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Simplifying complexity

A Safe and Secure ROS 2 Multi-Domain Architecture for AMD Embedded Heterogeneous Platforms

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Mixed-Criticality Software for Robotics

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Multimedia

Perception

Low-level Control

Monitoring

Third-Party Network

High-level Control

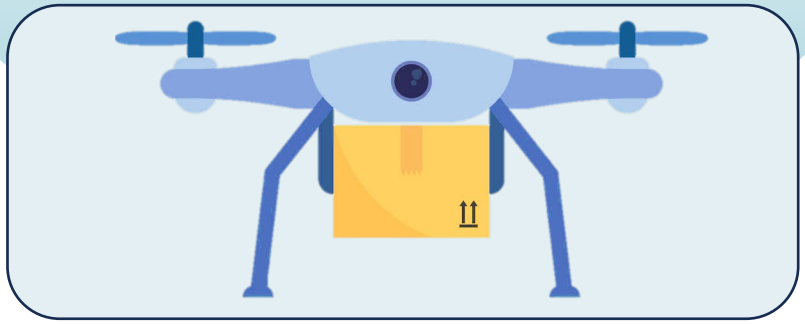
Collision avoidance

Machine Learning

Planning

Field Network

Localization



Mixed-Criticality Software for Robotics

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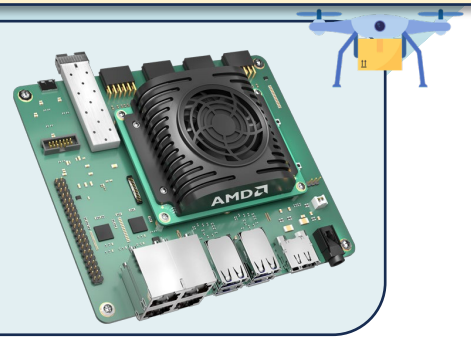
Localization

All in one platform to contain *space*, *weight*, *wiring*, *power*, and **cost** (SWaP-C)!

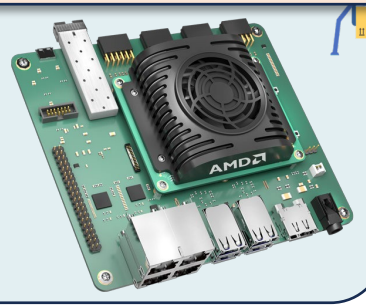
AMD Kria™ KR260 Robotics



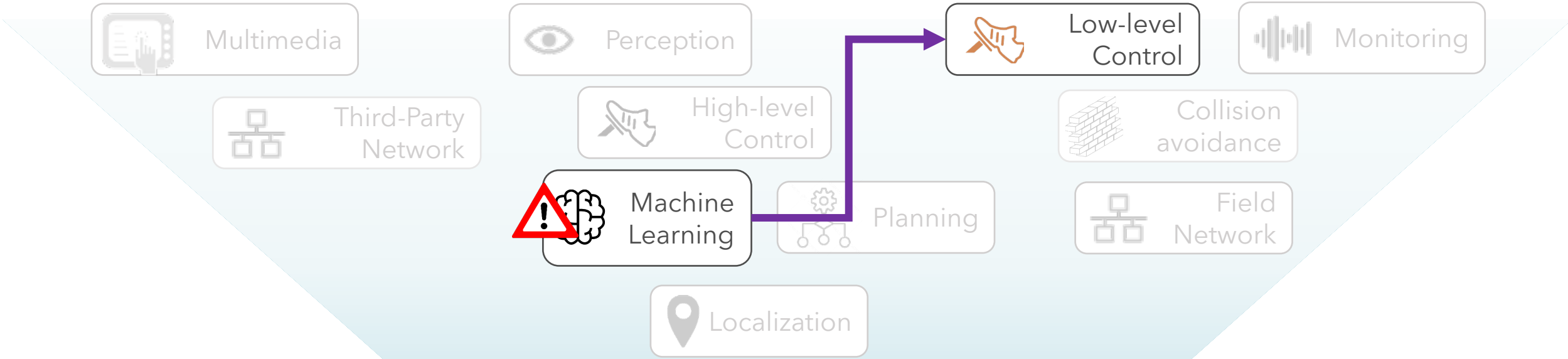
Cyber-Security Threats

Cyber-attacks starting from *low-criticality* software can **compromise** the mission of the system

