Лабораторная работа 11

Модель системы массового обслуживания $M|M|1$

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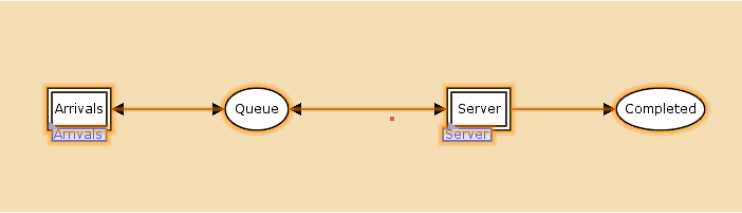
Цель работы

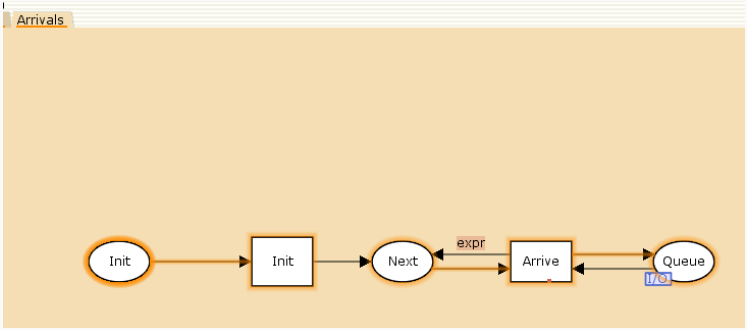
Реализовать модель M|M|1 в CPN tools.

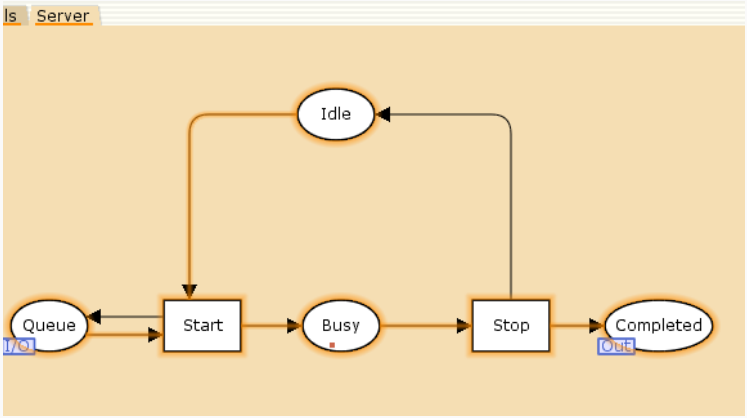
Задание

1. Реализовать в CPN Tools модель системы массового обслуживания M|M|1.
2. Настроить мониторинг параметров моделируемой системы и нарисовать графики очереди.

