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Операційні системи
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1   Варіант 9

Батьківський процес поміщає в сегмент поділюваної пам'яті імена програм з попередніх лабораторних робіт, які можуть бути запущені. Виконуючи деякі цикли робіт, породжені процеси випадковим чином обирають імена програм з таблиці сегмента поділюваної пам'яті, запускають ці програми, і продовжують свою роботу. За допомогою апарату семафорів має бути забезпечено, щоб не були одночасно запущені дві однакові програми. В процесі роботи через чергу повідомлень батьківський процес інформується, які програми і від імені кого запущені.

2   Project directory

```
-exe
  |--ferry
  |--processes
  |--threading
-geeks
  |--geeksRead.cpp
  |--geeksWrite.cpp
  |--gread.o
  |--Makefile
-main.cpp
-main.o
-Makefile
-test.cpp
-test.o
```

3   Programs that were launched

```
-exe
|--ferry
|--processes
|--threading
```

4   Code

```
1  #include <sys/types.h>
2  #include <semaphore.h>
3  #include <sys/wait.h>
4  #include <sys/ipc.h>
5  #include <sys/shm.h>
6  #include <sys/msg.h>
7  #include <pthread.h>
8  #include <stdlib.h>
9  #include <string.h>
10 #include <unistd.h>
11 #include <stdio.h>
12 #include <time.h>
13 #include <list>
14
15 #define PROG_COUNT 3
16 #define LOOPS_FOR_SUBPROCESS 3
17 #define MSGSZ 2048
18
19 typedef struct message{
20     long mtype;
21     char mtext[MSGSZ];
22 } message;
23
24 sem_t * sem_progs;
25 char ** shared;
26 char name[] = "MAIN";
27 int msgid;
28
29 int get_sem_value(sem_t sem);
30 int create_shared_programm_list();
31 int shared_semaphores_init();
32 int create_message_queue();
33 int send_message(char * text);
34 void receive_messages();
35 void* thread_work(void * param);
36 void* check_semaphore(void * param);
37
38 int main()
39 {
40     printf("%15s: state\n%13s\n", "Process name", "--------------------------");
41     printf("%15s: Starting\n", name);
42     printf("%15s: PID: %d\n", name, getpid());
43
44     pid_t pID = 1;
45     std::list<pid_t> pids;
46     char * sIdentifier;
47
48     srand(time(0));
49     create_shared_programm_list();
50     shared_semaphores_init();
51     create_message_queue();
52
53
54     for(int i = 0; i < 2 && pID > 0; i++)
55     {
56         sleep(1);
57         pID = fork();
58         if(pID > 0)
59             pids.push_back(pID);
60     }
61
62     if (pID == 0)
63     {
64         srand(time(0));
65         for(int i = 0; i < LOOPS_FOR_SUBPROCESS; i++)
66         {
67             pthread_t thread1;
68             pthread_create(&thread1, NULL, thread_work, NULL);
69             pthread_join(thread1, NULL);
70         }
```

```
71
72          }
73          else if (pID < 0)
74          {
75              printf("Failed to fork\n");
76              _exit(1);
77              // Throw exception
78          }
79          else
80          {
81              // Code only executed by parent process
82              for(auto iter : pids)
83              wait(&iter);
84              receive_messages();
85          }
86
87
88          return 0;
89      }
90
91      int get_sem_value(sem_t sem)
92      {
93          int value;
94          sem_getvalue(&sem_progs[2], &value);
95          return value;
96      }
97
98      int create_message_queue()
99      {
100         int key = ftok("/tmp/", 32);
101         msgid = msgget(key, 0666|IPC_CREAT);
102         printf("%15s: Created message queue:\n", name);
103         printf("%15s Queue id = %d\n", "-", msgid);
104         printf("%15s Key = %d\n", "-", key);
105
106         return 1;
107     }
108
109     int create_shared_programm_list()
110     {
111         int key = ftok("/tmp/", 8);
112         int shmid = shmget(key, 1024, 0666|IPC_CREAT);
113         if(shmid < 0)
114             return -1;
115         shared = (char**) shmat(shmid, (void*)0, 0);
116         shared = new char*[PROG_COUNT];
117         for(int i = 0; i < PROG_COUNT; i++)
118             shared[i] = new char[20];
119         strcpy(shared[0], "./exe/threading");
120         strcpy(shared[1], "./exe/processes");
121         strcpy(shared[2], "./exe/ferry");
122
123         printf("%15s: Created shared programm list:\n", name);
124         printf("%15s Key = %d\n", "-", key);
125         for(int i = 0; i < PROG_COUNT; i++)
126             printf("%15s %s\n", "-", shared[i]);
127
128         return 1;
129     }
130
131     int shared_semaphores_init()
132     {
133         int key = ftok("/tmp/", 97);
134         int shmid = shmget(key, 1024, 0666|IPC_CREAT);
135         if(shmid < 0)
136             return -1;
137
138         sem_progs = (sem_t*) shmat(shmid, (void*)0, 0);
139         for(int i = 0; i < PROG_COUNT; i++)
140             sem_init(&sem_progs[i],0,1);
141
142         printf("%15s: Created semaphores for all programms\n", name);
143         printf("%15s Key = %d\n", "-", key);
```

```cpp
144     for(int i = 0; i < PROG_COUNT; i++)
145         printf("%15s Semaphore %d ('%15s'). Value:%d\n", "-", i, shared[i], get_sem_value(
    sem_progs[i]));
146
147     return 1;
148 }
149
150 char* itoa(int i)
151 {
152     char * buffer = new char[10];
153     sprintf(buffer, "%d", i);
154     return buffer;
155 }
156
157 int send_message(char * text)
158 {
159     char part[] = "Executing: ";
160     char * pid = itoa(getpid());
161     int bufsize;
162     char * newtext = new char[strlen(text) + strlen(part) + strlen(" PID: ") + strlen(pid) +
     1];
163     strcpy(newtext, part);
164     strcat(newtext, text);
165     strcat(newtext, " PID: ");
166     strcat(newtext, itoa(getpid()));
167     printf("NewText: %s\n", newtext);
168     message msg;
169     msg.mtype = 1;
170     strcpy(msg.mtext, newtext);
171     bufsize = strlen(newtext) + 10;
172     printf("%15s: PID: %d: Sending message '%s' to the MAIN process...\n", "CHILD PROCESS",
    getpid(), newtext);
173     printf("%15s: Message size: %d\n", " ", bufsize);
174     if(msgsnd(msgid, &msg, bufsize, IPC_NOWAIT) < 0)
175     {
176         printf ("%d, %d, %s, %d\n", msgid, msg.mtype, msg.mtext, bufsize);
177         perror("msgsnd");
178     }
179     return 1;
180 }
181
182 void receive_messages()
183 {
184     message msg;
185     for(int i = 0; i < 9; i++)
186     {
187         if(msgrcv(msgid, &msg, MSGSZ, 1, 0) < 0)
188         {
189             printf ("%d, %d, %s\n", msgid, msg.mtype, msg.mtext);
190             perror("msgsnd");
191         }
192         if(strcmp(msg.mtext, "Executing: ") > 0)
193             printf("%15s: Receied message: %s\n", name, msg.mtext);
194
195     }
196 }
197
198 void* thread_work(void * param)
199 {
200
201     int i = rand() % PROG_COUNT;
202     message msg;
203
204     printf("%15s: PID: %d: Choose for execution '%s'\n",
205         "CHILD PROCESS", getpid(), shared[i]);
206     printf("%15s: PID: %d: Sending message to the main process...\n",
207         "CHILD PROCESS", getpid());
208     while(get_sem_value(sem_progs[i]) == 0)
209         sleep(1);
210
211     sem_wait(&(sem_progs[i]));
212     send_message(shared[i]);
213     printf("%15s: PID: %d Executing command:'%s'\n", "CHILD PROCESS", getpid(), shared[i]);
```

