

tinyML® Talks

Enabling Ultra-low Power Machine Learning at the Edge

“Embedded Edge Intelligence with Infineon New Products and Imagimob Studio”

Moenes Iskarous – CTO IoT AI/ML, Infineon Technologies

Sam Al-Attiyah – Head of Customer Success, Imagimob

May 16, 2024



www.tinyML.org



Thank you, **tinyML Strategic Partners**,
for committing to take tinyML to the next Level, together



Executive Strategic Partners

Qualcomm
AI research

Advancing AI research to make efficient AI ubiquitous

Power efficiency

Model design, compression, quantization, algorithms, efficient hardware, software tool

Personalization

Continuous learning, contextual, always-on, privacy-preserved, distributed learning

Efficient learning

Robust learning through minimal data, unsupervised learning, on-device learning

A platform to scale AI across the industry



Perception

Object detection, speech recognition, contextual fusion



Reasoning

Scene understanding, language understanding, behavior prediction



Action

Reinforcement learning for decision making



Edge cloud



Cloud



IoT/IIoT



Automotive



Mobile



Accelerate Your Edge Compute

SYNTIANT

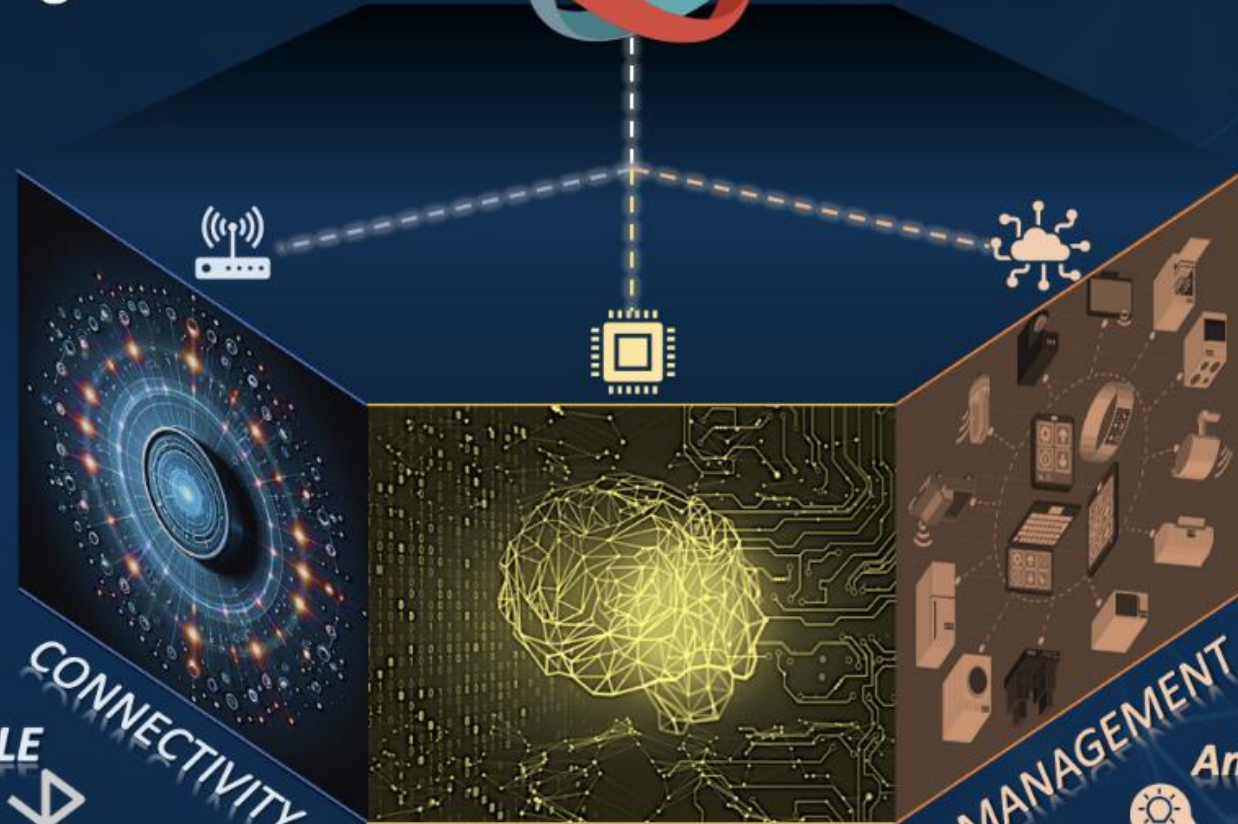
Making Edge AI A Reality

www.syntiant.com

Platinum Strategic Partners



Software Services to Edge Ahead



CONNECTIVITY

MANAGEMENT

INTELLIGENT EDGE



IMAGINE IT. DONE.



