МИЭТ
Национальный исследовательский университет «МИЭТ»
Институт интегральной электроники (группа ЭН-14М, каф. ПКИМС)

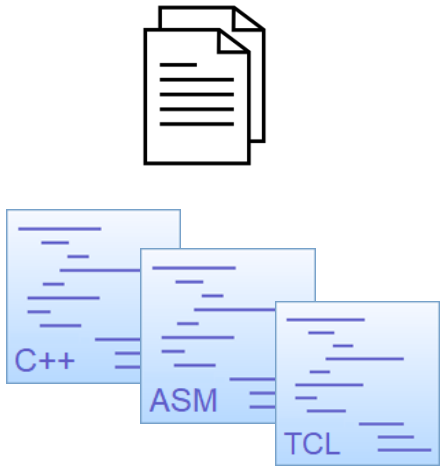
Компьютерные технологии в научных исследованиях

Семинар №3

Текстовые и бинарные данные.
Построение вычислений

Способы представления данных в файлах

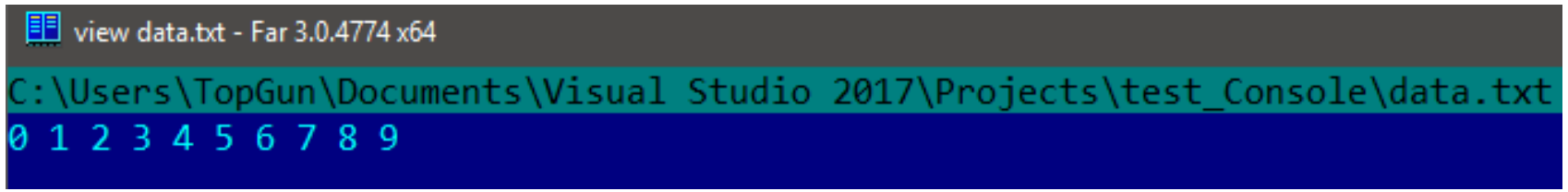
Текстовые
(ASCII)



Бинарные
(двоичные)

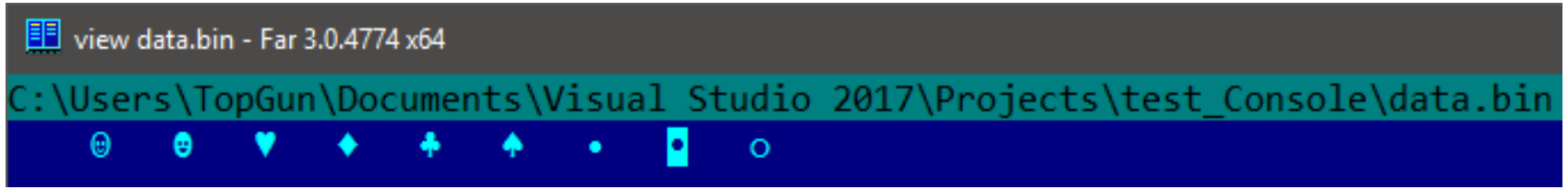
Запись текстовых данных (на примере языка C++)

```cpp
#include <fstream>
using namespace std;

#define ARRAY_SIZE  10

int main() {
  int mas[ARRAY_SIZE];
  for (int i = 0; i < ARRAY_SIZE; ++i)
    mas[i] = i;

  fstream file_txt("data.txt", ios::out);
  for (int i = 0; i < ARRAY_SIZE; ++i)
    file_txt << mas[i] << " ";
  file_txt.close();

  return 0;
}
```

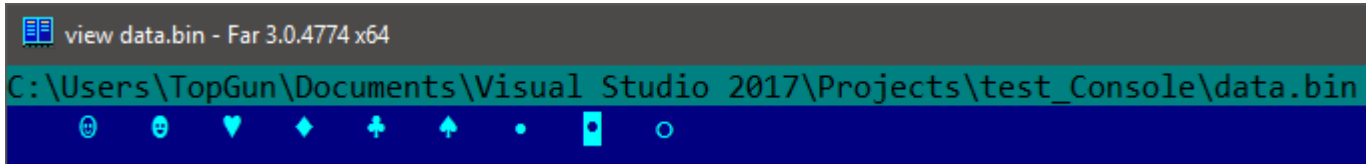


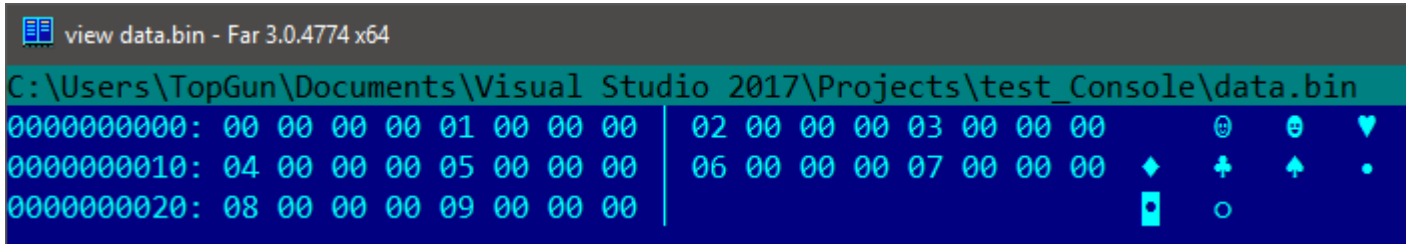
Запись бинарных данных (на примере языка C++)

```
#include <fstream>
using namespace std;

#define ARRAY_SIZE  10

int main() {
  int mas[ARRAY_SIZE];
  for (int i = 0; i < ARRAY_SIZE; ++i)
    mas[i] = i;

  fstream file_bin("data.bin", ios::out | ios::binary);
  file_bin.write((char *)&mas, sizeof(int)*ARRAY_SIZE);
  file_bin.close();

  return 0;
}
```



Что именно хранится в бинарном виде?

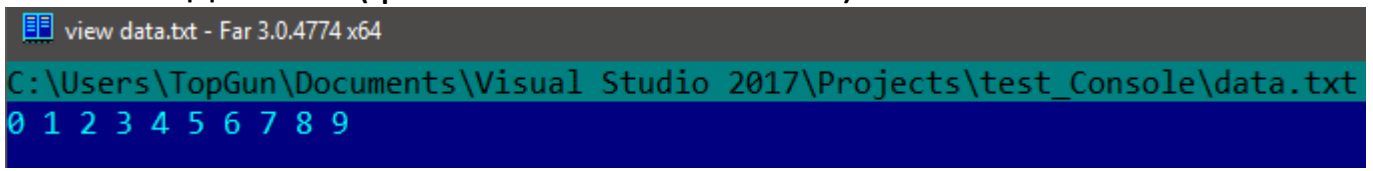




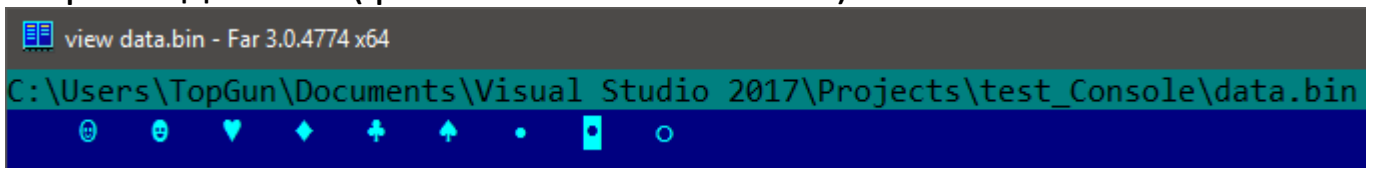
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0		☺ 1	☻ 2	♥ 3	♦ 4	♣ 5	♠ 6	• 7	8	○ 9	10	11	12	13	14	15
1	► 16	◄ 17	18	19	20	21	_ 22	23	↑ 24	↓ 25	→ 26	← 27	28	↔ 29	▲ 30	▼ 31
2	32	! 33	" 34	# 35	$ 36	% 37	& 38	' 39	(40	) 41	* 42	+ 43	, 44	- 45	. 46	/ 47
3	0 48	1 49	2 50	3 51	4 52	5 53	6 54	7 55	8 56	9 57	: 58	; 59	< 60	= 61	> 62	? 63
4	@ 64	A 65	B 66	C 67	D 68	E 69	F 70	G 71	H 72	I 73	J 74	K 75	L 76	M 77	N 78	O 79
5	P 80	Q 81	R 82	S 83	T 84	U 85	V 86	W 87	X 88	Y 89	Z 90	[91	\ 92	] 93	^ 94	_ 95
6	` 96	a 97	b 98	c 99	d 100	e 101	f 102	g 103	h 104	i 105	j 106	k 107	l 108	m 109	n 110	o 111
7	p 112	q 113	r 114	s 115	t 116	u 117	v 118	w 119	x 120	y 121	z 122	{ 123	| 124	}] 125	~ 126	⌂ 127
8	А 128	Б 129	В 130	Г 131	Д 132	Е 133	Ж 134	З 135	И 136	Й 137	К 138	Л 139	М 140	Н 141	О 142	П 143
9	Р 144	С 145	Т 146	У 147	Ф 148	Х 149	Ц 150	Ч 151	Ш 152	Щ 153	Ъ 154	Ы 155	Ь 156	Э 157	Ю 158	Я 159
A	а 160	б 161	в 162	г 163	д 164	е 165	ж 166	з 167	и 168	й 169	к 170	л 171	м 172	н 173	о 174	п 175
B	░ 176	▒ 177	▓ 178	| 179	┤ 180	╡ 181	╢ 182	╖ 183	╕ 184	╣ 185	║ 186	╗ 187	╝ 188	╜ 189	╛ 190	┐ 191
C	└ 192	┴ 193	┬ 194	├ 195	─ 196	┼ 197	╞ 198	╟ 199	╚ 200	╔ 201	╩ 202	╦ 203	╠ 204	═ 205	╬ 206	╧ 207
D	╨ 208	╤ 209	╥ 210	╙ 211	╘ 212	╒ 213	╓ 214	╫ 215	216	┘ 217	┌ 218	█ 219	▄ 220	▌ 221	▐ 222	▀ 223
E	р 224	с 225	т 226	у 227	ф 228	х 229	ц 230	ч 231	ш 232	щ 233	ъ 234	ы 235	ь 236	э 237	ю 238	я 239
F	Ё 240	ё 241	≥ 242	≤ 243	⌠ 244	⌡ 245	÷ 246	≈ 247	° 248	∙ 249	· 250	√ 251	ⁿ 252	² 253	■ 254	□ 255

