisticated physical modeling techniques, streaming audio, streaming video, or the like.

Course Notes Table of Contents

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Section 4: SSE Technology Overview Slides

Section 5: Developing High-Performance Software with 3DNow! and SSE Slides

Section 6: 3DNow! Technology Manual

Section 7: AMD Processor Recognition Application Note

Section 8: Streaming SIMD Extensions Mini-Reference