



Leadership in the **new computing era**

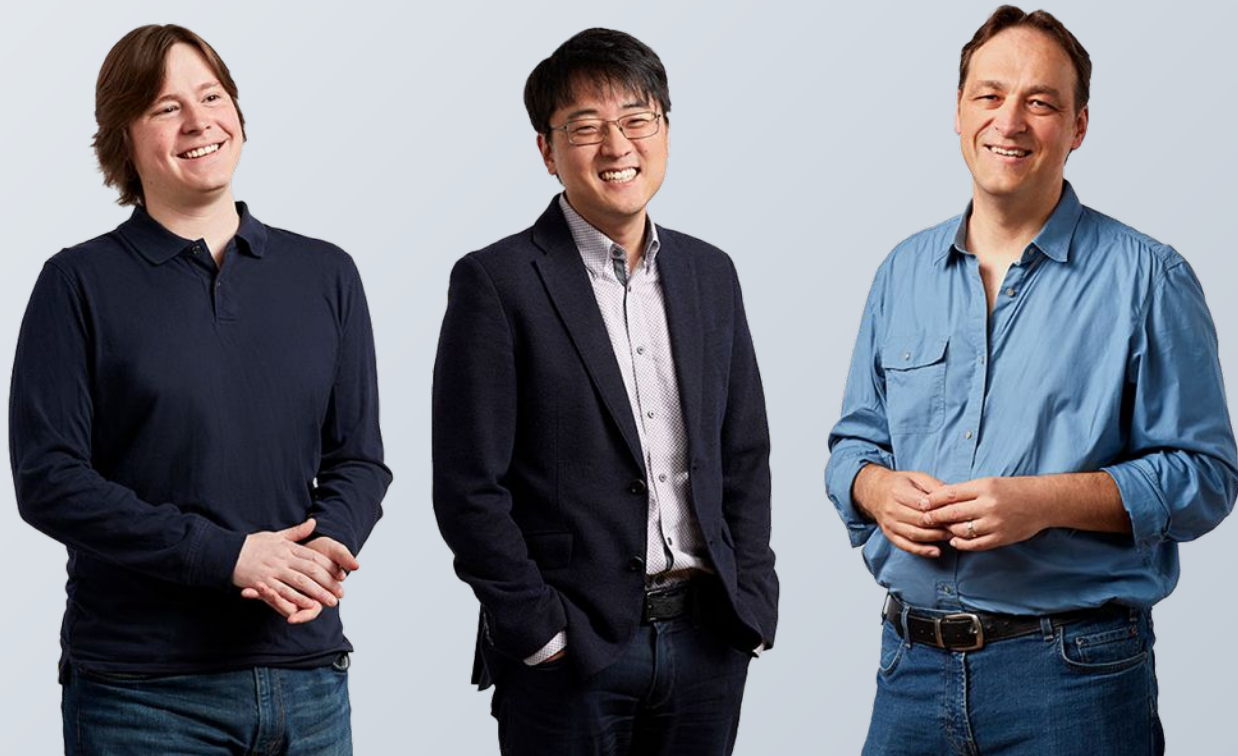
Future of Computing: RISC-V
TUM Labs, 23.4.2024, Munich

SiFive
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Senior Director, Business Development
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Founded by the inventors of RISC-V



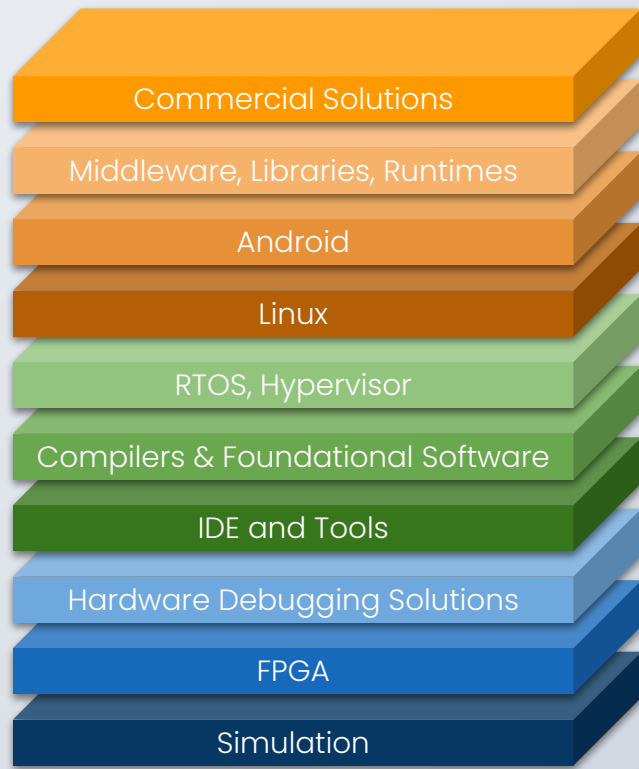
- SiFive founded 2015
- SiFive is the RISC-V founder & brand standard
- Largest team & investment
- World's largest technology companies work with SiFive to adopt RISC-V

2 Billion

Chips based on **SiFive** RISC-V cores



RISC-V Software Ecosystem



The success of RISC-V is built on open standards

Open architecture driving exponential growth

Android on RISC-V is a first-class citizen

SiFive is the biggest contributor of RISC-V software tools and OS

RISE consortium accelerates software optimizations on RISC-V



Google

SAMSUNG

intel.