4

```
214    system(shared[i]);
215    sem_post(&sem_progs[i]);
216
217    return NULL;
218 }
```

4.1 Output 1

```
1     Process name: state
2  ---------------------------
3             MAIN: Starting
4             MAIN: PID: 21127
5             MAIN: Created shared programm list:
6                 - Key = 137363458
7                 - ./exe/threading
8                 - ./exe/processes
9                 - ./exe/ferry
10            MAIN: Created semaphores for all programms
11                - Key = 1630535682
12                - Semaphore 0 ('./exe/threading'). Value:1
13                - Semaphore 1 ('./exe/processes'). Value:1
14                - Semaphore 2 ('    ./exe/ferry'). Value:1
15            MAIN: Created message queue:
16                - Queue id = 10
17                - Key = 540016642
18   CHILD PROCESS: PID: 21128: Choose for execution './exe/ferry'
19   CHILD PROCESS: PID: 21128: Sending message to the main process...
20 NewText: Executing: ./exe/ferry PID: 21128
21   CHILD PROCESS: PID: 21128: Sending message 'Executing: ./exe/ferry PID: 21128' to the MAIN
        process...
22                 : Message size: 43
23   CHILD PROCESS: PID: 21128 Executing command:'./exe/ferry'
24 Enter N: 2
25      INFORMATION
26 Available places: 4
27     Paratroopers: 4
28           Marins: 4
29         ------------
30   CHILD PROCESS: PID: 21139: Choose for execution './exe/ferry'
31   CHILD PROCESS: PID: 21139: Sending message to the main process...
32  Paratrooper 2 boarded  < Current Time: 1590055699
33      Marine 4 boarded  < Current Time: 1590055699
34  Paratrooper 3 boarded  < Current Time: 1590055699
35  Paratrooper 4 canceled < Current Time: 1590055699
36  Paratrooper 1 canceled < Current Time: 1590055700
37      Marine 1 boarded  < Current Time: 1590055701
38      Marine 2 canceled < Current Time: 1590055701
39      Marine 3 canceled < Current Time: 1590055701
40
41 Cleaning all threads troops that are not in ferry
42
43   Ferry in trip!
44   Ferry in trip!
45   Ferry in trip!
46
47 Eject all troops on coast
48
49  Paratrooper 2 disembarked. < Current time: 1590055704
50      Marine 4 disembarked. < Current time: 1590055705
51  Paratrooper 3 disembarked. < Current time: 1590055706
52      Marine 1 disembarked. < Current time: 1590055707
53   CHILD PROCESS: PID: 21128: Choose for execution './exe/ferry'
54   CHILD PROCESS: PID: 21128: Sending message to the main process...
55 NewText: Executing: ./exe/ferry PID: 21128
56   CHILD PROCESS: PID: 21128: Sending message 'Executing: ./exe/ferry PID: 21128' to the MAIN
        process...
57                 : Message size: 43
58   CHILD PROCESS: PID: 21128 Executing command:'./exe/ferry'
59 Enter N: 2
60      INFORMATION
61 Available places: 4
62     Paratroopers: 4
63           Marins: 4
```

```
 64          ------------
 65   Paratrooper 3 boarded  < Current Time: 1590055709
 66   Paratrooper 4 boarded  < Current Time: 1590055709
 67       Marine 1 boarded  < Current Time: 1590055710
 68       Marine 2 boarded  < Current Time: 1590055711
 69   Paratrooper 2 canceled < Current Time: 1590055711
 70   Paratrooper 1 canceled < Current Time: 1590055711
 71       Marine 3 canceled < Current Time: 1590055711
 72       Marine 4 canceled < Current Time: 1590055712
 73
 74  Cleaning all threads troops that are not in ferry
 75
 76    Ferry in trip!
 77    Ferry in trip!
 78    Ferry in trip!
 79
 80  Eject all troops on coast
 81
 82   Paratrooper 3 disembarked. < Current time: 1590055715
 83   Paratrooper 4 disembarked. < Current time: 1590055716
 84       Marine 1 disembarked. < Current time: 1590055717
 85       Marine 2 disembarked. < Current time: 1590055718
 86    CHILD PROCESS: PID: 21128: Choose for execution './exe/ferry'
 87    CHILD PROCESS: PID: 21128: Sending message to the main process...
 88  NewText: Executing: ./exe/ferry PID: 21128
 89    CHILD PROCESS: PID: 21128: Sending message 'Executing: ./exe/ferry PID: 21128' to the MAIN
         process...
 90                 : Message size: 43
 91    CHILD PROCESS: PID: 21128 Executing command:'./exe/ferry'
 92  Enter N: 2
 93       INFORMATION
 94  Available places: 4
 95     Paratroopers: 4
 96          Marins: 4
 97          ------------
 98   Paratrooper 1 boarded  < Current Time: 1590055721