Преимущество использования бинарных данных (3)

Текстовые данные (файл занимает 20 байт)

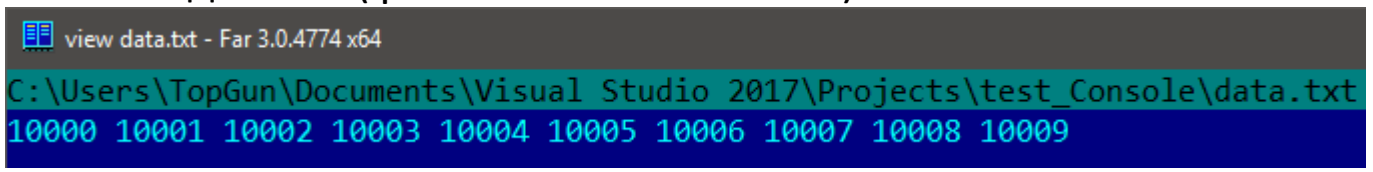


Бинарные данные (файл занимает 40 байт)

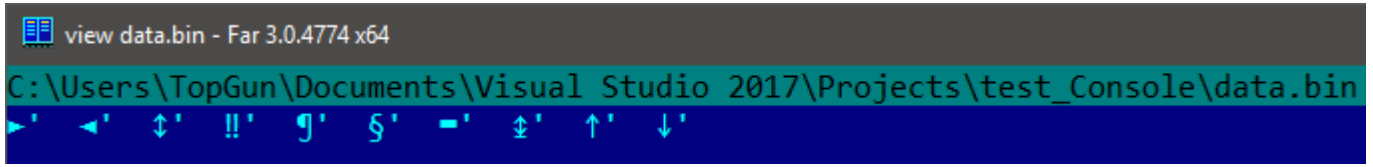


10 чисел
от 0

Текстовые данные (файл занимает 60 байт)

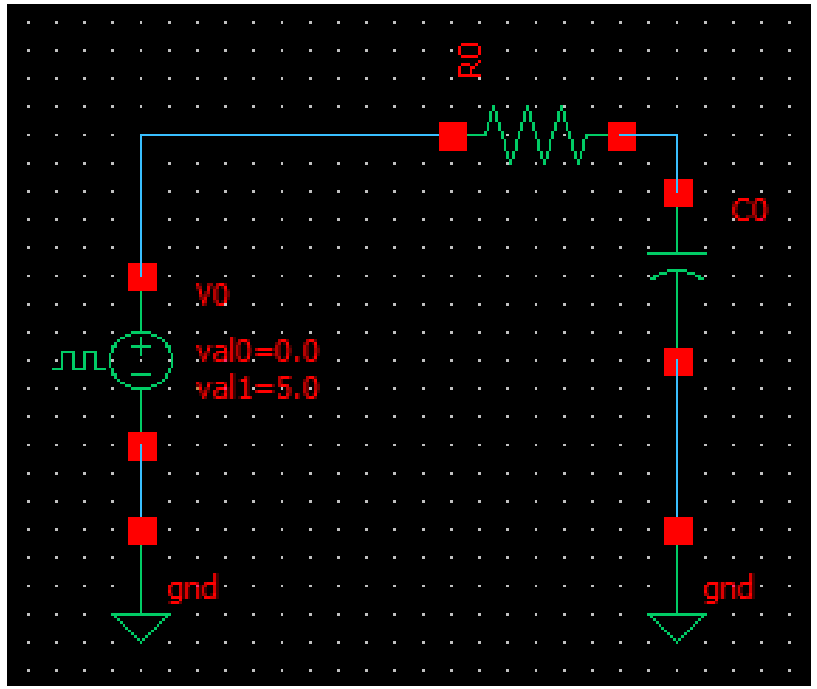


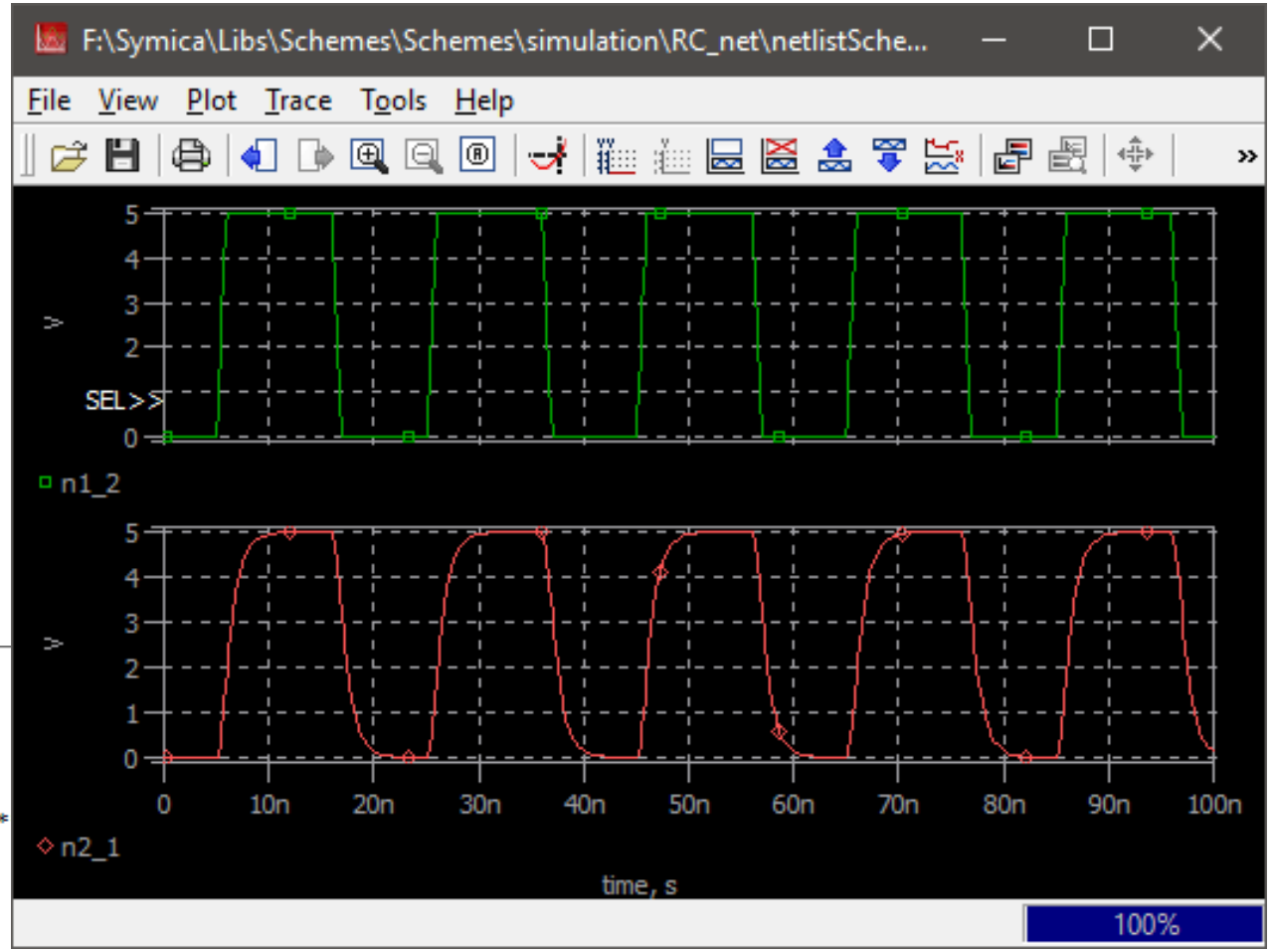
Бинарные данные (файл занимает 40 байт)