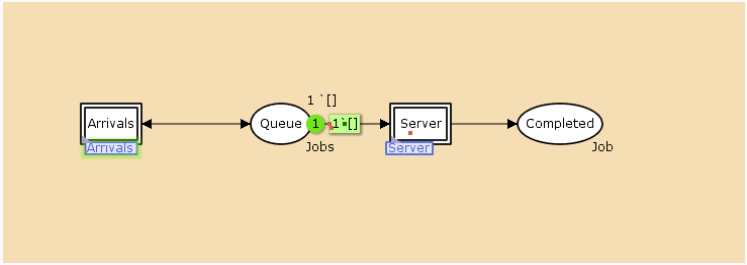
Выполнение лабораторной работы

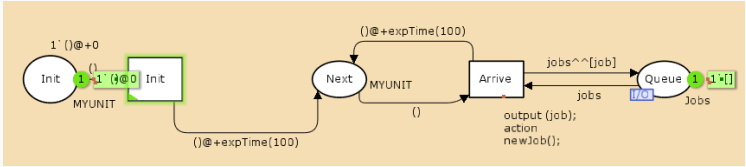


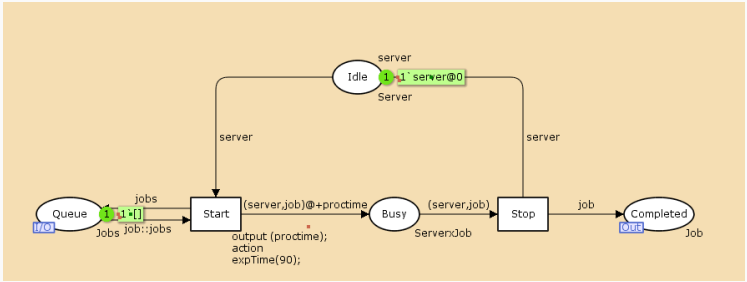

Arrivals
Init
Init
Next
expr
Arrive
Queue
I/O


ls
Server
Idle
Queue
Start
Busy
Stop
Completed
I/O
Out

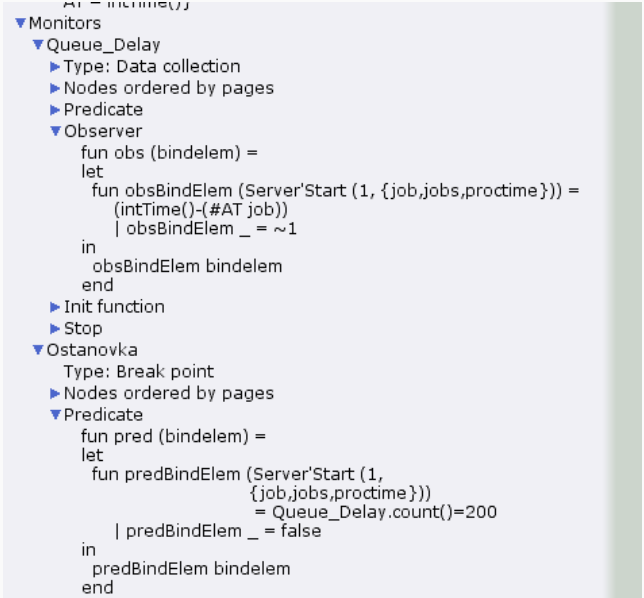

queue_system.cpn
Step: 0
Time: 0
Options
History
Declarations
Standard declarations
System
colset MYUNIT = unit timed;
colset INT = int;
colset Server = with server timed;
colset JobType = with A|B;
colset Job = record
jobType: JobType*
AT: INT;
colset Jobs = list Job;
colset ServerxJob = product
Server* Job timed;
var proctime: INT;
var job : Job;
var jobs : Jobs;
fun expTime(mean: int) =
let
val realMean = Real.fromInt mean
val rv = exponential ((1.0/realMean))
in
floor (rv+0.5)
end;
fun intTime() = IntInf.toInt (time());
fun newJob() = {
jobType = JobType.ran(),
AT = intTime()}
Monitors
System
Arrivals
Server


Arrivals
Arrivals
Queue
1
1`[]
1`[]
Jobs
Server
Server
Completed
Job


1`()@+0
()
Init
1
1`()@+0
Init
MYUNIT
()@+expTime(100)
Next
MYUNIT
()
Arrive
jobs^^[job]
jobs
Queue
1
1`[]
Jobs
output (job);
action
newJob();
()@+expTime(100)

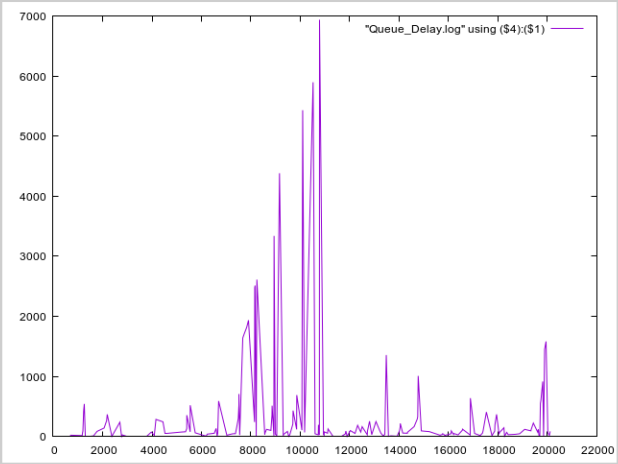

server
Idle
1`server@0
Server
server
server
jobs
Queue
1
1`[]
Start
(server,job)@+proctime
Busy
(server,job)
Stop
job
Completed
I/O
Jobs
job::jobs
output (proctime);
action
expTime(90);
Server*Job
out
Job