 99   Paratrooper 4 boarded  < Current Time: 1590055721
100       Marine 4 boarded  < Current Time: 1590055721
101       Marine 2 boarded  < Current Time: 1590055721
102   Paratrooper 2 canceled < Current Time: 1590055722
103   Paratrooper 3 canceled < Current Time: 1590055722
104       Marine 1 canceled < Current Time: 1590055723
105       Marine 3 canceled < Current Time: 1590055723
106
107  Cleaning all threads troops that are not in ferry
108
109    Ferry in trip!
110    Ferry in trip!
111    Ferry in trip!
112
113  Eject all troops on coast
114
115   Paratrooper 1 disembarked. < Current time: 1590055726
116   Paratrooper 4 disembarked. < Current time: 1590055727
117       Marine 4 disembarked. < Current time: 1590055728
118       Marine 2 disembarked. < Current time: 1590055729
119  NewText: Executing: ./exe/ferry PID: 21139
120    CHILD PROCESS: PID: 21139: Sending message 'Executing: ./exe/ferry PID: 21139' to the MAIN
         process...
121                 : Message size: 43
122    CHILD PROCESS: PID: 21139 Executing command:'./exe/ferry'
123  Enter N: 2
124       INFORMATION
125  Available places: 4
126     Paratroopers: 4
127          Marins: 4
128          ------------
129   Paratrooper 1 boarded  < Current Time: 1590055732
130   Paratrooper 2 boarded  < Current Time: 1590055732
131   Paratrooper 4 boarded  < Current Time: 1590055732
132       Marine 2 canceled < Current Time: 1590055734
133   Paratrooper 3 boarded  < Current Time: 1590055734
134       Marine 3 canceled < Current Time: 1590055734
```

```
135      Marine 1 canceled < Current Time: 1590055735
136      Marine 4 canceled < Current Time: 1590055735
137
138 Cleaning all threads troops that are not in ferry
139
140   Ferry in trip!
141   Ferry in trip!
142   Ferry in trip!
143
144 Eject all troops on coast
145
146  Paratrooper 1 disembarked. < Current time: 1590055738
147  Paratrooper 2 disembarked. < Current time: 1590055739
148  Paratrooper 4 disembarked. < Current time: 1590055740
149  Paratrooper 3 disembarked. < Current time: 1590055741
150   CHILD PROCESS: PID: 21139: Choose for execution './exe/threading'
151   CHILD PROCESS: PID: 21139: Sending message to the main process...
152 NewText: Executing: ./exe/threading PID: 21139
153   CHILD PROCESS: PID: 21139: Sending message 'Executing: ./exe/threading PID: 21139' to the
        MAIN process...
154                : Message size: 47
155   CHILD PROCESS: PID: 21139 Executing command:'./exe/threading'
156 Text: thread
157 Text: first
158 Text: Heh Ipsum
159   CHILD PROCESS: PID: 21139: Choose for execution './exe/ferry'
160   CHILD PROCESS: PID: 21139: Sending message to the main process...
161 NewText: Executing: ./exe/ferry PID: 21139
162   CHILD PROCESS: PID: 21139: Sending message 'Executing: ./exe/ferry PID: 21139' to the MAIN
        process...
163                : Message size: 43
164   CHILD PROCESS: PID: 21139 Executing command:'./exe/ferry'
165 Enter N: 2
166       INFORMATION
167 Available places: 4
168     Paratroopers: 4
169          Marins: 4
170          ------------
171  Paratrooper 1 boarded  < Current Time: 1590055745
172      Marine 1 boarded  < Current Time: 1590055745
173      Marine 2 boarded  < Current Time: 1590055745
174  Paratrooper 4 boarded  < Current Time: 1590055745
175      Marine 4 canceled < Current Time: 1590055745
176  Paratrooper 3 canceled < Current Time: 1590055745
177  Paratrooper 2 canceled < Current Time: 1590055745
178      Marine 3 canceled < Current Time: 1590055746
179
180 Cleaning all threads troops that are not in ferry
181
182   Ferry in trip!
183   Ferry in trip!
184   Ferry in trip!
185
186 Eject all troops on coast
187
188  Paratrooper 1 disembarked. < Current time: 1590055749
189      Marine 1 disembarked. < Current time: 1590055750
190      Marine 2 disembarked. < Current time: 1590055751
191  Paratrooper 4 disembarked. < Current time: 1590055752
192         MAIN: Receied message: Executing: ./exe/ferry PID: 21128
193         MAIN: Receied message: Executing: ./exe/ferry PID: 21128
194         MAIN: Receied message: Executing: ./exe/ferry PID: 21128
195         MAIN: Receied message: Executing: ./exe/ferry PID: 21139
196         MAIN: Receied message: Executing: ./exe/threading PID: 21139
197         MAIN: Receied message: Executing: ./exe/ferry PID: 21139
```

