RISC-V – Success factors & opportunities for dependable automotive applications

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June 2024

Infineon at a glance

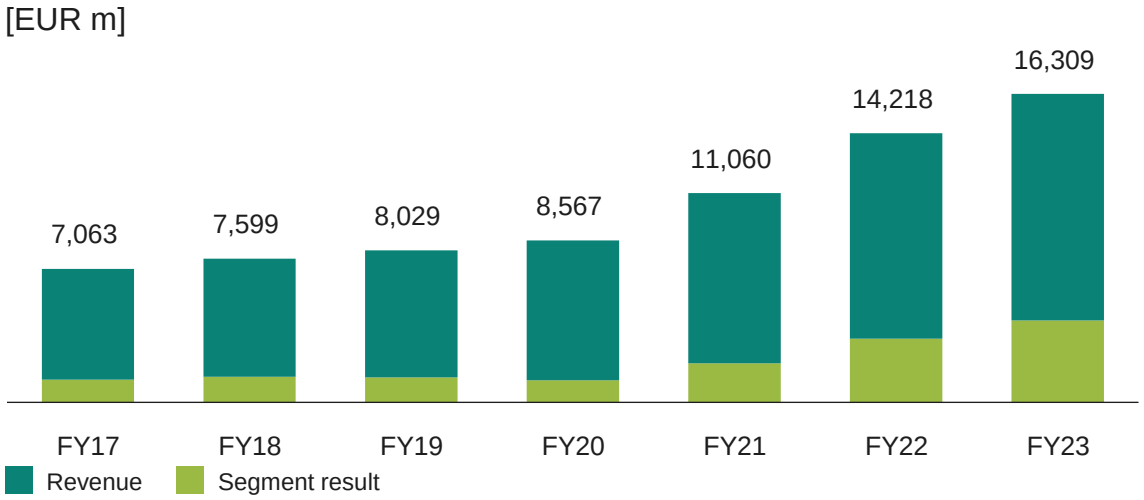
Growth areas

Energy
green and efficient

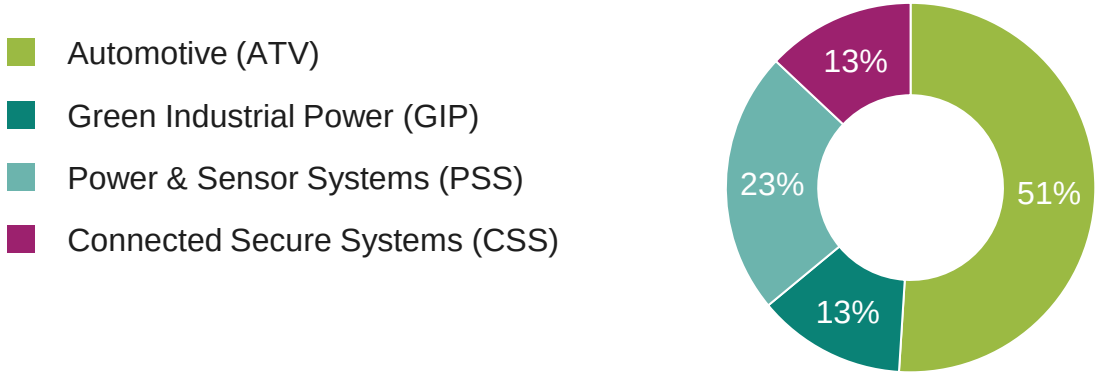
Mobility
clean and safe

IoT
smart and secure

Financials



FY23 revenue by segment[1]

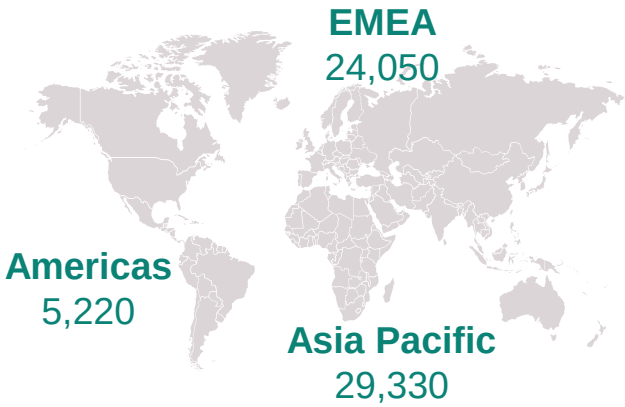


Employees[2]

