# Paving the way for sustainable AI

## We enable and provide AI

October 2024

# Infineon and you – driving the AI revolution

Our technologies and AI-models drive the development of energy-efficient, high-performance and reliable AI applications of the future – and thus for your successful market entry.

## We power AI

Creating a more sustainable future by providing technologies to reduce power losses and cooling costs in greener data centers of the future.

## We enable and provide AI

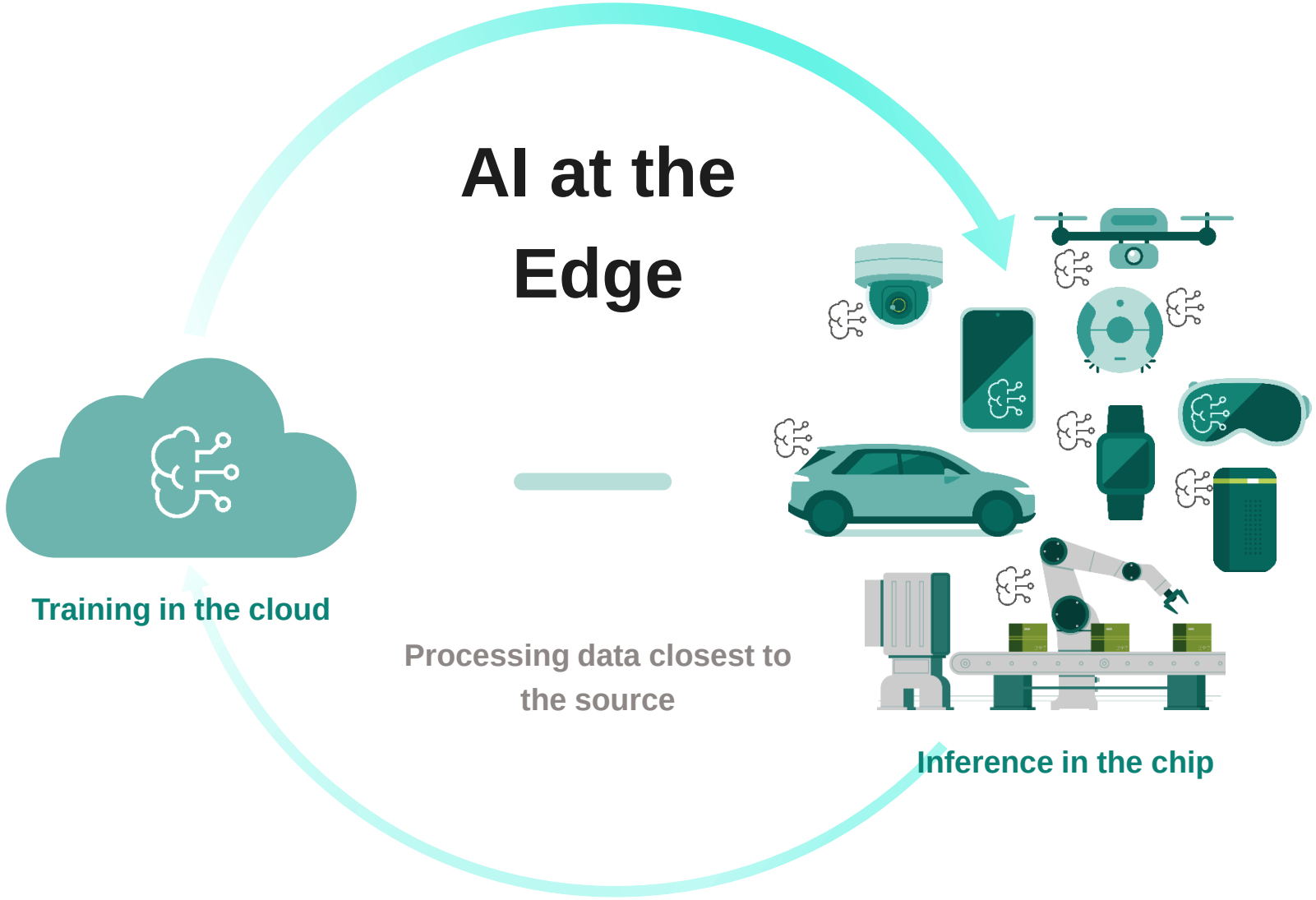
Supporting customer’s innovation with semiconductor solutions, software, and tools that help deliver AI innovation quickly, efficiently, and at scale.

## We use AI

Moving forward for high-quality solutions by adopting AI across the organization for smarter products and more streamlined processes.

# We enable and provide AI

# Real-time requirements and the need for power-efficiency, security and privacy drives AI-processing at the edge




## Key benefits of Edge AI

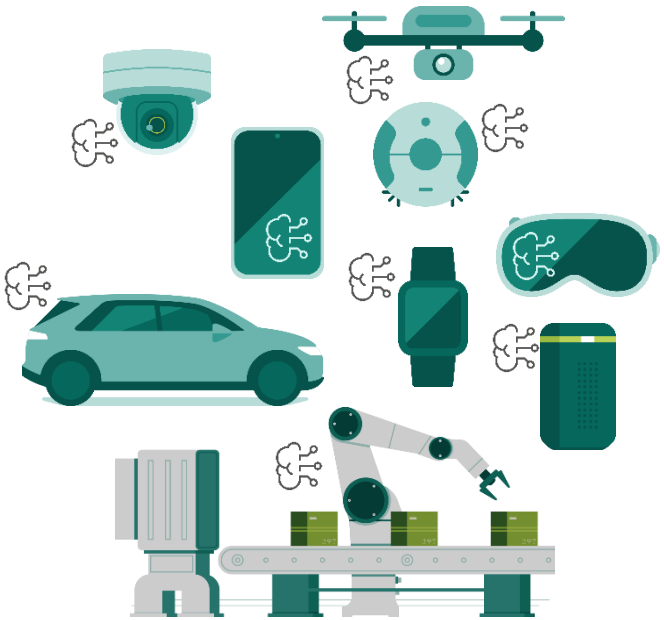
**Low latency and real-time response**

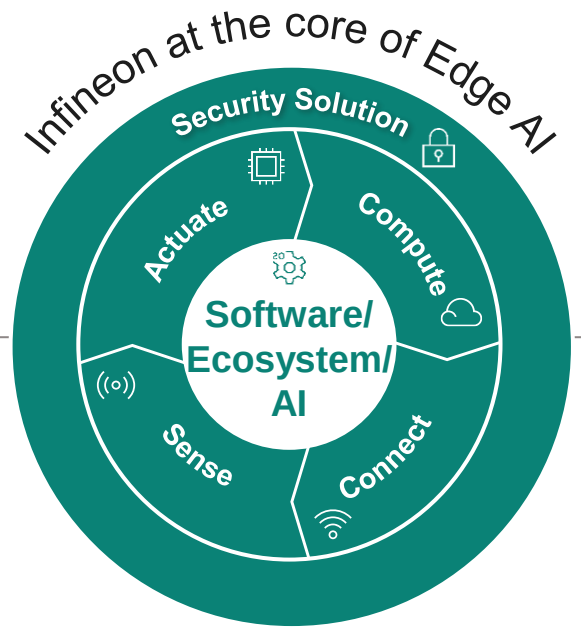
**Higher power efficiency**

**Improved security and data privacy**

**Reduced cost**

# We provide & enable a wide range of technology-solutions for your AI solutions – for every level of AI knowledge







**Infineon at the core of Edge AI:** Infineon's complementary set of AI-specific products and solutions, an end-to-end ML platform as well as an extensive application knowledge and a broad network of experienced AI partners allows you to get your AI application to market quickly – without having to be a proven AI expert.

