



# Paving the way for sustainable AI

We enable and provide AI

August 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.



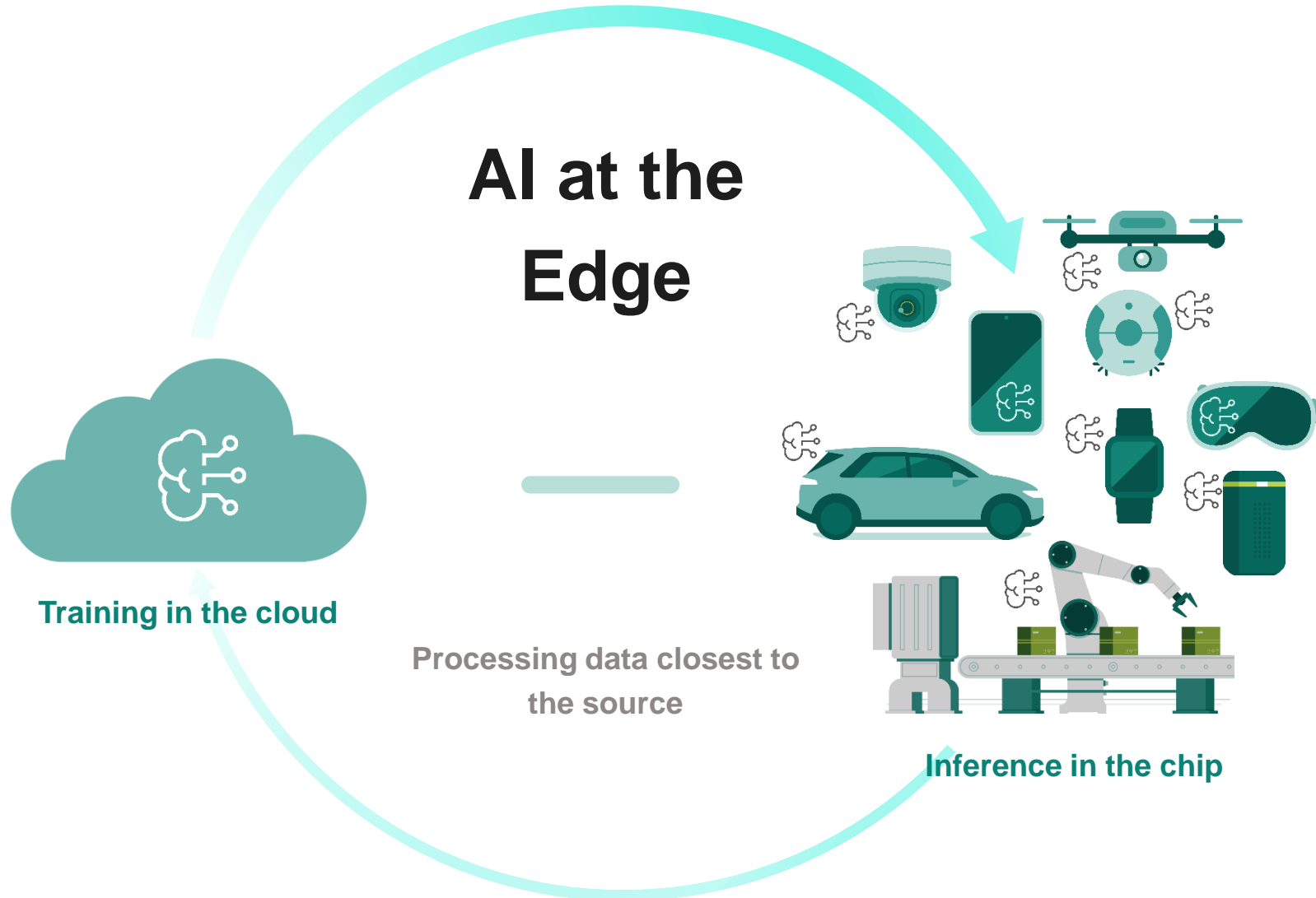
## We use AI

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

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Higher power efficiency

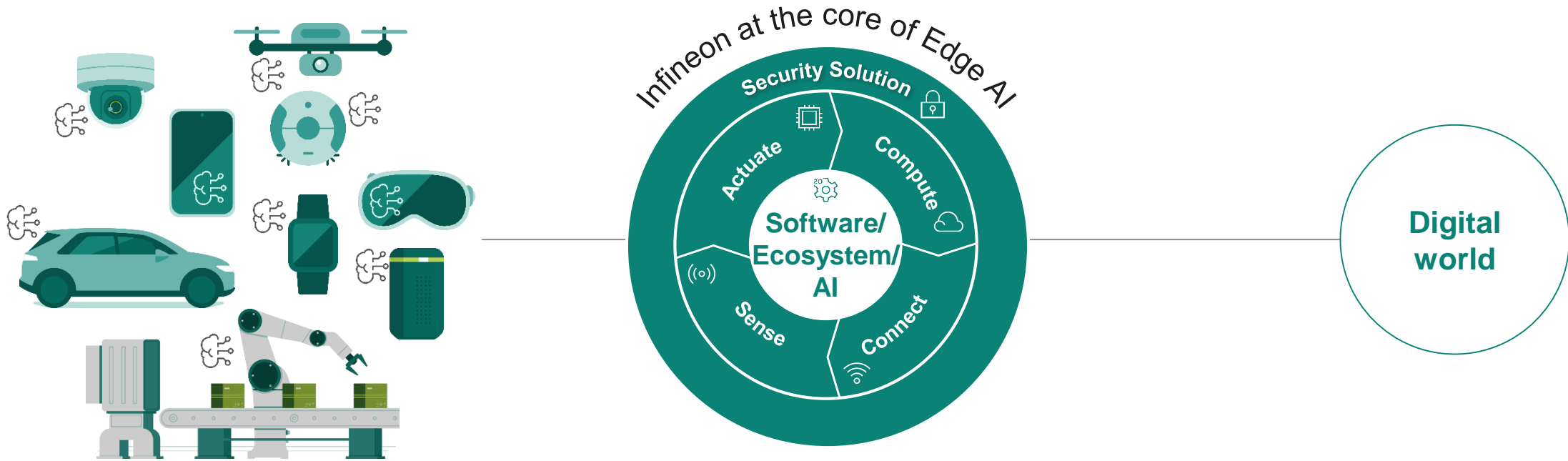
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Improved security and data privacy

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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**

**imagimob**  
An Infineon Technologies Company  
**Ready Models**

Baby cry detection	Siren detection	Surface detection	Wearing detection (for headphones, helmets, etc.)
Coughing detection	Alarm detection	Yelling & commotion detection	...
Snoring detection	Gesture detection	Arc Fault Circuit Interrupters	

