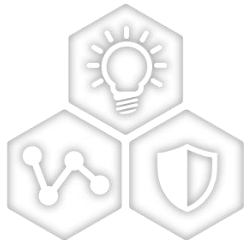


Microchip 科技創新暨技術趨勢論壇 Microcontroller BU



A Leading Provider of Smart, Connected and Secure Embedded Control Solutions



SMART | CONNECTED | SECURE

Microchip Proprietary and Confidential

Sep'26

AI 時代下的32位元微處理器 平台策略: 光模組應用案例

光模組、AEC是什麼？

- 光模組 (**Optical Transceiver**，又稱 **Optical Module**): 是負責將電信號與光信號互相轉換的元件，讓資料能透過光纖進行高速、長距離的傳輸。
- **AEC 主動式電纜 (Active Electrical Cable)**: 則是一種在連接器兩端內建晶片(如 **Retimer**) 的高速銅線。

光模組外形規格



外形規格	全名	速度	主要應用
SFP28	Small Form-factor Pluggable 28	10–25G	Enterprise/Servers
QSFP28	Quad SFP 28	40–100G	Cloud DC
QSFP-DD	Quad SFP Double Density	400–800G	Mainstream AI
OSFP	Octal SFP	400–800G	AI Clusters
OSFP-XD	OSFP Extra Dense	1.6T+	Future AI

AEC 外形規格

ACTIVE ELECTRICAL CABLE (AEC) FORM FACTORS

QSFP28



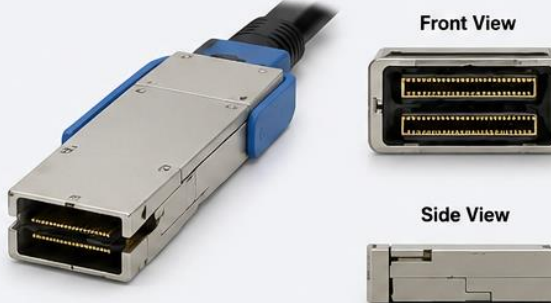
- Data Rate: 100Gb/s
- Lanes: 4 x 25Gb/s
- Max Length: 1–5 m
- Size (LxWxH): 72 x 18.4 x 8.5 mm

QSFP56



- Data Rate: 200Gb/s
- Lanes: 4 x 50Gb/s
- Max Length: 1–5 m
- Size (LxWxH): 72 x 18.4 x 8.5 mm

QSFP-DD



- Data Rate: 200G / 400Gb/s
- Lanes: 8 x 25Gb/s or 8 x 50Gb/s
- Max Length: 1–5 m
- Size (LxWxH): 89 x 18.4 x 11.5 mm

OSFP



- Data Rate: 400G / 800Gb/s
- Lanes: 8 x 50Gb/s or 8 x 100Gb/s
- Max Length: 1–5 m
- Size (LxWxH): 107 x 22.6 x 13.0 mm

OSFP-XD



- Data Rate: 1.6Tb/s
- Lanes: 16 x 100Gb/s or 8 x 200Gb/s
- Max Length: 1–2 m (expected)
- Size (LxWxH): 107 x 22.6 x 15.0 mm

QSFP112



- Data Rate: 400Gb/s
- Lanes: 4 x 100Gb/s
- Max Length: 1–5 m
- Size (LxWxH): 89 x 18.4 x 11.5 mm

QSFP-DD1600



- Data Rate: 1.6Tb/s
- Lanes: 8 x 200Gb/s
- Max Length: 1–2 m (expected)
- Size (LxWxH): 89 x 18.4 x 11.5 mm

Form Factor	Definition
QSFP28	Quad SFP · 4×25G · 100 GbE
QSFP56	Quad SFP · 4×56G · 200 GbE
QSFP-DD	Quad SFP, Double Density · 8×50G · 400 GbE
OSFP	Octal SFP · 8 lanes · 400/800 GbE
OSFP-XD	Octal SFP, eXtra Dense · 16 lanes · 1.6 TbE
QSFP112	Quad SFP · 4×112G · 400 GbE
QSFP-DD1600	Quad SFP, Double Density · 8×200G · 1.6 TbE

