Innovation Unleashed: Solutions Enabling Embedded Intelligence

SiFive China
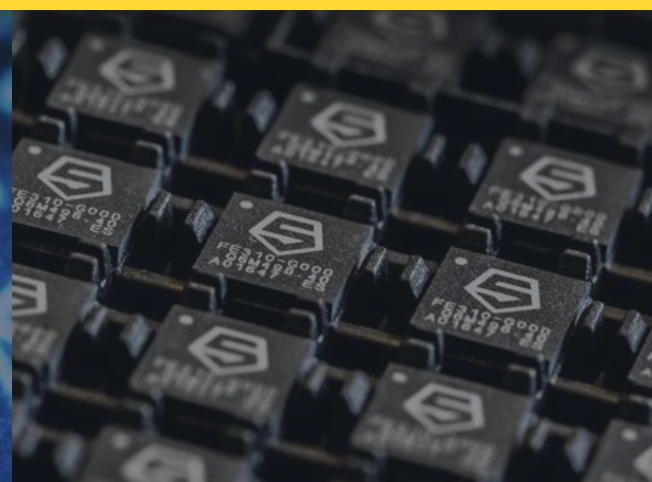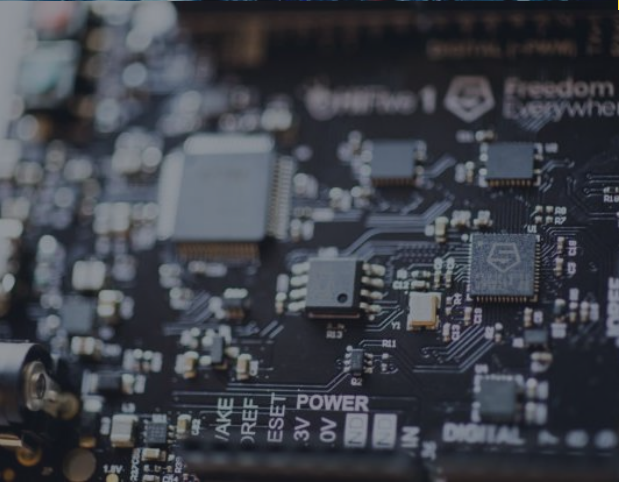
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Agenda

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Global Trends

Internet users by 2022

60%
of the population will be using the Internet *up from 45% in 2017*

Internet traffic by 2022

85 GB
of Internet traffic per month, per user *up from 29 GB in 2017*

Devices/connections by 2022

3.6
networked devices and connections per person *up from 2.4 in 2017*
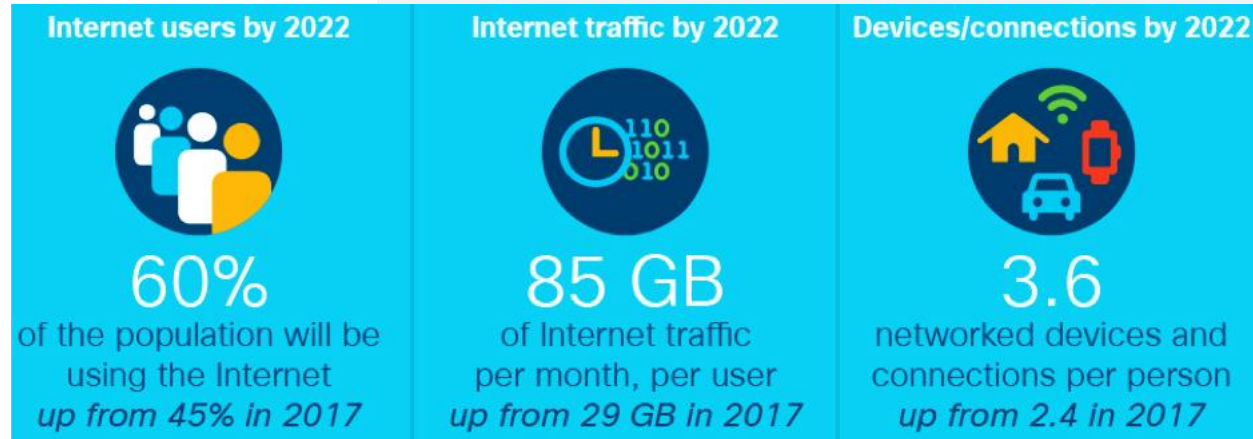
26% CAGR
2017 - 2022

