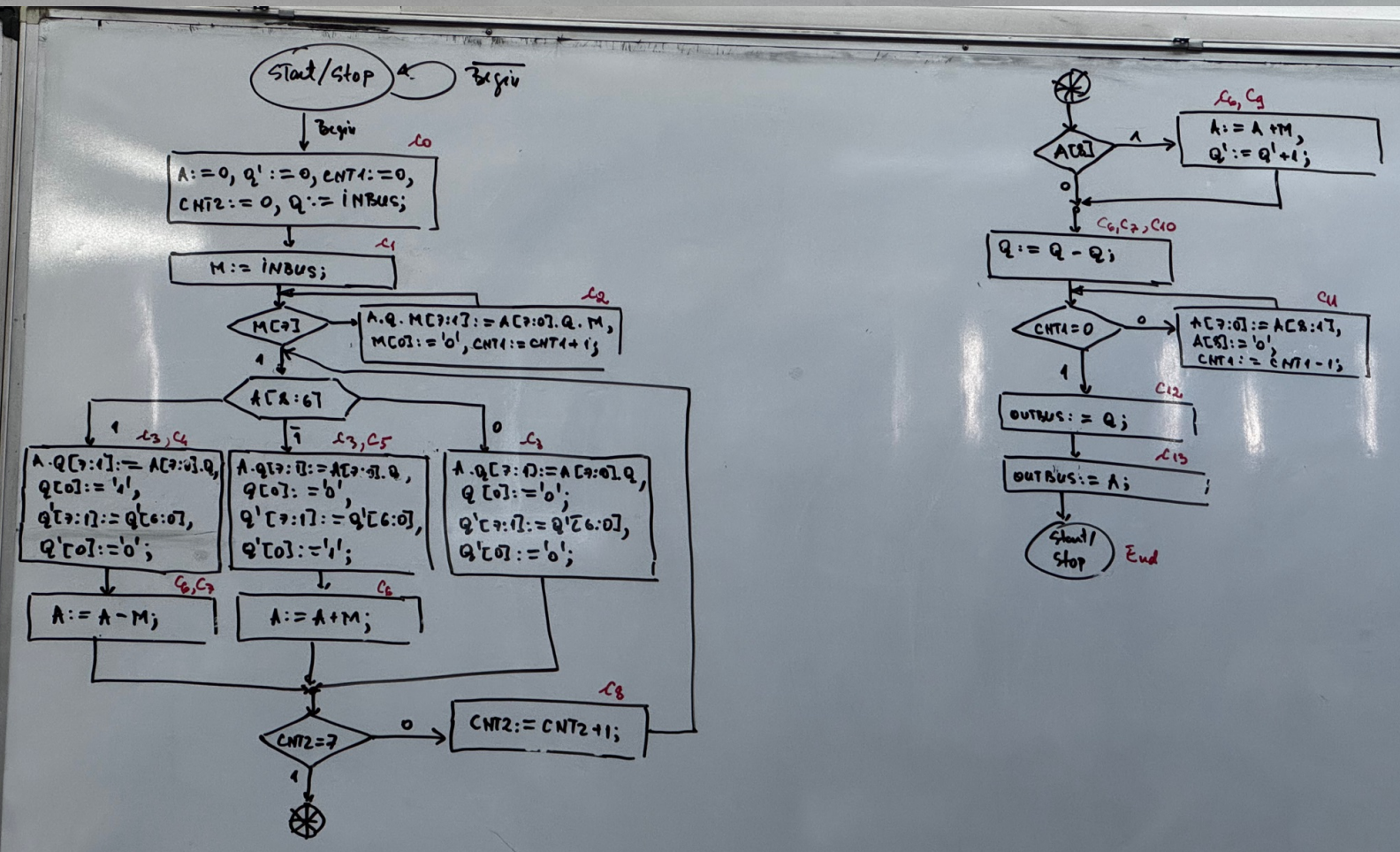
