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2/27/2016

Computer Architecture & Design

Introduction

Computer Architecture:

Computer architecture is about selecting and interconnecting hardware components to create a computer that meet functional performance of cost goals.

Computer architecture refers to instruction set design and implementation.

- The term Instruction Set Architecture(ISA) refers to the actual programmer visible instruction set. It servers as the boundary of software and hardware.

- Implementation of machine has two components:
  - Organization – includes the high level aspects of computer design. Such as memory system, bus structure.
  - Hardware – refers to the specifics of a machine, including the detailed logic design and packaging technology of the machine.

Task of a Computer Designer

→ Determine the attributes that are important for new machine.
→ Design a machine to maximize performance while staying within cost constrains and power constrains.

- Some important design aspects:
  - Instruction set design
  - Functional organization
  - Logic design
  - Implementation
- Must be aware of important trends in both implementation technology and the use of computers.

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Measuring and Reporting

- Response time – the time between the start and the completion of an event. It is also referred to as execution time.

Response time high → slower.
low → faster.

- Throughput– the total amount of work done in a given time.

Throughput high → faster
Throughput low → slower.

X is faster than Y:

- X is faster than Y is used to mean that the response/execution time is lower on X than to Y for the given task. Thus,

$$\frac{\text{Execution time}_Y}{\text{Execution time}_X} = n$$

- Since execution time is reciprocal to performance, the following relationship holds,

$$n = \frac{\text{Execution time}_Y}{\text{Execution time}_X} = \frac{\frac{1}{\text{Performance}_Y}}{\frac{1}{\text{Performance}_X}} = \frac{\text{Performance}_X}{\text{Performance}_Y}$$

Throughput of X is 1.3 higher than Y:

The throughput of X is 1.3 times higher than Y means that the number of tasks completed per unit time on machine X is 1.3 times the number completed on Y. $(X = 1.3Y)$

Choosing programs to evaluate performance

- There are five levels of programs used to evaluate performance. They are listed below in decreasing order of accuracy of prediction.

1. Real-time application - compiler, word, Photoshop etc.
2. Modified application
3. Kernels.
4. Toy benchmarks.
5. Synthetic benchmark.