

IMAGINATION CATAPULT: THE RISC-V CPU CORES

A secure and reliable partner

\$125m

2020 Revenues

+44%

Revenue Growth YoY

Market share

35% mobile; 53% automotive



MIRA

RENESAS

NXP

DiSTI



QNX

INNOSILICON

Visteon

SEM(DRIVE)
芯驰科技



Continental

HISILICON

ST

MEDIATEK

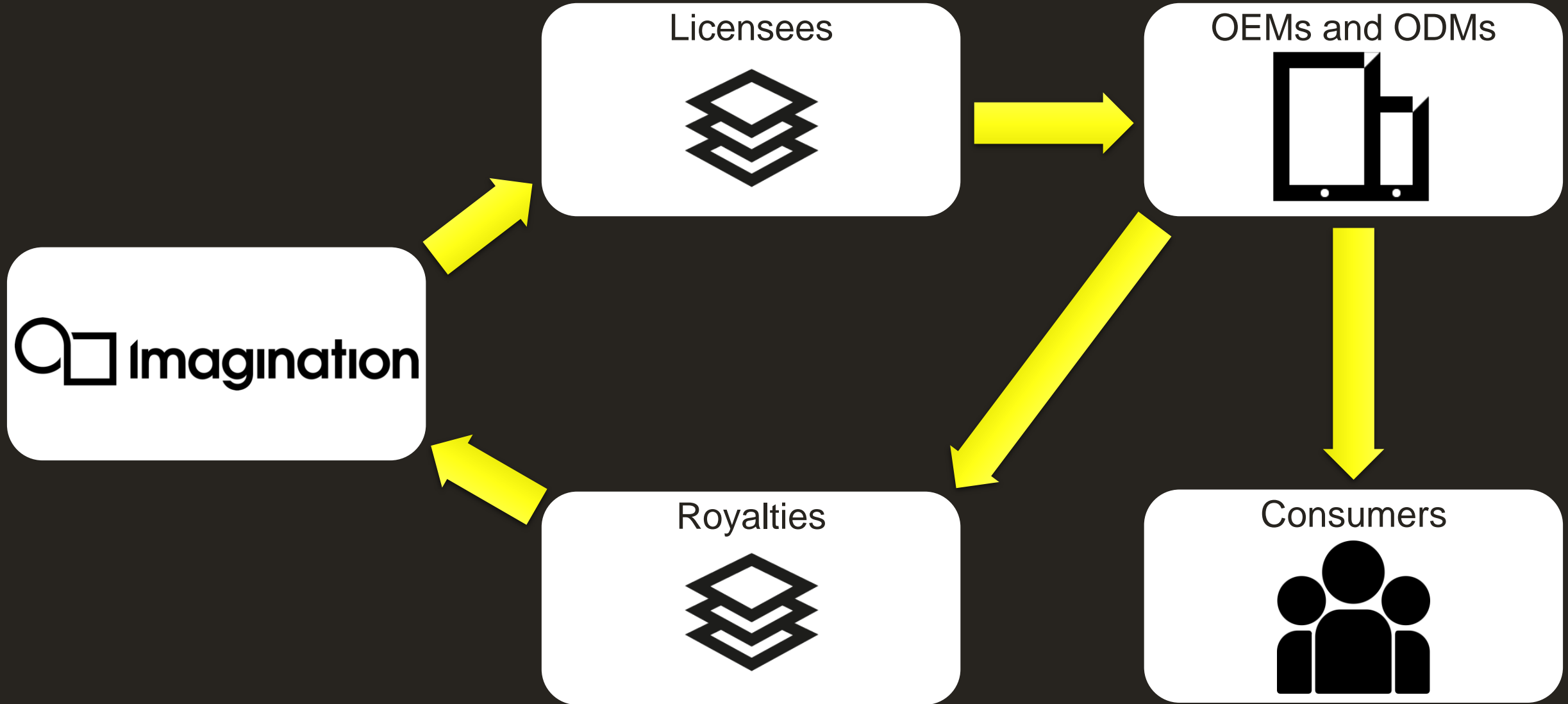
socionext



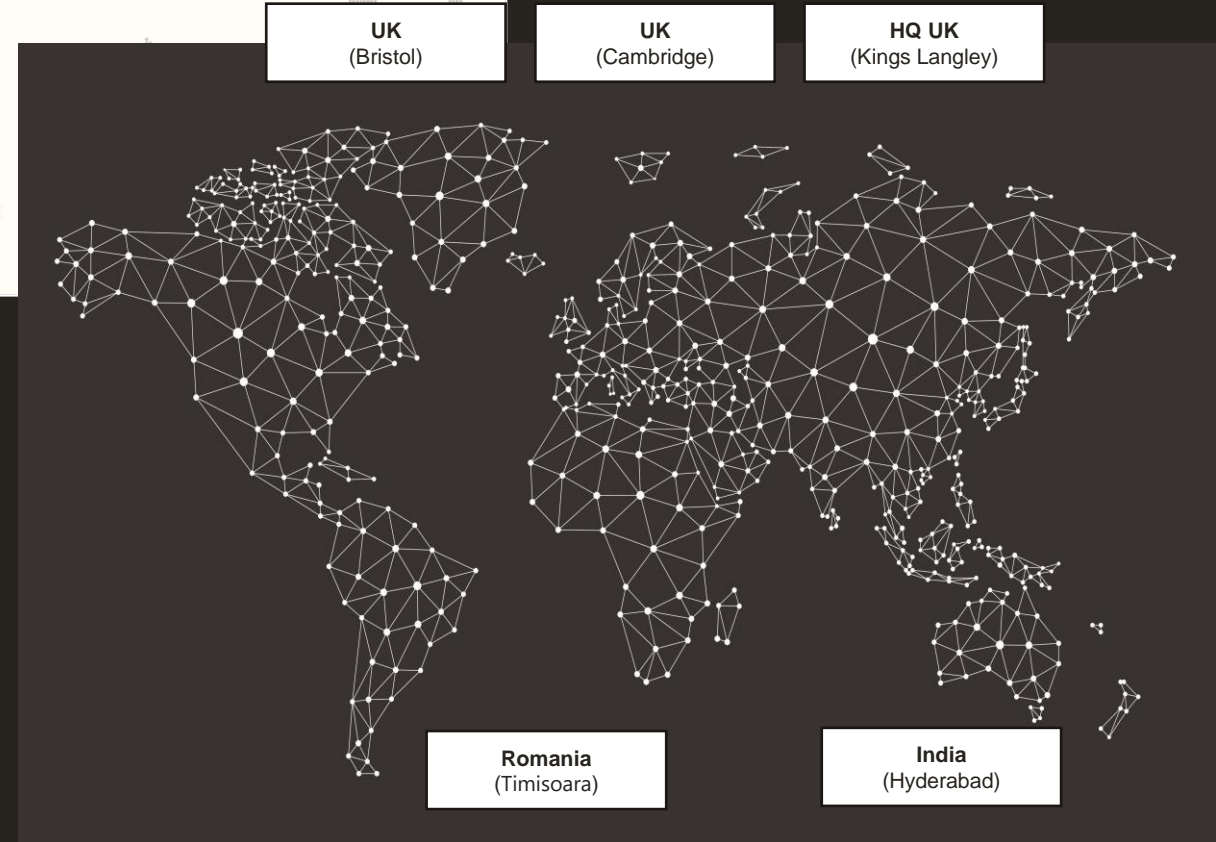
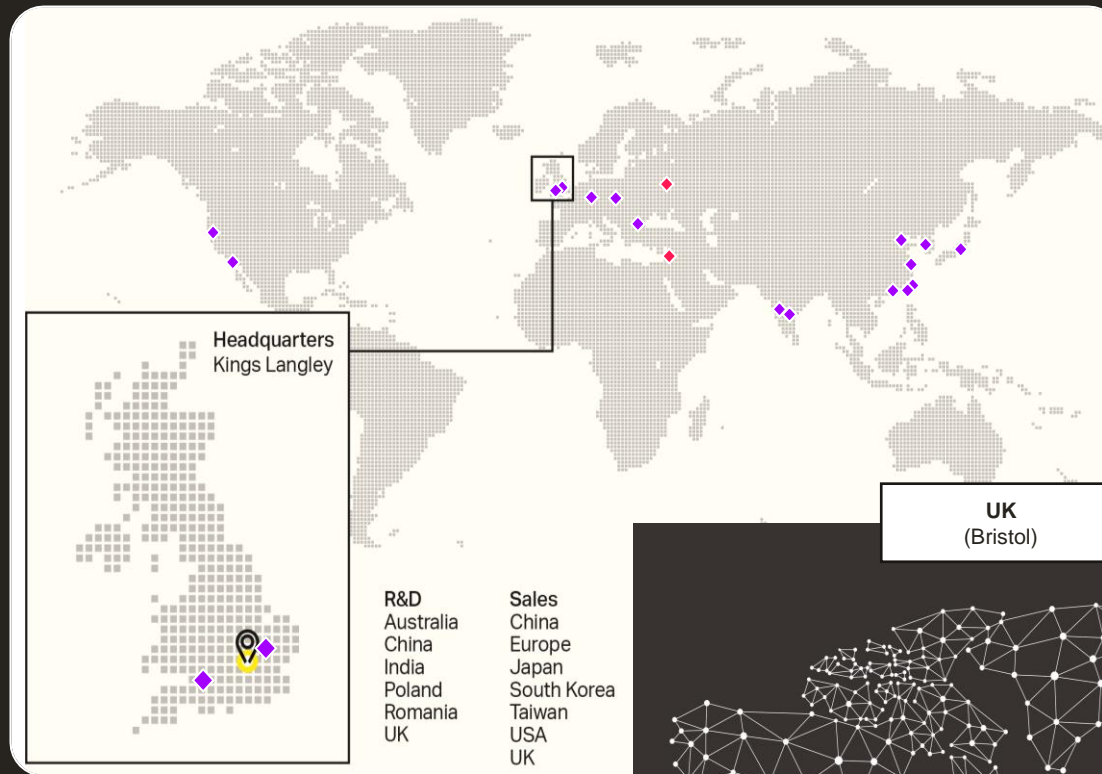
UNISOC