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

TensorFlow  
Keras  
ONNX

**imagimob**  
An Infineon Technologies Company  
Imagimob Studio

ModusToolbox™

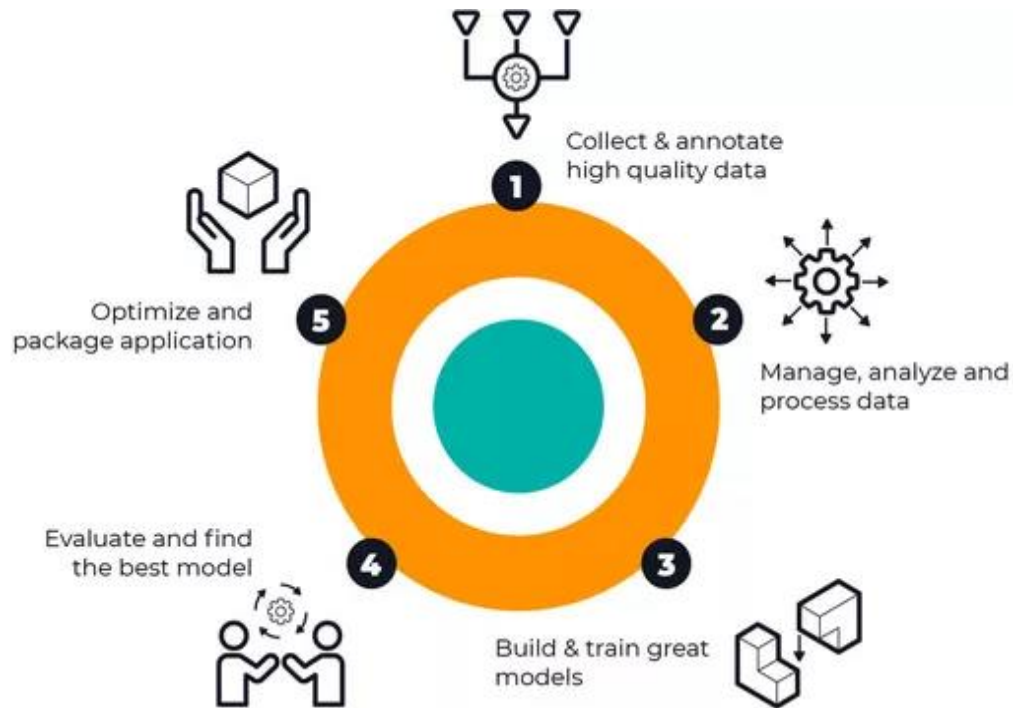
**AI partner ecosystem:**  
SYNOPSIS® DesignWare ARC MetaWare Toolkit  
EKONO AI  
SensiML

**The right hardware for your Edge AI model**

**MCUs:** PSOC™, AURIX™, TRAVEO™, XMC™

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

# Imagimob Studio helps you take your Edge AI ideas to production quickly and easily



**State-of-the art, end-to-end ML development platform:** Collect & annotate data directly from your target hardware. Create, train, evaluate & deploy great ML models fast.



**Own your own data:** Data is only used by Imagimob 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 models optimized for speed and low footprint.



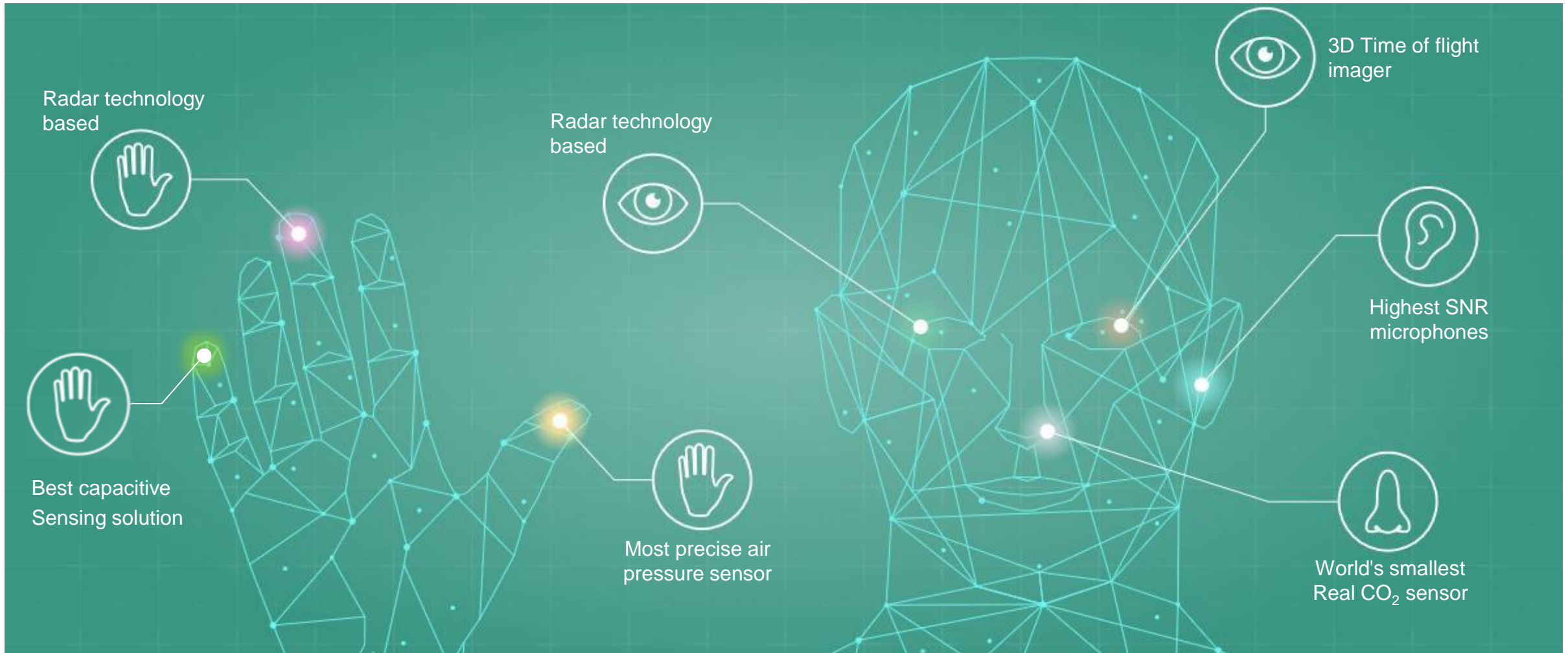
**Visualization is king:** No more "black box": Follow your machine learning model creation journey with our Graph UX.

- Imagimob Studio supports all INFINEON Microcontrollers (PSoC™, AURIX™, TRAVEO™, XMC™)
- Imagimob in cooperation with INFINEON can 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



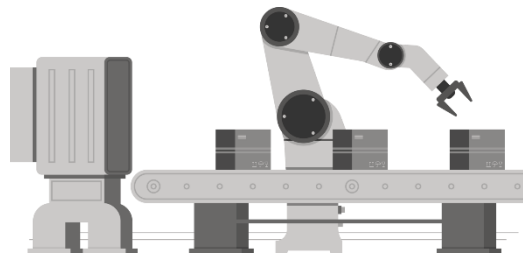
**Democratizing AI** by bringing the computational power of AI algorithms **closer to the source data** with **smarter** and **greener** devices for **intuitive real-time** interaction.