# Infineon offers end-to-end technology solutions for your AI market entry

## Digital Services and AI solution platforms

INDUSTRIAL ANALYTICS

Hybrid AI-based services

**In-field Power Analytics**

e.g. RUL*

**XENSIV™ sensor solutions**

e.g. Sleep quality service

And others…

## AI-models for a wide variety of applications

**DEEPCRAFT™ Ready Models**

| | | | |
|---|---|---|---|
| Baby cry detection | Siren detection | Surface detection - indoor | Presence detection |
| Cough detection | Alarm detection | Surface detection - outdoor | |
| Snore detection | Gesture detection | Fall detection | ... |

## End-to-end software solutions for easy training & deployment

TensorFlow

Keras

ONNX

**DEEPCRAFT™ Studio**

ModusToolbox™

**AI partner ecosystem:**

SYNOPSYS®

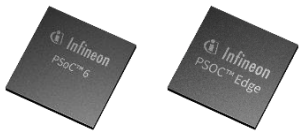
DesignWare ARC MetaWare Toolkit

EKHONO AI

SensiML™

## The right hardware for your Edge AI model

**MCUs:**




PSOC™


AURIX™

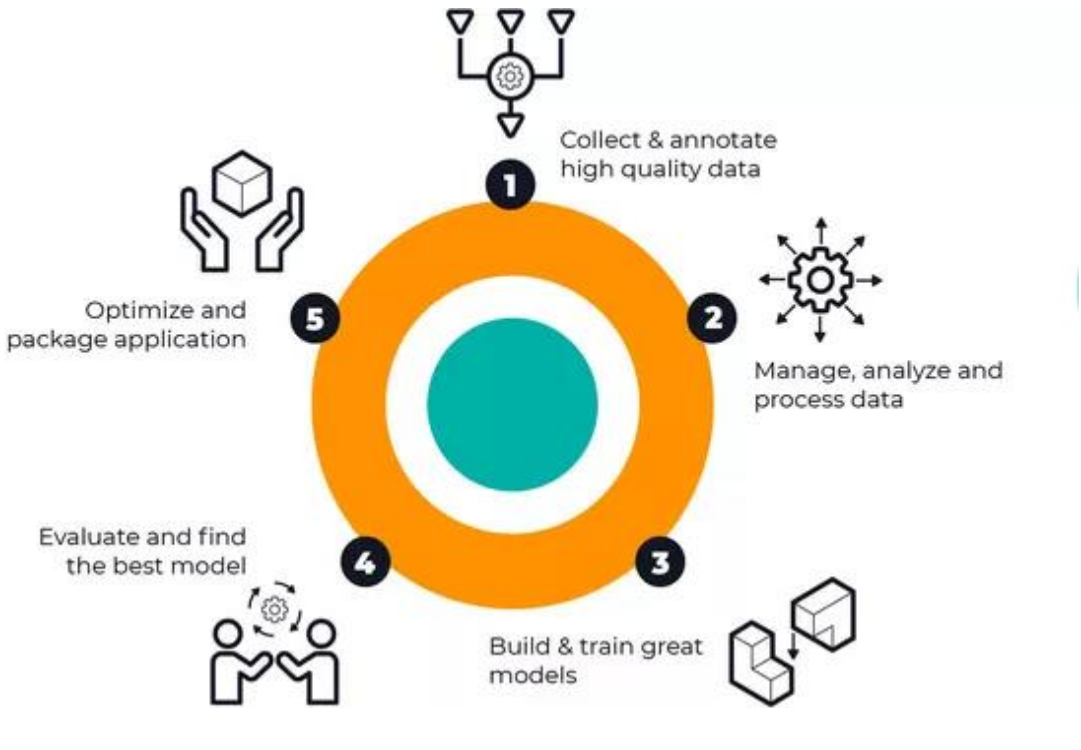

TRAVEO™


XMC™

**XENSIV™** smart sensors portfolio for automotive, industrial and consumer

*Remaining useful life

# DEEPCRAFT™ Studio: take your Edge AI ideas to production quickly and easily

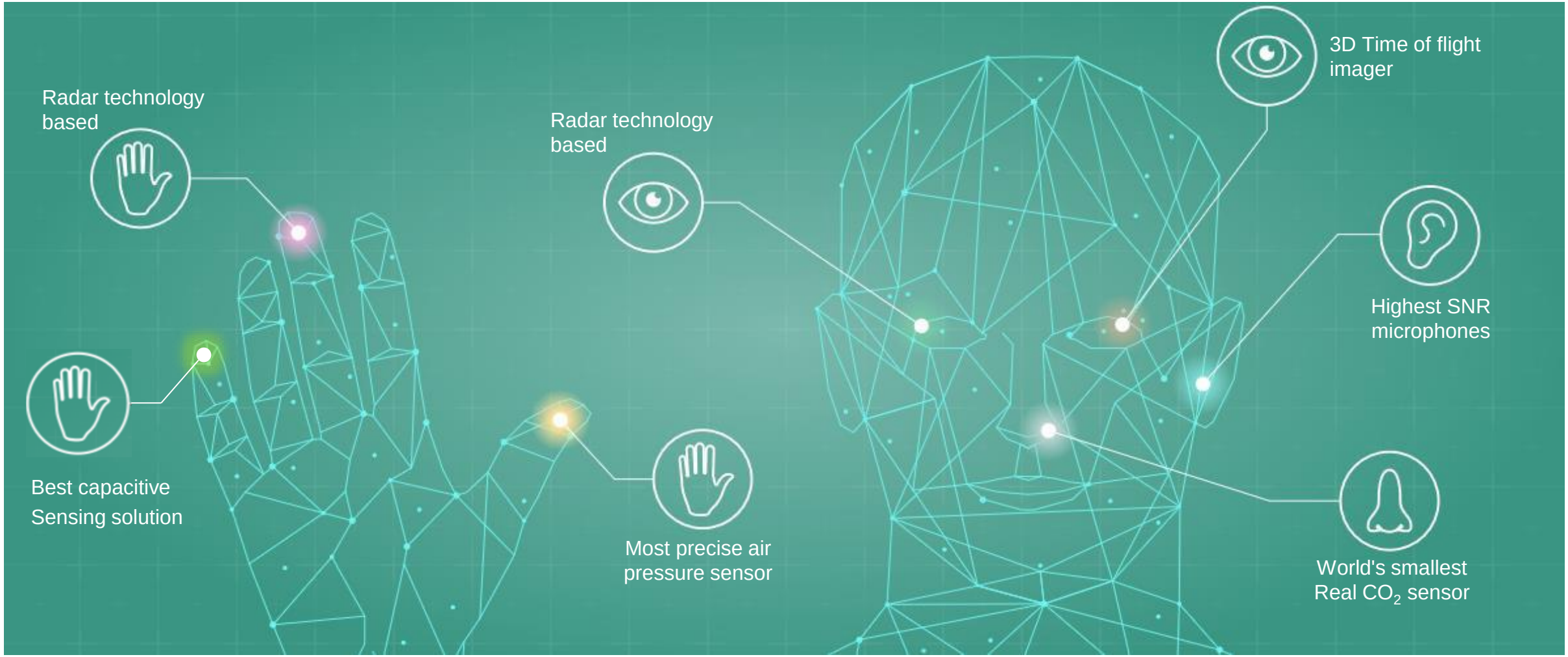



- **State-of-the art, end-to-end AI development platform:** Collect & annotate data directly from your target hardware. Create, train, evaluate & deploy great AI/ML models fast.
- **Own your own data.** Data is only used to train your models. Data is stored offline on your machine.
- **Not locked into the ecosystem:** Build a custom model, or bring your own to optimize for the edge, and deploy on the hardware of your choice.
- **AutoML functionality**: Auto-generates high performance AI/ML models optimized for speed and low footprint.
- **Visualization is king**: No more "black box": Follow your machine learning model creation journey with our Graph UX.