58,600
employees worldwide

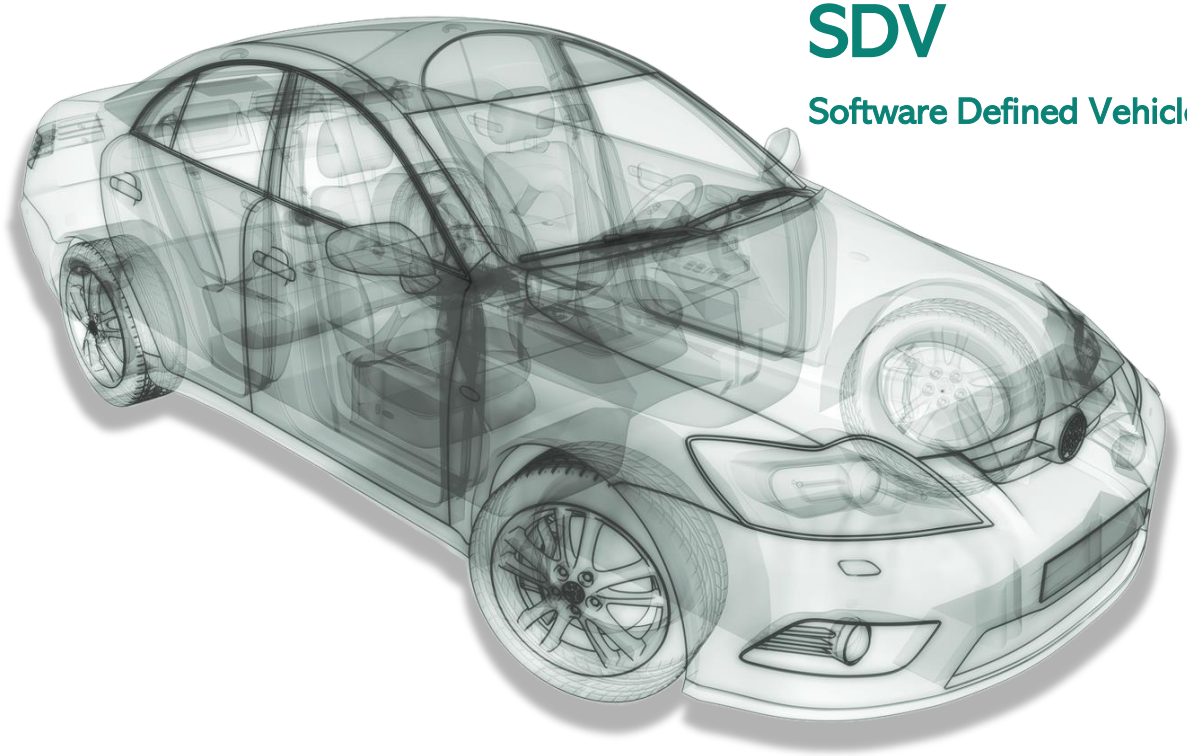
69
R&D and

17
manufacturing locations[2]



For further information: Infineon Annual Report.

[1] 2023 Fiscal year (as of 30 September 2023) | [2] As of 30 September 2023



SDV

Software Defined Vehicle

Major innovations are software driven

Number of vehicle ECUs is reducing

Automotive industry design cycles are shortening

Microcontrollers innovation runs out of steam, no more new products, no more disruption?