## 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




**imagimob**  
An Infineon Technologies Company


Development & AI Ecosystem




ModusToolbox™  
Software



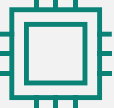
SensiML





Cyberon  
Leading Speech Solution Provider




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



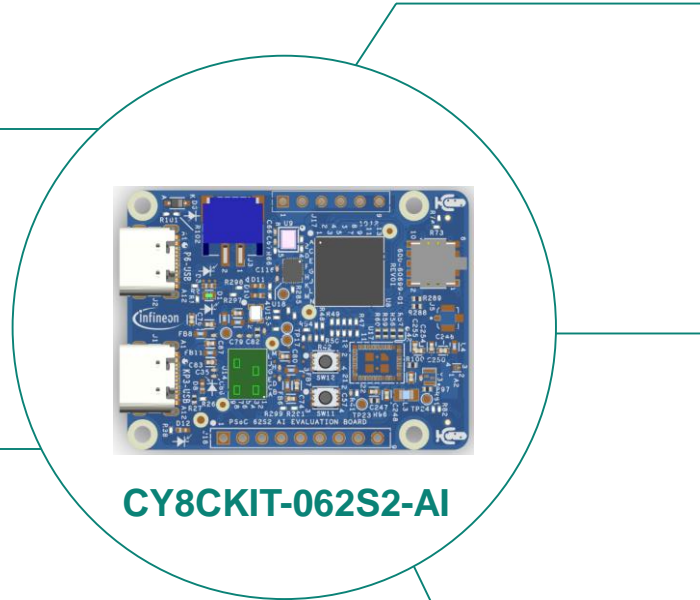
## Easy creation of ML models

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

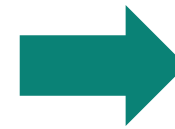
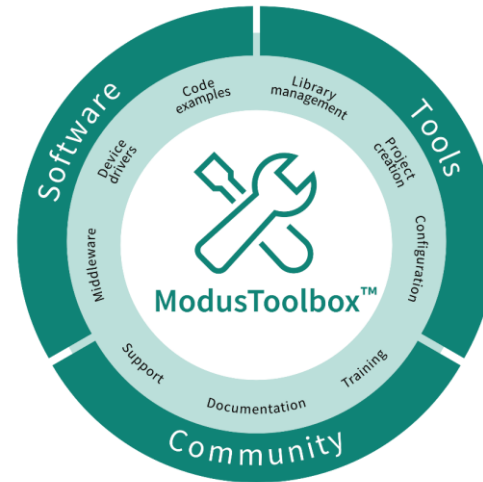
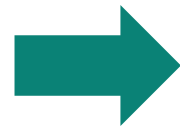
Solution approach with PSoC™ 6, QSPI Flash & multi-sensor input: radar, microphone, pressure & 6-axis motion sensor



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



With the seamless integration of **Imagimob 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.



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

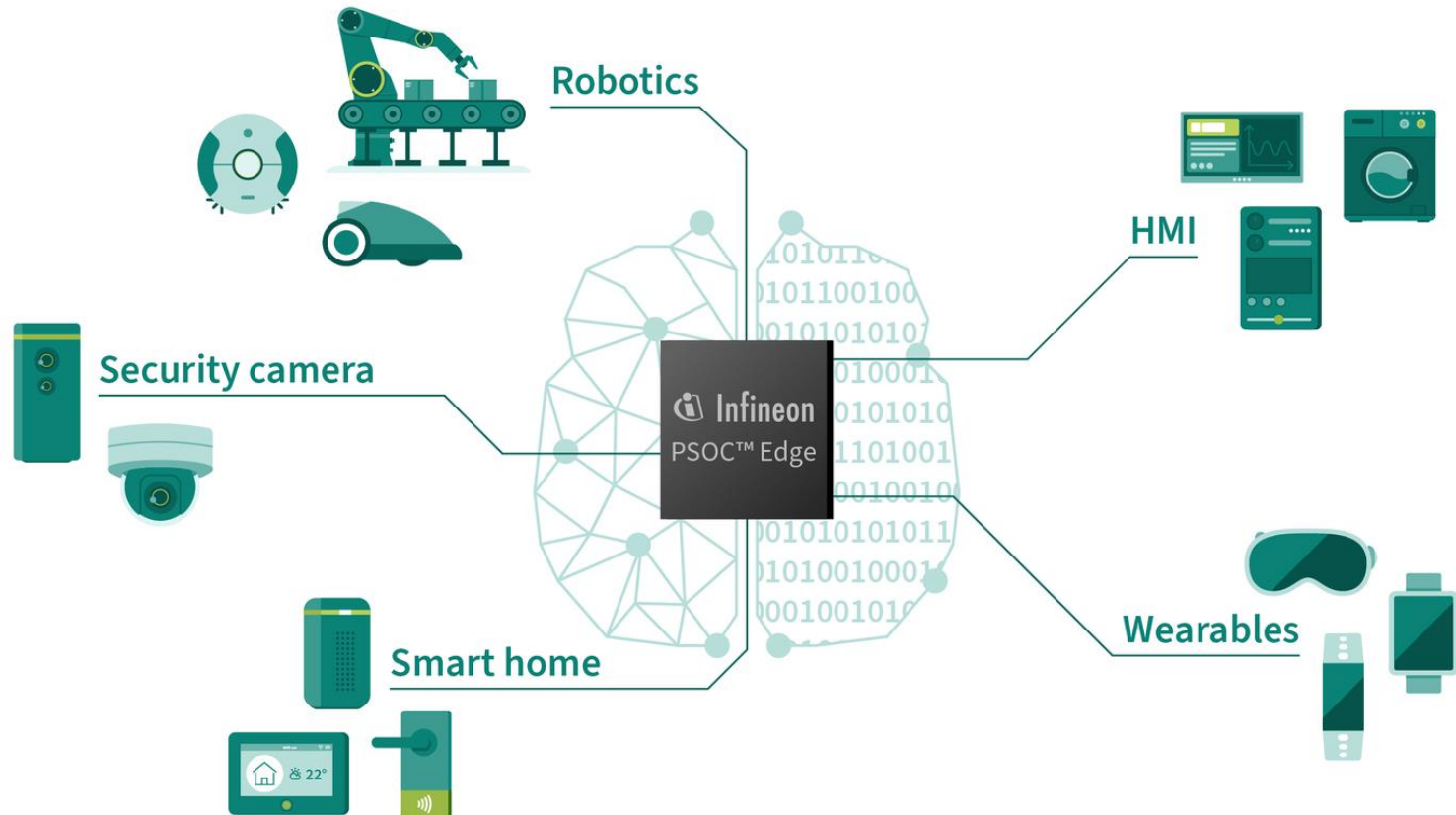
**ModusToolbox™ Software** is a modern, extensible development ecosystem

