1) Personal computers / small servers

2) Top 500

3) Clouds

3) CLOUDS

↑ E2C — 4 core

AZUR — 8 core Xeon

1) PC — Laptop — Tablet

PDA / Smartphone → 2 ÷ 4 cores ARM

Pentium ← 2010 —

'90 — '2000

→ i3 - i7 — > 4 core

Xeon — 8 ÷ 16

i3 - i7

2 ÷ 4 cores

2) www.top500.org

→ FLOPS

POWER

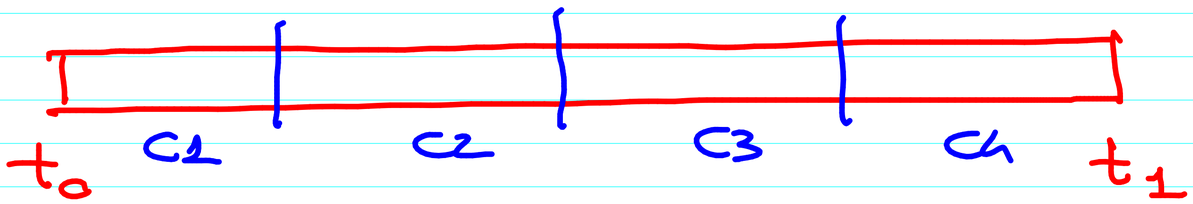
FLOPS / WATT

* board — socket 2 ÷ 4 — multicore 8 ÷ 16 cores

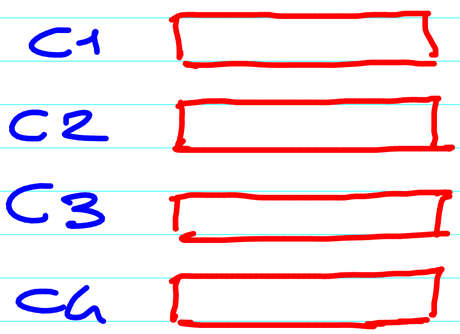
* rack

GPU (co-processors)

