

## PINE64/AOSC Presentation

TL Lim  
Community Founder

# How the PINE64 born?

On August 15, 2015, I visited Daniel Kottke and he asked me about a China company (Allwinner) introduced a 64bit quad core ARM CPU for \$5 and questioned whether this is real. I answered "lets me call to my friend in China and find out".



## Allwinner \$5 quad-core ARM Cortex-A53 chipset hits mass production

A complete 64-bit \$5 quad-core ARM Cortex-A53 based tablet chipset with Android 5.1 support and fast boot times, all for \$5.



By Adrian Kingsley-Hughes for Hardware 2.0 | August 14, 2015 -- 14:09 GMT (07:09 PDT) | Topic: Innovation

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At CES this year Chinese fabless semiconductor company Allwinner announced its first 64-bit tablet solution, the \$5 quad-core ARM Cortex-A53 based A64 chipset. As of August the company has revealed that those chips have entered mass production with several customers.

The new chipset supports the newest Android 5.1 operating system, offers high system performance, and 9.9-second boot times. It also supports H.265/H.264 hardware decoding and 1080P HDMI output, to deliver high-performance audio/video performance.

Other benefits include:

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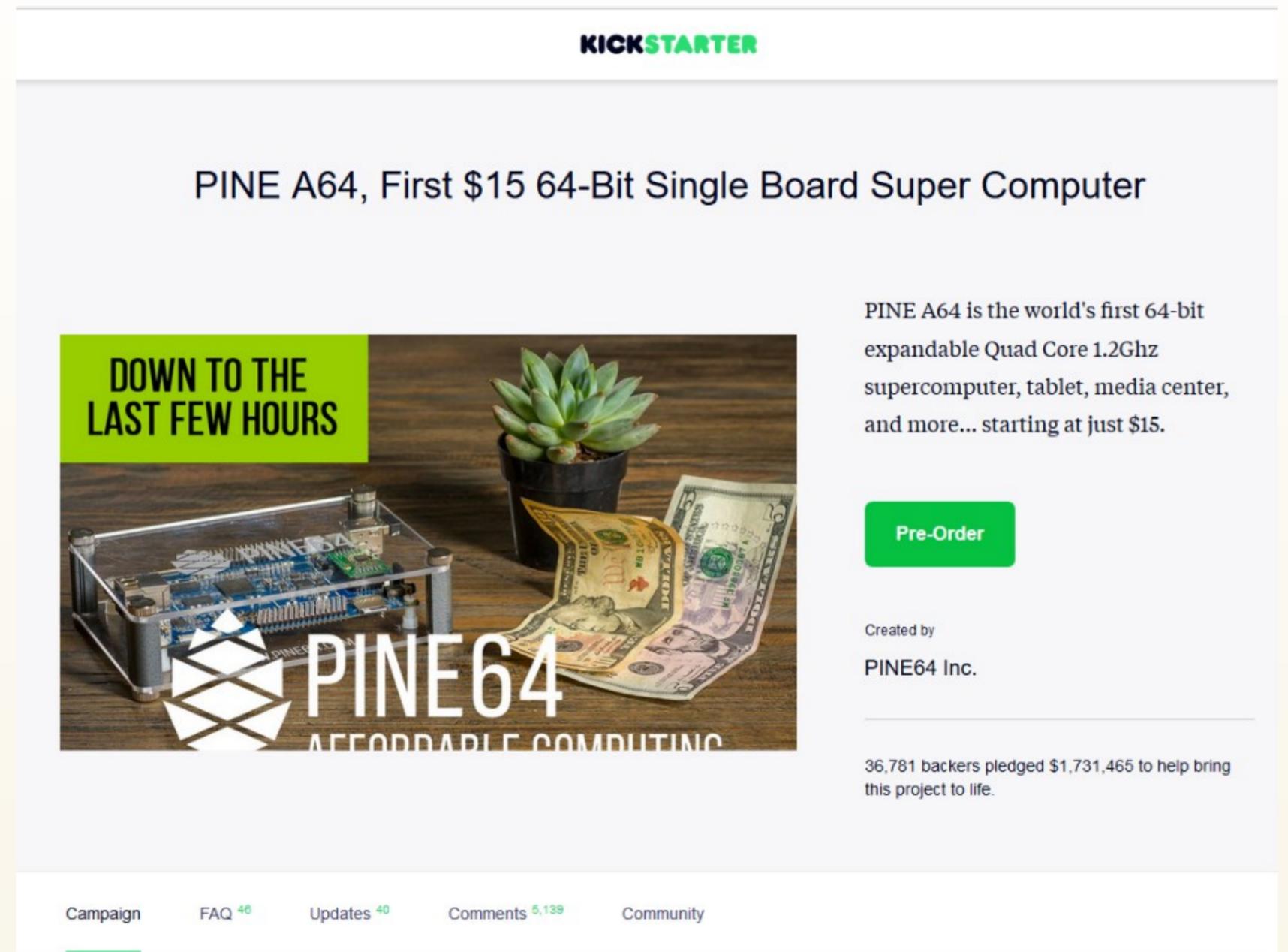
Enterprise Software  
Watch out Windows, Android, and iOS: Amazon's Alexa is turning into the next big operating system

