



RISC-V, the Computing Trend of AIoT

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RISC-V, the Trend of SoC Computing Engine





RISC-V 特質



- 開放源指令集架構 (Open source ISA)
- 簡潔 (Simple, Clean-Slate)
- 模組化 (Modular)
- 工程人員可加功能或特殊指令
(Extensibility/Specialization)

初生之犢不怕虎:包袱小 - 1 of 2

- 簡潔 (Simple, Clean-Slate)
- 模組化 (Modular)

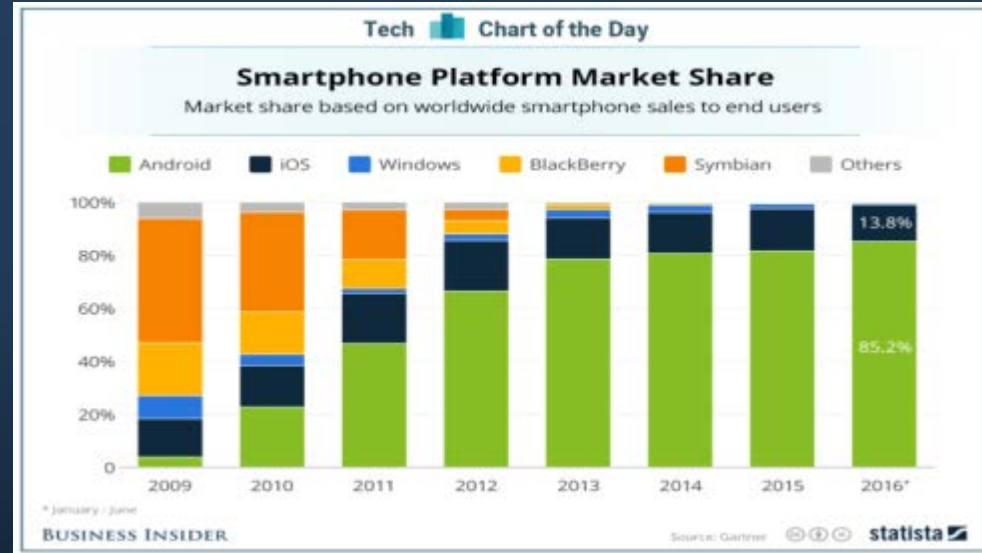
較低功耗 較小面積 可以更快

Name	Description	Version	Status
基本指令集			
RV32I	基本整數指令集, 32位元	2.0	Frozen
RV32E	基本整數指令集(嵌入式系統), 32位元, 16 暫存器	1.9	Open
RV64I	基本整數指令集, 64位元	2.0	Frozen
RV128I	基本整數指令集, 128位元	1.7	Open

Name	Description	Version	Status
初生之犢不怕虎:包袱小 - 2 of 2	標準擴充指令集	I & E: Basic ISA	
M	整數乘除法標準擴充	2.0	Frozen
A	不可中斷指令(Atomic)標準擴充	2.0	Frozen
F	單精確度浮點運算標準擴充	2.0	Frozen
D	雙倍精確度浮點運算標準擴充	2.0	Frozen
G	所有以上的擴充指令集以及基本指令集的總和的簡稱	不適用	不適用
Q	四倍精確度浮點運算標準擴充	2.0	Frozen
L	十進位浮點運算標準擴充	0.0	Open
C	壓縮指令標準擴充	2.0	Frozen
B	位元運算標準擴充	0.37	Open
J	動態指令翻譯標準擴充	0.0	Open
T	順序記憶體存取標準擴充	0.0	Open
P	單指令多資料流 (SIMD) 運算標準擴充	0.1	Open
V	向量運算標準擴充	0.7	Open
N	使用者中斷標準擴充	1.1	Open

開放源是RISC-V成功之道

- RISC-V 與 Open Source
- 因 Open Source 而產生的 Business Model
- 以 Android, Linux, Verilog 為成功案例
- 遵守 Open Source 遊戲規則
- Open source ISA 與 Open source core 的差別



Courtesy of: Statista



Berkley Software Distribution License (BSD)



- BSD 授權條款是自由軟體中使用最廣泛的授權條款之一。BSD 就是遵照這個許可證來發布，也因此而得名 BSD 授權條款。BSD 套件最初所有者是加州大學的董事會，這是由於 BSD 源自加州大學伯克利分校。基於公平互惠的原則，使用者也必須公開其對自由軟體的原始碼，修改的成果。而這就是自由軟體的精神——自由、分享、互惠。跟其他條款相比，從GNU通用公眾授權條款（GPL）到限制重重的著作權（Copyright），BSD授權條款比較寬鬆，甚至跟公有領域更為接近。事實上，BSD授權條款被認為是copycenter（中間著作權），介乎標準的copyright與GPL的copyleft之間。"Take it down to the copy center and make as many copies as you want"。可以說，GPL強迫後續版本必須一樣是自由軟體，BSD的後續版本可以選擇要繼續是BSD或其他自由軟體條款或封閉軟體等等。