Application X



4 core

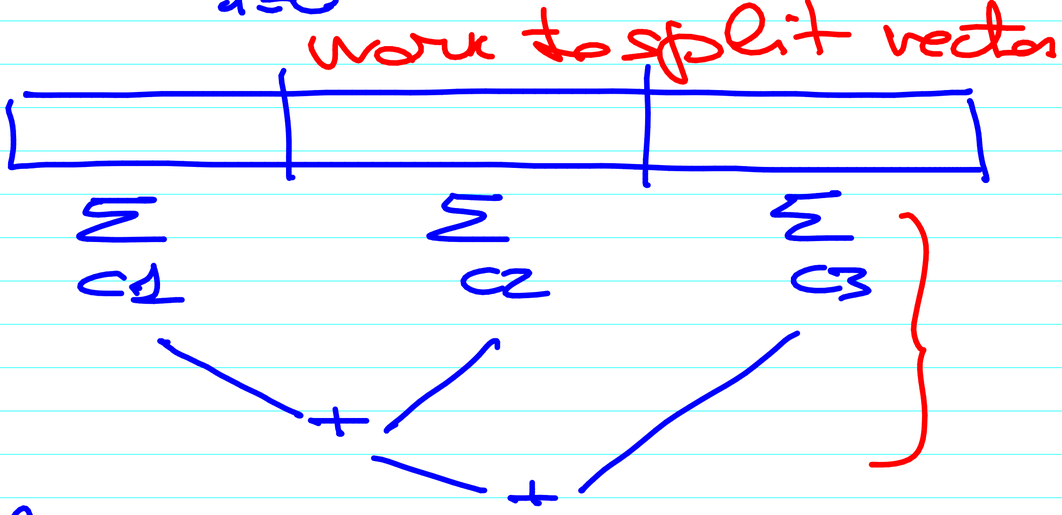


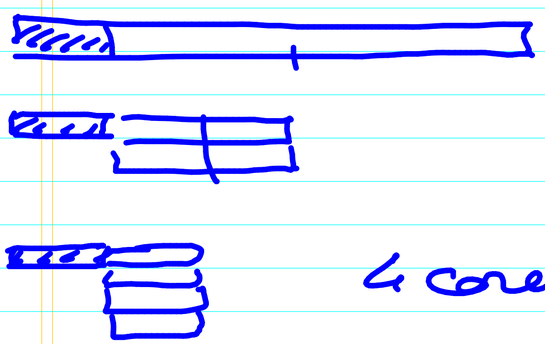
$\frac{1}{4}(t_1 - t_0)$

A[] $\quad \emptyset .. (N-1)$

$\sum_{i=0}^{N-1} A[i]$

work to split vector





$\lim_{\text{cores} \to \infty} T(n) = fT$

Amdahl law

T total time (sequential)

$f \in [0,1]$ % of serial time

$(1-f)$ % of time "parallelizable"