4.2 Output 2

```
1      Process name: state
2      ---------------------------
3               MAIN: Starting
4               MAIN: PID: 21427
5               MAIN: Created shared programm list:
```

```
  6                          - Key = 137363458
  7                          - ./exe/threading
  8                          - ./exe/processes
  9                          - ./exe/ferry
 10                MAIN: Created semaphores for all programms
 11                      - Key = 1630535682
 12                      - Semaphore 0 ('./exe/threading'). Value:1
 13                      - Semaphore 1 ('./exe/processes'). Value:1
 14                      - Semaphore 2 ('    ./exe/ferry'). Value:1
 15                MAIN: Created message queue:
 16                      - Queue id = 10
 17                      - Key = 540016642
 18      CHILD PROCESS: PID: 21428: Choose for execution './exe/processes'
 19      CHILD PROCESS: PID: 21428: Sending message to the main process...
 20    NewText: Executing: ./exe/processes PID: 21428
 21      CHILD PROCESS: PID: 21428: Sending message 'Executing: ./exe/processes PID: 21428' to
        the MAIN process...
 22                     : Message size: 47
 23      CHILD PROCESS: PID: 21428 Executing command:'./exe/processes'
 24      CHILD PROCESS: PID: 21432: Choose for execution './exe/threading'
 25      CHILD PROCESS: PID: 21432: Sending message to the main process...
 26    NewText: Executing: ./exe/threading PID: 21432
 27      CHILD PROCESS: PID: 21432: Sending message 'Executing: ./exe/threading PID: 21432' to
        the MAIN process...
 28                     : Message size: 47
 29      CHILD PROCESS: PID: 21432 Executing command:'./exe/threading'
 30    Text: thread
 31    Text: first
 32    Text: Heh Ipsum
 33    Child Process:  Global variable: 3 Stack variable: 21 Pid: 21431
 34      CHILD PROCESS: PID: 21432: Choose for execution './exe/ferry'
 35      CHILD PROCESS: PID: 21432: Sending message to the main process...
 36    NewText: Executing: ./exe/ferry PID: 21432
 37      CHILD PROCESS: PID: 21432: Sending message 'Executing: ./exe/ferry PID: 21432' to the
        MAIN process...
 38                     : Message size: 43
 39      CHILD PROCESS: PID: 21432 Executing command:'./exe/ferry'
 40    Parent Process: Global variable: 2 Stack variable: 20 Pid: 21430
 41      CHILD PROCESS: PID: 21428: Choose for execution './exe/processes'
 42      CHILD PROCESS: PID: 21428: Sending message to the main process...
 43    Enter N: 2
 44          INFORMATION
 45    Available places: 4
 46        Paratroopers: 4
 47            Marins: 4
 48            ------------
 49        Marine 1 boarded  < Current Time: 1590055945
 50        Marine 3 boarded  < Current Time: 1590055945
 51   Paratrooper 2 boarded  < Current Time: 1590055945
 52   Paratrooper 4 boarded  < Current Time: 1590055945
 53   Paratrooper 3 canceled < Current Time: 1590055945
 54   Paratrooper 1 canceled < Current Time: 1590055946
 55        Marine 2 canceled < Current Time: 1590055947
 56        Marine 4 canceled < Current Time: 1590055947
 57
 58    Cleaning all threads troops that are not in ferry
 59
 60      Ferry in trip!
 61      Ferry in trip!
 62      Ferry in trip!
 63
 64    Eject all troops on coast
 65
 66        Marine 1 disembarked. < Current time: 1590055950
 67        Marine 3 disembarked. < Current time: 1590055951
 68   Paratrooper 2 disembarked. < Current time: 1590055952
 69   Paratrooper 4 disembarked. < Current time: 1590055953
 70      CHILD PROCESS: PID: 21432: Choose for execution './exe/ferry'
 71      CHILD PROCESS: PID: 21432: Sending message to the main process...
 72    NewText: Executing: ./exe/ferry PID: 21432
 73      CHILD PROCESS: PID: 21432: Sending message 'Executing: ./exe/ferry PID: 21432' to the
        MAIN process...
 74                     : Message size: 43
```

```
75          CHILD PROCESS: PID: 21432 Executing command:'./exe/ferry'
76      Enter N: 2
77            INFORMATION
78      Available places: 4
79          Paratroopers: 4
80                Marins: 4
81                ------------
82       Paratrooper 3 boarded  < Current Time: 1590055955
83       Paratrooper 4 boarded  < Current Time: 1590055955
84       Paratrooper 2 boarded  < Current Time: 1590055956
85            Marine 2 canceled < Current Time: 1590055956
86       Paratrooper 1 boarded  < Current Time: 1590055957
87            Marine 3 canceled < Current Time: 1590055957
88            Marine 4 canceled < Current Time: 1590055957
89            Marine 1 canceled < Current Time: 1590055958
90
91      Cleaning all threads troops that are not in ferry
92
93        Ferry in trip!
94        Ferry in trip!
95        Ferry in trip!
96
97      Eject all troops on coast
98
99       Paratrooper 3 disembarked. < Current time: 1590055961
100      Paratrooper 4 disembarked. < Current time: 1590055962
101      Paratrooper 2 disembarked. < Current time: 1590055963
102      Paratrooper 1 disembarked. < Current time: 1590055964
103     NewText: Executing: ./exe/processes PID: 21428
104       CHILD PROCESS: PID: 21428: Sending message 'Executing: ./exe/processes PID: 21428' to
        the MAIN process...
105                    : Message size: 47
106       CHILD PROCESS: PID: 21428 Executing command:'./exe/processes'
107     Child Process:  Global variable: 3 Stack variable: 21 Pid: 21468
108     Parent Process: Global variable: 2 Stack variable: 20 Pid: 21467
109       CHILD PROCESS: PID: 21428: Choose for execution './exe/threading'
110       CHILD PROCESS: PID: 21428: Sending message to the main process...
111     NewText: Executing: ./exe/threading PID: 21428
112       CHILD PROCESS: PID: 21428: Sending message 'Executing: ./exe/threading PID: 21428' to
        the MAIN process...
113                    : Message size: 47
114       CHILD PROCESS: PID: 21428 Executing command:'./exe/threading'
115     Text: thread
116     Text: first
117     Text: Heh Ipsum
118              MAIN: Receied message: Executing: ./exe/processes PID: 21428
119              MAIN: Receied message: Executing: ./exe/threading PID: 21432
120              MAIN: Receied message: Executing: ./exe/ferry PID: 21432
121              MAIN: Receied message: Executing: ./exe/ferry PID: 21432
122              MAIN: Receied message: Executing: ./exe/processes PID: 21428
123              MAIN: Receied message: Executing: ./exe/threading PID: 21428
```