SFP = Small Form-factor Pluggable Quad=4 lanes
Octal=8 lanes DD=Double Density XD=eXtra Dense

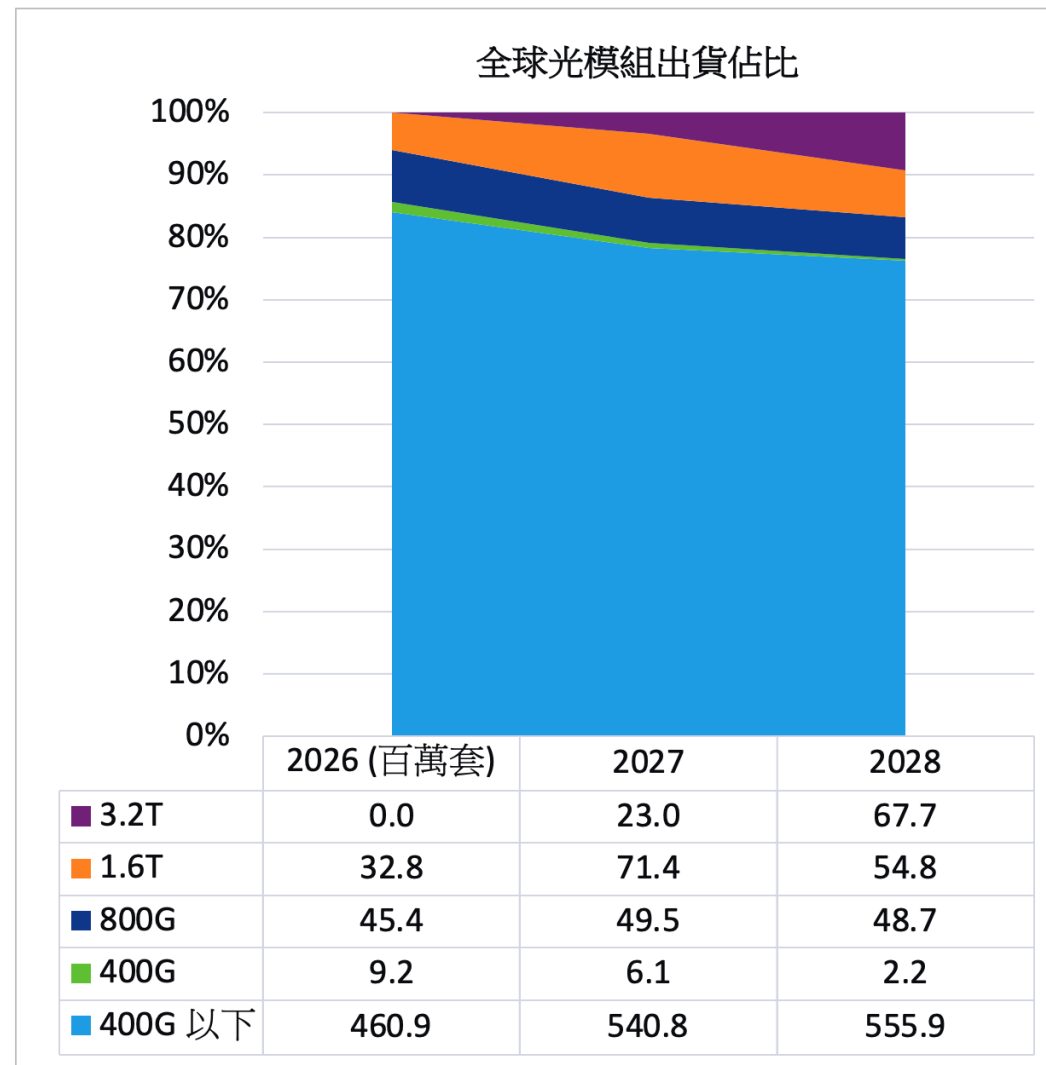
市場展望

資料中心互連生態系統

層級	在生態系中的作用	重點企業
Hyperscalers 超大規模雲端服務商	定義系統需求 (AI clusters, scale, performance)	Amazon, Microsoft, Google, Alibaba, Oracle
NVIDIA	定義 AI 平台與互連架構 (NVLink, topology)	NVIDIA
ODMs / 系統整合商	建構機架、交換器及系統平台	Accton, Celestica, Quanta, WiWynn
光模組 OEMs	設計並製造光模組	InnoLight, Coherent, Lumentum, Applied Optoelectronics, Eoptolink
AEC Cable 供應商	設計/建造 AEC 互連組件	Amphenol, TE Connectivity, Molex, Astera Labs, BizLink
DSP / ASIC IC 供應商	定義光學架構、電軌及性能	Broadcom, Marvell, MaxLinear, Credo
Retimer IC 供應商	實現 AEC 訊號完整性	Astera Labs, Credo, Broadcom, Marvell

光模組市場展望

- 高盛最新預測: 全球光模組市場規模將在**2028**年達到**1485**億美元。2028年同期全球光模組出貨量預計達到**7.29**億隻。
- 普通資料中心和電信營運商仍主要使用**400G**及以下產品。電信長途傳輸，**400G** 模組是目前的技術與性價比極限。
- 光模組市場主要的增長在於 **AI 伺服器**向**800G**、**1.6T**及**3.2T** 高速規格遷移。
- **800G**目前已經成為大型資料中心的主流規格，**2026**年至**2028**年出貨趨勢持平。預估部分市場開始轉向更高速的**1.6T**和**3.2T**。
- **1.6T**預計從**2026**年進入快速放量階段。**3.2T**則預計從**2027**年開始大規模出貨。