Wait a minute …

Here’s how open source technologies can enable affordable and dependable car architectures

Performance, Cost & Dependability: Microcontroller architectures have undergone major innovations in the last 25 years

Performance

- **2000**: 8 & 16bit is standard, 32bit gains share in >2005
- **2008-2010**: Memory integration & 16bit instructions introduced

2000

- **2008-2010:** Real-time capabilities: interrupt latency minimized & fast context switching
- **2008-2010:** Safety: Memory protection

Security & Safety

- **2010-2015:** Security extension added: instructions, HSM module
- **2015-2020:** Safety becomes a standard: ISO26262

2010

- **2015-2020:** Performance: Direct NVM access & application-specific accelerators, e.g. radar processing

Software & AI

- **2020-2025:** Software: Virtualization, SOTA and new types of NVM
- **2020-2025:** Security: CSRM security acceleration

2020

- **2020-2025:** Performance: AI acceleration
- **2020-2025:** Performance: Data routing acceleration

What is next…

Features disruption

Cost focus

Development speed

Enabling SDV: Key innovation areas for automotive microcontroller platforms in future vehicle architectures

Performance and throughput

- Handling of **large amounts of parallel tasks and I/O** without compromising real-time performance

Determinism and low latency

Source: Vitesco, Inverter design

- **Predictable execution time** and guaranteed timing of computations
- Minimal downtime, **robust fault tolerance and fast recovery mechanisms**
- Hardware redundancy and software diversity

Reliability and availability

Safety and security

- **High diagnostic coverage**, fault detection and mitigation, mechanism to brings systems to safe state
- Secure boot, restricted access to resources and data encryption

Source: Arnold NextG, X-by-wire

Reuse and Scalability

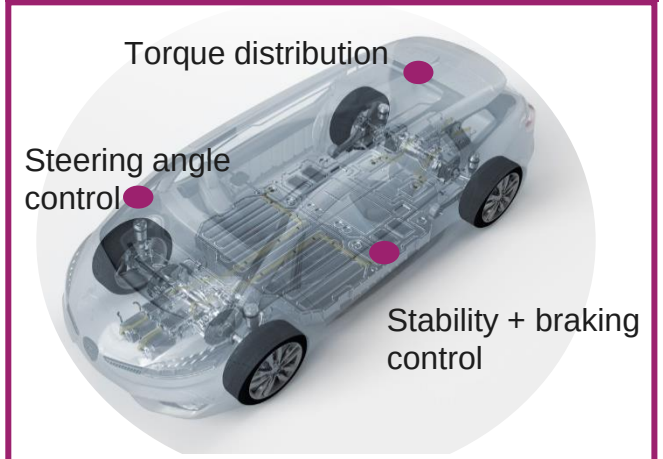
Source: Hyundai, e-GMPP

- **Modularity and reuse of existing software** components
- Ability to adapt to software loads, memory, communication capabilities and **system target costs**

Application classes require specific computational capabilities but common requirements exist for all domains

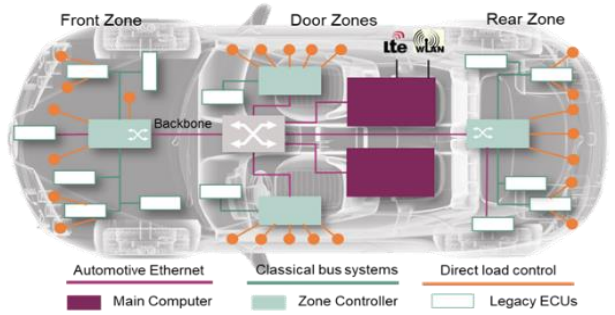
Application

Chassis/Powertrain



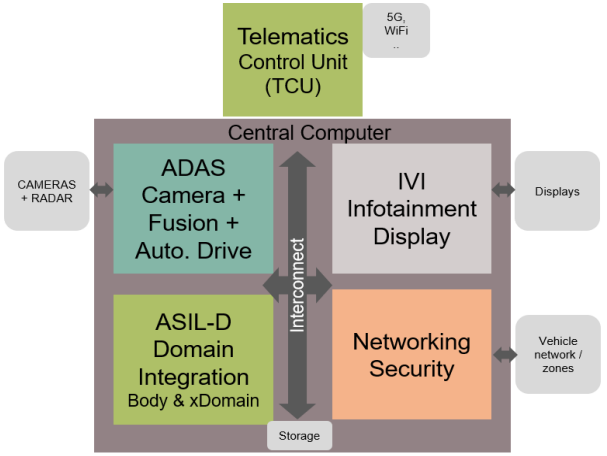
Real-Time, low latencies, highest Integrity-Level