10 чисел
от 10000

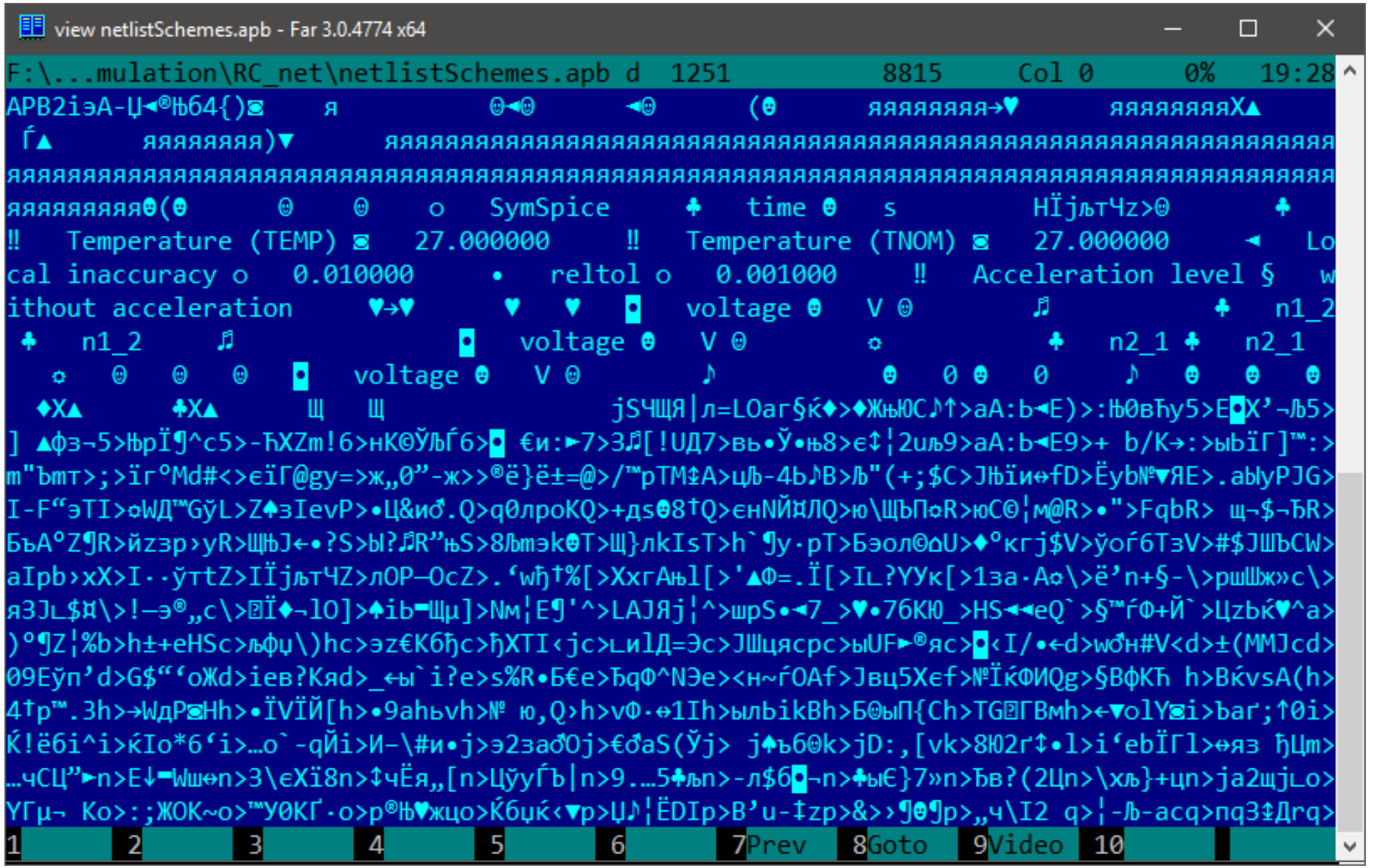
Текстовые и бинарные данные в САПР (1)



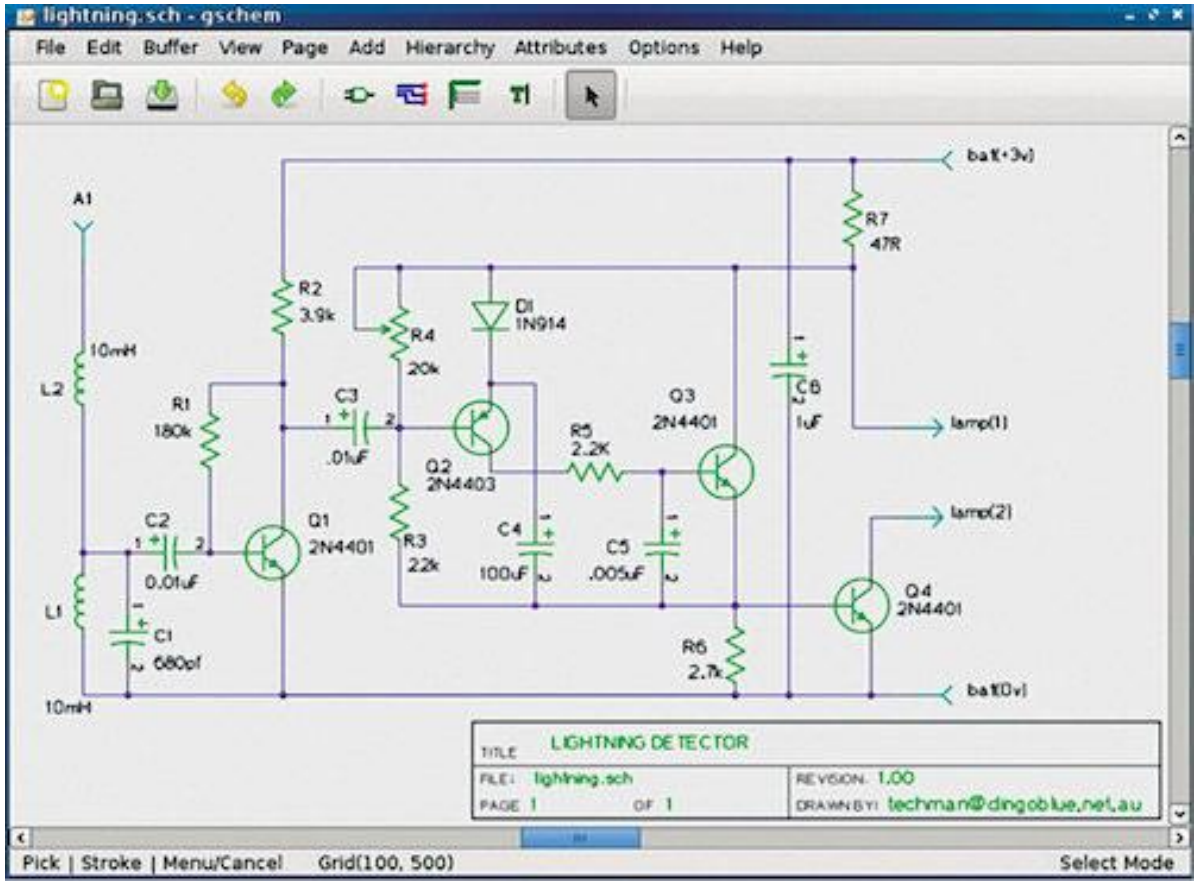



```
*** Title: "F:\Symica\Libs\Schemes\Schemes\simulation\RC_net\netlistSchemes.net"
*** Generated by:  Symica
*** © 2009-2014 Symica. All rights reserved. (www.symica.com)
*** Generated for: SymSpice
*** Generated on:  Wed Feb 20 13:49:32 2019
********************************************************************************
simulator lang=local

parameters

V0 n1_2 gnd vsource type=pulse val0=0 val1=5 delay=5e-009 period=2e-008 rise=1e-0
R0 n1_2 n2_1 resistor r=1000
C0 n2_1 gnd capacitor c=1e-012
```

Текстовые и бинарные данные в САПР (2)



Текстовые и бинарные данные в САПР (3)



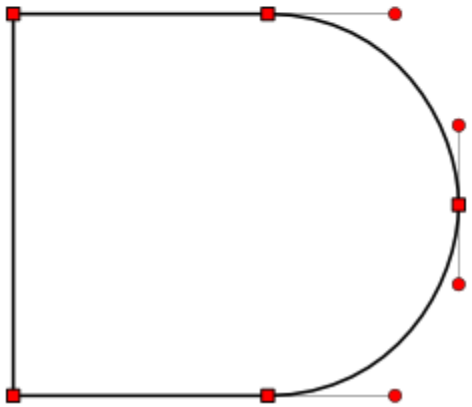
As example, lets draw the outline of an AND gate. The path data is:

```
M 100,100 L 500,100 C 700,100 800,275 800,400
C 800,525 700,700 500,700 L 100,700 z
```

And a complete schematic:

```
v 20080706 1
H 3 0 0 0 -1 -1 0 2 20 100 -1 -1 6
M 100,100
L 500,100
C 700,100 800,275 800,400
C 800,525 700,700 500,700
L 100,700
z
```

The resulting path (with control points drawn on to illustrate their positions) is shown here:



Текстовые и бинарные данные в САПР (4)

view lab_3.tr0 - Far 3.0.4774 x64

```
C:\Users\TopGun\Documents
HEADER
"PSFversion" "1.00"
"simulator" "KSI"
"runtype" "Transient Analy
TYPE
"node" FLOAT DOUBLE PROP(
"key" "node"
)
"branch" FLOAT DOUBLE PRO
"key" "branch"
)
"sweep" FLOAT DOUBLE
SWEEP
"time" "sweep"
TRACE
"group" GROUP 4
"v(1)" "node"
"v(2)" "node"
"v(3)" "node"
"i(d1:1)" "branch"
VALUE
"time" 0.000000e+00
"group"
0.000000e+00
0.000000e+00
0.000000e+00
0.000000e+00
"time" 1.000000e-09
```