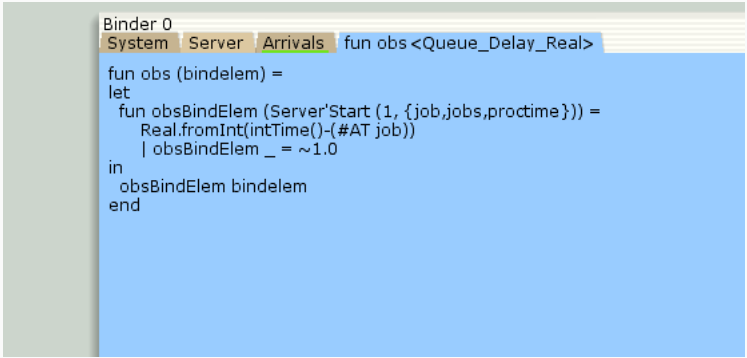
Мониторинг параметров моделируемой системы



```
#data counter step time
0 1 3 43
100 2 6 231
0 3 9 447
85 4 13 651
33 5 18 823
2 6 21 893
56 7 24 1081
315 8 26 1090
374 9 28 1093
790 10 30 1287
0 11 33 1319
257 12 39 1682
45 13 42 1751
364 14 44 1779
32 15 50 1869
43 16 53 1921
118 17 55 1935
193 18 57 2000
71 19 63 2334
258 20 65 2417
361 21 67 2489
408 22 69 2489
7 23 73 2535
17 24 75 2542
787 25 77 2581
29 26 80 2634
1259 27 82 2642
1520 28 84 2861
0 29 87 2918
0 30 90 3004
30 31 94 3116
173 32 96 3231
35 33 100 3307
6 34 104 3394
96 35 106 3408
155 36 108 3424
45 37 112 3601
200 38 114 3627
19 39 118 3659
77 40 120 3707
0 41 123 3789
14 42 126 3881
0 43 129 3910
0 44 132 4043
38 45 136 4099
99 46 138 4142
53 47 141 4248
12 48 144 4365
55 49 149 4669
125 50 151 4711
209 51 153 4740
10 52 157 4874
11 53 160 4893
```

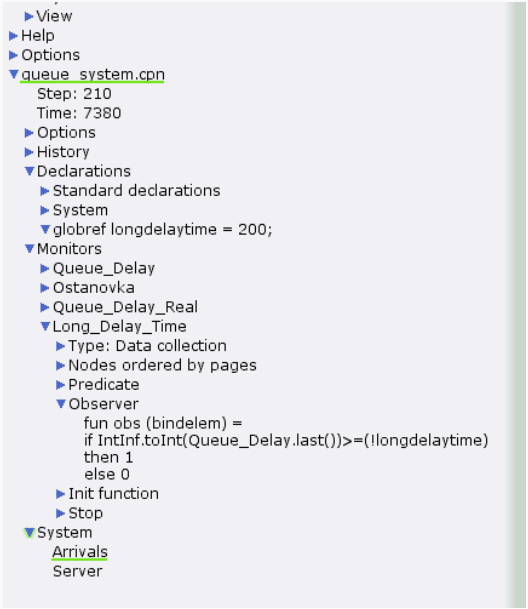
```
#!/usr/bin/gnuplot -persist

set encoding utf8
set term pngcairo font "Helvetica,9"

set out 'win_1.png'
plot "Queue_Delay.log" using ($4):($1) with lines
```


"Queue_Delay.log" using ($4):($1)
7000
6000
5000
4000
3000
2000
1000
0
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
22000


Binder 0
System
Server
Arrivals
fun obs <Queue_Delay_Real>
fun obs (bindelem) =
let
fun obsBindElem (Server'Start (1, {job,jobs,proctime})) =
Real.fromInt(intTime()-(#AT job))
| obsBindElem _ = ~1.0
in
obsBindElem bindelem
end