# PINE64 at Kickstarter

- Launched at Kickstarter on December 9, 2015 for 45 days and ended on January 23, 2016
- However this is a bad period of time to launch campaign due to Christmas, New Year and CES (Consumer Electronic Show). BTW, even worst if launch on November (Black Friday).
- Successfully raised \$1.7 million with 36,781 backers.

January 23, 2016

Successfully raised \$1,731,465 with 36,781 backers



The image shows a screenshot of the PINE64 Kickstarter campaign page. At the top, the Kickstarter logo is visible. The main heading reads "PINE A64, First \$15 64-Bit Single Board Super Computer". Below this is a promotional image featuring a PINE64 board, a succulent, and US dollar bills. A green banner in the top left of the image says "DOWN TO THE LAST FEW HOURS". The PINE64 logo and the tagline "AFFORDABLE COMPUTING" are overlaid on the image. To the right of the image, a text block describes the product: "PINE A64 is the world's first 64-bit expandable Quad Core 1.2Ghz supercomputer, tablet, media center, and more... starting at just \$15." Below this is a green "Pre-Order" button. Further down, it says "Created by PINE64 Inc." and "36,781 backers pledged \$1,731,465 to help bring this project to life." At the bottom, there is a navigation bar with links for "Campaign", "FAQ 46", "Updates 40", "Comments 5,139", and "Community".

**KICKSTARTER**

## PINE A64, First \$15 64-Bit Single Board Super Computer

DOWN TO THE LAST FEW HOURS

PINE64  
AFFORDABLE COMPUTING

PINE A64 is the world's first 64-bit expandable Quad Core 1.2Ghz supercomputer, tablet, media center, and more... starting at just \$15.

**Pre-Order**

Created by  
**PINE64 Inc.**

36,781 backers pledged \$1,731,465 to help bring this project to life.

Campaign    FAQ <sup>46</sup>    Updates <sup>40</sup>    Comments <sup>5,139</sup>    Community