C:\Users\TopGun\netlist.csdf - Notepad++

File Edit Search View Encoding Lan

netlist.sp | netlist.csdf

```
1   #H
2   SOURCE='SYMSPICE'
3   TITLE='* # file name: C:
4   SUBTITLE=''
5   TIME='19:39:10' DATE='28
6   ANALYSIS='TR' TEMPERATUR
7   COMPLEXVALUES='NO' FORMA
8   XBEGIN=' 0.000000e+000'
9   NODES='     3'
10  #N 'v(1)' 'v(2)' 'i(v1)'
11
12  #C      0.00000000e+000
13    -0.00000000e+000
14
15  #C      2.00000000e-011
16    -1.99999998e-005
17
18  #C      4.00000000e-011
19    -3.99999996e-005
20
21  #C      6.00000000e-011
22    -5.99999994e-005
23
24  #C      8.00000000e-011
25    -7.99999992e-005
26
27  #C      1.00000000e-010
```

N length : 4 942 lines : 164 Ln : 1

C:\Users\TopGun\netlist.nut - Notepad++

File Edit Search View Encoding Language Settings Macro Run Plugins Window ? X

netlist.sp | netlist.csdf | netlist.nut

```
1   Title: // Generated for: SymSpice
2   Date: 7:40:14 PM, Sat Sep 28, 2019
3   Plotname: Transient Analysis `tranl': time = (0.s -> 1.e-09s)
4   Flags: real
5   No. Variables: 4
6   No. Points: 50
7   Variables:
8           0   time    s
9           1   1   voltage
10          2   2   voltage
11          3   v1:p    current
12  Values:
13   0      0
14          0
15          0
16          0
17   1      2.00000000e-11
18          2.00000000e-02
19          1.99999998e-10
20          -1.99999998e-05
21   2      4.00000000e-11
22          4.00000000e-02
23          3.99999996e-10
24          -3.99999996e-05
25   3      6.00000000e-11
26          6.00000000e-02
27          5.99999994e-10
```

N length : 3 780 lines : 213 Ln : 1 Col : 1 Sel : 0 | 0 Unix (LF) UTF-8 INS

Текстовые и бинарные данные в САПР (5)

C:\Users\TopGun\netlist.nut - Notepad++

File Edit Search View Encoding Language Settings

netlist.sp | netlist.csdf | netlist.nut

```
1   Title: // Generated for: SymSpice
2   Date: 7:40:14 PM, Sat Sep 28, 2019
3   Plotname: Transient Analysis `tranl
4   Flags: real
5   No. Variables: 4
6   No. Points: 50
7   Variables:
8           0   time    s
9           1   1   voltage
10          2   2   voltage
11          3   vl:p    current
12  Values:
13   0      0
14          0
15          0
16          0
17   1      2.00000000e-11
18          2.00000000e-02
19          1.99999998e-10
20          -1.99999998e-05
21   2      4.00000000e-11
22          4.00000000e-02
23          3.99999996e-10
24          -3.99999996e-05
25   3      6.00000000e-11
26          6.00000000e-02
27          5.99999994e-10
```

length : 3 780 lines : 213 Ln : 1 Col : 1 Sel : 0

E:\SymicaFree\test_NOT_nutbin.tr0

```
Title: // Generated for: SymSpice
Date: 1:22:05 PM, Thu Oct 21, 2021
Plotname: DC Analysis `dc1': vin:dc = (0.V -> 5.0 V)
Flags: real
No. Variables: 6
No. Points: 501
Variables:
                0       volt    V
                1       in      voltage
                2       out     voltage
                3       vcc     voltage
                4       vcc:p   current
                5       vin:p   current
Binary:
                @!!яяя2w®@¶     S¦↓Ґ¤ЃwюЂ       ?„z6G®¶{?„z6G®¶{@!!яяя2♂S@¶     S¦↓Ґ¦§L8Ђ       ?”z6G®¶{?”z6G®¶{@!!яяя1h†@¶
=pJЧ
?.
=pJЧ
@!!яяя.□&@¶     S¦↓ҐћQb:Ђ       ?№™™™™™ль?№™™™™™ль@!!яяя.'Є@¶     S¦↓Ґ-→.йЂ       ?j(xBЏ\)?j(xBЏ\)@!!яяя-¶¶@¶     S¦↓Ґ -y'Ђ
=p¤?AJЧ
=p¤@!!яяя,У_@¶     S¦↓Ґ™xl#Ђ       ?Бл…▲ёQм?Бл…▲ёQм@!!яэ¬)µ‡@¶     s?L3n=rPЂ       ?Г333333?Г333333@!!япLc °@¶     sl(+0_+
=pJЧ
?3
=pJЧ
@!!яr}TЁ+@¶     sќMмЬ0X♫Ђ       ?ИQл…▲ёR?ИQл…▲ёR@!!я--At⌂@¶     sҐєъw◄RyЂ       ?Й™™™™™ль?Й™™™™™ль@!!юЫ!!Ik◘@¶     s®2н:W%ЋЂ
=q?HpJЧ
=q@!!эЏ §rГ@¶     sїщ.pµdKЂ       ?OёQл…▲ё?OёQл…▲ё@!!э♦y▬h+@¶     sГ~,гаA0Ђ       ?P       ?P       @!!ьl♥knў@¶     s3Yiьц)g
=p¤?PJЧ
=p¤@!!ыДёwШ8@¶     sЛЌLE‡д◙Ђ       ?CG®¶z6H?CG®¶z6H@!!ы◘шЇ@8@¶     sP
§ќrr'Ђ       ?Сл…▲ёQм?Сл…▲ёQм@!!ъJЄ&↔ф@¶     sTЂ°Ґ”~Ђ       ?TЏ\(xBЏ?TЏ\(xBЏ@!!щwIЏЬ!!@¶     sX▼mьfPMЂ       ?У333333?У333
=pJЧ?УЧ
=pJЧ@!!чҐ]↑kx@¶     sЬrjф♥—ьЂ       ?Фz6G®¶{?Фz6G®¶{@!!цҐИ¦Р»@¶     sЮ◘Ўcj↑¤Ђ       ?X▲ёQл…▼?X▲ёQл…▼@!!x—▲♥ –@¶     sa-⊗X]
=pJЧ
```

Текстовые и бинарные данные в САПР (6)

```
E:\SymicaFree\test_NOT_nutascii.tr0
Title: // Generated for: SymSpice
Date: 1:22:06 PM, Thu Oct 21, 2021
Plotname: DC Analysis `dc1': vin:dc = (0.V -> 5.0 V)
Flags: real
No. Variables: 6
No. Points: 501
Variables:
                0       volt    V
                1       in      voltage
                2       out     voltage
                3       vcc     voltage
                4       vcc:p   current
                5       vin:p   current
Values:
 0              0
                0
                4.99999999e+00
                5
                -1.00500000e-11
                0
 1              1.00000000e-02
                1.00000000e-02
                4.99999999e+00
                5
                -1.00500001e-11
                0
```

40 600 Байт

```
E:\SymicaFree\test_NOT_nutbin.tr0
Title: // Generated for: SymSpice
Date: 1:22:05 PM, Thu Oct 21, 2021
Plotname: DC Analysis `dc1': vin:dc = (0.V -> 5.0 V)
Flags: real
No. Variables: 6
No. Points: 501
Variables:
                0       volt    V
                1       in      voltage
                2       out     voltage
                3       vcc     voltage
                4       vcc:p   current
                5       vin:p   current
Binary:
                @‼яяя2w®@¶      S¦↓Ґ¤ҐwюЂ      ?„z6G®¶{?„z6G®¶{@‼я
=pJЧ
?·
=pJЧ
@‼яяя.🄱&@¶     S¦↓ҐњЏb:Ђ      ?№™ᵀᴹᵀᴹᵀᴹᵀᴹᵀᴹљ?№™ᵀᴹᵀᴹᵀᴹᵀᴹᵀᴹљ@‼яяя.'Є@¶      S¦↓
=p¤?AJЧ
=p¤@‼яяя,У_@¶     S¦↓Ґ™xl#Ђ      ?Бл…▲ёQм?Бл…▲ёQм@‼яэ¬)µ‡@¶
=pJЧ
?3
=pJЧ
@‼яr}TЁ+@¶      sќᴹмЬ⊖XЉЂ      ?ИQл…▲ёR?ИQл…▲ёR@‼я--Atₒ@¶      sҐ
=q?HpJЧ
```

24 333 Байт

Текстовые и бинарные данные в САПР (8)