- DEEPCRAFT™ Studio supports all Infineon Microcontrollers (PSOC™, AURIX™, TRAVEO™, XMC™)
- Use DEEPCRAFT™ Studio to develop customer specific AI-Models

# Our intuitive sensors are enabling Edge AI – Giving things the human sense

Infineon **XENSIV™ sensors** are exceptionally precise, thanks to industry-leading technologies. They are the perfect fit for your AI applications in automotive, industrial and consumer markets.

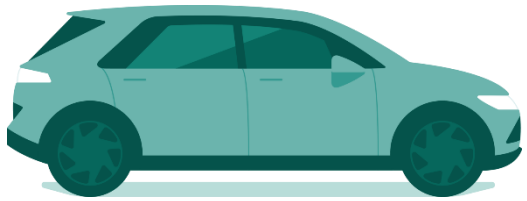


# Our advanced technological solutions address a wide range of Edge AI applications

## AI in IoT & Consumer

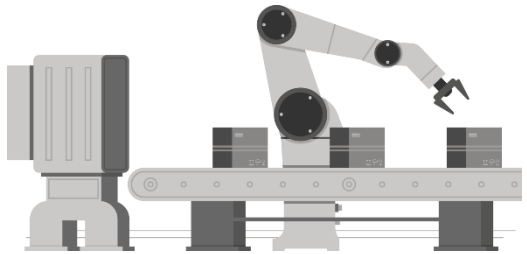
**Democratizing AI** by bringing the computational power of AI algorithms **closer to the source data** with **smarter** and **greener** devices for **intuitive real-time** interaction.

## AI in Automotive



Ushering in a new era of connected and autonomous vehicles with **reliable**, **safe**, and **secure** systems for **real-time safety critical applications**.

## Industrial AI



Creating self-learning systems for greater **productivity**, **quality**, and **efficiency** and supporting the adoption of sensor-based **predictive maintenance** models.

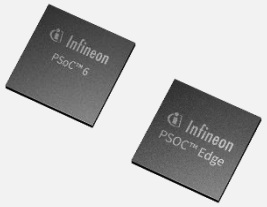
# AI solutions for IoT & consumer applications

# Infineon provides a comprehensive end-to-end embedded AI solution

In-house AI Software
**DEEPCRAFT™ Studio**

Development & AI Ecosystem
**ModusToolbox™ Software**
SensiML
Cyberon
Micro.ai

PSOC™ 6 or PSOC™ Edge Microcontroller




Infineon sensors

Connectivity
& security solutions

# PSOC™ 6 AI Evaluation Kit is Infineon's HW Platform for Edge AI. It Enables the full ML to embedded SW journey with endless possibilities for customers.

## Easy to use & low-cost

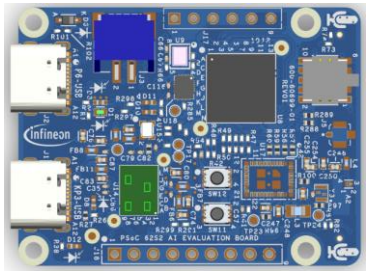
Evaluation board with efficient form factor for easy prototyping

## Easy creation of ML models

Sensor fusion-, ML-, acoustic-, time series- and radar models

## Connect easily & continuously improve models

Wired & wirelessly



**CY8CKIT-062S2-AI**

## Fast time to market at minimal development cost

Direct launch for PSOC™ 6 & AURIX™

## End-to-end

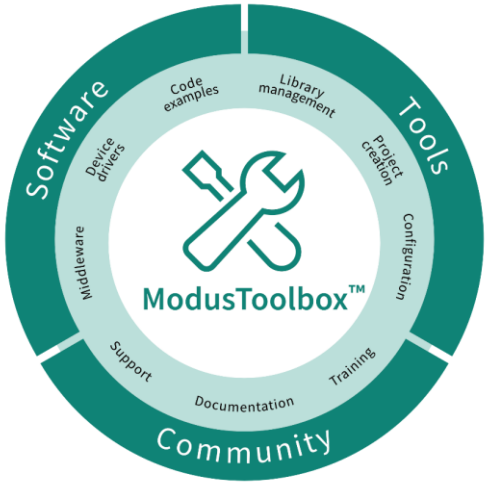
Collect data, create, train, evaluate & deploy your ML models fast

## The best of Hardware, Software & ML

Solution approach with PSOC™ 6, QSPI Flash & multi-sensor input: radar, microphone, pressure & 6-axis motion sensor

# Customized Machine Learning on PSOC™ Edge with Imagimob Studio and ModusToolbox™

With the seamless integration of **DEEPCRAFT™ Studio** and **ModusToolbox™** companies can build and deploy robust machine learning models. When paired with **PSOC™ Edge**, companies can optimize power consumption and improve efficiency while adding intelligence to products.