**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



## PSOC™ Edge – Enables a new generation of responsive machine learning edge devices



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

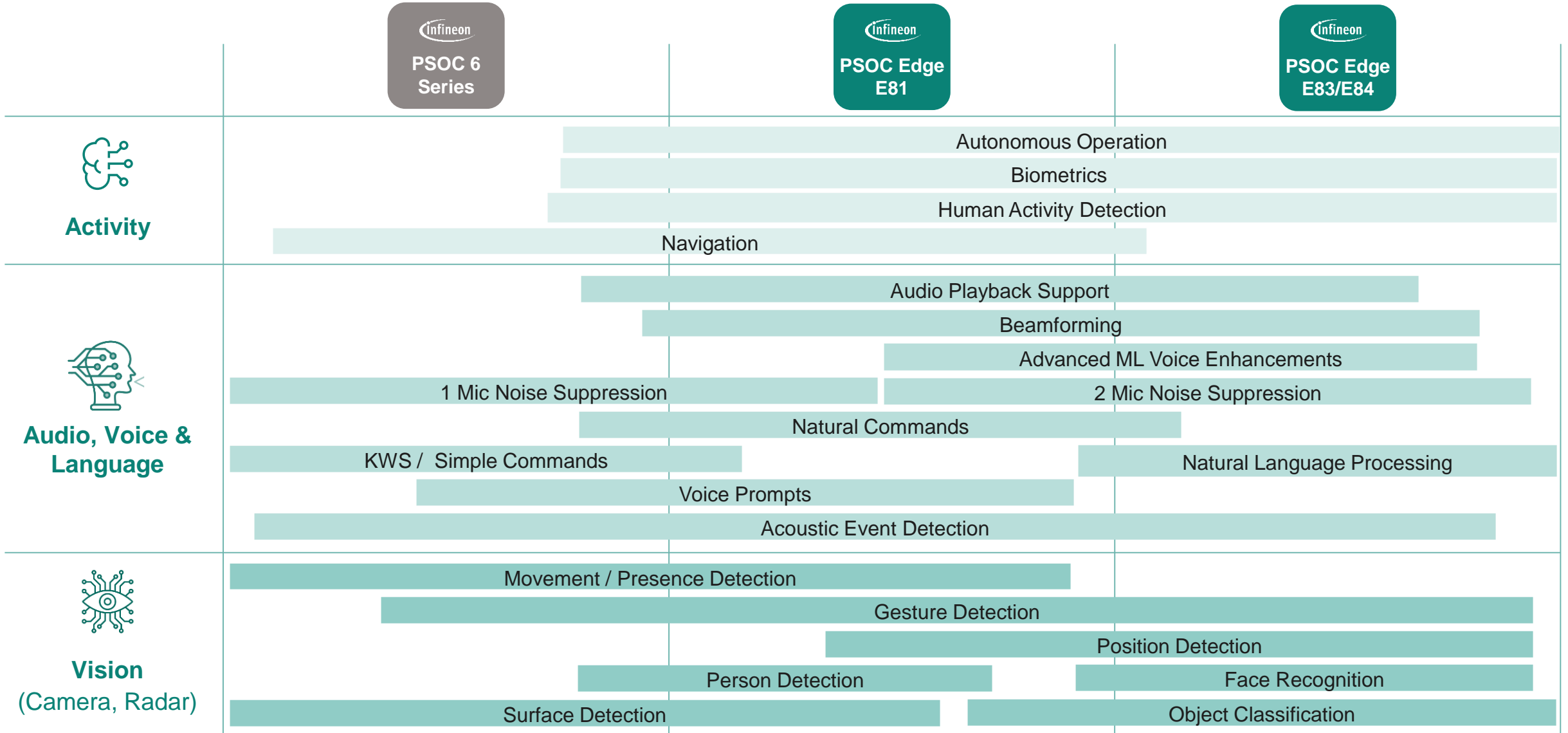
**Based on the high-performance Arm® Cortex-M55.**

**Quick move from concept to product.**

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

# PSOC™ Edge expands AI/ML use cases

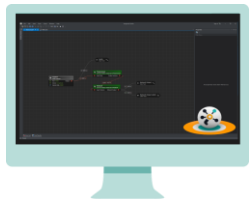
## AI/ML Use Case Compute Requirements for Next Gen Devices



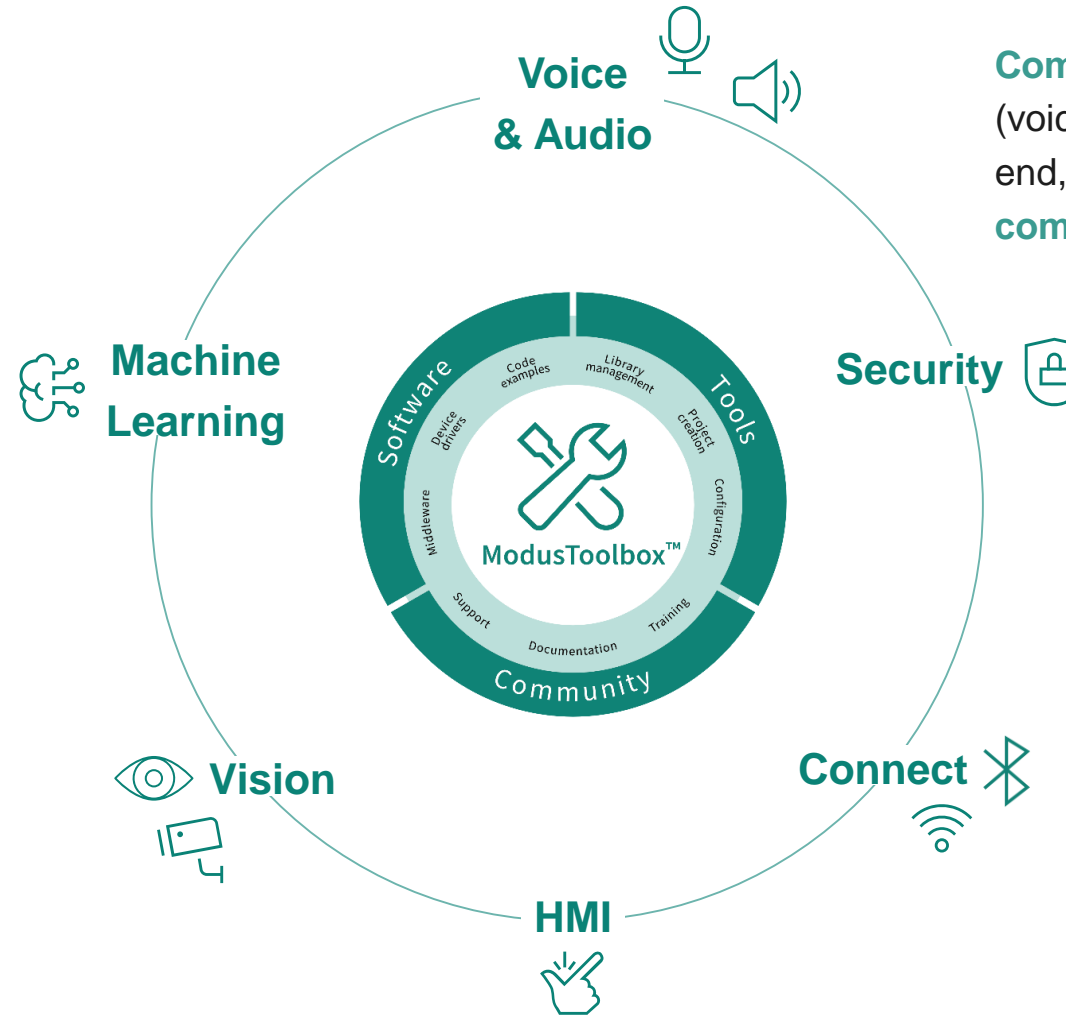
# Unlock high-end user experiences for next gen devices with PSoC™ Edge power/performance, Software & ML Ecosystem



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



Ready ML Models adding specific capability immediately



Comprehensive set of voice products (voice assistant, wake word, acoustic front end, ..) offering lowest power without compromising user experience

Full unified set of traditional embedded Development Tools – provided through ModusToolbox™ development environment.