4.3   Output 3

```
1     Process name: state
2  --------------------------
3            MAIN: Starting
4            MAIN: PID: 21722
5            MAIN: Created shared programm list:
6              - Key = 137363458
7              - ./exe/threading
8              - ./exe/processes
9              - ./exe/ferry
10           MAIN: Created semaphores for all programms
11             - Key = 1630535682
12             - Semaphore 0 ('./exe/threading'). Value:1
13             - Semaphore 1 ('./exe/processes'). Value:1
14             - Semaphore 2 ('    ./exe/ferry'). Value:1
15           MAIN: Created message queue:
16             - Queue id = 10
17             - Key = 540016642
18  CHILD PROCESS: PID: 21723: Choose for execution './exe/threading'
19  CHILD PROCESS: PID: 21723: Sending message to the main process...
```

```
20  NewText: Executing: ./exe/threading PID: 21723
21    CHILD PROCESS: PID: 21723: Sending message 'Executing: ./exe/threading PID: 21723' to the
        MAIN process...
22                : Message size: 47
23    CHILD PROCESS: PID: 21723 Executing command:'./exe/threading'
24  Text: thread
25  Text: first
26  Text: Heh Ipsum
27    CHILD PROCESS: PID: 21723: Choose for execution './exe/processes'
28    CHILD PROCESS: PID: 21723: Sending message to the main process...
29  NewText: Executing: ./exe/processes PID: 21723
30    CHILD PROCESS: PID: 21723: Sending message 'Executing: ./exe/processes PID: 21723' to the
        MAIN process...
31                : Message size: 47
32    CHILD PROCESS: PID: 21723 Executing command:'./exe/processes'
33    CHILD PROCESS: PID: 21730: Choose for execution './exe/ferry'
34    CHILD PROCESS: PID: 21730: Sending message to the main process...
35  NewText: Executing: ./exe/ferry PID: 21730
36    CHILD PROCESS: PID: 21730: Sending message 'Executing: ./exe/ferry PID: 21730' to the MAIN
        process...
37                : Message size: 43
38    CHILD PROCESS: PID: 21730 Executing command:'./exe/ferry'
39  Enter N: 2
40        INFORMATION
41  Available places: 4
42      Paratroopers: 4
43            Marins: 4
44        ------------
45  Child Process:  Global variable: 3 Stack variable: 21 Pid: 21729
46  Parent Process: Global variable: 2 Stack variable: 20 Pid: 21728
47    CHILD PROCESS: PID: 21723: Choose for execution './exe/threading'
48    CHILD PROCESS: PID: 21723: Sending message to the main process...
49   Paratrooper 2 boarded  < Current Time: 1590056189
50   Paratrooper 4 boarded  < Current Time: 1590056189
51   Paratrooper 1 boarded  < Current Time: 1590056190
52   Paratrooper 3 boarded  < Current Time: 1590056190
53        Marine 1 canceled < Current Time: 1590056191
54        Marine 2 canceled < Current Time: 1590056191
55        Marine 3 canceled < Current Time: 1590056191
56        Marine 4 canceled < Current Time: 1590056191
57
58  Cleaning all threads troops that are not in ferry
59
60    Ferry in trip!
61    Ferry in trip!
62    Ferry in trip!
63
64  Eject all troops on coast
65
66   Paratrooper 2 disembarked. < Current time: 1590056194
67   Paratrooper 4 disembarked. < Current time: 1590056195
68   Paratrooper 1 disembarked. < Current time: 1590056196
69   Paratrooper 3 disembarked. < Current time: 1590056197
70    CHILD PROCESS: PID: 21730: Choose for execution './exe/ferry'
71    CHILD PROCESS: PID: 21730: Sending message to the main process...
72  NewText: Executing: ./exe/ferry PID: 21730
73    CHILD PROCESS: PID: 21730: Sending message 'Executing: ./exe/ferry PID: 21730' to the MAIN
        process...
74                : Message size: 43
75    CHILD PROCESS: PID: 21730 Executing command:'./exe/ferry'
76  Enter N: 2
77        INFORMATION
78  Available places: 4
79      Paratroopers: 4
80            Marins: 4
81        ------------
82   Paratrooper 3 boarded  < Current Time: 1590056199
83        Marine 3 boarded  < Current Time: 1590056200
84        Marine 1 boarded  < Current Time: 1590056201
85   Paratrooper 1 boarded  < Current Time: 1590056201
86        Marine 2 canceled < Current Time: 1590056201
87   Paratrooper 2 canceled < Current Time: 1590056201
88   Paratrooper 4 canceled < Current Time: 1590056201
```

```
 89        Marine 4 canceled < Current Time: 1590056202
 90
 91 Cleaning all threads troops that are not in ferry
 92
 93   Ferry in trip!
 94   Ferry in trip!
 95   Ferry in trip!
 96
 97 Eject all troops on coast
 98
 99  Paratrooper 3 disembarked. < Current time: 1590056205
100       Marine 3 disembarked. < Current time: 1590056206
101       Marine 1 disembarked. < Current time: 1590056207
102  Paratrooper 1 disembarked. < Current time: 1590056208
103   CHILD PROCESS: PID: 21730: Choose for execution './exe/ferry'
104   CHILD PROCESS: PID: 21730: Sending message to the main process...
105 NewText: Executing: ./exe/ferry PID: 21730
106   CHILD PROCESS: PID: 21730: Sending message 'Executing: ./exe/ferry PID: 21730' to the MAIN
        process...
107                : Message size: 43
108   CHILD PROCESS: PID: 21730 Executing command:'./exe/ferry'
109 Enter N: 2
110      INFORMATION
111 Available places: 4
112     Paratroopers: 4
113          Marins: 4
114          ------------
115  Paratrooper 4 boarded  < Current Time: 1590056210
116       Marine 2 boarded  < Current Time: 1590056211
117  Paratrooper 1 boarded  < Current Time: 1590056212
118  Paratrooper 2 canceled < Current Time: 1590056212
119  Paratrooper 3 canceled < Current Time: 1590056212
120       Marine 1 boarded  < Current Time: 1590056213
121       Marine 3 canceled < Current Time: 1590056213
122       Marine 4 canceled < Current Time: 1590056213
123
124 Cleaning all threads troops that are not in ferry
125
126   Ferry in trip!
127   Ferry in trip!
128   Ferry in trip!
129
130 Eject all troops on coast
131
132  Paratrooper 4 disembarked. < Current time: 1590056216
133       Marine 2 disembarked. < Current time: 1590056217
134  Paratrooper 1 disembarked. < Current time: 1590056218
135       Marine 1 disembarked. < Current time: 1590056219
136 NewText: Executing: ./exe/threading PID: 21723
137   CHILD PROCESS: PID: 21723: Sending message 'Executing: ./exe/threading PID: 21723' to the
      MAIN process...
138                : Message size: 47
139   CHILD PROCESS: PID: 21723 Executing command:'./exe/threading'
140 Text: thread
141 Text: first
142 Text: Heh Ipsum
143           MAIN: Receied message: Executing: ./exe/threading PID: 21723
144           MAIN: Receied message: Executing: ./exe/processes PID: 21723
145           MAIN: Receied message: Executing: ./exe/ferry PID: 21730
146           MAIN: Receied message: Executing: ./exe/ferry PID: 21730
147           MAIN: Receied message: Executing: ./exe/ferry PID: 21730
148           MAIN: Receied message: Executing: ./exe/threading PID: 21723
```