Exabytes
Per Month

Year	Exabytes Per Month
2017	122
2018	156
2019	201
2020	254
2021	319
2022	396
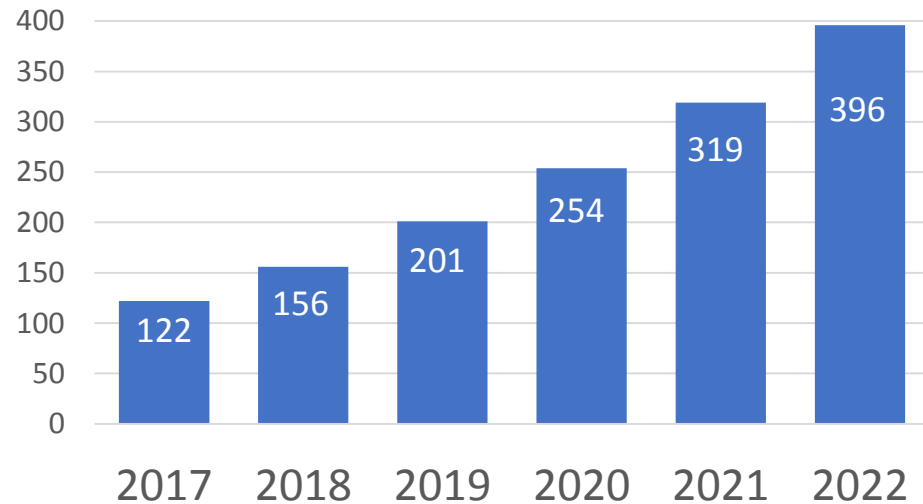
Source: Cisco VNI Global IP Traffic Forecast, 2017 - 2022

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SiFive Core IP
Embedding Intelligence Everywhere

Consumer

AR/VR/Gaming devices

Smart Home

Imaging/Wearables

Storage/Networking/5G

SSD, SAN, NAS

Base Stations, Small cells, APs

Switches, Smart NICs, Offload cards

ML/Edge

Sensor Hubs, Gateways

Autonomous machines

IoT devices
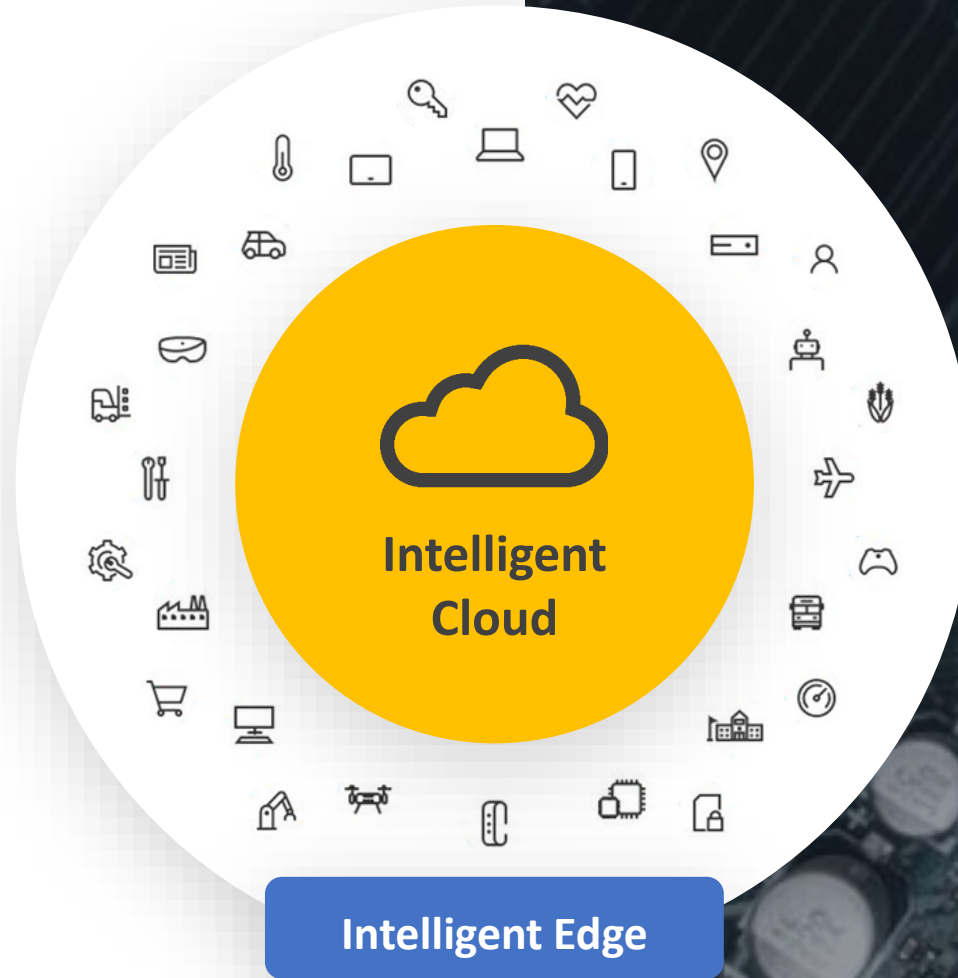
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U Cores
64-bit Application Processors

