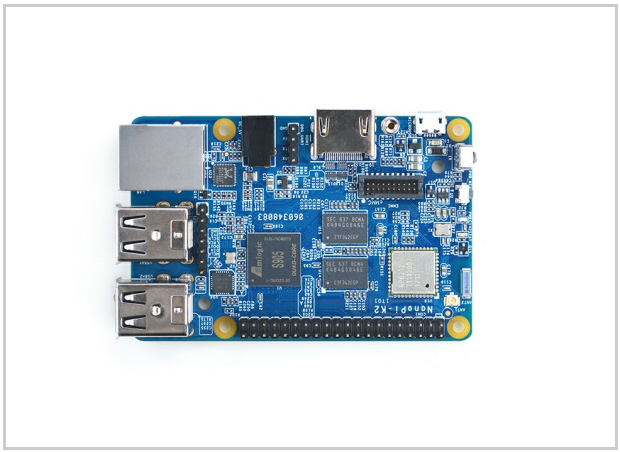
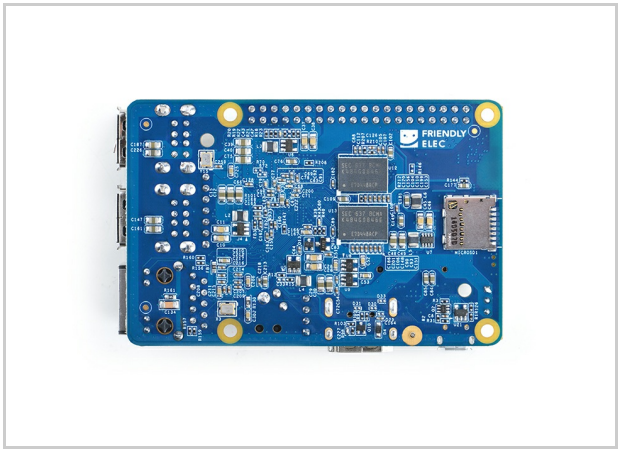
NanoPi K2

wiki.friendlyarm.com/wiki/index.php/NanoPi_K2

Introduction

- FriendlyElec's NanoPi K2 uses Amlogic's 64-bit quad-core A53 S905 SoC. This SoC has an internal Mali450 GPU. S905's dynamic frequency scales up to 2G Hz.In FriendlyElec's tests it can scale up to 2G. Its most significant feature is that it supports various video formats and has strong video decoding capability
- The NanoPi K2 has 2GB DDR3 RAM, onboard WiFi & Bluetooth, 1000M Ethernet, USB, HDMI, IR and more. It has a socket for adding an external eMMC card. It boots an OS from a TF card. It has the same form factor, GPIO interface and port layout as the RPi 3. An Android image is ready for K2. Later on a Ubuntu image will be ready.
- A special feature of the NanoPi K2 is that it supports DVFS and can play high-definition video steams stably and smoothly. It is a good platform for applications such as advertisement machines, TV boxes, home entertainment appliances, multi-media devices and etc.





Hardware Spec

- SoC: Amlogic S905, Quad-core ARM Cortex-A53@1.5GHz, DVFS
- GPU: Penta-core ARM Mali™-450
- RAM: 2GB DDR3
- Network Connectivity: 10/100/1000M (RTL8211F)

- Wireless：802.11 b/g/n
- Bluetooth：4.0 dual mode
- Antenna: One onboard porcelain antenna shared by both WiFi and Bluetooth. One individual IPX interface.
- IR: Onboard IR receiver
- Audio: Via HDMI/Bluetooth
- eMMC interface: eMMC socket
- I2S: 7-Pin, 2.54mm pitch pin-header
- SD: 1 x MicroSD slot
- USB Host: 4 x USB 2.0 Host, standard type A
- Micro USB: 1 x USB 2.0, OTG, power input and data transmission
- HDMI: HDMI 2.0, Type-A. It supports 4K video
- GPIO: 40-Pin, 2.54mm pitch pin-header including I2C, ADC, GPIO, UART, PWM, SPDIF and CVBS
- Serial debug port: 4-Pin, 2.54mm pitch single-row pin-header
- User Key: 1 x power key
- LED: 1 x power LED and 1 x status LED
- Power Interface: DC jack, MicroUSB
- Power Supply: DC 5V/2A
- PCB dimension: 56 x 85mm，6-layer, ENIG

