O’ZBEKISTON RESPUBLIKASI AXBOROT TEXNOLOGIYALARI VA KOMMUNIKATSIYALARNI RIVOJLANTIRISH VAZIRLIGI

TOSHKENTAXBOROT TEXNOLOGIYALARI UNIVERSITETI
NUKUS FILIALI

“Telekommunikatsiya injiniringi” kafedrasi

KURS ISHI

Mavzu: Ma’lumotlarni uzatish tarmoqlarini modellashtirish va simulyatsiyalash

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Kirish

Ommaviy xizmat ko’rsatish modellarining klassifikatsiyasi.
Asosiy modellar.

Diskret xarakterli real tizimlarni funksiyalashtirishni modellashtirishda OXKT ko’rinishidagi bazaviy modellar keng qo’llaniladi, ular quyidagicha klassifikatsiyalanadi:

- xotira qurilmasidagi joylar soni bo’yicha;
- xizmat ko’rsatuvchi qurilmalar soni bo’yicha;
- OXKT ga tushuvchi buyurtma klasslari soni bo’yicha.

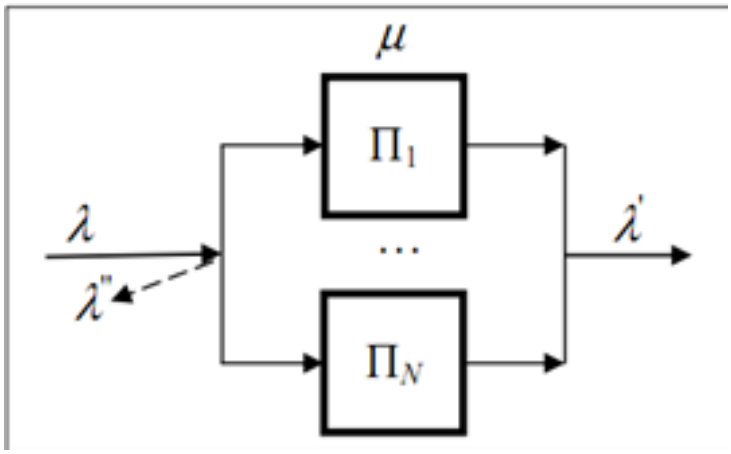
Xotira qurilmasiga ega bo’lmagan ko’p kanalli OXKT(OmmaviyXizmatKo‘rsatishtizimlari)

Tizimtavsifi.

Tizim N ta xizmat ko’rsatish qurilmasiga ega ya’ni u ko’p kanalli tizim hisoblanadi. Tizimga bir klassga oid buyurtmalar kelib tushmoqda (buyurtmalar oqimi bir xil).

Xizmat ko’rsatish qurilmalarining barchasi bir xil ishlaydi shuning uchun, buyurtmalar ixtiyoriy qurilmada xizmat ko’rsatilishi mumkin. Bir nechta buyurtmalarga bir vaqtning o’zida xizmat ko’rsatilishi mumkin.

Tizimning yana bir o’ziga xos hususiyati u xotiralash qurilmasiga ega emas.



Rasm 1.Ko’pkanalli OXKT.

Tizimga tushayotgan buyurtmalar oddiy λ intensivlikka ega oqim hosil bo’ladi. Ixtiyoriy qurilmadagi buyurtmaga xizmat ko’rsatish vaqti $\mu =$

$^{1}/_{b}$intensivlikg ega exponensial taqsimot qonuniga bo’ysinadi, bundab qurilmada o’rtacha xizmat ko’rsatish vaqti.

Buferlash qoidasi – agar qurilmalarning barchasi band bo’lsa buyurtma kelganda bu buyurtma yo’qoladi.

Agar buyurtma qurilmalardan bittasi bo’sh bo’lgan holatda kelsa buyurtma o’sha qurilmani egallaydi. Agar qurilmalardan bir nechtasi bo’sh bo’lsa tushgan buyurtma ulardan birini tasodifiy tarzda egallaydi.

Tasodifiy jarayon holatini tavsiflash uchun OXKTdagi buyurtmalar soni k dan foydalanamiz. Bunda tizim ixtiyoriy momentda (N+1) holatdan birida bo’lishi mumkin:

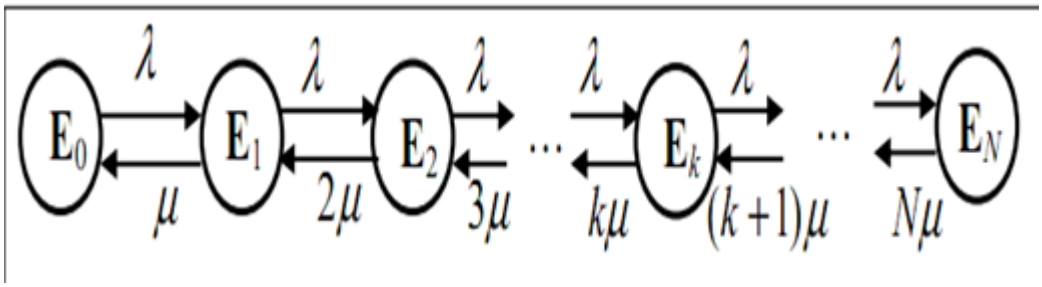
E_0; k=0 – tizimda buyurtma yo’q;

E_1; k=1 –tizimda1 ta buyurtma bor (qurilmalardan bittasi ishlayapti, qolganlar ishsiz rejimda);

E_2; k=2 –tizimda2 ta buyurtma bor (qurilmalardan ikkitasi ishlayapti, qolganlar ishsiz rejimda);

....

E_N; k=N – tizimda N ta buyurtma bor (qurilmalardan barchasi ishlayapti).



Rasm 2. Markov jarayonida o’tishlar Grafi

2-rasmdagi o’tishlar grafiga quyidagi o’tishlar intensivligi matritsasidan foydalaniladi:

$$G = \begin{array}{c|cccccc} \mathbf{E}_i & 0 & 1 & 2 & \dots & N-1 & N \\ \hline 0 & -\lambda & \lambda & 0 & \dots & 0 & 0 \\ 1 & \mu & -(\lambda+\mu) & \lambda & \dots & 0 & 0 \\ 2 & 0 & 2\mu & -(\lambda+2\mu) & \dots & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ N-1 & 0 & 0 & 0 & \dots & -(\lambda+(N-1)\mu) & \lambda \\ N & 0 & 0 & 0 & \dots & N\mu & -N\mu \end{array}.$$

Statsionar ehtimolliklarni aniqlash uchun tenglamalar sistemasi quyidagi ko'rinishga ega bo'ladi:

$$\begin{cases} \lambda p_0 = \mu p_1 \\ (\lambda+\mu) p_1 = \lambda p_0 + 2\mu p_2 \\ \dots \\ (\lambda+k\mu) p_k = \lambda p_{k-1} + (k+1)\mu p_{k+1} \\ \dots \\ N\mu p_N = \lambda p_{N-1} \\ p_0 + p_1 + \dots + p_N = 1 \end{cases}.$$

Matematik induksiya usulidan foydalangan holda quyidagi tenglikni aniqlash mumkin:

$p_k = \frac{y^k}{k!} p_0 \quad (k = \overline{0,N})$, bunda $y=\lambda b$ – tizimning yuklamasi.

