

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ УКРАЇНИ
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

ЗВІТ
ПРО ЛАБОРАТОРНУ РОБОТУ №1-2

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Тема: Збирання виконуваних файлів для ОС Linux для процесорів архітектури ARM. Розвертання Linux Kernel в середовищі програмного емулятора Qemu для архітектури процесорів ARM.

Історія виконаних команд:

```
1 sudo apt update
2 sudo apt install git vim vim-gtk tree curl
3 sudo dpkg --configure -a
4 sudo apt install git vim vim-gtk tree curl
5 sudo apt install ccache
6 ccache -M 5G
7 ccache -s
8 ccache -C
9 tree ~/.ccache
10 export CROSS_COMPILE="ccache your-toolchain-prefix"
11 export
12 echo $PWD
13 echo $PATH
14 sudo tar xJvf gcc-arm-8.3-2019.03-x86_64-arm-eabi.tar.xz -C /opt/
15 cd ~/Downloads/
16 sudo tar xJvf gcc-arm-8.3-2019.03-x86_64-arm-eabi.tar.xz -C /opt/
17 uname -a
18 file /bin/ip
19 sudo tar xJvf gcc-arm-8.3-2019.03-x86_64-arm-linux-gnueabi.tar.xz \
20 sudo tar xJvf gcc-arm-8.3-2019.03-x86_64-arm-linux-gnueabi.tar.xz -C /opt/
21 sudo apt install make libncurses5-dev libssl-dev bc bison flex
22 cd ~
23 mkdir ~/repos
24 cd ~/repos
25 git clone https://gitlab.denx.de/u-boot/u-boot.git
26 ls
27 cd u-boot/
28 git tag | grep -v rc | tail -5
29 git checkout v2019.07
30 curl https://patchwork.ozlabs.org/series/130450/mbox/ | git am
31 export PATH=/opt/gcc-arm-8.3-2019.03-x86_64-arm-eabi/bin:$PATH
32 export CROSS_COMPILE='ccache arm-eabi-'
33 export ARCH=arm
34 make am335x_boneblack_defconfig
35 cat .config
36 cat .checkpatch.conf
37 make -j4
38 gcc --version
39 sudo apt install gcc-9
40 sudo update-alternatives --install /usr/bin/gcc gcc /usr/bin/gcc-9 9
41 gcc --version
42 cd ~
43 sudo update-alternatives --install /usr/bin/gcc gcc /usr/bin/gcc-9 9
44 sudo apt install gcc-9
45 sudo add-apt-repository ppa:ubuntu-toolchain-r/test
46 sudo apt update
```

```
47 sudo apt install gcc-9
48 sudo update-alternatives --install /usr/bin/gcc gcc /usr/bin/gcc-9 9
49 gcc --version
50 make am335x_boneblack_defconfig
51 cd ~/repos/u-boot/
52* make am335x_boneblack_defconfig
53 make -j4
54 curl https://patchwork.ozlabs.org/series/130450/mbox/ | git am
55 git revert --no-edit d30ba2315ae3
56 curl https://patchwork.ozlabs.org/series/130450/mbox/ | git am
57 git config --global user.email "bozhyk45@gmail.com"
58 git config --global user.name "Your Name"
59 git config --global user.name "Nazar"
60 curl https://patchwork.ozlabs.org/series/130450/mbox/ | git am
61 cd ~/repos/
62 git clone https://gitlab.denx.de/u-boot/u-boot.git
63 cd u-boot
64 git tag | grep -v rc | tail -5