Enabling further investment to strengthen & broaden our IP portfolio

Our business model



Our world



>800 employees worldwide

>150 yrs of experience building high efficiency CPUs

>100 dedicated CPU engineers in 2022

Based mainly across the UK and going through significant growth

Consists of hardware, software, modelling, and toolchain engineers

Complementary skill set with customers and capable of full end-to-end development and support

Thousands

Owned technology patents and the only non-US core GPU patents holder

Access to hundreds of CPU patents

Total owned portfolio size (as of today) 2700+ patents and applications

Number 17 in league table of UK companies filing patents in EU

Number 7 for the number of patents granted in the UK from all applicants worldwide

GPU: One of small number of companies with fundamental GPU patents. Patent portfolio going back 20 years – constitutes about 40% of the patent portfolio; core assets are tiling, memory/parameter management, deferred rendering, compression.

CPU: Our CPU designs are covered by rights to a large number of core RISC patents from historical development and M&A, giving our customers the broadest protection of any RISC-V developer

Ray tracing: Industry leading real-time ray-tracing portfolio; hierarchy building, intersection testing

Neural networks: Fundamental techniques for low-power inference; quantisation, weight optimisation, network tiling

Functional safety: Innovative GPU solutions for safety-critical applications; redundancy, tile region protection, workgroup protection

Datapath: Low-level hardware modules for ultra-low power/area

Verification: Fundamental formal verification concepts for complex designs

Strategic focus



Automotive

Market leader in HMI GPU

ADAS/AV technology leadership with AI, GPU and compute

High performance ethernet solution for automotive

Underpinned by functional safety

Complementary to industrial applications



Mobile & Consumer

Leadership in GPU and ray tracing for ultra/sub-ultra mobile

GPU scalability to high volume handsets, DTV, STB, OTT and other consumer devices

AI acceleration for consumer devices and AIoT



Data Centre & Desktop

Leading GPU IP supplier for PC and Data Centre

Focus on cloud gaming opportunity worldwide

Imagination's scalable GPU enables customers to disrupt current hyper-scaler supply chain



Compute

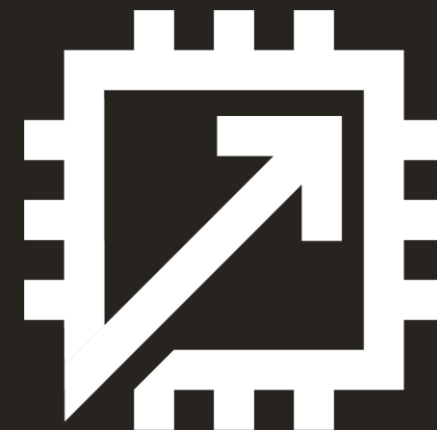
Goal to provide the #1 heterogenous compute solution from Imagination and our partners inc. AI, CPU, EPP, GPU

New RISC-V CPU built from the ground up

Segment focused solutions with specific software and features

Why CPU?