Qualcomm

NVIDIA

MEDIATEK

Red Hat

SiFive

Imagination

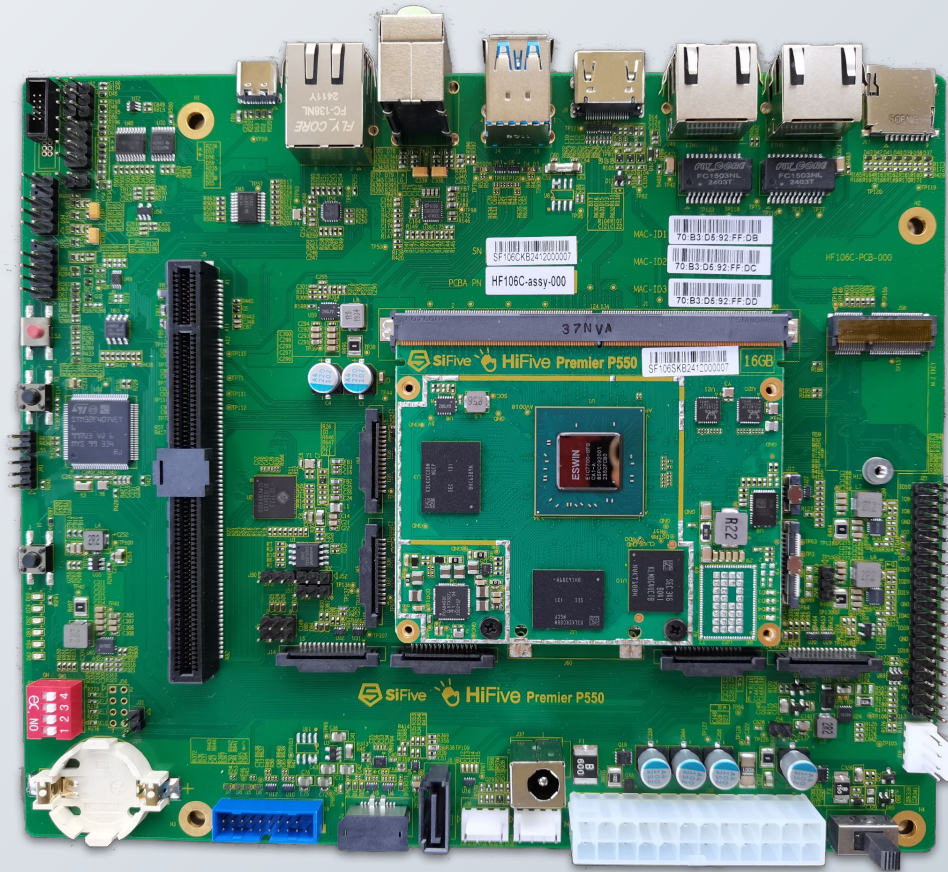
VENTANA

Rivos

ANDES TECHNOLOGY

T-HEAD

SiFive HiFive Premier P550 sets a new standard

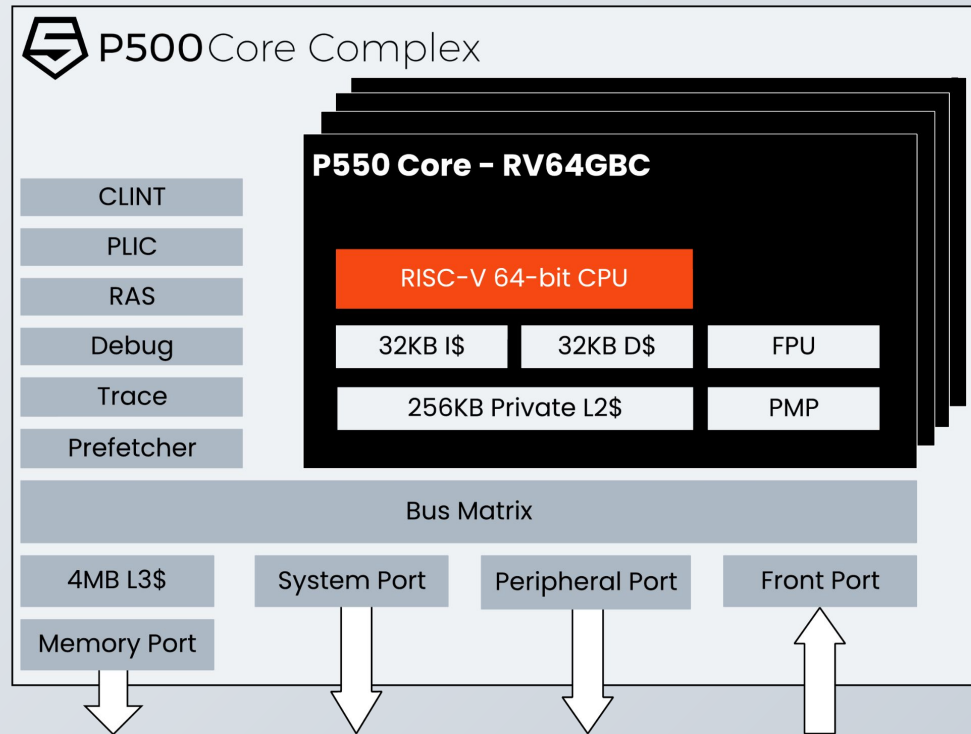


- Quad-core out-of-order SiFive P550 @1.4GHz
- 4MB L3 cache, 16GB LPDDR5 (optional 32GB version)
- NPU and 2D/3D GPU
- On-board 128GB eMMC
- PCI Express Gen3 x4 via a PCIe x16 slot
- SATA3 connector (6 Gb/s)
- Dual 10/100/1000 Ethernet + remote board management ethernet port
- 5x USB 3.2 Gen1
- New System-On-Module approach (SOM)
- Mini-DTX form factor (8" x 6.7" / 203mm x 170mm)
- Ubuntu to be fully supported
- Shipping expected in July 2024 from Arrow Electronics
 - HF106-000 (16GB LPDDR5): ~ \$650
 - HF106-100 (32GB LPDDR5): ~ \$800



SiFive P550 Application Processor

High-Performance Out-of-Order RISC-V Application Processor



P550 Core Architectural Features

- RV64GBC capable core with Sv39/Sv48 Virtual Memory Support
- Triple-issue, 13-stage out-of-order processor tuned for scalable performance
- Private L2 Caches for improved memory performance
- SECCDED ECC with Error Reporting
- Performance 8.7 SpecINT2k6/GHz

The Undisputed Leader in RISC-V Computing



Broadest portfolio of processors from embedded to high-performance computing

CPU Cores



SiFive Essential™

32 and 64-bit Processors

- ◆ Microcontrollers, IoT devices, real-time control, control plane processing
- ◆ Highly customizable to application specific requirements
- ◆ Mature, industry proven designs



SiFive Performance™

64-bit Application Processors

Consumer

- ◆ High performance RISC-V processor with best compute density and power efficiency
- ◆ Android ready

Infrastructure

- ◆ Highest performance, most advanced RISC-V processor
- ◆ Scale out, high performance, processing capabilities with vector compute, NoC and D2D

AI Cores



SiFive Intelligence™

Scalable 64-bit AI Processors

- ◆ Edge AI, Cloud, Training, Inference
- ◆ Very high performance and efficiency for AI workloads with vector processing
- ◆ Built on top of RISC-V Vectors, SiFive Intelligence Extensions and AI hardware accelerators

Functional Safety



SiFive Automotive™

32/64-bit Safety Processors

- ◆ Broadest range of RISC-V safety processors, from MCU to high performance SoC, with ASIL B and ASIL D options
- ◆ Multi-core/cluster, vectors, virtualization, and security features
- ◆ Strong automotive RISC-V ecosystem