4.4   Output 4

```
1 g++ -g main.cpp -o main.o -lpthread
2 ./main.o
3      Process name: state
4 --------------------------
5                MAIN: Starting
6                MAIN: PID: 22009
7                MAIN: Created shared programm list:
8                - Key = 137363458
```

```
 9                 - ./exe/threading
10                 - ./exe/processes
11                 - ./exe/ferry
12                 MAIN: Created semaphores for all programms
13                 - Key = 1630535682
14                 - Semaphore 0 ('./exe/threading'). Value:1
15                 - Semaphore 1 ('./exe/processes'). Value:1
16                 - Semaphore 2 ('      ./exe/ferry'). Value:1
17                 MAIN: Created message queue:
18                 - Queue id = 10
19                 - Key = 540016642
20      CHILD PROCESS: PID: 22010: Choose for execution './exe/ferry'
21      CHILD PROCESS: PID: 22010: Sending message to the main process...
22 NewText: Executing: ./exe/ferry PID: 22010
23      CHILD PROCESS: PID: 22010: Sending message 'Executing: ./exe/ferry PID: 22010' to the
   MAIN process...
24                 : Message size: 43
25      CHILD PROCESS: PID: 22010 Executing command:'./exe/ferry'
26 Enter N: 2
27      INFORMATION
28 Available places: 4
29      Paratroopers: 4
30          Marins: 4
31          ------------
32      CHILD PROCESS: PID: 22021: Choose for execution './exe/ferry'
33      CHILD PROCESS: PID: 22021: Sending message to the main process...
34      Paratrooper 2 boarded  < Current Time: 1590056425
35      Paratrooper 3 boarded  < Current Time: 1590056425
36          Marine 3 boarded  < Current Time: 1590056426
37      Paratrooper 4 canceled < Current Time: 1590056426
38      Paratrooper 1 canceled < Current Time: 1590056427
39          Marine 4 boarded  < Current Time: 1590056427
40          Marine 1 canceled < Current Time: 1590056428
41          Marine 2 canceled < Current Time: 1590056428
42
43 Cleaning all threads troops that are not in ferry
44
45      Ferry in trip!
46      Ferry in trip!
47      Ferry in trip!
48
49 Eject all troops on coast
50
51      Paratrooper 2 disembarked. < Current time: 1590056431
52      Paratrooper 3 disembarked. < Current time: 1590056432
53          Marine 3 disembarked. < Current time: 1590056433
54          Marine 4 disembarked. < Current time: 1590056434
55      CHILD PROCESS: PID: 22010: Choose for execution './exe/ferry'
56      CHILD PROCESS: PID: 22010: Sending message to the main process...
57 NewText: Executing: ./exe/ferry PID: 22021
58      CHILD PROCESS: PID: 22010: Sending message 'Executing: ./exe/ferry PID: 22021' to the
   MAIN process...
59                 : Message size: 43
60      CHILD PROCESS: PID: 22010 Executing command:'./exe/ferry'
61 Enter N: 2
62      INFORMATION
63 Available places: 4
64      Paratroopers: 4
65          Marins: 4
66          ------------
67      Paratrooper 1 boarded  < Current Time: 1590056437
68          Marine 2 boarded  < Current Time: 1590056437
69          Marine 1 boarded  < Current Time: 1590056437
70      Paratrooper 2 boarded  < Current Time: 1590056437
71      Paratrooper 4 canceled < Current Time: 1590056437
72          Marine 4 canceled < Current Time: 1590056437
73      Paratrooper 3 canceled < Current Time: 1590056438
74          Marine 3 canceled < Current Time: 1590056439
75
76 Cleaning all threads troops that are not in ferry
77
78      Ferry in trip!
79      Ferry in trip!
```

```
80        Ferry in trip!
81
82   Eject all troops on coast
83
84        Paratrooper 1 disembarked. < Current time: 1590056442
85            Marine 2 disembarked. < Current time: 1590056443
86            Marine 1 disembarked. < Current time: 1590056444
87        Paratrooper 2 disembarked. < Current time: 1590056445
88        CHILD PROCESS: PID: 22010: Choose for execution './exe/ferry'
89        CHILD PROCESS: PID: 22010: Sending message to the main process...
90   NewText: Executing: ./exe/ferry PID: 22010
91        CHILD PROCESS: PID: 22010: Sending message 'Executing: ./exe/ferry PID: 22010' to the
         MAIN process...
92                  : Message size: 43
93        CHILD PROCESS: PID: 22010 Executing command:'./exe/ferry'
94   Enter N: 2
95        INFORMATION
96   Available places: 4
97        Paratroopers: 4
98            Marins: 4
99            ------------
100       Paratrooper 1 boarded  < Current Time: 1590056448
101       Paratrooper 3 boarded  < Current Time: 1590056448
102       Paratrooper 2 boarded  < Current Time: 1590056448
103           Marine 2 canceled < Current Time: 1590056449
104       Paratrooper 4 boarded  < Current Time: 1590056449
105           Marine 1 canceled < Current Time: 1590056450
106           Marine 4 canceled < Current Time: 1590056450
107           Marine 3 canceled < Current Time: 1590056451
108
109  Cleaning all threads troops that are not in ferry
110
111       Ferry in trip!
112       Ferry in trip!
113       Ferry in trip!
114
115  Eject all troops on coast
116
117       Paratrooper 1 disembarked. < Current time: 1590056454
118       Paratrooper 3 disembarked. < Current time: 1590056455
119       Paratrooper 2 disembarked. < Current time: 1590056456
120       Paratrooper 4 disembarked. < Current time: 1590056457
121  NewText: Executing: ./exe/ferry PID: 22021
122       CHILD PROCESS: PID: 22021: Sending message 'Executing: ./exe/ferry PID: 22021' to the
         MAIN process...
123                  : Message size: 43
124       CHILD PROCESS: PID: 22021 Executing command:'./exe/ferry'
125  Enter N: 2
126       INFORMATION
127  Available places: 4
128       Paratroopers: 4
129           Marins: 4
130           ------------
131       Paratrooper 1 boarded  < Current Time: 1590056459
132       Paratrooper 3 boarded  < Current Time: 1590056459
133       Paratrooper 2 boarded  < Current Time: 1590056460
134       Paratrooper 4 boarded  < Current Time: 1590056461
135           Marine 1 canceled < Current Time: 1590056462
136           Marine 2 canceled < Current Time: 1590056462
137           Marine 3 canceled < Current Time: 1590056462
138           Marine 4 canceled < Current Time: 1590056462
139
140  Cleaning all threads troops that are not in ferry
141
142       Ferry in trip!
143       Ferry in trip!
144       Ferry in trip!
145
146  Eject all troops on coast
147
148       Paratrooper 1 disembarked. < Current time: 1590056465
149       Paratrooper 3 disembarked. < Current time: 1590056466
150       Paratrooper 2 disembarked. < Current time: 1590056467
```

```
151      Paratrooper 4 disembarked. < Current time: 1590056468
152      CHILD PROCESS: PID: 22021: Choose for execution './exe/ferry'
153      CHILD PROCESS: PID: 22021: Sending message to the main process...
154 NewText: Executing: ./exe/ferry PID: 22010
155      CHILD PROCESS: PID: 22021: Sending message 'Executing: ./exe/ferry PID: 22010' to the
     MAIN process...
156                : Message size: 43
157      CHILD PROCESS: PID: 22021 Executing command:'./exe/ferry'
158 Enter N: 2
159      INFORMATION
160 Available places: 4
161      Paratroopers: 4
162          Marins: 4
163          ------------
164      Paratrooper 3 boarded  < Current Time: 1590056471
165      Paratrooper 1 boarded  < Current Time: 1590056472
166          Marine 2 boarded  < Current Time: 1590056472
167      Paratrooper 2 canceled < Current Time: 1590056472
168          Marine 4 boarded  < Current Time: 1590056472
169      Paratrooper 4 canceled < Current Time: 1590056473
170          Marine 1 canceled < Current Time: 1590056474
171          Marine 3 canceled < Current Time: 1590056474
172
173 Cleaning all threads troops that are not in ferry
174
175      Ferry in trip!
176      Ferry in trip!
177      Ferry in trip!
178
179 Eject all troops on coast
180
181      Paratrooper 3 disembarked. < Current time: 1590056477
182      Paratrooper 1 disembarked. < Current time: 1590056478
183          Marine 2 disembarked. < Current time: 1590056479
184          Marine 4 disembarked. < Current time: 1590056480
185      CHILD PROCESS: PID: 22021: Choose for execution './exe/threading'
186      CHILD PROCESS: PID: 22021: Sending message to the main process...
187 NewText: Executing: ./exe/threading PID: 22021
188      CHILD PROCESS: PID: 22021: Sending message 'Executing: ./exe/threading PID: 22021' to
     the MAIN process...
189                : Message size: 47
190      CHILD PROCESS: PID: 22021 Executing command:'./exe/threading'
191 Text: thread
192 Text: first
193 Text: Heh Ipsum
194               MAIN: Receied message: Executing: ./exe/ferry PID: 22010
195               MAIN: Receied message: Executing: ./exe/ferry PID: 22021
196               MAIN: Receied message: Executing: ./exe/ferry PID: 22010
197               MAIN: Receied message: Executing: ./exe/ferry PID: 22021
198               MAIN: Receied message: Executing: ./exe/ferry PID: 22010
199               MAIN: Receied message: Executing: ./exe/threading PID: 22021
```