- Importance
 - Defines architecture and structure of SoC
 - Defines security model of SoC => defines how applications work in the SoC
- **Key trends**
 - Moore's law ending => driving heterogeneous computing
 - Industry looking for alternate solutions: RISC-V emerging as leading ISA competitor
- **Opportunity**
 - Alternate leadership in CPUs
 - Leadership in heterogeneous computing
 - Revenue and market share opportunity



Our CPU history

- **20 years of CPU development**

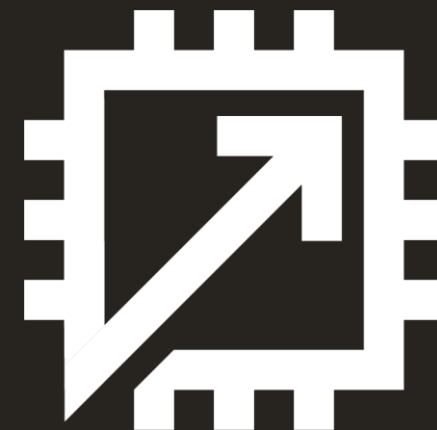
- Meta – multi-threaded CPUs, debuted 2001 – shipped to several customers in AV and used in billions of devices (in our own IP cores)
- MIPS – bought in 2012, launched three new core families, shipped in >3 billion CPU devices (excluding our own IP cores)

- **Experience**

- Excellent team with experience in Imagination, MIPS, Arm
- Plan to grow team up to 3x in 2022

- **Patent protections**

- Extensive patent protections (from over 500 CPU patents)
- Differentiated from other RISC-V suppliers



Democratisation and acceleration with RISC-V

Opportunity for companies to create unique products

- **RISC-V** foundation based in Switzerland – non-profit - neutral vs geopolitical challenges
- Driven by contributions of members – **not control by one entity** – enables independence and democratization of Compute
- Growing ecosystem of more than 1K members
- Open ISA built on 30 years of knowhow of RISC architecture
- Scalable modern architecture – for next generation AI/ML compute
- Custom extensions for unique use cases and operations



“The RISC-V Foundation welcomes Imagination’s introduction of a line of RISC-V CPUs. These products by Imagination underline the growth of the RISC-V marketplace and its ecosystem of suppliers and their industry partners. Imagination demonstrates the rich and diversified opportunities that exist in RISC-V solutions targeting heterogeneous computing.”
 - Calista Redmond, Chief Executive Officer, RISC-V International

Some of our RISC-V partners



Intelligent autonomy driving demand for compute



Explosion of data



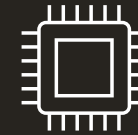
Performance & power efficiency



Proliferation of AI



Choose the right compute appropriate to the workload



Distinct processor architectures



Diverse workloads

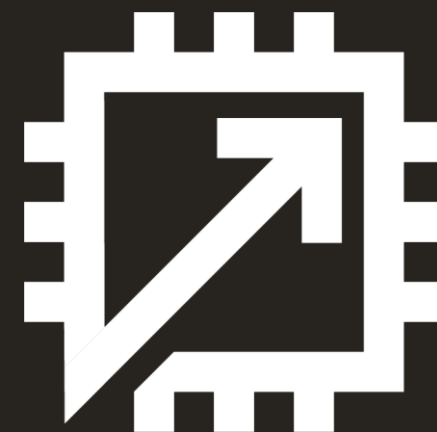


Simple deployment

Flexibility, efficiency & resilience require heterogeneity

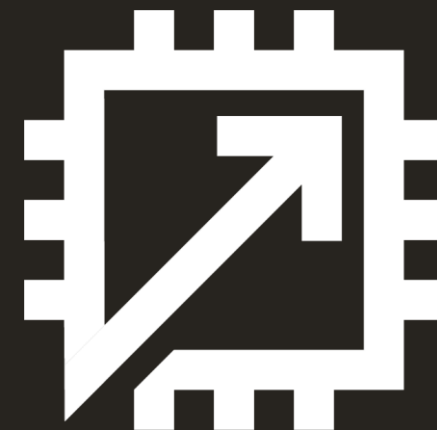
Introducing Catapult

- **Catapult -- a RISC-V CPU family designed from the ground-up for next-generation heterogeneous compute needs**
- **Configurable for performance, efficiency, or balanced profiles, making them suitable for a wide range of markets**
- **Leveraging Imagination's 20 years of experience in delivering complex IP solutions**
- **Supported by the rapidly expanding open-standard RISC-V ecosystem**