SiFive broad IP portfolio

Scalable from MCU to high-performance compute



Intelligence

X200-Series

512-bit VLEN
Single Vector ALU
VCIX

X300-Series

Up to 1024-bit VLEN
Single / Dual Vector ALU
VCIX

Performance

P200-Series

2-wide in-order core
256b vector length
WorldGuard
RVA20

P400-Series

3-wide OoO core
128b vector length
Hypervisor extension
Vector crypto
IOMMU & AIA
WorldGuard
RVA22

P500-Series

3-wide OoO core
Hypervisor extension
WorldGuard
RVA20

P600-Series

4-wide OoO core
128b vector length
Hypervisor extension
Vector crypto
IOMMU & AIA
WorldGuard
RVA22

P800-Series

6-wide OoO core
128b vector length
Hypervisor extension
Vector crypto
IOMMU & AIA
WorldGuard
Shared cluster cache
RVA23

Essential

U6-Series

64-bit, high performance

U7-Series

64-bit, superscalar performance

S2-Series

64-bit, Area optimized

S6-Series

64-bit, power efficiency

S7-Series

64-bit, high performance, embedded

E2-Series

Smallest, most efficient

E6-Series

Balanced performance and efficiency

E7-Series

32-bit, optimized performance

Automotive

E6-A

32-bit, balanced performance and efficiency ASIL B, D

S7-A

64-bit, high performance embedded ASIL D

X280-A

512-bit VLEN
Single Vector ALU
VCIX

P870-A

6-wide OoO core
128b vector length
Hypervisor extension
Vector crypto
IOMMU & AIA
WorldGuard
Shared cluster cache
RVA23
ASIL B, D

RISC-V is based on standards

Standards Accelerate Software Adoption and Portability

Standards reduce cost

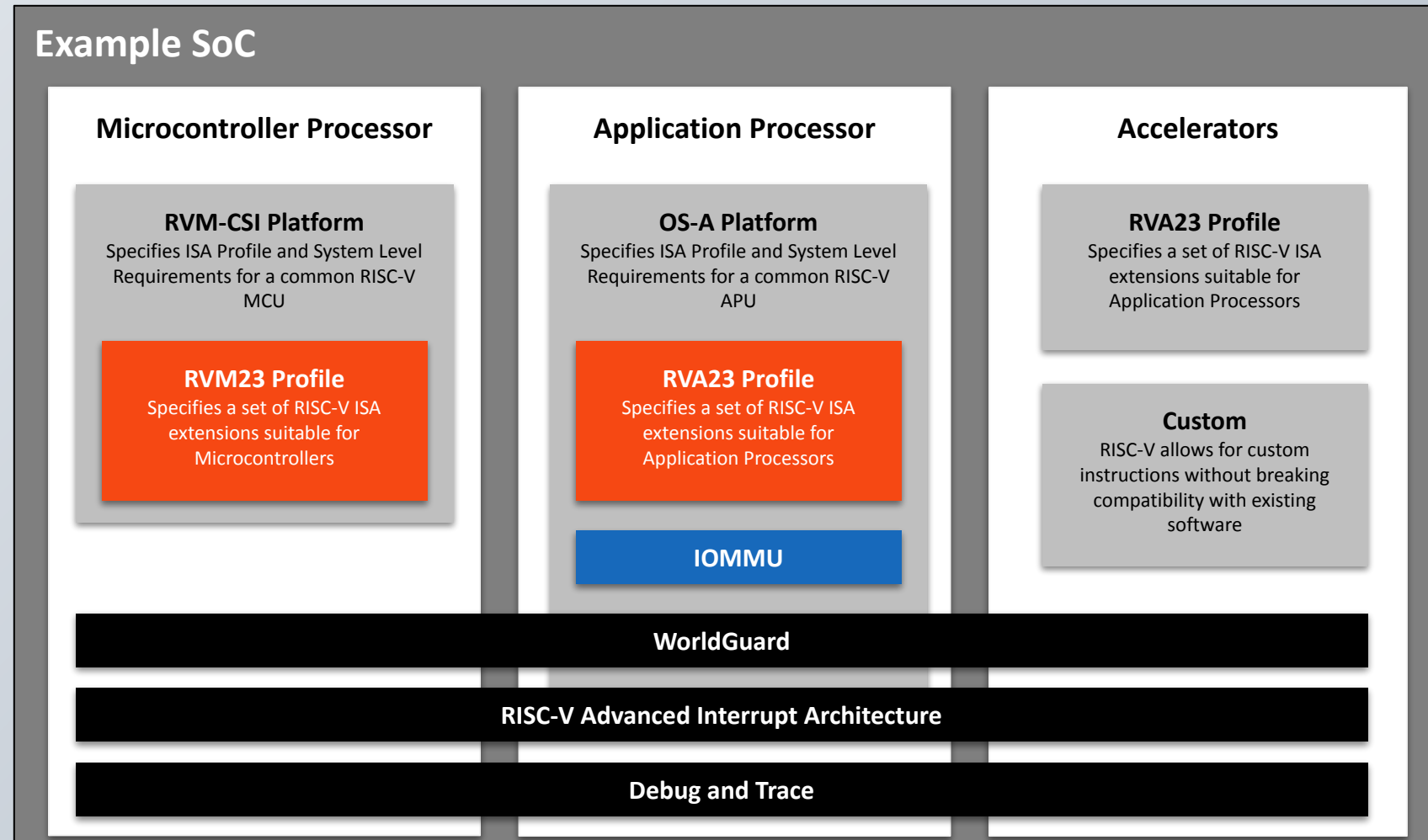
- Faster Adoption
- Compatibility across vendors