Software Features

UbuntuCore

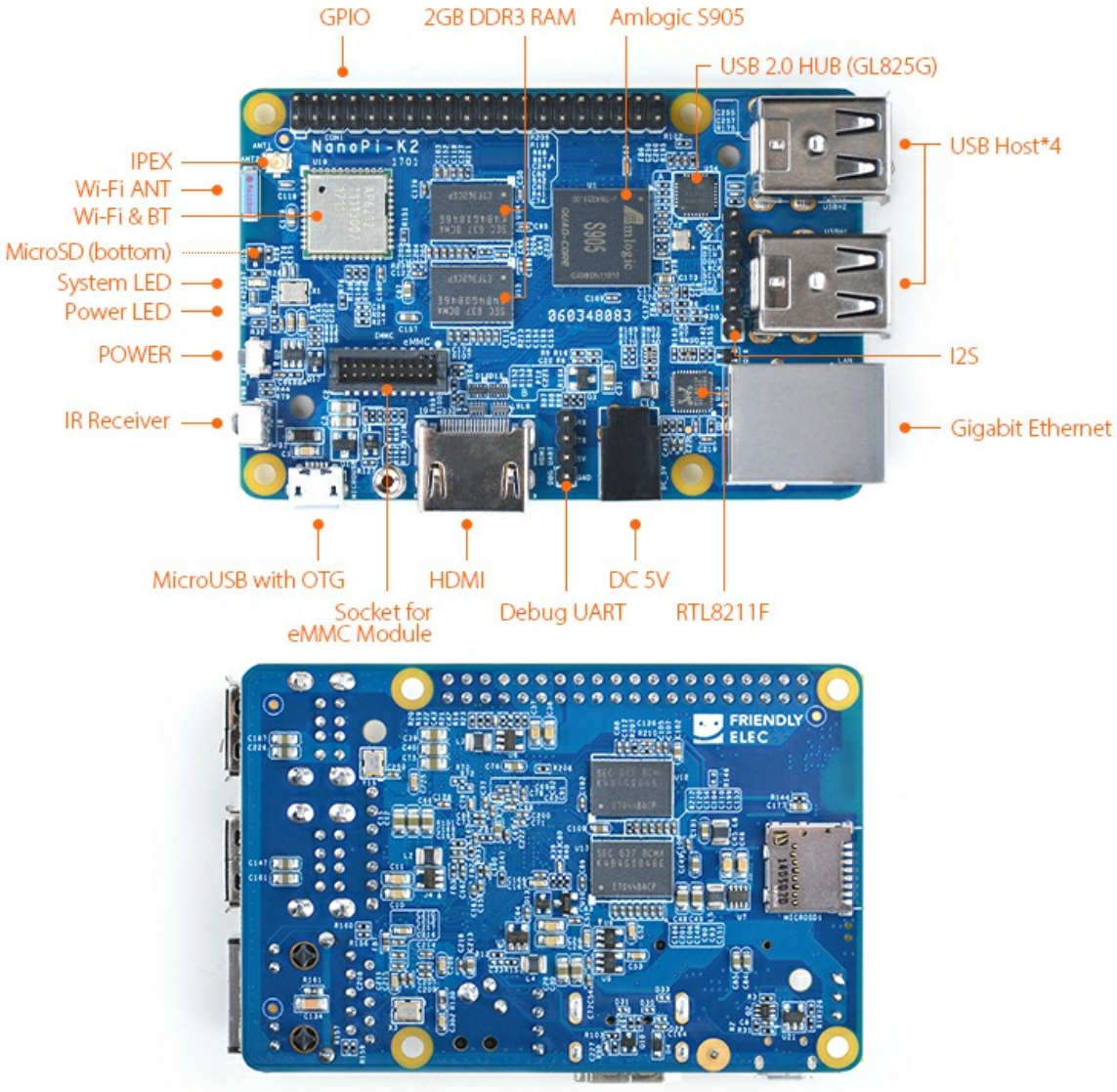
- it supports output to an HDMI monitor
- it supports WiFi
- it supports Ethernet
- it supports Bluetooth
- built-in Qt-Embedded