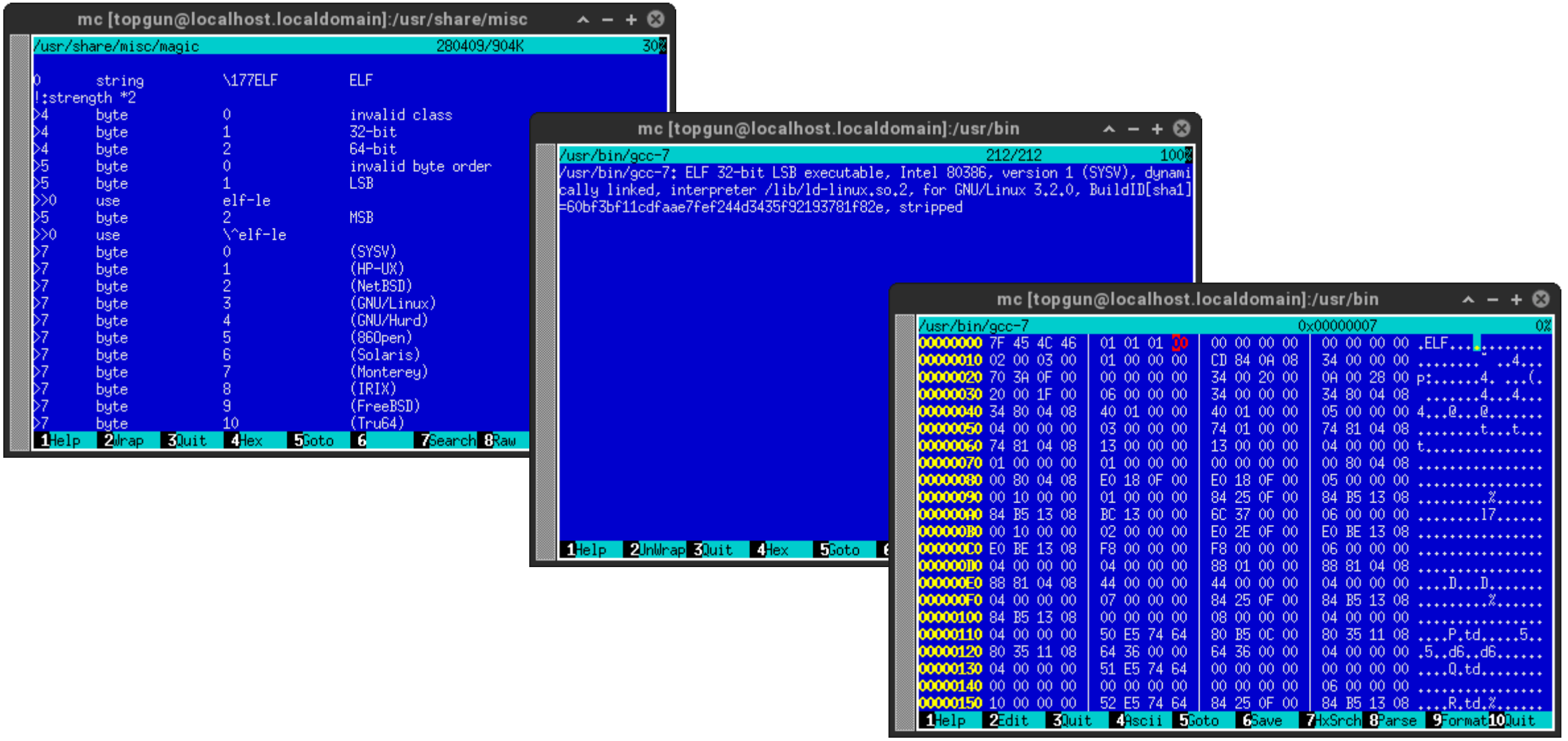
view simple1_msh.grd - Far 3.0.3000 x86

```
E:\Samples_tplot\3D_first\Simple\simple1_msh.grd
DF-ISE text

# filename: simple1_msh.grd
# written by the library Delaunay
Info {
version     =  1.1
type        = grid
dimension   =  3
nb_vertices =  45
nb_edges    =  180
nb_faces    =  232
nb_elements =  112
nb_regions  =  4
regions     = [ "bott" "top" "Nplus" "pSubs" ]
materials     = [ Contact Contact Silicon Silicon ]
 }
Data {
CoordSystem {
translate = [  0  0  0 ]
transform = [  1  0  0  0  1  0  0  0  1 ]
 }
Vertices (  45) {
 0 0 0
 2.5 0 0
 2.5 2.5 0
 0 2.5 0
 0 0 2.5
```

view simple1_msh.dat - Far 3.0.3000 x86

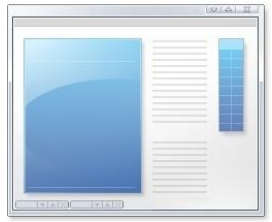
```
E:\Samples_tplot\3D_first\Simple\simple1_msh.dat
DF-ISE text

# filename: simple1_msh.dat
# written by the library Delaunay
Info {
version     =  1
type        = dataset
dimension   =  3
nb_vertices =  45
nb_edges    =  180
nb_faces    =  232
nb_elements =  112
nb_regions  =  4
datasets     = [ "DopingConcentration" "BoronActiveConce
functions     = [ DopingConcentration BoronActiveConcent
 }
Data {
Dataset ("DopingConcentration") {
function = DopingConcentration
type = scalar
dimension =  1
location = vertex
validity = ["Nplus"]
Values (  27) {
 1e+20
 1e+20
 1e+20
```

Как Linux определяет тип файла?



Распараллеливание вычислений: процессы и потоки

Поток – (thread, нить) – базовая единица загрузки процессора

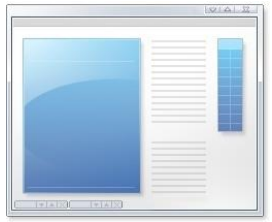


ПРОЦЕСС

поток 1

Сегмент кода
Сегмент данных

Регистры
Стек
+
идентификатор



ПРОЦЕСС

поток 1

поток 2

поток 3

Как распараллеливание реализуется?

Распараллеливание расчётов в современном C++

```cpp
#include <thread>

void print_0() {
  for (int i = 0; i < 1000; ++i)
    printf("0");
}

void print_1() {
  for (int i = 0; i < 1000; ++i)
    printf("1");
}


int main() {
  std::thread thread1(print_0);
  std::thread thread2(print_1);

  thread1.join();
  thread2.join();
  return 0;
}
```

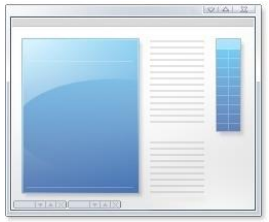
```cpp
#include <pthread.h>

void *print_0(void *args) {
  for (int i = 0; i < 1000; ++i)
    printf("0");
  return NULL;
}

void *print_1(void *args) {
  for (int i = 0; i < 1000; ++i)
    printf("1");
  return NULL;
}

int main() {
  pthread_t thread1, thread2;

  pthread_create(&thread1, NULL, print_0, NULL);
  pthread_create(&thread2, NULL, print_1, NULL);

  pthread_join(thread1, NULL);
  pthread_join(thread2, NULL);

  return 0;
}
```

Распараллеливание расчётов: взаимодействие потоков

```
std::vector<int> values;

void print_0() {
  for (int i = 0; i < 10000; i++)
    printf("0");
  values.push_back(0);
}

void print_1() {
  for (int i = 0; i < 10000; i++)
    printf("1");
  values.push_back(1);
}


int main() {
  thread thread1(print_0);
  thread thread2(print_1);

  thread1.join();
  thread2.join();
  return 0;
}
```

```
std::vector<int> values;
std::mutex       m;

void print_0() {
  for (int i = 0; i < 10000; i++)
    printf("0");
  m.lock();
  values.push_back(0);
  m.unlock();
}

void print_1() {
  for (int i = 0; i < 10000; i++)
    printf("1");
  m.lock();
  values.push_back(1);
  m.unlock();
}
```

Межпроцессное взаимодействие



Файлы

Сообщения и сигналы

Сокеты

Разделяемая память

IPC: файлы (FS change notification)

```
HANDLE FindFirstChangeNotificationA(
  LPCSTR lpPathName,
  BOOL   bWatchSubtree,
  DWORD  dwNotifyFilter
);
```

Заголовочный файл: fileapi.h

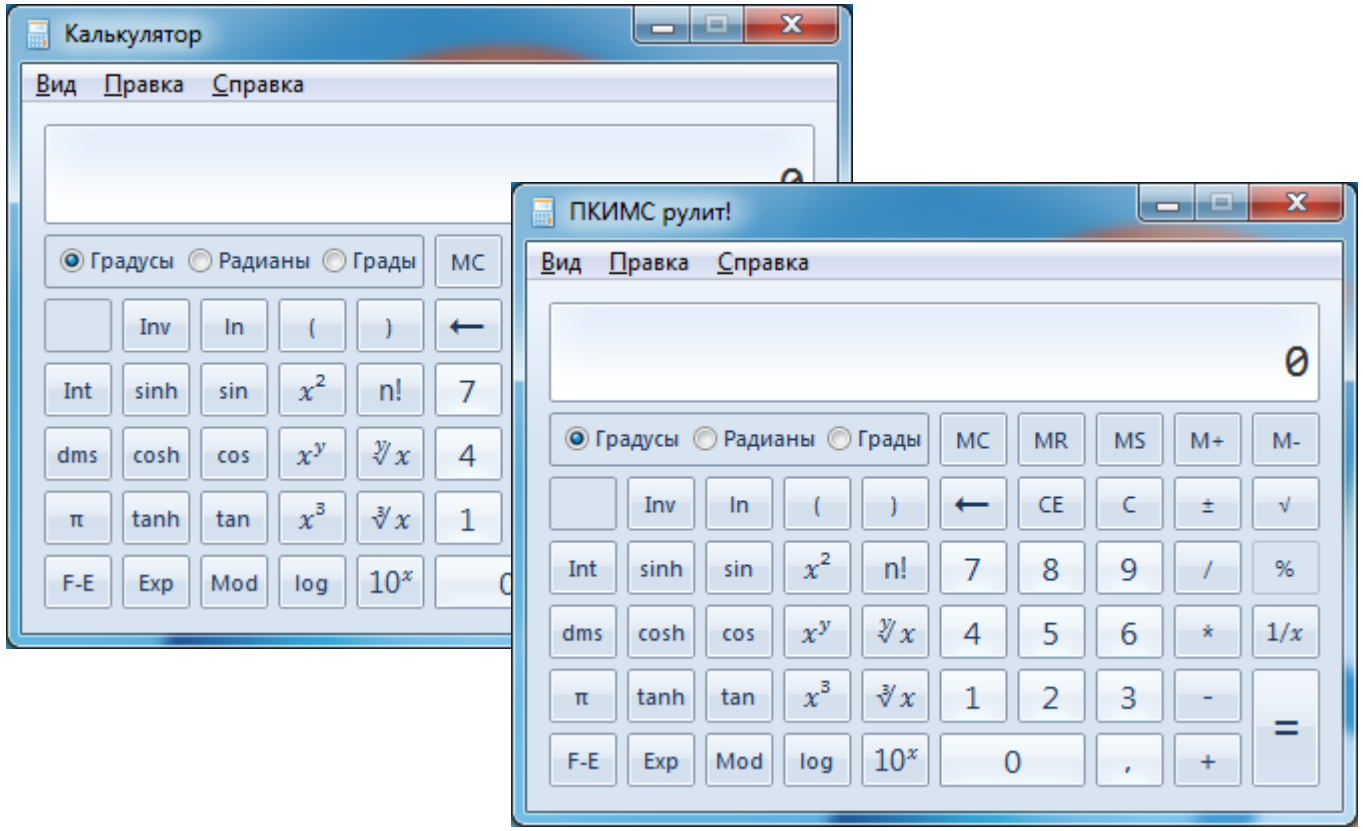
`[in] dwNotifyFilter`

The filter conditions that satisfy a change notification wait. This parameter can be one or more of the following values.

