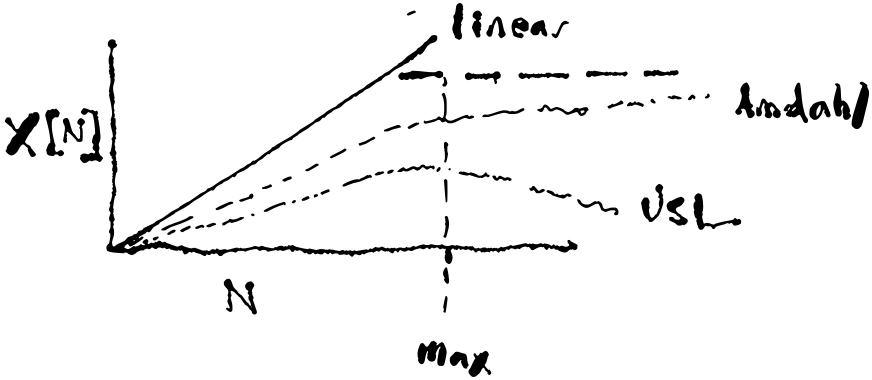
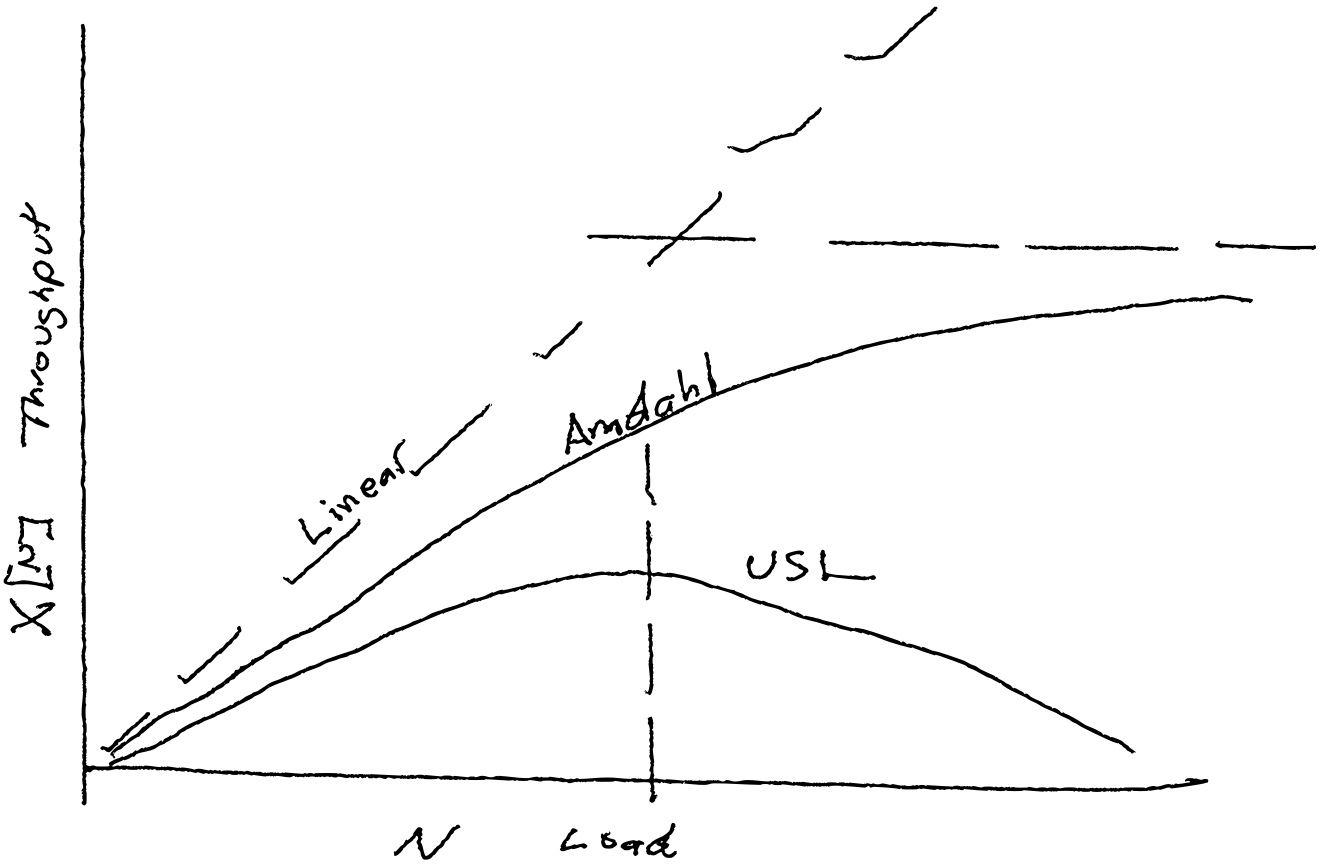

