

**Performanse računarskih sistema (IR4PRS, SI4PRS)
-rešenja zadataka-**

1. Pogledati predavanja.

2.

$$T_{rot} = \frac{30}{N_{rev}} = 5.55ms$$

$$T_{dt} = \frac{1}{8} T_{rev} = \frac{60}{8N_{rev}} = 1.388ms$$

$$\overline{t}_{11} = \frac{2}{200^2} \cdot \int_0^{200} (200-x) \cdot 0.5 \cdot x \cdot dx = \frac{1}{200^2} \cdot \int_0^{200} (200x - x^2) \cdot dx =$$

$$= \frac{1}{200^2} \cdot \left(100x^2 - \frac{x^3}{3} \right) \Big|_0^{200} = 100 - \frac{200}{3} = 33.33ms$$

$$\overline{t}_{22} = \frac{2}{400^2} \cdot \int_0^{400} (400-x) \cdot 0.5 \cdot x \cdot dx = \frac{1}{400^2} \cdot \int_0^{400} (400x - x^2) \cdot dx =$$

$$= \frac{1}{400^2} \cdot \left(200x^2 - \frac{x^3}{3} \right) \Big|_0^{400} = 200 - \frac{400}{3} = 66.66ms$$

$$\overline{t}_{12} = \overline{t}_{21} = \frac{1}{400} \int_{z=500}^{900} \left(\frac{1}{200} \int_{100}^{300} T_{am}(z-x) \cdot dx \right) \cdot dz = \frac{1}{400} \int_{z=400}^{800} \left(\frac{1}{200} \int_0^{200} T_{am}(z-x) \cdot dx \right) \cdot dz =$$

$$= \frac{1}{400^2} \int_{z=400}^{800} \left(\int_0^{200} (z-x) \cdot dx \right) \cdot dz = \frac{1}{400^2} \int_{z=400}^{800} (200z - 20000) \cdot dz = \frac{1}{800} \int_{z=400}^{800} (z-100) \cdot dz =$$

$$= \frac{1}{800} \cdot \left(\frac{z^2}{2} - 100z \right) \Big|_{400}^{800} = 250ms$$

U 5000 pristupa disku, uključeno je 1000 t_{11} , 2000 t_{22} , 1000 t_{12} i 1000 t_{21} .

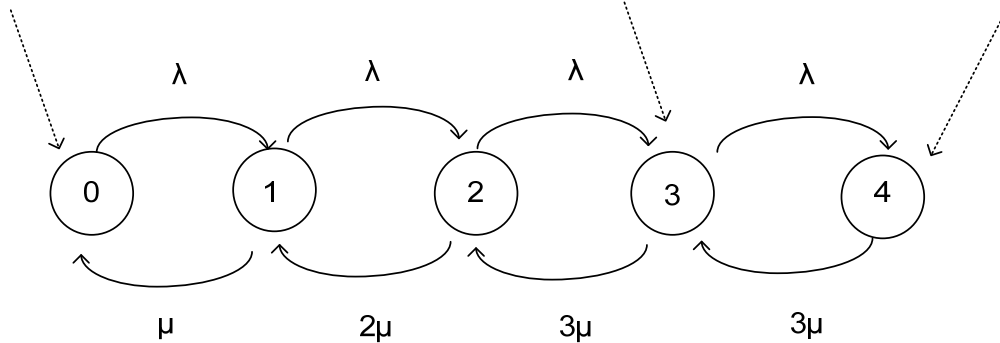
$$\overline{T} = 5000(\overline{T}_{rot} + \overline{T}_{dt}) + 1000 \cdot \overline{t}_{11} + 2000 \cdot \overline{t}_{22} + 1000 \cdot \overline{t}_{12} + 1000 \cdot \overline{t}_{21} = 701.388s$$

3. Dijagram sistema je dat na narednoj slici. Stanje i označava da u sistemu trenutno ima i procesa:

Nema poslova u sistemu

Svi opslužioци su uposlени

Čeka jedan proces (dalji zahtevi se odbijaju)



$$\mu = \frac{1}{s} = 50 \text{ posl / sec}, \quad \lambda = \frac{1}{a} = 100 \text{ posl / sec}, \quad \rho = \frac{\lambda}{\mu} = 2$$