Source: 高盛集團

光模組 SWOT 分析

S 優勢

- 高速傳輸技術能力
- 垂直整合與封裝優勢
- 深度綁定雲端大廠

O 機會

- AI 資料中心需求爆發
- 矽光子與 **CPO** 技術商轉
- 新興應用擴展

W 劣勢

- 客戶集中度高
- 資本與研發支出龐大
- 良率與量產挑戰

T 威脅

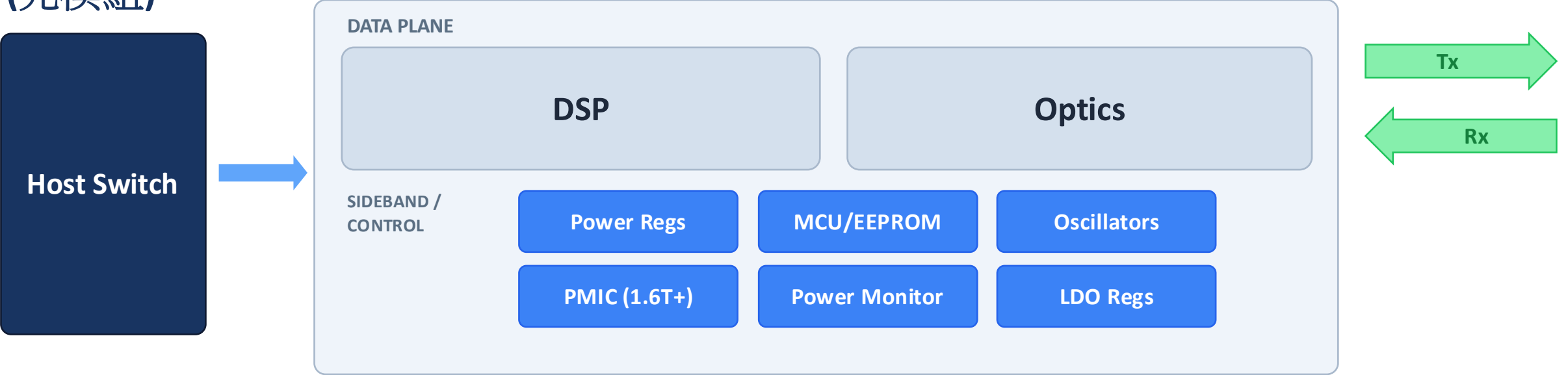
- 地緣政治與供應鏈風險
- 技術替代風險
- 同業競爭加劇

Source: 產業分析報告

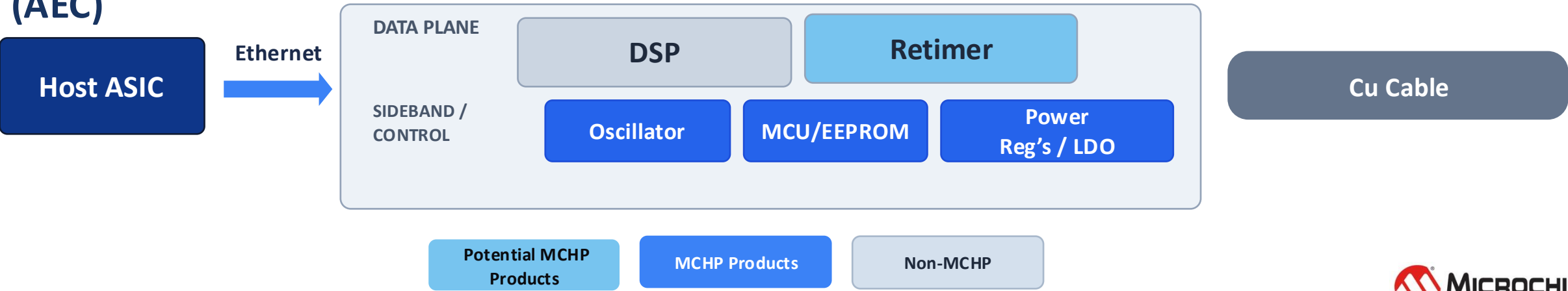
光模組解決方案

架構比較: 光模組與 AEC

(光模組)



(AEC)



Microchip 光模組解決方案



MCU

PIC32CL PC20 / PIC32CX SG

Secure module controller for CMIS, diagnostics, telemetry, firmware and system management.



Buck / Point-of-Load

MIC22xxx / MIC22950

High-density conversion for DSP, ASIC, FPGA and local high-current rails with fast transient response.



LDO / Clean Rails

MCP17xx / MCP1726

Low-noise regulation for sensitive optical, analog, timing and always-on rails.



PMIC / Power Tree

MCP16502 / MCP16701/MCP16xxx

Multi-rail integration high current, sequencing and control to simplify future power architectures.



Power Monitor

PAC1934 / PAC1954

Digital voltage/current/energy telemetry for power visibility, optimization and anomaly detection.