AMD Kria™ KR260 Robotics

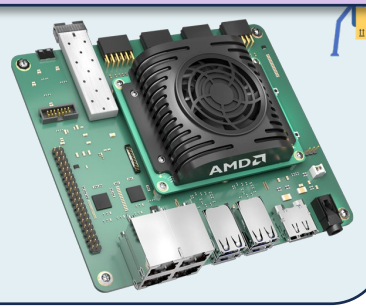


Safety Issues

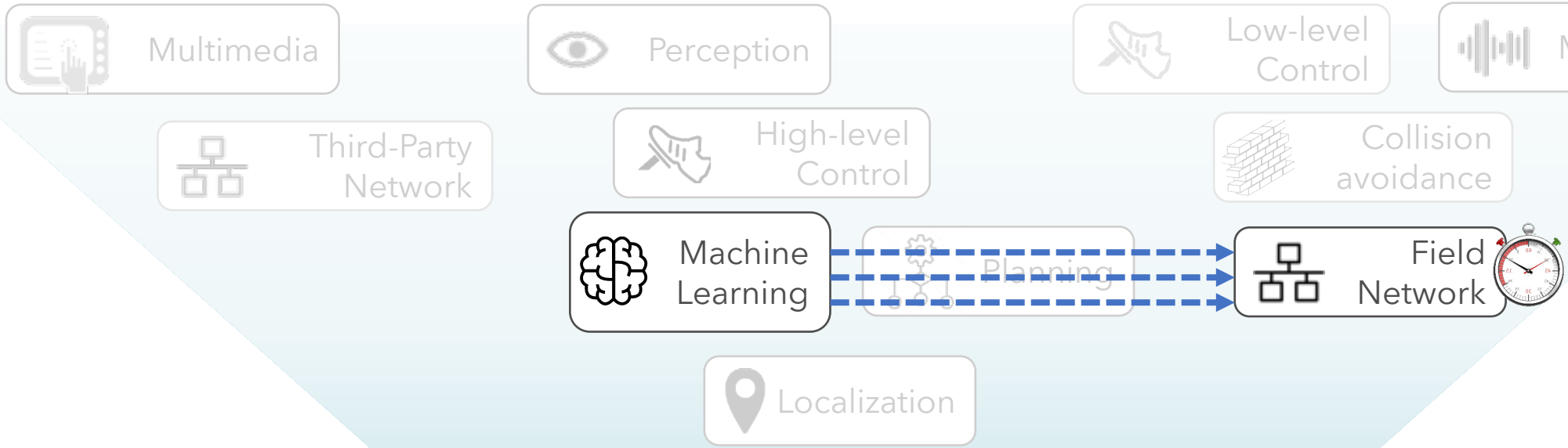


Safety issues that interest complex, *mid-criticality* software can **propagate** to *safety-critical* software