# 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

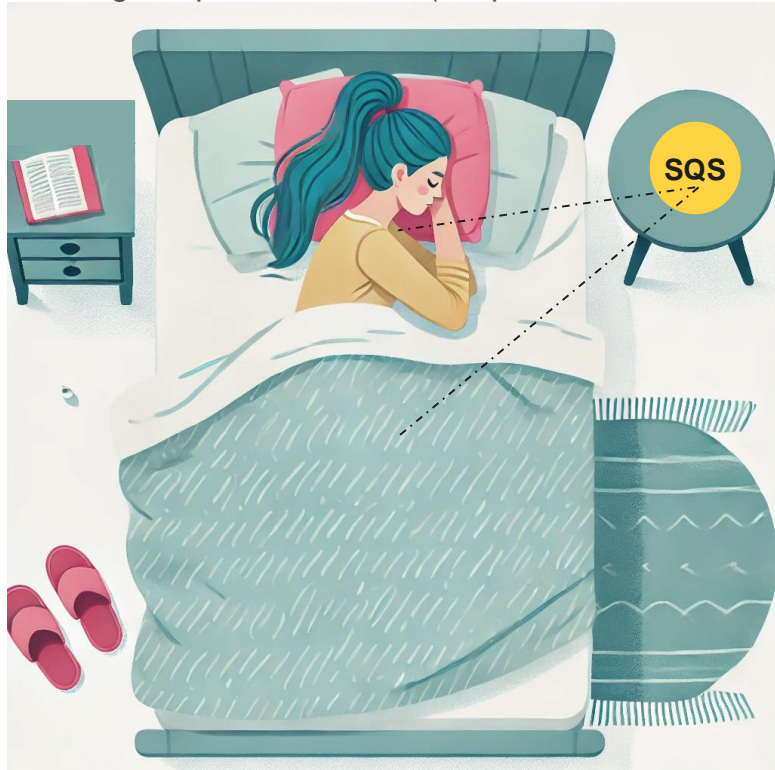
Isolation of security protection and AI acceleration computation

# 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 prerequisites 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.



Customer evaluation kit

Total surface area required in the product PCB:

**50mm x 25mm**

Key Analytics	Sleep Attributes	Sleep Stages
	<ul style="list-style-type: none"> <li>- Total sleep time</li> <li>- Sleep efficiency</li> <li>- Sleep latency</li> <li>- No. of awakes</li> </ul>	<ul style="list-style-type: none"> <li>- Absence / Presence</li> <li>- Awake / Asleep indicator</li> <li>- REM</li> <li>- NREM</li> </ul>

## 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%
<b>XENSIV™ SQS**</b>	<b>&gt;90%</b>	<b>72%</b>



- 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)

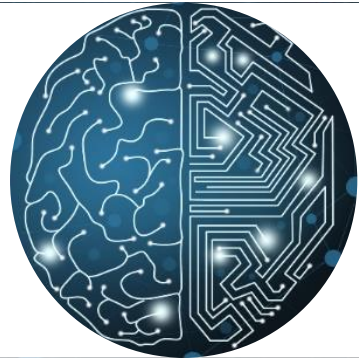
# Embedded AI solutions for Automotive



# 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



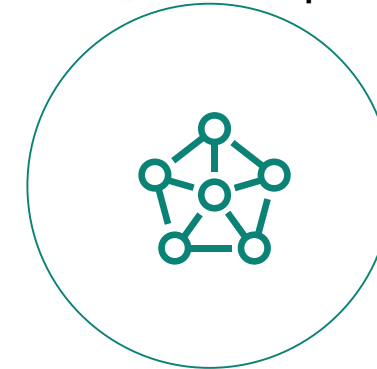
### xEV Applications

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

## PPU accelerator



SIMD vector DSP Co-processor

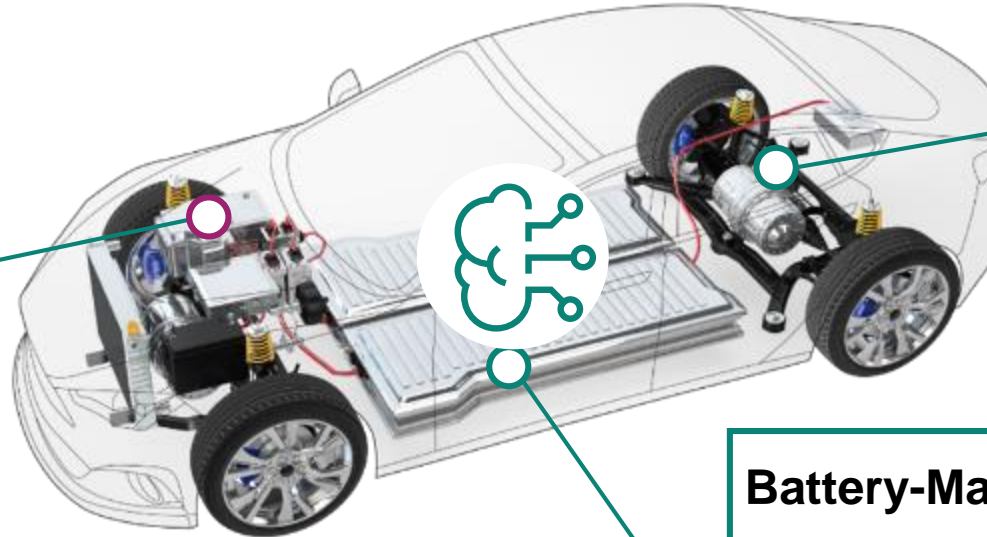


- › Data processing of linear algebra (e.g. matrix operations) and signal processing (e.g. filtering, convolutions)
- › Ultra fast control loop implementation
- › Implemented in low-latency cluster with mixed signal peripherals