Layered standards enable customization

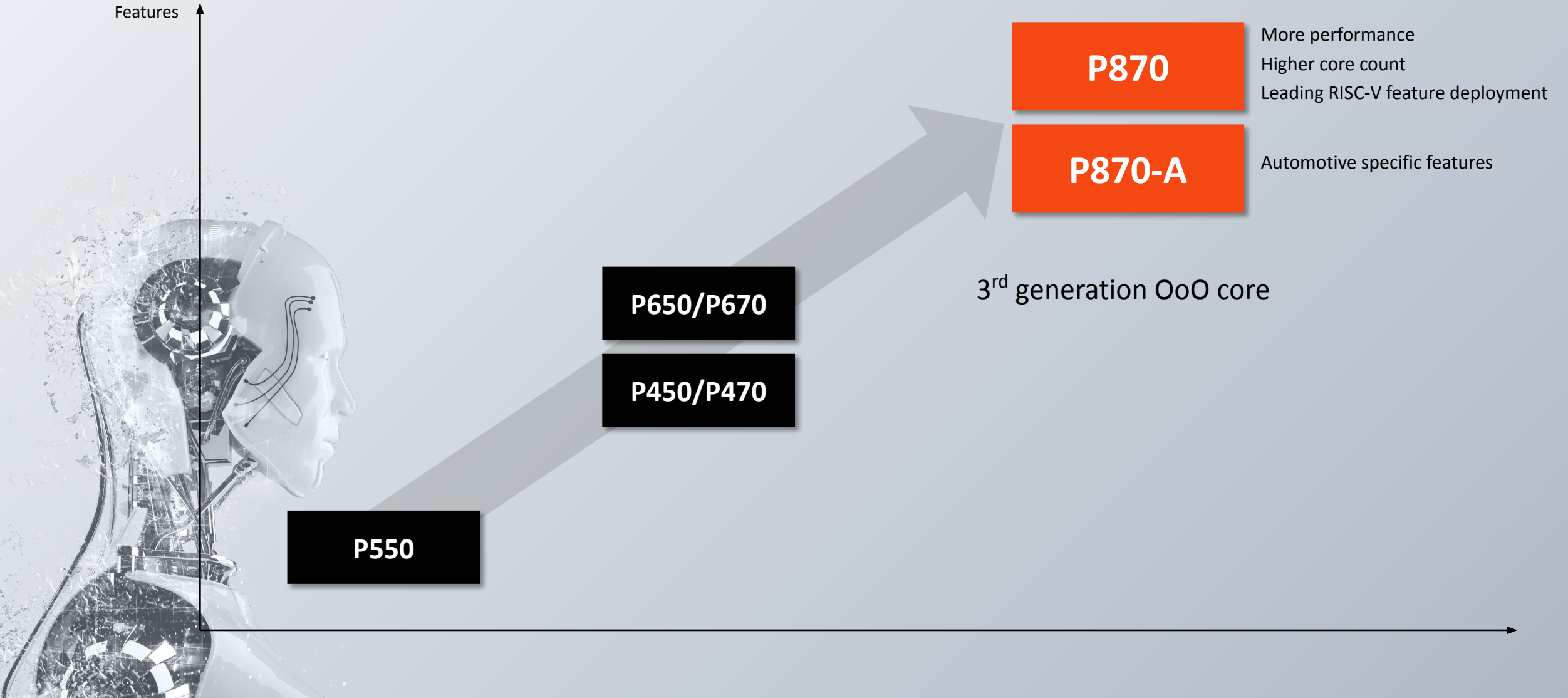
- RISC-V embraces customization without breaking compatibility

More than just ISA Standards

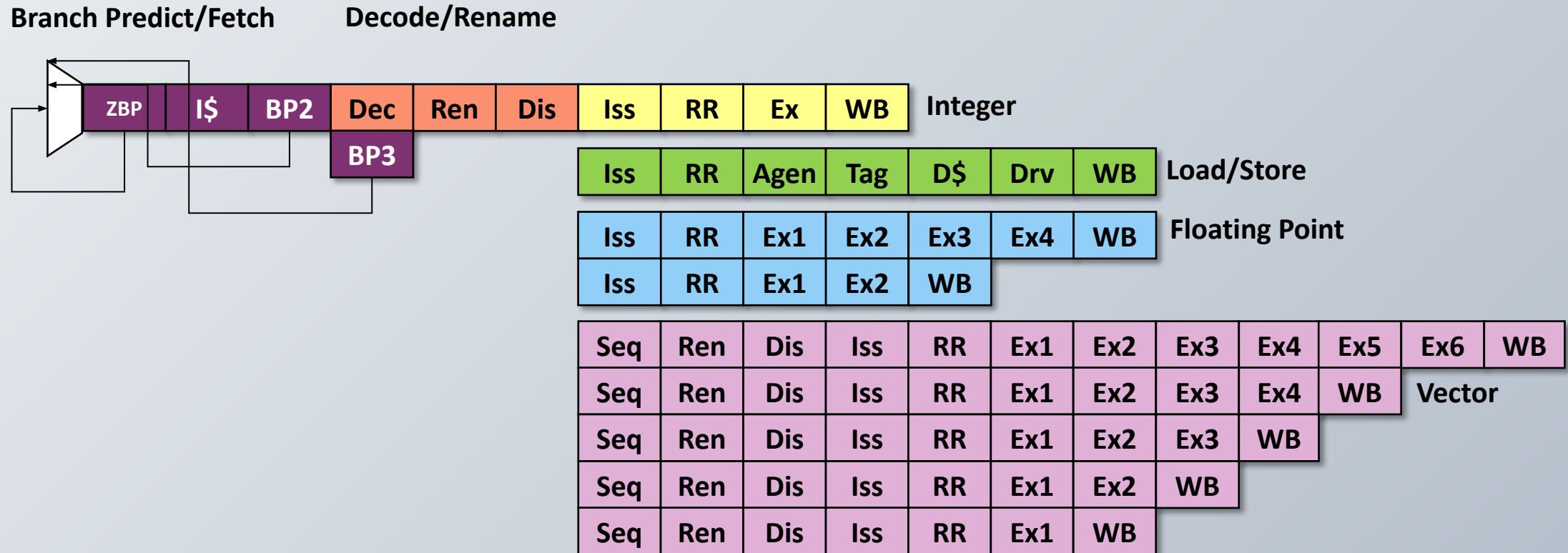
- RISC-V Standards extend beyond the Core ISA to system-level components