Android

- Kodi integrated

Diagram, Layout and Dimension

Layout



NanoPi-K2 Layout

- **GPIO Pin Description**

Pin#	Name	Pin#	Name
1	SYS_3.3V	2	VDD_5V
3	GPIODV_24/I2C_SDA_A	4	VDD_5V
5	GPIODV_25/I2C_SCK_A	6	GND
7	GPIOY_0	8	GPIOY_13/UART_TX_C
9	DGND	10	GPIOY_13/UART_RX_C
11	GPIOY_1	12	GPIOY_16/PWM_A
13	GPIOY_2	14	GND
15	GPIOY_3	16	GPIOY_15/PWM_F
17	SYS_3.3V	18	GPIOY_4
19	GPIOY_5	20	GND

21	GPIOY_7	22	GPIOY_6
23	GPIOY_9	24	GPIOY_8
25	DGND	26	GPIOY_10
27	GPIODV_26/I2C_SDA_B	28	GPIODV_27/I2C_SCK_B
29	GPIOY_11/SPDIF_IN	30	GND
31	GPIOAO_5	32	GPIOY_12/SPDIF_OUT
33	GPIOH_3	34	GND
35	GPIOCLK_1	36	CVBS
37	AIN1	38	1.8V Vref Out
39	GND	40	AIN0

- **eMMC Interface Pin Description**

Pin#	Name	Pin#	Name
1	eMMC_D0	2	eMMC_D1
3	eMMC_D2	4	eMMC_D3
5	eMMC_D4	6	eMMC_D5
7	eMMC_D6	8	eMMC_D7
9	eMMC_DS	10	GND
11	eMMC_CMD	12	eMMC_CLK
13	NC	14	GND
15	NC	16	1.8V OUT
17	eMMC_RST	18	3.3V OUT
19	GPIOY_5	20	GND

- **Debug Port（UART0）**

Pin#	Name
1	GND
2	VDD_5V
3	UART_TX_AO_A
4	UART_RX_AO_A

- **7Pin I2S Interface Pin Description**

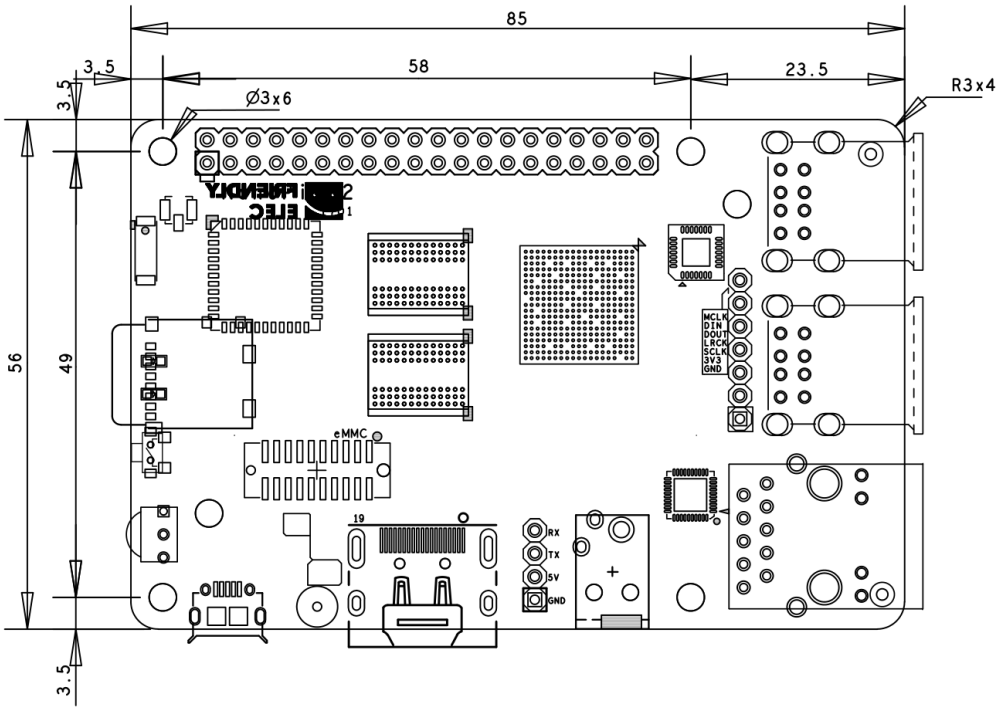
Pin#	Name
1	GND

2	SYS_3.3V
3	I2S_SCLK
4	I2S_LRCLK
5	I2S_DATA_OUT
6	I2S_DATA_IN
7	I2S_MCLK

Notes

1. SYS_3.3V: 3.3V power output
2. VDD_5V: 5V power output5V. The input range is 4.7V ~ 5.6V
3. All pins are 3.3V
4. For more details refer to the document:NanoPi-K2-1701-Schematic.pdf