S Cores
64-bit Embedded Processors

E Cores
32-bit Embedded Processors

Intelligent Cloud

Intelligent Edge

Embedding Intelligence from the Edge to the Cloud

SiFive Core IP 2 series:

SiFive's **smallest** and most **efficient** RISC-V processor IP

E2 Series

32-bit Embedded Processors

S2 Series

Tiny, Full Featured, 64-bit MCU

Efficient RISC-V MCU
Configurable Core and Memory System
Ultra low-latency interrupts

Higher Performance

Configurable

Low latency interrupts

SiFive Core IP 7 series:

The **highest performance** commercial **RISC-V** processor IP

E7 Series

32-bit Embedded Processors

S7 Series

64-bit Embedded Processors

U7 Series

64-bit Application Processors

Common Feature sets
Hard Real-time capabilities
Unprecedented **scalability**

~60% increase in CoreMarks/MHz*

~40% increase in DMIPS/MHz*

10% increase in Fmax*

*Compared to SiFive 5 series

Core IP 7 Series
Standard Cores

01   **E76, E76-MC**

02   **S76, S76-MC**

03   **U74, U74-MC**

Standard Cores represent **pre-configured implementations of a Core Series** which are available for free RTL and FPGA evaluations

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SiFive 7 Series
Embedded Intelligence Everywhere