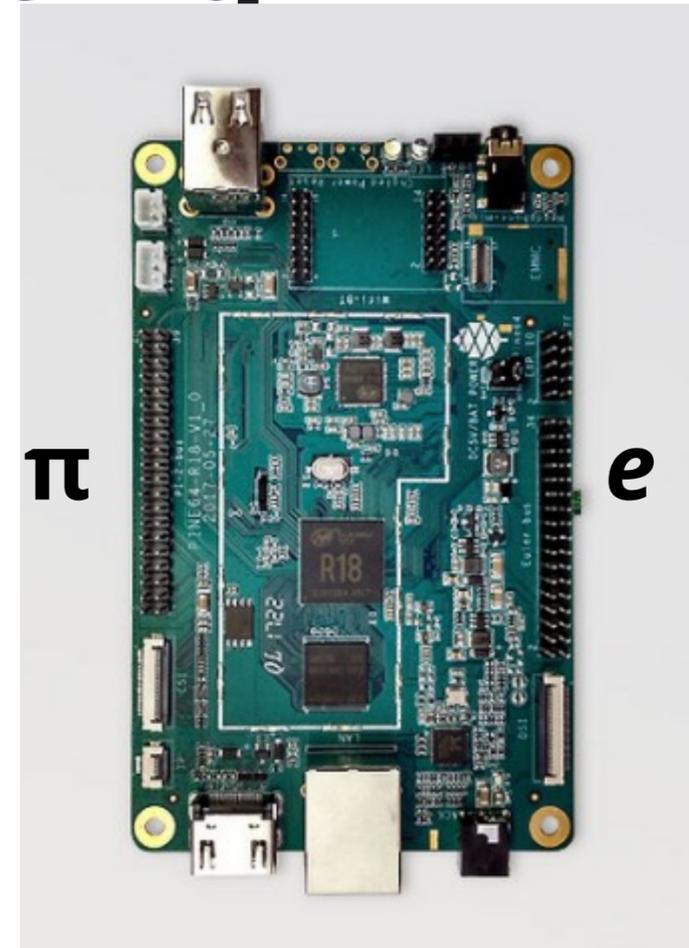
# Why name “PINE64” ?

- PINE64 name derives from two mathematic constants and 64-bit computing

$$\pi + e = \text{PINE}$$

## “64” just means 64 bit computing

- PINE64 is a 64-bit Single Board Computer platform that runs by community. Most community members are makers and developers.
- We published PINE64 schematics but not consider as a Open Source Hardware Project. 
- We setup the PINE64 forum (<http://www.pine64.org>) and community help to setup the PINE64 IRC (<http://www.pine64.xyz>)



# PINE64 has three “NOT” Principles

**-NOT SEEKING FOR VENTURE CAPITAL FUNDING**

**-NOT SEEKING TO BORROW MONEY**

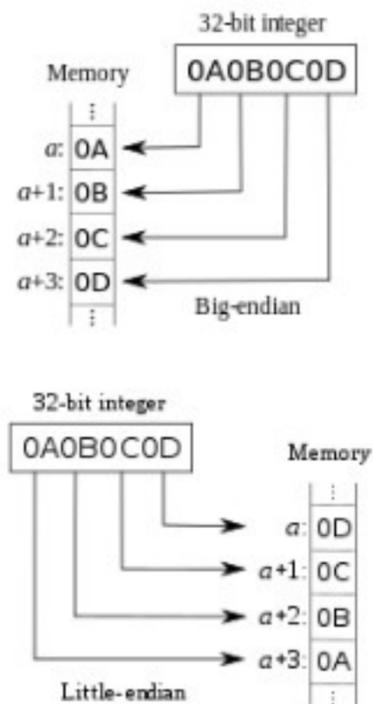
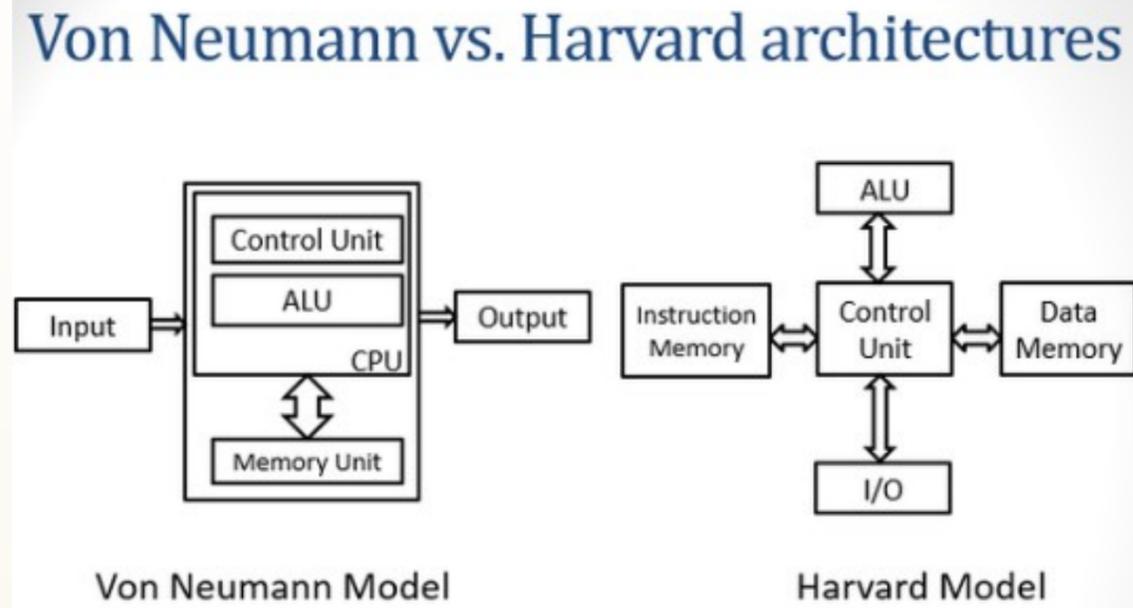
**-NOT SEEKING FOR PUBLIC OFFERING (IPO)**

