

# arm

Empower every stage of  
TinyML application  
development

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© 2024 Arm

AI-generated image

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## The AI Landscape

# Machine Learning is Being Deployed Everywhere

Healthcare



Smart Home



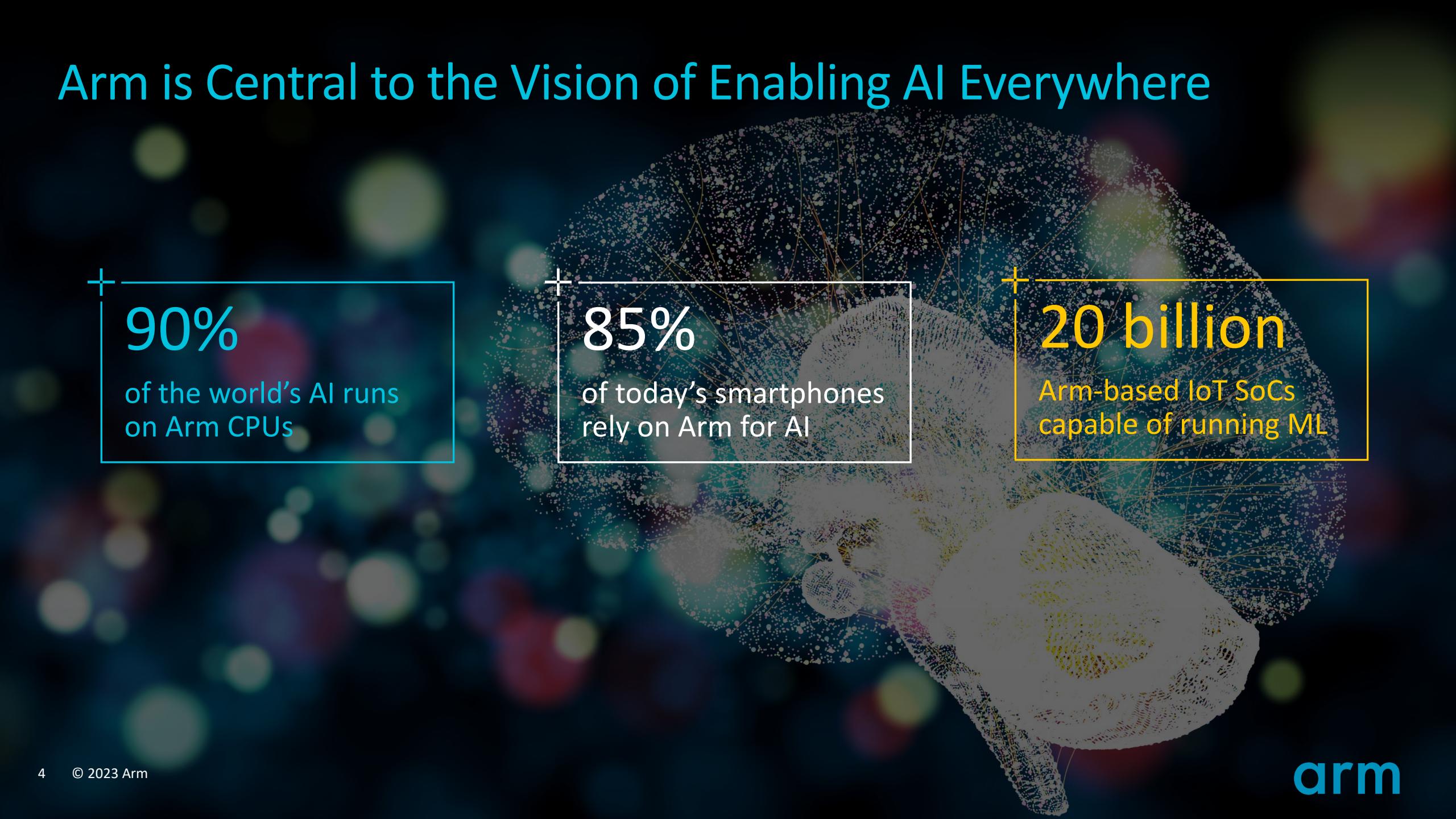
Industrial



Smart City