Scalable throughput provided by **8+1** cores per cluster

Extensible design via custom instructions

Configurable memory architecture for application specific tuning

Enhanced determinism for hard real-time constraints

Functional safety provided by in-built fault tolerance mechanisms

A **single** pre-integrated and verified deliverable

U7 Series

CLIC

PLIC

Debug

8 ...
3
2
1

U7X
Core

SV39 MMU

I$ w/ECC   PMP   D$ w/ECC

0

S7X
Core

PMP

I$ w/ECC   DTIM w/ECC

Bus Matrix

L2 Cache with ECC   System Port   Peripheral Port   Front Port
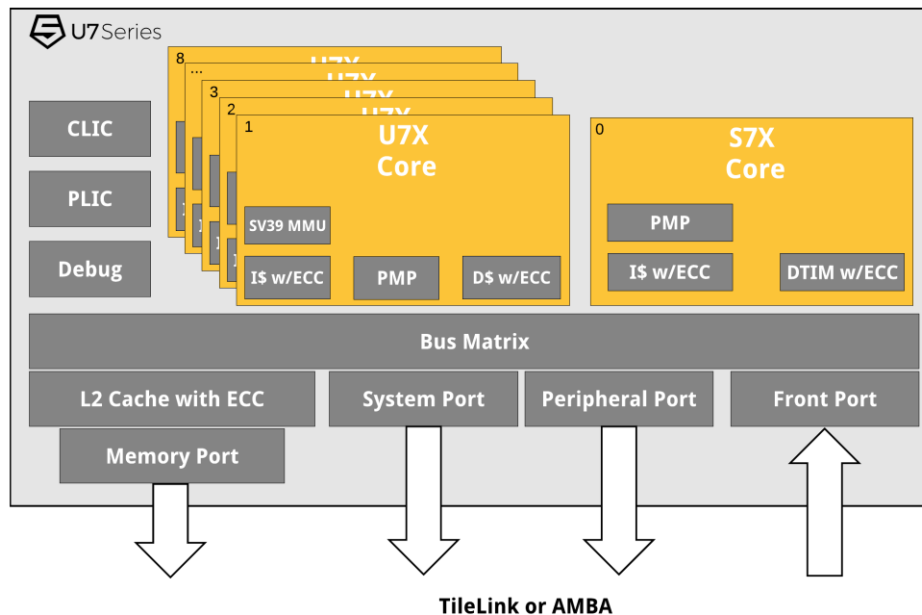
Memory Port

TileLink or AMBA

Tightly integrated memory for low latency access

64-bit addressability for real time latency sensitive applications

Mixed-precision arithmetic for efficient compute of ML workloads

Cache lock capability for mission-critical computing

In-cluster coherent combination of real-time and application processors

Product Map

	E Cores 32-bit embedded cores MCU, edge computing, AI, IoT	**S Cores** 64-bit embedded cores Storage, AR/VR, machine learning	**U Cores** 64-bit application cores Linux, datacenter, network baseband
7 Series Highest performance: 8-stage, dual-issue superscalar pipeline	**E7 Series**	**S7 Series**	**U7 Series**
	› **E76-MC** Compare to Cortex-M7 Quad-core 32-bit embedded processor	› **S76-MC** No 64-bit Cortex equivalent Quad-core 64-bit embedded processor	› **U74-MC** Compare to Cortex-A55 MP4 Multicore: four U74 cores and one S76 core
	› **E76** Compare to Cortex-M7 High performance 32-bit embedded core	› **S76** No 64-bit Cortex equivalent High-performance 64-bit embedded core	› **U74** Compare to Cortex-A55 High performance LInux-capable processor
3/5 Series Efficient performance: 5–6-stage, single-issue pipeline	**E3 Series**	**S5 Series**	**U5 Series**
	› **E34** Compare to Cortex-R5F E31 features + single-precision floating point	› **S54** No 64-bit Cortex equivalent S51 features + single-precision floating point	› **U54-MC** Compare to Cortex-A53 Multicore application processor with four U54 cores and one S76 core
	› **E31** Compare to Cortex-R5 Balanced performance and efficiency	› **S51** No 64-bit Cortex equivalent Low-power 64-bit MCU core	› **U54** Compare to Cortex-A53 Linux-capable application processor
2 Series Power & area optimized: 2–3-stage, single-issue pipeline	**E2 Series**	**S2 Series**	
	› **E24** Compare to Cortex-M4F E21 + single-precision floating point	› **S21** No 64-bit Cortex equivalent Area-efficient 64-bit MCU core	
	› **E21** Compare to Cortex-M4 E20 + User Mode, Atomics, Multiply, TIM		
	› **E20** Compare to Cortex-M0+ Our smallest, most efficient core		

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Storage

Coherent in-cluster combination of application processors and real-time processors