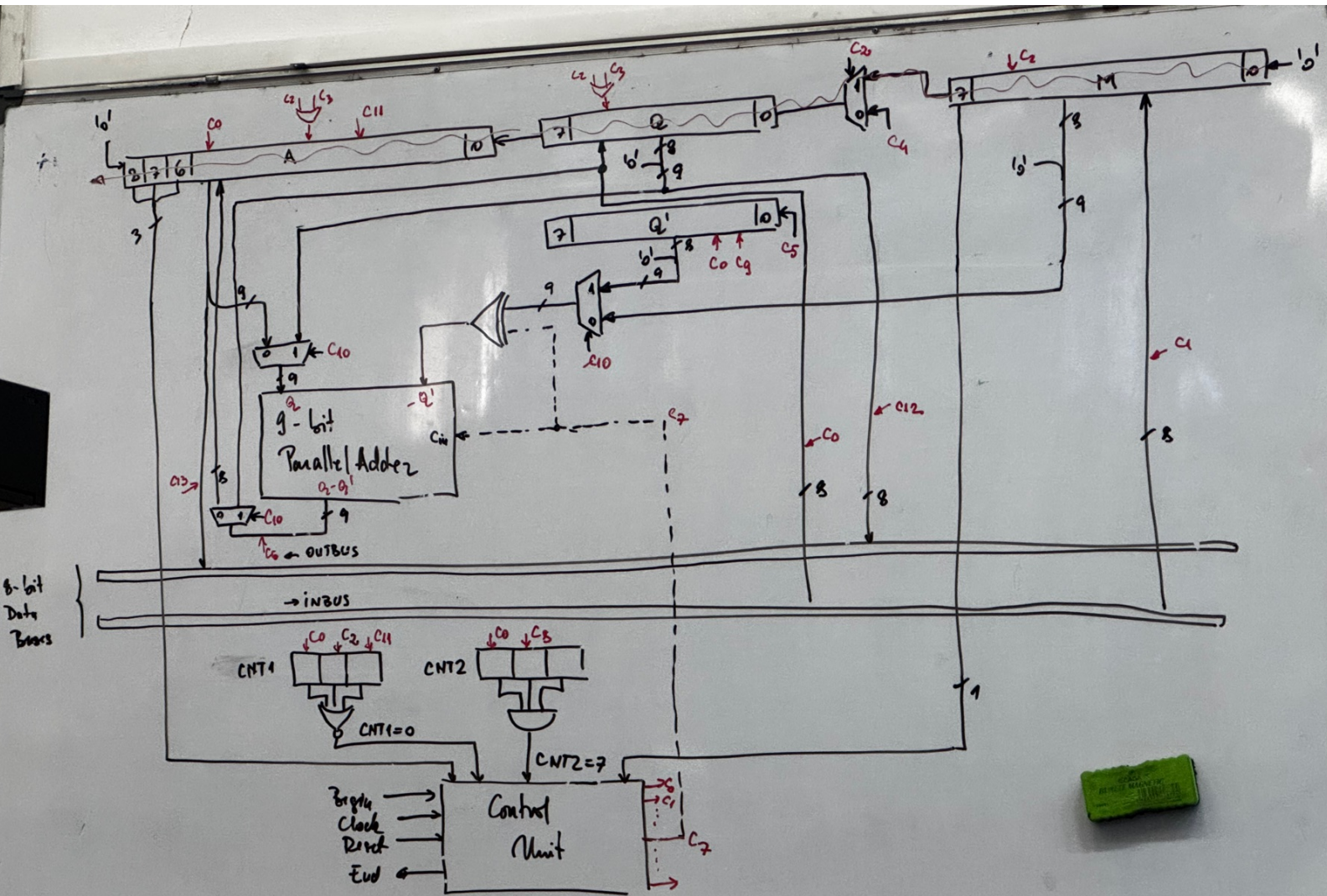