# Arm is Central to the Vision of Enabling AI Everywhere



**90%**

of the world's AI runs  
on Arm CPUs

**85%**

of today's smartphones  
rely on Arm for AI

**20 billion**

Arm-based IoT SoCs  
capable of running ML

# Arm is at the Center of the AI Ecosystem





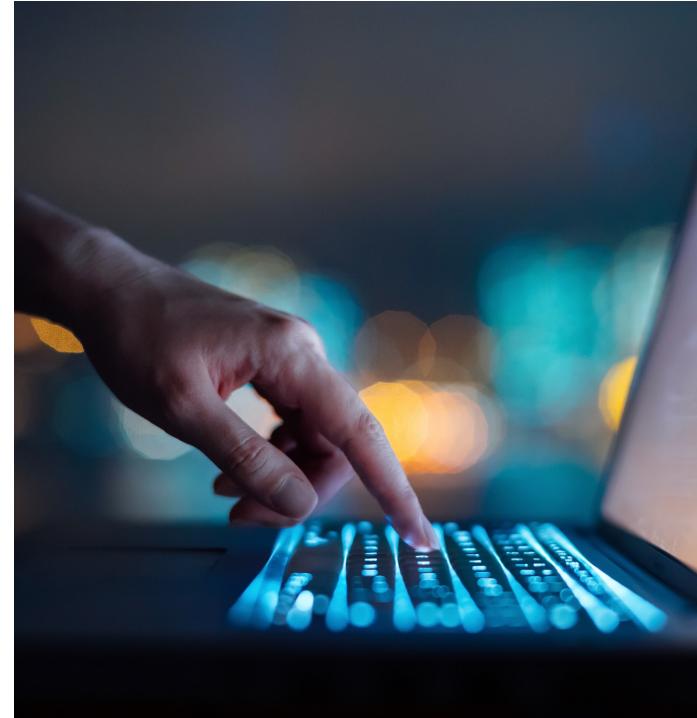
# Enabling ‘AI on the Edge’ Using Arm’s Solutions