Zone Controllers



Power-efficiency, Secure Compute, Integration capability

ADAS

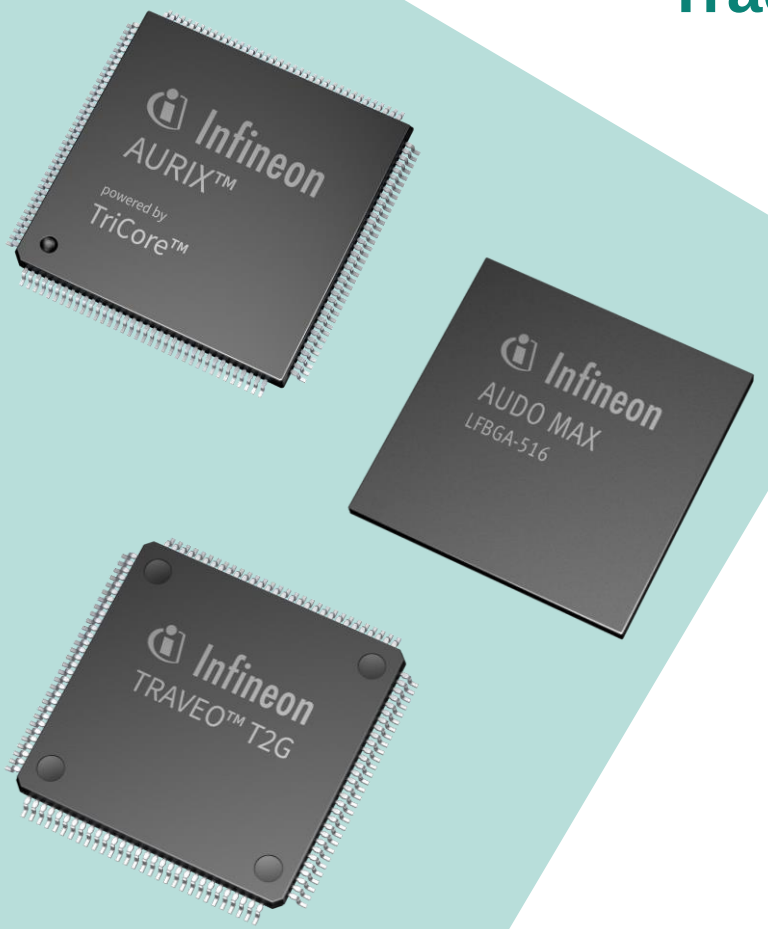


Memory-bandwidth, Vector-Performance

X-Domain

- Safety
- Security
- Availability
- Analyzability

Traditionally microcontroller consisted of two building blocks using programable cores:

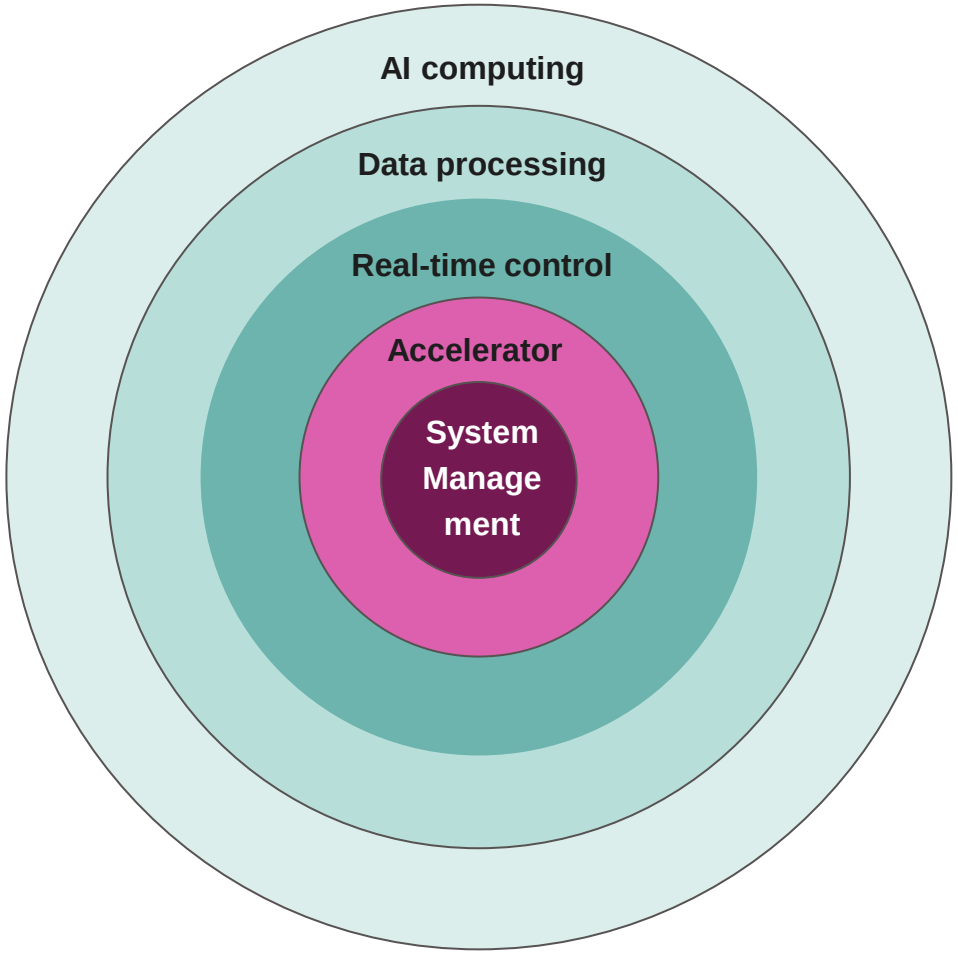


- **System management**
  - Reset management, clock system, memory initialization
  - Power mode handling

- **Real-time control**
  - Predictable execution time & low-latency interrupt handling
  - RTOS support incl. scheduling, task management