# Radix 2 SRT



# 1.4.4. Radix-4 SRT

$$\text{radix } 2 \quad r_{i+1} \leftarrow 2r_i - q_i b$$

$$q_i \in \{-1, 0, 1\}$$

$$\text{radix } 4 \quad r_{i+1} \leftarrow 4r_i - q_i b$$

$$q_i \in \{-2, -1, 0, 1, 2\}$$

$$\text{if } |r_i| < b \quad \text{then } |r_{i+1}| < b$$

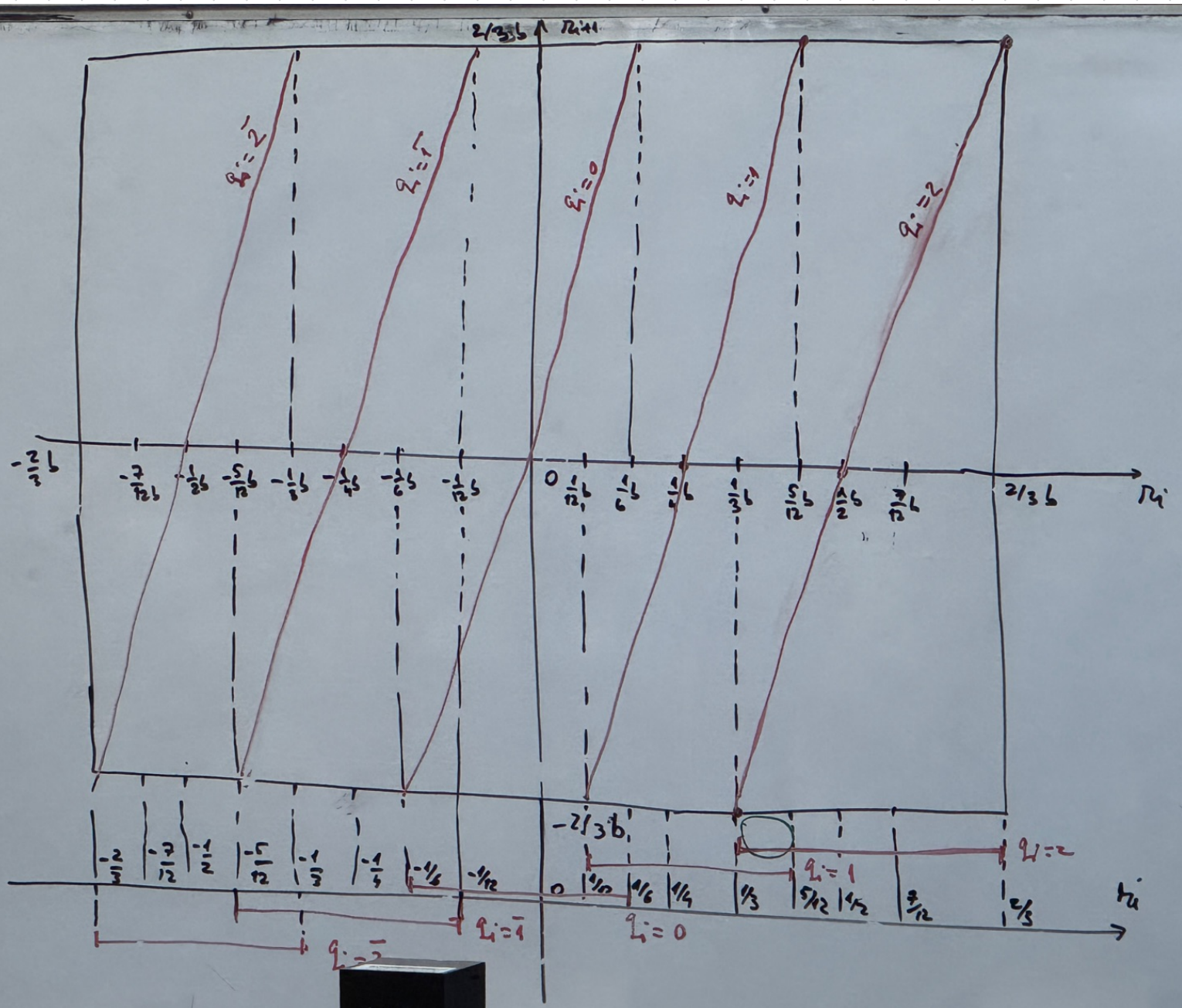
$$r_i = b \rightarrow 4b - \underset{2}{q_i} b \leq b$$
$$\geq 2b$$

$$\text{Constraints: } |r_i| < \frac{2}{3}b$$

$$\Rightarrow |r_{i+1}| < \frac{2}{3}b$$

$$r_i = \frac{2}{3}b \rightarrow 4 \cdot \frac{2}{3}b - 2b$$
$$\frac{8-6}{3}b \leq \frac{2}{3}b$$





$$0 \rightarrow \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$$

$$1 \rightarrow \begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix}$$

$$2 \rightarrow \begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}$$

$$\frac{1}{1} \rightarrow \begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix}$$

$$\frac{1}{2} \rightarrow \begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix}$$



# 1.4.4. Radix-4 SRT

P  
[4i+1]

A  
[4i]