**DEPLOY VISION AI
AT THE EDGE AT SCALE**

SONY

Gold Strategic Partners

Build the
Future of tinyML

on **arm**



T I N Y



TALKS
webcast



EDGE IMPULSE

The Leading Development Platform for Edge ML

edgeimpulse.com

Decarbonization

Digitalization



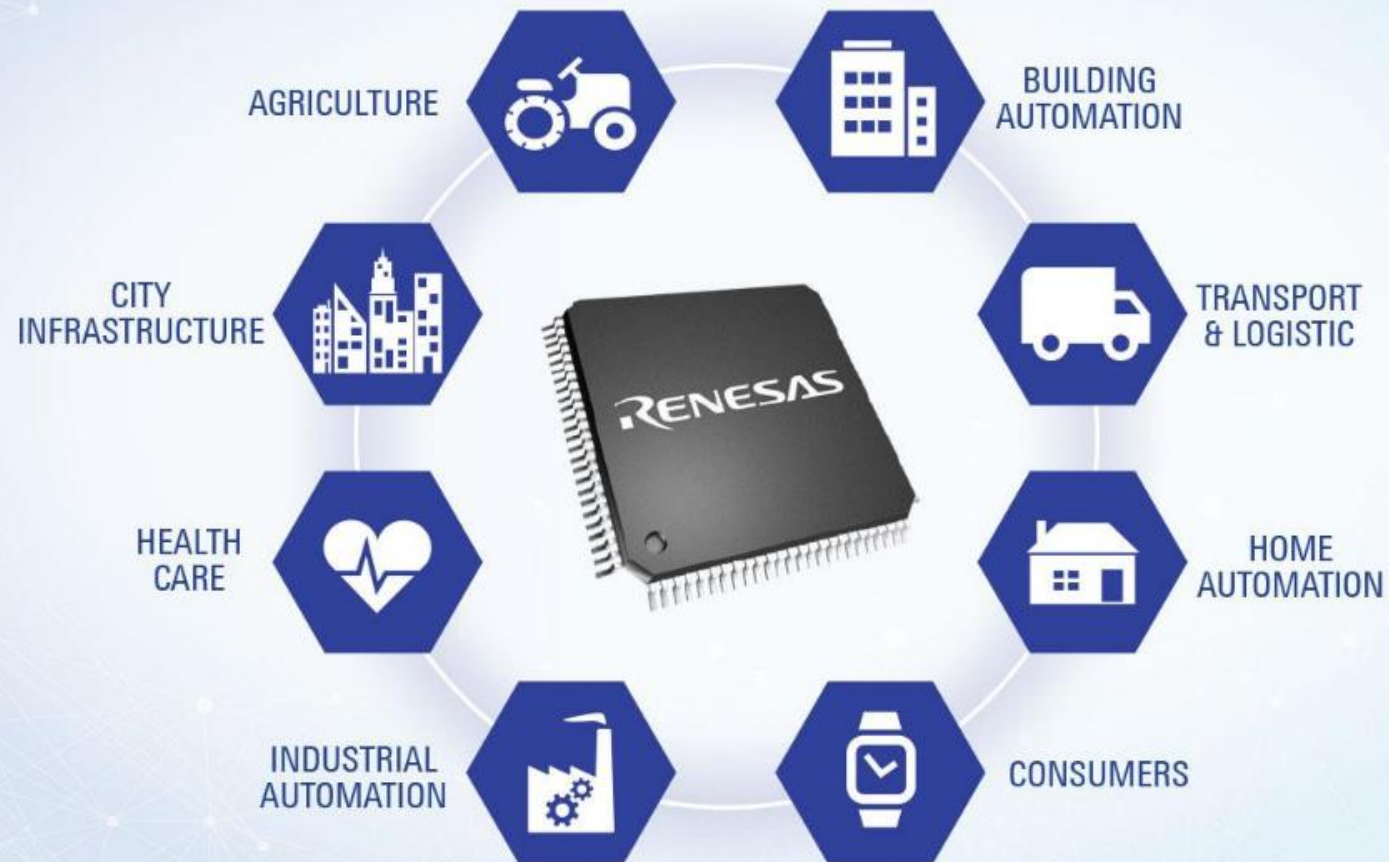
Driving decarbonization and digitalization. Together.

Infineon serving all target markets as
Leader in Power Systems and IoT

www.infineon.com



Renesas is enabling the next generation of AI-powered solutions that will revolutionize every industry sector.



[renesas.com](https://www.renesas.com)



life.augmented

STMicroelectronics provides extensive solutions to make tiny Machine Learning easy

T I N Y



Silver Strategic Partners



brainchip



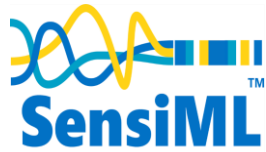
GREENWAVES
TECHNOLOGIES



NotaAI



QORVO





Join Growing tinyML Communities:



20k members in
50 Groups in 42 Countries

tinyML - Enabling ultra-low Power ML at the Edge

<https://www.meetup.com/tinyML-Enabling-ultra-low-Power-ML-at-the-Edge/>



4k members
&
16k followers

The tinyML Community

<https://www.linkedin.com/groups/13694488/>





Subscribe to
tinyML YouTube Channel
 for updates and notifications
(including this video)

www.youtube.com/tinyML



tinyML
4.33K subscribers

12.6k subscribers, 686 videos with 462k views

HOME VIDEOS PLAYLISTS COMMUNITY CHANNELS ABOUT

106 views · 4 days ago	138 views · 4 days ago	54 views · 4 days ago	47 views · 4 days ago	132 views · 4 days ago	137 views · 4 days ago
122 views · 4 days ago	262 views · 2 weeks ago	511 views · 3 weeks ago	229 views · 3 weeks ago	265 views · 3 weeks ago	286 views · 1 month ago
351 views · 1 month ago	462 views · 2 months ago	374 views · 2 months ago	133 views · 2 months ago	287 views · 2 months ago	336 views · 2 months ago
378 views · 2 months ago	214 views · 2 months ago	448 views · 2 months ago	159 views · 2 months ago	190 views · 2 months ago	545 views · 2 months ago



tinyML EMEA 2024

Amplifying Impact – Unleashing the Potential of TinyML



tinyML EMEA
June 24 -26, 2024 in Milan, Italy

REGISTER NOW



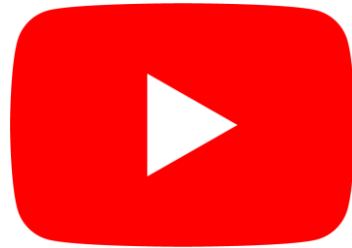


Reminders

Slides & Videos will be posted asap



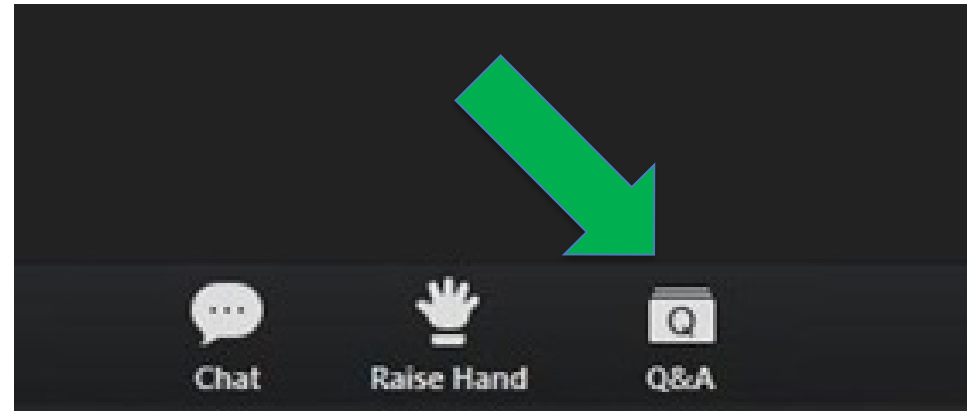
tinyml.org/forums



youtube.com/tinyml



Please use the Q&A window for your questions





Moenes Iskarous



Moenes is passionate about embedded development and believes that edge intelligence is a major growth area for AI. He has more than 32 years of industrial experience in the computer and semiconductor industry with focusing on ML technology development. Moenes received his PhD from Vanderbilt University in Neural Networks Architectures and application in Robotics then he worked at C-Cube Microsystems, Intel, SiMa.ai and SK Hynix before joining Infineon as the CTO for IoT AI/M leading the Machine Learning Center of Excellence.



Sam Al-Attiah



Sam has been working at Imagimob for more than 7 years. He has a Master in Electrical Engineering having studied both in Australia and in Sweden. Over this time he has had experience working with the end-to-end machine learning applications on the edge and led multiple projects to production. Sam is now heading the Customer Success team at Imagimob which focuses on ensuring customers get to production with their machine learning applications. Sam is also the product manager for the Imagimob Ready Models which are fully trained models ready deployment and commercialization.



Ashutosh Pandey



Ashutosh Pandey is currently a Lead Sr. Principal Systems Engineer at Infineon Technologies where he is responsible for Machine learning solutions, architecture, and tooling. He holds a PhD from the University of Utah and has over 50 papers and patents on speech/audio/machine learning systems and algorithms.

Agenda

- 1 IoT @ Infineon
- 2 Embedded Edge Intelligence with Infineon New Products
- 3 Imagimob Studio
- 4 Q&A

IoT @ Infineon

Infineon leader in IoT – driving digitalization by serving strongly growing multi-application markets