65 git checkout v2019.07
66 curl https://patchwork.ozlabs.org/series/130450/mbox/ | git am
67 export PATH=/opt/gcc-arm-8.3-2019.03-x86_64-arm-eabi/bin:$PATH
68 export CROSS_COMPILE='ccache arm-eabi-'
69 export ARCH=arm
70 make am335x_boneblack_defconfig
71 make -j4
72 cat .config
73 file u-boot.img
74 file ./MLO
75 cd ~/repos
76 git clone git://git.kernel.org/pub/scm/linux/kernel/git/stable/linux-stable.git
77 cd linux-stable
78 git checkout linux-4.19.y
79 export PATH=/opt/gcc-arm-8.3-2019.03-x86_64-arm-eabi/bin:$PATH
80 export CROSS_COMPILE='ccache arm-eabi-'
81 export ARCH=arm
82 make menuconfig
83 mkdir fragments
84 vim fragments/bbb.cfg
85 ./scripts/kconfig/merge_config.sh arch/arm/configs/multi_v7_defconfig
fragments/bbb.cfg
86 make -j4 zImage modules am335x-boneblack.dtb
87 cd ~/repos
88 git clone git://git.busybox.net/busybox
89 cd busybox
90 git branch -a | grep stable | sort -V | tail -1
91 git checkout 1_31_stable
92 export ARCH=arm
93 export PATH=/opt/gcc-arm-8.3-2019.03-x86_64-arm-linux-gnueabi/bin:$PATH
94 export CROSS_COMPILE="ccache arm-linux-gnueabi-"
95 make defconfig
96 make -j4
97 make install
98 ls
99 mkdir -p _install/{boot,dev,etc\init.d,lib,proc,root,sys\kernel\debug,tmp}
100 vim _install/etc/init.d/rcS
```

```

101 cat _install/etc/init.d/rcS
102 chmod +x _install/etc/init.d/rcS
103 ln -s bin/busybox _install/init
104 cd _install/boot/
105 cp ~/repos/linux-stable/arch/arm/boot/zImage .
106 cp ~/repos/linux-stable/arch/arm/boot/dts/am335x-boneblack.dtb .
107 cp ~/repos/linux-stable/System.map .
108 cp ~/repos/linux-stable/.config ./config
109 cd -
110 cd ~/repos/linux-stable
111 export INSTALL_MOD_PATH=~/.repos/busybox/_install
112 export ARCH=arm
113 make modules_install
114 cd -
115 ${CROSS_COMPILE}readelf -d _install/bin/busybox | grep NEEDED
116 cd _install/lib
117 libc_dir=${${CROSS_COMPILE}gcc -print-sysroot}/lib
118 cp -a $libc_dir/*.so* .
119 cd -
120 $ echo '$MODALIAS=.* root:root 660 @modprobe "$MODALIAS"' >
_install/etc/mdev.conf
121 echo '$MODALIAS=.* root:root 660 @modprobe "$MODALIAS"' >
_install/etc/mdev.conf
122 echo 'root:x:0:' > _install/etc/group
123 echo 'root:x:0:0:root:/bin/sh' > _install/etc/passwd
124 echo 'root::10933:0:99999:7:::' > _install/etc/shadow
125 echo "nameserver 8.8.8.8" > _install/etc/resolv.conf
126 sudo apt install qemu-system-arm
127 cd _install
128 find . | cpio -o -H newc | gzip > ../rootfs.cpio.gz
129 ls
130 cd ..
131 ls
132 qemu-system-arm -kernel _install/boot/zImage -initrd rootfs.cpio.gz -machine virt -
nographic -m 512 --append "root=/dev/ram0 rw console=ttyAMA0,115200 mem=512M"
133 history

