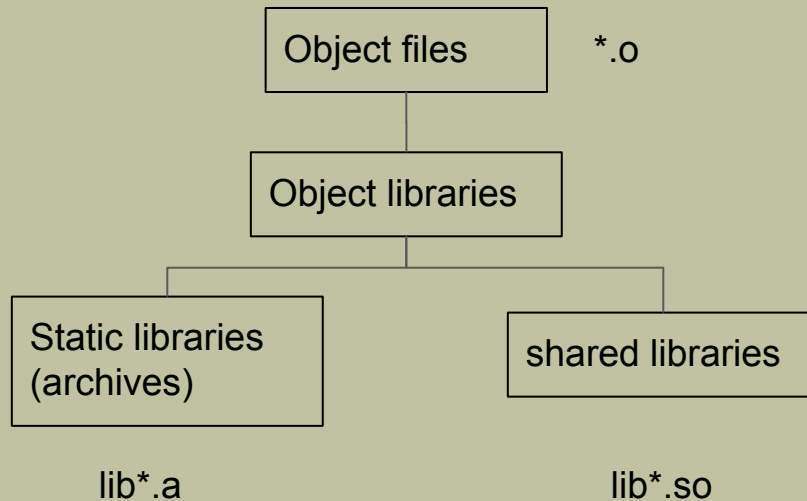


Лекция 5

- Библиотеки объектных модулей (архивы и разделяемые библиотеки).
- ELF (***E**xecutable and **L**inking **F**ormat*) файлы.

Статические библиотеки - архивы, и библиотеки динамической компоновки.



```
~/Lab5> cat lab5-1.c
```

```
double fun1(double x, int n){  
    return n*x;  
}
```

```
int fun2(int n){  
    int m;  
    m=n*n;  
    return m;  
}
```

```
double y=12.4;
```

```
~/Lab5> cat lab5-2.c
```

```
double z=2.87;
```

```
double gun1(){  
    int a[3]={2,3,4};  
    return (double)(a[0]+a[1]+a[2])/3.0;  
}
```

~/Lab5> cat lab5.c

```
#include <stdio.h>
double fun1(double, int);
int fun2(int);
double gun1();
extern double y;
extern double z;
int main(){
    fprintf(stdout, "%g\t%d\t%g\t%g\t%g\n",
        fun1(0.1,123), fun2(8), y,gun1(),z);
return 0;
}
```

```
~/Lab5> vim lab5-1.c
~/Lab5> vim lab5-2.c
~/Lab5> gcc -c lab5-1.c lab5-2.c
~/Lab5> ar cr liblab5.a *.o
~/Lab5> vim lab5.c
~/Lab5> gcc -c lab5.c
~/Lab5> gcc lab5.o -L. -llab5 -o lab5
~/Lab5> ./lab5
```

12.3	64	12.4	3	2.87
------	----	------	---	------

```
~/Lab5> gcc -c -fPIC -Wall lab5-*.c
~/Lab5> gcc -shared lab5-*.o -o liblab5.so
~/Lab5> gcc -c lab5.c
~/Lab5> gcc lab5.o -L. -llab5 -o lab5s
~/Lab5> export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:.
~/Lab5> ./lab5s
12.3      64      12.4      3      2.87
```

```
~Lab5> cat lab5d.c
```

```
#include <stdio.h>
#include <stdlib.h>
#include <dlfcn.h>
typedef double (*fun) (double, int);
typedef double (*gun) ();
extern double y,z;

int main() {
    gun g;
```



```
void* h=dlopen("liblab5.so", RTLD_LAZY);  
    fprintf(stdout, "%g\t%g\n", y,z);  
    g=(gun)dlsym(h, "gun1");  
    fprintf(stdout, "%g\t%d\t%g\n",  
        ((fun)dlsym(h, "fun1"))(0.1,123),  
        ((int (*)(int))dlsym(h, "fun2"))(8),  
        g());  
  
    dlclose(h);  
    return 0;  
}
```

```
~Lab5> gcc lab5d.c -L. -llab5 -ldl -o lab5d
~/Lab5> export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:.
~/Lab5> ./lab5d
12.4      2.87
12.3      64      3
```

```
~/Lab5> ldd lab5s
        linux-vdso.so.1 (0x00007ffdb8de8000)
liblab5.so => not found
        libc.so.6 => /lib64/libc.so.6
(0x00007fc5dfc5f000)
        /lib64/ld-linux-x86-64.so.2
(0x00007fc5e001a000)
```

```
/Lab5> ldd lab5d
        linux-vdso.so.1 (0x00007fff037bc000)
        liblab5.so => not found
        libdl.so.2 => /lib64/libdl.so.2
(0x00007f1fb3b05000)
        libc.so.6 => /lib64/libc.so.6
(0x00007f1fb374a000)
        /lib64/ld-linux-x86-64.so.2
(0x00007f1fb3d09000)
```