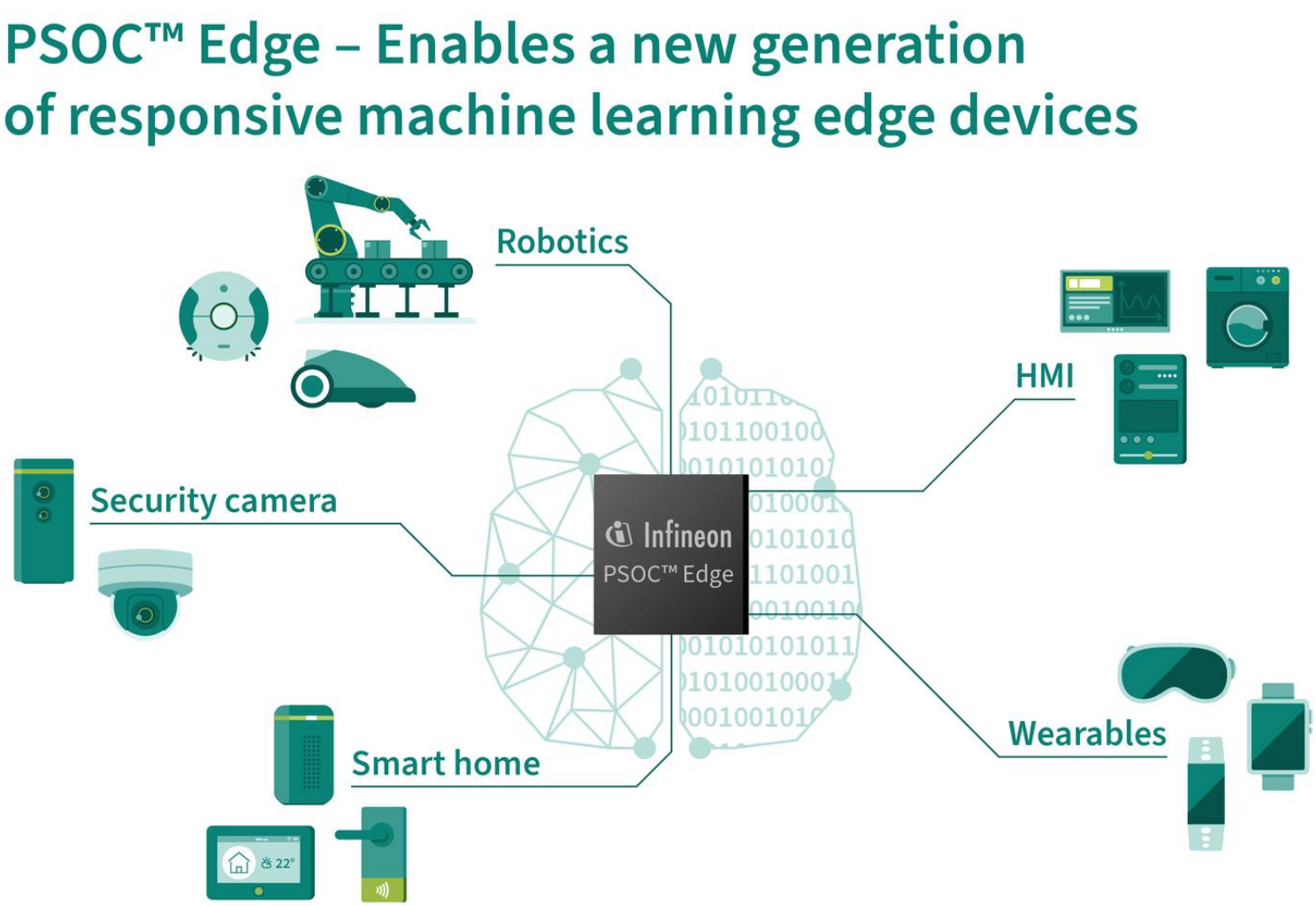


**DEEPCRAFT™ Studio**, Infineon's platform for machine learning development, makes it easier to create Edge AI models

**ModusToolbox™ Software** is a modern, extensible development ecosystem

**PSOC™ Edge** is the next generation Machine Learning-enhanced sensing, low power, secured, and advanced HMI high-performance microcontroller family

# Next-generation PSOC™ Edge portfolio: Infineon PSOC™ Edge E81, E83 and E84 MCUs




**Fully integrated system-on-chip (SoC) devices supported with comprehensive system design tools and software.**

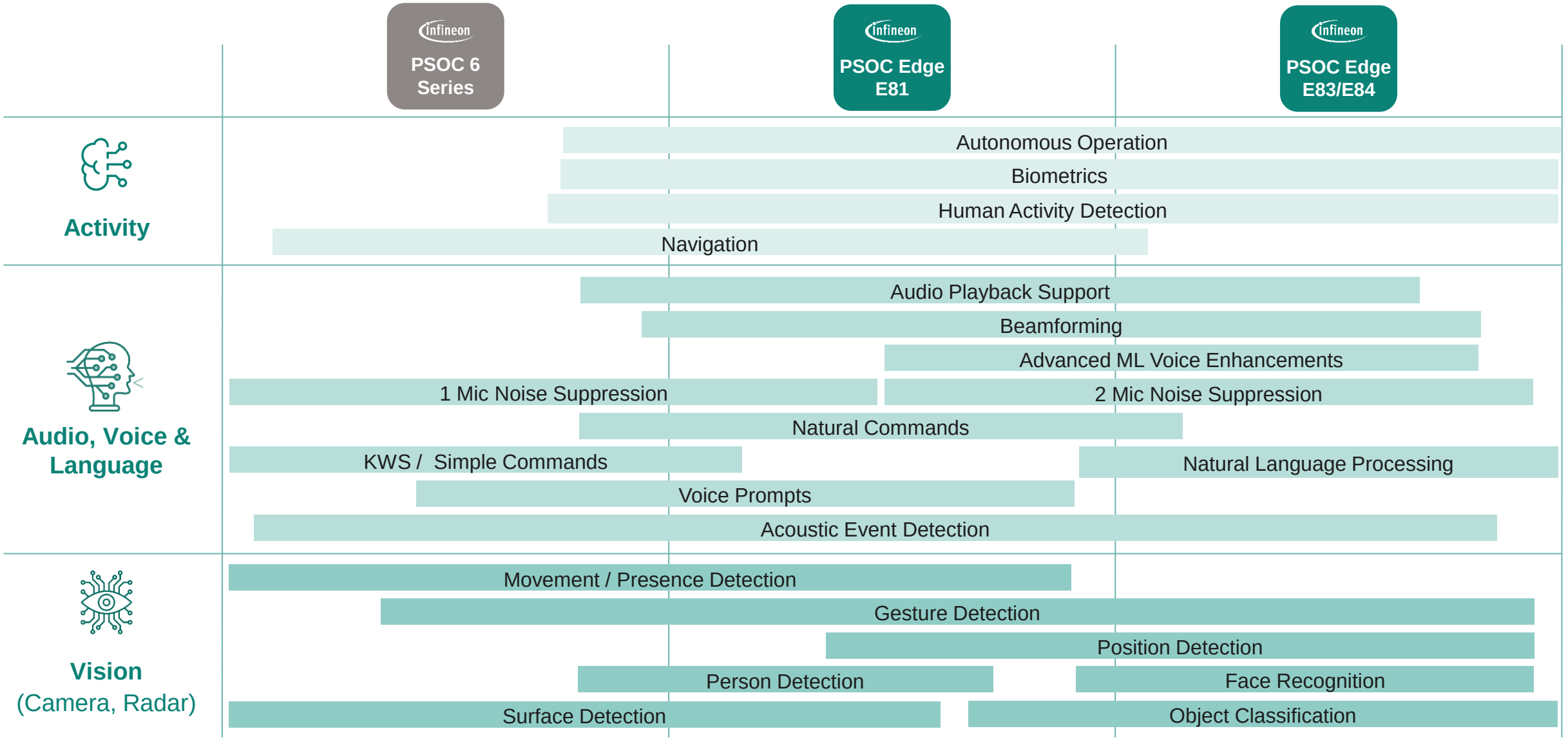
**Based on the high-performance Arm® Cortex-M55.**

