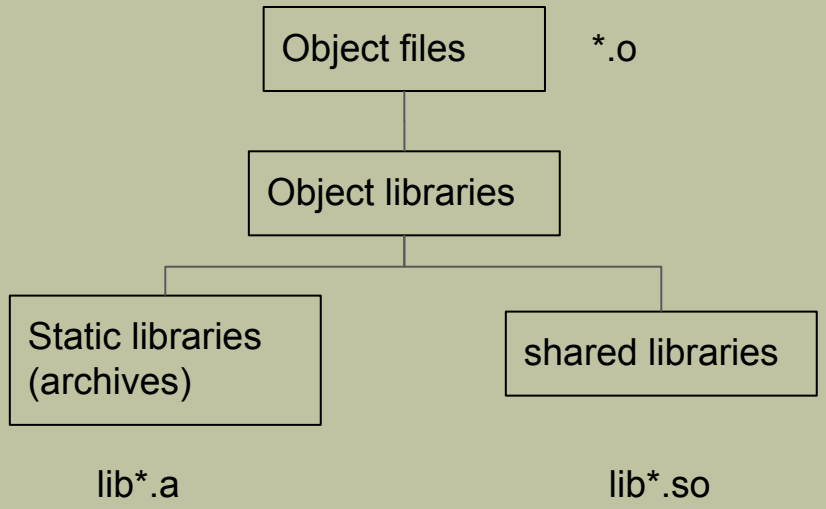
Лекция 5

- 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;
```

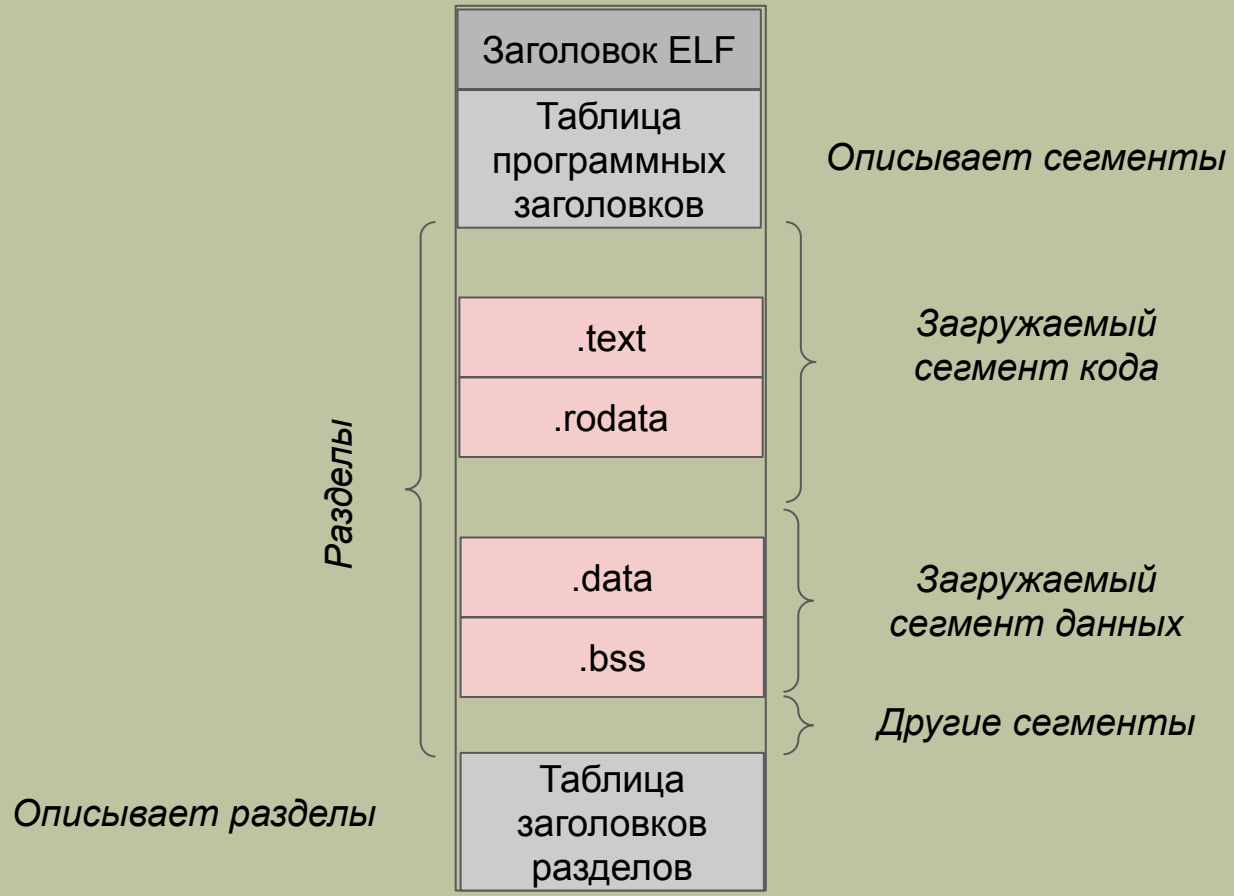
```
void* h=dlopen("liblab5.so", RTLD_LAZY);
 fprintf(stdout, "%g\t%g\n", y,z);
 g=(gun)dlsym(h, "gun1");
 fprintf(stdout, "%g\t%d\t%g\n",
   ((fun)dlsym(h, "fun1"))(0.1,123),
   ((int (*)(int))dlsym(h, "fun2"))(8),
   g());

 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)
```

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
 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.             Вирт.адр           Физ.адр
                Рзм.фйл           Рзм.пм              Флаги  Выравн
 LOAD           0x0000000000000000 0x0000000000000000 0x0000000000000000
                0x000000000000078c 0x000000000000078c  R E    0x200000
 LOAD           0x0000000000000e30 0x0000000000200e30 0x0000000000200e30
                0x0000000000000200 0x0000000000000208  RW     0x200000
 DYNAMIC        0x0000000000000e40 0x0000000000200e40 0x0000000000200e40
                0x00000000000001a0 0x00000000000001a0  RW     0x8
 NOTE           0x00000000000001c8 0x00000000000001c8 0x00000000000001c8
                0x0000000000000024 0x0000000000000024  R      0x4
 GNU_EH_FRAME   0x0000000000000698 0x0000000000000698 0x0000000000000698
                0x0000000000000034 0x0000000000000034  R      0x4
 GNU_STACK      0x0000000000000000 0x0000000000000000 0x0000000000000000
                0x0000000000000000 0x0000000000000000  RW     0x10
 GNU_RELRO      0x0000000000000e30 0x0000000000200e30 0x0000000000200e30
                0x00000000000001d0 0x00000000000001d0  R      0x1
```

```c
#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.

~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) */
},
```