# Arm is Enabling Machine Learning within Three Focus Areas

## Hardware IP Portfolio



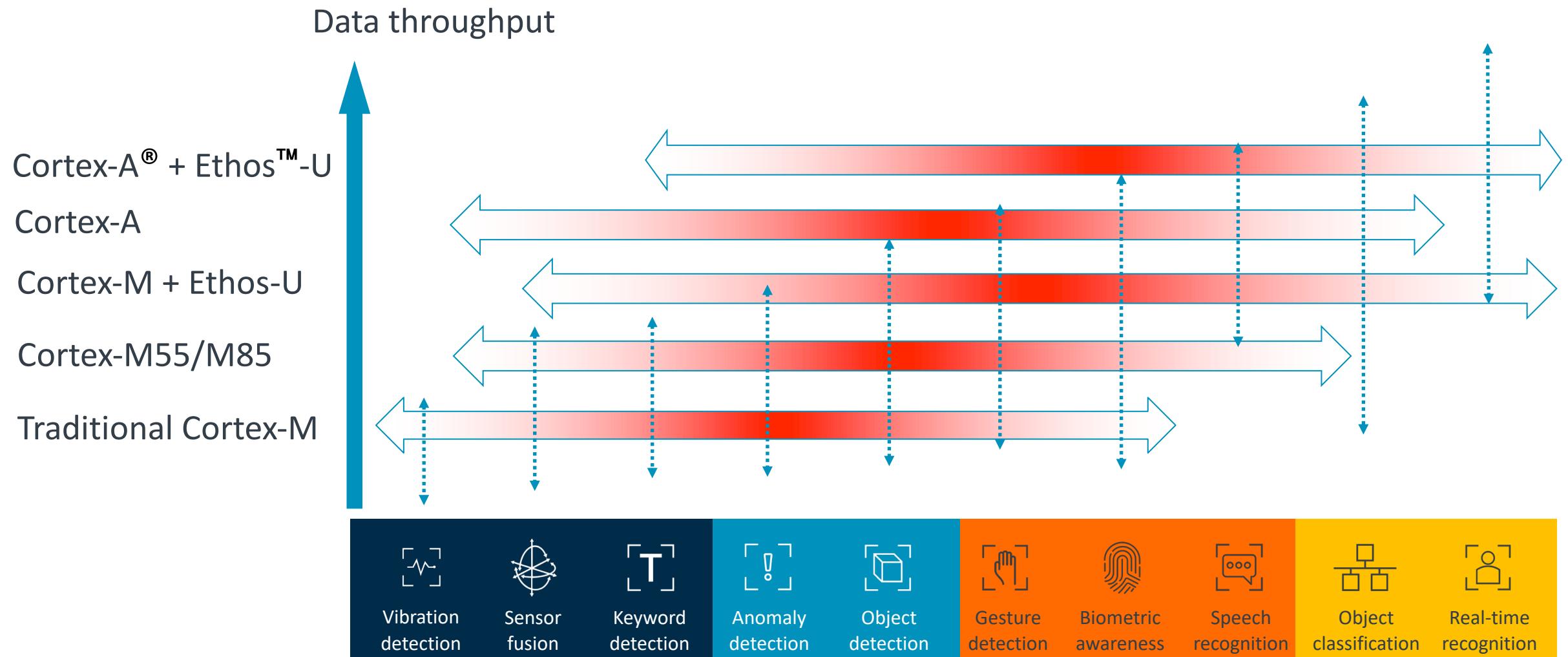
## Standards, Software and Tools



## Developer Experience



# Broadest Range of ML-optimized