Bundan kelib chiqib tizimning turib qolish koeffitsienti quyidagiga teng bo'ladi:

$$p_0 = \frac{1}{\sum_{i=0}^{N} \frac{y^i}{i!}}.$$

U holda markov tasodifiy jarayoni uchun holatlarning statsionar ehtimolligi quyidagiga teng bo'ladi:

$$p_k = \frac{\frac{y^k}{k!}}{\sum_{i=0}^{N} \frac{y^i}{i!}} \qquad (k = \overline{0,N})$$

OXKT xarakteristikalarini hisoblashda quyidagi matematik ifodalardan foydalanish mumkin:

1. Yuklama : $y = \lambda / \mu = \lambda b$;
2. Yuklanish : $\rho = \frac{1}{N}\sum_{k=0}^{N} kp_k$;
3. Tizimning turib qolish koeffitsienti: $\eta = \frac{1}{N}\sum_{k=0}^{N}(N-k)p_k = 1-\rho$;
4. Tizimdagi buyurtmalarning o’rtacha soni, ishlayotgan priborlarning o’rtacha soniga teng: $m = \sum_{k=1}^{N} kp_k = N\rho$;
5. Turib qolgan qurilmalarning o’rtacha soni: $\hat{N} = N - m$;
6.

1. Asosiynazariyma’lumotlar.

OXKT ning parametr va xarakteristikalari

OXKT ning parametrlari

OXKT ni tavsiflash uchun uch guruh parametrlardan foydalaniladi:

- struktura;
- yuklama;
- funksional parametrlar (boshqaruv parametrlari).

Struktura parametrlariga quyidagilar kiradi:

- xizmat ko’rsatuvchi qurilmalar soni K, 1 ga teng bo’lsa bir kanalli OXKT va K>1 bo’lsa ko’p kanalli OXKT;
- xotira qurilmalari soni k va sig’imi E_j (j=1,…,k);

xotiraning qurilmalar bilan o’zaro bog’lanish usuli (ko’p kanalli OXKT uchun), masalan, matritsali aloqa shaklida.

OXKTning yuklama parametrlariga quyidagilar kiradi:

- tizimga tushuvchi buyurtmalar klasslari soni N, buyurtmalar oqimi bir jinsli OXKT lar uchun 1 ga teng, buyurtmalar oqimi bir jinsli bo'lmagan OXKTlar uchun H>1;
- tizimga tushayotgan i=1,…,H klass buyurtmalari orasidagi vaqt intervalining taqsimot qonuni $A_i(\tau)$ yoki berilgan, masalan, intensilik λ_i va variatsiya koeffitsienti ν_{ai} shaklida intervalning birinchi ikkita moment taqsimoti;
- i=1,…,H klass buyurtmalariga xizmat ko'rsatish vaqti taqsimot qonuni $V_i(\tau)$ yoki birinchi ikkita momentning ko'pincha foydalaniladigan xizmat ko'rsatish o'rtacha vaqti b_i yoki intensivligi $\mu_i=1/b_i$ va variatsiya koeffitsienti ν_{bi} sifatidagi taqsimoti.

OXKT ning belgilanishi (Kendall simvolikasi)

Ommaviy xizmat ko'rsatish tizimlarini ixcham qilib tavsiflash uchun ko'pincha D.Kendall tomonidan taklif etilgan quyidagi ko'rinishdagi belgilanish ishlatiladi:

A/B/N/L

bu yerda A va B – mos holda buyurtmalarni tizimga tushish momentlari orasidagi vaqt intervali va buyurtmalarga qurilmada xizmat ko'rsatish vaqti taqsimot qonunini beradi; N – tizimlagi xizmat ko'rsatuvchi qurilmalar soni (N=1,2,…,∞); L – xotira qurilmasidagi joylar soni, 0,1,2,... qiymatlarni qabul qilishi mumkin (L ning mavjud bo'lmasligi xotira qurilmasi cheksiz sig'imga ega ekanligini ko'rsatadi).

A va Btaqsimot qonunlarini berish uchun quyidagi belgilashlardan foydalaniladi:

- G (General) – umumiy shakldagi ixtiyoriy taqsimot;
- M (Markovian) – eksponensial (ko'rsatkichli) taqsimot;
- D (Determinstik) – determinirlangan taqsimot;
- U (Uniform) – tekis taqsimot;
- E_k (Erlangian) – Erlangning k-tartibli taqsimoti (k ta ketma-ket bir xil eksponentsial fazalar bilan);

- h_k (hiroexponential) – k-tartibli gipoeksponensial taqsimot (k ta ketma-ket xar xil eksponentsial fazalar bilan);
- H_r (Hiperexponential) – r tartibli giperekspоnensial taqsimot (r ta parallel eksponensial faza bilan);
- g (gamma) – gamma taqsimoti;
- p (pareto) – Pareto taqsimoti va x.k.

Misollar:

M/M/1 – cheksiz sig'imli xotira qurilmasiga ega bir kanalli OXKT, tushayotgan bir jinsli buyurtmalar oqimidagi ketma-ket buyurtmalar orasidagi vaqt intervali (oddiy oqim) va qurilmada buyurtmaga xizmat ko'rsatish vaqti eksponensial taqsimot bilan berilgan.

M/G/3/10 – xotira sig'imi 10 ga teng 3 kanalli OXKT, bunda tushayotgan bir jinsli buyurtmalar oqimidagi ketma-ket buyurtmalar orasidagi vaqt intervali eksponensial taqsimot (oddiy oqim) va qurilmada buyurtmaga xizmat ko'rsatish vaqti umumiy shakldagi taqsimot qonuni bilan berilgan.

$D/E_2/7/0$ – xotirasiz (xotira sig'imi 0 ga teng) 7 kanalli OXKT, bunda bir jinsli buyurtmalar oqimidagi ketma-ket buyurtmalar determinirlangan vaqt intervali (determinirlangan oqim) bilan tushadi va qurilmada buyurtmaga xizmat ko'rsatish vaqti Erlangning 2-tartibli taqsimot qonuni bilan berilgan.

Buyurtmalar oqimi bir jinsli bo'lgan OXKT xarakteristikalari

Funksiyalashtirish xarakteri stoxastik bo'lgan tizimlar xarakteristikasi tasodifiy kattaliklar hisoblanadi va to'laligicha mos bo'lgan taqsimot qonunlari bilan tavsiflanadi. Amaliyotda modellashtirishda faqatgina o'rta qiymat (matematik kutilma) ni aniqlash bilan chegaralanadi, bu xarakteristikaning birinchi ikkita momenti aniqlanadi.