Timing + Memory + Connectivity

VC-844, SST/24C, XpressConnect

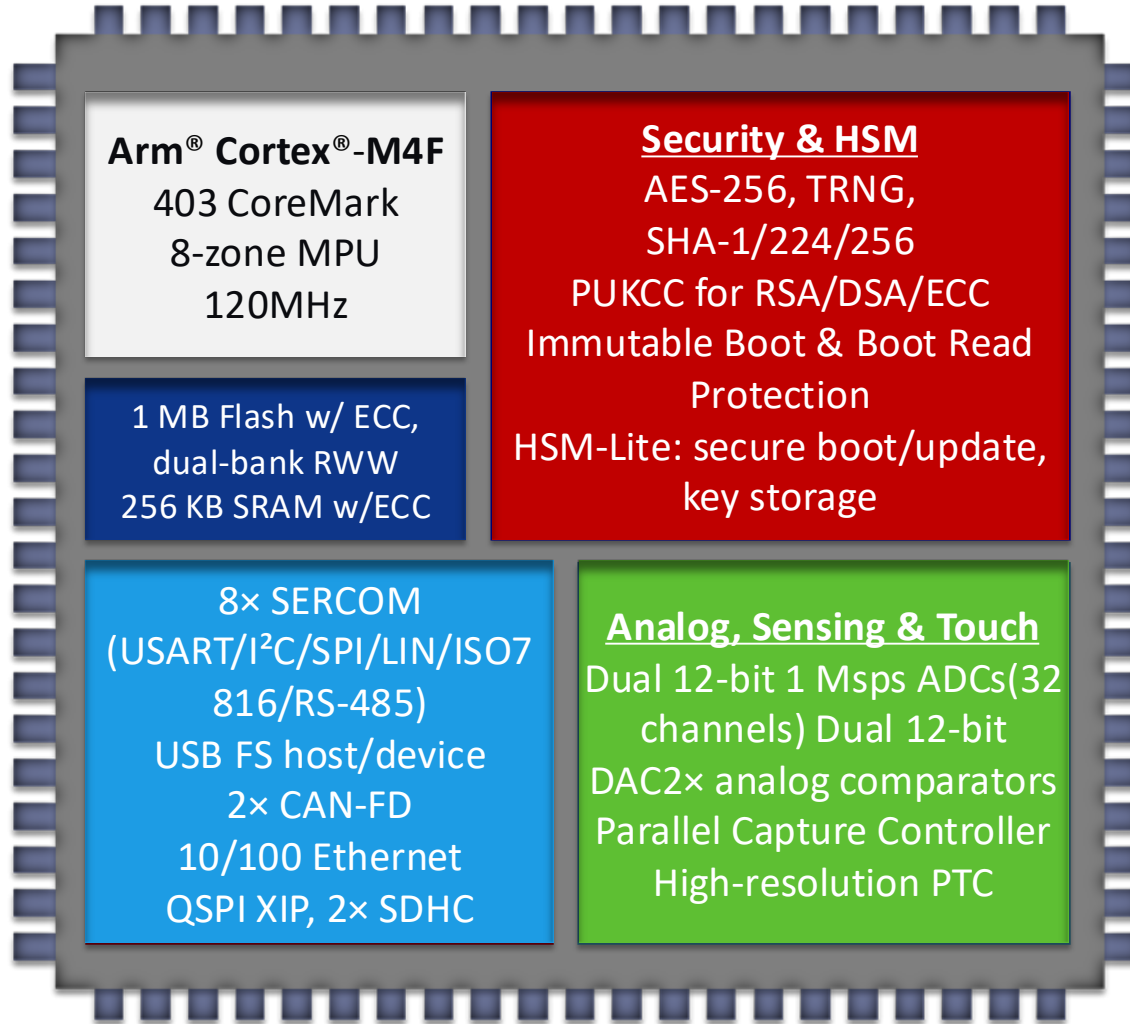
Timing margin, code/config storage and high-speed interconnect attach points across optical and AEC designs.

微處理器晶片架構

特點	x86 (CISC)	ARM (RISC)	RISC-V (RISC)
指令	複雜	簡單	簡單
能效	低	高	高
市場影響力	個人電腦, 伺服器	行動裝置	新興市場
授權與否	需授權	需授權	開源
效能擴充	高但耗電量大	跨裝置高效運行	可自訂的但碎片化的
關鍵參與者	Intel, AMD	ARM	SiFive, Andes, Alibaba