```

Проблеми, які виникли:

Під час виконання команди make -j4 у пункті 2.1 виникла наступна проблема:

*** Can't find default configuration "arch/./configs/am335x_boneblack_defconfig"!

scripts/kconfig/Makefile:128: recipe for target 'am335x_boneblack_defconfig' failed
make[1]: *** [am335x_boneblack_defconfig] Error 1

Makefile:516: recipe for target 'am335x_boneblack_defconfig' failed make:

***** [am335x_boneblack_defconfig] Error 2.**

Проблема була у встановленій версії gcc 7. Для її вирішення було виконано наступні команди для оновлення gcc:

```
45 sudo add-apt-repository ppa:ubuntu-toolchain-r/test
46 sudo apt update
47 sudo apt install gcc-9
48 sudo update-alternatives --install /usr/bin/gcc gcc /usr/bin/gcc-9 9
```

Перевірка результату роботи:

Для перевірки результатів використана команда пункту 3.1:

```
qemu-system-arm -kernel _install/boot/zImage -initrd rootfs.cpio.gz \
-machine virt -nographic -m 512 \
--append "root=/dev/ram0 rw console=ttyAMA0,115200 mem=512M"
```

```

bozhyk_n@nazar-VirtualBox: ~/repos/busybox
File Edit View Search Terminal Help
bozhyk_n@nazar-VirtualBox:~/repos/busybox$ qemu-system-arm -kernel _install/boot/zImage -initrd rootfs.cpio.gz \
> -machine virt -nographic -m 512 \
> --append "root=/dev/ram0 rw console=ttyAMA0,115200 mem=512M"
[ 0.000000] Booting Linux on physical CPU 0x0
[ 0.000000] Linux version 4.19.296 (bozhyk_n@nazar-VirtualBox) (gcc version 8.3.0 (GNU Toolchain for the A-profile Architecture 8.3-2019.03 (arm
-rel-8.36))) #1 SMP Sun Oct 15 16:24:52 EEST 2023
[ 0.000000] CPU: ARMv7 Processor [412fc0f1] revision 1 (ARMv7), cr=10c5387d
[ 0.000000] CPU: div instructions available: patching division code
[ 0.000000] CPU: PIPT / VIPT nonaliasing data cache, PIPT instruction cache
[ 0.000000] OF: fdt: Machine model: linux,dummy-virt
[ 0.000000] Memory policy: Data cache writealloc
[ 0.000000] efi: Getting EFI parameters from FDT:
[ 0.000000] efi: UEFI not found.
[ 0.000000] cma: Reserved 64 MiB at 0x5c000000
[ 0.000000] pci: probing for conduit method from DT.
[ 0.000000] pci: PSCIv0.2 detected in firmware.
[ 0.000000] pci: Using standard PSCI v0.2 function IDs
[ 0.000000] pci: Trusted OS migration not required
[ 0.000000] percpu: Embedded 16 pages/cpu s36748 r8192 d20596 u65536
[ 0.000000] Built 1 zonelists, mobility grouping on. Total pages: 130048
[ 0.000000] Kernel command line: root=/dev/ram0 rw console=ttyAMA0,115200 mem=512M
[ 0.000000] Dentry cache hash table entries: 65536 (order: 6, 262144 bytes)
[ 0.000000] Inode-cache hash table entries: 32768 (order: 5, 131072 bytes)
[ 0.000000] Memory: 407360K/524288K available (12288K kernel code, 1617K rwdma, 4792K rodata, 2048K init, 395K bss, 51392K reserved, 65536K cm
a-reserved, 0K
highmem)
[ 0.000000] Virtual kernel memory layout:
[ 0.000000] vector : 0xffff0000 - 0xffff1000 ( 4 kB)
[ 0.000000] fixmap : 0xfffc0000 - 0xffff0000 (3072 kB)
[ 0.000000] vmalloc : 0xe0800000 - 0xff800000 ( 496 MB)
[ 0.000000] lowmem : 0xc0000000 - 0xe0000000 ( 512 MB)
[ 0.000000] pkmap : 0xbfe00000 - 0xc0000000 ( 2 MB)
[ 0.000000] modules : 0xbfe00000 - 0xbfe00000 ( 14 MB)
[ 0.000000] .text : 0x(ptrval) - 0x(ptrval) (13280 kB)
[ 0.000000] .init : 0x(ptrval) - 0x(ptrval) (2048 kB)
[ 0.000000] .data : 0x(ptrval) - 0x(ptrval) (1618 kB)
[ 0.000000] .bss : 0x(ptrval) - 0x(ptrval) ( 396 kB)
[ 0.000000] SLUB: HWalign=64, Order=0-3, MinObjects=0, CPUs=1, Nodes=1
[ 0.000000] rcu: Hierarchical RCU implementation.
[ 0.000000] rcu: RCU event tracing is enabled.
[ 0.000000] rcu: RCU restricting CPUs from NR_CPUS=16 to nr_cpu_ids=1.
[ 0.000000] rcu: Adjusting geometry for rcu_fanout_leaf=16, nr_cpu_ids=1
[ 0.000000] NR_IRQS: 16, nr_irqs: 16, preallocated irq: 16
[ 0.000000] GICv2m: range[mem 0x08020000-0x08020fff], SPI[80:143]
[ 0.000000] arch_timer: cp15 timer(s) running at 62.50MHz (virt).
[ 0.000000] clocksource: arch_sys_counter: mask: 0xffffffffffffff max_cycles: 0x1cd42e208c, max_idle_ns: 881590405314 ns
[ 0.000206] sched_clock: 56 bits at 62MHz, resolution 16ns, wraps every 4398046511096ns
[ 0.000390] Switching to timer-based delay loop, resolution 16ns
[ 0.013654] console: colour dummy device 80x30
[ 0.015610] calibrating delay loop (skipped), value calculated using timer frequency.. 125.00 BogoMIPS (lpj=625000)
[ 0.015776] CPU: Testing write buffer coherency: ok
[ 0.016981] CPU0: Spectre v2: firmware did not set auxiliary control register IBE bit, system vulnerable