**Quick move from concept to product.**

**Fast time-to-market for IoT and consumer applications.**

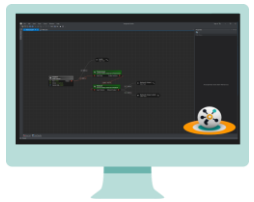
# PSOC™ Edge expands AI/ML use cases

## AI/ML Use Case Compute Requirements for Next Gen Devices

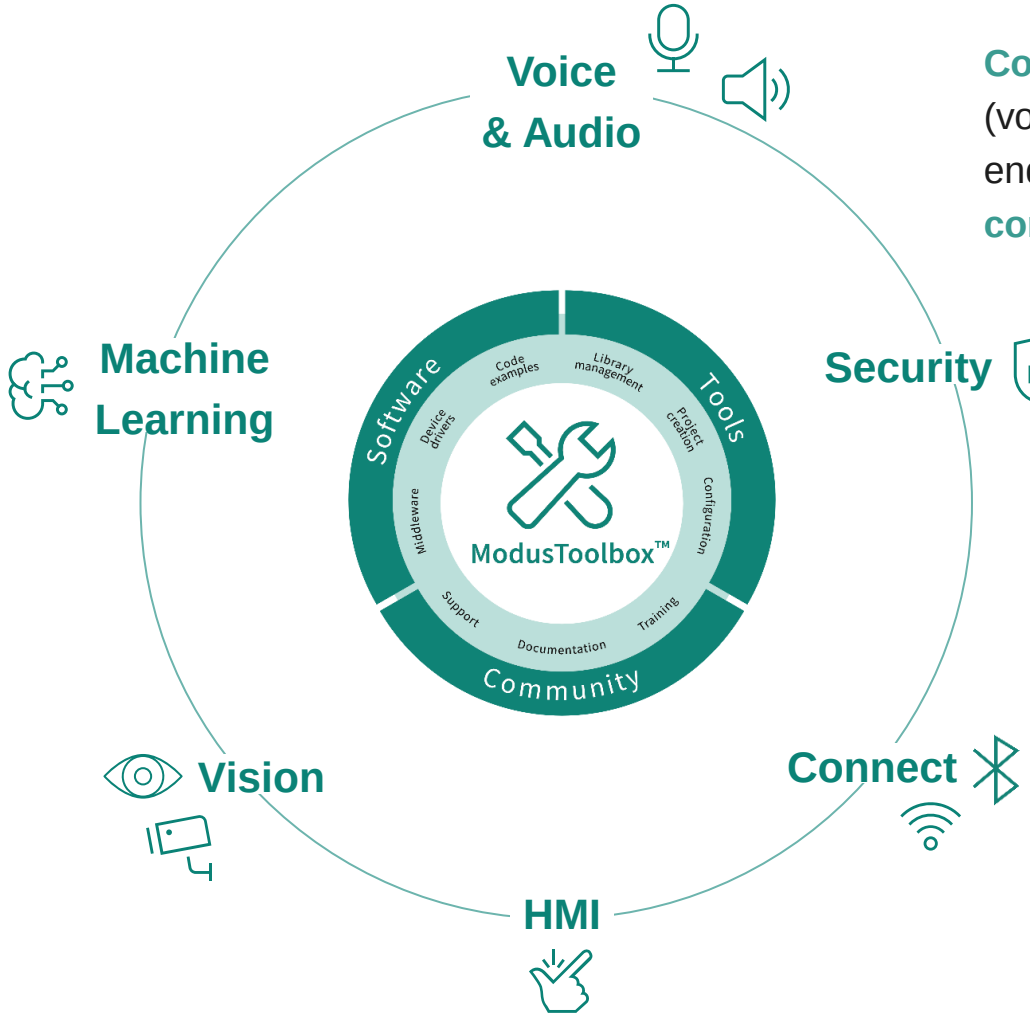


# Unlock high-end user experiences for next gen devices with PSOC™ Edge power/performance, Software & ML Ecosystem

**DEEPCRAFT™ Studio ML Development Tool** for data collection & pre-processing,
model training, model conversion & deployment



**DEEPCRAFT™ Ready Models** adding specific AI capability immediately



# Security is key in the context of AI and in our portfolio

**Security is crucial for Edge AI** + **Security is part of our DNA** › **New PSOC™ Edge E8X product family**

- Multiple points of attack
- Critical IP
- Sensitive data

- Designed to meet highest certification level provided in the Platform Security Architecture (PSA) PSA L4 iSE
- Integrated secure enclave to support boot-time and run-time security services
- Isolation of security protection and AI acceleration computation

# XENSIV™ Sleep Quality Service is a fully managed end-to-end solution with all important functions to quantify sleep

**SaaS Product:** Bed-side sleep quality monitoring service

- Provides a completely contactless, privacy centric end-to-end solution that is easy to consume.
- Radar measures breathing rate and limb movement which are essential for detecting sleep related issues (not possible with wearable technology).


XENSIV™ SQS
fully managed service

XENSIV™ Hardware

Sense (BGT60TR13C), Compute (PSoC62 Family), Connect (WiFi module)

*The 60GHz mmwave and PSoC62 along with WiFi connectivity are prequisites for the XENSIV™ SQS.*

## Product details

- **Embedded Sensor:** IFX **60GHz mmwave sensor** for precise sensing.
- **Compute and Connect:** IFX **PSOC™** and **WiFi+BT module** for edge compute and cloud connectivity.
- **Cloud AI:** Globally accessible, near real-time analytics.
- **OEM Data Ownership:** Secure consumer data controlled by the OEM.
- **Sleep Analytics API:** Access to 30+ sleep and breathing related insights (available during evaluation and prototyping)

# XENSIV™ Sleep Quality Service is an easy to use, fully integrated end-to-end solution with all important functions to quantify sleep.


Total surface area required in the product PCB:
**50mm x 25mm**

| | Sleep Attributes | Sleep Stages |
|---|---|---|
| **Key Analytics** | – Total sleep time<br>– Sleep efficiency<br>– Sleep latency<br>– No. of awakes | – Absence / Presence<br>– Awake / Asleep indicator<br>– REM<br>– NREM |

## Meets common sleep detection standards & provides additional insight along relevant factors

| | Awake - Sleep | Sleep Stages |
|---|---|---|
| Apple Watch* | 88% | 53% |
| Garmin* | 89% | 50% |
| Oura* | 89% | 61% |
| WHOOP* | 86% | 60% |
| **XENSIV™ SQS**** | **>90%** | **72%** |

+

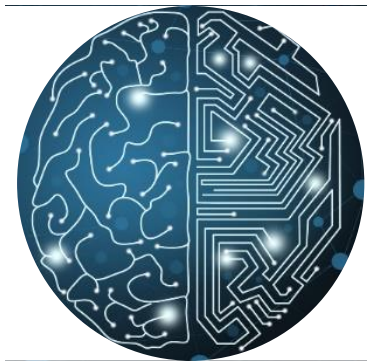
– Breathing patterns
– No. of respirational anomalies
– Breathing rate

Notes: ***** Accuracy data measured in comparison to Polysomnography as part of a study *<A Validation of Six Wearable Devices for Estimating Sleep, Heart Rate and Heart Rate Variability in Healthy Adults>* ****** Infineon XENSIV™ Sleep Quality Service (SQS) is benchmarked against Polysomnography in a separate study (intermediate results)

# Embedded AI solutions for Automotive

# AURIX™ TC4x Parallel Processing Unit (PPU) enables affordable artificial intelligence use cases for Automotive

Artificial Intelligence & Neural Networks



Optimize Automotive Use Cases

› Cost Reduction
› Innovation
› Improve Performance
› Accelerate Time to Market

## Automotive AI Use Cases

### Domain/Zone Control

› Modelling
› Model Predictive Control
› IDPS & other security methods

### ADAS

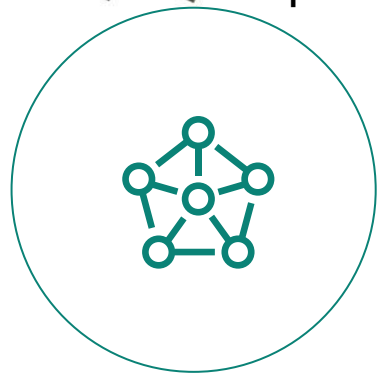
› Object classification
› Advanced Radar Signal Processing
› Sensor Fusion

### xEV Applications

› Predictive Control
› Virtual Sensing
› Advance State of Health (SoH) and State of Charge (SoC) algorithms

## PPU accelerator

SIMD vector DSP Co-processor



› Data processing of linear algebra (e.g. matrix operations) and signal processing (e.g. filtering, convolutions)
› Ultra fast control loop implementation
› Implemented in low-latency cluster with mixed signal peripherals

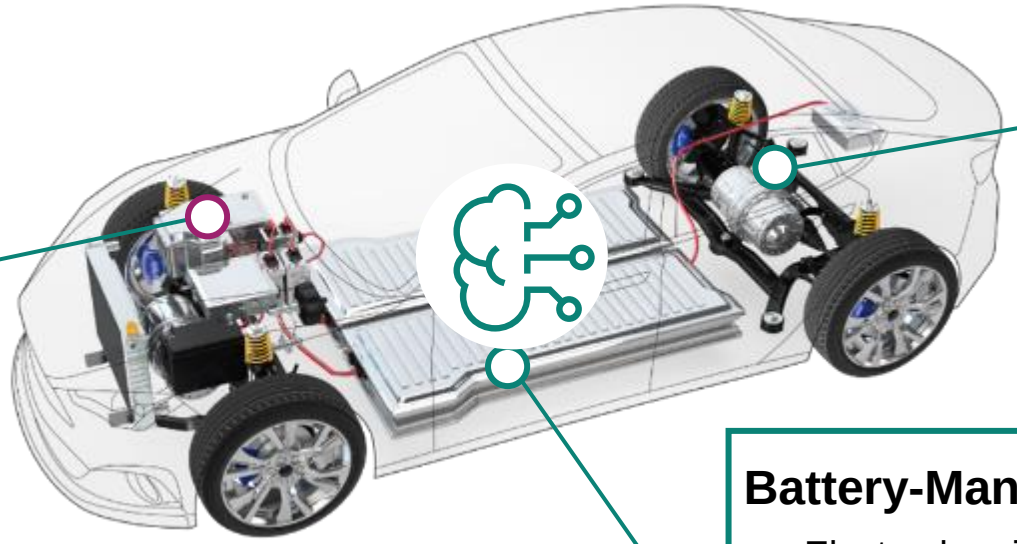
# For instance, AURIX™ TC4x PPU empowers the e-Drivetrain of the future for best-in-class system efficiency and cost-innovation