Board Dimension



For more details refer to the document:NanoPi-K2-1701-dxf.zip

Get Started

Essentials You Need

Before starting to use your NanoPi K2 get the following items ready

- NanoPi K2
- MicroSD Card/TF Card: Class 10 or Above, minimum 8GB SDHC
- A DC 5V/2A power is a must
- HDMI monitor

- USB keyboard and USB mouse
- A host computer running Ubuntu 16.04 64 bit system

TF Cards We Tested

To make your NanoPi K2 boot and run fast we highly recommend you use a Class10 8GB SDHC TF card or a better one. The following cards are what we used in all our test cases presented here:

- SanDisk TF 8G Class10 Micro/SD TF card:
- SanDisk TF128G MicroSDXC TF 128G Class10 48MB/S:
- 川宇 8G C10 High Speed class10 micro SD card:

Make an Installation TF Card/eMMC Module

Boot OS from TF Card/eMMC Module

Get the following files from download link:

- Download needed image files and utilities

Image File:	
nanopi-k2_android_5.1.1-YYYYMMDD.img.zip	Android5.1 Image File for flashing a TF card
nanopi-k2_ubuntu_core_xenial-YYYYMMDD.img.zip	Ubuntu-Core with Qt-Embedded Image File for flashing a TF card
nanopi-k2_android_5.1.1-emmc-YYYYMMDD.img.zip	Android5.1 Image File for flashing an eMMC module
nanopi-k2_ubuntu_core_xenial-emmc-YYYYMMDD.img.zip	Ubuntu-Core with Qt-Embedded Image File for flashing an eMMC module
Flash Utility:	

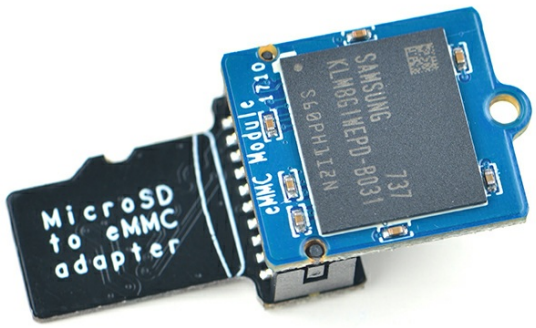
win32diskimager.rar	Windows utility. Under Linux users can use "dd"

Flash Image to TF Card

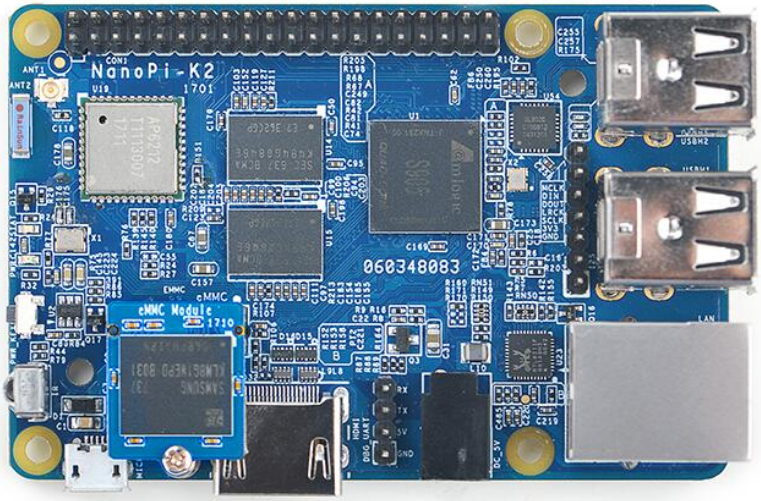
- Extract an image file and win32diskimager.rar. Insert a TF card(at least 8G) into a Windows PC and run the win32diskimager utility as administrator. On the utility's main window select your TF card's drive, the wanted image file and click on "write" to start flashing the TF card.
- Insert this card into your NanoPi K2's BOOT slot and power on (with a 5V/2A power source). If both the green LED and blue LED are solid on this indicates your NanoPi K2 has successfully booted.