Introducing Catapult

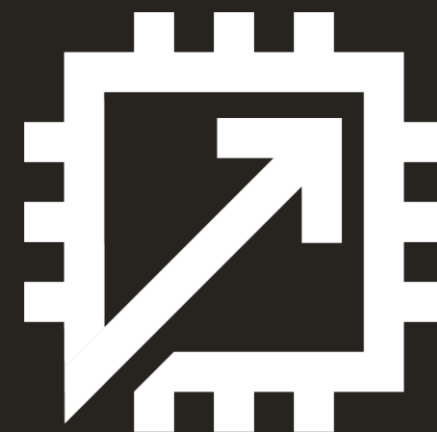
- Four distinct families
 - Dynamic Microcontrollers - ultra low power and ultra small cores for embedded and microcontroller applications
 - Realtime Embedded CPUs - highly scalable mid-range, feature-rich cores for mainstream devices
 - High-Performance Application CPUs - high-performance cores for demanding applications
 - Functionally safe Automotive CPUs – all the above with added functional safety features
- **Already shipping in high-performance automotive GPUs in SoCs from Imagination customers**
- Real-time embedded CPUs are available now
- High-performance application CPUs and automotive CPUs will follow from 2022



Catapult

Advanced RISC-V CPUs enabling heterogeneous solutions

- **Engineered for markets ranging from 5G modems, storage, ADAS / autonomous vehicles, data centre, and high-performance computing**
- **Use with GPU, EPP and NNA IP in flexible arrays of high-performance compute elements that meet exacting power and efficiency requirements**
- **Full hardware, software and debug support for SoCs using Imagination IP**
- **Compliant with the RISC-V ISA and fully supported by the broad and increasing RISC-V ecosystem of software and tools**