4.5 Output 5

```
1    Process name: state
2 --------------------------
3            MAIN: Starting
4            MAIN: PID: 22176
5            MAIN: Created shared programm list:
6              - Key = 137363458
7              - ./exe/threading
8              - ./exe/processes
9              - ./exe/ferry
10           MAIN: Created semaphores for all programms
11             - Key = 1630535682
12             - Semaphore 0 ('./exe/threading'). Value:1
13             - Semaphore 1 ('./exe/processes'). Value:1
14             - Semaphore 2 ('   ./exe/ferry'). Value:1
15           MAIN: Created message queue:
16             - Queue id = 10
17             - Key = 540016642
18   CHILD PROCESS: PID: 22177: Choose for execution './exe/threading'
19   CHILD PROCESS: PID: 22177: Sending message to the main process...
```

```
20  NewText: Executing: ./exe/threading PID: 22177
21    CHILD PROCESS: PID: 22177: Sending message 'Executing: ./exe/threading PID: 22177' to the
        MAIN process...
22                 : Message size: 47
23    CHILD PROCESS: PID: 22177 Executing command:'./exe/threading'
24  Text: thread
25  Text: first
26  Text: Heh Ipsum
27    CHILD PROCESS: PID: 22177: Choose for execution './exe/threading'
28    CHILD PROCESS: PID: 22177: Sending message to the main process...
29  NewText: Executing: ./exe/threading PID: 22177
30    CHILD PROCESS: PID: 22177: Sending message 'Executing: ./exe/threading PID: 22177' to the
        MAIN process...
31                 : Message size: 47
32    CHILD PROCESS: PID: 22177 Executing command:'./exe/threading'
33  Text: thread
34  Text: first
35  Text: Heh Ipsum
36    CHILD PROCESS: PID: 22177: Choose for execution './exe/threading'
37    CHILD PROCESS: PID: 22177: Sending message to the main process...
38  NewText: Executing: ./exe/threading PID: 22177
39    CHILD PROCESS: PID: 22177: Sending message 'Executing: ./exe/threading PID: 22177' to the
        MAIN process...
40                 : Message size: 47
41    CHILD PROCESS: PID: 22177 Executing command:'./exe/threading'
42  Text: thread
43  Text: first
44  Text: Heh Ipsum
45    CHILD PROCESS: PID: 22187: Choose for execution './exe/processes'
46    CHILD PROCESS: PID: 22187: Sending message to the main process...
47  NewText: Executing: ./exe/processes PID: 22187
48    CHILD PROCESS: PID: 22187: Sending message 'Executing: ./exe/processes PID: 22187' to the
        MAIN process...
49                 : Message size: 47
50    CHILD PROCESS: PID: 22187 Executing command:'./exe/processes'
51  Child Process:  Global variable: 3 Stack variable: 21 Pid: 22190
52  Parent Process: Global variable: 2 Stack variable: 20 Pid: 22189
53    CHILD PROCESS: PID: 22187: Choose for execution './exe/processes'
54    CHILD PROCESS: PID: 22187: Sending message to the main process...
55  NewText: Executing: ./exe/processes PID: 22187
56    CHILD PROCESS: PID: 22187: Sending message 'Executing: ./exe/processes PID: 22187' to the
        MAIN process...
57                 : Message size: 47
58    CHILD PROCESS: PID: 22187 Executing command:'./exe/processes'
59  Child Process:  Global variable: 3 Stack variable: 21 Pid: 22193
60  Parent Process: Global variable: 2 Stack variable: 20 Pid: 22192
61    CHILD PROCESS: PID: 22187: Choose for execution './exe/processes'
62    CHILD PROCESS: PID: 22187: Sending message to the main process...
63  NewText: Executing: ./exe/processes PID: 22187
64    CHILD PROCESS: PID: 22187: Sending message 'Executing: ./exe/processes PID: 22187' to the
        MAIN process...
65                 : Message size: 47
66    CHILD PROCESS: PID: 22187 Executing command:'./exe/processes'
67  Child Process:  Global variable: 3 Stack variable: 21 Pid: 22196
68  Parent Process: Global variable: 2 Stack variable: 20 Pid: 22195
69            MAIN: Receied message: Executing: ./exe/threading PID: 22177
70            MAIN: Receied message: Executing: ./exe/threading PID: 22177
71            MAIN: Receied message: Executing: ./exe/threading PID: 22177
72            MAIN: Receied message: Executing: ./exe/processes PID: 22187
73            MAIN: Receied message: Executing: ./exe/processes PID: 22187
74            MAIN: Receied message: Executing: ./exe/processes PID: 22187
```