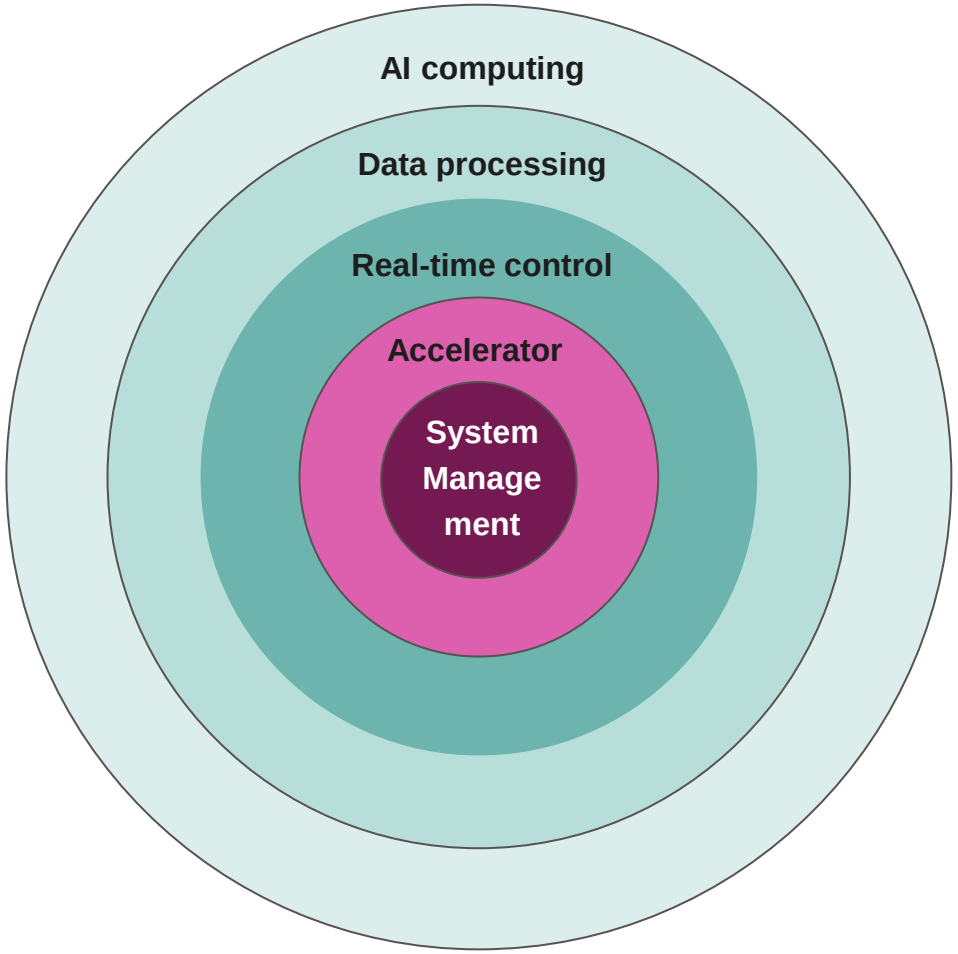
but complexity has evolved…

Microcontroller today: Change in automotive computational tasks requires specialization, standardization & instruction set reuse



- **System management** — 1x cores
  - Reset management, clock system, memory initialization
  - Power mode handling
- **Embedded accelerators** — 1-4x cores
  - Security sub-systems and accelerators
  - Application-specific signal processing, Networking & protocol engines
- **Real-time control** — 1-6x cores
  - Predictable execution time & low-latency interrupt handling
  - RTOS support incl. scheduling, task management
- **Data processing tasks** — 1-4x cores
  - High-performance handling of complex processing tasks
  - Memory management support & Privileged execution modes
- **AI inference tasks** — 1-Nx cores
  - Specialized hardware for matrix and tensor computations
  - Model compression and optimization support

Microcontroller today: Change in automotive computational tasks requires specialization, standardization & instruction set reuse



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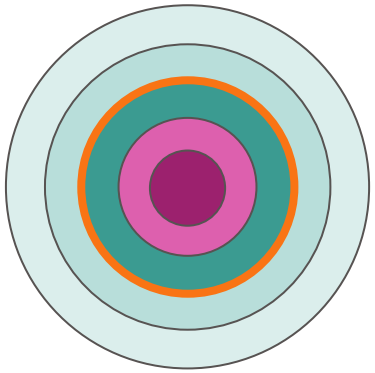
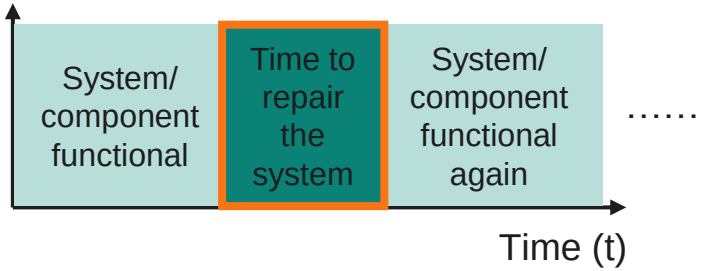
RISC-V

Modern core architectures address two main challenges: Dependability & Scalability