/Lab5> readelf -s liblab5.so

Таблица символов «.dynsym» содержит 12 элементов:

Чис:	Знач	Разм	Тип	Связ	Vis	Индекс имени
0:	000000000000000000	0	NOTYPE	LOCAL	DEFAULT	UND
1:	000000000000000000	0	NOTYPE	WEAK	DEFAULT	UND _ITM_deregisterT[...]
2:	000000000000000000	0	NOTYPE	WEAK	DEFAULT	UND __gmon_start__
3:	000000000000000000	0	NOTYPE	WEAK	DEFAULT	UND _ITM_registerTMC[...]
4:	000000000000000000	0	FUNC	WEAK	DEFAULT	UND [...]@GLIBC_2.2.5 (2)
5:	0000000000000061a	24	FUNC	GLOBAL	DEFAULT	12 fun1
6:	00000000000000648	56	FUNC	GLOBAL	DEFAULT	12 gun1
7:	00000000000000632	22	FUNC	GLOBAL	DEFAULT	12 fun2
8:	0000000000201020	8	OBJECT	GLOBAL	DEFAULT	22 y
9:	00000000000000508	0	FUNC	GLOBAL	DEFAULT	9 _init
10:	0000000000201028	8	OBJECT	GLOBAL	DEFAULT	22 z
11:	00000000000000680	0	FUNC	GLOBAL	DEFAULT	13 _fini

