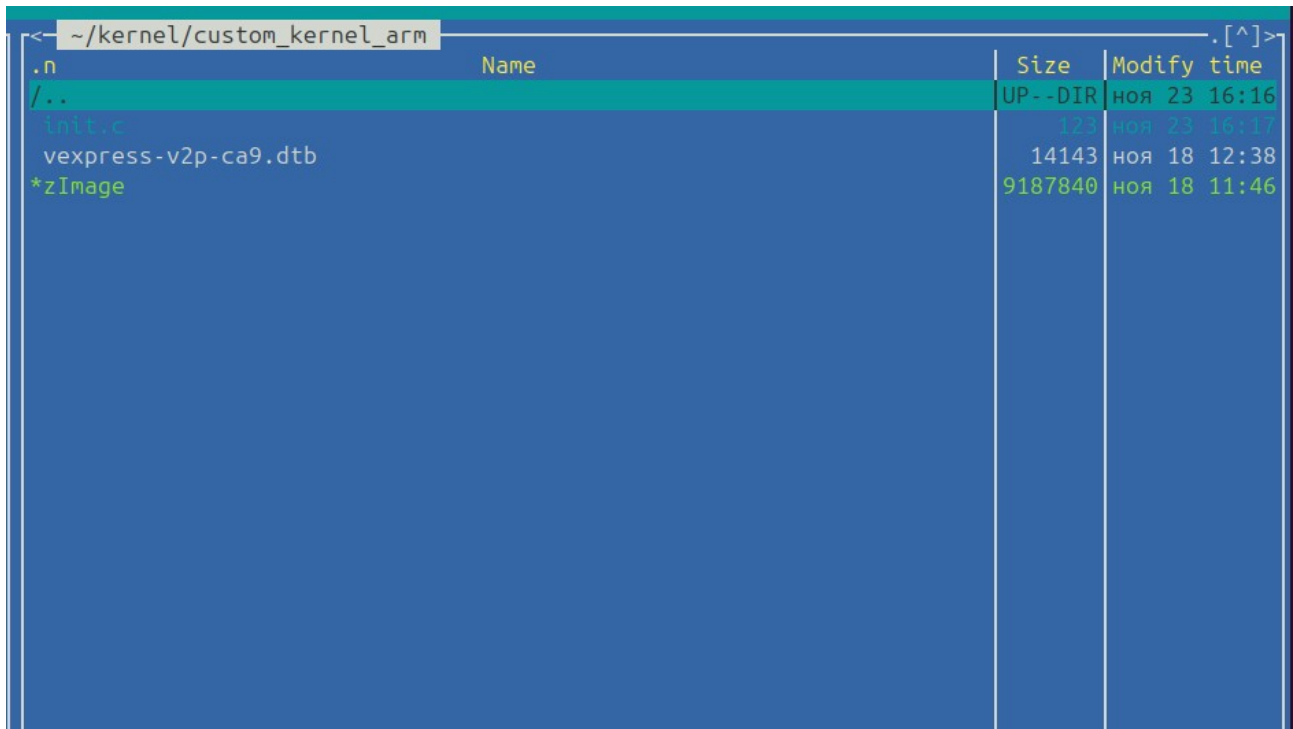


## Минимальная прошивка для ARM.

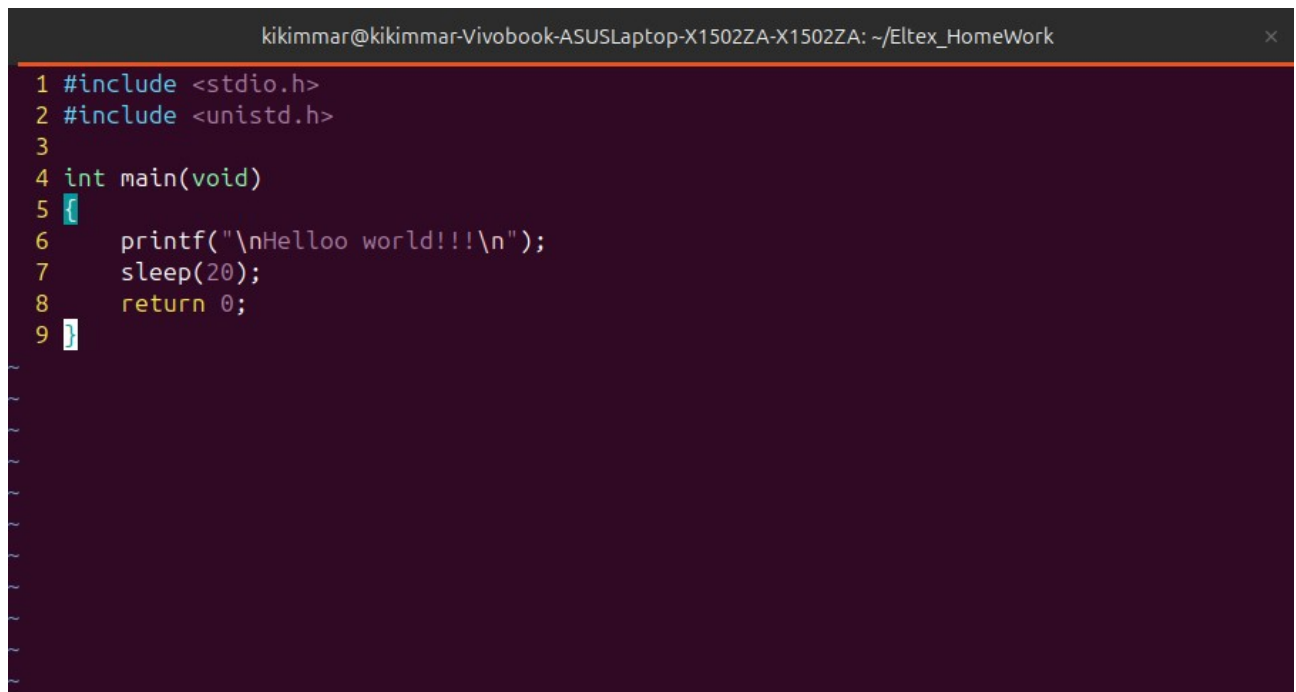
1. В дирректории с ядром и .dtb файлом, оставшимся с прошлой части, создаем файл init.c.



A terminal window showing the contents of the directory `~/kernel/custom_kernel_arm`. The output is a table with columns: Name, Size, and Modify time.

Name	Size	Modify time
..	UP--DIR	ноя 23 16:16
init.c	123	ноя 23 16:17
vexpress-v2p-ca9.dtb	14143	ноя 18 12:38
*zImage	9187840	ноя 18 11:46

2. В файле init.c пишем следующий код.



A code editor window showing the content of the file `init.c`. The code is as follows:

```
1 #include <stdio.h>
2 #include <unistd.h>
3
4 int main(void)
5 {
6     printf("\nHello world!!!\n");
7     sleep(20);
8     return 0;
9 }
```

3. Скомпилируем статически, чтобы на выходе получился один файл и не пришлось тащить все зависимые библиотеки.

```
kikimmar@kikimmar-Vivobook-ASUSLaptop-X1502ZA-X1502ZA: ~/kernel/custom_kernel_arm
kikimmar@kikimmar-Vivobook-ASUSLaptop-X1502ZA-X1502ZA:~/kernel/custom_kernel_arm$ arm-linux-gnueabi-gcc -static init.c -o init
```

< ~/kernel/custom_kernel_arm .[^]>			
.n	Name	Size	Modify time
./..		UP--DIR	ноя 23 16:16
*init		424112	ноя 23 16:26
init.c		123	ноя 23 16:17
vexpress-v2p-ca9.dtb		14143	ноя 18 12:38
*zImage		9187840	ноя 18 11:46