$$Speedup(n) = \frac{T_{seq}}{T(n)}$$

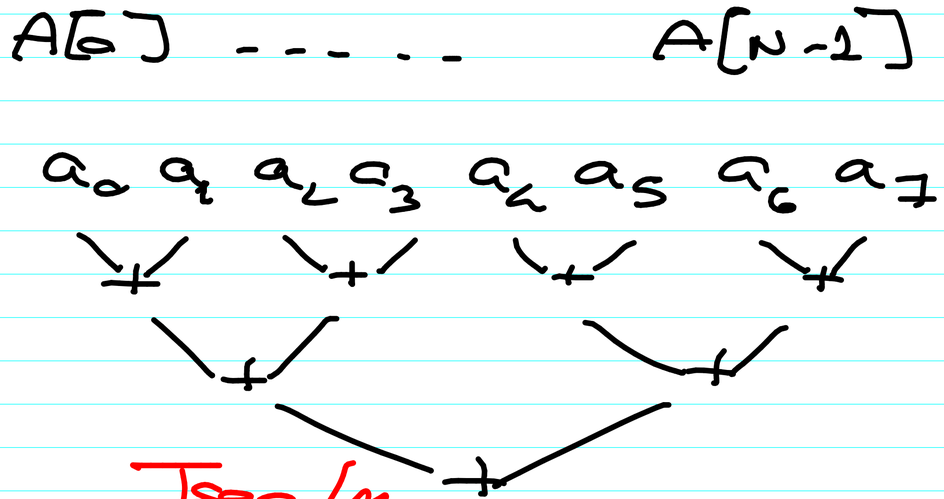
T_{seq} → best seq time

$T(n)$ → time spent on n resources

$$\frac{10h}{\frac{3}{2}h} = \frac{10 \times 2}{3}$$

$T(n) = f\,T$

$$Sp(n) = \frac{T}{fT} = \frac{1}{f}$$

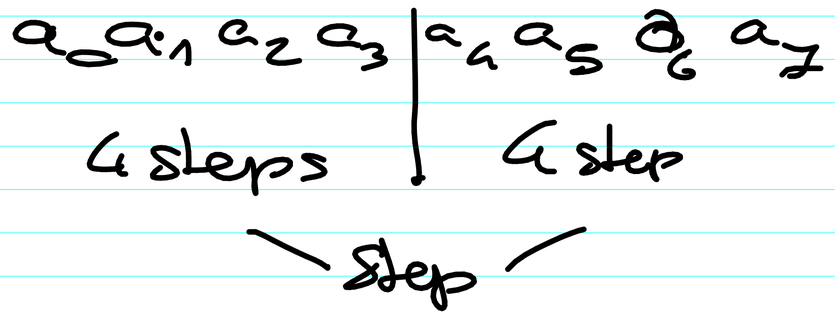


efficiency

$$E(n) = \frac{T_{id}}{T(n)} = \frac{T_{seq}/n}{T(n)} =$$

$= Sp(n)/n$

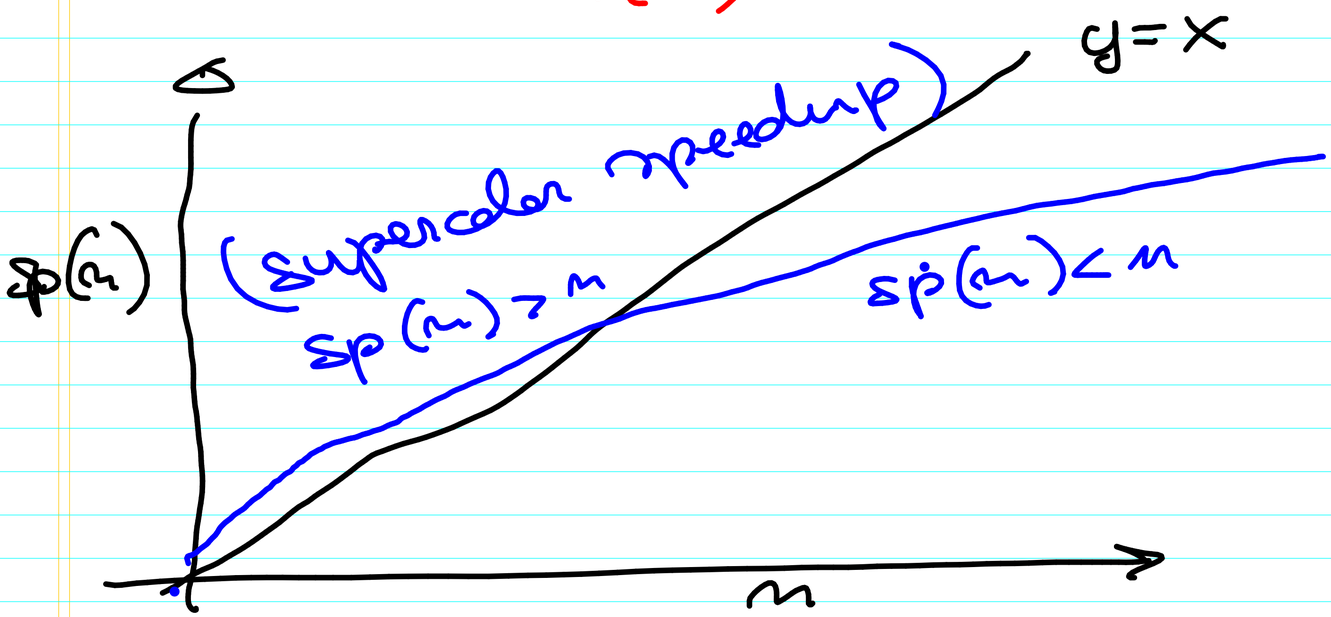
↑ ($\log_2$)

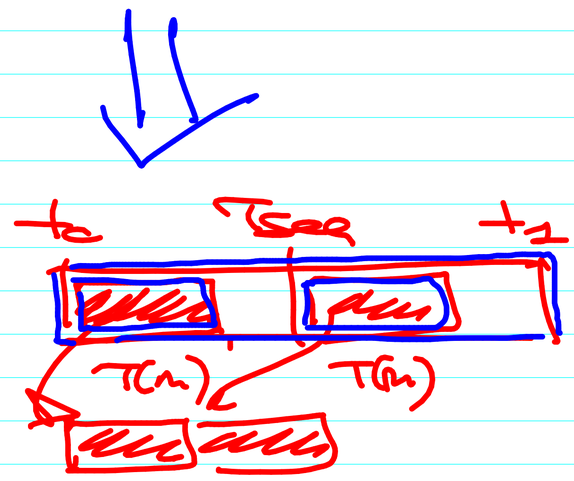


↑ linear time + log time

$$E(n) = \frac{T_{id}}{n\,T(n)} = \frac{sp(n)}{n}$$

$$sp(n) = \frac{T_{seq}}{T(n)}$$





$sp(n) > n$

$\frac{T_{seq}}{T(n)} > n$ $\quad T_{seq} > n\,T(n)$

$\equiv A[B[i]]$

↑ local $\quad$ ↑ B → locality

$B[] = \{1, 16, 1024, 128, 2, 4, 2048\}$

$t_h \approx 100\,msec \longrightarrow t_{dc} \approx 2\text{-}4\,msecs$

$$P \propto V^2 f_{req}$$

V: 0 - 5V