Consumer IoT



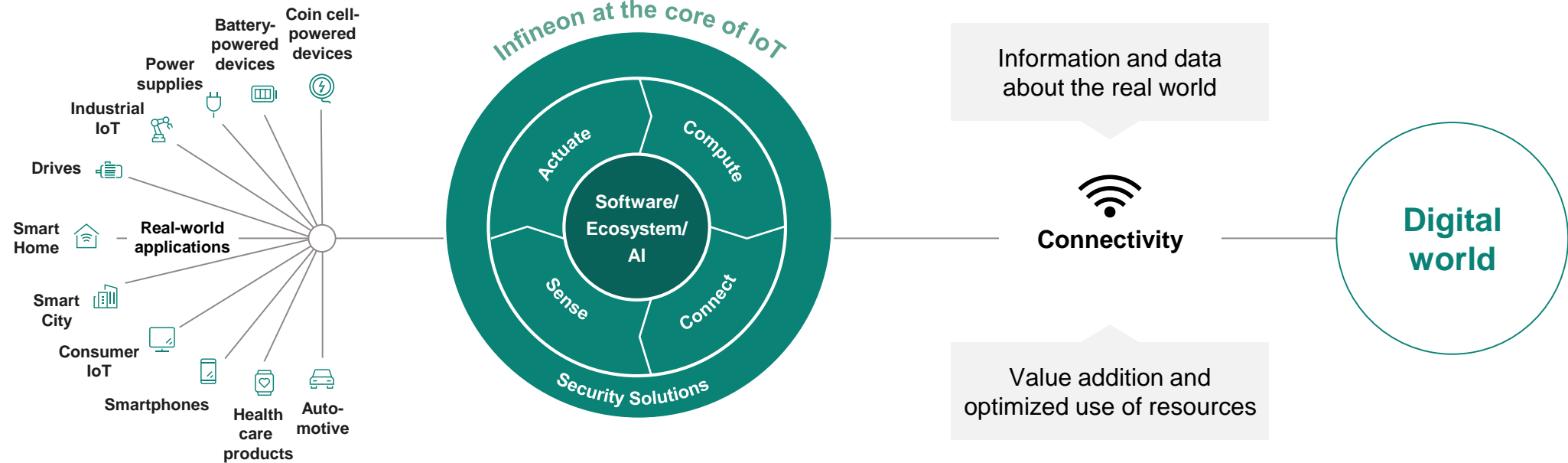
Industrial IoT



Automotive IoT

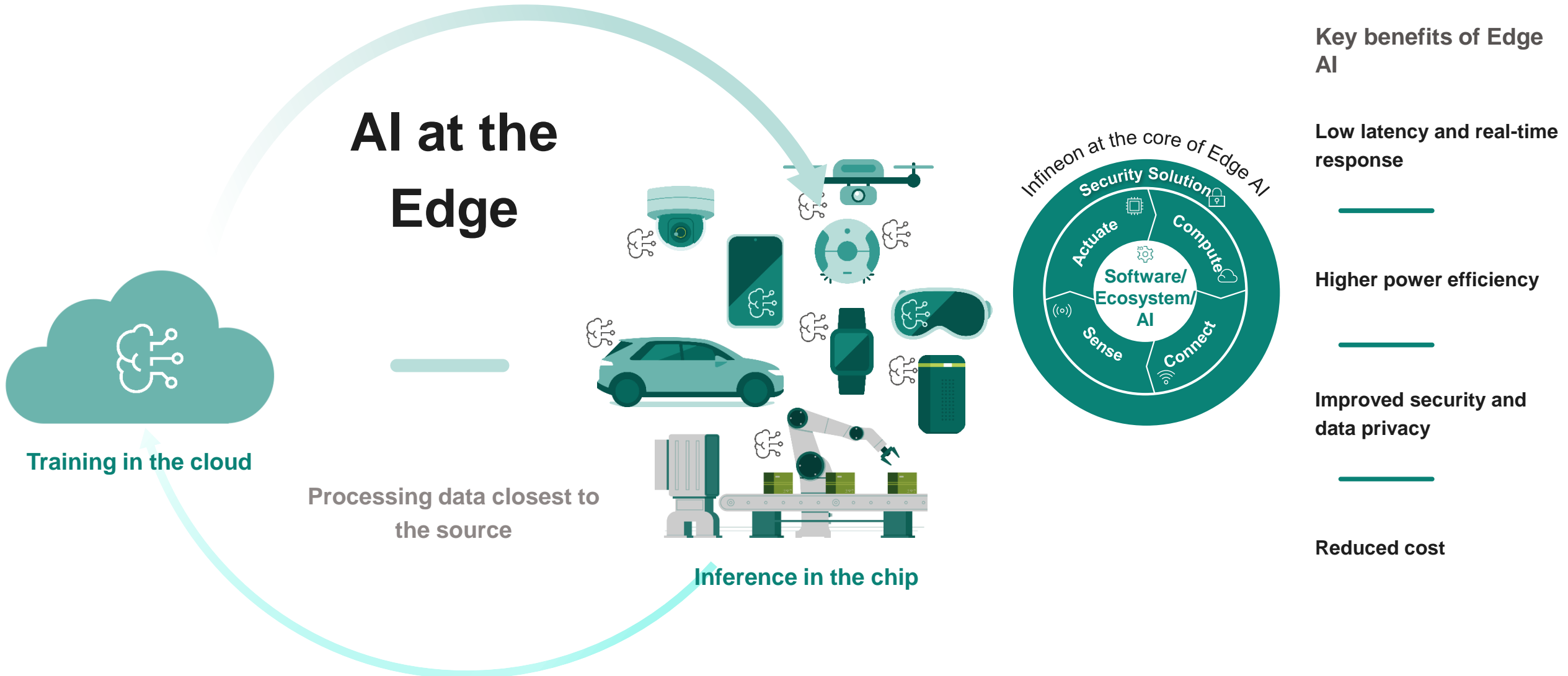


Products: MCU – Connectivity (Wi-Fi, BLE, NFC) – Sensors – Security – Power supply & switches



Embedded Edge Intelligence with PSOC™ Edge

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



Infinite offers end-to-end technology solutions for your AI market entry.