Flash Image to eMMC Module

- Extract an image file and win32diskimager.rar on a Window PC. Connect an eMMC module to a TF card to eMMC adapter, insert this TF card adapter to a TF to USB adapter and insert this USB adapter to the Windows PC. Run the win32diskimager utility as administrator. On the utility's main window select this TF adapter's drive, the wanted image file and click on "write" to start flashing the eMMC module.



- After flashing is done take off the eMMC module of the TF card adapter. Insert the eMMC module to the eMMC slot on a NanoPi K2 and power on (with a 5V/2A power source) the board. If both the green LED and blue LED are solid on this indicates your NanoPi K2 has successfully booted.



- When a K2 board has both a TF card and an eMMC module inserted it will always boot from the eMMC module. If you want to boot your K2 from a TF card just insert a TF card only and leave the eMMC slot empty.

Make Installation Card under Linux Desktop

- 1) Insert your TF card/TF adapter with eMMC flash into a host computer running Ubuntu and check your SD card's device name

```
dmesg | tail
```

Search the messages output by "dmesg" for similar words like "sdc: sdc1 sdc2". If you can find them it means your SD card has been recognized as "/dev/sdc". Or you can check that by commanding "cat /proc/partitions".

- 2) Downlaod Linux script

```
git clone https://github.com/friendlyarm/sd-fuse_amlogic.git
cd sd-fuse_amlogic
```

- 3) Make Android TF Card

```
su
./fusing.sh /dev/sdx android
```

(Note: you need to replace "/dev/sdx" with the device name in your system)
When you run the script for the first time it will prompt you to download an image you have to hit “Y” within 10 seconds otherwise you will miss the download

- 4) Make Android eMMC Module

```
su
./fusing.sh /dev/sdx android emmc
```

(Note: you need to replace "/dev/sdx" with the device name in your system)
When you run the script for the first time it will prompt you to download an image you have to hit “Y” within 10 seconds otherwise you will miss the download

Extend NanoPi K2's TF Card/eMMC Module Section

- If your board runs Ubuntu you can skip this section since Ubuntu will automatically extend your TF card's section. When Android is loaded you need to run the following commands on your host PC to extend your TF card's section:

```
sudo umount /dev/sdx?
sudo parted /dev/sdx unit % resizepart 4 100 unit MB print
sudo resize2fs -f /dev/sdx4
```

(Note: you need to replace "/dev/sdx" with the device name in your system)

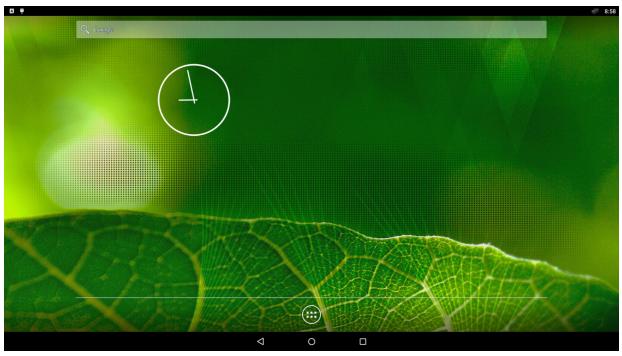
HDMI Resolution

If your NanoPi K2 is connected to an HDMI monitor and it runs Android it will automatically set the resolution to an appropriate HDMI mode by checking the "EDID".

Run Android

- Insert an SD card with Android image into your NanoPi K2, connect the board to an HDMI monitor, power on the board K2 will boot from the SD card. If you can see the PWR LED on and the blue LED are solid on it means your board is working and you will see Android being loaded on the HDMI monitor.

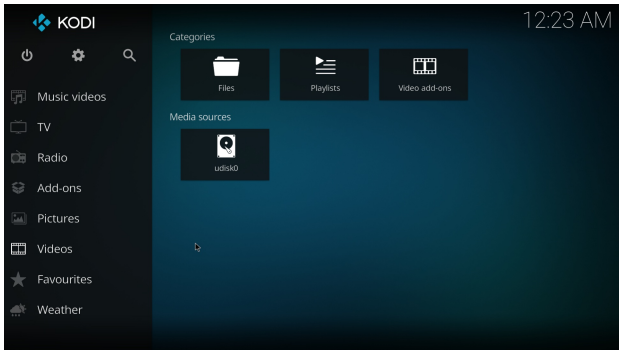
- It is recommended to turn off its power by pressing the PWR key otherwise the system data in the TF card will be damaged.