Yuklama va zagruzka OXKT ning tizimni funksiyalashtirish sifatini aniqlovchi muhim xarakteristikalari hisoblanadi.

1. Tugunlar xarakteristikalarini hisoblashning matematik formulalari:

Tugun yuklamasi $y_j = \lambda_j b_j = \alpha_j \lambda_0 b_j$

Tugun zagruzkasi $\rho_j = \frac{y_j}{K_j} = \frac{\alpha_j \lambda_0 b_j}{K_j} \quad \rho_j < 1$

Tugun bo'sh turish koeffitsiyenti $\eta_j = 1 - \rho_j$

Tugunda paketlarning kutish vaqti $w_j = \frac{\lambda j \cdot b^2 (1 + \nu_b^2)}{2(1 - \rho_j)}$

Tugunda bo'lish vaqti $u_j = w_j + b_j$

Tugundagi navbatning uzunligi $l_j = \lambda_j w_j = \alpha_j \lambda_0 w_j$

Tugundagi jami buyurtmalar soni $m_j = \lambda_j u_j = \alpha_j \lambda_0 (w_j + b_j) = l_j + y_j .$

Tugunning uzatish koeffitsienti $a_j = \frac{\lambda_j}{\lambda_0}$

Tugunning xizmat ko'rsatish vaqti b_j

Paketlar manbayi intensivligi

$\lambda_0 = \sum_{j=1}^{n} \gamma_j$ Bunda γ_j -har bir tugunga tashqaridan kelayotgan paketlar oqimlarning intensivligi (paket/sek.) variantda berilgan.

2. Tarmoq xarakteristikalarini hisoblashning matematik formulalari:

Tarmoqdagi tugunlar soni	N
Tarmoq yuklamasi	$Y = \sum_{j=1}^{n} y_j$
Tarmoq zagruzkasi	$R = \sum_{j=1}^{n} \rho_j$
Tarmoqda paketlarning kutish vaqti	$W = \sum_{j=1}^{n} \alpha_j w_j$
Tarmoqdagi navbatning uzunligi	$L = \sum_{j=1}^{n} l_j$

Tarmoqdagi jami buyurtmalar soni $M = \sum_{j=1}^{n} m_j$

Tarmoqda bo'lish vaqti $U = \sum_{j=1}^{n} \alpha_j u_j$

1. Kursishigaberilgantopshiriq.

Variant №4

1 - jadval

1. Tarmoq topologiyasi va paketlarni uzatish ehtimolliklari matritsasi:

Tugunlar (i, j)	1	2	3	4	5	6	7
1	0	1/3	0	0	0	0	0
2	1/2	0	½	0	0	0	0
3	0	0	0	0	1/2	1/4	0
4	0	1/2	0	0	1/4	0	0
5	0	1/2	0	0	0	1/2	0
6	0	0	0	1/2	0	0	1/2
7	0	0	0	0	0	1/2	0

p_{ij}- i –tugundan j-tugunga paketlarni uzatish ehtimolliklari.

Tarmoqning i-tugundan paketlarning chiqish ehtimolligi: $1 - \sum_{j=1}^{N} p_{ij}$

2 - jadval

2. Tugunga tashqaridan kelayotgan oqimlarning vektor intensivligi:

Tashqaridan kelayotgan paketlar oqimlarning	Tugunlar						
	1	2	3	4	5	6	7

intensivligi (paket/sek.)							
$\gamma * 10^6$	0.05	0	0.15	0.1	0	0	0.2

3- jadval

3. Tarmoq tugunlarining matematik modellari turi:

	Tugunlar						
	1	2	3	4	5	6	7
Matematik modellari	M/U/1	M/M/1	M/D/1	M/M/1	M/E_2/1	M/U/1	M/D/1

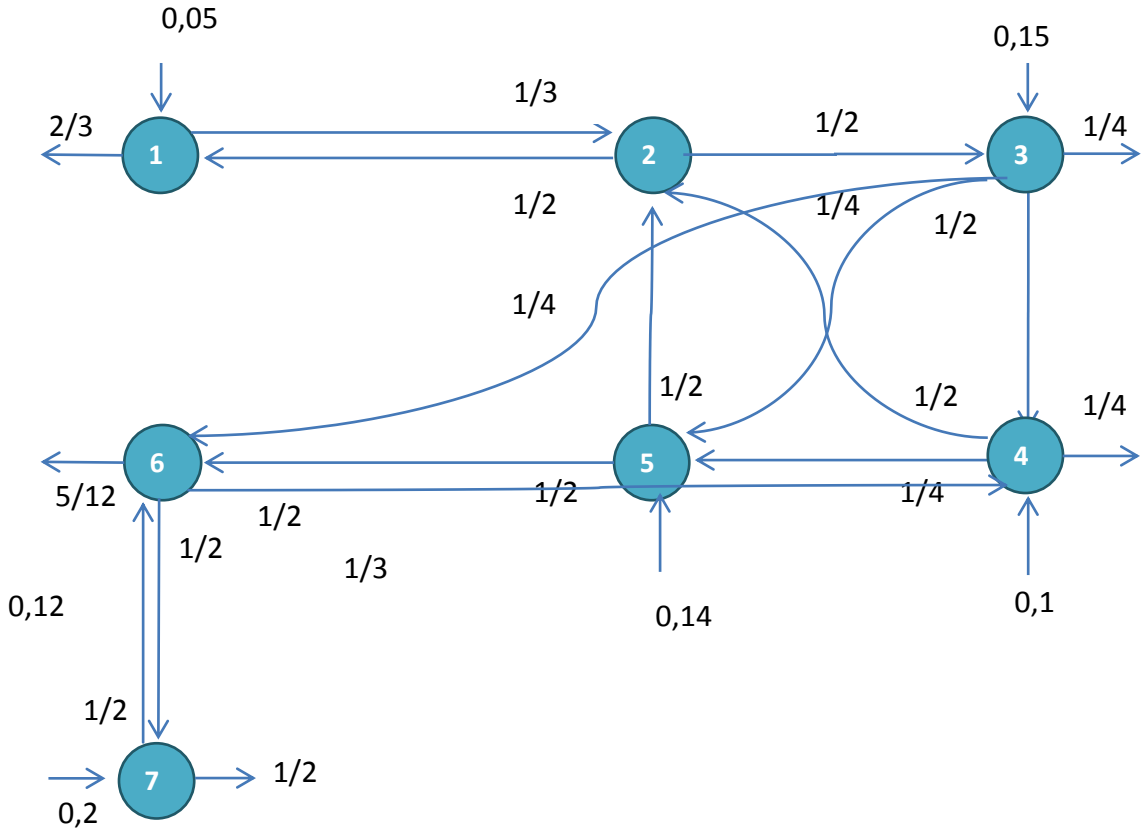
Paketlarga xizmat ko'rsatish vaqtining taqsimoti: M- eksponensial; D-determinant; E_2-Erlang 2-tartibli; U-bir tekis.