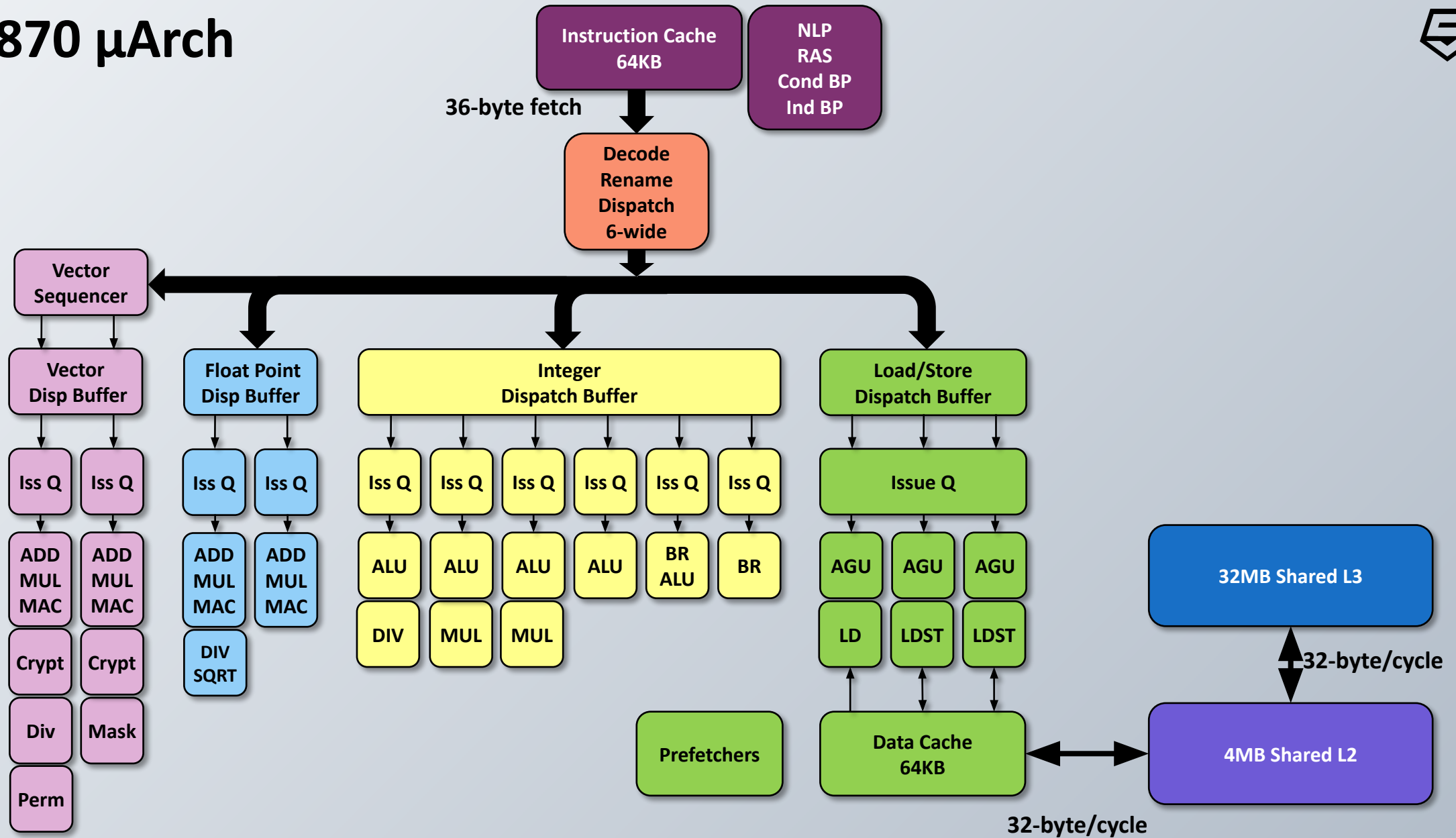
SiFive Performance family relentless innovation



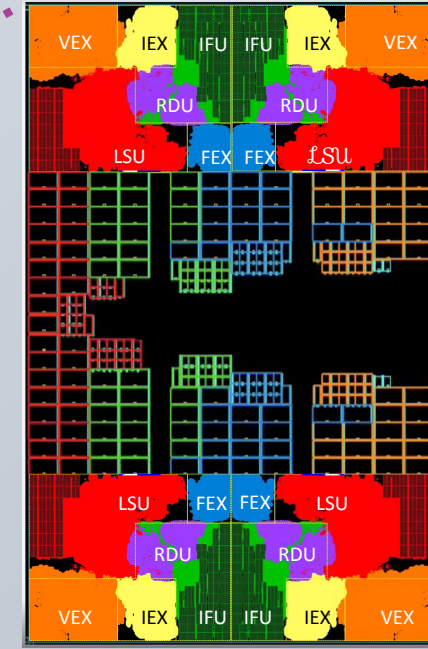
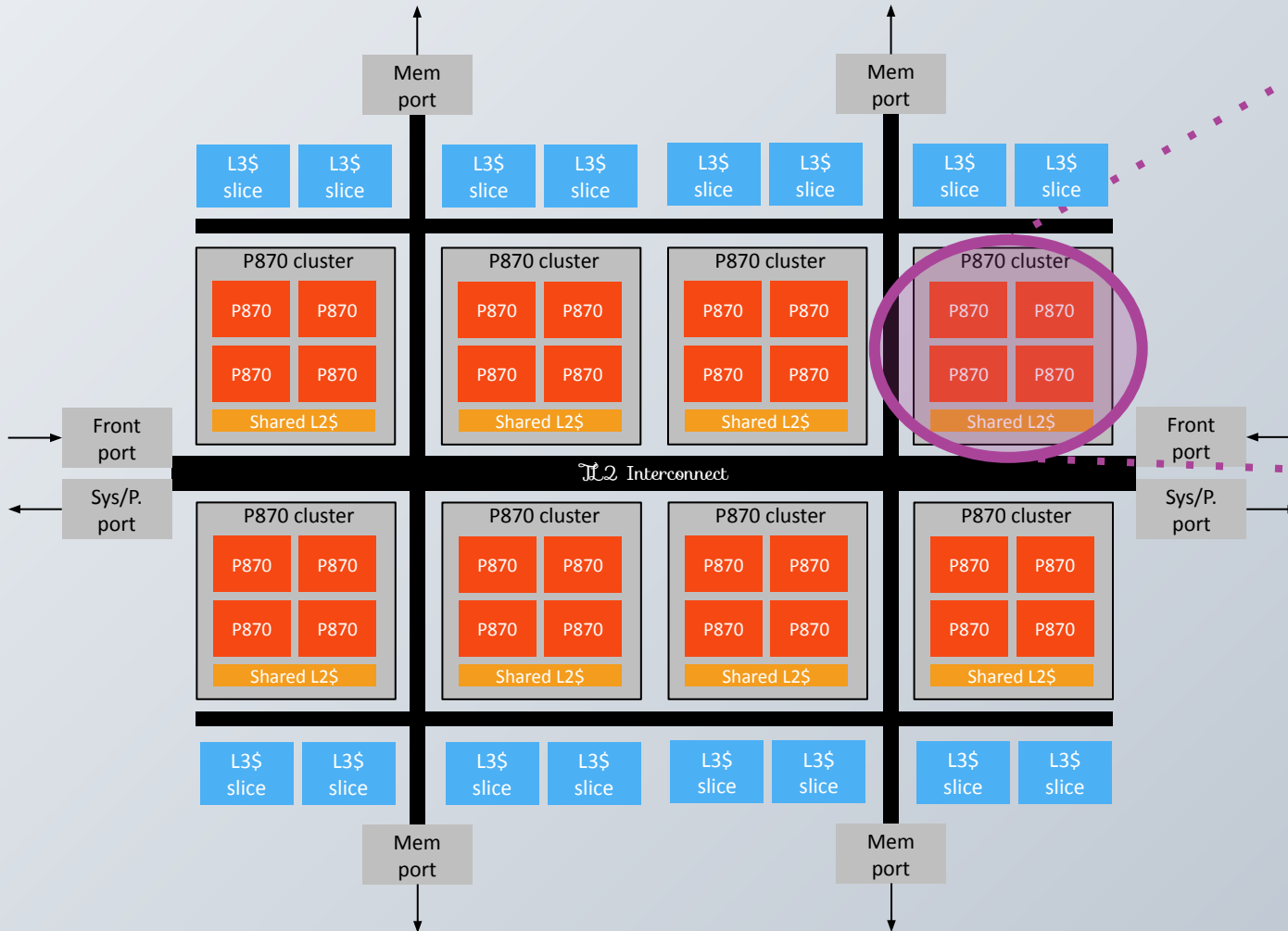
P870 Pipeline