B  
[4i]

| COUNT           | P   | A                      | B                      |
|-----------------|---|------------------------|------------------------|
| 00              | 00000 0000<br>00001 1010                              | 1101 0011<br>0100 0000 | 0000 0110<br>1100 0000 |
| 00              | $q_0 = 0$<br>00110 1001                               | 1000 0000<br>00        |                        |
| 01              | 11010 0110<br>- 11000 0000<br>00010 0110              | 0000 0010<br>0000      |                        |
| 10              | $q_2 = 1$<br>01001 1000<br>- 01100 0000<br>11011 0000 | 0000 1001<br>0000 0000 |                        |
| 11              | $q_3 = 1$<br>10110 0000<br>+ 01100 0000<br>00010 0000 | 0010 0100<br>0000 0001 |                        |
| Shift +<br>Conv | 00000000 1  | 001000 11              |                        |

remainder = 1 hex

quotient = 35 hex

$b = 12$

$$\begin{array}{r} 211- \\ 128 \\ \hline = 83- \\ 64 \\ \hline 19- \\ 16 \\ \hline = 3 \end{array}$$

$$0 \rightarrow \begin{array}{c} 00 \\ 00 \end{array} \quad 1 \rightarrow \begin{array}{c} 01 \\ 00 \end{array} \quad 2 \rightarrow \begin{array}{c} 10 \\ 00 \end{array}$$

$$\bar{1} \rightarrow \begin{array}{c} 00 \\ 01 \end{array} \quad \bar{2} \rightarrow \begin{array}{c} 00 \\ 10 \end{array}$$

$$q_{i+1} \leftarrow 4q_i - q_i b$$

$$B = 01100 0000$$

$$2B = 11000 0000$$

$$111011_2$$

↓

$$111010_{C1}$$

↓

$$100101_{5H}$$

$$(-5)_{10}$$

## 1 SRT-4

| b  | Range of P |    | q  | b  | Range of P |     | q  |
|----|------------|----|----|----|------------|-----|----|
| 8  | -12        | -7 | -2 | 12 | -18        | -10 | -2 |
| 8  | -6         | -3 | -1 | 12 | -10        | -4  | -1 |
| 8  | -2         | 1  | 0  | 12 | -4         | 3   | 0  |
| 8  | 2          | 5  | 1  | 12 | 3          | 9   | 1  |
| 8  | 6          | 11 | 2  | 12 | 9          | 17  | 2  |
| 9  | -14        | -8 | -2 | 13 | -19        | -11 | -2 |
| 9  | -7         | -3 | -1 | 13 | -10        | -4  | -1 |
| 9  | -3         | 2  | 0  | 13 | -4         | 3   | 0  |
| 9  | 2          | 6  | 1  | 13 | 3          | 9   | 1  |
| 9  | 7          | 13 | 2  | 13 | 10         | 18  | 2  |
| 10 | -15        | -9 | -2 | 14 | -20        | -11 | -2 |
| 10 | -8         | -3 | -1 | 14 | -11        | -4  | -1 |
| 10 | -3         | 2  | 0  | 14 | -4         | 3   | 0  |
| 10 | 2          | 7  | 1  | 14 | 3          | 10  | 1  |
| 10 | 8          | 14 | 2  | 14 | 10         | 19  | 2  |
| 11 | -16        | -9 | -2 | 15 | -22        | -12 | -2 |
| 11 | -9         | -3 | -1 | 15 | -12        | -4  | -1 |
| 11 | -3         | 2  | 0  | 15 | -5         | 4   | 0  |
| 11 | 2          | 8  | 1  | 15 | 3          | 11  | 1  |
| 11 | 8          | 15 | 2  | 15 | 11         | 21  | 2  |

$$\begin{array}{r} 211 \overline{) 6} \\ 18 \overline{) 35} \\ \hline = 31 \\ 30 \\ \hline = 1 \end{array}$$

$$\begin{array}{r} 213 \overline{) 5} \\ 20 \overline{) 42} \\ \hline = 13 \\ 10 \\ \hline = 3 \end{array}$$