Файл Правка Поиск Вид Док

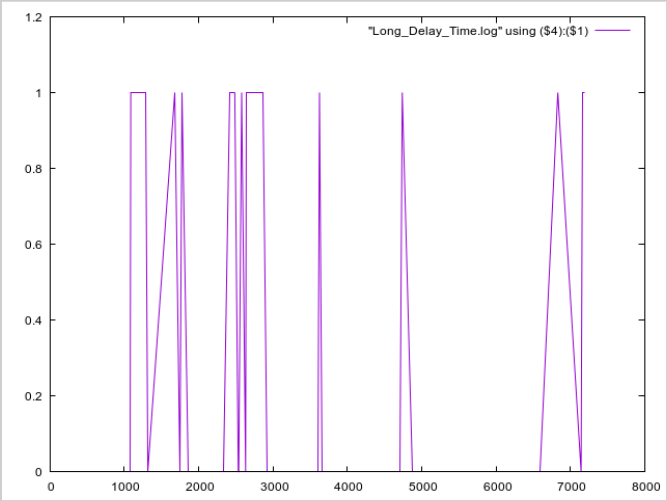
```
#data counter step time
0.000000 1 3 43
100.000000 2 6 231
0.000000 3 9 447
85.000000 4 13 651
33.000000 5 18 823
2.000000 6 21 893
56.000000 7 24 1081
315.000000 8 26 1090
374.000000 9 28 1093
790.000000 10 30 1287
0.000000 11 33 1319
257.000000 12 39 1682
45.000000 13 42 1751
364.000000 14 44 1779
32.000000 15 50 1869
43.000000 16 53 1921
118.000000 17 55 1935
193.000000 18 57 2000
71.000000 19 63 2334
258.000000 20 65 2417
361.000000 21 67 2489
408.000000 22 69 2489
7.000000 23 73 2535
17.000000 24 75 2542
787.000000 25 77 2581
29.000000 26 80 2634
1259.000000 27 82 2642
1520.000000 28 84 2861
0.000000 29 87 2918
0.000000 30 90 3004
30.000000 31 94 3116
173.000000 32 96 3231
35.000000 33 100 3307
6.000000 34 104 3394
96.000000 35 106 3408
155.000000 36 108 3424
45.000000 37 112 3601
200.000000 38 114 3627
19.000000 39 118 3659
77.000000 40 120 3707
0.000000 41 123 3789
14.000000 42 126 3881
0.000000 43 129 3910
0.000000 44 132 4043
38.000000 45 136 4099
99.000000 46 138 4142
53.000000 47 141 4248
12.000000 48 144 4365
55.000000 49 149 4669
125.000000 50 151 4711
209.000000 51 153 4740
10.000000 52 157 4874
11.000000 53 160 4893
```


View
Help
Options
queue_system.cpn
Step: 210
Time: 7380
Options
History
Declarations
Standard declarations
System
globref longdelaytime = 200;
Monitors
Queue_Delay
Ostanovka
Queue_Delay_Real
Long_Delay_Time
Type: Data collection
Nodes ordered by pages
Predicate
Observer
fun obs (bindelem) =
if IntInf.toInt(Queue_Delay.last())>=(!longdelaytime)
then 1
else 0
Init function
Stop
System
Arrivals
Server

Файл Правка Поиск

```
#data counter ste
0 1 3 43
0 2 6 231
0 3 9 447
0 4 13 651
0 5 18 823
0 6 21 893
0 7 24 1081
1 8 26 1090
1 9 28 1093
1 10 30 1287
0 11 33 1319
1 12 39 1682
0 13 42 1751
1 14 44 1779
0 15 50 1869
0 16 53 1921
0 17 55 1935
0 18 57 2000
0 19 63 2334
1 20 65 2417
1 21 67 2489
1 22 69 2489
0 23 73 2535
0 24 75 2542
1 25 77 2581
0 26 80 2634
1 27 82 2642
1 28 84 2861
0 29 87 2918
0 30 90 3004
0 31 94 3116
0 32 96 3231
0 33 100 3307
0 34 104 3394
0 35 106 3408
0 36 108 3424
0 37 112 3601
1 38 114 3627
0 39 118 3659
0 40 120 3707
0 41 123 3789
0 42 126 3881
0 43 129 3910
0 44 132 4043
0 45 136 4099
0 46 138 4142
0 47 141 4248
0 48 144 4365
0 49 149 4669
0 50 151 4711
1 51 153 4740
0 52 157 4874
```

```
#!/usr/bin/gnuplot -persist
set encoding utf8
set term pngcairo font "Helvetica,9"

set out 'win_3.png'
set style line 2
plot [0:] [0:1.2] "Long_Delay_Time.log" using ($4):($1) with lines
```


"Long_Delay_Time.log" using ($4):($1)
1.2
1
0.8
0.6
0.4
0.2
0
0
1000
2000
3000
4000
5000
6000
7000
8000

Выводы

В процессе выполнения данной лабораторной работы я реализовала модель системы массового обслуживания M|M|1 в CPN Tools.