Challenge: Dependability

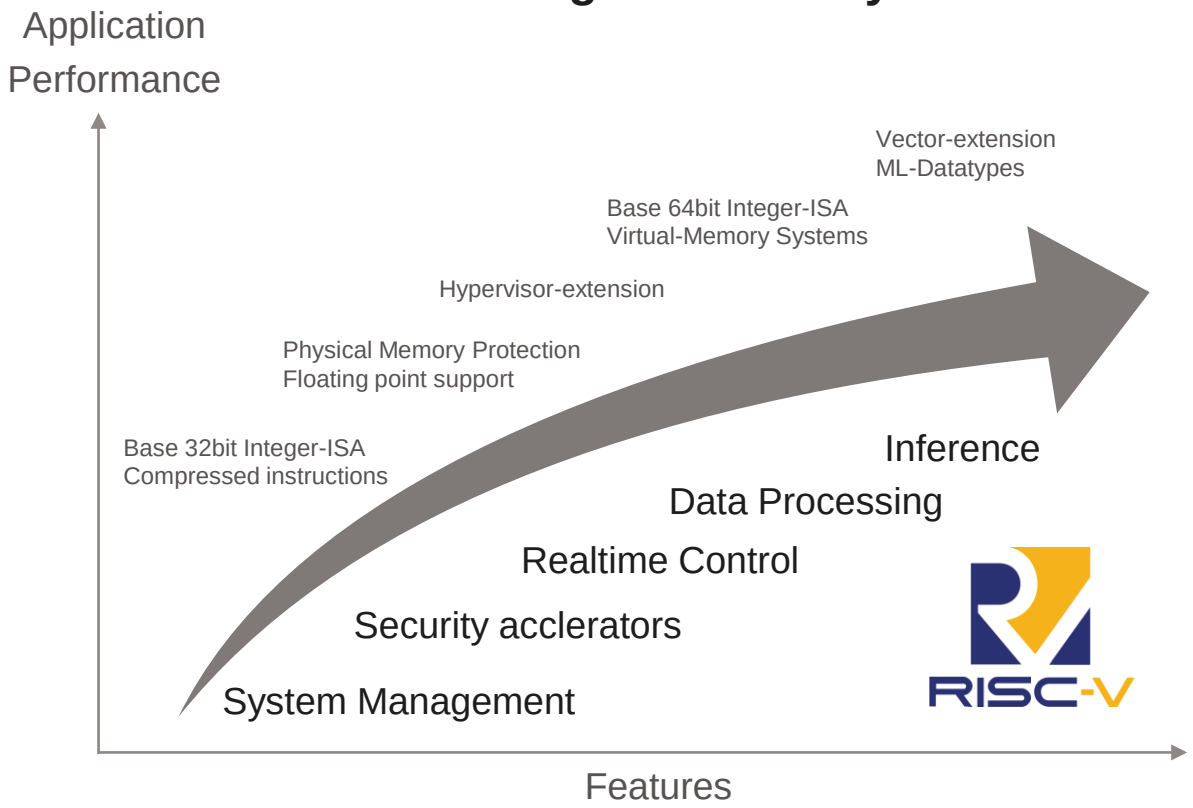
Dependability is a measure of a system's **availability, reliability, maintainability, safety and security.** The ability to maintain **functionality** when parts of a **system break down** is referred to as **graceful degradation**





Dependability and graceful degradation require highly integer and scalable core portfolio

Challenge: Scalability



Core architecture needs to support extensions to support all application domains

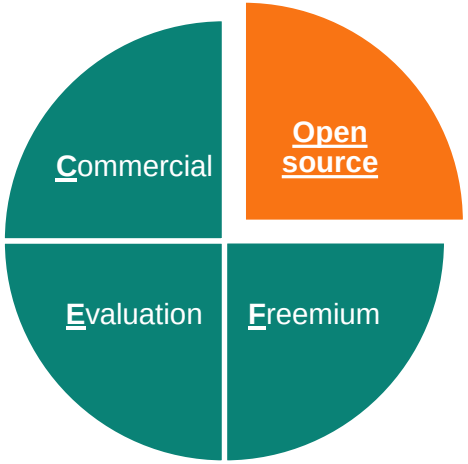
Note: Relevant extensions shown exemplary.

Further benefits of choosing RISC-V as ISA for future microcontroller generations in automotive applications and beyond

- Single **instruction set** architecture for **dependable platform**
- Extremely scalable **micro-architecture**
- Avoiding IP-Level **lock-in effects**
- Inclusive and open ISA eases **knowledge sharing**
- RISC ISA is an **open standard**
- **Synergies** with IOT and industrial
- Comprehensive and fast developing **ecosystem**

New technologies entering the automotive and IoT domain
Open source HW/SW standards and community platforms drive trends