Balansne jednačine za ovaj sistem:

$$p_0 \cdot \lambda = p_1 \cdot \mu \Rightarrow p_1 = p_0 \cdot \rho = 2p_0$$

$$p_1 \cdot \lambda = p_2 \cdot 2\mu \Rightarrow p_2 = p_1 \cdot \frac{\rho}{2} = 2p_0$$

$$p_2 \cdot \lambda = p_3 \cdot 3\mu \Rightarrow p_3 = p_2 \cdot \frac{\rho}{3} = \frac{4}{3}p_0$$

$$p_3 \cdot \lambda = p_4 \cdot 3\mu \Rightarrow p_4 = p_3 \cdot \frac{\rho}{3} = \frac{8}{9}p_0$$

$$p_0 + p_1 + p_2 + p_3 + p_4 = 1 \Rightarrow p_0 \cdot \left(1 + 2 + 2 + \frac{4}{3} + \frac{8}{9}\right) = 1$$

$$p_0 = \frac{9}{65}, \quad p_1 = p_2 = \frac{18}{65}, \quad p_3 = \frac{12}{65}, \quad p_4 = \frac{8}{65}$$

Srednji broj poslova u sistemu:

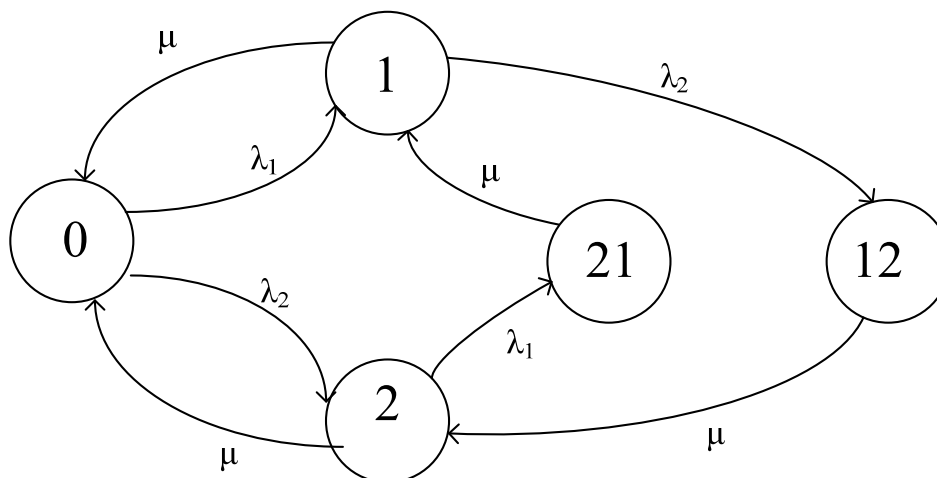
$$J = \sum_{j=0}^{\infty} j \cdot p_j = \sum_{j=1}^4 j \cdot p_j = p_1 + 2 \cdot p_2 + 3 \cdot p_3 + 4 \cdot p_4 = \frac{18}{65} + \frac{36}{65} + \frac{36}{65} + \frac{32}{65} = \frac{122}{65} = 1.877$$

$$\text{Protok: } X = \lambda \cdot (p_0 + p_1 + p_2 + p_3) = \lambda \cdot (1 - p_4) = 100 \cdot \frac{57}{65} \text{ posl / sec} = 87.69 \text{ posl / sec}$$

$$\text{Vreme odziva: } R = \frac{J}{X} = \frac{122}{5700} \text{ s} = 21.403 \text{ ms}$$

$$\text{Iskorišćenost sistema: } U = 1 - p_0 - \frac{2}{3} \cdot p_1 - \frac{1}{3} \cdot p_2 = 1 - \frac{9}{65} - \frac{12}{65} - \frac{6}{65} = \frac{38}{65} = 0.5846$$

4. a) Dijagram stanja datog sistema se može prikazati na sledeći način:



a

Stanje 0 znači da je procesor besposlen, odnosno oba terminala razmišljaju. Stanja 1 i 2 znače da je terminal 1, odnosno 2, izdao zahtev, a preostali terminal razmišlja. Stanje 12 znači da su oba terminala izdala zahteve, pri čemu se zahtev prvog terminala opslužuje, a zahtev drugog terminala čeka na opsluživanje. Analogno za stanje 21.

Balansne jednačine za ovaj sistem:

$$p_0 \cdot (\lambda_1 + \lambda_2) = p_1 \cdot \mu + p_2 \cdot \mu$$

$$p_1 \cdot (\lambda_2 + \mu) = p_0 \cdot \lambda_1 + p_{21} \cdot \mu$$

$$p_2 \cdot (\lambda_1 + \mu) = p_0 \cdot \lambda_2 + p_{12} \cdot \mu$$

$$p_{12} \cdot \mu = p_1 \cdot \lambda_2$$

$$p_{21} \cdot \mu = p_2 \cdot \lambda_1$$

$$p_0 + p_1 + p_2 + p_{12} + p_{21} = 1$$

Pri tom je:

$$\mu = \frac{1}{Sp}, \lambda_1 = \frac{1}{\theta_1} = \frac{\mu}{3}, \lambda_2 = \frac{1}{\theta_2} = \frac{\mu}{5}$$

