

Operands for Media and Signal Processing

- ▶ Graphics application require 3D data types:
 - ▶ Vertex data structure:
 - ▶ X-coordinate (32bit floating-point)
 - ▶ Y-coordinate (32bit floating-point)
 - ▶ Z-coordinate (32bit floating-point)
 - ▶ W
 - ▶ Colour or hidden surface
 - ▶ Pixels (32 bits)
 - ▶ Four 8bit channels:
 - ▶ R(red)
 - ▶ G(green)
 - ▶ B(blue)
 - ▶ A(transparency)

Operands for DSP

- ▶ Fixed-point data types are used in DSPs

	Integer		Fixed-point	
0 100 0000 0000 0000.	2^{14}	16384	2^{-1}	0.5
0 000 1000 0000 0000.	2^{11}	2048	2^{-4}	0.06250
0 100 1000 0000 0000.	$2^{14}+2^{11}+2^3$	18440	$2^{-1}+2^{-4}+2^{-12}$	0.56274

- ▶ Fixed-point data are fractions between -1 and +1
- ▶ Exponent in a separate variable.
- ▶ DSP should have larger registers to prevent round-off errors.

Operations

Operator type	Examples
Arithmetic and logical	Integer arithmetic and logic operations: add, subtract, and, or, multiply divide
Data transfer	Load-stores (more instructions with memory addressing)
Control	Branch, jump, procedure call and return, traps
System	Operating system call, virtual memory management instructions
Floating-point	Floating-point operations: add, multiply, divide, compare
Decimal	Decimal add, decimal multiply, decimal-to-character conversion
String	String move, string compare, string search
Graphics	Pixel and vertex operations, compression, decompression

Simple instructions

- ▶ Simple instructions are responsible for 96% of the executed instruction. (SPECint92)
- ▶ These instructions should be fast.
- ▶ The operation of the previous slide depend largely on the data types included in the instruction set.

3BA5 Top 10 Instructions

Rank	80x86	Integer average
1	Load	22%
2	Conditional branch	20%
3	compare	16%
4	store	12%
5	add	8%
6	and	6%
7	sub	5%
8	move register-register	4%
9	call	1%
10	return	1%
Total		100%

3BA5 Media and DSP Operations

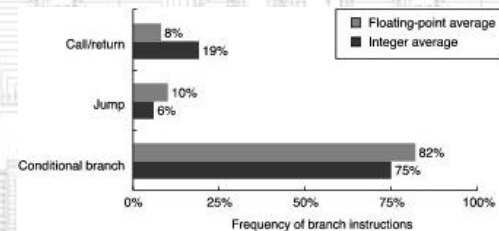
- ▶ Some machines use single-instruction multiple-data (SIMD) instructions for integer operations
- ▶ Or have two 32bit floating-point units for a 64bit register.
- ▶ Also DSPs use saturation arithmetic because they avoid exception to meet real-time constraints.
- ▶ An important operation for DSPs are they multiply-accumulator (MAC) instructions.
 - ▶ Used for vector and matrix multiplies.

3BA5 Flow Control Instructions

- ▶ We distinguish four different types of flow control:
 - ▶ Conditional branches
 - ▶ Jumps
 - ▶ Procedure calls
 - ▶ Procedure returns
- ▶ The following slide shows a breakdown of control flow instructions:
 - ▶ Measurements were taken on an Alpha execution a SPEC CPU2000 benchmark

Breakdown of Control Flow Instructions

Figure 2.19 - Hennessy & Patterson

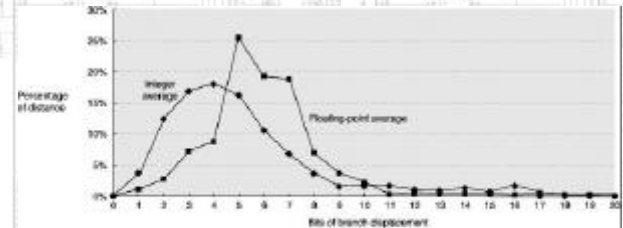


Addressing Modes for Control Flow Instructions

- ▶ Destination is specified explicitly in the instruction
- ▶ With the exception of return
 - ▶ The target is not known at compile time.
- ▶ Most common are PC-relative instruction
- ▶ If the program is linked at run-time it is necessary to specify the target dynamically.
 - ▶ This may be done through a register.
- ▶ The following slide shows Branch distances

Branch distances

Figure 2.20 - Hennessy & Patterson



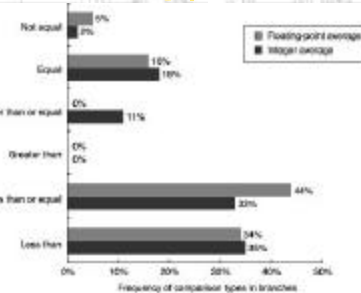
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Conditional Branch Options

- ▶ The next slide shows the frequency of different comparisons.
- ▶ DSPs have repeat instructions.

Frequency of different types of compares

Figure 2.22 - Hennessy & Patterson



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