# 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**



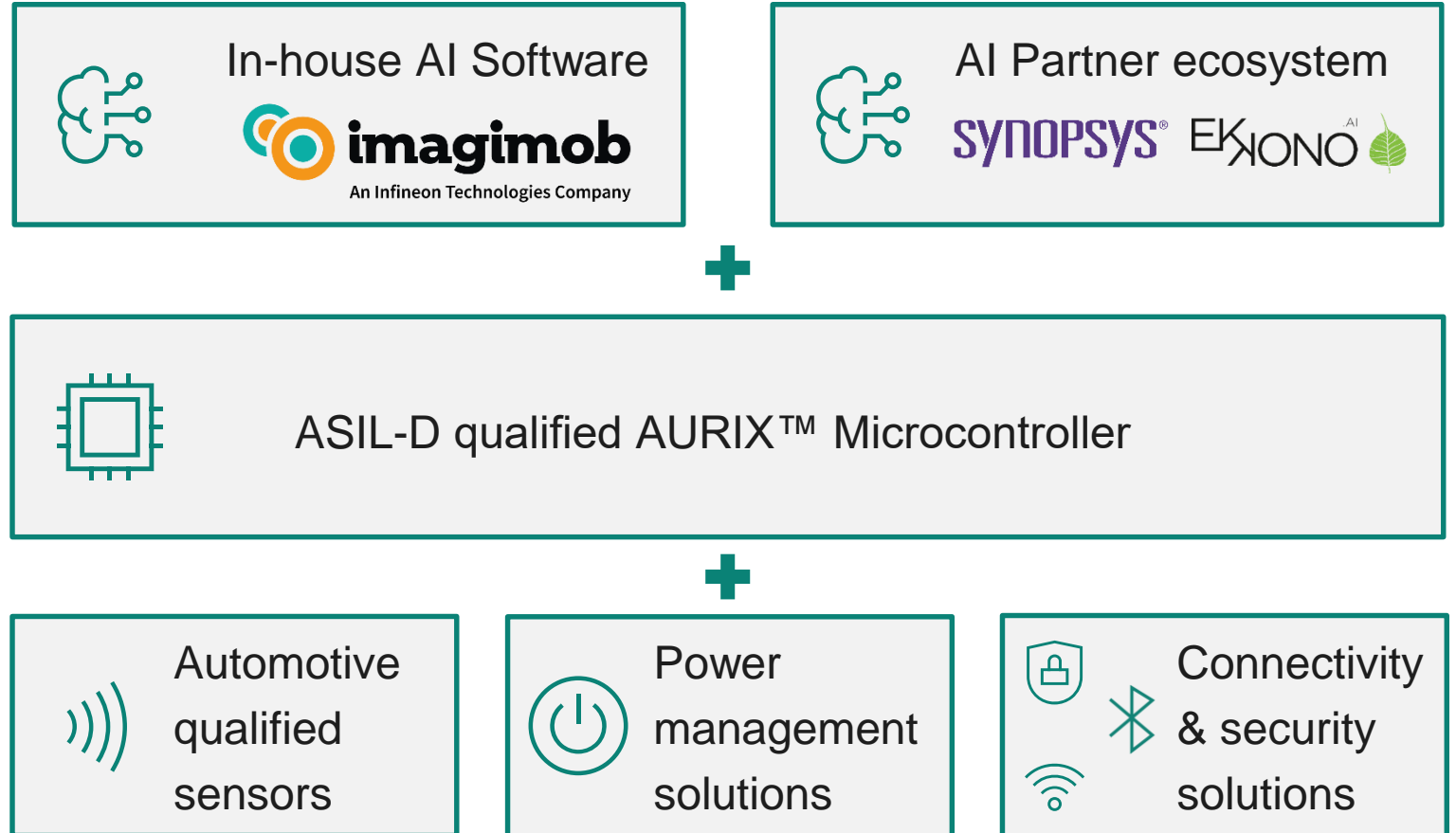
Up to **12x**

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



# 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

## Value proposition to our customers



Highly accurate and reliable physics-based models tailored to specific equipment and components

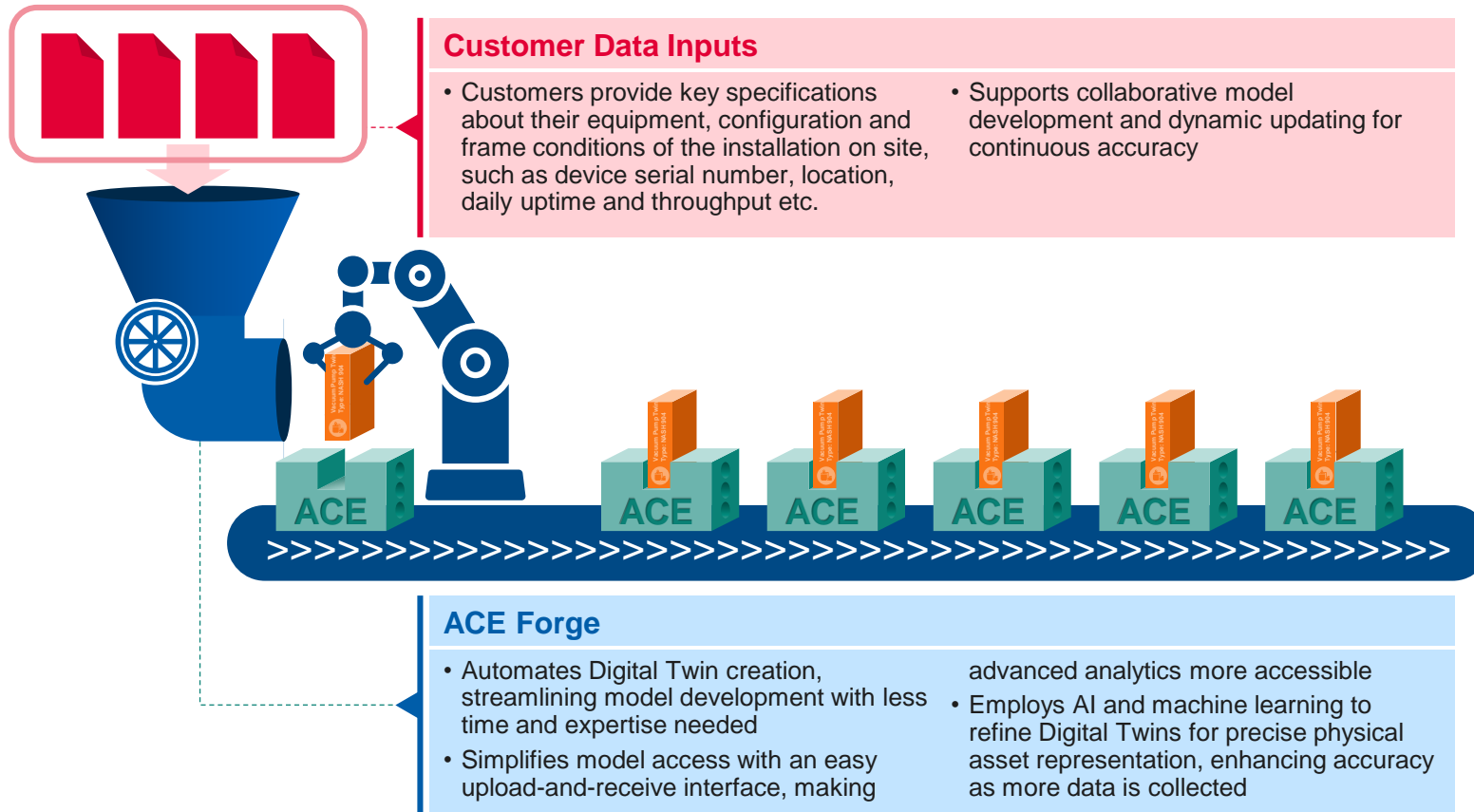


Precise analytics providing event notifications, alerts and status reports in real-time.