Value	Meaning
FILE_NOTIFY_CHANGE_FILE_NAME 0x00000001	Any file name change in the watched directory or subtree causes a change notification wait operation to return. Changes include renaming, creating, or deleting a file name.
FILE_NOTIFY_CHANGE_DIR_NAME 0x00000002	Any directory-name change in the watched directory or subtree causes a change notification wait operation to return. Changes include creating or deleting a directory.
FILE_NOTIFY_CHANGE_ATTRIBUTES 0x00000004	Any attribute change in the watched directory or subtree causes a change notification wait operation to return.
FILE_NOTIFY_CHANGE_SIZE 0x00000008	Any file-size change in the watched directory or subtree causes a change notification wait operation to return. The operating system detects a change in file size only when the file is written to the disk. For operating systems that use extensive caching, detection occurs only when the cache is sufficiently flushed.
FILE_NOTIFY_CHANGE_LAST_WRITE 0x00000010	Any change to the last write-time of files in the watched directory or subtree causes a change notification wait operation to return. The operating system detects a change to the last write-time only when the file is written to the disk. For operating systems that use extensive caching, detection occurs only when the cache is sufficiently flushed.
FILE_NOTIFY_CHANGE_SECURITY 0x00000100	Any security-descriptor change in the watched directory or subtree causes a change notification wait operation to return.

IPC: сообщения (signals, messages)


```
wchar_t str[] = L"ПКИМС рулит!";
HWND hWindow = FindWindow(nullptr, L"Калькулятор");

if (nullptr != hWindow)
  SendMessage(hWindow, WM_SETTEXT, 0, (LPARAM)str);
```



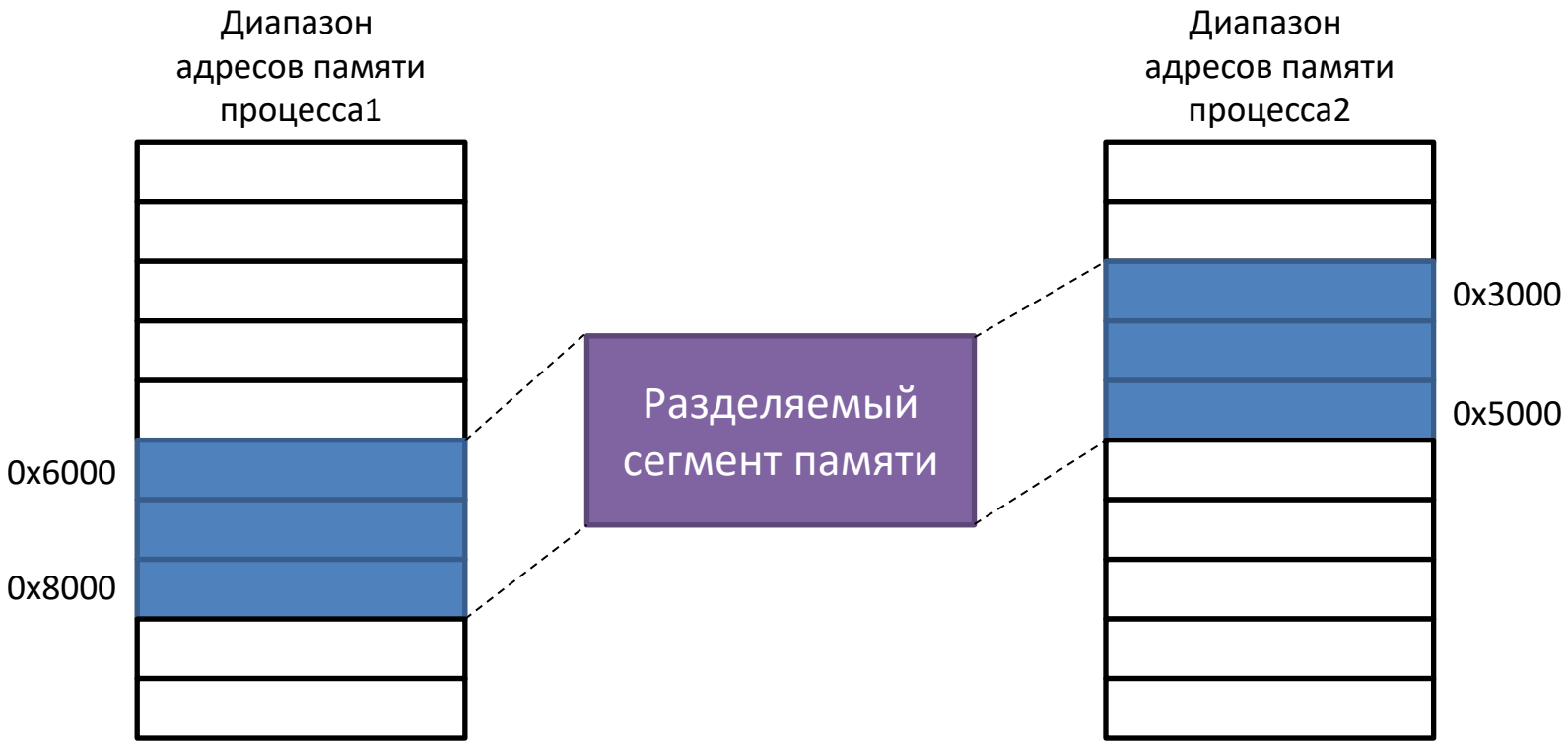
IPC: сокеты (sockets)

```python
import os
import socket

SOCKET_FILE = './echo.socket'

if os.path.exists(SOCKET_FILE):
    os.remove(SOCKET_FILE)

print("Открываем UNIX сокет...")
server = socket.socket(socket.AF_UNIX, socket.SOCK_DGRAM)
server.bind(SOCKET_FILE)

print("Слушаем...")
while True:
    datagram = server.recv(1024)
    if not datagram:
        break
    else:
        print("-" * 20)
    print(datagram)
    if b"DONE" == datagram:
        break
print("-" * 20)
print("Выключение...")
server.close()
os.remove(SOCKET_FILE)
print("Выполнено")
```

```python
import os
import socket

SOCKET_FILE = './echo.socket'

print("Подключение...")
if os.path.exists(SOCKET_FILE):
    client = socket.socket(socket.AF_UNIX, socket.SOCK_DGRAM)
    client.connect(SOCKET_FILE)
    print("Выполнено.")
    print("Ctrl-C чтобы выйти.")
    print("Отправьте 'DONE' чтобы выключить сервер.")
    while True:
        try:
            x = input("> ")  # for py2 use raw_input
            if "" != x:
                print("ОТПРАВЛЕНО: %s" % x)
                client.send(x.encode('utf-8'))
                if "DONE" == x:
                    print("Выключение.")
                    break
        except KeyboardInterrupt as k:
            print("Выключение.")
            break
    client.close()
else:
    print("Не могу соединиться!")
print("Выполнено")
```

https://lecturesnet.readthedocs.io/net/low-level/ipc/socket/unix.html

IPC: разделяемая память (shared memory) (1)