P870 μ Arch



Cluster topology with shared L2 cache and distributed L3 cache



P870 4-core cluster

Legend:

LSU - Load/Store Unit

IEX - Integer Execution Unit

FEX - Floating Point Execution Unit

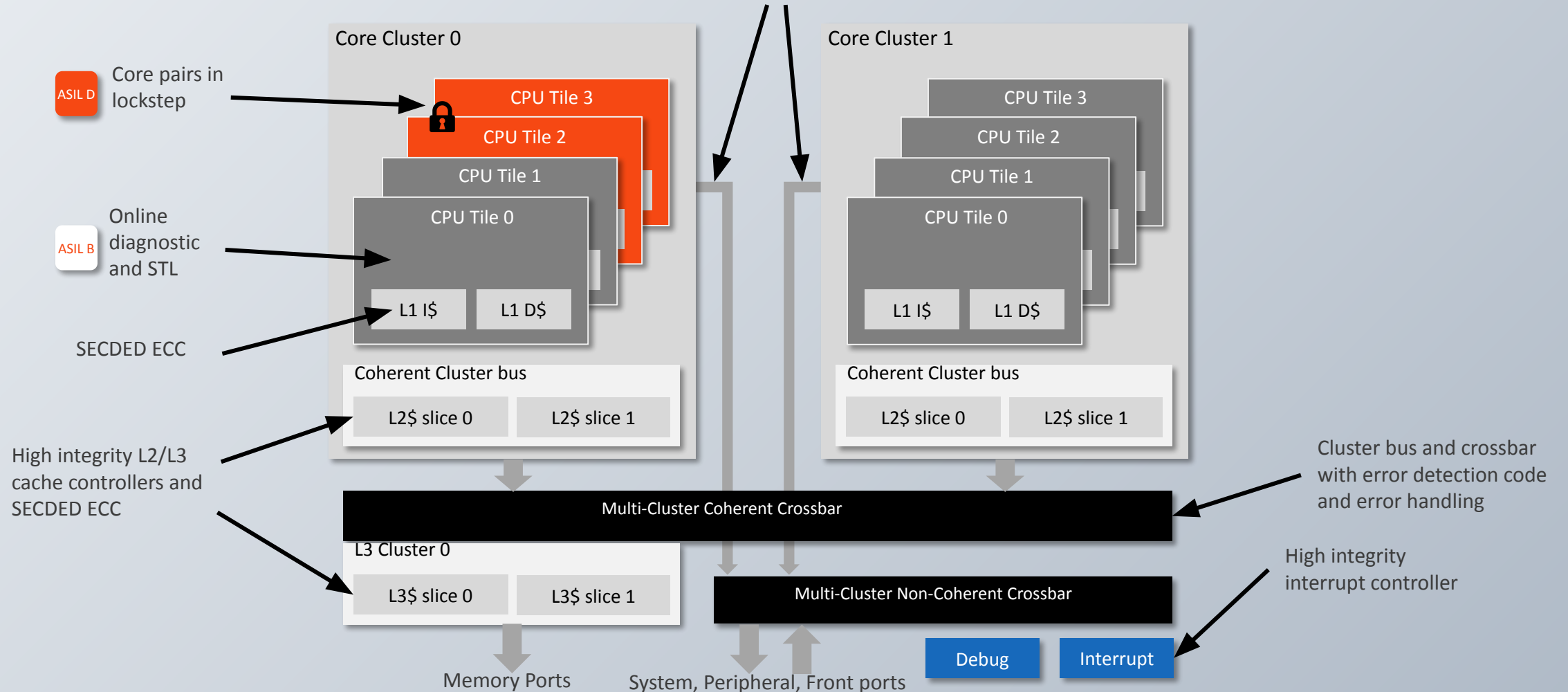
VEX - Vector Execution Unit

IFU - Instruction Fetch Unit

RDU - Rename/Dispatch Unit

P870-A **Functional safety** features

Advanced RAS architecture enabling error configuration, reporting, reaction and injection