AMD Kria™ KR260 Robotics

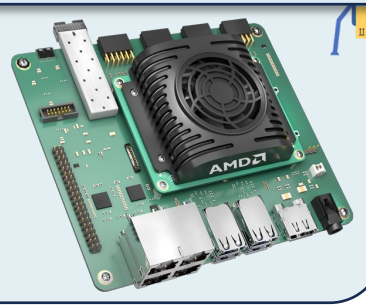


Time-Predictability/Determinism Issues

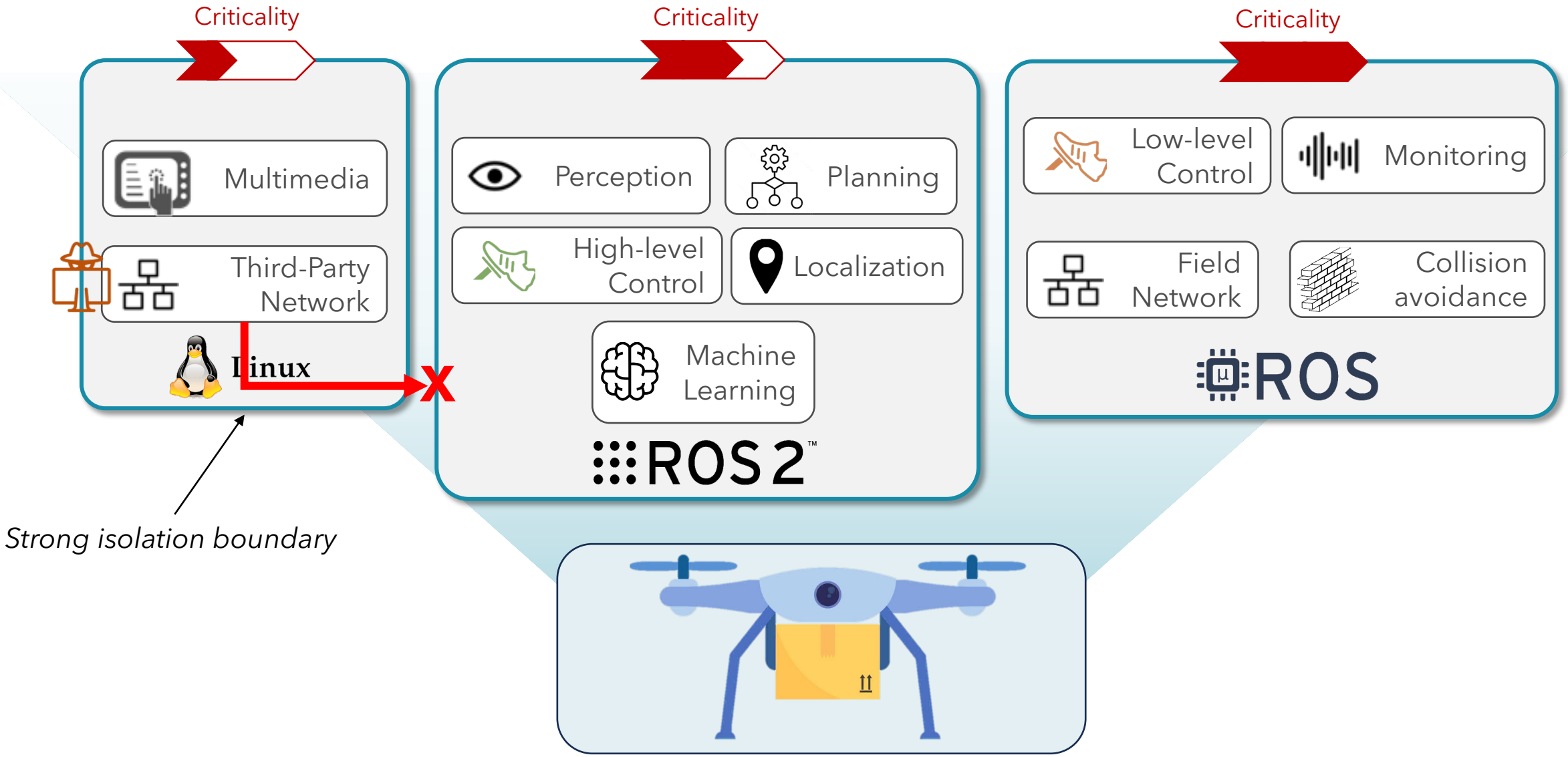


The temporal properties of *safety-critical* software can be **disrupted** by complex, *mid-criticality* software due to *on-chip interference*

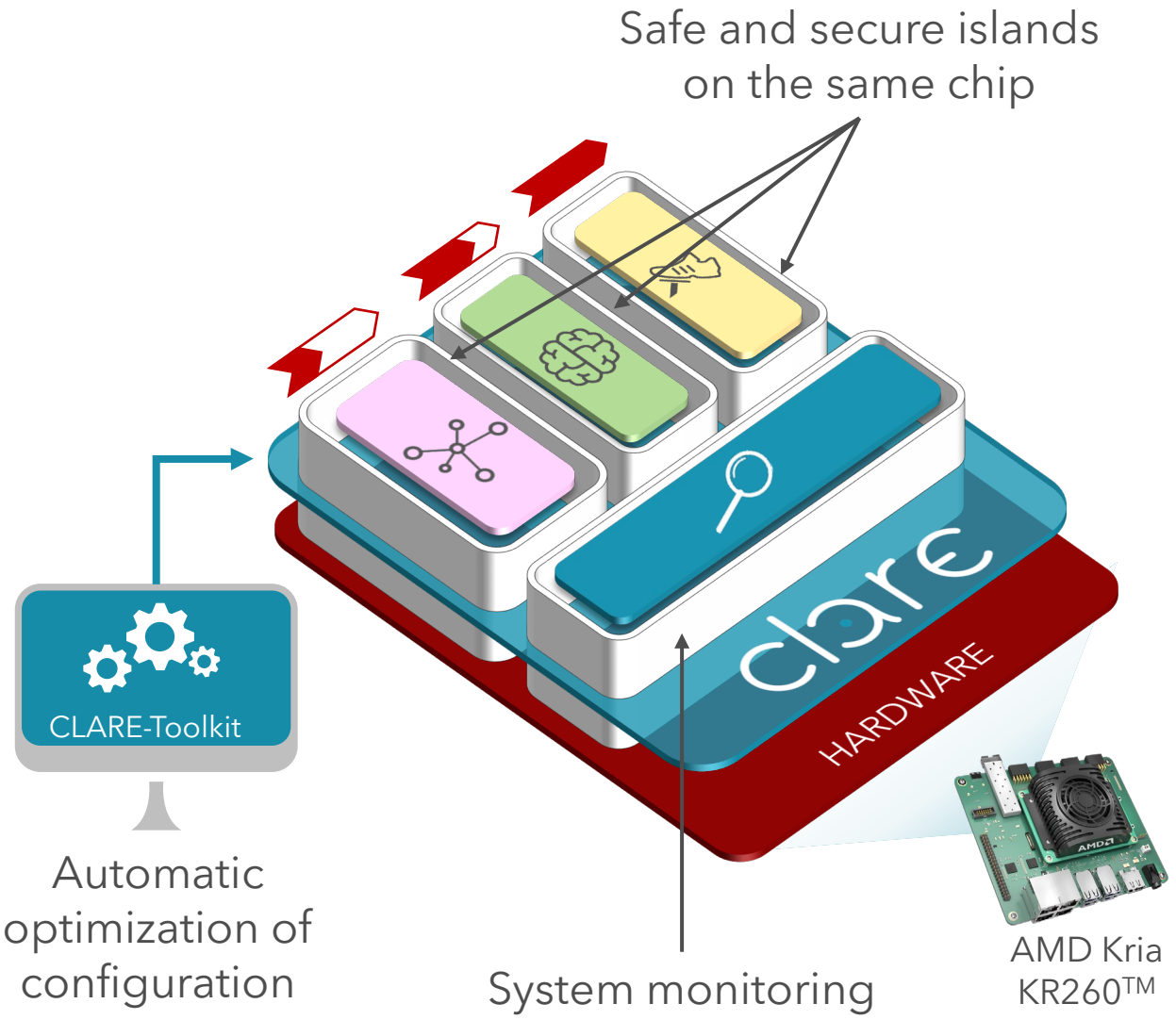
AMD Kria™ KR260 Robotics



Multi-Domain Architecture



The CLARE Software Stack



Strong isolation between islands
(next-gen Hypervisor technology pioneered with research activities)