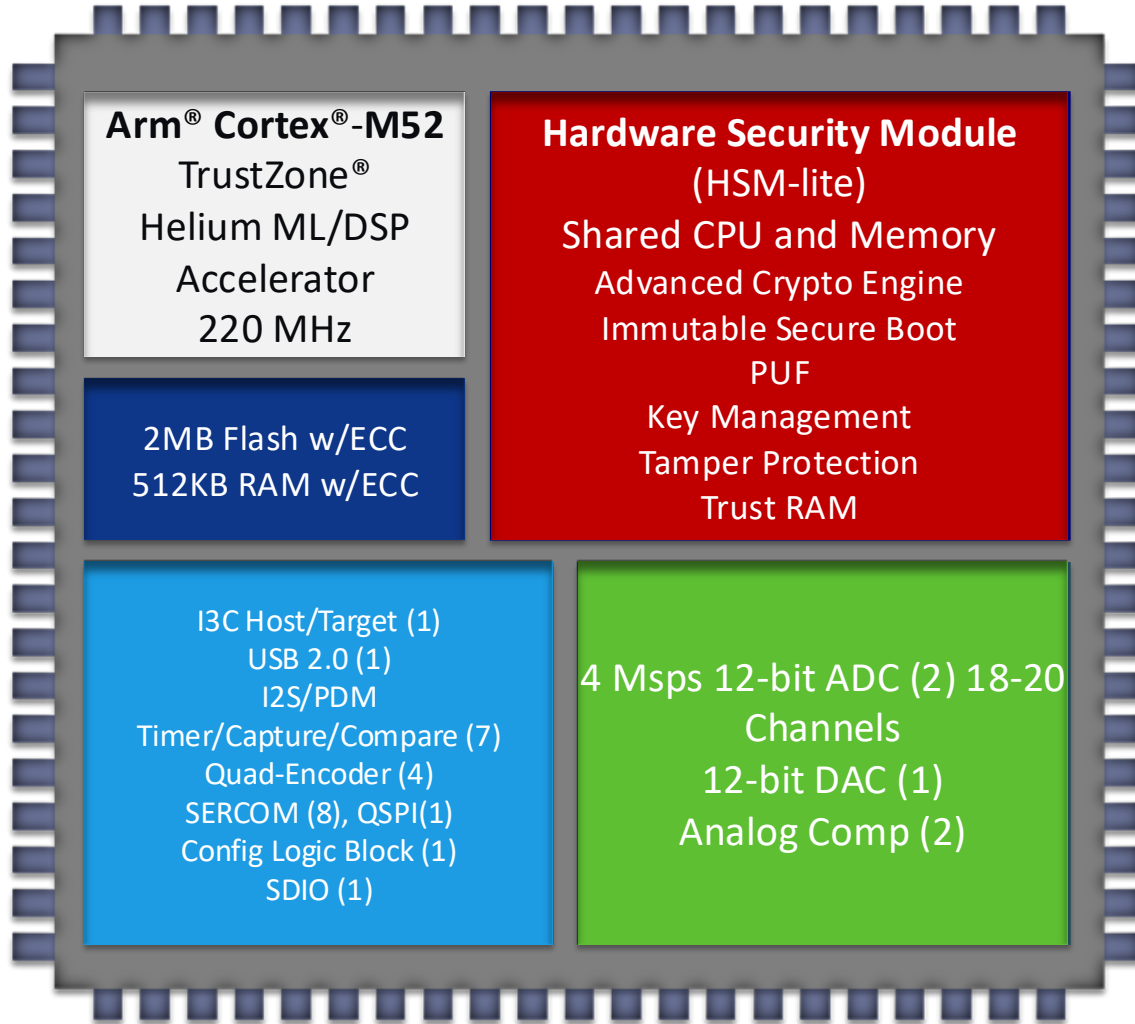
Source: Dual Insights

PIC32CX SG: Cortex®-M4F 内核



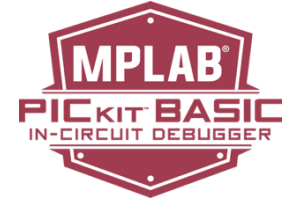
- 雙區加密快閃記憶體 **Dual Bank Flash**：支援不停機、**OTA無縫韌體遠端升級**。
- 安全啟動 **Secure Boot**：防止惡意代碼在系統啟動前植入。
- 加密儲存 **Key Storage**：保護核心韌體 IP、金鑰不被側信道攻擊或外部讀取竊取。
- 身份認證：依據 **CMIS 5.3** 協議新增光模組 **Command Data Block** 命令資料區塊。