**- 老干妈”的“三不”原则 ... 不上市、不贷款、不融资**

- Keep the core value:“Pure and Simple”
- There is ZERO employee in PINE64. All resource comes from either contract or contribute basis. This keeps the structure in very flexible way and also minimize operating expense.
- PINE64 is marginally profitable. Consider PINE64 as a store that services PINE64 community rather as a company.
- All recent profit recycle back as working capital and keeps bootstrapping.

# 64 bit Single Board Computer (SBC)

- PINE64 primary focus on 64 bit ARM and RISC-V based Single Board Computer platform for makers
- ARM vs Intel CPU Architectures:
  - ARM: RISC, Von Neumann, bi-endian
  - Intel: CISC, Harvard, little-endian

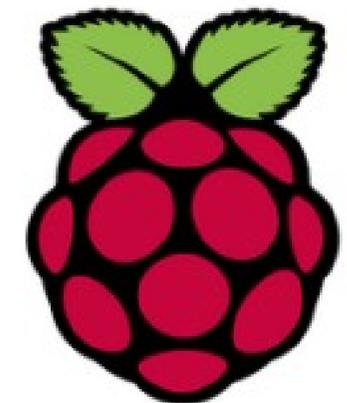


# Key factors on Single Board Computer selection

- What is the primary function?
- Runs solely on battery power? Rechargeable?
- Does the requirement needed Internet connectivity
- Which operating system?
- Which development language?
- Any religious consideration (ex: FOSS)?
- Hobby or project for actual deployment?
- Operate in indoor or outdoor environment?
- For project, needs to consider the supply factor on SBC longevity period
- After development, plan to continue using the SBC or port to starts own custom board design?

# Arduino or Raspberry Pi? the two most popular SBC in market

- Arduino Uno based on Atmel 8 bit AVR micro processor.
  - For simple program to acquire sensor data and control actuator, Arduino is the good choice.
  - For heavy computation such as voice or face recognition, Arduino CPU is too slow.
  - Arduino good on handling data between UART or i2C low speed bus. However, not suitable for high speed bus such as USB or Ethernet.
  - For internet connection, Arduino can only perform very limited function and small amount of data transaction (text type, no audio or video)
- Raspberry Pi based on Broadcom ARM based 32/64bit CPU
  - Considers the third largest computer platform beside Intel and Apple.
  - Runs on Linux operating
  - Capable on network connectivity
  - Capable on audio and video processing