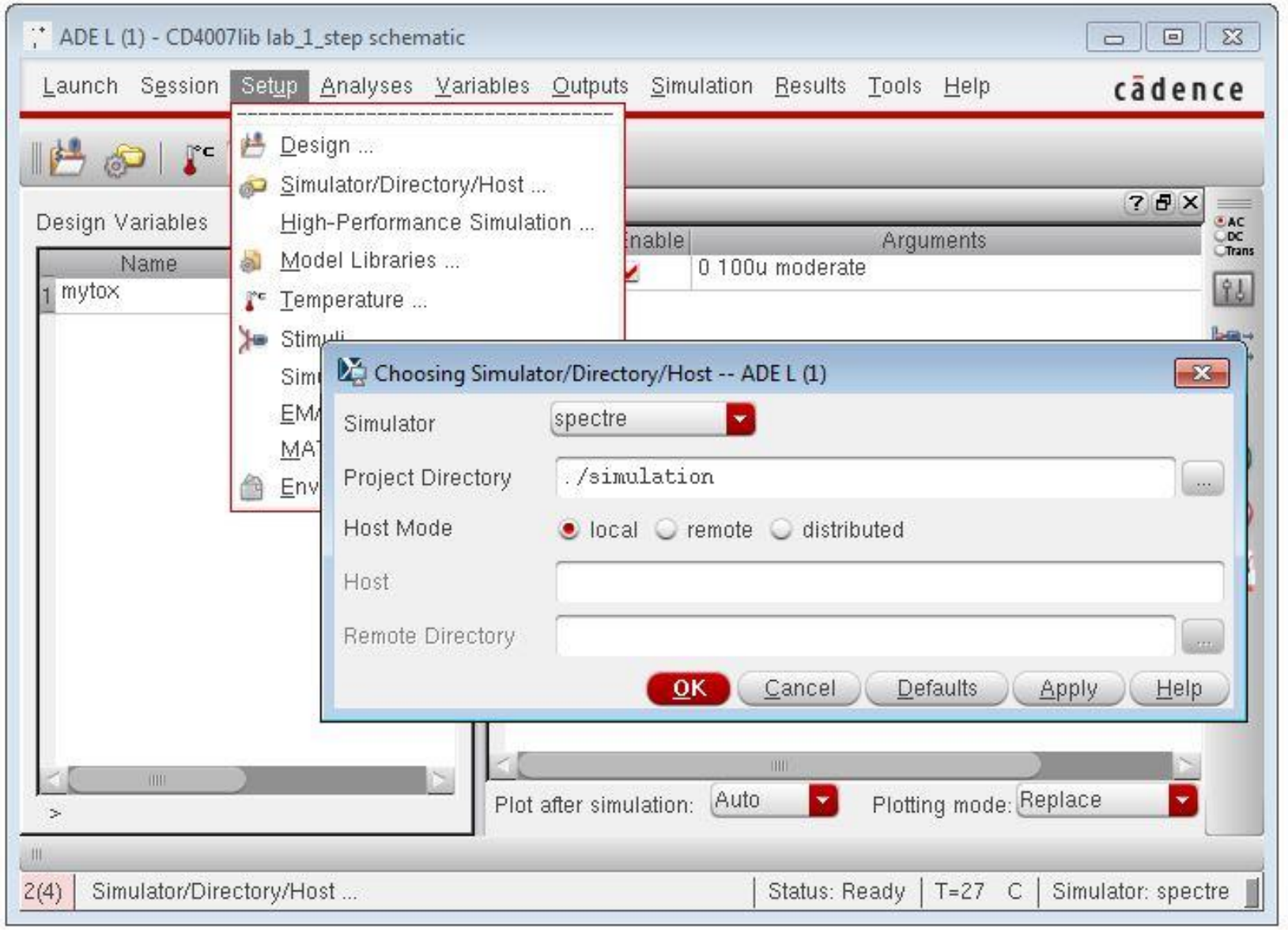


IPC: разделяемая память (shared memory) (2)

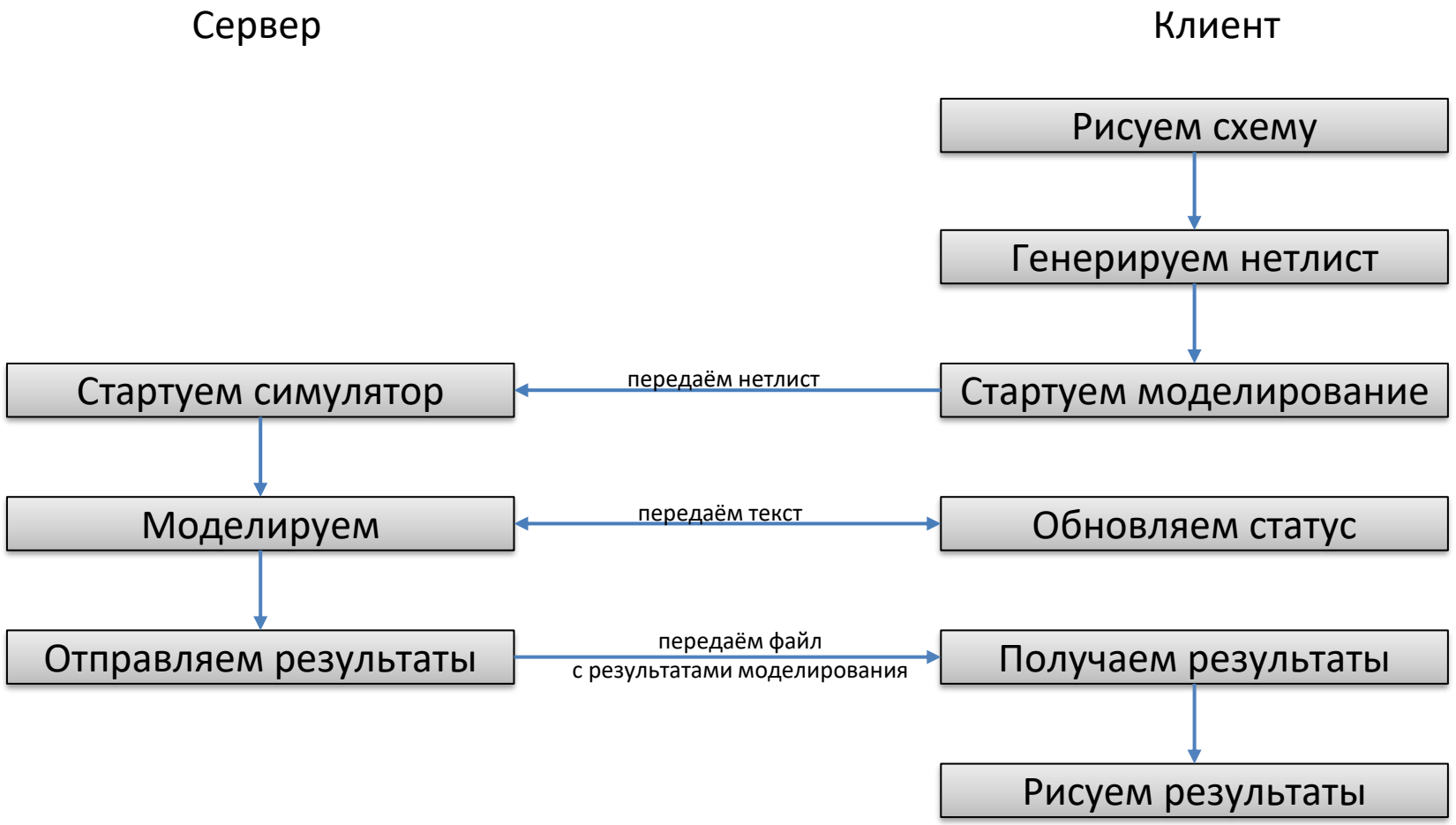
```
#include <iostream>
#include <sys/ipc.h>
#include <sys/shm.h>

using namespace std;

int main() {
  key_t key = ftok("shmfile", 65);

  int shmid = shmget(key, 1024, 0666 | IPC_CREAT);

  char *str = (char*) shmat(shmid,(void *)0, 0);

  cout << "Write Data : ";
  gets(str);

  cout << "Data written in memory: " << str << endl;

  shmdt(str);

  return 0;
}
```

```
#include <iostream>
#include <sys/ipc.h>
#include <sys/shm.h>

using namespace std;

int main() {
  key_t key = ftok("shmfile", 65);

  int shmid = shmget(key, 1024, 0666 | IPC_CREAT);

  char *str = (char*) shmat(shmid,(void *)0, 0);

  cout << "Data read from memory: " << str << endl;

  shmdt(str);

  shmctl(shmid, IPC_RMID, NULL);

  return 0;
}
```

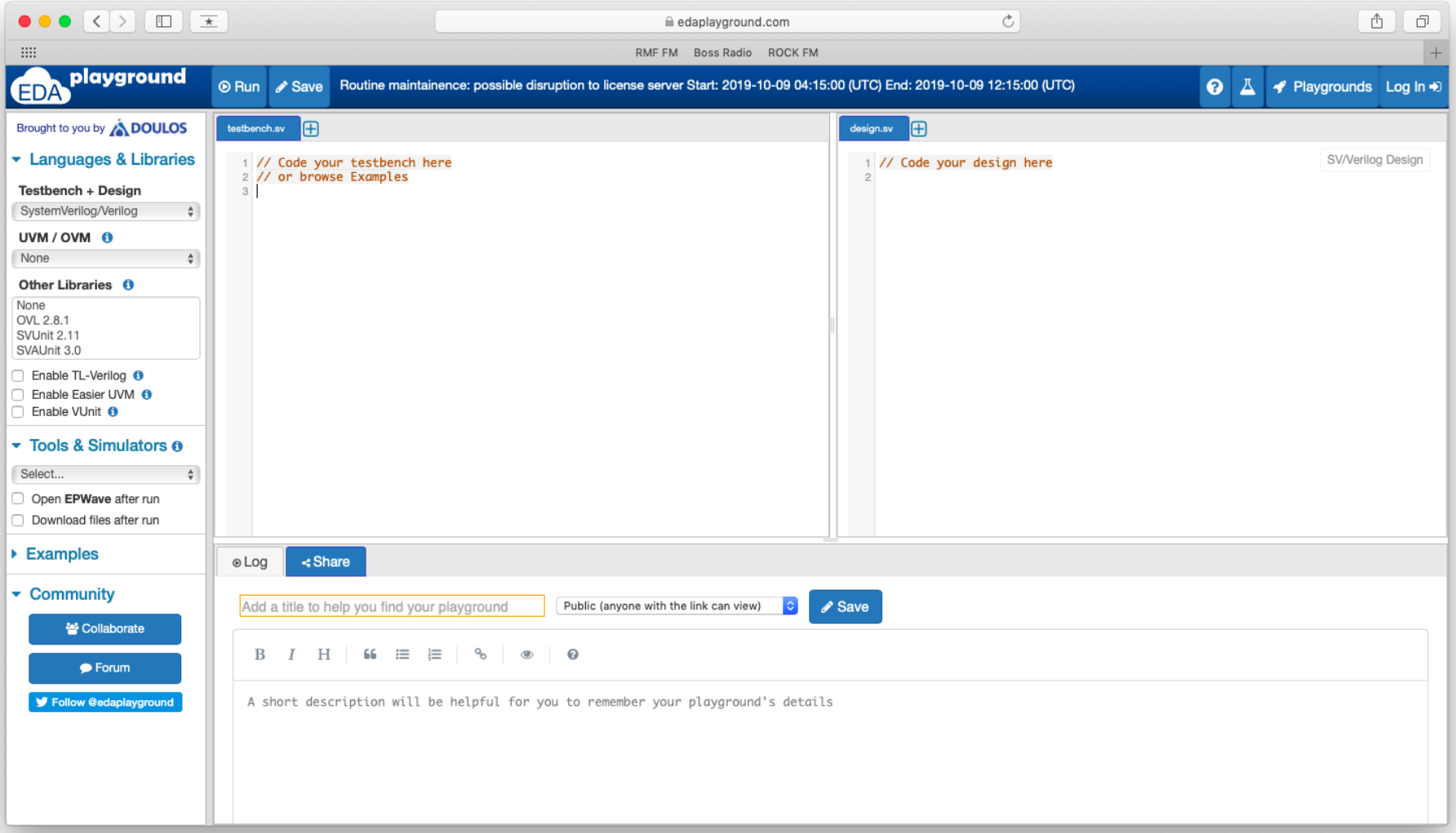
Нелокальное выполнение расчётов (1)