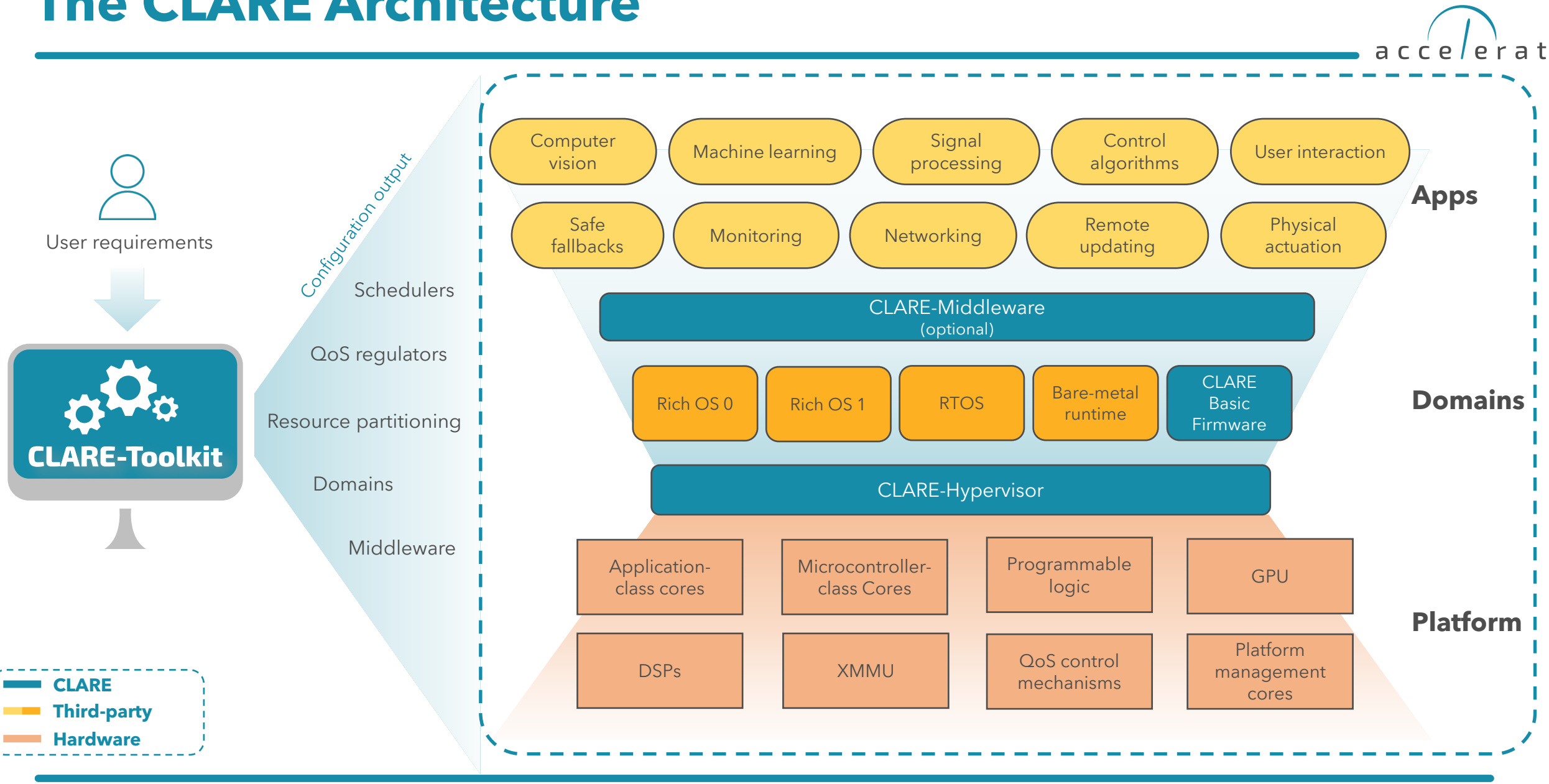
Automatic optimizations

Intelligent machine verification
(Design Rule Checking for avoiding mistakes in the configuration)