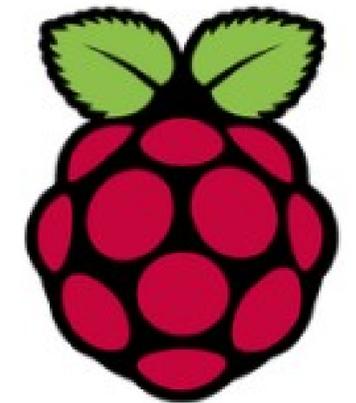


# Select between Raspberry Pi and PINE64

- **Raspberry Pi**

If you are a noob, Raspberry Pi is your board !!!

- focus on education, a lot of tutorial materials
- Wealth amount of information and easy to get support
- Comprehensive driver, OS and software available
- Although Raspberry Pi 3/4 CPU is 64 bit core but OS only support 32 bit due to legacy reason



- **PINE64**

Focus on high performance

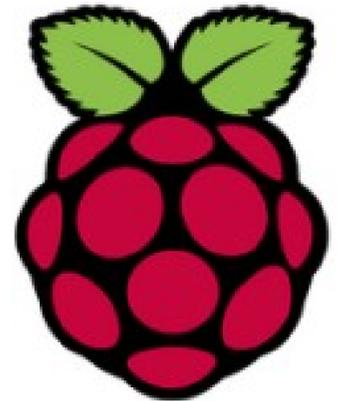
- True 64 bit operation, secure boot, and runs ARMv8
- Dedicate high speed IO bus, no bus sharing that traffic jam cause by slow devices
- Focus on China SoC such as Allwinner and Rockchip
- Mainline Linux support
- Possible to design your own custom board



# Raspberry Pi and PINE64 Direction

- **Raspberry Pi**

Aside from the accessibility a \$35 price tag offers, the foremost benefit of the Raspberry Pi is the community—the proliferation of projects and integrations that center around the Raspberry Pi, and the ease-of-use that creates, makes competing products that look better on spec sheets a disappointment when taken out of the box.



- **PINE64**

PINE64 has attempted to head this off by fostering an involved community; the PINE64 website explains their philosophy as "the community gets to actively shape the devices, as well as the social platform, of PINE64 from the ground up. The goal is to deliver ARM64 devices that you really wish to engage with and a platform that you want to be a part of."

PINE64 is differentiating itself by building not just SBCs, but notebooks, tablets, and phones with community input and feedback.



# CPU, GPU and VPU

## CPU

- often referred to as the brains of the computer and aids everything from loading operating system, to executing commands, and performing calculations in Excel.

## GPU

- handle graphics operations, includes both 2D and 3D calculations, though GPUs primarily excel at rendering 3D graphics.

## VPU

- hardware acceleration for video decoding and encoding

# PINE64 SBC Input-Output

- High Speed BUS
  - PCIe
  - USB 3.0 and 2.0
  - Ethernet
  - SATA
  - SDIO
  - SD
  - SPI
- Low Speed Bus
  - UART
  - I2C
  - GPIO
- Digital Audio Bus
  - I2S
  - PDM (Pulse Decode Modulation)
- Digital Video Bus
  - HDMI
  - eDP
  - MiPi Dsi, CSI
  - CIF (Camera)

# Kernel Boot Sequence on SBC vs PC

## Generic boot sequence



- SBC boot: ROM code -> SPL -> u-boot -> kernel
- Legacy PC boot: BIOS -> MBR (GPT) -> GRUB -> kernel
- New PC boot: UEFI (include GPT, GRUB) -> kernel

MBR: Master Boot Record

GPT: GUID (Global Unique Identifiers) Partition Table

GRUB: GRand Unified Bootloader (Multiboot Boot Loader)