Processing Solutions



# Cortex-M Processor Portfolio – Instruction Set Evolution

Cortex-M85

Cortex-M55

Cortex-M33

Cortex-M23\*

Cortex-M35P

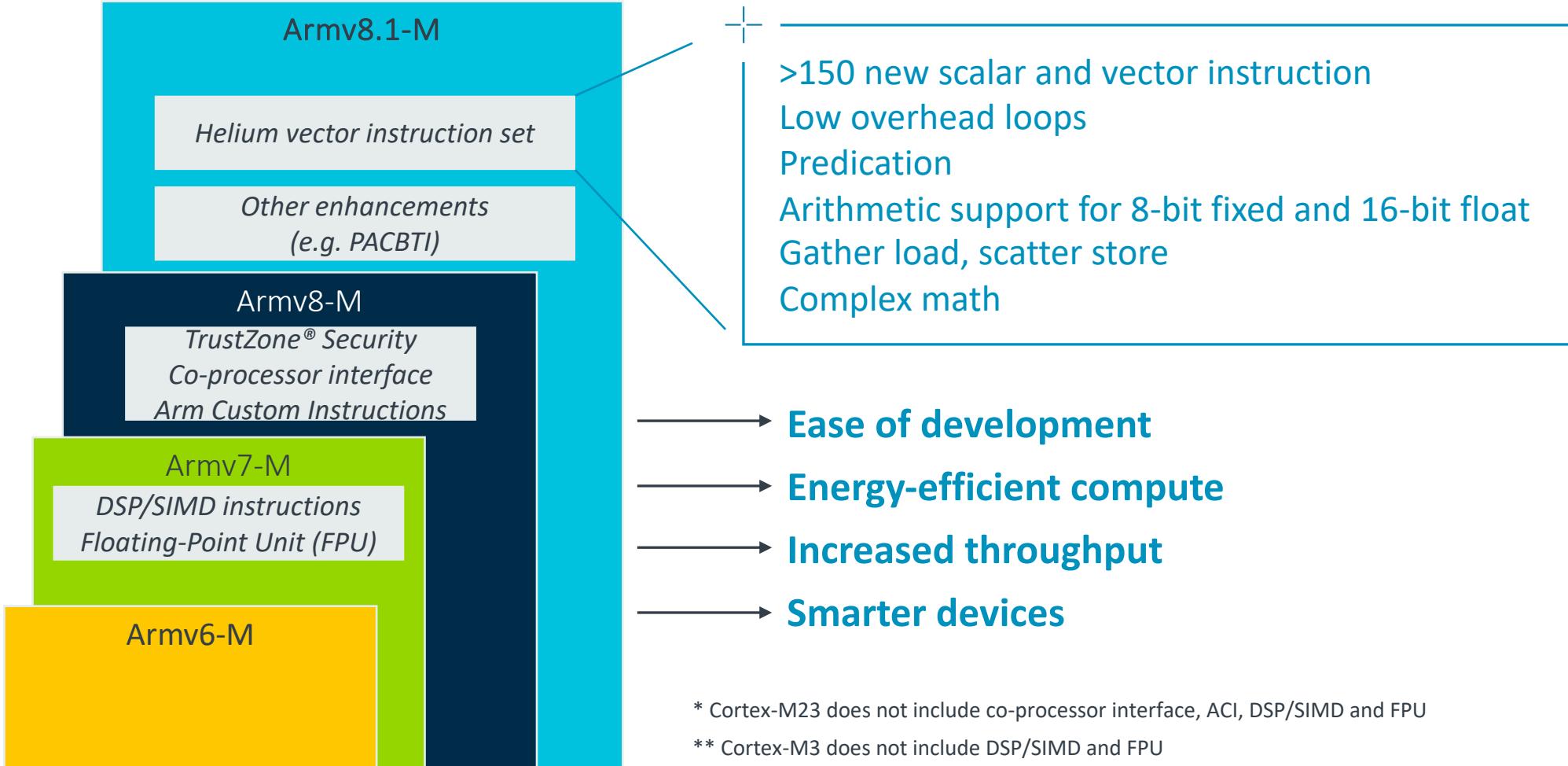
Cortex-M7

Cortex-M4

Cortex-M3\*\*

Cortex-M0+