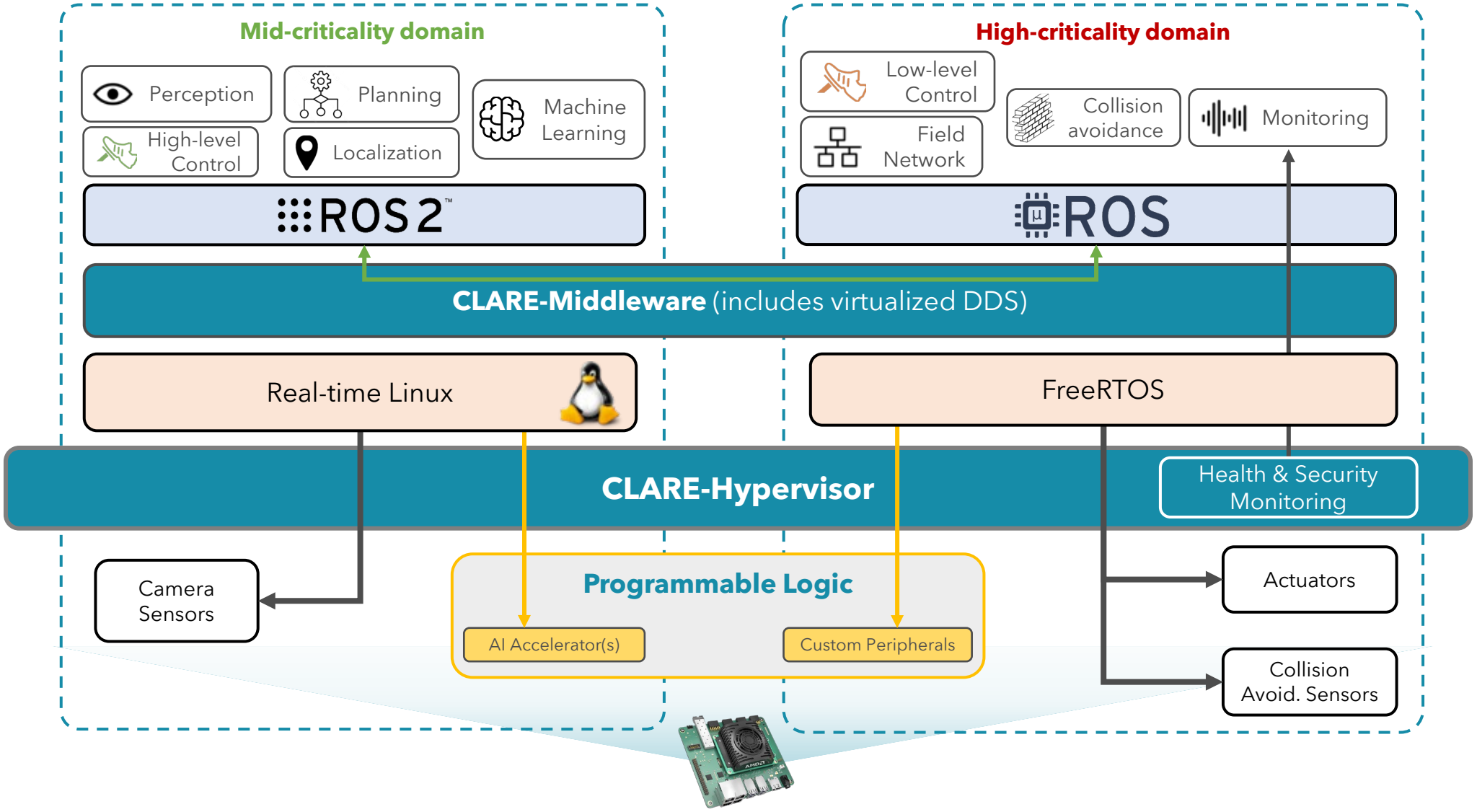
The expert is CLARE-Toolkit
(no need for experts in system-level software and hardware)