```

```
bozhyk_n@nazar-VirtualBox: ~/repos/busybox
File Edit View Search Terminal Help
[ 6.077150] usbserial: USB Serial support registered for carelink
[ 6.077479] usbserial: USB Serial support registered for flashloader
[ 6.078012] usbserial: USB Serial support registered for funsoft
[ 6.078343] usbserial: USB Serial support registered for google
[ 6.078745] usbserial: USB Serial support registered for hp4x
[ 6.079048] usbserial: USB Serial support registered for kaufmann
[ 6.079358] usbserial: USB Serial support registered for libtransistor
[ 6.079772] usbserial: USB Serial support registered for moto_modem
[ 6.080097] usbserial: USB Serial support registered for motorola_tetra
[ 6.081126] usbserial: USB Serial support registered for nokia
[ 6.083965] usbserial: USB Serial support registered for novatel_gps
[ 6.084175] usbserial: USB Serial support registered for siemens_mpi
[ 6.084369] usbserial: USB Serial support registered for suunto
[ 6.084553] usbserial: USB Serial support registered for vivopay
[ 6.084737] usbserial: USB Serial support registered for zio
[ 6.104659] rtc-pl031 9010000.pl031: rtc core: registered pl031 as rtc0
[ 6.114423] tzc /dev entries driver
[ 6.191861] sdhci: Secure Digital Host Controller Interface driver
[ 6.195436] sdhci: Copyright(c) Pierre Ossman
[ 6.202362] Synopsys Designware Multimedia Card Interface Driver
[ 6.208838] sdhci-pltfm: SDHCI platform and OF driver helper
[ 6.222404] ledtrig-cpu: registered to indicate activity on CPUs
[ 6.228481] usbcore: registered new interface driver usbhid
[ 6.240283] usbhid: USB HID core driver
[ 6.278513] NET: Registered protocol family 10
[ 6.296915] Segment Routing with IPv6
[ 6.311777] sit: IPv6, IPv4 and MPLS over IPv4 tunneling driver
[ 6.322228] NET: Registered protocol family 17
[ 6.326613] can: controller area network core (rev 20170425 abi 9)
[ 6.328821] NET: Registered protocol family 29
[ 6.330565] can: raw protocol (rev 20170425)
[ 6.331267] can: broadcast manager protocol (rev 20170425 t)
[ 6.332535] can: netlink gateway (rev 20170425) max_hops=1
[ 6.334817] Key type dns_resolver registered
[ 6.335590] ThumbEE CPU extension supported.
[ 6.335914] Registering SWP/SWPB emulation handler
[ 6.340908] Loading compiled-in X.509 certificates
[ 6.382418] input: gpio-keys as /devices/platform/gpio-keys/input/input0
[ 6.390507] rtc-pl031 9010000.pl031: setting system clock to 2023-10-16 11:22:53 UTC (1697455373)
[ 6.397092] uart-pl011 9000000.pl011: no DMA platform data
[ 6.616041] Freeing unused kernel memory: 2048K
[ 6.63527] Run /init as init process

Please press Enter to activate this console.
/ # poweroff
/ # umount: can't unmount /: Invalid argument
swapoff: can't open '/etc/fstab': No such file or directory
The system is going down NOW!
Sent SIGTERM to all processes
Sent SIGKILL to all processes
Requesting system poweroff
[ 77.194314] reboot: Power down
bozhyk_n@nazar-VirtualBox:~/repos/busybox$
```

Висновки:

1. Налаштована ubuntu-18.04.6-desktop-amd64 для роботи з англomовною версією BBB_-Platform_Bring_Up.
2. Для налаштування виконані виконати пункти з першого і до 3.1 (QEMU Boot) включно. Так як працюємо з емулятором (QEMU), а не справжньою платою, пункти 1.3 та 1.4 не потрібні.
3. Під час налаштування виникла проблема у пункті 2.1, яка була спричинена застарілою версією gcc.