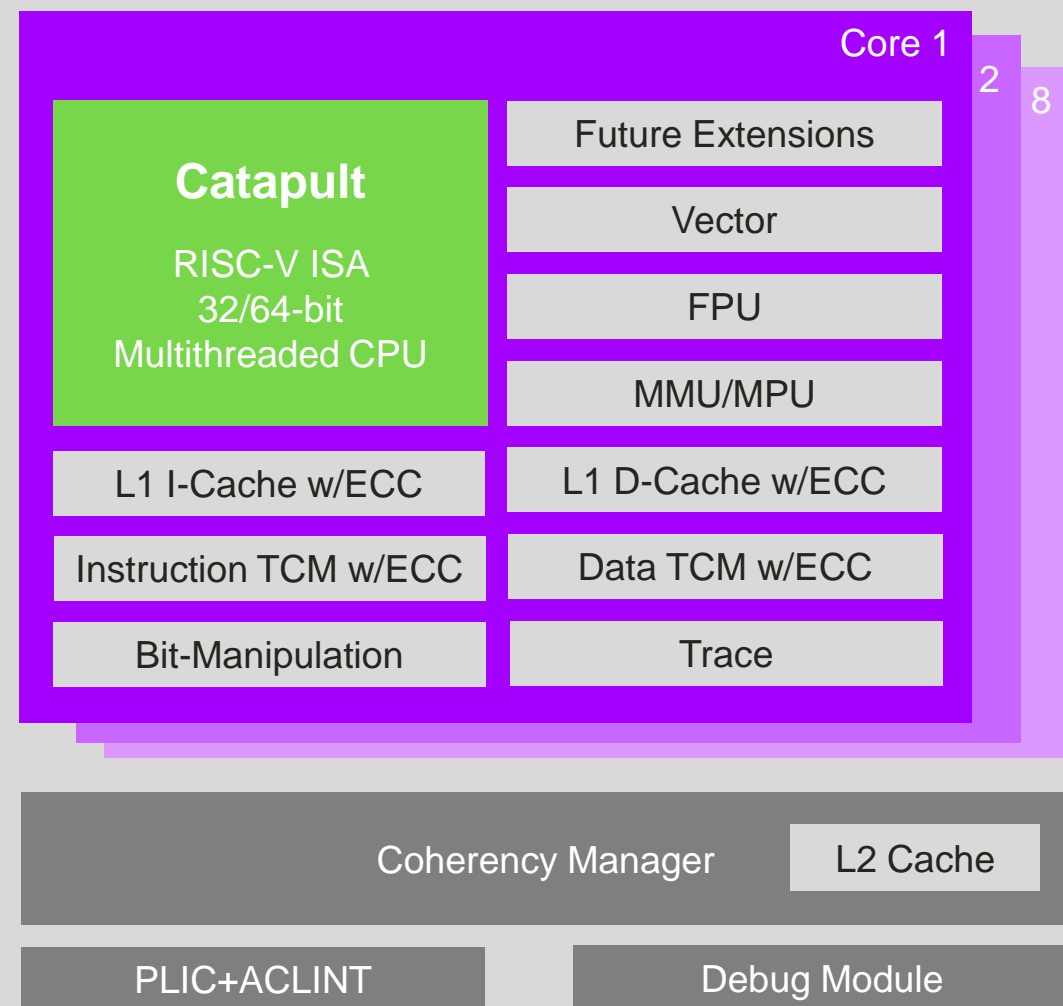


Catapult

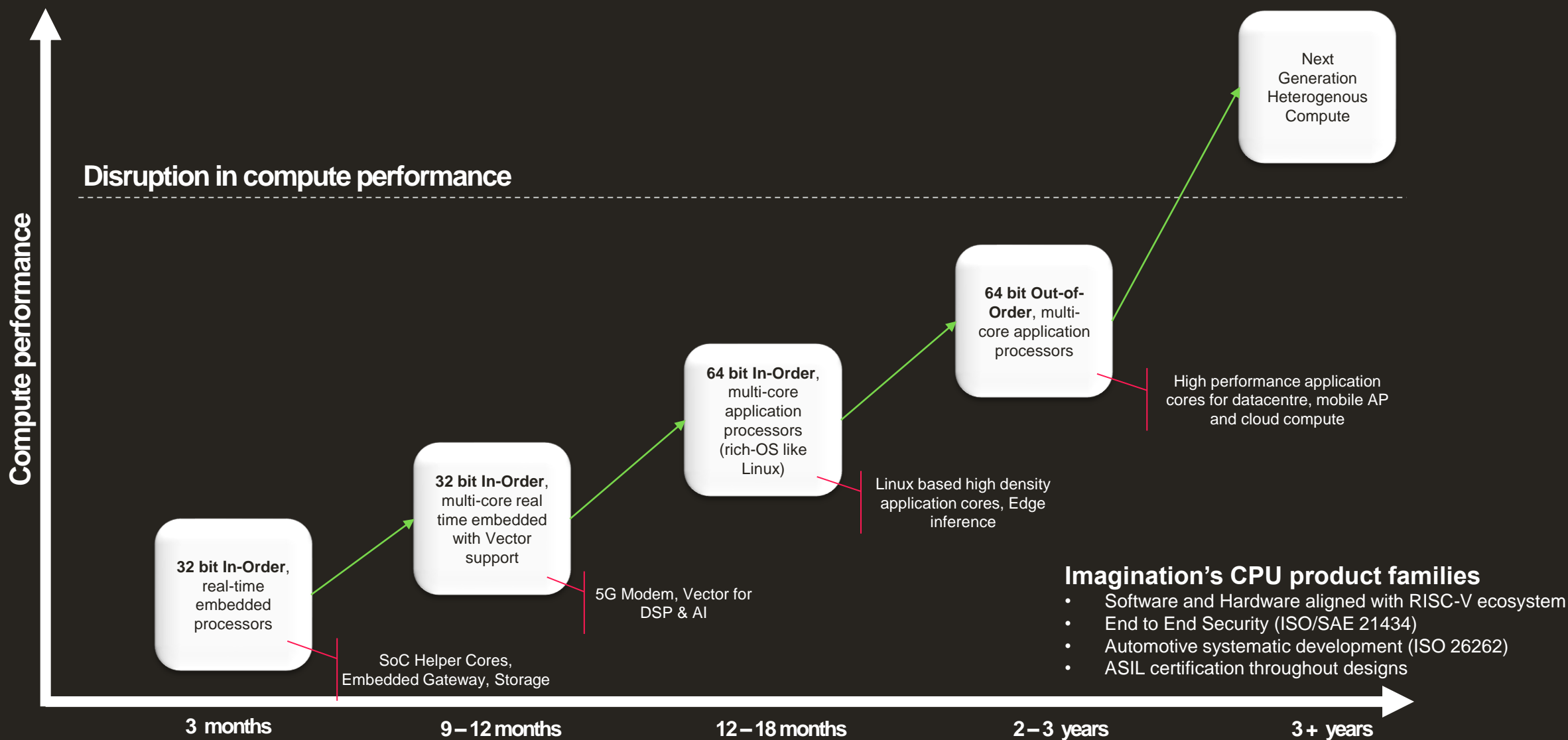
Advanced RISC-V CPUs enabling heterogeneous solutions

- Multi-threaded
- 32-bit and 64-bit variants with a plethora of options which are customer configurable
- Up to eight asymmetric coherent cores-per cluster for enhanced SoC versatility, with an option to add custom accelerators.
- Catapult automotive CPUs are developed to ISO 26262 automotive standards for a range of Automotive Safety Integrity Levels (ASIL)
- Based on industry proven security concepts such as a robust secure boot and mechanisms for isolated and secure execution environments
- Enables vendor to integrate their own root of trust and cryptography technologies and meet the highest levels of security requirements and certification required by the target markets