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



## Value proposition to our customers



Simple data entry thanks to user-friendly interface and menu navigation as well as plausibility check



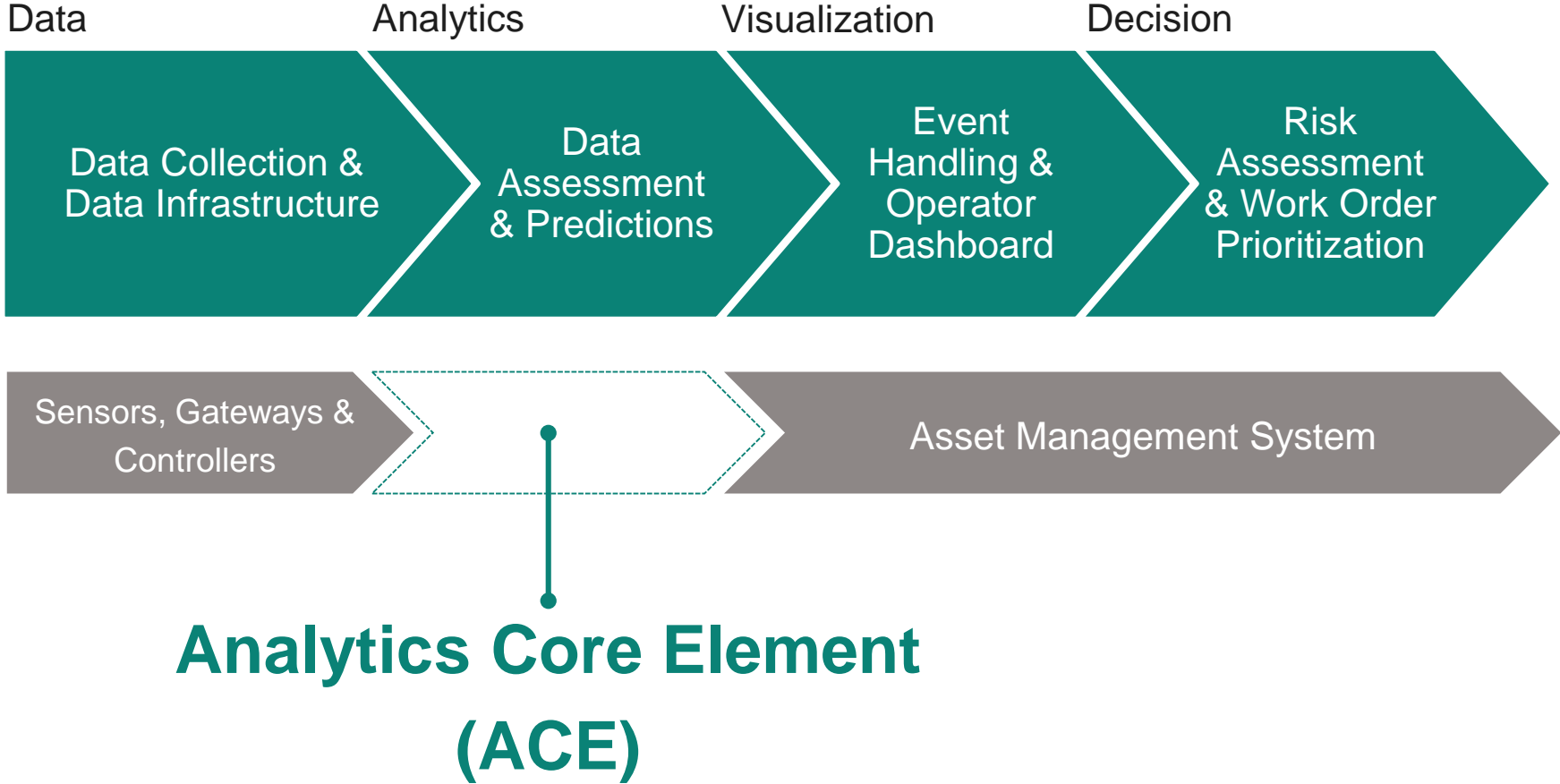
Immediate assessment of potential savings and immediate cost estimate



Fast and automated model development through the use of generative AI solutions

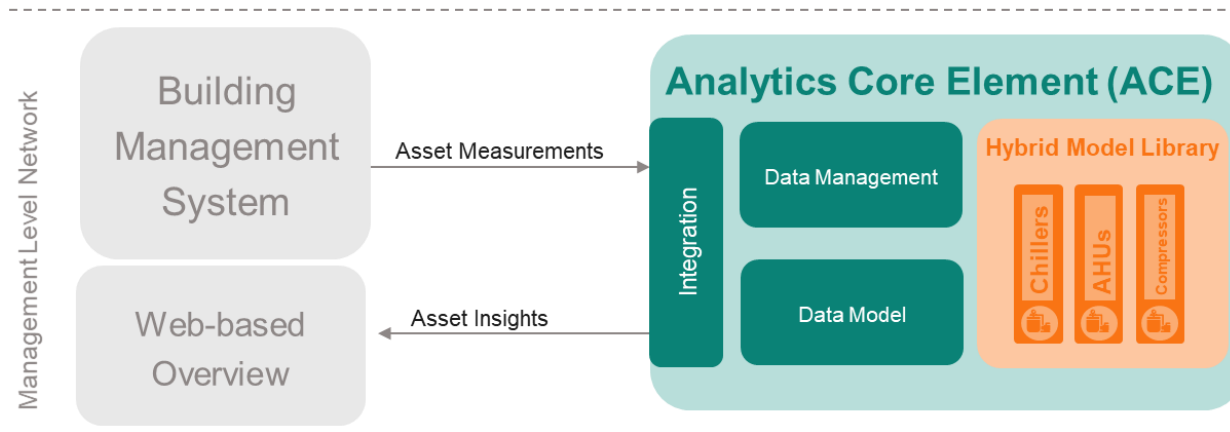


# Despite the prevalence of data infrastructure and asset management system, a gap exists in using advanced analytics for optimal decisions



# 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

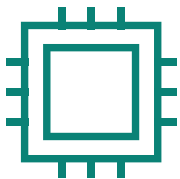
# Modernize industrial HVAC equipment anomaly detection and intelligence with AWS AI and tinyML at the Edge