< 1 hour for the whole configuration

The CLARE Architecture



CLARE for Multi-Domain ROS

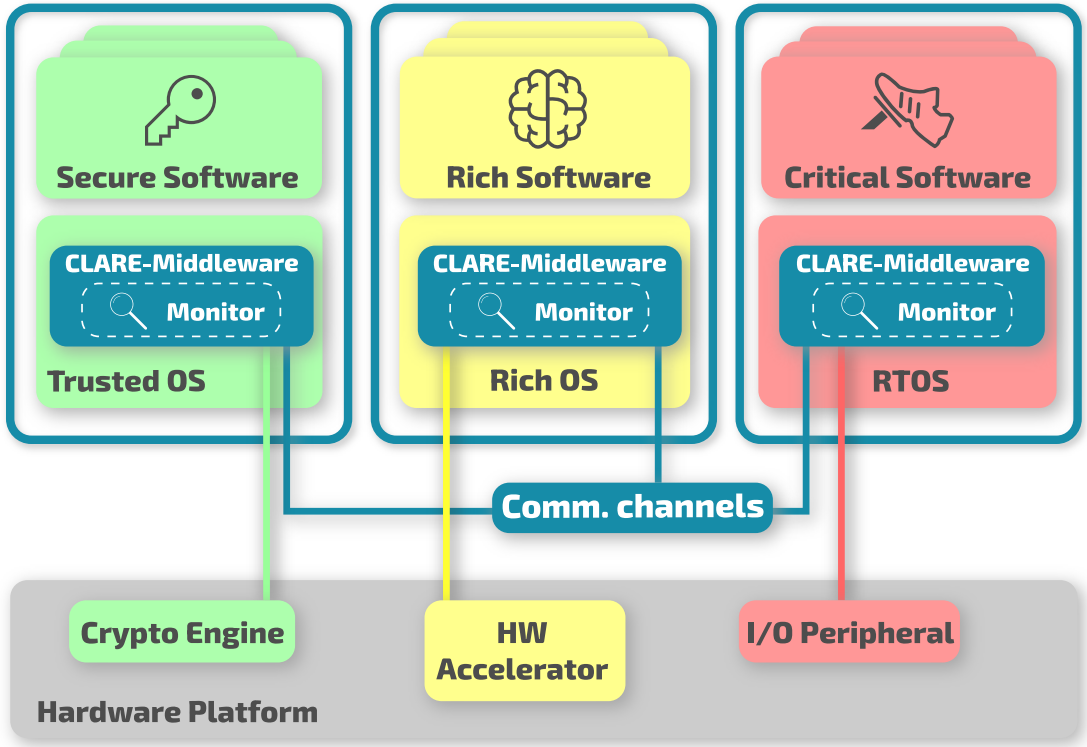


CLARE-Middleware

Unified and **simplified API** to access CLARE and platform services

Main features relevant to Multi-Domain ROS2:

- Transparent, virtualized **publisher/subscriber** data distribution service
  - Uses CLARE's built-in time-predictable, safe and robust **inter-domain communication**
- Signaling for **health and security monitoring**



CLARE-Hypervisor

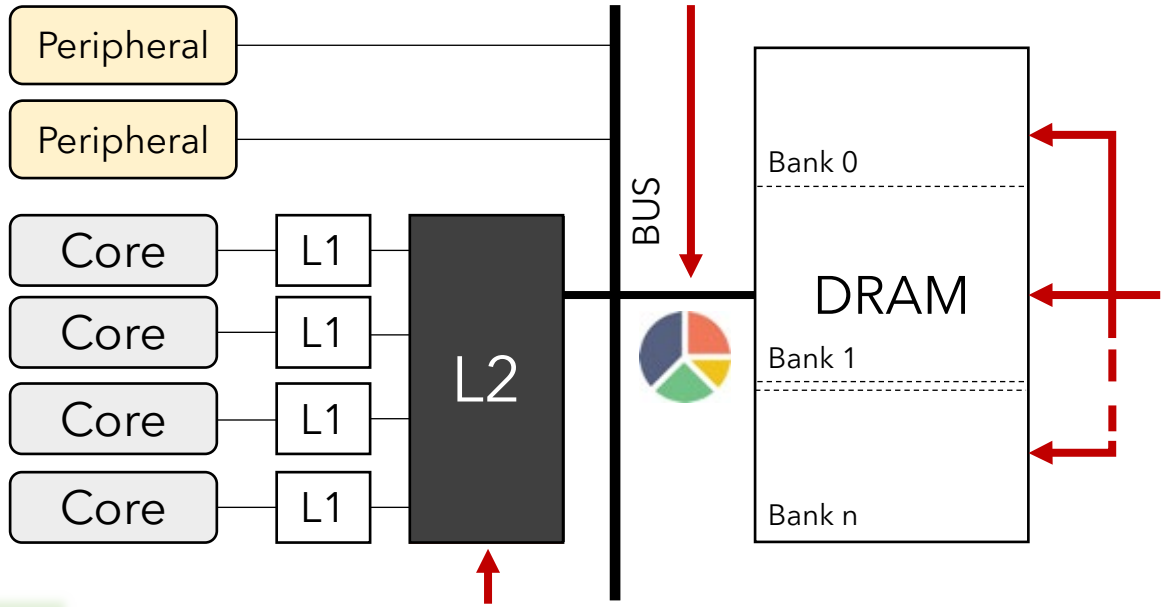
- Fixed-priority and EDF scheduling
- Bounded latency for event dispatching
- Super low-latency FastBoot
- Secure cache partitioning
- Bank-aware memory allocation
- Memory bandwidth reservation

- Address-Space Layout Randomization
- Control-Flow Integrity
- Secure boot for VMs
- TrustZone support
- Strong VM space separation
- Robust to denial-of-service and side-channel attacks

- Totally static
- MISRA compliancy
- Off-line auto-generated configuration
- Ongoing SIL4/ASIL-D certification
- ~ 8K LoC
- VM-level health-monitoring

Strong Isolation

CLARE-Hypervisor implements advanced mechanisms for **strong isolation**, which can be optimally and automatically configured from CLARE-Toolkit



Memory bandwidth reservation

Budgeting the number of transactions that can be issued by each core and each I/O peripheral over time

Countermeasure for memory-related *inter-domain* **DoS attacks**

Bank-aware partitioning

Allocating domains to different DRAM banks to control memory contention

Countermeasure for DRAM-related *inter-domain* **side-channel attacks** (e.g., Row Hammer)