UEFI: Unified Extensible Firmware Interface

# How the Linux Kernel Boot

## Generic boot sequence



- The ROM code is a small code generally reside inside SoC to handle boot sequence
- The 1<sup>st</sup> stage bootloader sometimes also call SPL (Secondary Program Loader), mini-loader, or Boot0
- The 2<sup>nd</sup> stage bootloader normally refer as u-boot

Boot stage number	Terminology #1	Terminology #2	Actual program name
1	Primary Program Loader	-	ROM code
2	Secondary Program Loader (SPL)	1st stage bootloader	u-boot SPL
3	-	2nd stage bootloader	u-boot
4	-	-	kernel

# Current SBC Linux OS ARM build dilemma

- Current SBC boot sequence: ROM code -> SPL -> u-boot -> kernel -> OS build
- Every OS build needs to include boot code. This means developers (maintainers) always need to build different OS builds for different SBC board and also maintain the OS build update. Such method required a lot of development time and resources to keep generating and updating different OS builds.
- New SBC boot sequence: ROM code -> EFI -> kernel
  - Major Linux OS companies already familiar and prefer with EFI booting, this allows common OS build release for x86 and ARM.
  - The Linux OS companies support EFI method includes Ubuntu, Debian, Suse, Fedora, and Cent OS.
  - Need to have a small SPI FLASH memory on board (SBC) to store EFI code

# BSP Kernel vs Mainline Kernel

- **BSP (Board Support Package)**

- is the layer of software containing hardware-specific drivers and other routines that allow operating system to function in a particular hardware environment integrated with the OS itself. In general, the BSP are provided by SoC vendor. Most of the time, BSP is not fully GPL comply and contains blob (binary large object).

- The advantage of using BSP is the OS can highly integrated with SoC functionalities and support comprehensive functionality.

- SoC vendor seldom update their BSP and this cause the BSP Linux kernel version normally outdated and no longer supported.

- **Mainline**

- Mainline tree is maintained by Linus Torvalds. It's the tree where all new features are introduced and where all the exciting new development happens. The mainline kernel actively maintained and optimized by open source developers and generally free from blob.

- Due to constantly optimize and update by open source developers, the mainline kernel in general has better performance and security patch over BSP kernel.

- Mainline kernel may lack some functionalities until been developed by open source developers.

- Head-less server typical is the first and popular mainline OS application due to require less drivers.

# Why Mainline ?

Support of Mainline Linux does not happen overnight. It requires both a time and resource commitment. But the benefits are lasting - likely as long as the lifetime of the devices supported.

- **Ensuring Quality**
  - The hierarchy of maintainers in the Linux community helps ensure quality by forcing developers to consider the impact of their code base on others. The intent of the Linux community is to move Linux and everyone's work forward and provide scalability across future kernel versions while ensuring quality.
- **Scalability**
  - Scalability and reuse can only be achieved through support of Mainline Linux. Once support of a common IP is pushed upstream, it will move forward as Mainline Linux moves forward.
- **Lifetime supported**
  - In general, SoC vendors only support their BSP when product still active in market. The mainline approach free out from SoC vendors support and the software able to support and maintain beyond the SoC sales cycle.
- **Reduce dependency technical support from SoC vendors**
  - By supporting mainline activity, the SoC vendor able to reduce the technical support loading and widen the usage of the SoC functionality.
- **PINE64 roles on mainlining**
  - PINE64 actively provides PINE64 hardware to Kernel CI Labs and ensures device under test for mainline kernel testing.

# PINE64 OS builds

- **Linux**

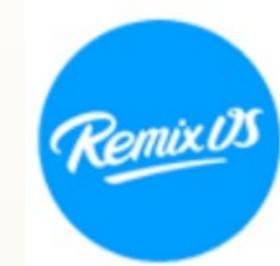
- Always using LTS (Long Term Support) version and focus on mainline.