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!**



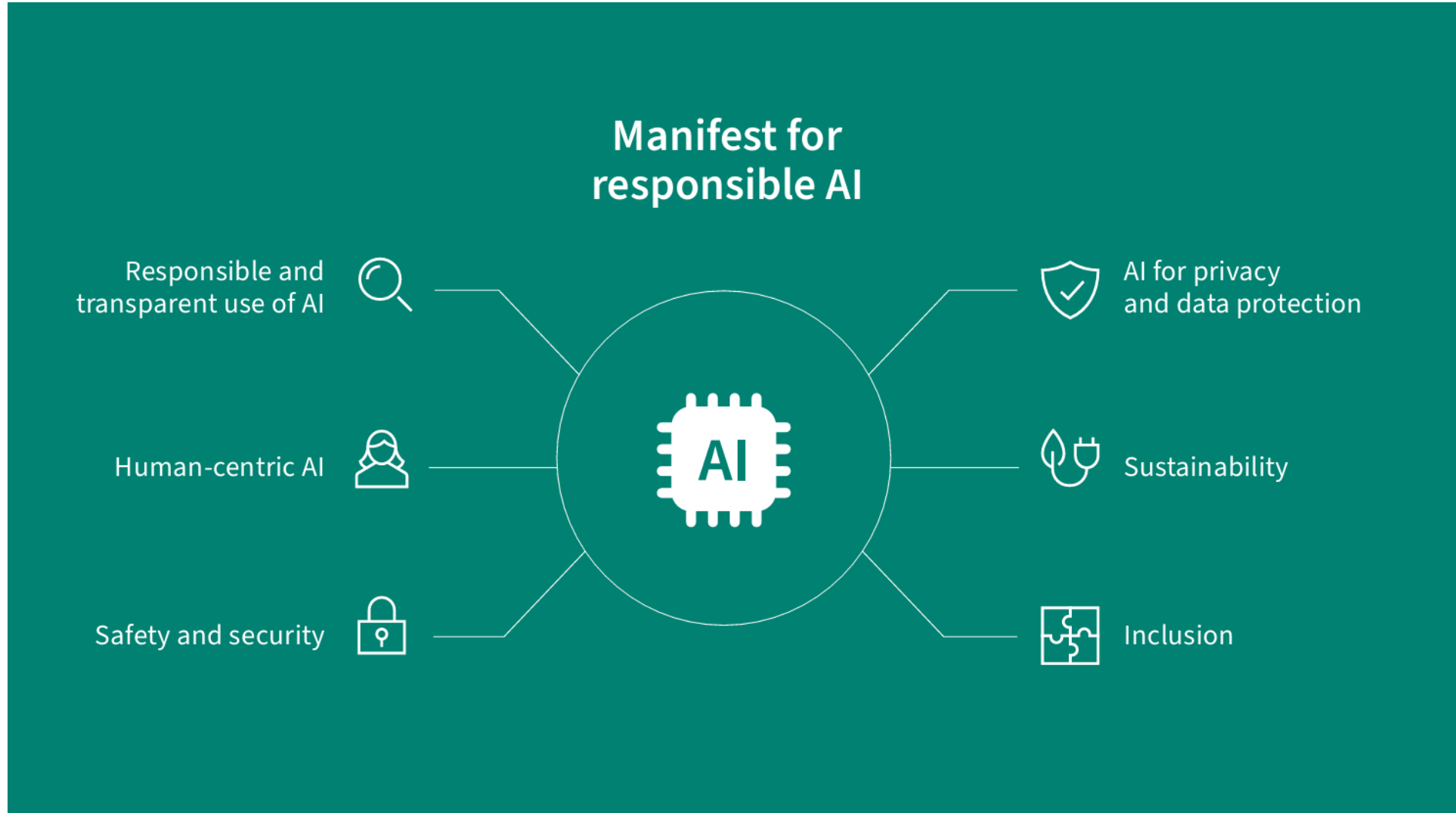
**Infineon** and **Klika Tech** provide a solution incorporating highly precise **XENSIV™ sensors**, **XMC™ microcontrollers**, and **OPTIGA™ Trust** family, sensors that will feed data into the **TinyML model** that can **detect anomalies in real time** enabling the system to transmit the identified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





**We pave the way  
for trustworthy and  
sustainable AI**

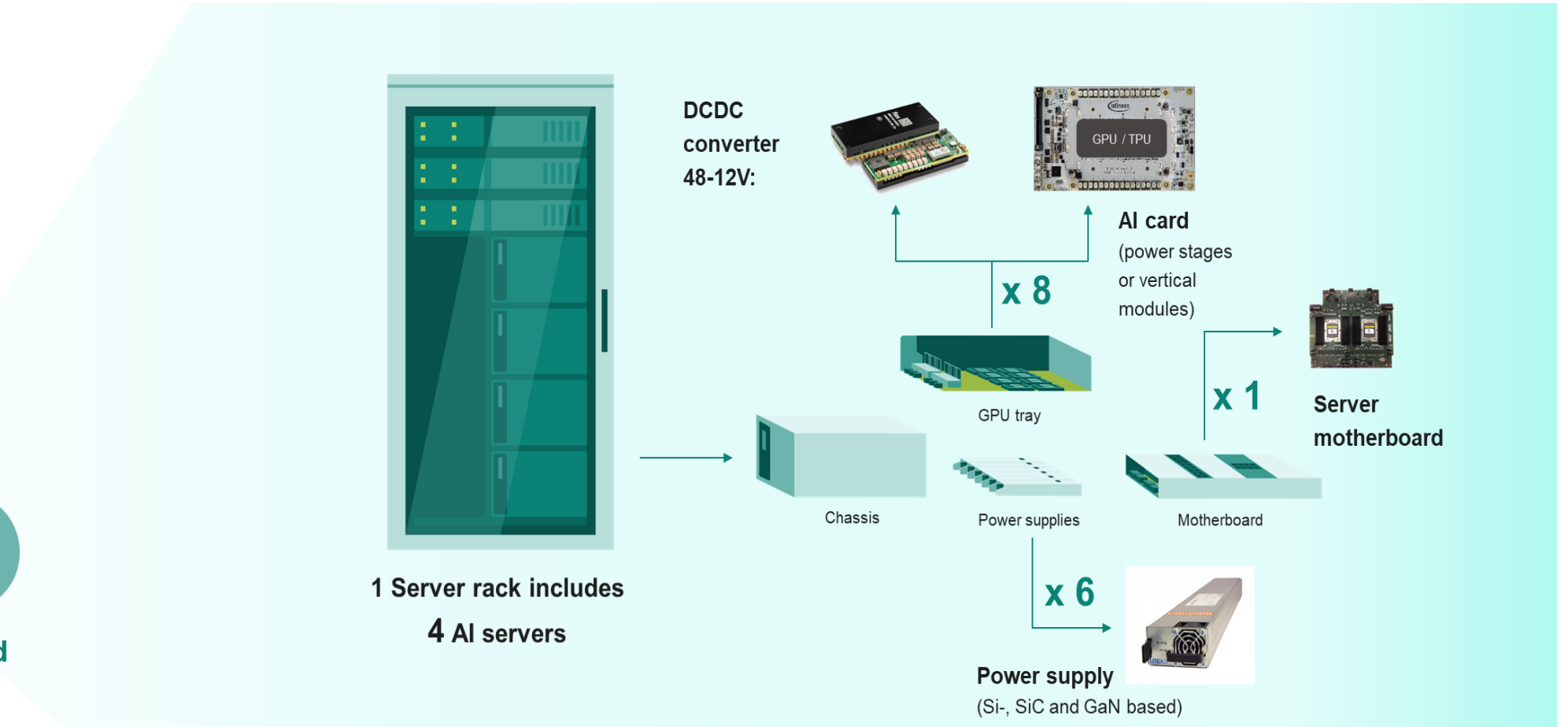
# Infiniteon's mission – to make life easier, safer and greener with responsible AI



# 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.