4. Imitatsion modellashtirish muhiti: GPSS World.

3. Ma'lumot uzatish tarmoqlarini analitik modellashtirish.

3.1. Tarmoq topologiyasi grafini tuzish.

Berilgan o'tish jadvalidan foydalanib tarmoq topologiyasining grafini chizamiz (1-rasm.):



1-rasm. Tarmoq topologiyasi

3.2. Intensivlikbalanstenglamasinihisoblash.

Tarmoqtopologiyasigrafigaasosanintensivlikbalanstenglamasinituzamiz:

$$\lambda_1 = 0.05 + \frac{1}{3}\lambda_2$$
$$\lambda_2 = \frac{1}{2}\lambda_5 + \frac{1}{2}\lambda_4$$
$$\lambda_3 = 0.15 + \frac{1}{2}\lambda_2$$
$$\lambda_4 = 0.1 + \frac{1}{4}\lambda_3 + \frac{1}{2}\lambda_6$$
$$\lambda_5 = 0.14 + \frac{1}{2}\lambda_3 + \frac{1}{4}\lambda_4$$
$$\lambda_6 = \frac{1}{4}\lambda_3 + \frac{1}{2}\lambda_5 + \frac{1}{2}\lambda_7$$
$$\lambda_7 = 0.2 + \frac{1}{2}\lambda_6$$

Gauss metodiusulidaintensivlikbalanstenglamasinihisoblab, tarmoqdagitugunlargakelibtushayotganpaketlartezliklarinitopamiz:

$\boldsymbol{\lambda_1 = 0,2041}$	$\boldsymbol{\lambda_2 = 0,4623}$	$\boldsymbol{\lambda_3 = 0,3811}$	$\boldsymbol{\lambda_4 = 0,4752}$	
$\boldsymbol{\lambda_5 = 0,4494}$	$\boldsymbol{\lambda_6 = 0,56}$	$\boldsymbol{\lambda_7 = 0,48}$		

3.3. Tugunning uzatish koeffitsientini aniqlash

Tugunning uzatish koeffitsienti aniqlash formulasi:

$$\alpha_i = \frac{\lambda_i}{\sum_{i=0}^{n} \lambda_i}$$

Tarmoqqakelibtushayotganpaketlartezliklariningumumiyyig'indisi:

$\lambda = 0,2041 + 0,4623 + 0,3811 + 0,4752 + 0,4494 + 0,56 + 0,48 = 3,0121$

Tugunning uzatish koeffitsientlari:

$\alpha_1 = 0,2041 / 3,0121 = 0,06776$

$\alpha_2 = 0,4623 / 3,0121 = 0,15348$

$\alpha_3 = 0,3811 / 3,0121 = 0,12652$

$\alpha_4 = 0,4752 / 3,0121 = 0,15776$

$\alpha_5 = 0,4494 / 3,0121 = 0,14919$

$\alpha_6 = 0,56 / 3,0121 = 0,18591$

$\alpha_7 = 0,48 / 3,0121 = 0,15935$

3.4. Tugunxarakteristikalarinianiqlash.

1-Tugun

Tugunmodeli: **M/U/1**

Paketlarkelibtushishtezligi: $\lambda_1 = 0,2041$

Xizmatko'rsatisho'rtachavaqti: $b_1 = 2$

Tugunning variatsiya koeffitsienti: $v = (b-a)/(\sqrt{3}(a+b))$

b=3va a=1qiymatlarni olamiz: $v = (3-1)/(\sqrt{3}(3+1)) = 0,29$

1. Tugun yuklanishi: $\rho_1 = \lambda_1 b_1 = 0,2041 * 2 = 0,40$

2. Tugun turib qolish koeffitsienti: $\eta = 1-\rho = 1 - 0,4 = 0,6$

3. Kutish vaqti: $w = \lambda b^2(1 + v^2)/2(1 - \rho) = 1,08$

4. Tizimda bo'lishning o'rtacha vaqti: $u = w+b = 1,08+2 = 3,08$

5. Buyurtmalrning o’rtacha navbat uzunligi:$l = \lambda w = 0{,}2041 * 1{,}08 = 0{,}22$

6. Tizimdagi buyurtmalarning o’rtacha soni: $m = \lambda u = 0{,}2041 * 3{,}08 = 0{,}62$

2 - Tugun

Tugunmodeli: **M/M/1**

Paketlarkelibtushishtezligi: $\lambda_2 = 0{,}4623$

Xizmatko’rsatisho’rtachavaqti: $b_2 = 1{,}5$

1. Tugunyuklanishi: $\rho_2 = \lambda_2 b_2 = 0{,}4623 * 1{,}5 = 0{,}693$

2. Tugunning uzatish koeffitsienti: $\eta = 1-\rho = 1 - 0{,}693 = 0{,}307$

3. Tugunda paketlarni kutish vaqti: $w = \rho b/(1-\rho) = 0{,}693*1{,}5/(1-0{,}693) = 3{,}38$

4. Tugunda bo’lish o’rtacha vaqti: $u = w+b = 3{,}38+1{,}5 = 4{,}88$

5. Buyurtmalarni o’rtacha navbat uzunligi: $l = \lambda w = 0{,}4623 * 3{,}38 = 1{,}56$

6. Tizimda buyurtmalarni o’rtacha soni: $m = \lambda u = 0{,}4623 * 4{,}88 = 2.25$

3 - Tugun

Tugunmodeli: **M/D/1** $\lambda_3 = 0{,}3811$ $b_3 = 1{,}4$

1. Tugunyuklanishi: $\rho_3 = \lambda_3 b_3 = 0{,}3811 * 1{,}4 = 0{,}5335$

2. Tugunning uzatish koeffitsienti: $\eta = 1-\rho = 1 - 0{,}5335 = 0{,}4664$

3. Tugunda paketlarni kutish vaqti: $w = \lambda b^2/2(1-\rho) = 0{,}3811 * 1{,}4^2/2(1-0{,}4664) = 0{,}79$

4. Tugunda bo’lish o’rtacha vaqti: $u = w+b = 0{,}79+1{,}4 = 2{,}19$

5. Buyurtmalarni o’rtacha navbat uzunligi: $l = \lambda w = 0{,}3811 * 0{,}79 = 0{,}301$

6. Tizimda buyurtmalarni o’rtacha soni: $m = \lambda u = 0{,}3811 * 2{,}19 = 0{,}834$

4 -Tugun

Tugunmodeli: **M/M/1** $\lambda_4 = 0,4752$ $b_4 = 1,5$

1. Tugunyuklanishi: $\rho_4 = \lambda_4 b_4 = 0,4752 * 1,5 = 0,712$

2. Tugunning uzatish koeffitsienti :$\eta = 1-\rho = 1 - 0,712 = 0,288$

3. Tugunda paketlarni kutish vaqti: $w = \rho b/ (1-\rho) = 0,712*1,5/(1-0,712) = 3,70$

4. Tugunda bo'lish o'rtacha vaqti: $u = w+b = 3,70+1,5 = 5,2$

5. Buyurtmalarni o'rtacha navbat uzunligi: $l = \lambda w = 0,4752*3,7 = 1,75$

6. Tizimda buyurtmalarni o'rtacha soni: $m = \lambda u = 0,4752* 5,2 = 2,47$

5 - Tugun

Tugunmodeli: **M/E_2/1**$\lambda_5 = 0,4494$ $b_5 = 1,4$ $k = 2$

Variatsiyakoeffietsienti: $v = 1/\sqrt{k} = 1/\sqrt{2} = 0,707$

1. Tugunyuklanishi: $\rho_5 = \lambda_5 b_5 = 0,4494* 1,4 = 0,62$

2. Tugunning uzatish koeffitsienti: $\eta = 1-\rho = 1 - 0,62 = 0,38$

3. Tugunda paketlarni kutish vaqti: $w = \lambda b^2(1+ v^2)/2(1- \rho) = 1,72$

4. Tugunda bo'lish o'rtacha vaqti: $u = w+b = 1,72+1,4 = 3,12$

5. Buyurtmalarni o'rtacha navbat uzunligi: $l = \lambda w = 0,4494 *1,72 = 0,77$

6. Tizimda buyurtmalarni o'rtacha soni: $m = \lambda u = 0,4494 * 3,12 = 1,40$

6 - Tugun

Tugunmodeli: **M/U/1** $\lambda_6 = 0,56 b_6 = 1,3$

Tugunvariatsiyakoeffitsienti: $v = (b-a)/(\sqrt{3}(a+b))$

b=3 va a=1 qiymatlarniolamiz: $v = (3-1)/(\sqrt{3}(3+1)) = 0,29$

1. Tugunyuklanishi:$\rho_6 = \lambda_6 b_6 = 0,56 * 1,3 = 0,72$

2. Tugunning uzatish koeffitsienti: $\eta = 1-\rho = 1 - 0,72 = 0,28$

3. Tugunda paketlarni kutish vaqti:$w = \lambda b^2(1+ v^2)/2(1- \rho) = 1,82$

4. Tugunda bo'lish o'rtacha vaqti: $u = w+b = 1,82+1,3 = 3,12$

5. Buyurtmalarni o'rtacha navbat uzunligi: $l = \lambda w = 0,56 * 1,82 = 1,01$

6. Tizimda buyurtmalarni o'rtacha soni:$m = \lambda u = 0,56 * 3,12 = 1,74$

Узел7

Tugunmodeli: **M/D/1** $\lambda_7 = 0,48$ $b_7 = 1,4$

1. Tugunyuklanishi $\rho_7 = \lambda_7 b_7 = 0,48 * 1,4 = 0,672$

2.Tugunturibqolishkoeffitsienti: $\eta = 1-\rho = 1 - 0,672 = 0,328$

3. Kutishvaqti: $w = \lambda b^2/2(1- \rho)=0,48*1,4^2 /2(1-0,672)=1,43$

4. O'rtachatizimdabo'lishvaqti: $u = w+b = 1,43+1,4 =2,83$

5. Navbatdaturganbuyurtmaluzunligi: $l = \lambda w = 0,48 * 1,43=0,686$

6. Tizimdagibuyurtmalarningo'rtachasoni: $m = \lambda u = 0,48 * 2,83= 1,358$

Tugunlarxarakteristikasiumumlashganjadvali

4-jadval

4. Tarmoqdama’lumotlaruzatishsimulyatsiyasi.

4.1 GPSSdasturidatarmoqstrukturasituzilishi.

	Tugunlar						
	1	2	3	4	5	6	7
Matematik modellar	M/U/1	M/M/1	M/D/1	M/M/1	M/E_2/1	M/U/1	M/D/1

1- tugunuchunmatemtik model **M/U/1.**

GPSS world da dasturtuzilishi:

```
GENERATE(EXPONENTIAL(1,0,20))
QUEUE t1;
SEIZE tt1;
DEPART t1;
ADVANCE(Uniform(1,1,2);
RELEASE tt1;
TERMINATE 1;
START 10000;
```

2- tugunuchunmatemtik model **M/M/1.**

GPSS world da dasturtuzilishi:

```
QUEUE t2;
SEIZE tt2;
DEPART t2;
ADVANCE(EXPONENTIAL(1,0,1.5));
RELEASE tt2;
TERMINATE 1;
START 10000;
```

3- tugunuchunmatemtik model **M/D/1.**

GPSS world da dasturtuzilishi:

```
GENERATE(EXPONENTIAL(1,0,6.7))
QUEUE t3;
SEIZE tt3;
DEPART t3;
ADVANCE(1.4);
RELEASE tt3;
TERMINATE 1;
START 10000;
```

4- tugunuchunmatemtik model **M/M/1.**

GPSS world da dasturtuzilishi:

```
GENERATE(EXPONENTIAL(1,0,10))
QUEUE t4;
SEIZE tt4;
DEPART t4;
ADVANCE(EXPONENTIAL(1,0,1.5));
RELEASE tt4;
TERMINATE 1;
START 10000;
```

5- tugunuchunmatemtik model **$M/E_2/1$.**

GPSS world da dasturtuzilishi:

```
QUEUE t5;
```
-t1 tuguni navbatiga paketning kelib tushgan momenti(vaqtini) qayd qilish(yozish)

```
SEIZE tt5;
```
- t1 tuguninavbatiga

```
DEPART t5;
```

```
ADVANCE(EXPONENTIAL(1,0,1.4)+EXPONENTIAL(1,0,1.4));
RELEASE tt5;
TERMINATE 1;
START 10000;
```

6- tugunuchunmatemtik model **M/U/1.**

GPSS world da dasturtuzilishi:

```
QUEUE t6;
SEIZE tt6;
DEPART t6;
ADVANCE(Uniform(1,1,1.3));
RELEASE tt6;
TERMINATE 1;
START 10000;
```

7- tugunuchunmatemtik model **M/D/1.**

GPSS world da dasturtuzilishi:

```
GENERATE(EXPONENTIAL(1,0,5))
QUEUE t7;
SEIZE tt7;
DEPART t7;
ADVANCE(1.4);
RELEASE tt7;
TERMINATE 1;
START 10000;
```

4.2. 7 ta tugunningumumiydasturtuzilishi

GENERATE(EXPONENTIAL(1,0,20))

met_1 QUEUE t1

SEIZE tt1

DEPART t1

ADVANCE(Uniform(1,1,2))

RELEASE tt1

TRANSFER 0.33,,met_2

TERMINATE 1

met_2 QUEUE t2

SEIZE tt2

DEPART t2

ADVANCE(EXPONENTIAL(1,0,1.5))

RELEASE tt2

TRANSFER 0.5,met_1,met_3

GENERATE(EXPONENTIAL(1,0,6.7))

met_3 QUEUE t3

SEIZE tt3

DEPART t3

ADVANCE(1.4)