Deterministic mode for FAST DATA applications with hard real-time constraints
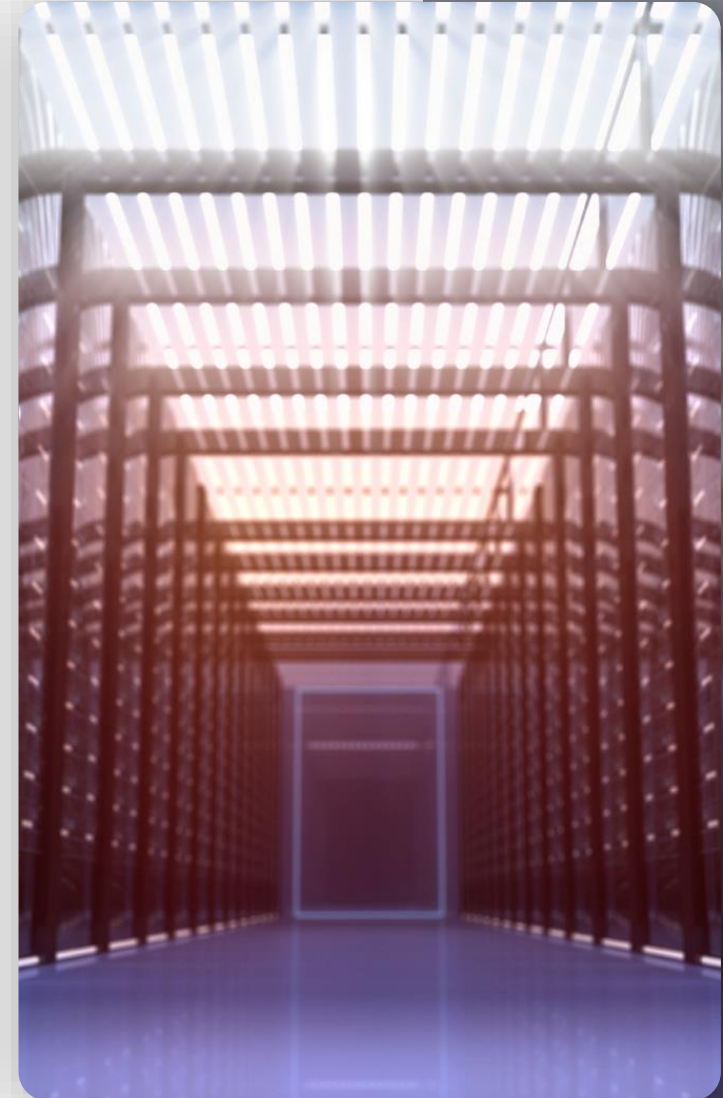
Configurable memory maps and coherent accelerator ports for tightly coupling storage specific accelerators

Tightly integrated memories and Cache lock capability for critical real time workloads

Optional FPU for applications which don't need floating point capability

Storage, ML, Cryptography specific custom instructions

64-bit real-time addressability for BIG DATA applications

5G/Networking

Complex arithmetic capability for accelerating baseband functions

In-cluster coherence of application and real-time processor enables 5G latency (<1ms) requirements

High bandwidth accelerator ports for enabling intelligent offload processing

Hard real-time capabilities for scheduling baseband protocol layers

Configurable memory maps for optimizing QoS

High throughput processing for next gen 5G stacks

Tightly Integrated Memories and Cache lock capability for critical real time workloads

AR/VR/Sensor Fusion

Low Latency peripheral access and coherent accelerator port

Combine with SiFive 2, 3 or 5 series for designs with tight power constraints

Coherent in-cluster combination of application processors with real time processors

Workload specific customizations (AR/VR/MR/CV)