## TC4x PPU is enabling

### Power-Conversion

› Combining control and communication functions and reducing number of system MCUs from up to 7 to 1

**clear cost-down path and further efficiency increase**



### HV Traction Inverter

› Motor Position Sensing
› Health Observing
› Temperature Estimation
› Model Predictive Control

**best-in-class system efficiency and cost-innovation**

### Battery-Management

› Electrochemical models
› Hybrid ML accelerated models
› Artificial intelligence

**optimized Charging, extended vehicle range and battery life**

Up to **12x**

TriCore performance, eg. for AI-applications based on 256 bit PPU

# Infineon provides a comprehensive end-to-end embedded AI solution with automotive qualified hardware and software

## End-to-end solution stack for Automotive AI

In-house AI Software
**DEEPCRAFT™ Studio**

AI Partner ecosystem
SYNOPSYS® EKHONO AI

ASIL-D qualified AURIX™ Microcontroller

Automotive qualified sensors

Power management solutions

Connectivity & security solutions

# Industrial AI solutions

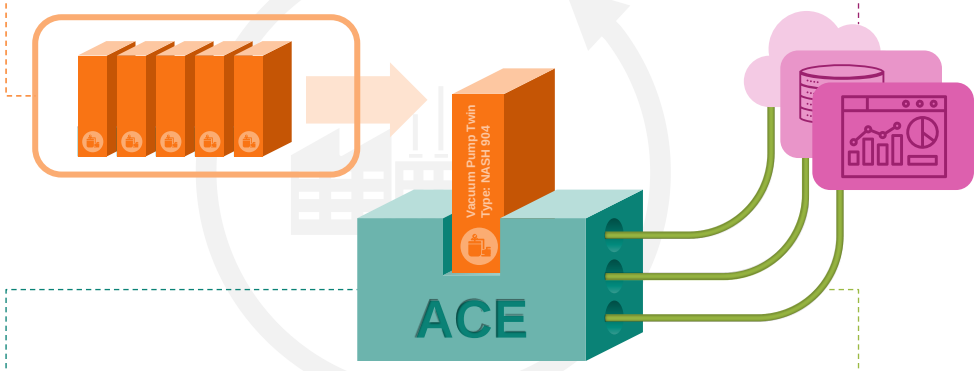
# IAX provides digital representations of physical assets, housed in a docker with standardized interfaces to customer applications

## 1. Digital Twin / Digital Twin Library

- Database of digital replicas for industrial equipment
- Physics-based models reflecting real-world properties of the corresponding asset for high accuracy and efficiency
- Simulation of asset condition to predict failures, optimizing lifespan & energy use

## 4. Customer applications

- Customer applications (e.g. Building Management Systems) can seamlessly integrate data from deployed ACE
- IAX offers complementary applications like interactive dashboards and mobile apps that can be customized to specific front-end use cases




## 2. Analytics Core Element (ACE)

- Acts as pre-processing brain of the Digital Twin
- Stored on a PLC on site and compares sensor input data with model data
- Runs essential real-time analytics tasks, identifying anomalies and reports product status via APIs to Customer Applications

## 3. APIs

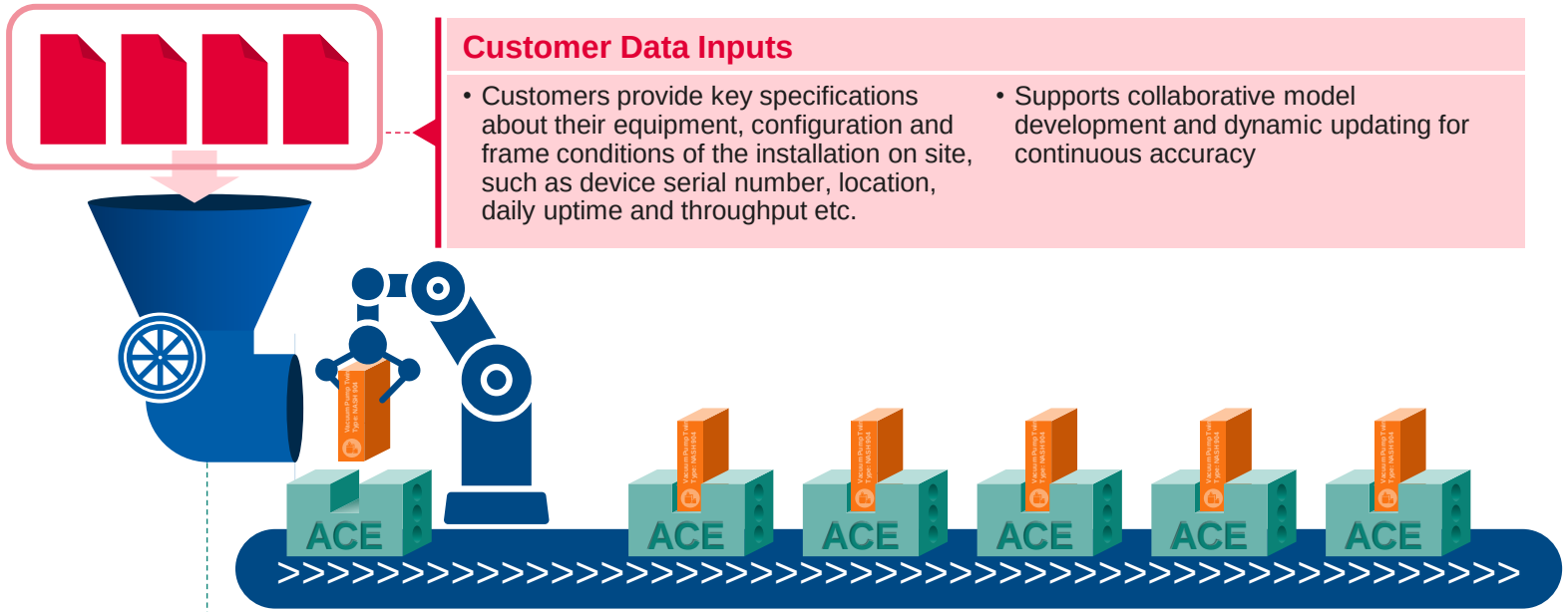
- Standardized interfaces for seamless integration of Digital Twin Model and ACE into customer applications, enhancing functionality
- Promotes ecosystem growth through third-party application development

INDUSTRIAL ANALYTICS

## Value proposition to our customers

- Highly accurate and reliable physics-based models tailored to specific equipment and components
- Precise analytics providing event notifications, alerts and status reports in real-time.
- Ease of implementation thanks to standardized interfaces to common customer applications

# In the future, ACE Forge will mostly automate creating digital twins with ACE dockers that are compatible with customer infrastructure




## Customer Data Inputs

- Customers provide key specifications about their equipment, configuration and frame conditions of the installation on site, such as device serial number, location, daily uptime and throughput etc.
- Supports collaborative model development and dynamic updating for continuous accuracy