RELEASE tt3

TRANSFER 0.5,,met_5

TRANSFER 0.125,,met_4

TERMINATE 1

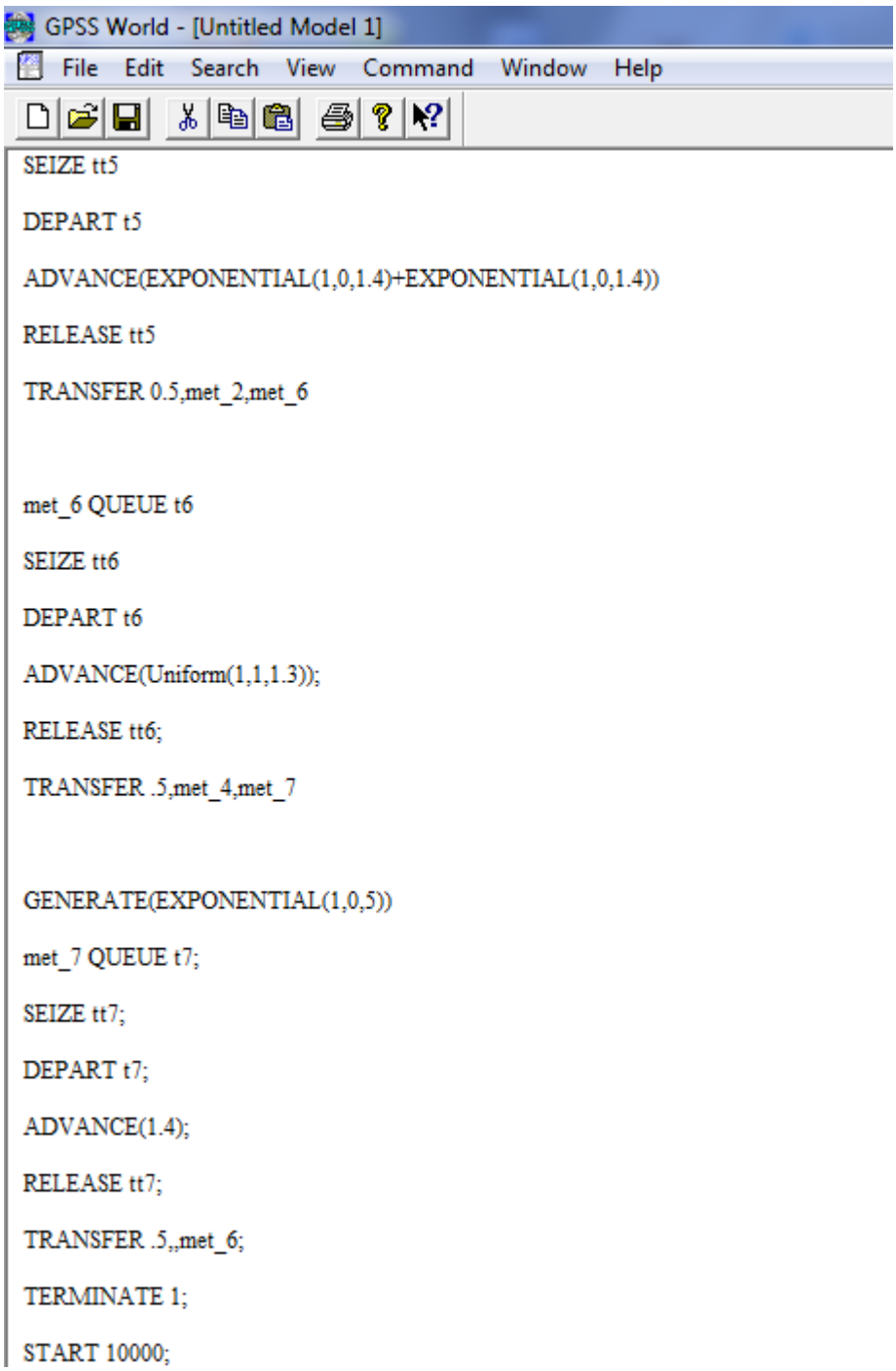
GENERATE(EXPONENTIAL(1,0,10))

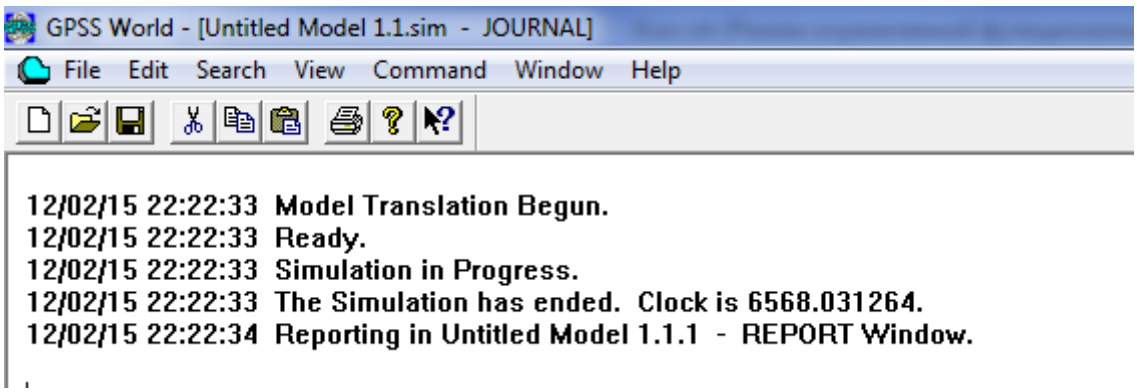
met_4 QUEUE t4

```
SEIZE tt4
DEPART t4
ADVANCE(EXPONENTIAL(1,0,1.5))
RELEASE tt4
TRANSFER .5,,met_2
TRANSFER .125,,met_5
TERMINATE 1;

met_5 QUEUE t5
SEIZE tt5
DEPART t5
ADVANCE(EXPONENTIAL(1,0,1.4)+EXPONENTIAL(1,0,1.4))
RELEASE tt5
TRANSFER 0.5,met_2,met_6

met_6 QUEUE t6
SEIZE tt6
DEPART t6
ADVANCE(Uniform(1,1,1.3));
RELEASE tt6;
TRANSFER .5,met_4,met_7

GENERATE(EXPONENTIAL(1,0,5))
met_7 QUEUE t7;
SEIZE tt7;
DEPART t7;
ADVANCE(1.4);
RELEASE tt7;
TRANSFER .5,,met_6;
TERMINATE 1;
START 10000;
```