PIC32CL PC20: Cortex®-M52 内核



- 整合了邊緣智慧與硬體安全功能的光模組單晶片MCU。
- M52 内核 AI/ML Helium 支援更聰明的診斷和預測模組監控。
- 支援 I3C Host/Target 模式。支援 I2C 和 SMBus 3.0。

開發工具生態系統支持



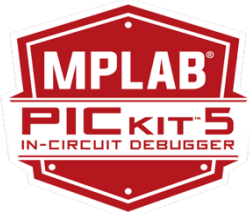
Visual Studio Code



seeed studio



DEVELOPMENT TOOLS



SIEMENS



MPLAB® for VS Code®

專為現代嵌入式開發而構建

- **Why VS Code?**

- **The majority of developers worldwide are using VS Code**
- Lightweight install, faster startup, with automatic updates
 - Auto-updates can be disabled
- Full Language Server Protocol (LSP) support for enhanced error checking, auto-complete, and code navigation
- Provides a seamless, flexible, and efficient development environment

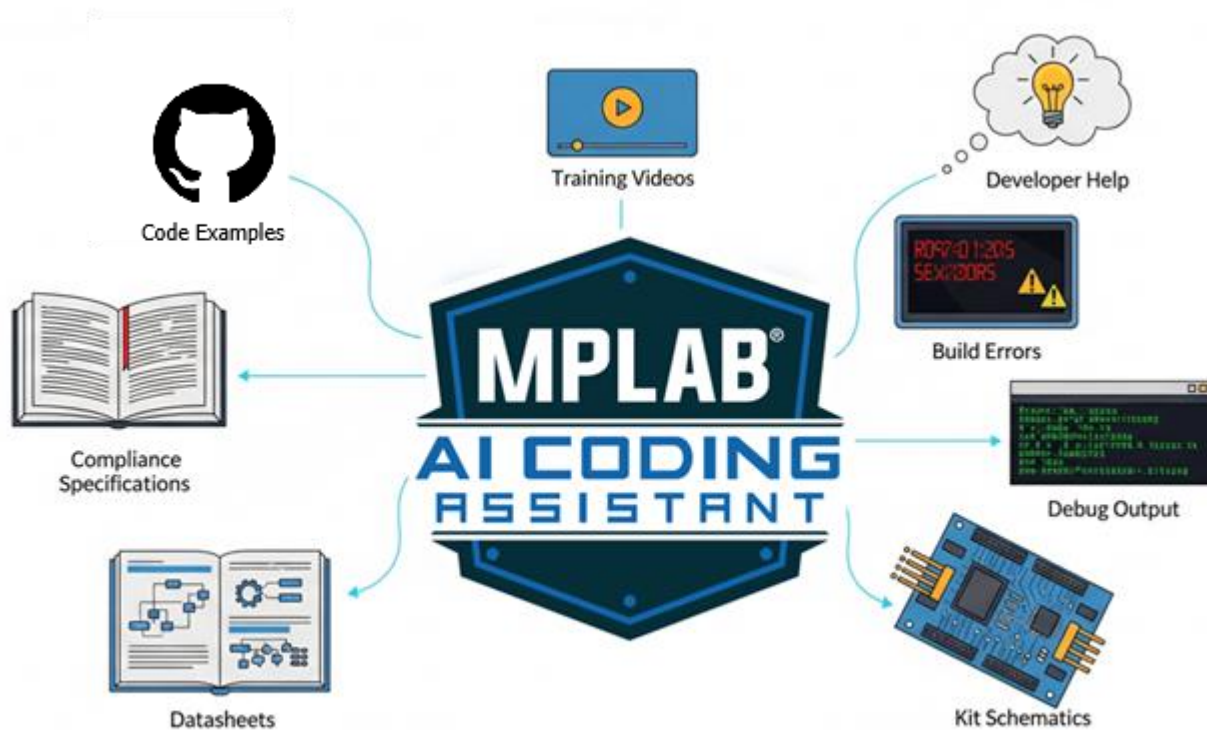
- **Key MPLAB components**

- Extension support for MPLAB Code Configurator, MPLAB Data Visualizer, and MPLAB AI Coding Assistant