Secure cache partitioning

Partitioning the shared levels of cache to control inter-core interference

Countermeasure for cache-related *inter-domain* **side-channel attacks**

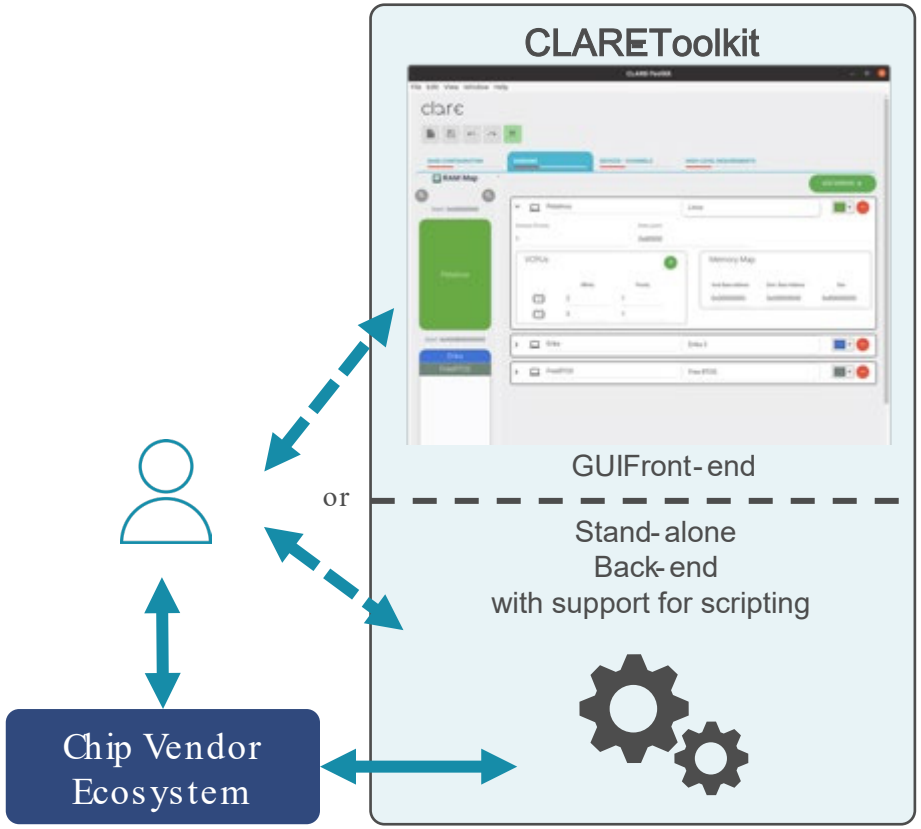
CLARE-Toolkit

Configuration of the entire CLARE Software Stack with availability of a rich **template library**

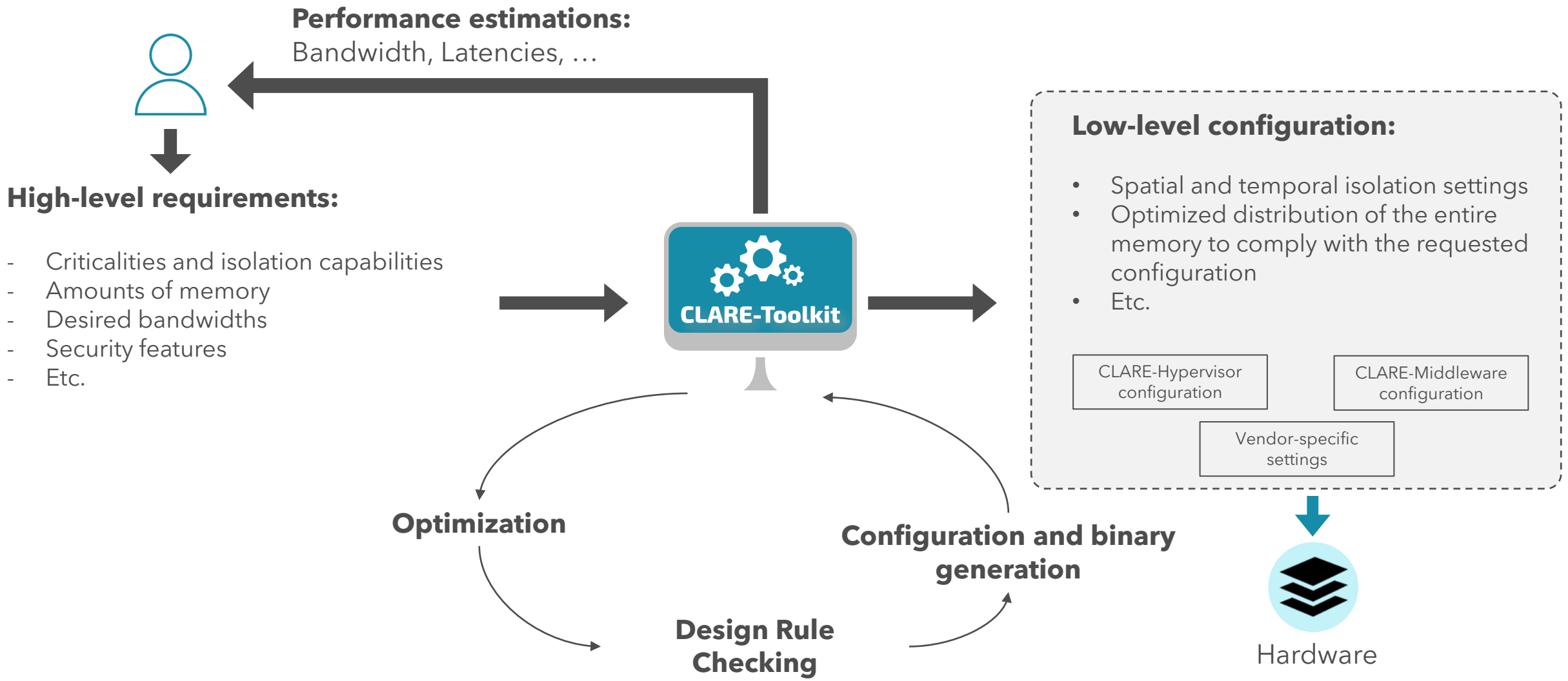
Automatic optimization of the deployment and configuration of complex **mixed-criticality applications**