Play Multi-Media Stream with Kodi

Kodi is pre-installed on Android. It supports hard-decoding. Here is how Kodi looks like:

Insert a USB storage card with a video file to K2's USB port and on Kodi's main window select "Videos -> udisk0" to load and play the video file in the storage card:



Run Ubuntu core

Introduction to Ubuntu core

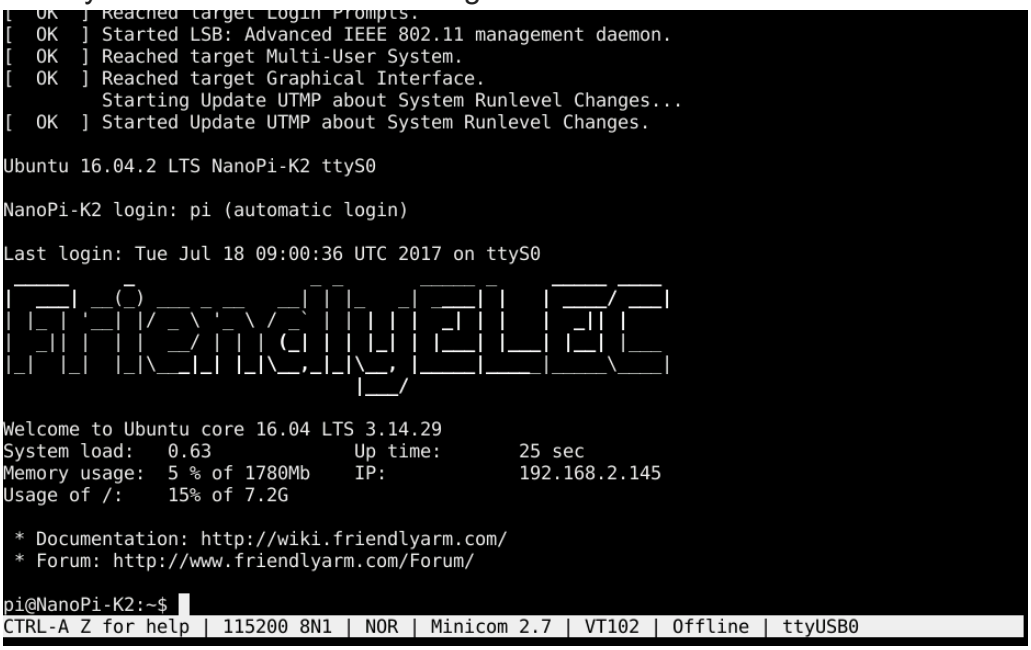
Ubuntu Core with Qt-Embedded is a light Linux system without X-windows. It uses the Qt-Embedded's GUI and is popular in industrial and enterprise applications. Besides the regular Ubuntu core's features our Ubuntu-Core has the following additional features:

- it supports output to an HDMI monitor
- it supports WiFi
- it supports Ethernet
- it supports Bluetooth
- built-in Qt-Embedded

Thanks to A53 SoC's powerful performance, 2G RAM and Gbps Ethernet the NanoPi K2 with Ubuntu is well suited for IoT applications and light server applications such as NAS.

Applications under Ubuntu core

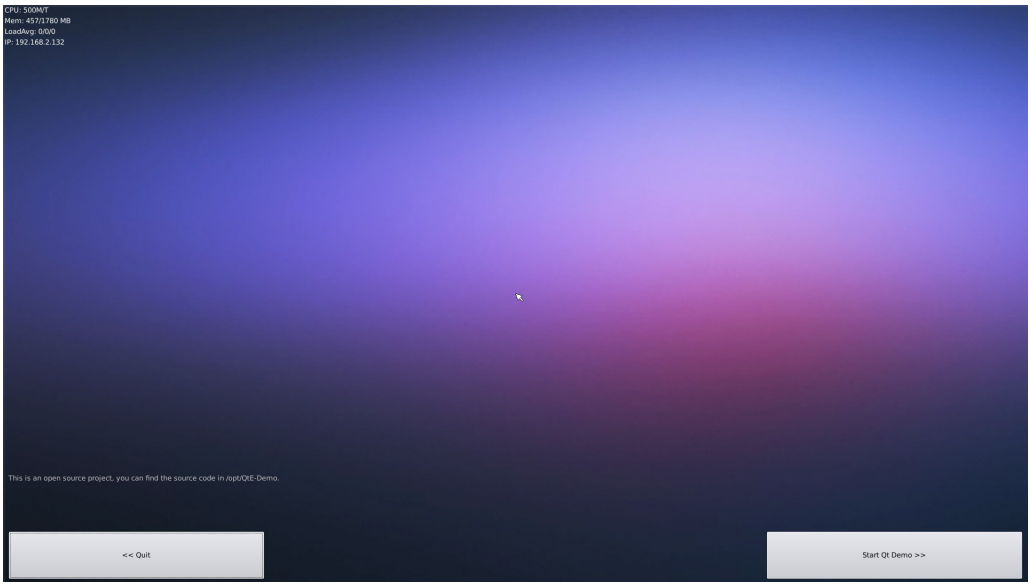
After you insert an SD card pre-installed with Ubuntu to a NanoPi K2 and power up the board you will observe the following GUI:



To enable Qt-Embedded GUI you can run the following command:

```
$ sudo /opt/QtE-Demo/run.sh
```

Here is a what you expect to observe. This is an open source Qt Demo application:



For more details about Ubuntu Core refer to: Ubuntu Core with Qt-Embedded

Make Your Own OS Image

Install Cross Compiler

- Install ARMv7 Cross Compiler

Download the compiler package:

```
git clone https://github.com/friendlyarm/prebuilts.git
sudo mkdir -p /opt/FriendlyARM/toolchain
sudo tar xf prebuilts/gcc-x64/arm-cortexa9-linux-gnueabihf-4.9.3.tar.xz -C
/opt/FriendlyARM/toolchain/
```

Then add the compiler's directory to "PATH" by appending the following lines in "~/.bashrc".:

```
export PATH=/opt/FriendlyARM/toolchain/4.9.3/bin:$PATH
export GCC_COLORS=auto
```

Execute "~/.bashrc" to make the changes take effect. Note that there is a space after the first ".":

```
. ~/.bashrc
```

This compiler is a 64-bit one therefore it cannot be run on a 32-bit Linux machine. After the compiler is installed you can verify it by running the following commands:

```
arm-linux-gcc -v
Using built-in specs.
COLLECT_GCC=arm-linux-gcc
COLLECT_LTO_WRAPPER=/opt/FriendlyARM/toolchain/4.9.3/libexec/gcc/arm-cortexa9-
linux-gnueabihf/4.9.3/lto-wrapper
Target: arm-cortexa9-linux-gnueabihf
Configured with: /work/toolchain/build/src/gcc-4.9.3/configure --build=x86_64-
build_pc-linux-gnu
--host=x86_64-build_pc-linux-gnu --target=arm-cortexa9-linux-gnueabihf --
prefix=/opt/FriendlyARM/toolchain/4.9.3
--with-sysroot=/opt/FriendlyARM/toolchain/4.9.3/arm-cortexa9-linux-gnueabihf/sys-
root --enable-languages=c,c++
--with-arch=armv7-a --with-tune=cortex-a9 --with-fpu=vfpv3 --with-float=hard
...
Thread model: posix
gcc version 4.9.3 (ctng-1.21.0-229g-FA)
```

- Install AArch64 Cross Compiler

The AArch64 cross compiler is needed to compile U-Boot and Linux. We used linaro toolchain:

```
wget http://releases.linaro.org/components/toolchain/binaries/4.9-2017.01/aarch64-
linux-gnu/gcc-linaro-4.9.4-2017.01-x86_64_aarch64-linux-gnu.tar.xz
tar xf gcc-linaro-4.9.4-2017.01-x86_64_aarch64-linux-gnu.tar.xz
export PATH=~/gcc-linaro-4.9.4-2017.01-x86_64_aarch64-linux-gnu/bin:$PATH
```

Add the compiler's directory to "PATH".

Compile U-Boot

Download the U-Boot source code and compile it. Note that the github's branch is nanopi-k2-v2015.01:

```
git clone https://github.com/friendlyarm/u-boot.git uboot
cd uboot
git checkout nanopi-k2-v2015.01
make nanopi-k2_defconfig
make
```

After your compilation succeeds a u-boot.bin will be generated. If you want to test it flash it to your installation TF card via fastboot. Here is how you can do it:

```
sudo ./fusing.sh /dev/sdc
```

You can type the following command to update both a TF card and an eMMC Flash

```
sudo ./fusing.sh /dev/sdc emmc
```

Or you can do it with fastboot:
1) On your host PC run "sudo apt-get install android-tools-fastboot" to install the fastboot utility;
2) Connect your NanoPi K2 to your host PC via a serial cable (e.g. PSU-ONECOME). Press the enter key within two seconds right after you power on your NanoPi K2 and you will enter uboot's command line mode;
3) After type in "fastboot" and press "enter" you will enter the fastboot mode;
4) Connect your NanoPi K2 to this host PC via a microUSB cable and type in the following command to flash u-boot.bin:

```
fastboot flash bootloader fip/gxb/u-boot.bin
```

We haven't found a way to update the uboot on an eMMC flash with fastboot.