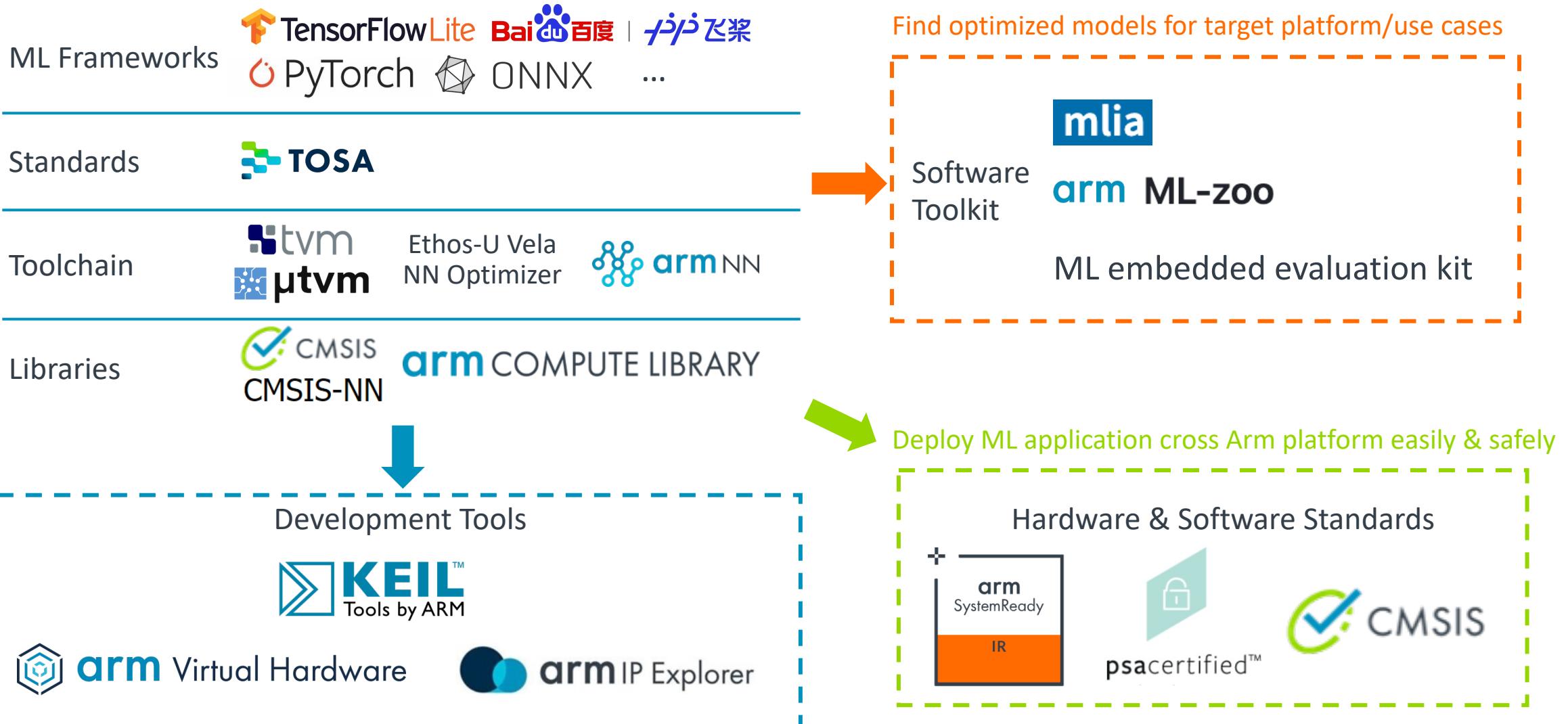
Cortex-M0



\* Cortex-M23 does not include co-processor interface, ACI, DSP/SIMD and FPU

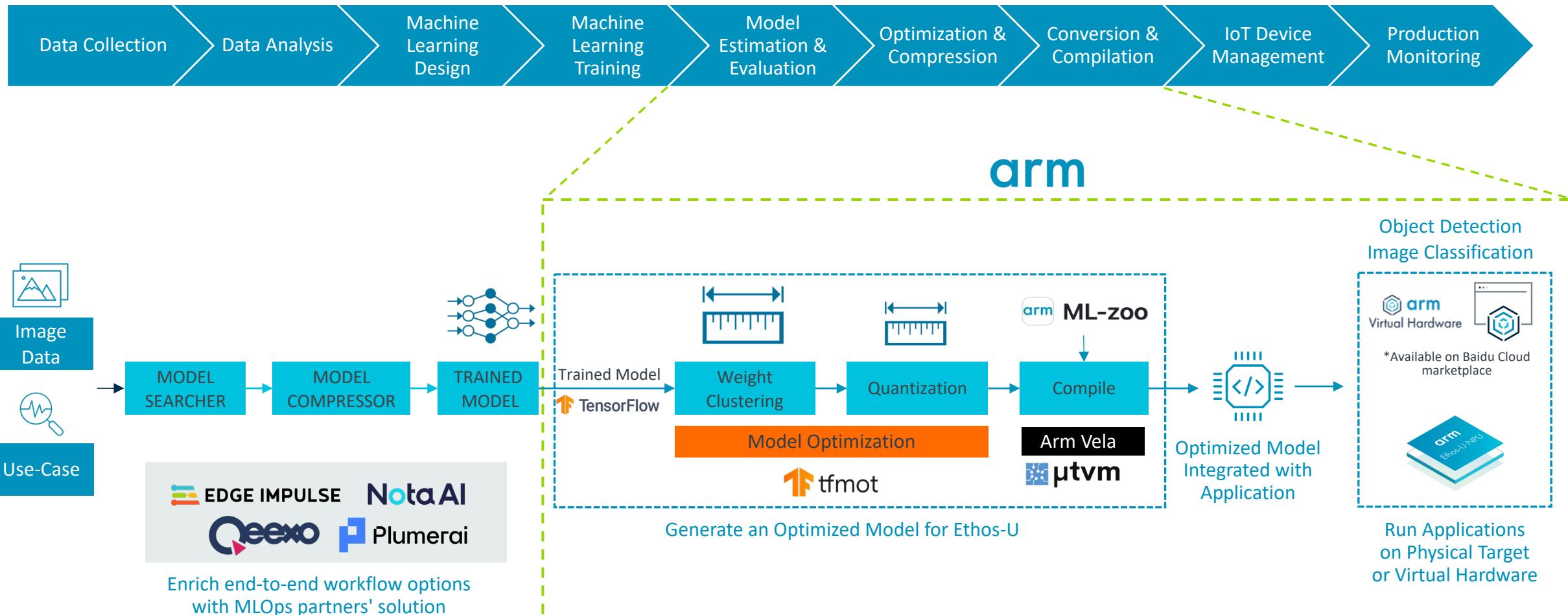
\*\* Cortex-M3 does not include DSP/SIMD and FPU