Digital Services and AI solution platforms



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



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

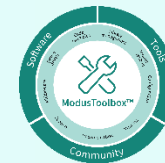
...



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



Imagimob Studio

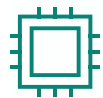


ModusToolbox™

AI partner ecosystem:



DesignWare ARC
MetaWare Toolkit



The right hardware for your Edge AI model

MCUs:



PSOC™



AURIX™



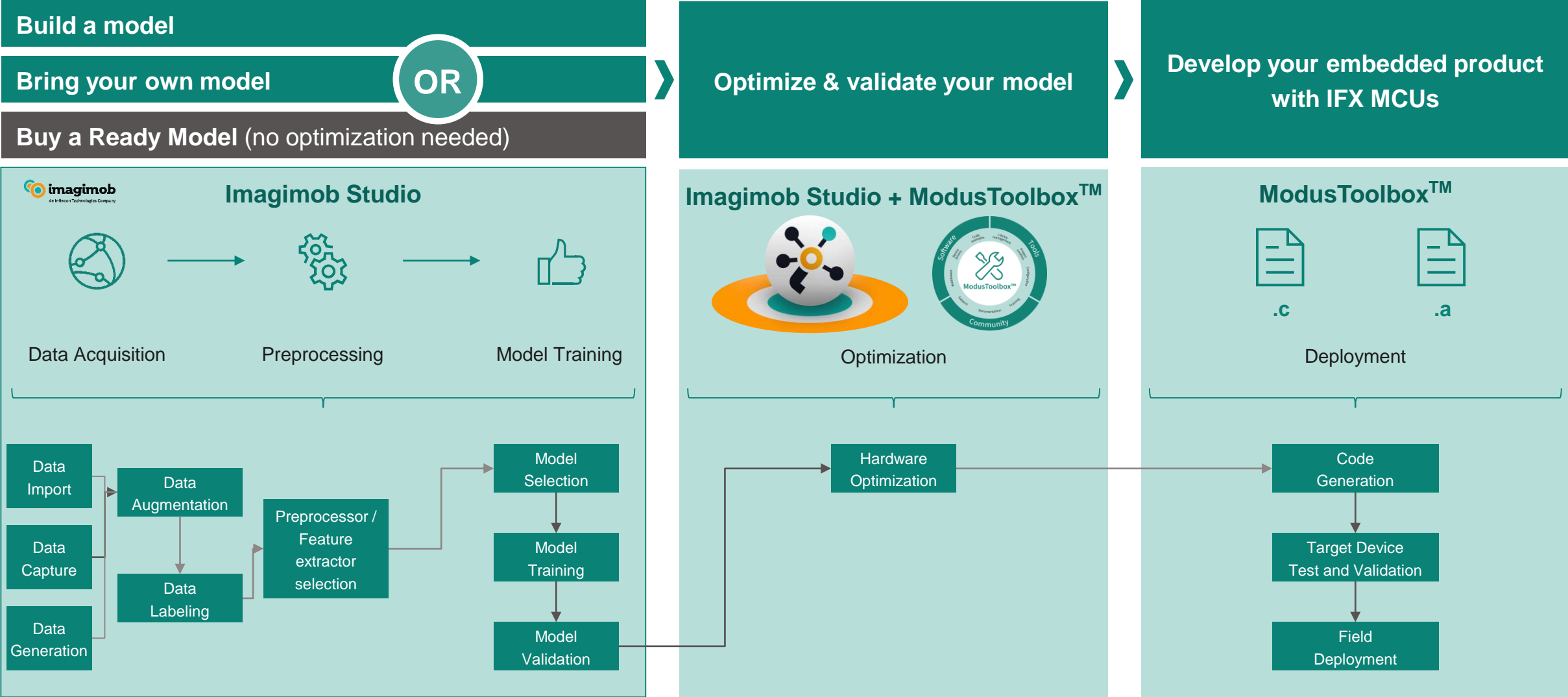
TRAVEO™



XMC™

XENSIV™ smart sensors portfolio for automotive, industrial and consumer

Imagimob with ModusToolbox™ from data to edge model



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



AI in IOT & Consumer



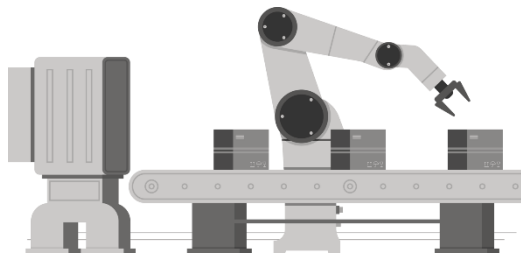
Democratizing AI by bringing the computational power of AI algorithms **closer to the source data** with **smarter** and **greener** devices for **intuitive real-time** interaction.

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.