Platform-awareness for low-level isolation mechanisms

Designed to be **integrated with Chip Vendor Ecosystems**



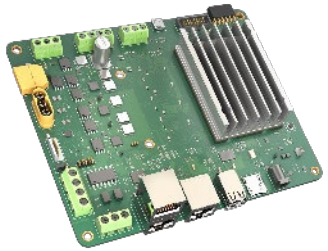
CLARE-Toolkit



Scalable AMD Kria™ Portfolio

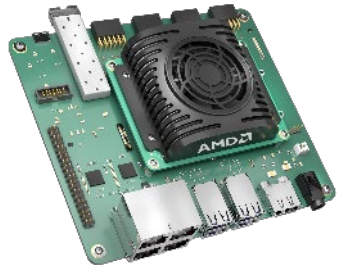
Choose the **Starter Kit** → Select the right **Production SOM** → Develop your **Custom Carrier Card**

KD240 DRIVES
For Drives and Motor Control Systems



KV260 VISION AI
For Vision AI Cameras and Systems

KR260 ROBOTICS
For Robotics and Machine Vision Systems

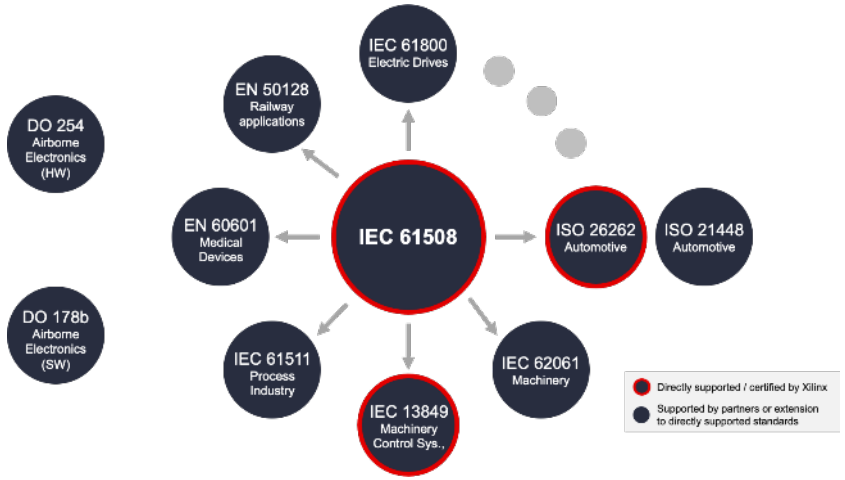


KRIA™ K24 SOM
- Half the size of a credit card
- Power efficient
- ECC support

KRIA K26 SOM
- VCU and larger DPU
- 55% more I/Os
- Transceivers

Safety Certifications for AMD

- **Functional Safety Certifications**
  - ISO 26262
  - IEC 61508
  - ISO 13849
- **Certified**
  - Vitis/Vivado Developer Tools
  - MicroBlaze compiler
  - Zynq Ultrascale+ MPSoC



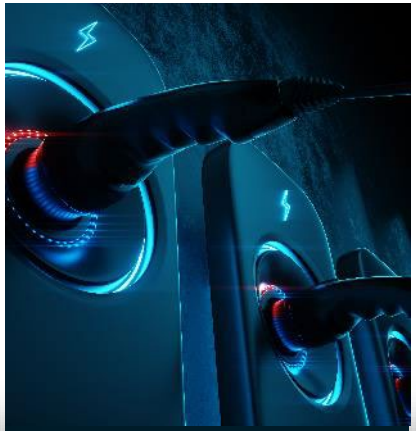
Target Applications for Embedded Developers

Robotics

- Joint Control
- Actuation
- Motion

Power Generation

- Pitch/Yaw Control
- Multi-level Inverter
- Communications



EV Charging

- Inverter Control
- V2G Communication

Medical Control

- Gantry and Bed
- Surgical Actuation
- Surgical Generator

Patient Care

- Sensor Fusion
- 3D Graphic Display
- Precision Calculations

Public Transportation

- Train Control / Mgmt.
- Comfort / Information
- Comms / Recorder

AMD
together we advance_

Simplifying complexity

THANK YOU

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