4. Теперь собираем простую корневую файловую систему.

```
kikimmar@kikimmar-Vivobook-ASUSLaptop-X1502ZA-X1502ZA: ~/kernel/custom_kernel_arm
kikimmar@kikimmar-Vivobook-ASUSLaptop-X1502ZA-X1502ZA:~/kernel/custom_kernel_arm$ arm-linux-gnueabi-gcc -static init.c -o init
kikimmar@kikimmar-Vivobook-ASUSLaptop-X1502ZA-X1502ZA:~/kernel/custom_kernel_arm$ echo init | cpio -o -H newc | gzip > initramfs.cpio.gz
829 blocks
kikimmar@kikimmar-Vivobook-ASUSLaptop-X1502ZA-X1502ZA:~/kernel/custom_kernel_arm$
```

< ~/kernel/custom_kernel_arm		.[^]>	
Name		Size	Modify time
..		UP- -DIR	ноя 23 16:16
*init		424112	ноя 23 16:26
init.c		123	ноя 23 16:17
initramfs.cpio.gz		225534	ноя 23 16:29
vexpress-v2p-ca9.dtb		14143	ноя 18 12:38
*zImage		9187840	ноя 18 11:46

## 5. Запускаем через Qemu.

```
kikinnar@kikinnar-Vivobook-ASUSLaptop-X1502ZA-X1502ZA:~/kernel/custom_kernel_arm$ qemu-system-arm -M vexpress-v2p-ca9.dtb -kernel zImage -dtb vexpress-v2p-ca9.dtb -initrd initramfs.cpio.gz -append "console=ttyAMA0" -nographic
```

```
[ 1.672473] mmci-pl18x 10005000.mmci: Got CD GPIO
[ 1.672640] mmci-pl18x 10005000.mmci: Got WP GPIO
[ 1.673939] mmci-pl18x 10005000.mmci: mmc0: PL181 manf 41 rev0 at 0x10005000 irq 25,26 (pio)
[ 1.674214] mmci-pl18x 10005000.mmci: DMA channels RX none, TX none
[ 1.701512] sdhci: Secure Digital Host Controller Interface driver
[ 1.701683] sdhci: Copyright(c) Pierre Ossman
[ 1.703338] Synopsys Designware Multimedia Card Interface Driver
[ 1.704258] sdhci-pltfm: SDHCI platform and OF driver helper
[ 1.709311] ledtrig-cpu: registered to indicate activity on CPUs
[ 1.710444] usbcore: registered new interface driver usbhid
[ 1.710626] usbhid: USB HID core driver
[ 1.715298] drop_monitor: Initializing network drop monitor service
[ 1.714618] NET: Registered protocol family 10
[ 1.719286] Segment Routing with IPv6
[ 1.719661] sit: IPv6, IPv4 and MPLS over IPv4 tunneling driver
[ 1.721357] NET: Registered protocol family 17
[ 1.721531] can: controller area network core (rev 20170425 abi 9)
[ 1.721849] NET: Registered protocol family 29
[ 1.721919] can: raw protocol (rev 20170425)
[ 1.722049] can: broadcast manager protocol (rev 20170425 t)
[ 1.722224] can: netlink gateway (rev 20190810) max_hops=1
[ 1.722992] Key type dns_resolver registered
[ 1.723236] ThumbEE CPU extension supported.
[ 1.723356] Registering SWP/SWPB emulation handler
[ 1.724329] Loading compiled-in X.509 certificates
[ 1.732055] rtc-pl031 10017000.rtc: setting system clock to 2025-11-23T09:40:23 UTC (1763890823)
[ 1.732799] clk: Disabling unused clocks
[ 1.735119] uart-pl011 10009000.uart: no DMA platform data
[ 1.774154] Freeing unused kernel memory: 2048K
[ 1.776021] input: AT Raw Set 2 keyboard as /devices/platform/smb@40000000/smb@40000000:motherboard/smb@40000000:motherboard:iofpga@7,00000000/10006000.kmi/serio0/input/input0
[ 1.783800] Run /init as init process

Hello world!!!
[ 2.414844] input: InExPS/2 Generic Explorer Mouse as /devices/platform/smb@40000000/smb@40000000:motherboard/smb@40000000:motherboard:iofpga@7,00000000/10007000.kmi/serio1/input/input1
```

По таймеру, через 20 сек, Init прекратит свою работу и ядро выдаст “kernel panic” прекратив свою работу.