$\frac{1}{\lambda}$: Avg. inter-arrival time = Time between arr. x proba.

$\frac{1}{\mu}$: Avg. service time = Service time x Proba

Stat acc.

	Clock	Q(t)	B(t)	Checkout	Future event list	ND	S
	Init	0	0		(A,1,0)(E,20)	0	0
A	0	0	1	(1,0)	(A,2,1.73)(D,1,2.90)(E,20)	0	0
A	1.73	1	1	~~(1,0)~~(2,1.73)	(A,3,3.08)(D,1,2.90)(E,20	0	0
D	2.90	0	1	(2,1.73)	(A,3,3.08)(D,2,4.66)(E,20	1	2.90
A	3.08	1	1	(2,1.73)(3,3.08)	(A,4,3.79)(D,2,4.66)(E,20	1	2.90
A	3.79	2	1	... (4,3.79)	(A,5,4.41)(D,2,4.66)(E,20	1	2.90
A	4.41	3	1	... (5,4.41)	(A,6,18.69)(D,2,4.66)(E,20)	1	2.90
D	4.66	2	1	~~(2,1.73)~~ ...	(D,3,8.05)(A,6,18.69)(E,20)	2	5.83
D	8.05	1	1	~~(3,3.08)~~ ...	(D,4,12.57)(A,6,18.69)(E,20	3	10.8
D	12.57	0	1	~~(4,3.79)~~ ...	(D,5,17.03)(A,6,18.69)(E,20	4	19.58
D	17.03	0	0	~~(5,4.41)~~	(A,6,18.69)(E,20)(D,6,21.39)	5	32.2
A	18.69	0	1	(6,18.69)	(E,20)	5	32.2

$N(t) =$ nb clients

$E(t,s) =$ clients entrées $[t, t+s]$

$D(t,s) =$ ——— partis $[t, t+s]$

Little : $\overline{N} = \lambda \cdot \overline{T}$ ← temps moy

$\overline{N}$: N moy ; λ : τ arrivé clients

$$\overline{N} = \frac{\int_0^t N(t)\,dt}{t_{max}} \qquad \overline{\overline{T}} = \frac{\int_0^t N(t)\,dt}{n}$$

$$= \frac{\overline{N}}{\overline{\overline{T}}} = \frac{n}{t_{max}} = \lambda$$

Intensité du traffic :

Régime stationnaire ? $\rho = \frac{\lambda}{\mu} < 1 \Rightarrow$ Oui

$\geq 1 \Rightarrow$ Non

Systeme continu :

Soit $U = [a, b]$

function t_inter_arr() :

```
return a+(b-a)(double)rand() / RAND_MAX;
```

function t_service() :

```
return ________________________________;
```

Systeme discret :

T_1	T_2	T_3	T_4	T_5
tia_1	tia_2	tia_3	tia_4	tia_5

function t_inter_arr() : ← same for service

```
rand_n = 99 * (double)rand() / RAND_MAX;

if (rand_n < tia1)
    return T1
elif (rand_n < tia1 + tia2)
    return T2
:
:
else
    return T5
```

boucle de simu. (t ≤ t_max)

<u>debut</u>

```
si_evenement_arrivée (t_arr < t_dep)
    q ++ ;
    delta = t_arr - t ;
    t_cumul += delta*(long_file + etat
    t_att_cumul += delta * long_file
    t_occ += delta * etat ;
    t_arr = t + generer_t_ia() ;
    t = t_arr
    si (etat == 0)
        etat = 1 ;
        t_dep = t + generer_t_srv() ;
sinon       // evenement_départ
                (t_dep <= t_arr)
    p ++ ;
    delta = t_dep - t ;
    t_att_cumul += delta*(long_file
    t_occ += delta * etat ;        + etat)
    t = t_dep
    if (long_file > 0)
        long_file -- ;
        t_dep = t + gen_t_srv()
    else
        etat = 0
        t_dep = RAND_MAX
fin

delta = t_max - t
t_att_cumul += delta *
                    (long_file + etat)
t_occ += delta * etat

N_moy = t_cumul / t_max
T_moy = t_cumul / q

t_att_moy = t_att_cum / q
```

1. M/M/1/1

2. Intensité du traffic :

$$\rho = \frac{\lambda}{\mu}$$

$$\lambda = \frac{1}{E(a)} = \frac{1}{20} = 0,05$$

$$\mu = \frac{1}{E(S)} = \frac{1}{30} = 0,033$$

donc $\rho = \frac{\lambda}{\mu} = \frac{0,05}{0,033} < 1$ donc

le système est stable et atteint son régime stationnaire

3. On suppose avoir fait le déroulement + graphique.

$$\tau_{occupation} = \frac{\int_0^t B(t)\,dt}{t_{max}} = \frac{90}{100} = 0,9 = 90\%$$

$$T_{att\_moyen} = \frac{\int_0^t Q(t)\,dt}{n} = \frac{90}{5} = 18 \text{ min}$$

$$N_{moyen} = \frac{\int_0^t N(t)\,dt}{t_{max}} = \frac{\int_0^t Q(t)+B(t)}{t_{max}}$$

$$= \frac{90+90}{100}$$

$$= 1,8 \text{ clients}$$