站在巨人肩膀上前進 進步較單打獨鬥快 合作共利

RISC-V, the Trend of SoC Computing Engine

- 初生之犢不怕虎:包袱小
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- RISC-V CPU IP進步相當的快
 - 標準擴充指令集發展快, CPU IP推出也快
- RISC-V是系統晶片運算引擎的未來趨勢

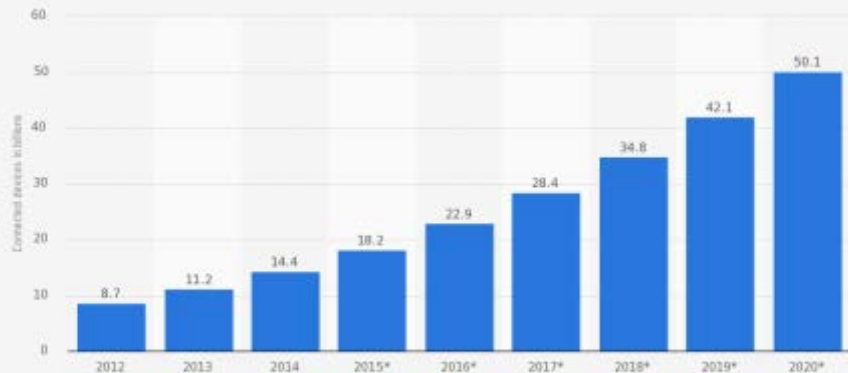
AIoT, the Trend of Emerging Application



人工智慧和物聯網是無庸置疑的市場趨勢



Internet of Things (IoT): number of connected devices worldwide from 2012 to 2020 (in billions)



Source: Intel News Resource © Statista 2019

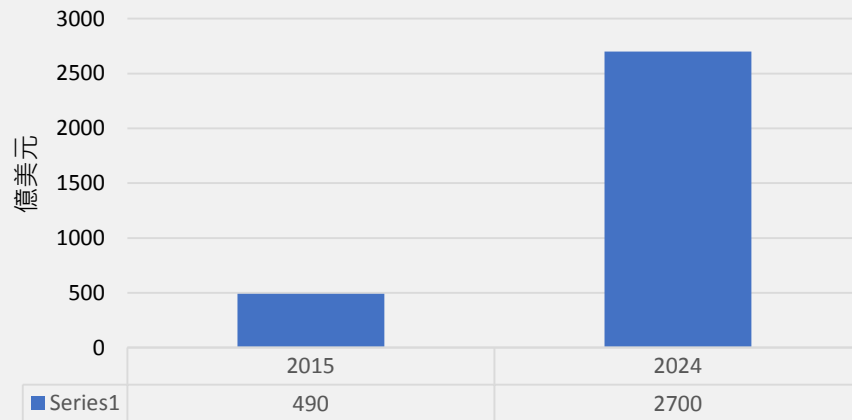
Additional Information: Worldwide: Intel News Resource: 2013 to 2018