Catapult



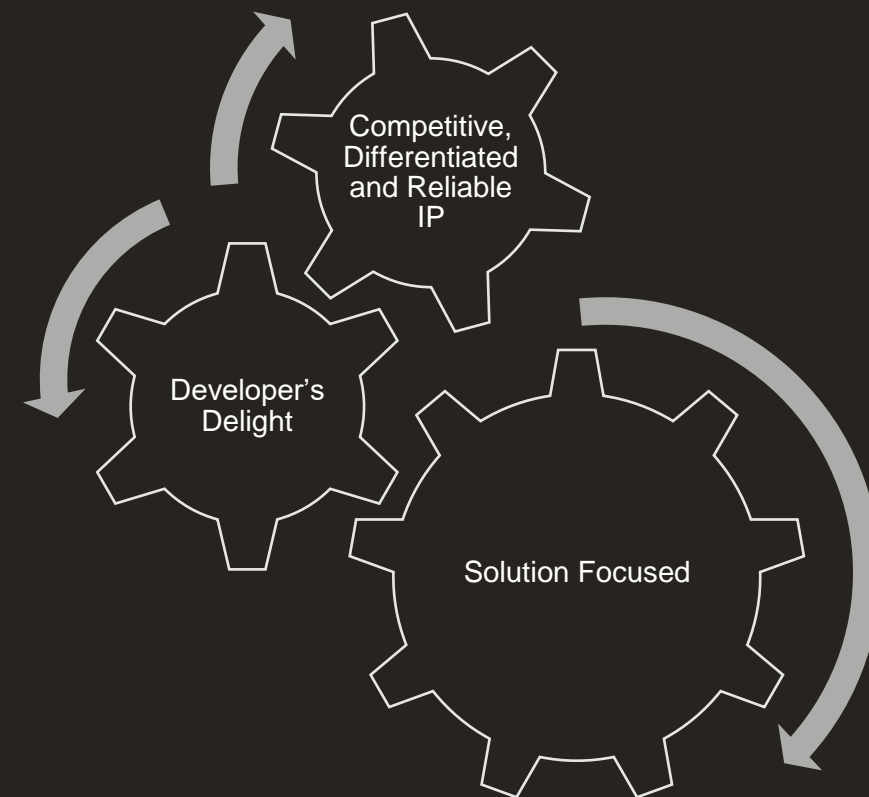
Catapult



Catapult SDK & Catapult Studio

Comprehensive SDK Support

- Catapult CPUs can be easily integrated into existing and new SoC designs
- Delivered with software support for Linux and FreeRTOS
- Fully compatible with industry-standard tools, including:
 - GCC and LLVM compilers
 - GDB debugger
- Catapult Studio (IDE), based on Visual Studio Code
 - empowers developers to take full advantage of the Catapult CPUs,
 - offering enhancements for embedded and application cores.
 - available for Windows, Ubuntu, CentOS and MacOS,
 - full Linux support including reference bootloaders, kernel and filesystem.
 - compatible with gem5 software, unlocking simulation environments for enhanced power and energy-efficiency testing.



RVfpga: Understanding Computer Architecture

A teaching package with instructions, tools, and labs that show how to:

- Target a commercial RISC-V system-on-chip (SoC) to an FPGA
- Program the RISC-V SoC
- Add more functionality to the RISC-V SoC

The RVfpga Package provides:

- a comprehensive, freely distributed, complete RISC-V course
- a hands-on and easily accessible way to learn about RISC-V processors and the RISC-V ecosystem
- a RISC-V system targeted to low-cost FPGAs, which are readily available at many universities and companies