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

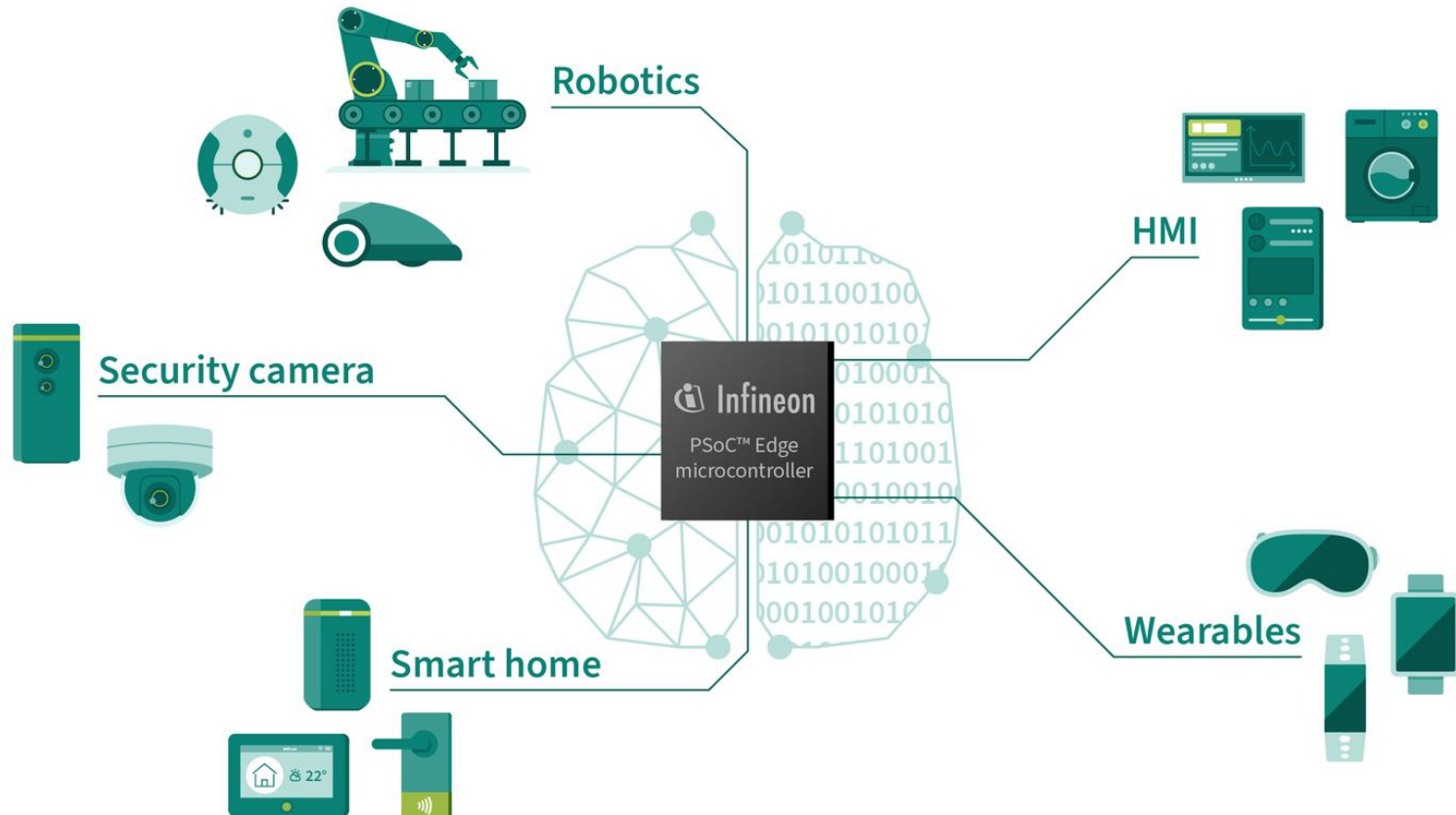


Connectivity
& security solutions

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



PSoC™ Edge – Enables a new generation of responsive machine learning devices



Human Machine Interface (HMI)

- Appliances
- Industrial Device Usability
- Factory Automation

Smart Home

- Thermostat
- Speaker
- Door lock

Robotics

- Vacuum Cleaner
- Vacuum Robots
- Service Robot
- Lawn & Garden Robotics
- Industrial Robotics

Wearables

- Fitness Watch
- AR/MR/VR Glasses & Accessories
- Audio Accessories

Security Camera

- IP Camera
- Doorbell
- Security Camera & Accessories

PSOC™ Edge – Next Gen MCU based Edge Device Platform

Fully Integrated MCU SoC Family with comprehensive Tools, Software & Enablement

... enables developers of tomorrow's applications to move faster, with a richer set of capabilities, at lower system power and cost



