Lab 4, Loading kernel

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Time to study the way how we place our kernel into the memory on R-Pi.
U-Boot have usually convention to place loaded binaries at 0×8000 (32KB) and just pass control there. So, let's compile trivial program and study generated binary to understand the way how we can operate with it.

In Lab 1 we found a way of making ARM executables. Check what actually the file is:

```
$ file test
test: Plan 9 executable, ARM 7-something
```

By checking Plan 9 a.out format document we will find that it has 32 bytes header and following TEXT section. To have U-Boot passing control just to TEXT section we may load kernel into address 0×8000-0×20 = 0x7fe0, and then by "go 8000" we jump just to first byte/command in TEXT section. Also we need all addresses of routines to have the base of 0×8000. Manual http://man.cat-v.org/plan_9/1/2l gives us a way to do this by **"-T"** command line option.

To have specific code at 0×8000 we will created some ASM file with a loader which just call main routine. (we may take example from ARM native ports, see **l.s** file). Plus we use **"-l"** option to linker (see link to manual above) **load.s:**

```
TEXT _start(SB), 1, $-4
    MOVW    $setR12(SB), R12    /* static base (SB) */
    BL      ,main(SB)
```

We need to be sure about DATA section to be addressed in right way. Let's compile this small exe and study in hex editor and disassembler. **test.c:**

```
int main() {
    char * s = "Hello world!\n";
    return 123;
}
```

```
$ 5a load.s
$ 5c test.c
$ 5l -l -o irpi -T0x8000 load.5 test.5
```

We got just 423 bytes executable **"irpi"**:

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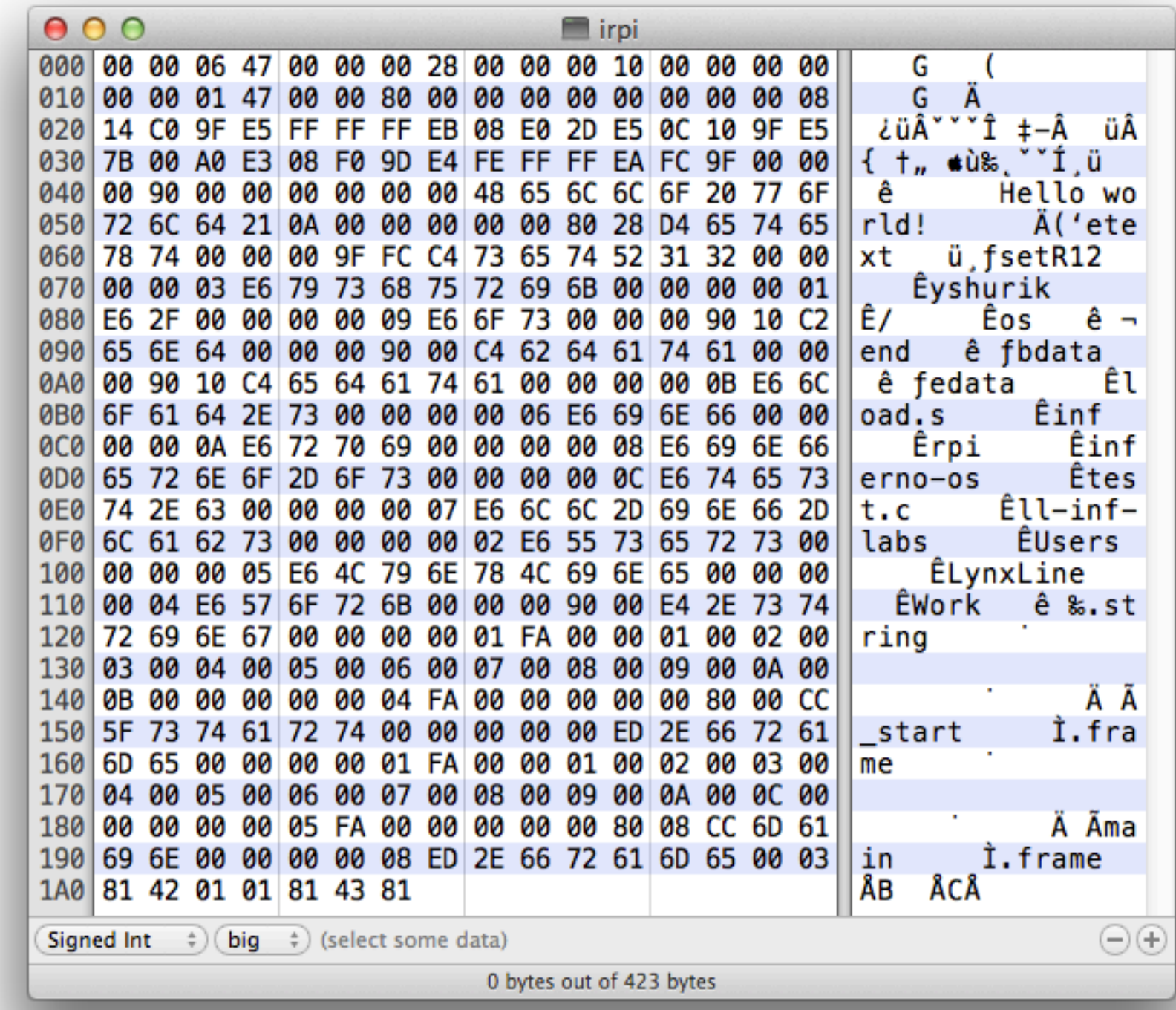