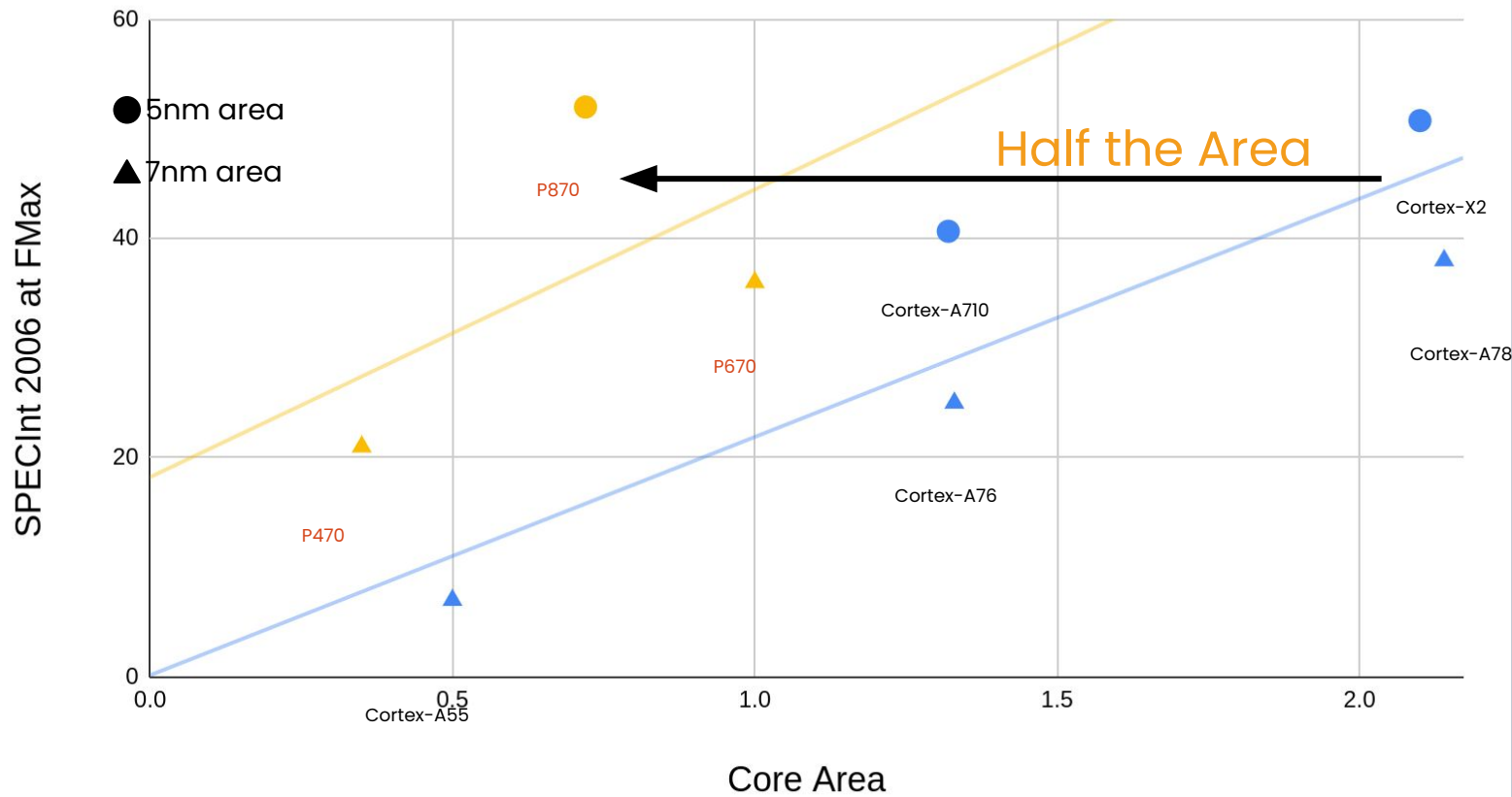


Significant Area Advantage



Enabling unparalleled cost efficiency across the SiFive Performance family

Peak Performance vs Area



Area is for Core plus private caches needed to achieve the indicated SPEC score
P470 and P670 FMax measured at 0.95V and reach 2.9GHz
P870 FMax measured at 0.95V and reach 3.3GHz
Cortex-A55 Source: Measured on Snapdragon 7c

Cortex-A76 Source: <https://www.anandtech.com/show/13814/arm-delivers-on-cortex-a76-promises>
<https://www.linleygroup.com/mpr/article.php?id=12342>

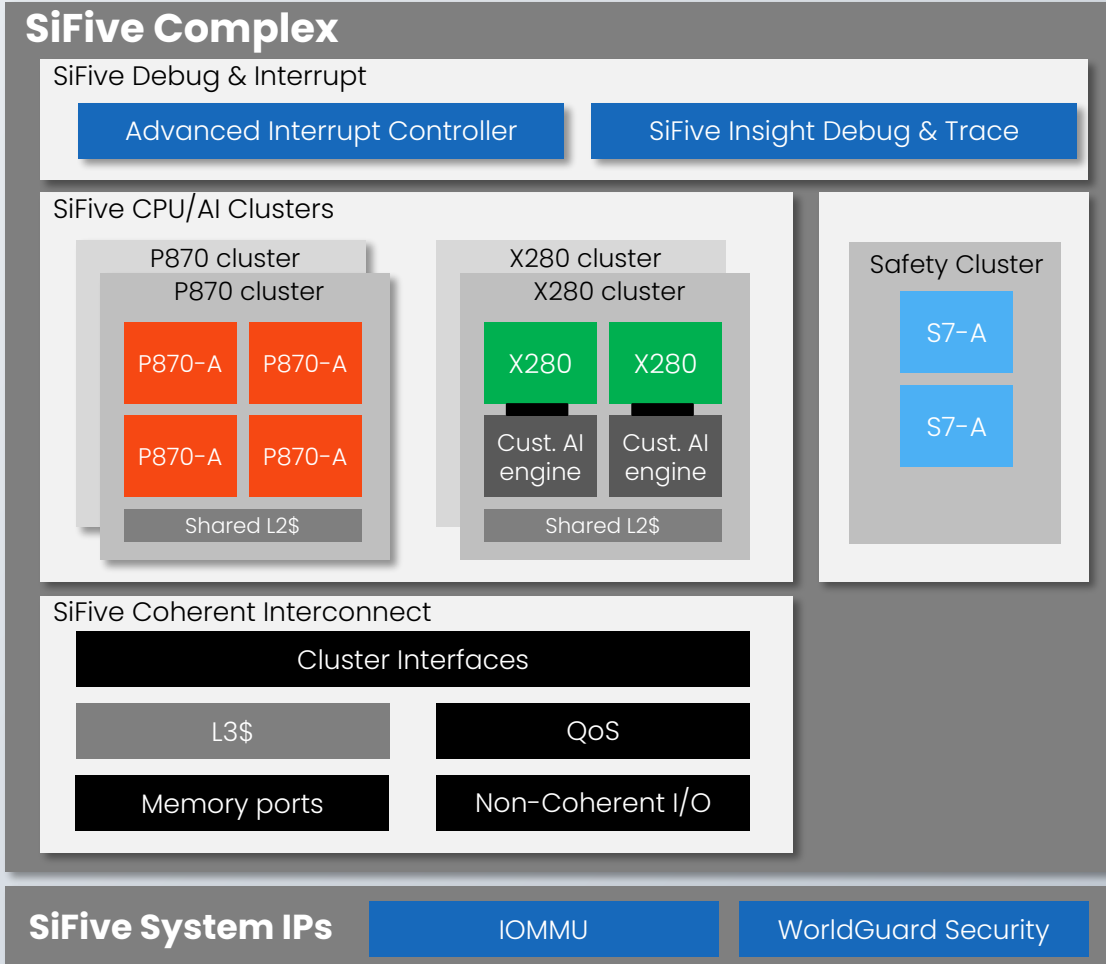
Cortex-A78 Source: <https://www.anandtech.com/show/15813/arm-cortex-a78-cortex-x1-cpu-ip-diverging/4>
TechInsights Microprocessor Reports: Die Photos Show Cortex-A78 Shortfall

Cortex-A710 and X2 Performance Estimated from:
<https://www.anandtech.com/show/16693/arm-announces-mobile-armv9-cpu-microarchitectures-cortex2-cortexa710-cortexa510>

Cortex-A710 and X2 Area from:

TechInsights Microprocessor Reports MediaTek Delivers Efficient Cortex-X2:

SiFive solutions for Automotive ADAS



- Safety features including split-lock, RAS and memory safety
- Support for mixed criticality supporting ASIL-B and/or ASIL-D
- Leading compute density
- Automotive-grade software ecosystem