MPLAB® AI Coding Assistant

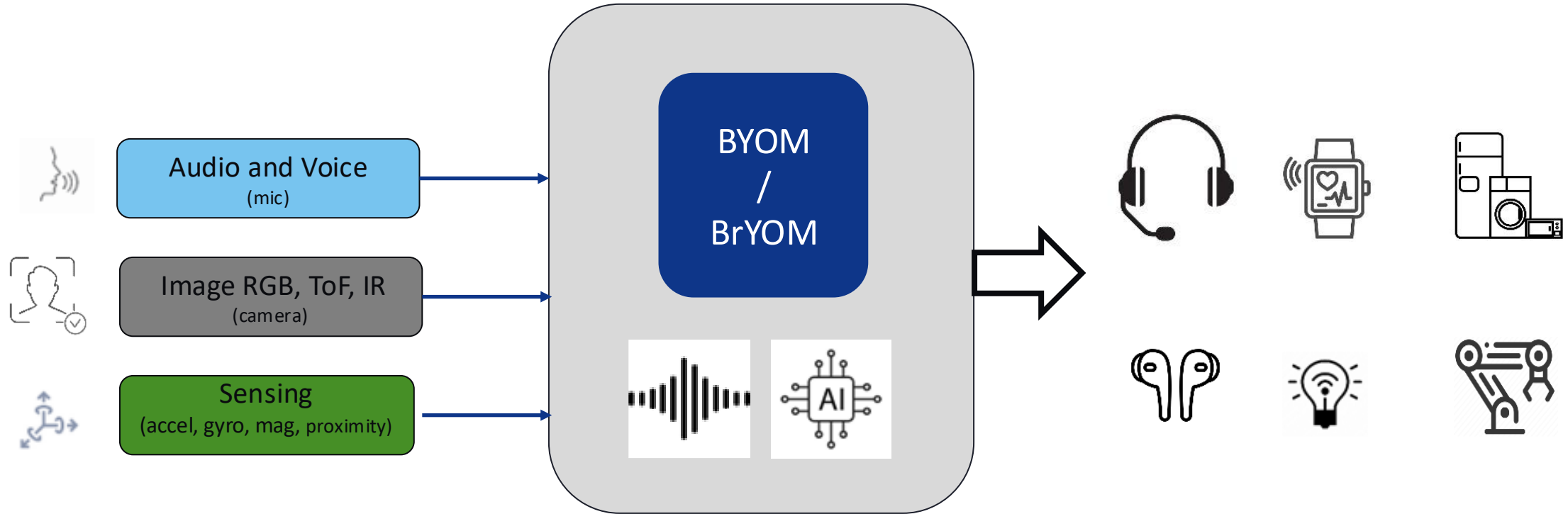
確保資料隱私 無網路存取或外部共用



- **Expert Partner, fully integrated in the IDE**
 - In-session assistance avoids user context switching
 - Precise responses with minimal hallucinations
- **Chat with the datasheet**
 - “What features are available for power-sensitive applications?”
- **Feature / Peripheral explanation**
 - “Can you explain SleepWalking in simpler terms?”
- **Chat with the IDE**
 - “@Terminal – please explain the error”
- **AI Assistant support for the AI Assistant**
 - “How do I create effective prompts for the MPLAB AI Coding Assistant?”
 - “Any tips for new users”

MPLAB[®] ML Development Suite

單一平台 提供多種應用場景



- **BYOM (Build Your Own Model):** Use [MPLAB ML Dev Suite](#) to design and train models.
- **BrYOM (Bring Your Own Model):** Import open-source models (ONNX, PyTorch, TensorRT Lite) or pick from the custom model zoo for various applications. Use our [plugin](#) to deploy.
- Tool to guide **preprocessing**, **hardware optimization** and **deployment**.

謝謝