Let's copy bytes 0×20-0×48 (skip 0×20 plan9 header and until the "Hello world!") to online disassembler to see what's there:

```
0x00000000    e59fc014        ldr         ip, [pc, #20]    ; 0x0000001c
0x00000004    ebffffff        bl 0x00000008
0x00000008    e52de008        str         lr, [sp, #-8]!
0x0000000C    e59f100c        ldr         r1, [pc, #12]    ; 0x00000020
0x00000010    e3a0007b        mov         r0, #123         ; 0x7b
0x00000014    e49df008        ldr         pc, [sp], #8
0x00000018    eafffffe        b  0x00000018
0x0000001C    00009ffc        strdeq      r9, [r0], -ip
0x00000020    00009000        andeq       r9, r0, r0
0x00000024    00000000        andeq       r0, r0, r0
```

We see that in line **"ldr r1, [pc, #12] ; 0×00000020"** it would initialize **R1** with address located at 0×20 (disassembler shows TEXT started at 0×0, so in **irpi** file it is 0×20+0×20). Oops, this memory cell have reference to "0×9000", which is not we expected, our "Hello world!" will be located at 0×8000+0×28.

So, let's again check linker options and find **"-Rr The text segment is rounded to a multiple of r"**.

Looks like by default it is aligned by 0×1000. Because it is ARM, then everything is aligned by 4 bytes, we just pass **"-R4"**:

```
1 $ 5l -l -o irpi -T0x8000 -R4 load.5 test.5
```

Now check again with disassembler, and yes:

```
0x00000000    e59fc014        ldr         ip, [pc, #20]    ; 0x0000001c
0x00000004    ebffffff        bl 0x00000008
0x00000008    e52de008        str         lr, [sp, #-8]!
0x0000000C    e59f100c        ldr         r1, [pc, #12]    ; 0x00000020
0x00000010    e3a0007b        mov         r0, #123         ; 0x7b
0x00000014    e49df008        ldr         pc, [sp], #8
0x00000018    eafffffe        b  0x00000018
0x0000001C    00009024        andeq       r9, r0, r4, lsr #32
0x00000020    00008028        andeq       r8, r0, r8, lsr #32
0x00000024    00000000        andeq       r0, r0, r0
```

We see 0×8028 address.

So now we are ready to load our kernel/binary with U-Boot at 0x7fe0, pass control to 0×8000 and expect that all addresses/references will work as expected.

FILES:
2l.pdf
a.out.pdf

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