Component Level Construction



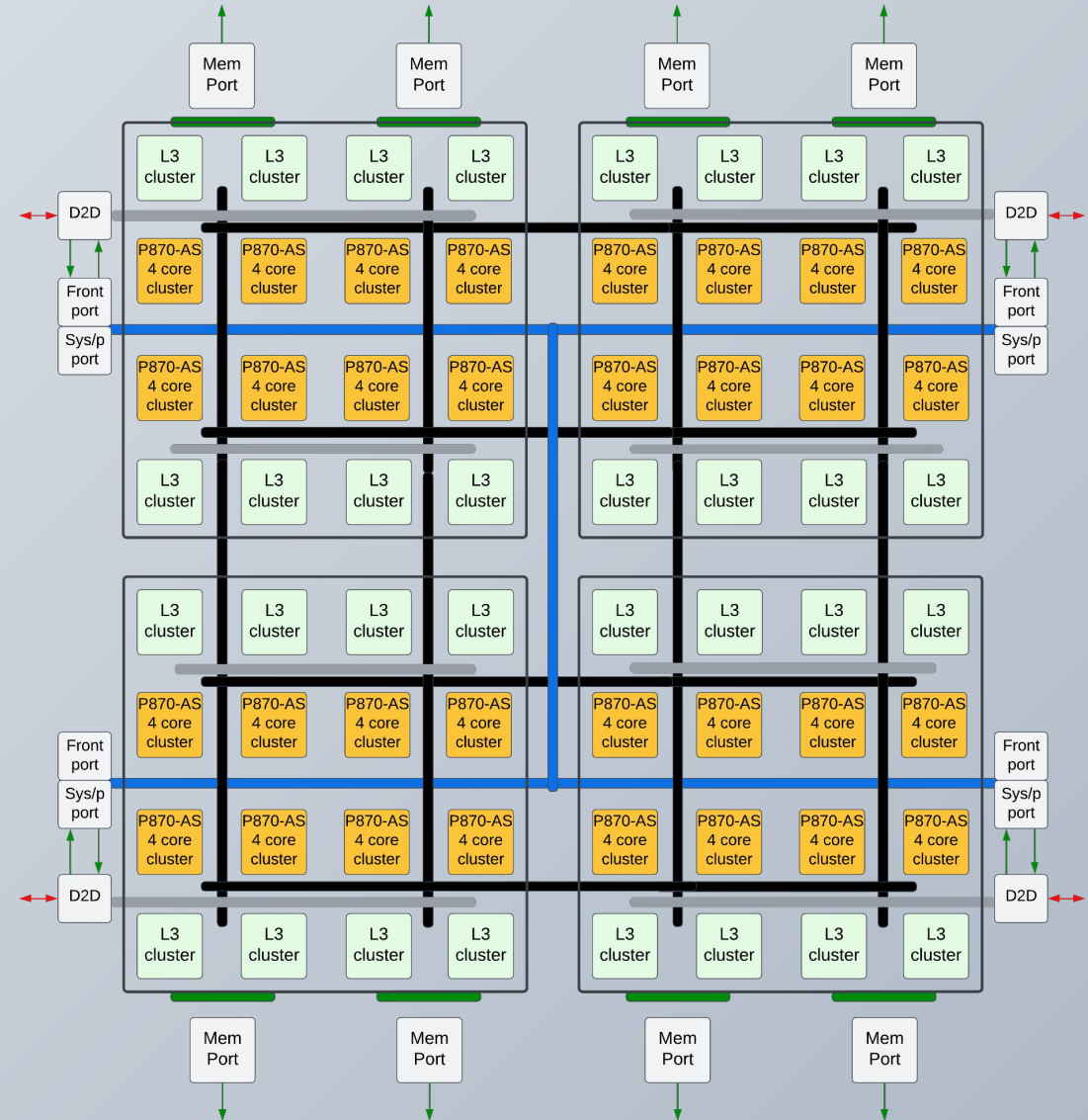
Modular Design for Datacenter and Automotive

Key features are high core count, scalability, and reliability

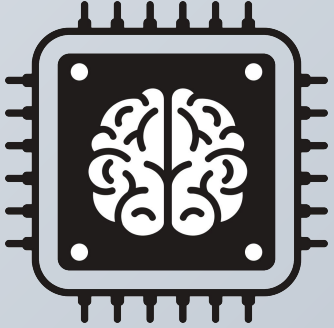
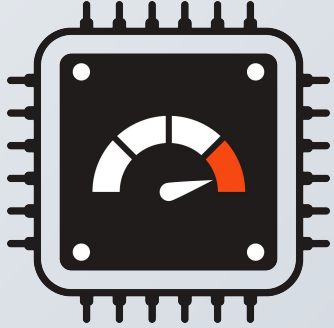
- Architected to provide a scalability path for expansion both on die and D2D
- Core disable for compute on demand and yield recovery purposes
- Larger granularity on DVFS and power gating boundaries
 - Modular architecture (tile DVFS, cluster DVFS, quadrant DVFS, etc.)
- Additional RAS features for both datacenter and automotive

Modular compilation and stampability to simplify floorplan

- Maintaining low latency while covering long distances is the goal of NoCLink



SiFive is empowering the **new computing era**



Large-scale high-performance general-purpose CPU

High-performance NPU

SiFive Performance Family

P470
P670

P870

SiFive Intelligence Family
Vector CPU

Built-in AI hardware engine

X3M

or

SiFive Intelligence Family
Vector CPU

Customer AI hardware engine

X280

X390

SiFive Software Products



Freedom Studio

Eclipse C/C++ environment

- Import, Edit, Build, Run
- Visual debug and trace support
- Profiling annotations
- Pipeline visualization
- Performance analyzers

Freedom Tools

RISC-V development tools

- GCC + LLVM Toolsuite
- SiFive Recode
- Auto vectorization
- Configurable QEMU
- Trace decoder

Kernel Library

Performance libraries

- Linear algebra
- Nonlinear functions
- Signal processing
- Neural network
- Combinatorial Algorithms

Freedom SDK for Metal

Bare metal software

- C Runtime
- CSR / MMIO + drivers
- FreeRTOS kernel
- Example programs
- Industry standard benchmarks

Freedom SDK for Linux

Embedded Linux software

- Yocto / OpenEmbedded based
- Includes U-Boot and OpenSBI
- Virtualization (AIA, IOMMU, KVM)
- Enhanced perf support
- Enhancement kernel for IP
- Power management support

Models

Simulation models

- Cycle model
- Fast functional model
- SystemC interface
- TLM 2.0 interface
- Single or Multi-threaded



Empowering **innovators**

www.sifive.com