Rešavanjem sistema dolazi se do sledećih verovatnoća stanja:

$$p_0 = \frac{3}{5}, p_1 = \frac{1}{5}, p_2 = \frac{3}{25}, p_{12} = p_{21} = \frac{1}{25}$$

Procesor nije iskorišćen jedino u stanju 0, tako da je iskorišćenje procesora:

$$U = 1 - p_0 = \frac{2}{5} = 40\%$$

Protok kroz procesor:

$$X = \frac{U}{Sp} = 40 \text{ posl / sec}$$

Prosečan broj poslova u procesorskom sistemu:

$$J = p_1 + p_2 + 2 \cdot p_{12} + 2 \cdot p_{21} = \frac{12}{25}$$

Vreme odziva procesora:

$$R = \frac{J}{X} = 12ms$$

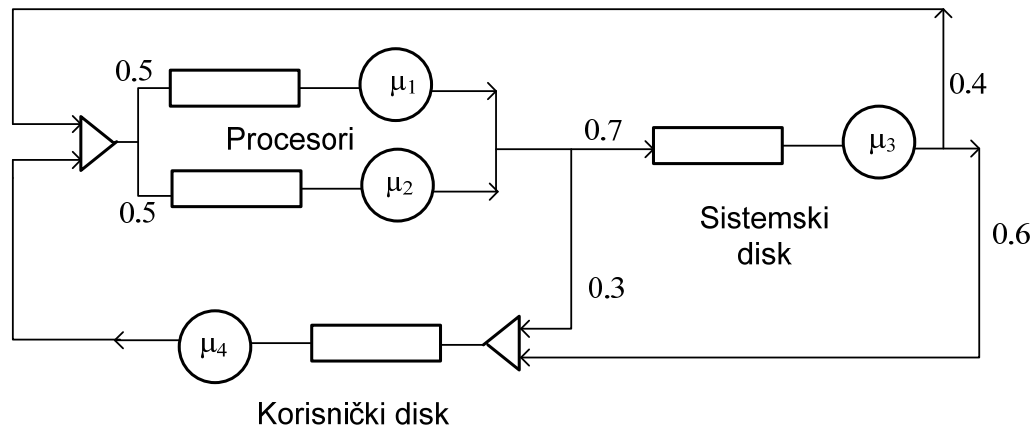
Ovo vreme predstavlja očekivano vreme od trenutka izdavanja zahteva do kraja njegove obrade.

b) Za sortiranje 3 puta dužeg vektora potrebno je, po datom algoritmu, 9 puta više procesorskog vremena. Pritom se sortiranje vrši jedino kada je procesor slobodan što se tiče interaktivnih zahteva.

$$T_1 \cdot (1 - U) = 9 \cdot T$$

$$T_1 = \frac{9 \cdot T}{1 - U} = 300s = 5 \text{ min}$$

5. Dati sistem je prikazan na sledećoj slici:



Gordon-Newell-ove jednačine za data 4 resursa:

$$-(1 - p_{11})\mu_1 x_1 + p_{21}\mu_2 x_2 + p_{31}\mu_3 x_3 + p_{41}\mu_4 x_4 = 0$$

$$p_{12}\mu_1 x_1 - (1 - p_{22})\mu_2 x_2 + p_{32}\mu_3 x_3 + p_{42}\mu_4 x_4 = 0$$

$$p_{13}\mu_1 x_1 + p_{23}\mu_2 x_2 - (1 - p_{33})\mu_3 x_3 + p_{43}\mu_4 x_4 = 0$$

$$p_{14}\mu_1 x_1 + p_{24}\mu_2 x_2 + p_{34}\mu_3 x_3 - (1 - p_{44})\mu_4 x_4 = 0$$

$$p_{13} = p_{23} = 0.7, \quad p_{14} = p_{24} = 0.3, \quad p_{31} = p_{32} = 0.4 \cdot 0.5 = 0.2, \quad p_{34} = 0.6, \quad p_{41} = p_{42} = 0.5$$

ostale verovatnoće su jednake nuli.

$$\mu_1 = \mu_2 = \frac{1}{S_p} = 200 \text{ sec}^{-1}, \quad \mu_3 = \frac{1}{S_{sd}} = 50 \text{ sec}^{-1}, \quad \mu_4 = \frac{1}{S_{kd}} = 10 \text{ sec}^{-1}$$

$$-\mu_1 x_1 + 0.2 \cdot \mu_3 x_3 + 0.5 \cdot \mu_4 x_4 = 0$$

$$-\mu_2 x_2 + 0.2 \cdot \mu_3 x_3 + 0.5 \cdot \mu_4 x_4 = 0$$

$$0.7 \cdot \mu_1 x_1 + 0.7 \cdot \mu_2 x_2 - \mu_3 x_3 = 0$$

$$0.3 \cdot \mu_1 x_1 + 0.3 \cdot \mu_2 x_2 + 0.6 \cdot \mu_3 x_3 - \mu_4 x_4 = 0$$

Kako je $\mu_1 = \mu_2$, to iz prve dve jednačine sledi da je $x_1 = x_2$.

