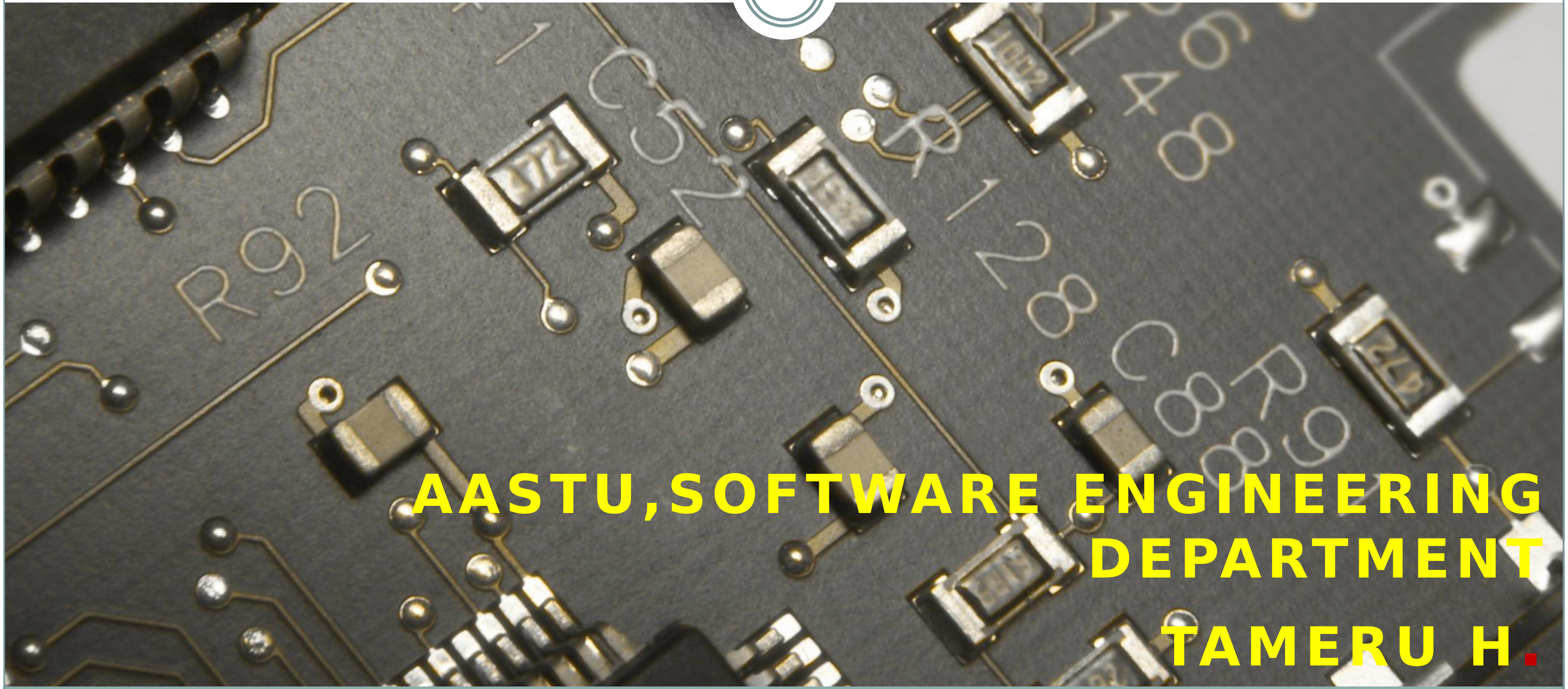
Chapter Two
Part-2
Performance Assessment



AASTU,SOFTWARE ENGINEERING DEPARTMENT

TAMERU H.

Performance assessment

Key parameters to evaluate processor hardware:

- Performance,
- cost,
- size,
- security,
- reliability,
- power consumption

Cont'd…

When we say one computer **has better performance** than another, **what do we mean**?

Cont’d…

What affects the performance of your application software?

Cont'd…

Application performance depends not just on the raw speed of the processor but also on:

- The instruction set,
- Choice of implementation language,
- Efficiency of the compiler, and
- Skill of the programming done to implement the application.

Clock Speed and Instructions per Second

Operations performed by a processor are governed by a system clock. Such as:

- fetching an instruction,
- decoding the instruction,
- performing an arithmetic operation and others

Cont'd…

- All operations begin with the pulse of the clock.

- Thus, at the most fundamental level, the speed of a processor is dictated by the pulse frequency produced by the clock.

- Pulse is measured in cycles per second, or Hertz (Hz).

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- All clock signals are generated by a quartz crystal, which generates a constant signal wave while power is applied.
- This wave is converted into a digital voltage pulse stream that is provided in a constant flow to the processor circuitry.