Partners include Western Digital, RISC-V International and Digilent

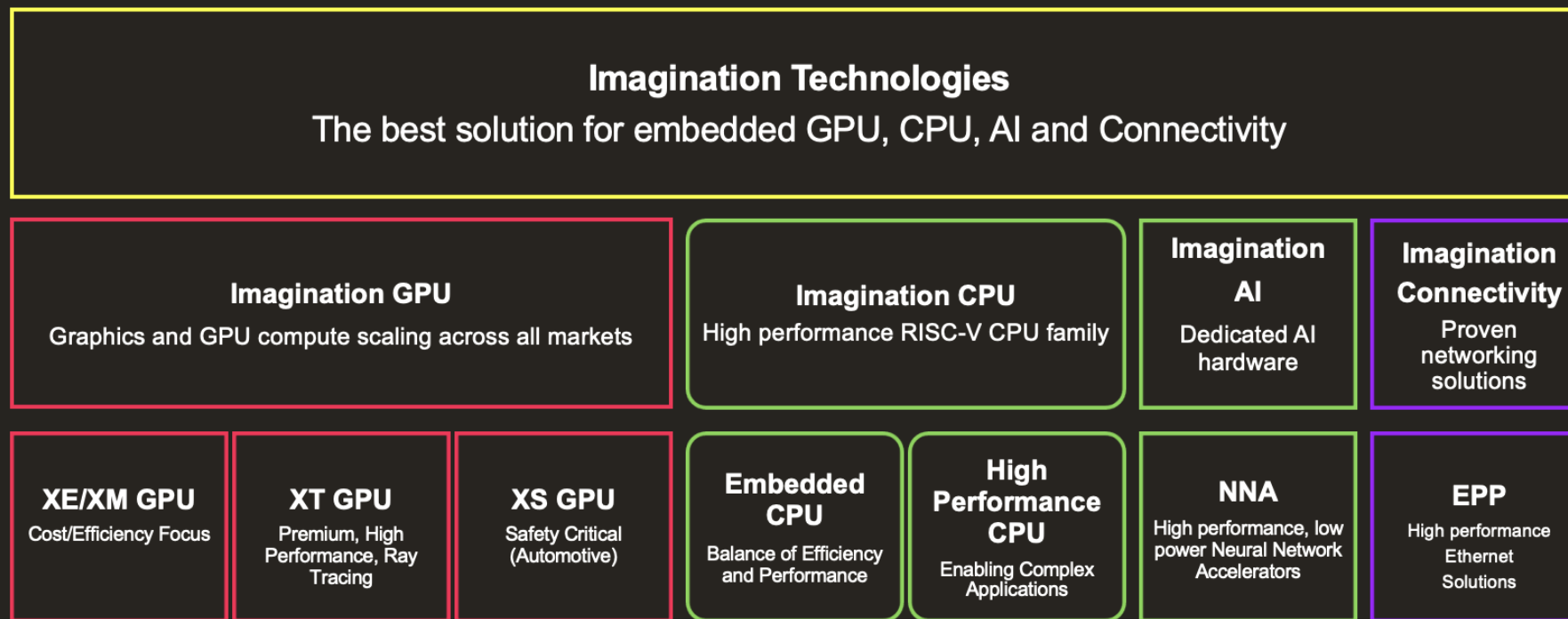
Available in 8 languages, comprising some 25 Labs, and enough material for 3 semesters of teaching

Demonstrates Imagination's commitment to this once-in-a-generation technology



Already have a CPU?

➤ We have the key components you need for a powerful and competitive heterogeneous SoC: GPU with optional ray tracing; AI (NNA); and ethernet (EPP)

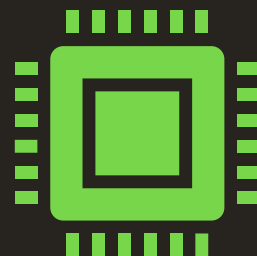


Why work with us?



Pedigree

Imagination's established and proven expertise to deliver very complex solutions reinforced by a strong support function. Work with a trusted vendor



Complementary IP for heterogeneous compute

Focus on Innovation around how the major processing elements in a system – CPU, GPU and AI Neural Network Accelerators (NNA) - inter-work



Right levels of protection

Rights to use a rich portfolio of fundamental CPU patents* and ownership of broad GPU/Compute design patents provides the right levels of protection for Imagination's partners

Catapult in summary

- Major new entrant to CPU market, taking RISC-V forward
- Engineered for – Quality, Reliability, Efficiency and Performance
- Proven Support – billions of devices with our IP inside shipped
- Experienced with CPU
- Compute performance ranging from embedded to high-end applications
- Flexible - make small optimisations, or implement a unique processor for your segment
- First product now, aggressive roadmap
- Functionally safe design
- End to End Security
- Complete verified IP
- Reduce cost of ownership of custom processor
- Reduce TTM - reverified, tape out quality, supported
- Patent protection
- Wide Ecosystem support AND outstanding proprietary tools
- Business model incentivises us to get customers to market



A true IP partner

Delivering exceptional service

Enabling very fast time to market

Enabling customers to leverage IP to maximise differentiation

Driving major markets

Helping our partners to create successful solutions

Influencing new and emerging opportunities

Showcasing and proving our technology with real products

Our royalty based business model means we succeed when our customers succeed

Exceptional IP that delivers true differentiation and leading performance for heterogeneous SoC

AI, Ethernet, GPU, CPU

>25 years of experience getting customers to market



**SHARPENING
YOUR
COMPETITIVE
EDGE**