linear
X[N]
Amdahl
USL
N
max


X [=] Throughput
Linear
Amdahl
USL
N Load

Little's Law

$$N = X R$$

Load = Throughput · ResponseTime

$$1 = \left(\frac{X}{N}\right) R$$

Throughput per Load is inverse ResponseTime

$$X[N] = \frac{N\gamma}{1 + \alpha(N-1) + N(N-1)\beta}$$

$$R[N] = \frac{1 + \alpha(N-1) + N(N-1)\beta}{\gamma}$$

$$N^* = \sqrt{\frac{1-\alpha}{\beta}}$$

$X[N^*]$ is max throughput

$\frac{X[N]}{X[1]}$ is efficiency

Little's Law

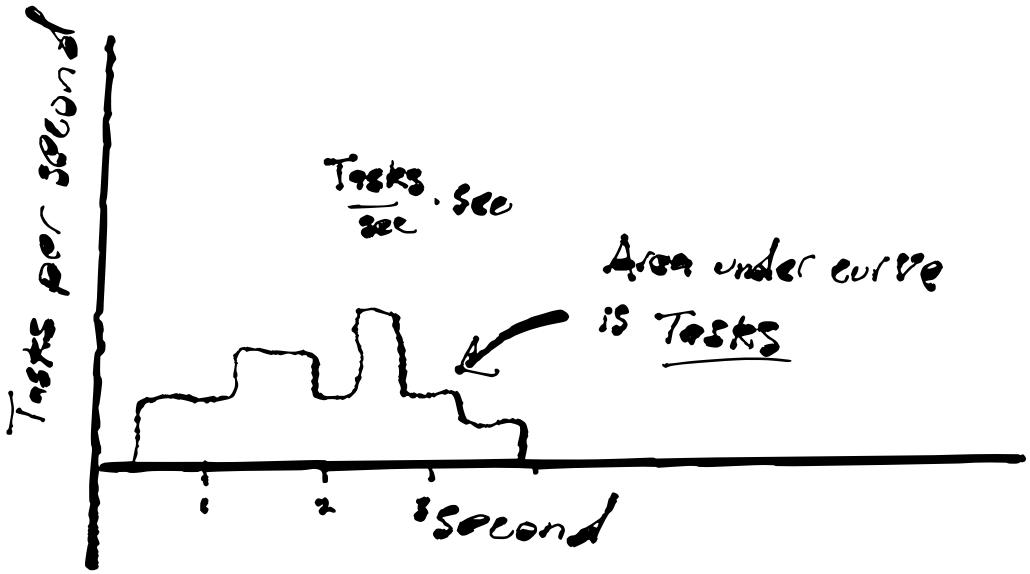
* Load is the number of tasks
* Throughput is tasks per time