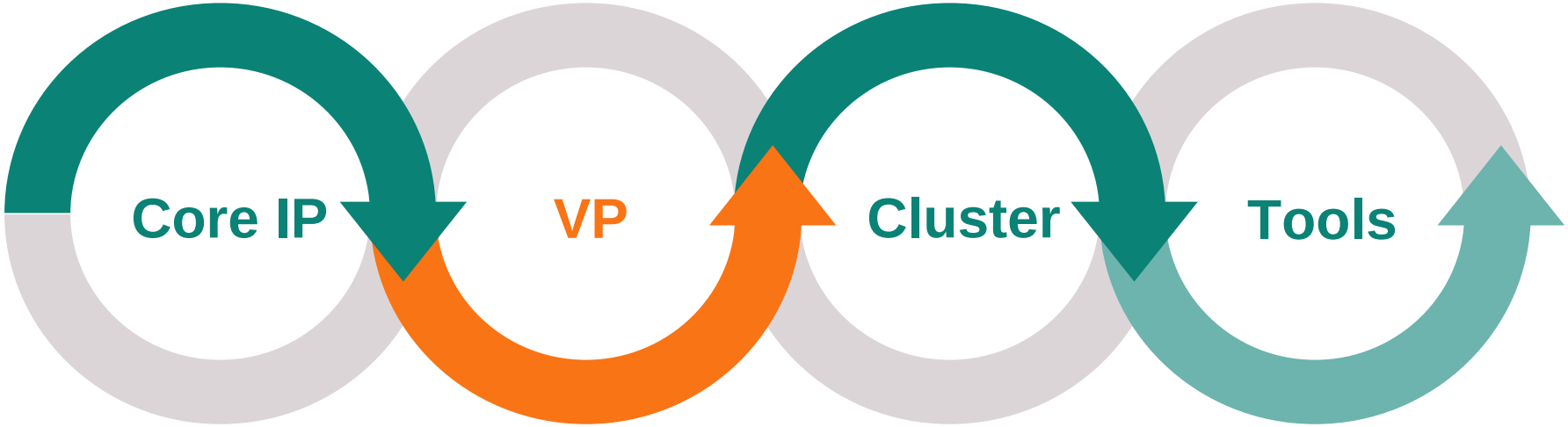
RISC-V – Infineon added RISC-V to core roadmap for future products in automotive and IoT



RUST - compilers are available today for Infineon TriCore™

- Open source becomes an essential part of our approach to “getting customers started”
- IFX is working on development environments combining open source technologies with qualified toolchains

Infineon and industry partners build a strong RISC-V eco-system
First Virtual prototype of new RISC-V architecture available this year



First Virtual Prototype for Infineon **next generation MCU based on RISC-V** will be already available at **the end of 2024**

Infineon and Synopsys bringing together expertise in **MCU- and IP-Development –** leveraging learnings and deep understanding to bring **benefit to RISC-V community**

The mission to make RISC-V available for Automotive

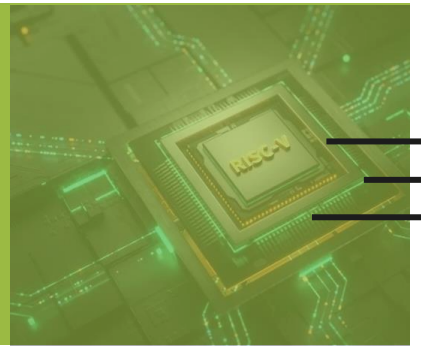
QUINTAURIS

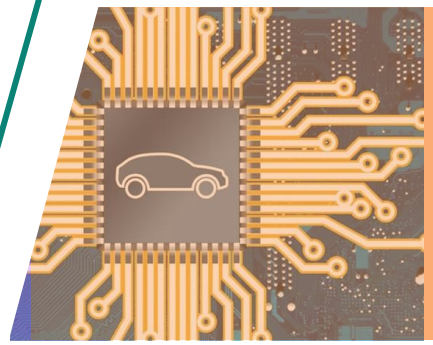
a joint platform to foster standardization in the ecosystem

Aligned with the RISC-V community and government bodies

Accelerating the **commercialization of RISC-V** based products, **addressing certification and maintenance** challenges

Leveraging RISC-V benefits of flexibility, control and visibility, providing a blueprint for **reliable implementations**





Quintauris as trusted bridge between **RISC-V innovation & commercial** solutions – **defragmenting** the ecosystem **without lock-in**

Five leading industry players as shareholders:

BOSCH Infineon NORDIC SEMICONDUCTOR NXP QUALCOMM

Quitauris logo protected by https://www.quintauris.eu/

Key take-aways

- IFX as #1 automotive microcontroller company is investing in open source technologies – RISC-V is a key technology for further expansion of our portfolio
- RISC-V offers both, a very lean and cost-efficient starting point for future high-performance, dependable and scalable controller products
- Infineon is actively shaping the RISC-V eco-system in the market – we are driving standardization with partners


Infineon