**Simple caching hierarchy** for ease of application optimization

Mixed precision arithmetic for accelerating machine learning compute

Enterprise SSD

- FADU Annapurna SSD Controller
  - **World's first** RISC-V SSD controller

- FADU Bravo Series Enterprise SSD

- **3.5GB** throughput and **800K IOPS** at less than 1.8W

- Powered by **SiFive E51**

"SiFive's RISC-V Core IP was **1/3 the power** and **1/3 the area** of competing solutions, and gave FADU the flexibility we needed in optimizing our architecture to achieve these groundbreaking products." J. Lee, FADU CEO
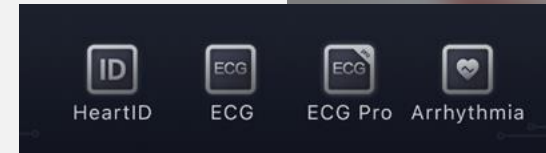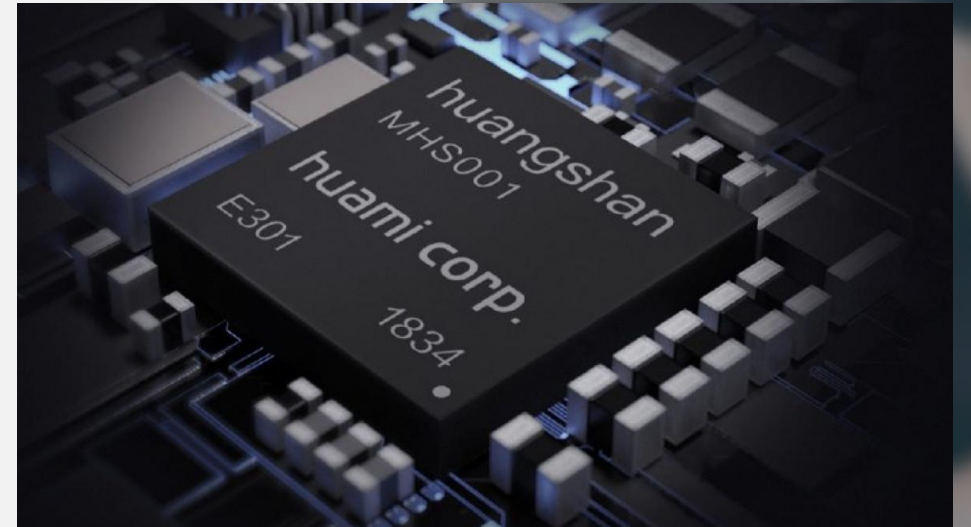
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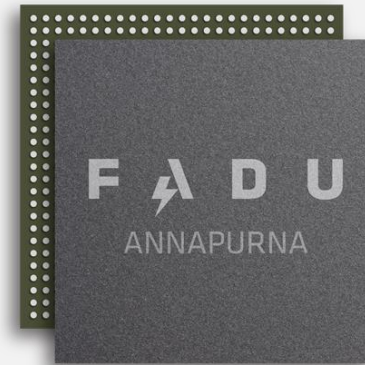
Intelligent Edge

- Microsemi's **PolarFire SoC**

- **World's first RISC-V SoC FPGA architecture** bringing Real-time to Linux

- Targeted for **real-time Linux** applications at the Edge

- **Defense-grade** security features
  - Secure boot
  - DPA safe crypto core
  - SECDED on all memories
  - Physical memory protection/PMP

- Powered by **SiFive U54-MC and SiFive E51**
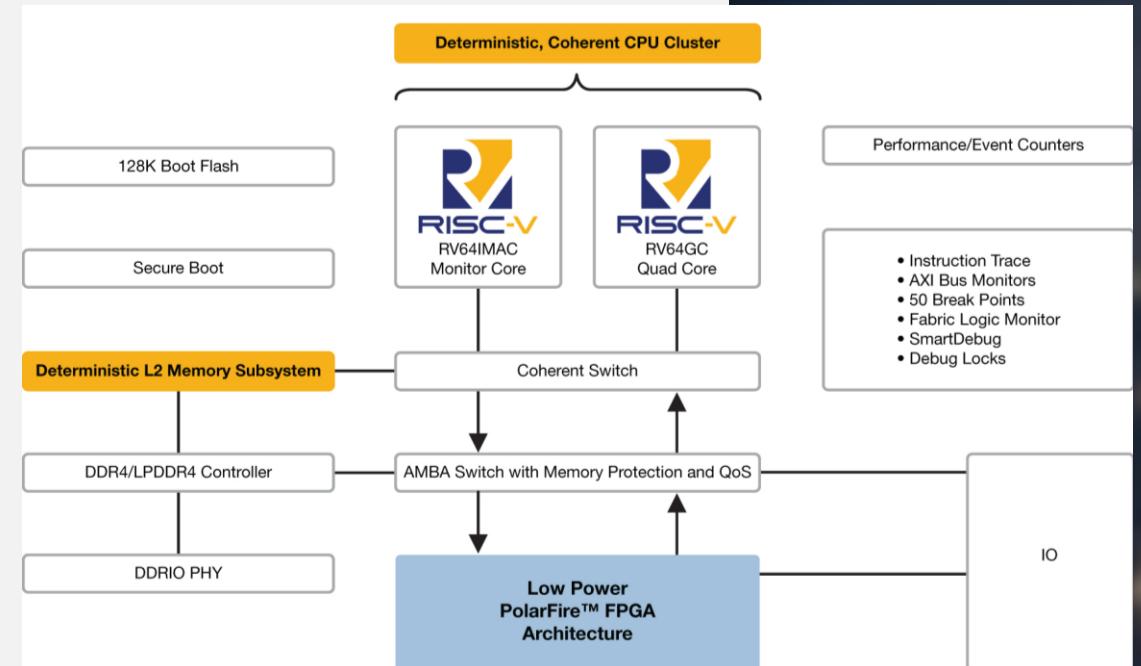
Wearable AI