## ACE Forge

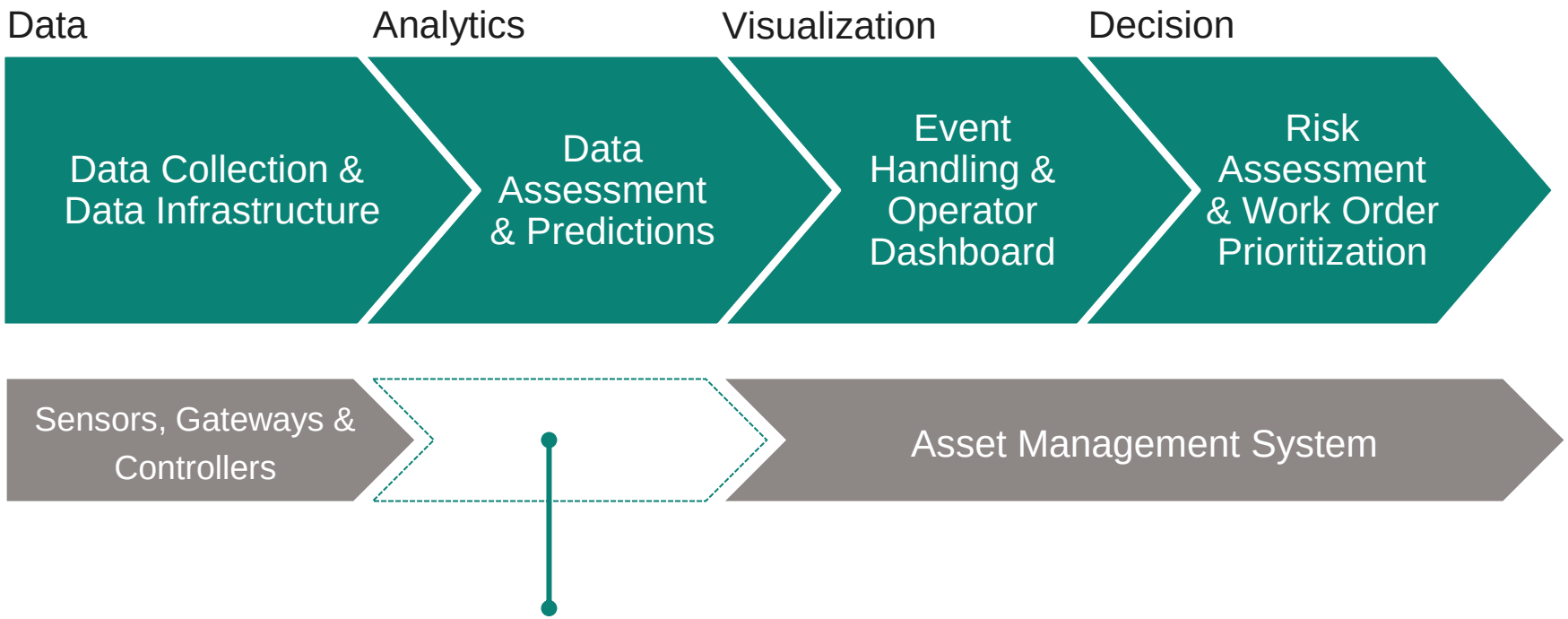
- Automates Digital Twin creation, streamlining model development with less time and expertise needed
- Simplifies model access with an easy upload-and-receive interface, making advanced analytics more accessible
- Employs AI and machine learning to refine Digital Twins for precise physical asset representation, enhancing accuracy as more data is collected

INDUSTRIAL ANALYTICS

## Value proposition to our customers

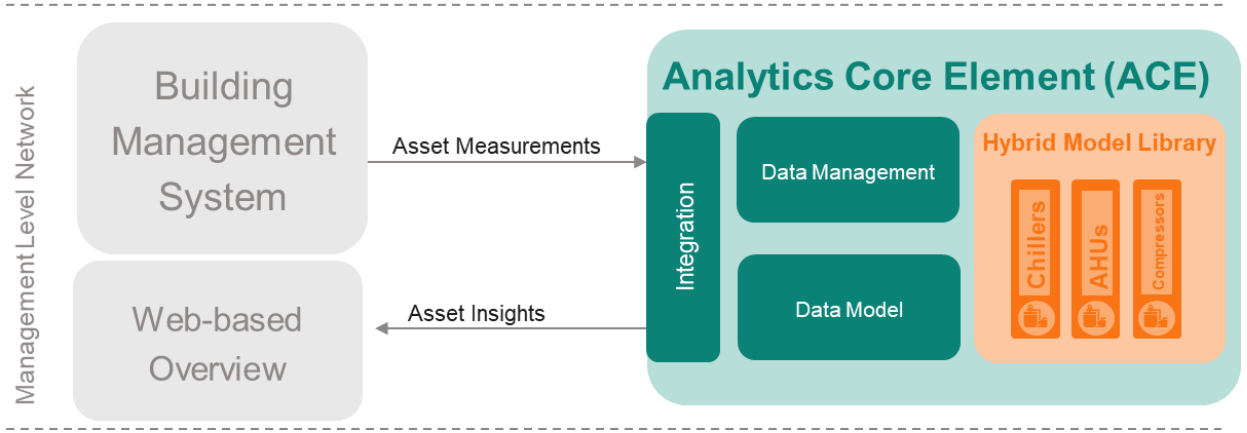
- Simple data entry thanks to user-friendly interface and menu navigation as well as plausibility check
- Immediate assessment of potential savings and immediate cost estimate
- Fast and automated model development through the use of generative AI solutions

# Despite the prevalence of data infrastructure and asset management system, a gap exists in using advanced analytics for optimal decisions



# We at Industrial Analytics want you to capitalize on available asset data with the Analytics Core Element (ACE).

ACE is a ready-to-deploy container loaded with hybrid AI models to enable efficient & reliable asset management




- **Reliable models:** Our expertise translated into **Hybrid AI models.** Combining physics-based models with the power of ML.
- **No additional tooling required:** Scale the results not the effort. Our models are ready-to-deploy
- **Easy to integrate & scale**: **API-based integration** into your IT/OT environment