	High Performance & Low Power Compute	<ul style="list-style-type: none"> - Cortex®-M55 MCU core with Helium™ DSP - Cortex®-M33 MCU core with NNLite for always-on operation - Embedded ultra low-power RRAM technology
	More Memory Resources & SoC Integration	<ul style="list-style-type: none"> - More and more memory available for next-gen apps - Richer Peripheral set to reduce system cost
	More Robust Security	<ul style="list-style-type: none"> - Infineon Edge Protect Technology (EPC2 or EPC4)
	Enablement	<ul style="list-style-type: none"> - ModusToolbox™ : Software, tools, middleware & more - Imagimob AI/ML Solution - Hardware evaluation kit
	Machine Learning	<ul style="list-style-type: none"> - Ethos-U55 for high-performance AI/ML hardware NN compute
	Graphics	<ul style="list-style-type: none"> - Graphics fully synchronized with voice and smart apps

E81

E83

E84

Driving tomorrow's products with:

**More Features
Lower Power
More Security
Motor Control
Machine Learning**

- Presence/Gesture/Motion
- Predictive Maintenance
- Anomaly Detection
- Autonomous Operation

Advanced ML

- Voice & Natural Language
- Vision
- Access & Safety

Graphics

PSOC™ Edge Portfolio – Next Gen MCU based Edge Device Platform



Scalable, compatible, future proof platform for your next-gen MCU based smart devices



PSOC™ Edge E81

- Higher Performance
- More Memory
- More Peripheral Support
- Higher Integration
- Lower Power
- Base Edge ML
- Robust Security

PSOC™ Edge E83

Adds:

- Advanced Edge ML
- Audio/Voice
- Vision
- Presence/Gesture/Motion

PSOC™ Edge E84

Adds:

- Graphics
- Even More Memory



PSOC™ Edge E8 MCU Family



	PSOC™ Edge E81	PSOC™ Edge E83	PSOC™ Edge E84
Processor	Cortex-M55 + DSP (High Performance Domain) Cortex-M33 and DSP (Low-Power Domain)	Cortex-M55 + DSP (High Performance Domain) Cortex-M33 and DSP (Low-Power Domain)	Cortex-M55 + DSP (High Performance Domain) Cortex-M33 and DSP (Low-Power Domain)
Machine Learning	M55 w/ Helium DSP/NN accelerator NNLite	M55 w/ Helium DSP/NN Accelerator, NNLite Ethos-U55 - 128 MACs	
SRAM	Up to 4 MB (SoC SRAM) Up to 1 MB (Low-Power Domain)		Up to 5 MB (SoC SRAM) Up to 1 MB (Low-Power Domain)
RRAM	512 kB		
External Memory	2x SMIF, 2x SD Host Controller		
Peripherals & IO	USB, 10/100 Ethernet, CAN, SPI, UART, I2C, I3C, I2S		
Audio/Voice	ULP Always ON prog. analog for voice, audio, sensing 4x Analog Mic, 6x Digital Mic NNLite Wake Word & Acoustic Activity Detection	ULP Always ON prog. analog for voice, audio, sensing 4x Analog Mic, 6x Digital Mic U55 ML-based Wake Word & Acoustic Activity Detection Full Voice Inferencing	
Graphics	No	No	LP 2.5D GPU Up to 1024 x 768, MIPI-DSI/DBI formats
Vision	No	Position Detection/Face Recognition/Object Detection (VGA)	
Security	Secured Enclave, Edge Protect Category 2 and 4		

PSOC™ Edge E81: Next Gen, Low Power MCU

Features

- **High performance real-time compute domain**
 - Cortex®-M55 w FPU + Helium DSP
 - Up to 4 MB System SRAM, 256 KB I&D TCMs
 - 512 kB RRAM
- **Low power compute domain**
 - Cortex®-M33 and DSP + IFX NNLite for ML
 - 1 MB SRAM
- **HMI**
 - Traditional MCU HMI
- **ML**
 - Base ML leveraging M55, Helium DSP and NNLite
- **Peripherals & IO**
 - USB, 10/100 Ethernet, CAN, SPI, UART, I2C, I3C, I2S
 - Ultra-low-power always-on analog
- **Security**
 - Secured Enclave @ 25 JIL pts, fit for ARM PSA L4

Target Applications: Appliances, Thermostats, Home Security, Industrial HMI, etc.

System Power Modes: Active/Sleep DeepSleep Hibernate

High Performance CPU System

Compute Memory DSP

Arm® Cortex®-M55, 50-400 MHz		
Helium™ DSP	FPU	MPU
NVIC	32 kB I-Cache	32 kB D-Cache
HPDMA	256 kB I-TCM	256 kB D-TCM

Up to 4 MB SRAM 512 kB RRAM

Low Power CPU System

Compute Memory DSP

Arm® Cortex®-M33, 50-200 MHz		
NNLite	DMA	64 kB ROM
	1 MB SRAM	16 kB I-Cache

External Memory

2x Serial Memory IF, xSPI/Hyperbus, On-the-fly Encrypted XIP
2x SD Host Controller (SD/SDIO/eMMC)

ML Enhanced Next Gen HMI

Keyword Spotting
Wake Word Detection

Peripherals & IO

12b ADC * 5/0.2 Msps	11x SCB (UART,I ² C,SPI)	
2x 12b DAC	1x SCB (I ² C,SPI)	10/100 Ethernet
2x 4b Prog. Ref.	2x TDM/I2S	2x CAN FD
2x PTCOMP	1x I3C	2x Smart IO
2x LPCOMP	6x PDM	USB HS/FS w/ PHY
4x Amplifiers	32x TCPWM	