- **Huangshan No. 1** (MHS001) from Huami using Upbeat Tech

- **Integrated biometric signal processor** with 4 dedicated AI engines and built-in CNN based inference engine

- **38 percent more efficient** than the Arm Cortex-M4

- Powered by **SiFive E31**

"The world's first artificial intelligence powered wearable chipset"

SiFive Core IP: Embedded Intelligence Everywhere

Efficient Performance

Scalability

Compelling Feature Set

→ **Embedding intelligence** for a world of a **Trillion Connected Devices**
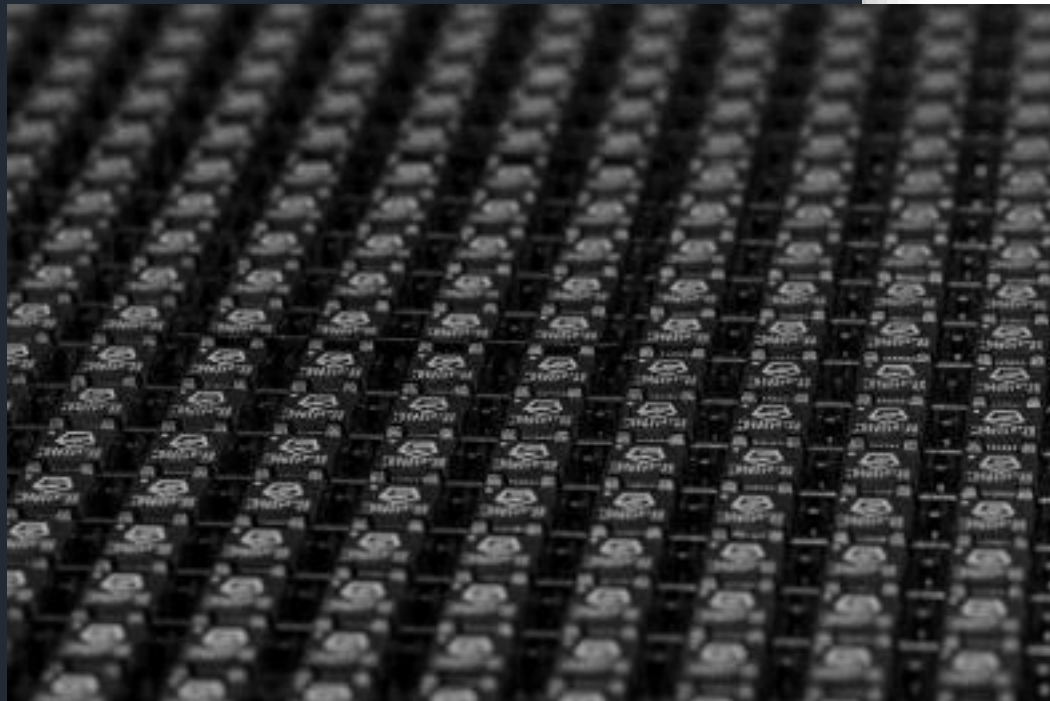
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SiFive China Wechat

- Best in class in RISC-V based solution with local customer support

- Leader in RISC-V ecosystem development to support China semiconductor industry, growing with open-source community

- Pioneer in cloud-based SaaS service for custom ASICs.