111 001 c<sub>2</sub>  
↓  
111 000 c<sub>1</sub>  
↓  
100 111 s<sub>M</sub>

$$\begin{array}{r} 213 - 128 \\ \hline = 85 - (-7)_{10} \\ 64 \\ \hline 21 - 16 \\ \hline = 5 \end{array}$$

| COUNT          | P  | A   | B                             |
|----------------|--|---|-------------------------------|
| 00             | 00000 0000<br><u>00001 1010</u>                                | 11010101<br>10100000                      | 0000 0101<br><u>1010</u> 0000 |
| 00             | $q_0 = 1$<br>00110 1010<br>- 01010 0000<br><u>11100 1010</u>   | 10000001<br>00                            |                               |
| 01             | $q_0 = 1$<br>10010 1010<br>+ 01010 0000<br><u>11100 1010</u>   | 00000100<br>0001                          |                               |
| 10             | $q_1 = 1$<br>10010 1000<br>+ 01010 0000<br><u>11100 1000</u>   | 00010000<br>000101                        |                               |
| 11             | $q_2 = 1$<br>10010 0000<br>+ 01010 0000<br><u>(4)1100 0000</u> | 01000000<br><u>00010101</u>               |                               |
| 002 +          | 01010 0000<br>00110 0000                                       | 01000000 -<br>00010110                    |                               |
| shift +<br>low | 000000011<br>remainder = (3) <sub>10</sub>                     | 00101010<br>quotient = (42) <sub>10</sub> |                               |

→ b = (10)<sub>ten</sub>

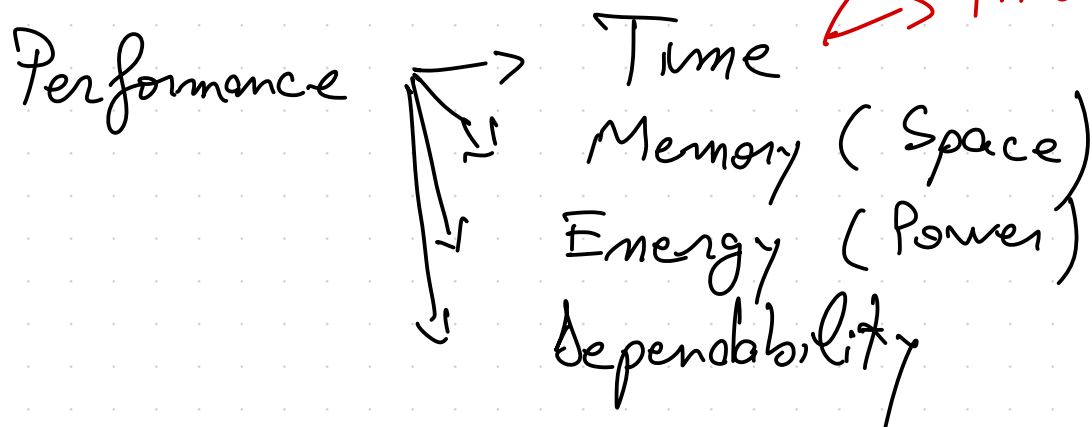
B = 01010 0000



## 2. Computer System Performance

### 2.1 Intro

- \* 1. Desktop Comp.
- 2. Servers
- 3. Embedded Systems



Desktop  $\rightarrow$  Run Time

Server  $\rightarrow$  Throughput

Embedded  $\rightarrow$  "computers as components"

$\rightarrow$  Real Time Systems

(measure of perf.  $\rightarrow$  Deadline)  
Worst Case Scenario

---

1 CPU and 10 Tasks (Seq.)

a) faster processor  $\rightarrow$  faster run time  
 $\downarrow$   
implicit  $\uparrow$  throughput

b) add a 2nd processor  $\rightarrow$  better throughput  
 $\downarrow$   
implicit  $\uparrow$  run time

$$\text{Performance } x = \frac{1}{\text{Exec. time } x}$$

Machine  $x$  is  $n$  times faster than  $M_y$

$$\frac{\text{Perf. } x}{\text{Perf. } y} = \frac{\text{Exec. time } y}{\text{Exec. time } x} = n$$

## 2.2. Benchmark Suites

spec.org

- Synthetic Benchmarks
  - Toy Programs
- wrong tests  
transitive !!!

if  $A > B$  and  $B > C \Rightarrow A > C$

$$\text{SPEC} = \sqrt[n]{\prod_{i=1}^n \frac{1}{\text{Exec. } i}}$$

$i = 1 \dots n$  programs

+ Mașină de referință

$$\text{SPEC}_x = \sqrt[n]{\prod_{i=1}^n \frac{\text{Perf. } x}{\text{Perf. Ref}} \left( \frac{\text{Exec Ref } i}{\text{Exec } x i} \right)}$$

SPEC Ratio  $x$