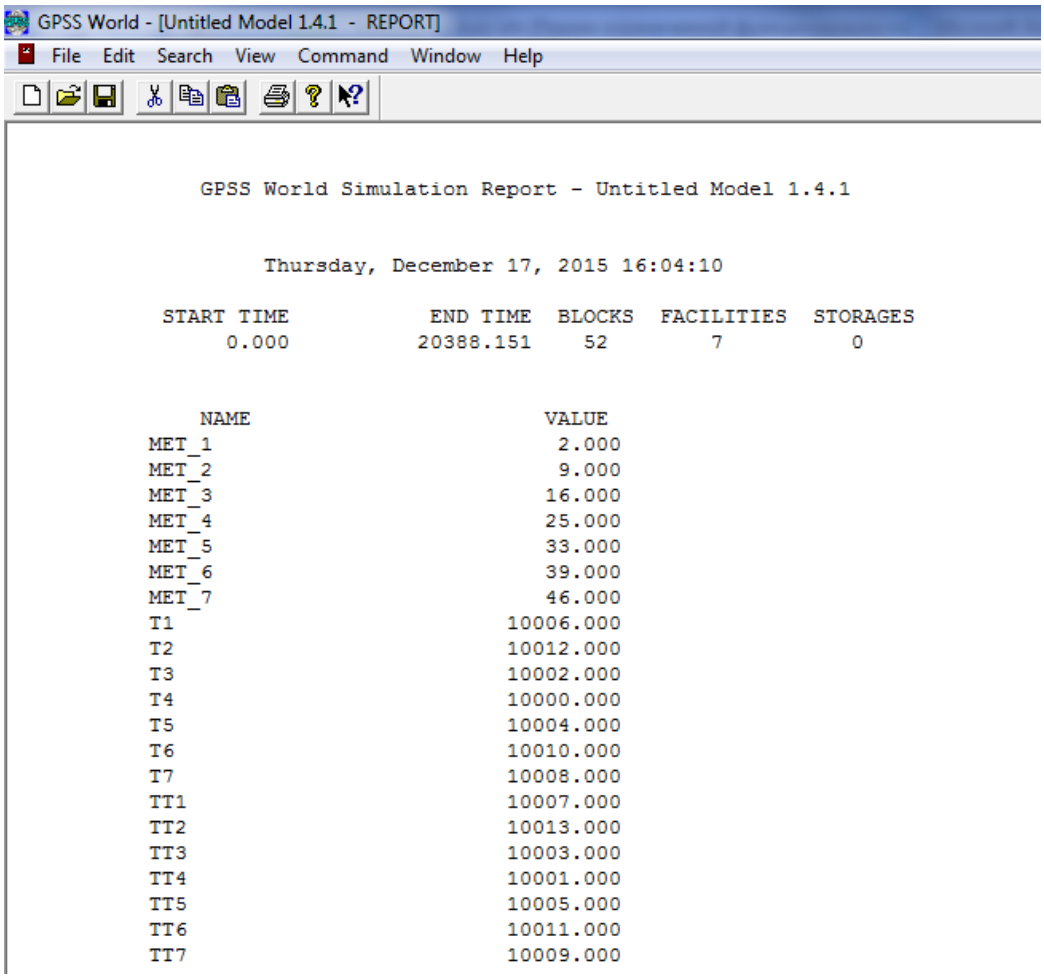
GPSS da dasturlangan model ko’rinishi:


GPSS World - [Untitled Model 1]
File Edit Search View Command Window Help
SEIZE tt3
DEPART t3
ADVANCE(1.4)
RELEASE tt3
TRANSFER 0.5,,met_5
TRANSFER 0.125,,met_4
TERMINATE 1
GENERATE(EXPONENTIAL(1,0,10))
met_4 QUEUE t4
SEIZE tt4
DEPART t4
ADVANCE(EXPONENTIAL(1,0,1.5))
RELEASE tt4
TRANSFER .5,,met_2
TRANSFER .125,,met_5
TERMINATE 1;
met_5 QUEUE t5
SEIZE tt5
DEPART t5


GPSS World - [Untitled Model 1]
File Edit Search View Command Window Help
SEIZE tt5
DEPART t5
ADVANCE(EXPONENTIAL(1,0,1.4)+EXPONENTIAL(1,0,1.4))
RELEASE tt5
TRANSFER 0.5,met_2,met_6
met_6 QUEUE t6
SEIZE tt6
DEPART t6
ADVANCE(Uniform(1,1,1.3));
RELEASE tt6;
TRANSFER .5,met_4,met_7
GENERATE(EXPONENTIAL(1,0,5))
met_7 QUEUE t7;
SEIZE tt7;
DEPART t7;
ADVANCE(1.4);
RELEASE tt7;
TRANSFER .5,,met_6;
TERMINATE 1;
START 10000;


GPSS World - [Untitled Model 1.1.sim - JOURNAL]
File Edit Search View Command Window Help
12/02/15 22:22:33 Model Translation Begun.
12/02/15 22:22:33 Ready.
12/02/15 22:22:33 Simulation in Progress.
12/02/15 22:22:33 The Simulation has ended. Clock is 6568.031264.
12/02/15 22:22:34 Reporting in Untitled Model 1.1.1 - REPORT Window.