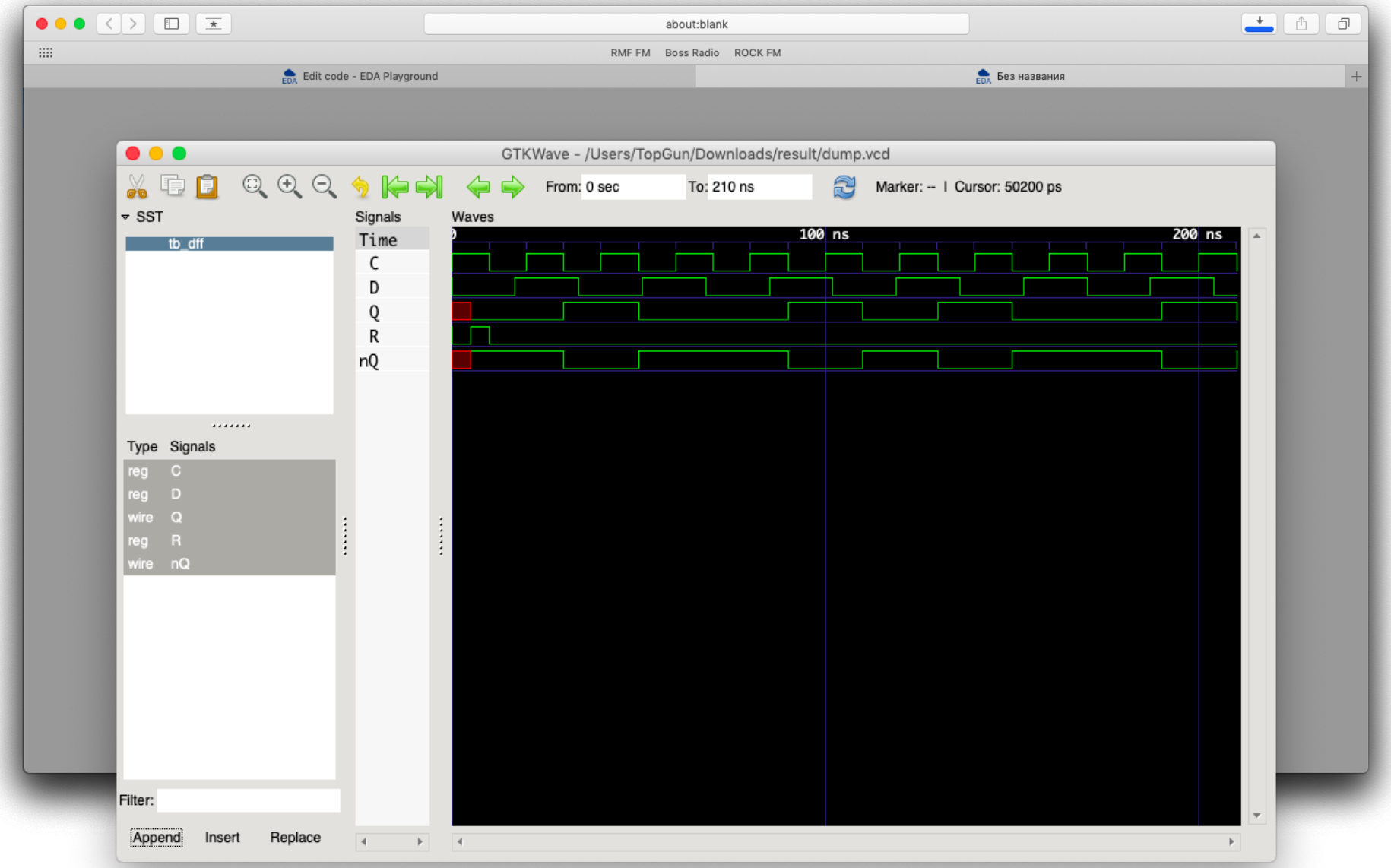
Нелокальное выполнение расчётов (2)



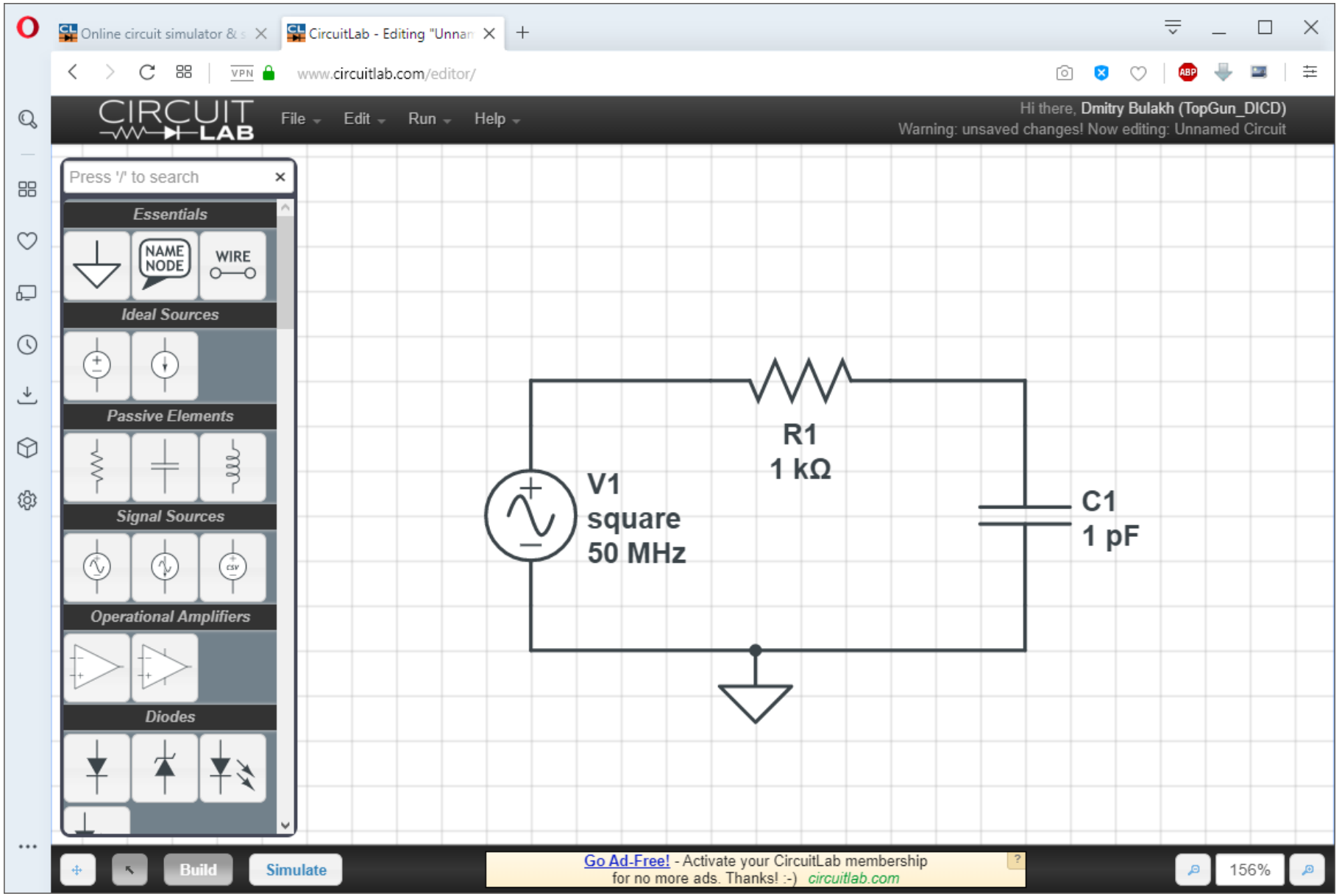
Онлайн симуляторы: цифровой этап проектирования (1)



Онлайн симуляторы: цифровой этап проектирования (2)



Онлайн симуляторы: схемотехническое моделирование (1)



Онлайн симуляторы: схемотехническое моделирование (2)