Compile Linux kernel

Compile Kernel

- Download Kernel Source Code

```
git clone https://github.com/friendlyarm/linux.git
cd linux
git checkout nanopi-k2-3.14.y
```

The NanoPi K2's kernel source code lies in the "nanopi-k2-3.14.y" branch.

- Compile Android Kernel

```
touch .scmversion
make ARCH=arm64 nanopi-k2_android_defconfig
make ARCH=arm64 CROSS_COMPILE=aarch64-linux-gnu- Image nanopi-k2.dtb
```

After your compilation succeeds an arch/arm64/boot/dts/amlogic/nanopi-k2.dtb file and an arch/arm64/boot/Image will be generated. You can use them to replace the existing files under your SD card's boot section.

- Compile Ubuntu Kernel

```
touch .scmversion
make ARCH=arm64 nanopi-k2_ubuntu_defconfig
make ARCH=arm64 CROSS_COMPILE=aarch64-linux-gnu- Image nanopi-k2.dtb
```

User Your Generated Kernel

- Update the kernel file in SD card

If you use an SD card to boot Android you can copy your generated uImage file and nanopi-k2.dtb file to your SD card's boot section(e.g. section 1 /dev/sdX1).

- Update kernel with adb

You can update your kernel with adb and here is how you can do it:

```
adb shell mount -t ext4 /dev/block/mmcblk0p1 /storage/sdcard1/
adb push arch/arm64/boot/Image /storage/sdcard1/
adb push arch/arm64/boot/dts/amlogic/nanopi-k2.dtb /storage/sdcard1/
adb reboot
```

- Update Image and nanopi-k2.dtb

If you want to generate a new Android's boot.img you need to use your newly generated image and nanopi-k2.dtb to replace the existing files under "device/friendly-arm/nanopi-k2-kernel" and recompile Android.

Compile Android

- Install Cross Compiler

Install a 64-bit Ubuntu 14.04 on your host PC

```
sudo apt-get install bison g++-multilib git gperf libxml2-utils make python-networkx zip
sudo apt-get install flex libncurses5-dev zlib1g-dev gawk minicom
```

For more details refer to https://source.android.com/source/initializing.html

- Download Android5.1 Source Code

You need to use repo to get the Android source code. Refer to https://source.android.com/source/downloading.html .

```
mkdir android && cd android
repo init -u https://github.com/friendlyarm/android_manifest.git -b nanopi-k2-lollipop
repo sync
```

"android" is the working directory.

- Compile System

```
source build/envsetup.sh
lunch nanopi_k2-userdebug
make -j8
```

After compilation succeeds an image file will be generated under "out/target/product/nanopi-k2"

filename	partition	Description
u-boot.bin	bootloader	-
boot.img	boot	-
cache.img	cache	-
userdata.img	userdata	-
system.img	system	-
partmap.txt	-	partition file

- Flash Image to SD Card

If you want to boot your board from an SD card you need to copy your generated image file to the "sd-fuse_amlogic/android/" directory and flash it to your SD card with our script. For more details refer to # Make Installation Card under Linux Desktop.

- Update Image with fastboot

Right after the NanoPi K2 is booted press any key to enter the uboot commandline mode and type in "fastboot usb"
Connect your K2 to a host PC with a USB cable and type the following commands from your PC's terminal:

```
cd out/target/product/nanopi-k2
sudo fastboot flash boot boot.img
sudo fastboot flash cache cache.img
sudo fastboot flash userdata userdata.img
sudo fastboot flash system system.img
sudo fastboot reboot
```

Update Log

April-14-2017

- Released English version

June-4-2017

- Added section 4.5: kodi support

July-21-2017

- Added sections 3 and 5.5

Nov-17-2017

- Added sections 5.3.1.2
- Updated sections 5.3.1, 5.3.3, 6.2 and 6.3