**ACE at Energy Optimization:** reduce up to 30% the energy bill

**ACE at Predictive Maintenance:** cut up to 12% of maintenance cost

# Modernize industrial HVAC equipment anomaly detection and intelligence with AWS AI and tinyML at the Edge

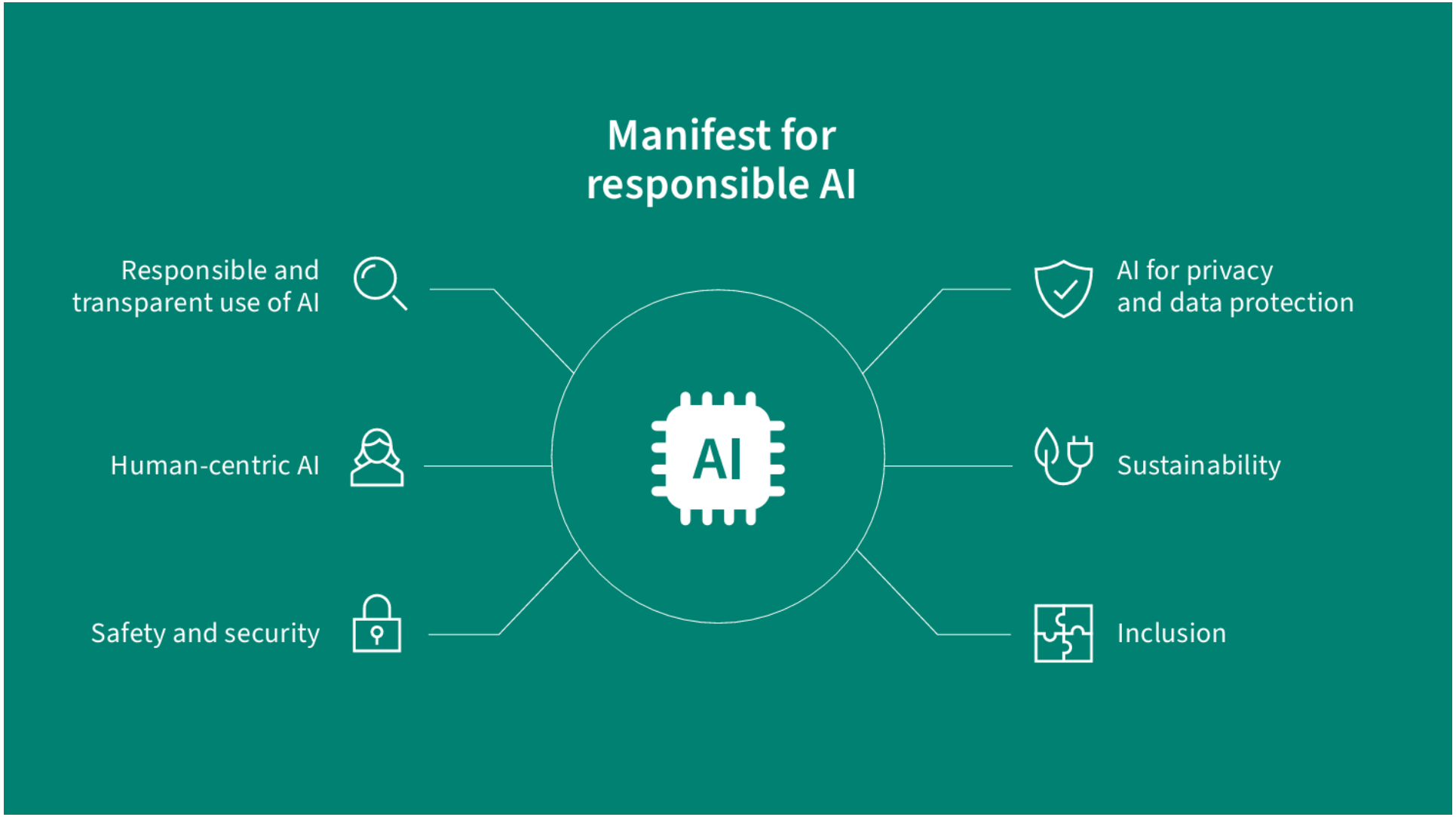
Office buildings, industrial and manufacturing facilities, and commercial living spaces rely on modern, industrial HVAC systems to meet their respective heating and cooling needs. While the aim is to provide customer comfort in a climate-controlled environment, configuration complexities in modern equipment, as well as compatibility issues with legacy systems, can result in **costly failures and downtime**.

**Monitoring the status, health, and working condition of industrial HVAC is key!**

**Infineon** and **Klika Tech** provide a solution incorporating highly precise **XENSIV™ sensors**, **XMC™ microcontrollers**, and **OPTIGA™ Trust** family, sensors that will feed data into the **TinyML model** that can **detect anomalies in real time** enabling the system to transmit the identified anomaly information, along with relevant sensor data, to a cloud-based AI solution generator .

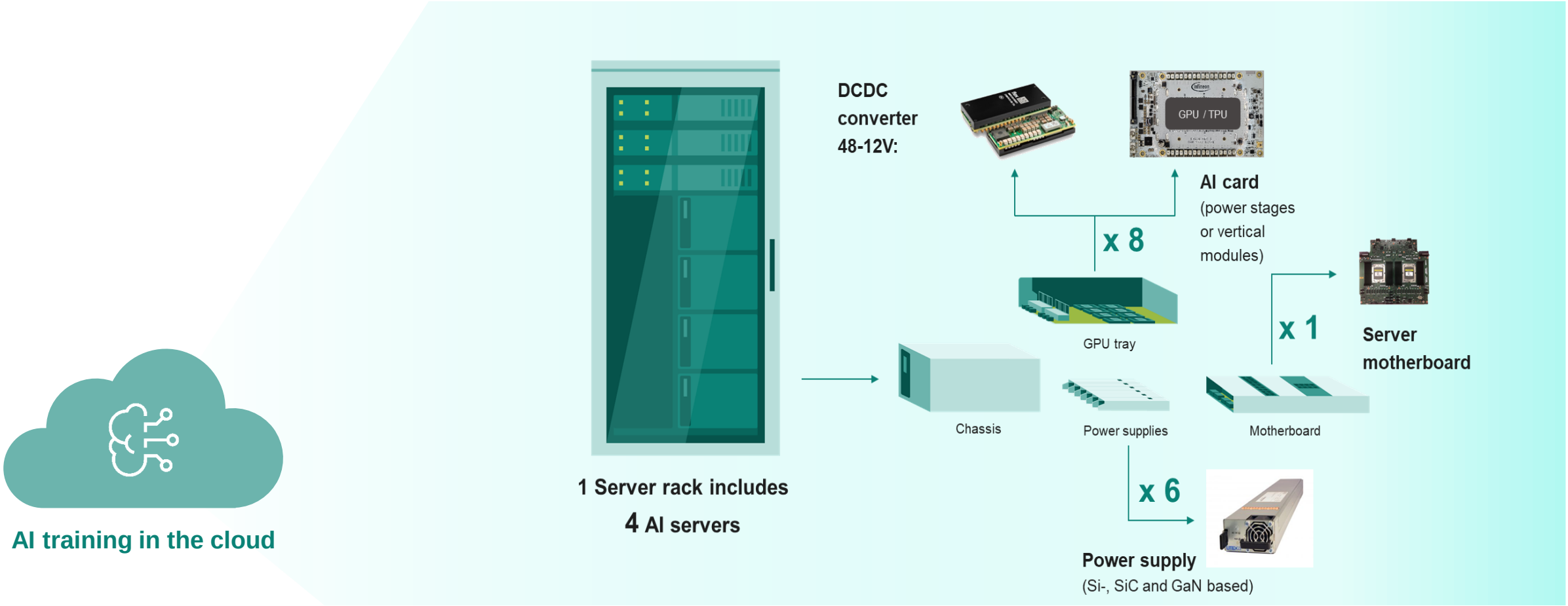
# We pave the way for trustworthy and sustainable AI

# Infineon’s mission – to make life easier, safer and greener with responsible AI



# As sustainability is core to value, we provide energy-efficient and top-performing power supply solutions for AI training workloads

Energy-efficient and top-performing power supply to minimize energy consumption, reduce costs, manage heat, ensure reliability, and meet sustainability goals.



# So, why Infineon for your AI solutions?

Enabling our customers to develop their own AI applications by providing world-leading semiconductor products, software, tools, and services.

## End to end ML software solution

End-to-end solutions from training to deployment.

## AI simplified

Tools and ecosystem for a simplified NN training and deployment for all level of skills.

## Application specific solutions

Infineon’s HW-/SW-/Services solutions and domain knowledge covering broad range of applications in IoT, Automotive and Industrial.

## Low power and high performance at the Edge

Infineon offers application-specific optimization of inference stacks for lowest power-consumption at the edge.

## Reliable, safe and secured AI solutions

Offering high-quality AI systems that provide highly reliable, safe and secured AI solutions for use in real-time critical applications.

## The right option for your design

One stop shop, ranging from data, ML pipe-line and chips to high-performance, low-power AI-enabled MCUs, modern sensors and easy-to-integrate AI solutions.


Infineon