# Provides The Best Experience to Develop ML on arm



# Empower Every Stage of ML Developer Workflow

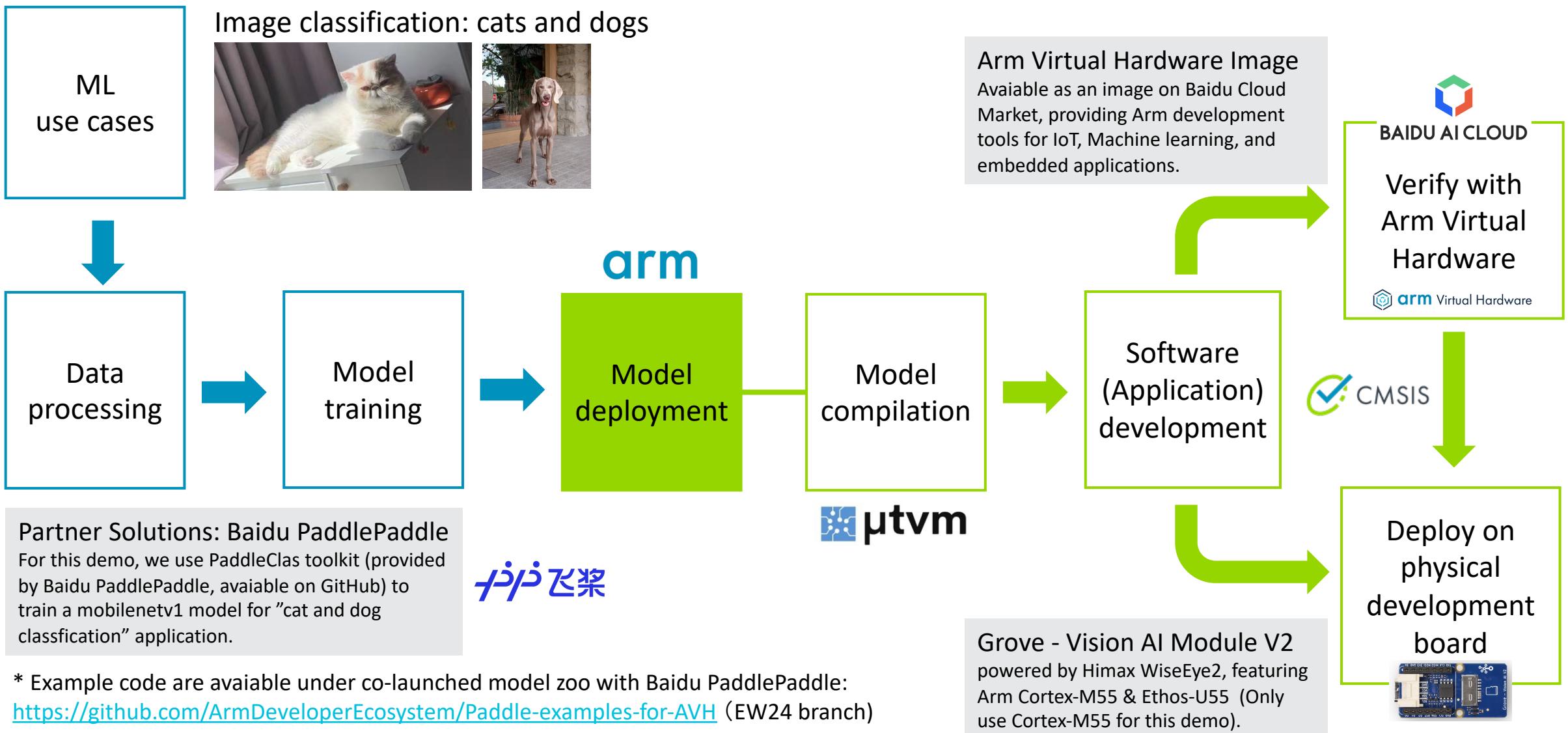
Example of multiple end-end workflow options for Arm Ethos-U NPU



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## Demo Walkthrough

# Leverage Arm's solutions to accelerate TinyML development

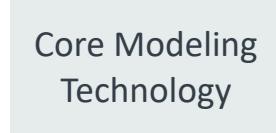
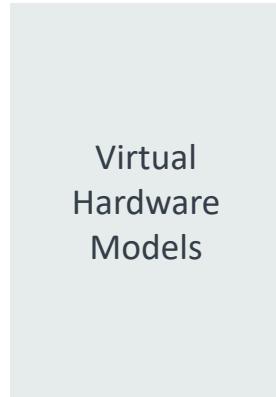


# Arm Virtual Hardware (AVH)

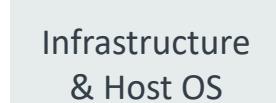
Consists of two different virtual hardware products to meet different application demands



Arm Virtual Hardware: Corstone™ and CPUs



Fixed Virtual Platforms (FVPs)  
based on Arm Fast Model technology



Arm & x86 (ubuntu)

Arm based processors and systems



Arm Virtual Hardware: Third-Party Hardware

Development Boards



In the cloud

Develop Software with Confidence

Achieve Maximum Scalability

Accelerate Development

Features and Benefits

Hypervisor Technology

Arm (bare-metal)

Popular IoT development kits

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# Introduction to Arm Education and Academic Engagements

# Academic Engagement

The **Semiconductor Education Alliance (SEA)** is a partnership of 20 organisations committed to creating learning pathways based on identified Knowledge, Skills and Attribute (KSA) gaps. Learn more [here](#)