statista

Courtesy of: Statista

2020:
50B IoT Connected Devices

全球AI市場規模

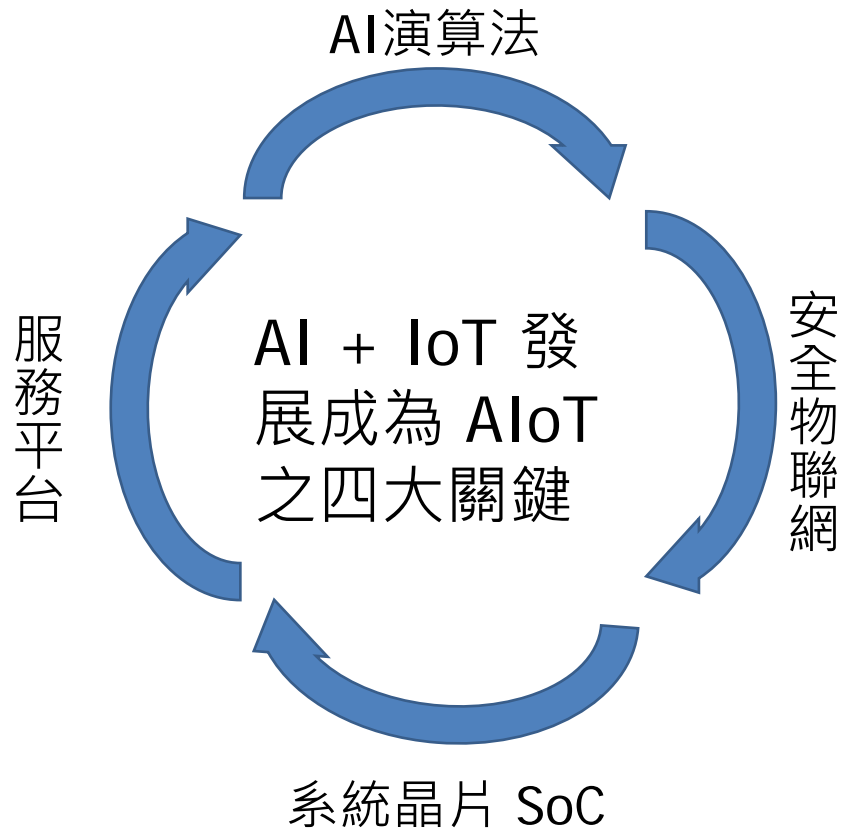


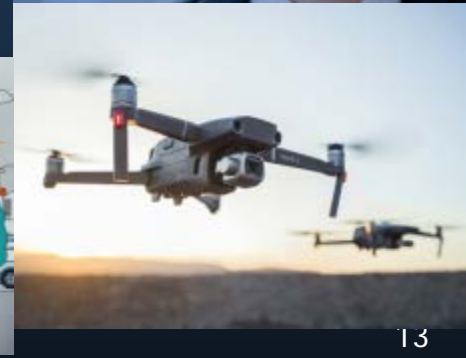
Courtesy of: 中国产业信息网 & Tractica

2024 :
US\$270B World AI Market

AIoT 智能物聯網驅動未來

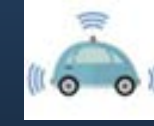
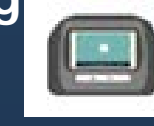
- Artificial Intelligence (AI) combines Internet of Things (IoT) advancing to AIoT is the hottest trend for near future
- AIoT will bring semiconductor, SoC, edge computing, 5G networking 、 intelligent automotive technology & application with innovation
- Let's go with forth generation technology innovation to the age of smart future



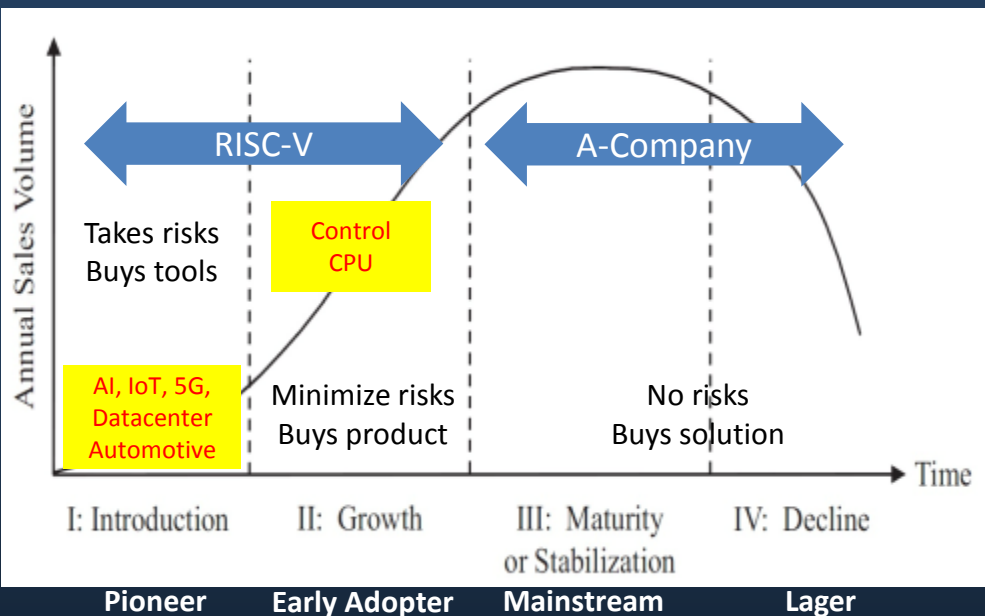


熱門AIoT應用

- Amazon launched intelligent device Echo in 2015, successfully combined AI and IoT, riding voice recognition featured smart speaker Alexa promoted to smart home market successfully
- Next home based AIoT application ranged from floor cleaning robot, service robot to nursing-care robot became hot, creating another smart home AIoT market
- More like drone speed delivery, autonomous taxi, unmanned store, fintech enriched "Unmanned Economics" for new smart business model. Emerging AIoT technology: face recognition pay, wisdom table, smart shelf, robots with emotion, social skill, escorting, logistic skills all become possible
- With AIoT hardware & software solutions available become more popular, AIoT may generate further innovative smart applications



勇於創新、積極求進的 RISC-V 先鋒隊



■ RISC-V in “pioneer” applications

- AI + IoT = AIoT
- 5G
- Datacenter
- Automotive
- AR/VR
- ...