- Ubuntu
- Debian
- Arch
- DietPi
- Gentoo
- Yacto
- openSuse
- Fedora
- Q4OS
- AOSC
- Manjaro



- **Android**

- Android 5/6/7/8/9
- Android TV
- Remix
- Bliss ROM



- **Unix**

- FreeBSD
- openBSD
- netBSD



- **Chromium OS**



# More PINE64 OS builds

- **Mobile OS** – for Linux Mobile Phone

- Ubuntu Mobile - UBports
- Web OS – Lune OS
- Maemo Leste
- NixOS
- Sailfish OS
- Nemo Mobile
- Postmarket OS



# PINE64 SBC Applications

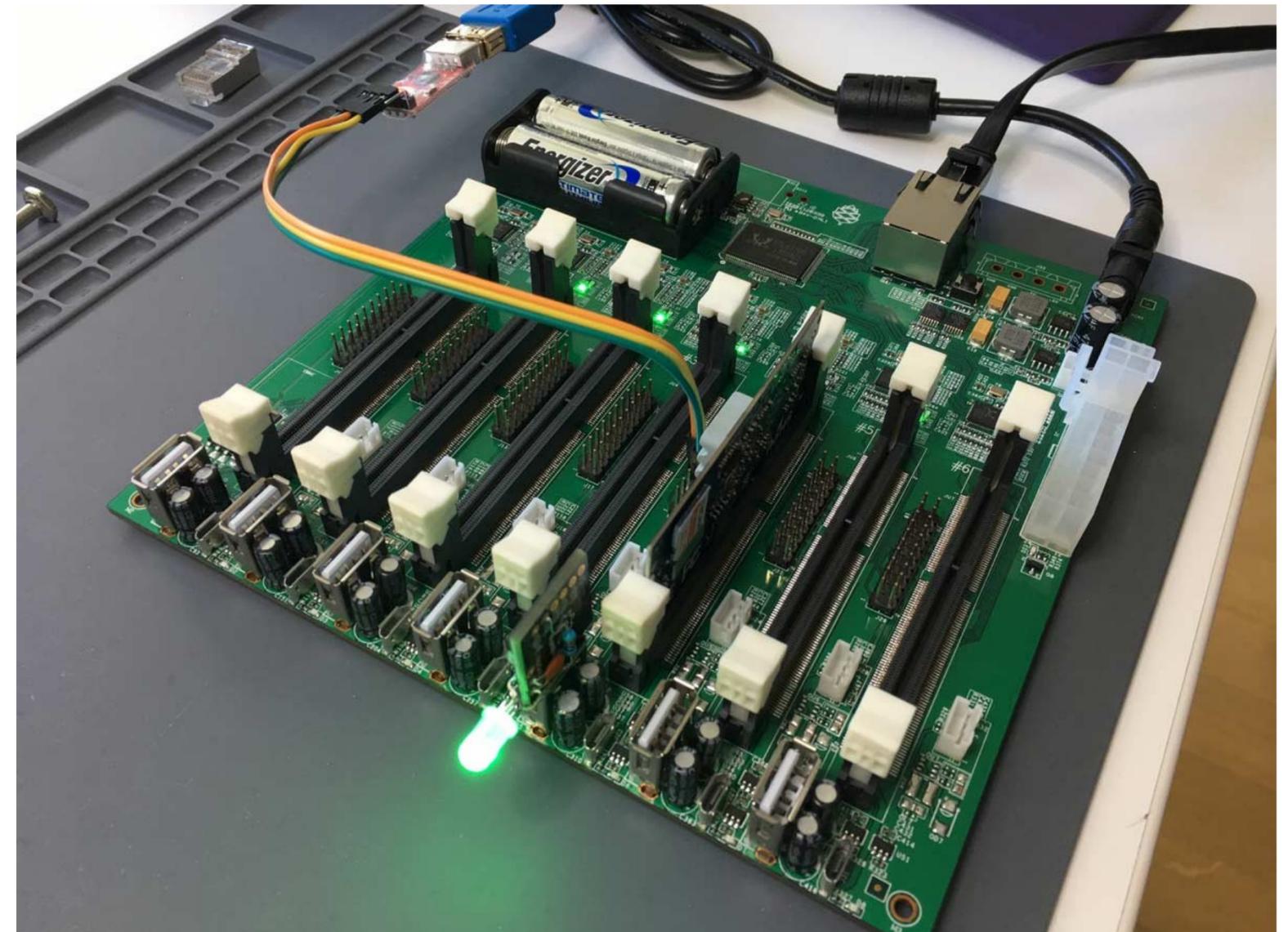
- Media Player
- Media Server
- Retro Game Player
- Network Router
- Web server
- File Server (NAS)
- Block Chain full node
- IOT Gateway
- STEAM Education