IP

Arm Academic Access (AAA) is a license and royalty free member program for university and other institutes worldwide for non-commercial research, providing portfolios of Arm technology on an ongoing basis. AAA has more than 115 members and is growing. Learn more [here](#)

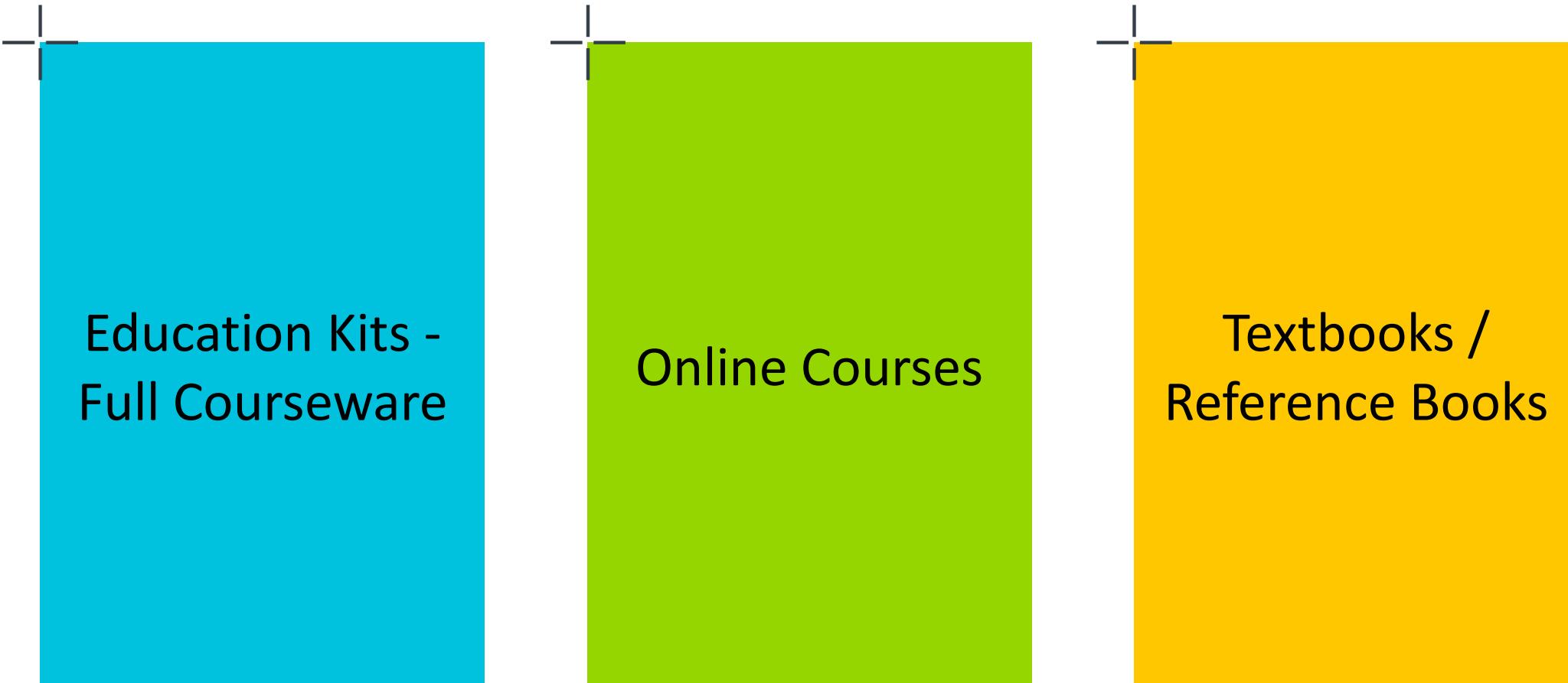
CONTENT

Arm Education provides curriculum aligned Education Kits for teachers, online courses for learners, text and reference books and tools, all to help universities worldwide demonstrate key principles and educate the next generation of engineers. Learn more [here](#)

COMMUNITY

Worldwide Communities of Practice such as **SoC Labs** for universities to share and collaborate on Arm-based projects and platforms, and **Edu Labs** for teachers to share, fork, modify and re-mix curriculum content to support above. Learn more [here](#) and [here](#)