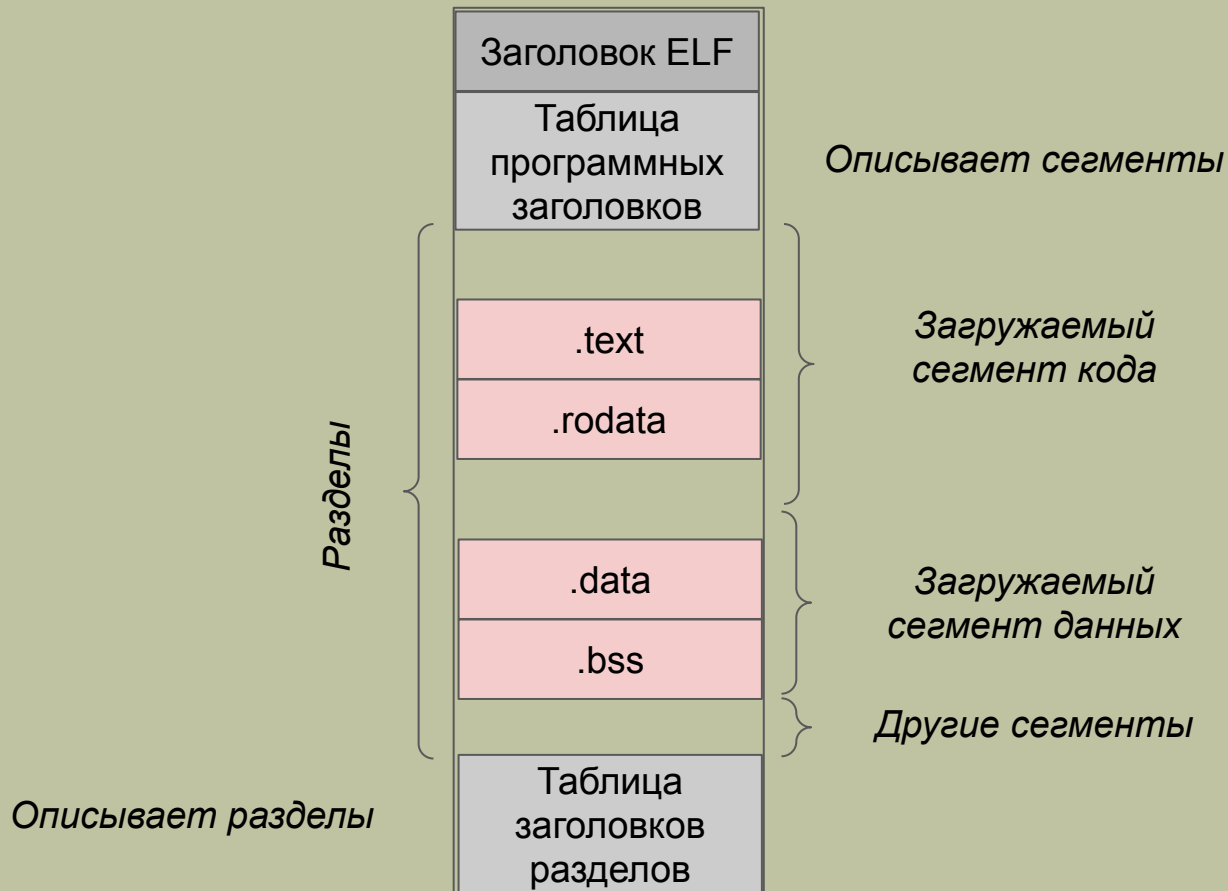
```
/Lab5> objdump -T liblab5.so
```

```
liblab5.so:          формат файла elf64-x86-64
```

DYNAMIC SYMBOL TABLE:

0000000000000000	w	D	*UND*	0000000000000000		
_ITM_deregisterTMCloneTable						
0000000000000000	w	D	*UND*	0000000000000000		
__gmon_start__						
0000000000000000	w	D	*UND*	0000000000000000		
_ITM_registerTMCloneTable						
0000000000000000	w	DF	*UND*	0000000000000000	GLIBC_2.2.5	
__cxa_finalize						
000000000000061a	g	DF	.text	0000000000000018	Base	fun1
0000000000000648	g	DF	.text	0000000000000038	Base	gun1
0000000000000632	g	DF	.text	0000000000000016	Base	fun2
0000000000201020	g	DO	.data	0000000000000008	Base	y
0000000000000508	g	DF	.init	0000000000000000	Base	_init
0000000000201028	g	DO	.data	0000000000000008	Base	z
0000000000000680	g	DF	.fini	0000000000000000	Base	_fini

Структура ELF файла



```
Lab5> readelf -h liblab5.so
```

```
  Magic:   7f 45 4c 46 02 01 01 00 00 00 00 00 00
00 00 00 00
```

```
Класс:                               ELF64
```

```
.....
Тип:                                DYN (Совм. исп. объектный файл)
```

```
Машина:                            Advanced Micro Devices X86-64
```

```
.....
Начало заголовков программы: 64 (байт в файле)
```

```
Size of this header:                64 (bytes)
```

```
Size of program headers:            56 (bytes)
```

```
Number of program headers:           7
```


Lab5> readelf -l liblab5.so

Заголовки программы:

Тип	Смещ. Рзм.фйл	Вирт.адр Рзм.пм	Физ.адр Флаги Выравн
LOAD	0x0000000000000000	0x0000000000000000	0x0000000000000000
	0x0000000000000078c	0x0000000000000078c	R E 0x200000
LOAD	0x00000000000000e30	0x000000000000200e30	0x000000000000200e30
	0x00000000000000200	0x00000000000000208	RW 0x200000
DYNAMIC	0x00000000000000e40	0x000000000000200e40	0x000000000000200e40
	0x000000000000001a0	0x000000000000001a0	RW 0x8
NOTE	0x000000000000001c8	0x000000000000001c8	0x000000000000001c8
	0x00000000000000024	0x00000000000000024	R 0x4
GNU_EH_FRAME	0x00000000000000698	0x00000000000000698	0x00000000000000698
	0x00000000000000034	0x00000000000000034	R 0x4
GNU_STACK	0x00000000000000000	0x00000000000000000	0x00000000000000000
	0x00000000000000000	0x00000000000000000	RW 0x10
GNU_RELRO	0x00000000000000e30	0x000000000000200e30	0x000000000000200e30
	0x000000000000001d0	0x000000000000001d0	R 0x1

~Lab5> dumpelf liblab5.so

```
.phdrs = {  
/* Program Header #0 0x40 */  
{  
    .p_type      = 1           , /* [PT_LOAD] */  
    .p_offset    = 0           , /* (bytes into file) */  
    .p_vaddr     = 0x0         , /* (virtual addr at runtime)  
*/  
    .p_paddr     = 0x0         , /* (physical addr at runtime)  
*/  
    .p_filesz    = 1932       , /* (bytes in file) */  
    .p_memsz     = 1932       , /* (bytes in mem at runtime)  
*/  
    .p_flags     = 0x5        , /* PF_R | PF_X */  
    .p_align     = 2097152    , /* (min mem alignment in  
bytes) */  
},
```

```
#include <elf.h>
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main(int argc, char** argv) {
    const char* elfFile=argv[1];
    Elf64_Ehdr header;
    Elf64_Phdr phheader;
    int i;
    FILE* file = fopen(elfFile, "rb");
```

```
fread(&header, sizeof(header), 1, file);  
fclose(file);
```

```
for(i=0;i<16;i++)  
    fprintf(stdout, "%x\t", header.e_ident[i]);  
fprintf(stdout, "\n");
```

```
fprintf(stdout, "type: %x\t machine: %x\n",  
        header.e_type, header.e_machine);  
fprintf(stdout, "e_phoff: %x\n",  
        header.e_phoff);  
fprintf(stdout, "e_phnum: %d\n",  
        header.e_phnum);
```

```
file = fopen(elfFile, "rb");

fseek(file, header.e_phoff, SEEK_SET);
for (i=0; i<header.e_phnum; i++) {
    if (i>0)
        fseek(file,
                header.e_phoff+header.e_phentsize*i,
                SEEK_SET);
    fread(&phheader, header.e_phentsize, 1,
          file);
    fprintf(stdout, "%x\t%x\t%x\t%x\n",
            phheader.p_type, phheader.p_offset,
            phheader.p_vaddr, phheader.p_paddr);
}
```

```
fprintf(stdout, "%x\t%x\t%x\t%x\n",  
        phheader.p_filesz, phheader.p_memsz,  
        phheader.p_flags, phheader.p_align);  
fprintf(stdout, "\n");  
}  
  
fclose(file);  
return 0;  
}
```

```
/Lab5> ./lab5-elf liblab5.so
```

7f	45	4c	46	2	1
----	----	----	----	---	---

1	0	0	0	0	0
---	---	---	---	---	---

0	0
---	---

0	0
---	---

```
type: 3 machine: 3e
```

```
e_phoff: 40
```

```
e_phnum: 7
```

1	0	0	0
----------	---	---	---

78c	78c	5	200000
-----	-----	----------	--------

1	e30	200e30	200e30
----------	-----	--------	--------

200	208	6	200000
-----	-----	----------	--------

2	e40	200e40	200e40
1a0	1a0	6	8

4	1c8	1c8	1c8
24	24	4	4

6474e550		698	698	698
34	34	4	4	

6474e551		0	0	0
0	0	6	10	

6474e552		e30	200e30	200e30
1d0	1d0	4	1	

..... •
p_flags This member holds a bit mask of
flags relevant to the segment:

PF_X	An executable segment.
PF_W	A writable segment.
PF_R	A readable segment.

.....