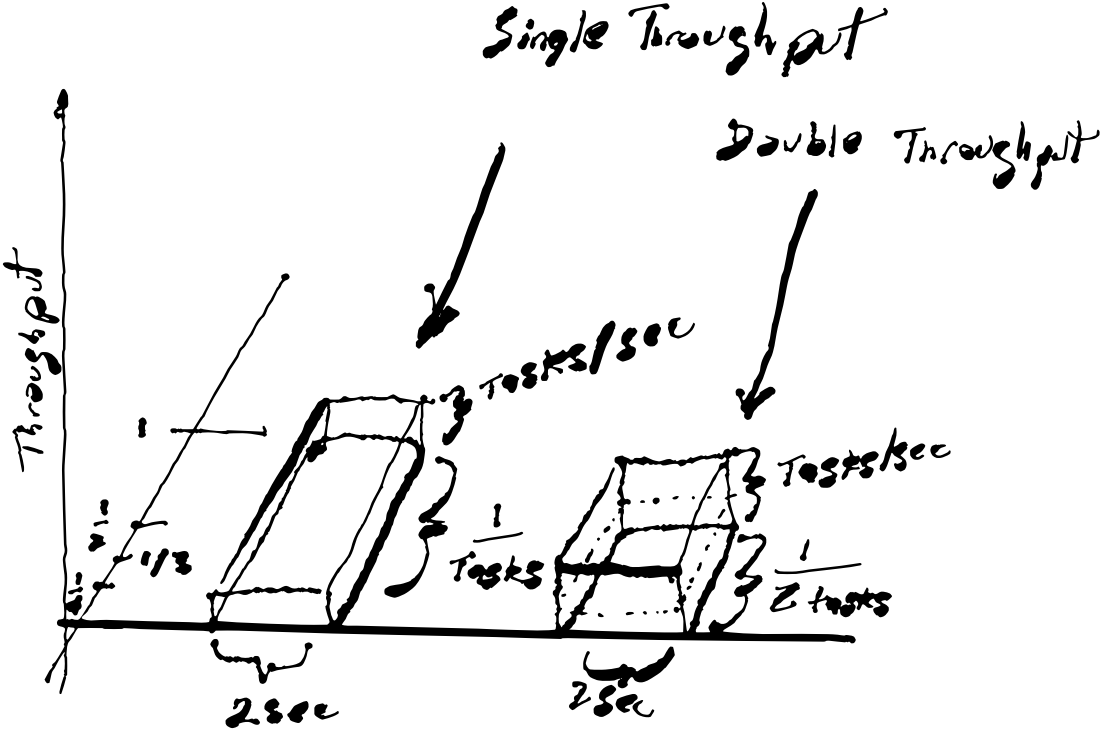
Load = Throughput · ResponseTime

$$N = X \cdot R$$

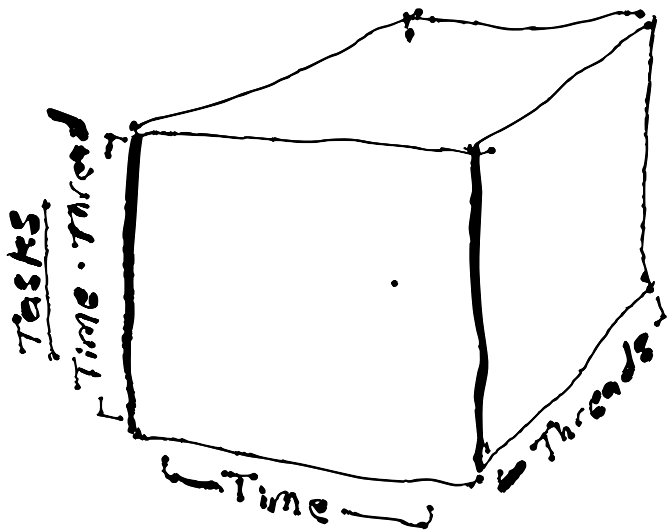
Throughput per task is inverse Response Time

$$1 = \left(\frac{X}{N}\right) \cdot R$$

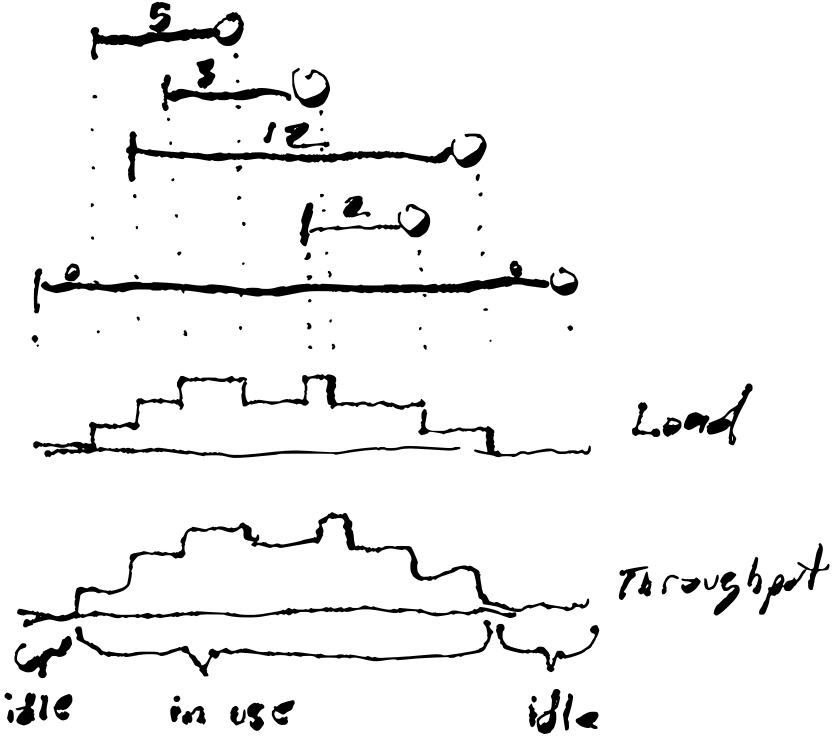

Tasks per second
Tasks/sec . sec
Area under curve is Tasks
1
2
3 Second


Single Throughput
Double Throughput
Throughput
3 Tasks/sec
1
1/2
1/3
1/3 Tasks
3 Tasks/sec
1/2 Tasks
2 sec
2 sec

Volume is work performed — Tasks



Reporting Performance



As one metric:

- ★ Throughput
- ★ Load
- ★ Response Time
- ★ Utilization

Time t

Work W

Throughput $\frac{W}{t} = X$

Processor Speed $\frac{X}{N} = \frac{W}{t \cdot N} = \frac{1}{R}$

Response Time R