■ Pioneers:

- Are world leading braves seeking breakthroughs
- Cannot use AXX-ISA because of restrictions & costs

Andes in AIoT



Gaming



Smart Speaker



Sharing bike



ADAS



Enterprise SSD

- ❖ Get in leading machine-learning computers for datacenter
- ❖ Get in tier-one switch routers for datacenter

- ❖ Also you may try applications: Set-top Boxes, 802.11ax, machine learning, edge compute, face recognition processors (using Andes Custom Extension, ACE)....

RISC-V, the Computing Trend of AIoT



Andes Technology Corporation

- A 14-year-old public CPU IP company
- >1B Andes-Embedded SoC shipped in 2018.
>3.5B cumulatively.



- A founding member of the RISC-V Foundation
- A major open source maintainer/contributor
- Active involvement in standard extensions
 - Chair of P-extension (Packed DSP/SIMD) Task Group
 - Co-chair of Fast Interrupt Task Group

GNU-Based Toolchains

- binutils, GCC: May, 2017
- glibc: February, 2018
 - only supports rv64-based ISAs
- newlib: August, 2017
- "Probably not a compiler bug"

Logos: SiFive, bluespec, redhat, ANDES TECHNOLOGY

LLVM

RISC-V LLVM Porting Effort

- Alex Bradbury is in charge of RISC-V LLVM
 - Take yesterday afternoon
 - Poster on Tuesday night
- RV32IM(A)FD support upstream
 - Missing hard-float calling convention
 - Missing 64-bit support
 - Missing compressed support
- Clang, Go, and OpenJDK have run code
 - Rust port in progress
 - Poster on Tuesday

Logos: ANDES TECHNOLOGY, lowRISC, Berkeley

Linux

RISC-V Linux Kernel Port

- Linux: January, 2018
 - Only RV64-based systems
 - Drivers are tracking in now

Logos: Berkeley, SiFive, ANDES TECHNOLOGY



Andes帶給RISC-V Core強處



■ Bring Andes strength to RISC-V Core family

- Architecture beyond the kernel for diversified requirements
- Efficient processor pipeline for leading PPA
- Platform IP support to help speed up SoC construction
- AndeSight IDE, and compiler/library optimizations
- RTOS and Linux support, and middleware (such as IoT stacks)
- Commercial-grade verification for all products
- Mass production experience with high quality deliverables
- Professional supporting infrastructure

AndeStar™ V5 Processor Lineup

Cache-Coherent
Multicores

A25MP^a

1/2/4 A25, L2\$,
L1/IO coherence

AX25MP^a

1/2/4 AX25, L2\$,
L1/IO Coherence

LM/Caches, Branch Pred, Vec. Intpt

Linux
with FPU/DSP

A25

N25F, MMU, DSP

AX25

NX25F, MMU, DSP

5-stage
> 1 GHz^b

Fast/Compact
with FPU/DSP

N25F/D25F

V5/32b, FPU, PMP,
DSP (D25F)

NX25F

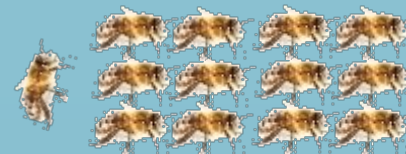
V5/64b, FPU, PMP

2-stage
700MHz^b

Slim and
Efficient

N22

V5[e]/32b
32/16 GPR

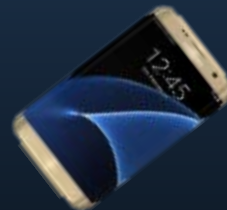


a. A(X)25MP: available Q2/2019; b. 28nm RVT, SS, 0.81V, 0C, with I/O constraints.

結論



- RISC-V特點使其成為SoC運算引擎趨勢
- AIoT 方興未艾,眾所看好
- 以RISC-V為AIoT SoC 運算引擎是目前的大熱門
- 晶心科技是 RISC-V CPU IP 領導供應商





Thank you !!