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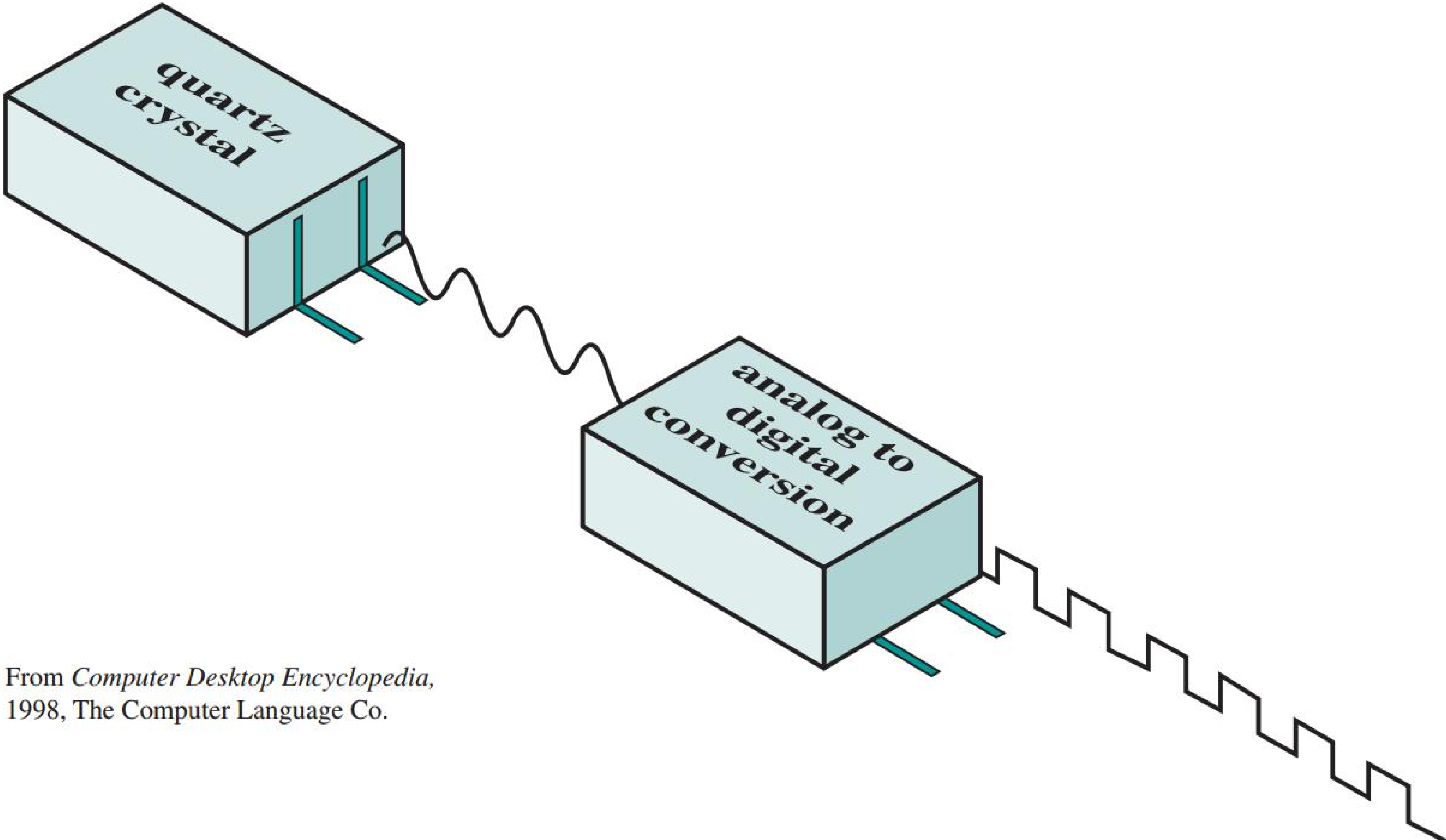

From *Computer Desktop Encyclopedia,* 1998, The Computer Language Co.

Cont'd…

- The rate of pulses is known as the **clock rate**, or **clock speed**.
- One increment, or pulse, of the clock is referred to as a **clock cycle**, or a **clock tick**.
- The time between pulses is the **cycle time**.

Cont'd…

- The execution of an instruction involves a number of discrete steps.
- Thus, most instructions on most processors require multiple clock cycles to complete.
- Some instructions may take only a few cycles, while others require dozens.

Cont'd…

Thus, a straight comparison of clock speeds on different processors does not tell the whole story about performance.

Instruction Execution Rate

A processor is driven by :

- a clock with a constant frequency ***f*** *or*
- equivalently, a constant cycle time **t,** where **t = 1/*f*.**
- I_c, for a program as the number of machine instructions executed for that program until it runs to completion
- An important parameter is **the average cycles** per instruction (*CPI*) for a program.

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Let CPI_i be the number of cycles required for instruction type i and I_i be the number of executed instructions of type i for a given program.

Then we can calculate an overall CPI as follows:

$$CPI = \frac{\sum_{i=1}^{n}(CPI_i \times I_i)}{I_c}$$

Cont'd…

The **processor time** T needed to execute a given program can be expressed as

$$T = I_c \times CPI \times \tau$$

Cont'd…

A common measure of performance for a processor is the rate at which instructions are executed, expressed as millions of instructions per second (**MIPS**),

$$\text{MIPS rate} = \frac{I_c}{T \times 10^6} = \frac{f}{CPI \times 10^6}$$

Reading Assignment

Amdahl’s law

Case study-1

Our favorite program *runs in 10 seconds* on computer **A**, which has a **2 GHZ** clock. We are trying to help a computer designer build a computer, **B,** which will run this program in *6 seconds*. The designer has determined that a substantial increase in the clock rate is possible, but this increase will affect the rest of the CPU design, causing computer B *to require 1.2 times* as many clock cycles as computer A for this program. What clock rate should we tell the designer to target?

Case study-2

Suppose we have two implementations of the same instruction set architecture. Computer A has a clock cycle time of 250 ps and a CPI of 2.0 for some program, and computer B has a clock cycle time of 500 ps and a CPI of 1.2 for the same program.

Which computer is faster for this program and by how much?