Modellashtirishnatijasi

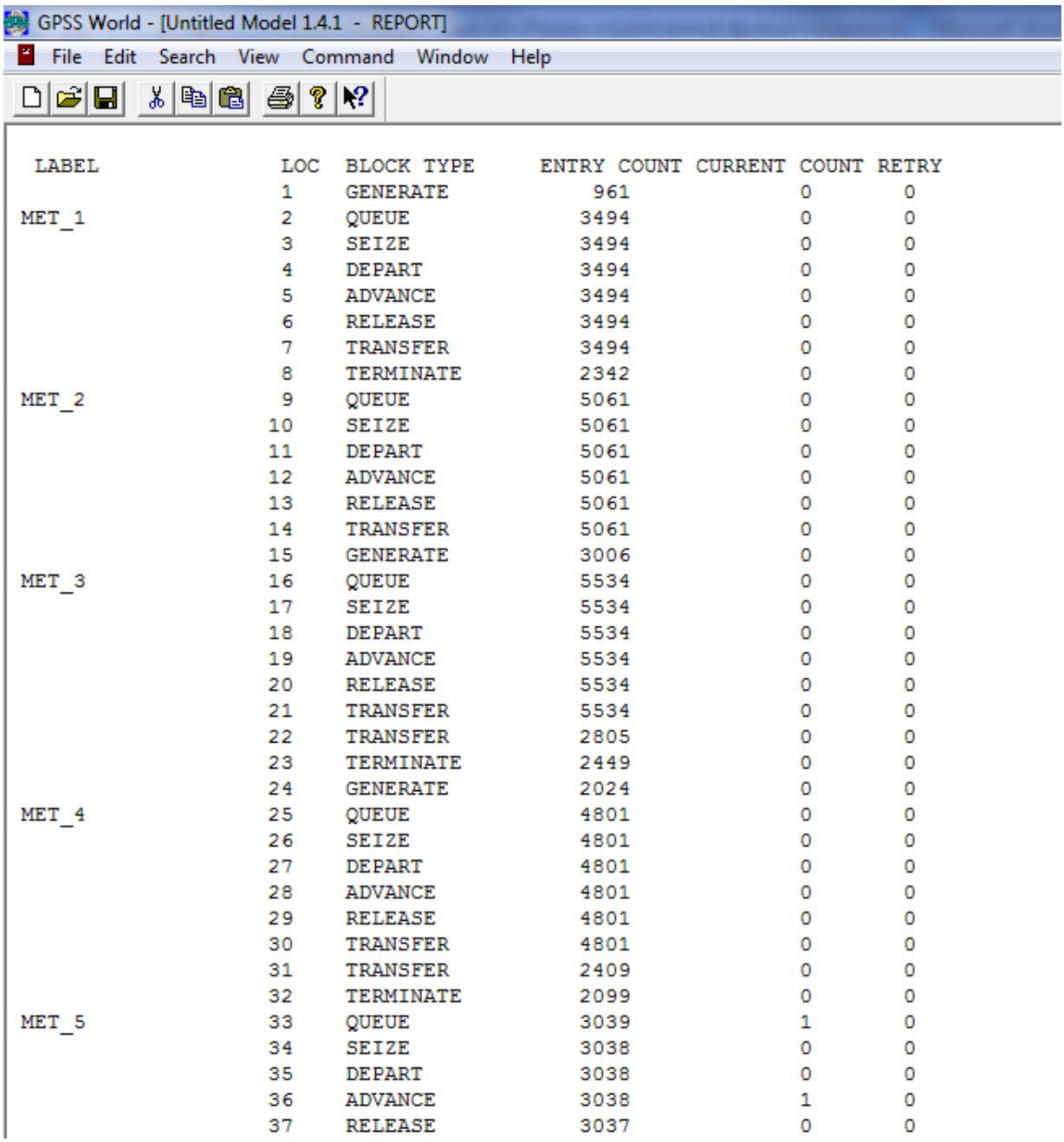


GPSS World Simulation Report - Untitled Model 1.4.1

Thursday, December 17, 2015 16:04:10

START TIME	END TIME	BLOCKS	FACILITIES	STORAGES
0.000	20388.151	52	7	0

NAME	VALUE
MET_1	2.000
MET_2	9.000
MET_3	16.000
MET_4	25.000
MET_5	33.000
MET_6	39.000
MET_7	46.000
T1	10006.000
T2	10012.000
T3	10002.000
T4	10000.000
T5	10004.000
T6	10010.000
T7	10008.000
TT1	10007.000
TT2	10013.000
TT3	10003.000
TT4	10001.000
TT5	10005.000
TT6	10011.000
TT7	10009.000



LABEL	LOC	BLOCK TYPE	ENTRY COUNT	CURRENT COUNT	RETRY
	1	GENERATE	961	0	0
MET_1	2	QUEUE	3494	0	0
	3	SEIZE	3494	0	0
	4	DEPART	3494	0	0
	5	ADVANCE	3494	0	0
	6	RELEASE	3494	0	0
	7	TRANSFER	3494	0	0
	8	TERMINATE	2342	0	0
MET_2	9	QUEUE	5061	0	0
	10	SEIZE	5061	0	0
	11	DEPART	5061	0	0
	12	ADVANCE	5061	0	0
	13	RELEASE	5061	0	0
	14	TRANSFER	5061	0	0
	15	GENERATE	3006	0	0
MET_3	16	QUEUE	5534	0	0
	17	SEIZE	5534	0	0
	18	DEPART	5534	0	0
	19	ADVANCE	5534	0	0
	20	RELEASE	5534	0	0
	21	TRANSFER	5534	0	0
	22	TRANSFER	2805	0	0
	23	TERMINATE	2449	0	0
	24	GENERATE	2024	0	0
MET_4	25	QUEUE	4801	0	0
	26	SEIZE	4801	0	0
	27	DEPART	4801	0	0
	28	ADVANCE	4801	0	0
	29	RELEASE	4801	0	0
	30	TRANSFER	4801	0	0
	31	TRANSFER	2409	0	0
	32	TERMINATE	2099	0	0
MET_5	33	QUEUE	3039	1	0
	34	SEIZE	3038	0	0
	35	DEPART	3038	0	0
	36	ADVANCE	3038	1	0
	37	RELEASE	3037	0	0

	38	TRANSFER	3037	0	0
MET_6	39	QUEUE	4804	0	0
	40	SEIZE	4804	0	0
	41	DEPART	4804	0	0
	42	ADVANCE	4804	0	0
	43	RELEASE	4804	0	0
	44	TRANSFER	4804	0	0
	45	GENERATE	4011	0	0
MET_7	46	QUEUE	6394	0	0
	47	SEIZE	6394	0	0
	48	DEPART	6394	0	0
	49	ADVANCE	6394	0	0
	50	RELEASE	6394	0	0
	51	TRANSFER	6394	0	0
	52	TERMINATE	3110	0	0

FACILITY	ENTRIES	UTIL.	AVE. TIME	AVAIL.	OWNER	PEND	INTER	RETRY	DELAY
TT4	4801	0.346	1.470	1	0	0	0	0	0
TT3	5534	0.380	1.400	1	0	0	0	0	0
TT5	3038	0.423	2.837	1	10001	0	0	0	1
TT1	3494	0.256	1.493	1	0	0	0	0	0
TT7	6394	0.439	1.400	1	0	0	0	0	0
TT6	4804	0.271	1.150	1	0	0	0	0	0
TT2	5061	0.379	1.526	1	0	0	0	0	0

QUEUE	MAX	CONT.	ENTRY	ENTRY(0)	AVE.CONT.	AVE.TIME	AVE.(-0)	RETRY
T4	6	0	4801	3232	0.182	0.771	2.361	0
T3	4	0	5534	3433	0.114	0.419	1.104	0
T5	6	1	3039	1828	0.199	1.336	3.352	0
T1	4	0	3494	2535	0.053	0.310	1.130	0
T7	6	0	6394	3365	0.179	0.571	1.204	0
T6	3	0	4804	3992	0.027	0.114	0.675	0
T2	6	0	5061	3232	0.210	0.845	2.338	0

FEC XN	PRI	BDT	ASSEM	CURRENT	NEXT	PARAMETER	VALUE
10001	0	20388.773	10001	36	37		
10005	0	20389.246	10005	0	15		
10003	0	20390.805	10003	0	24		
10006	0	20390.900	10006	0	45		
9994	0	20420.130	9994	0	1		

Foydalanilganadabiyotlar

1.Клейнрок Л. Теория массового обслуживани: Пер. с англ. – М.: Машиностроение, 1979. – 432 с.

2. Клейнрок Л. Вычислительные системы с очередями: Пер. с англ. –М.: Мир,1979. -600 с.

3. Алиев Т.И. Основы моделирования дискретных систем. – СПб.: СПбГУ ИТМО, 2009.- 363 с.

4.Боев В.Д., Кирик Д.И., Сыпченко Р.П. Компьютерное моделирование: Пособие для курсового и дипломного проектирования.-СПб: ВАС, 2011.-348 с.