# Flagship Products for University Education

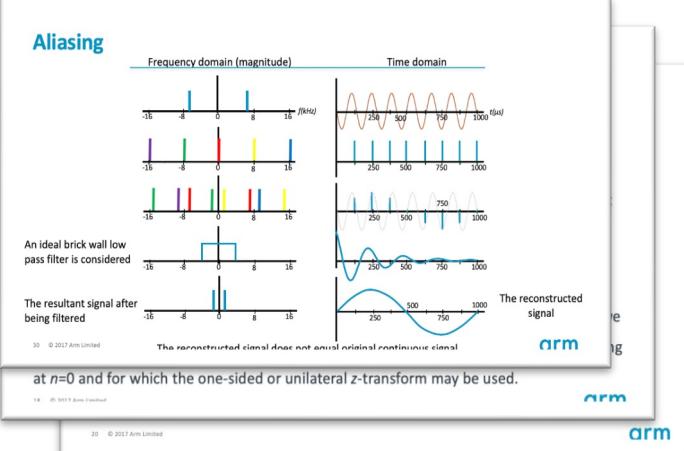


Education Kits -  
Full Courseware

Online Courses

Textbooks /  
Reference Books

# Education Kits



The slide is titled 'CPU ASM LAB EXERCISE: PROCESSING TEXT IN ASSEMBLY LANGUAGE'. It includes sections for 'OVERVIEW', 'DETAILS', 'ARDWARE', and 'SOFTWARE'. The software section shows a screenshot of a debugger interface with assembly code and memory dump tabs. The hardware section shows a Nucleo-F401RE board with various components like headphones, microphone, and sensors. The bottom of the slide includes copyright information: '© 2017 Arm Limited'.

Slides, quizzes, exam questions



Software tools  
(Arm Development Studio, Keil, etc.)

Lab manuals



CPUAsm\_lab.zip CPUAsm\_proj\_sol.zip CPUAsm\_proj.zip

Code solutions



Partner hardware

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# Online Courses



- [edX](#) is a massive open online course (MOOC) provider created by Harvard and MIT back in 2012.
- Since its inception, it has hosted over 3,600 courses from 360 content partners and has reached over 110 million learners.
- Arm Education's association with edX began in 2020, and since then our courses have reached in excess of **30,000 learners** from over **150 countries**.
- Courses available:
  - [Embedded Systems Essentials with Arm Professional Certificate](#)
  - [Build Your First Internet of Things Application on Arm](#)
  - [Machine Learning at the Edge on Arm: A Practical Introduction](#)
  - [Business Models for Technology Innovators](#)
  - [Computer Architecture Essentials on Arm](#)



- 7 online courses designed as companion resources to education kits: <https://www.arm.com/education/online-courses>

# ML at the Edge on Arm: A Practical Introduction

- + Hands on experience with creating ML applications on Arm
- + Specifically focused on applying ML at the 'Edge'.
- + Learning Outcomes:
  - How to get started with machine learning on Arm microcontrollers.
  - How to acquire data from sensors and peripherals on a microcontroller.
  - The fundamentals of Artificial Neural Networks in constrained environments.
  - Convolutional Neural Networks and Deep Learning.
  - How to deploy computer vision models using CMSIS-NN.





# Questions

# Developer Resources

- + Open-source software stacks for Cortex-M based ML applications
  - [CMSIS](#)
    - [CMSIS NN](#) – Neural network kernels optimized for Arm
    - [CMSIS DSP](#) – Compute library for embedded systems; includes compute graph for efficient data streaming between different algorithms
  - [Arm ML Embedded Evaluation Kit](#) – Build and deploy ML applications targeted for Corstone-300/310
  - [Synchronous Data Streaming \(SDS\) framework](#) - Simplify Development of Embedded Applications that utilize DSP or ML algorithms with Sensor/Audio Input
- + Example projects
  - [Paddle Examples for AVH](#) – Co-launch model zoo with more use cases based on PaddlePaddle models
  - Arm Virtual Hardware developer resources on [GitHub](#) – broader usage examples from ML to IoT, DevOps
- + Websites, blogs and courses
  - Courses: [Arm Tech Talks](#)
  - [IoT Solutions at Arm](#) - Arm is the Company, Technology and Unifying Force Behind the IoT Revolution
  - Blogs: The future of ML shifts to the edge, [New Arm Virtual Hardware Integrations](#)
  - Tutorial:
    - + [How to Deploy PaddlePaddle on Arm Cortex-M with Arm Virtual Hardware](#)
    - + [ML Developers Guide for Arm Cortex-M Processors and Ethos-U NPUs](#)

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Thank You

Danke

Gracias

Grazie

謝謝

ありがとう

Asante

Merci

감사합니다

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