# Micro Server Clustering

28x 64-bit ARM cores in one mini ITX board with Gigabit Ethernet

- Combine several SBC boards to form a multi core server clustering
- Using Ethernet as network backbone
- Low cost, low power consumption and easy to expend
- Good for job distribution type of application
- Soon released AI Neural module



# Others PINE64 SBC Applications

- Signage Display Board
- Robot
- ChatBot
- Smart City
- 3D Camera
- Autonomous Vehicle
- .....

# Essential Tools

## Serial Console

It allows get a console on the system if there are any problems with it (especially network problems, when SSH is not available). This is quite useful if your Linux server is in a headless configuration.



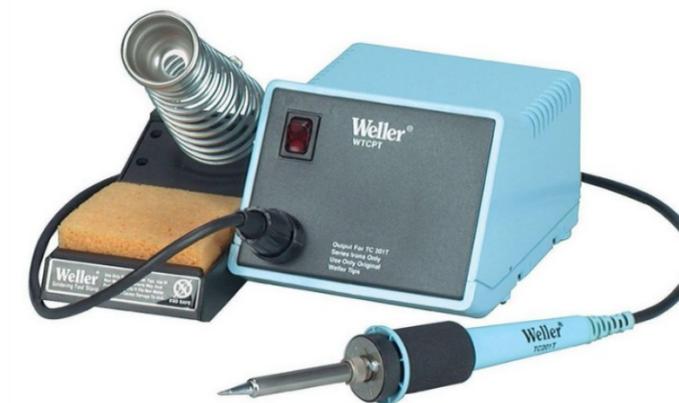
## Multimeter

It's a swiss army knife for geeks! A multimeter can measure continuity, resistance, voltage, current, and etc.



## Solder Iron

Soldering is one of the most fundamental skills needed to dabble in the world of electronics.



# Encourage active participation

- For PINE64 to growth and prosperous, we encourage students, users, makers, and developers active participate on forum, wiki, and IRC
- PINE64 forum link: <http://forum.pine64.org>  
PINE64 IRC (Internet Relay Chat) link: <http://www.pine64.xyz>  
PINE64 wiki link: <http://wiki.pine64.org>
- PINE64 always provide free SBC and accessories to forum/IRC moderators and active developers.
- Annually meet up at FOSDEM event (Brussels, Belgium)

# Special Thanks

Pine64 community  PINE64

Thanks to the PINE64 moderators and developers.

Sunxi , Linux-Rockchip , Armbian 

Sunxi - open source software community dedicated to Allwinner SoC mainline Linux

Linux-Rockchip - open source software community dedicated to RockChip SoC mainline Linux

Armbian - optimizing low-level settings, kernel settings and security for ARM SBC

Open Electron 

Publish excellent Linux training courses and available to public. Please visit

<http://free-electrons.com/>

# Q and A

## Disclaimer:

I am not an EXPERT or GURU !!!

If you have questions regarding OS build process, or in-depth technical discussion, please participate at PINE64 IRC (<http://www.pine64.xyz>) and you will find several gurus there.

PINE64

That is ALL !

[www.pine64.org](http://www.pine64.org)  
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