Uzimajući da je $x_1 = x_2 = 1$, dobija se:

$$x_3 = \frac{1}{\mu_3} \cdot (0.7 \cdot \mu_1 + 0.7 \cdot \mu_2) = 1.4 \cdot \frac{\mu_1}{\mu_3} = 5.6$$

$$x_4 = \frac{1}{\mu_4} \cdot (0.3 \cdot \mu_1 + 0.3 \cdot \mu_2 + 0.6 \cdot 5.6 \cdot \mu_3) = 0.6 \cdot \frac{\mu_1}{\mu_3} = 28.8$$

Broj poseta pojedinim resursima:

$$V_1 = V_2 = 0.5$$

$$V_3 = (V_1 + V_2) \cdot 0.7 = 0.7$$

$$V_4 = (V_1 + V_2) \cdot 0.3 + V_3 \cdot 0.6 = 0.72$$

Vremena servisiranja resursa:

$$S_1 = S_2 = S_p = 5ms$$

$$S_3 = S_{sd} = 20ms$$

$$S_4 = S_{kd} = 100ms$$

Podražnje za resursima:

$$D_1 = V_1 \cdot S_1 = 2.5ms$$

$$D_2 = V_2 \cdot S_2 = 2.5ms$$

$$D_3 = V_3 \cdot S_3 = 14ms$$

$$D_4 = V_4 \cdot S_4 = 72ms$$

a)

n	1	2	3
R1[ms]	2.5	2.5686813	2.585475
R2[ms]	2.5	2.5686813	2.585475
R3[ms]	14	16.153846	17.01020
R4[ms]	72	128.96703	195.5955
R [ms]	91	150.25824	217.776
X1[posl/s]	5.4945054	6.6552089	6.88778
X2[posl/s]	5.4945054	6.6552089	6.88778
X3[posl/s]	7.6923076	9.3172925	9.64290
X4[posl/s]	7.9120879	9.5835009	9.91841
X [posl/s]	10.989010	13.310417	13.7755
U1	0.0274725	0.0332760	0.03443
U2	0.0274725	0.0332760	0.03443
U3	0.1538461	0.1863458	0.19285
U4	0.7912087	0.9583500	0.99184
Q1	0.0274725	0.0341902	0.03561
Q2	0.0274725	0.0341902	0.03561
Q3	0.1538461	0.2150144	0.23432
Q4	0.7912087	1.7166051	2.69444

Iskoriscenje 1. procesora: 0.03443
 Iskoriscenje 2. procesora: 0.03443
 Iskoriscenje sistemskog diska: 0.19285
 Iskoriscenje korisnickog diska: 0.99184
 Protok kroz 1. procesor: 6.88778
 Protok kroz 2. procesor: 6.88778
 Protok kroz sistemski disk: 9.64290
 Protok kroz korisnicki disk: 9.91841
 Vreme odziva= 217.776ms

b)

#	X1=1	X2=1	X3=5.6	X4=28.8	
0	1	1	1	1	= G(0)
1	1	2	7.6	36.4	= G(1)
2	1	3	45.56	1093.88	= G(2)
3	1	4	259.136	31762.88	= G(3)

$$g = \frac{G(2)}{G(3)} = 0.034439$$

Iskorišćenje 1. procesora: $U_{p1} = g \cdot x_1 = 0.034439$

Iskorišćenje 2. procesora: $U_{p2} = g \cdot x_2 = 0.034439$

Iskorišćenje sistemskog diska: $U_{sd} = g \cdot x_3 = 0.19285$

Iskorišćenje korisničkog diska: $U_{kd} = g \cdot x_4 = 0.991841$

Protok kroz 1. procesor: $X_{p1} = \frac{U_{p1}}{s_{p1}} = 6.88778$

Protok kroz 2. procesor: $X_{p2} = \frac{U_{p2}}{S_{p2}} = 6.88778$

Protok kroz sistemski disk: $X_{sd} = \frac{U_{sd}}{S_{sd}} = 9.64290$

Protok kroz korisnički disk: $X_{kd} = \frac{U_{kd}}{S_{kd}} = 9.91841$

Vreme odziva: $R = \frac{n}{X} = \frac{3}{2 \cdot X_{p1}} \approx 217.776\text{ms}$

c)

Usko grlo sistema je korisnički disk, jer ima najveće iskorišćenje, odnosno najveću potražnju.