4.6   Output 6

```
1     Process name: state
2  --------------------------
3            MAIN: Starting
4            MAIN: PID: 22659
5            MAIN: Created shared programm list:
6               - Key = 137363458
7                  - ./exe/threading
8                  - ./exe/processes
9                  - ./exe/ferry
```

15

```
10            MAIN: Created semaphores for all programms
11               - Key = 1630535682
12               - Semaphore 0 ('./exe/threading'). Value:1
13               - Semaphore 1 ('./exe/processes'). Value:1
14               - Semaphore 2 ('    ./exe/ferry'). Value:1
15            MAIN: Created message queue:
16               - Queue id = 10
17               - Key = 540016642
18   CHILD PROCESS: PID: 22660: Choose for execution './exe/threading'
19   CHILD PROCESS: PID: 22660: Sending message to the main process...
20 NewText: Executing: ./exe/threading PID: 22660
21   CHILD PROCESS: PID: 22660: Sending message 'Executing: ./exe/threading PID: 22660' to the
     MAIN process...
22               : Message size: 47
23   CHILD PROCESS: PID: 22660 Executing command:'./exe/threading'
24 Text: thread
25 Text: first
26 Text: Heh Ipsum
27   CHILD PROCESS: PID: 22660: Choose for execution './exe/processes'
28   CHILD PROCESS: PID: 22660: Sending message to the main process...
29 NewText: Executing: ./exe/processes PID: 22660
30   CHILD PROCESS: PID: 22660: Sending message 'Executing: ./exe/processes PID: 22660' to the
     MAIN process...
31               : Message size: 47
32   CHILD PROCESS: PID: 22660 Executing command:'./exe/processes'
33   CHILD PROCESS: PID: 22667: Choose for execution './exe/threading'
34   CHILD PROCESS: PID: 22667: Sending message to the main process...
35 NewText: Executing: ./exe/threading PID: 22667
36   CHILD PROCESS: PID: 22667: Sending message 'Executing: ./exe/threading PID: 22667' to the
     MAIN process...
37               : Message size: 47
38   CHILD PROCESS: PID: 22667 Executing command:'./exe/threading'
39 Text: thread
40 Text: first
41 Text: Heh Ipsum
42   CHILD PROCESS: PID: 22667: Choose for execution './exe/processes'
43   CHILD PROCESS: PID: 22667: Sending message to the main process...
44 NewText: Executing: ./exe/processes PID: 22667
45   CHILD PROCESS: PID: 22667: Sending message 'Executing: ./exe/processes PID: 22667' to the
     MAIN process...
46               : Message size: 47
47   CHILD PROCESS: PID: 22667 Executing command:'./exe/processes'
48 Child Process:  Global variable: 3 Stack variable: 21 Pid: 22666
49 Parent Process: Global variable: 2 Stack variable: 20 Pid: 22665
50   CHILD PROCESS: PID: 22660: Choose for execution './exe/ferry'
51   CHILD PROCESS: PID: 22660: Sending message to the main process...
52 NewText: Executing: ./exe/ferry PID: 22660
53   CHILD PROCESS: PID: 22660: Sending message 'Executing: ./exe/ferry PID: 22660' to the MAIN
     process...
54               : Message size: 43
55   CHILD PROCESS: PID: 22660 Executing command:'./exe/ferry'
56 Enter N: 2
57      INFORMATION
58 Available places: 4
59     Paratroopers: 4
60          Marins: 4
61          ------------
62 Child Process:  Global variable: 3 Stack variable: 21 Pid: 22675
63 Parent Process: Global variable: 2 Stack variable: 20 Pid: 22672
64   CHILD PROCESS: PID: 22667: Choose for execution './exe/threading'
65   CHILD PROCESS: PID: 22667: Sending message to the main process...
66 NewText: Executing: ./exe/threading PID: 22667
67   CHILD PROCESS: PID: 22667: Sending message 'Executing: ./exe/threading PID: 22667' to the
     MAIN process...
68               : Message size: 47
69   CHILD PROCESS: PID: 22667 Executing command:'./exe/threading'
70  Paratrooper 2 boarded  < Current Time: 1590056874
71 Text: thread
72 Text: first
73 Text: Heh Ipsum
74      Marine 1 boarded  < Current Time: 1590056875
75      Marine 2 boarded  < Current Time: 1590056875
76  Paratrooper 1 boarded  < Current Time: 1590056875
```

16

```
77   Paratrooper 3 canceled < Current Time: 1590056875
78        Marine 4 canceled < Current Time: 1590056875
79   Paratrooper 4 canceled < Current Time: 1590056876
80        Marine 3 canceled < Current Time: 1590056877
81
82  Cleaning all threads troops that are not in ferry
83
84    Ferry in trip!
85    Ferry in trip!
86    Ferry in trip!
87
88  Eject all troops on coast
89
90   Paratrooper 2 disembarked. < Current time: 1590056880
91        Marine 1 disembarked. < Current time: 1590056881
92        Marine 2 disembarked. < Current time: 1590056882
93   Paratrooper 1 disembarked. < Current time: 1590056883
94             MAIN: Receied message: Executing: ./exe/threading PID: 22660
95             MAIN: Receied message: Executing: ./exe/processes PID: 22660
96             MAIN: Receied message: Executing: ./exe/threading PID: 22667
97             MAIN: Receied message: Executing: ./exe/processes PID: 22667
98             MAIN: Receied message: Executing: ./exe/ferry PID: 22660
99             MAIN: Receied message: Executing: ./exe/threading PID: 22667
```

5   Висновки

У цій лабораторній роботі я навчився синхронізовувати процеси між собою, надсилати повідомлення від процесу до процесу. Навчився використовувати спільні області пам'яті для процесів за допомогою shmget. Дізнався що можна використовувати семафори для забезбечення виконання "критичних секцій" не тільки в різних потоках але і різні процеси, що теж дуже важливо.