Secure Enclave 25 JIL Pts

Secure Key Storage	Side Channel Resistance
TRNG	Crypto Accel.
OTP	Secure JTAG
Secure Boot	Tamper Protect

System Resources

Power Mgmt.		Clock Mgmt.	
Sleep Control		Clock Control	
POR	BOD	PILO	IHO
LVD		WCO	ECO
Reset Control		3x DPLL	
Retention LDOs		WDT RTC	
Active LDOs		3x LPTimer	
Buck Converters		16x HFCLK DIV	

* 5 Msps in Active/Sleep, 200 kpsps in DeepSleep

PSOC™ Edge E83: Next Gen, Low Power ML MCU with Voice/Vision



Features

- **High performance real-time compute domain**
 - Cortex®-M55 w FPU + Helium DSP + Ethos-U55 for ML
 - Up to 4 MB System SRAM, 256 KB I&D TCMs
 - 512 kB RRAM
- **Low power compute domain**
 - Cortex®-M33 and DSP + IFX NNLite for ML
 - 1 MB SRAM
- **HMI**
 - Traditional MCU HMI
 - Local voice, cloud voice
 - Vision for friction free interface & safety
- **ML**
 - NNLite
 - Advanced ML leveraging U55
- **Peripherals & IO**
 - USB, 10/100 Ethernet, CAN, SPI, UART, I2C, I3C, I2S
 - Ultra-low-power always-on analog
- **Security**
 - Secured Enclave @ 25 JIL pts, fit for ARM PSA L4

Target Applications: Appliances, Wearables, Thermostats, Residential AC, Speakers, Industrial HMI, etc.

System Power Modes: Active/Sleep DeepSleep Hibernate

High Performance CPU System

Compute Memory ML DSP

Arm® Cortex®-M55, Ethos™-U55, 50-400 MHz		
Helium™ DSP	FPU	MPU
NVIC	32 kB I-Cache	32 kB D-Cache
HPDMA	256 kB I-TCM	256 kB D-TCM

Up to 4 MB SRAM 512 kB RRAM

Low Power CPU System

Compute Memory ML DSP

Arm® Cortex®-M33, 50-200 MHz		
NNLite	DMA	64 kB ROM
	1 MB SRAM	16 kB I-Cache

External Memory

2x Serial Memory IF, xSPI/Hyperbus, On-the-fly Encrypted XIP
2x SD Host Controller (SD/SDIO/eMMC)

ML Enhanced Next Gen HMI

Local Voice	Keyword Spotting	Vision
Cloud Voice	Wake Word Detection	Friction Free Interface and Safety

Peripherals & IO

12b ADC * 5/0.2 Msps	11x SCB (UART,I²C,SPI)	
2x 12b DAC	1x SCB (I²C,SPI)	10/100 Ethernet
2x 4b Prog. Ref.	2x TDM/I2S	2x CAN FD
2x PTCOMP	1x I3C	2x Smart IO
2x LPCOMP	6x PDM	USB HS/FS w/ PHY
4x Amplifiers	32x TCPWM	

Secure Enclave 25 JIL Pts.

Secure Key Storage	Side Channel Resistance
TRNG	Crypto Accel.
OTP	Secure JTAG
Secure Boot	Tamper Protect

System Resources

Power Mgmt.		Clock Mgmt.	
Sleep Control		Clock Control	
POR	BOD	PILO	IHO
LVD		WCO	ECO
Reset Control		3x DPLL	
Retention LDOs		WDT RTC	
Active LDOs		3x LPTimer	
Buck Converters		16x HFCLK DIV	

* 5 Msps in Active/Sleep, 200 kpsps in DeepSleep

PSOC™ Edge E84: Next Gen, Low Power ML MCU adds GPU

Features

- **High performance, real-time compute domain**
 - Cortex®-M55 w FPU + Helium DSP + Ethos-U55 for ML
 - Up to 5 MB System SRAM, 256 KB I&D TCMs
- **Low power, real-time compute domain**
 - Cortex®-M33 and DSP + IFX NNLite for ML
 - 512 KB RRAM, 1 MB SRAM
- **HMI**
 - Traditional MCU HMI
 - Local voice, cloud voice
 - Vision for friction free interface & safety
 - Low power Graphics, up to 1024x768, MIPI-DSI/DBI
- **ML**
 - NNLite
 - Advanced ML leveraging U55 and NNLite
- **Peripherals & IO**
 - USB, 10/100 Ethernet, CAN, SPI, UART, I2C, I3C, I2S
 - Ultra-low-power always-on analog
- **Security**
 - Secured Enclave @ 25 JIL pts, fit for ARM PSA L2/L4

Target Applications: Wearables, Appliances, Thermostats, Residential AC, Speakers, Industrial HMI, etc.

System Power Modes: Active/Sleep DeepSleep Hibernate

High Performance CPU System

Compute Memory ML DSP

Arm® Cortex®-M55, Ethos™-U55, 50-400 MHz		
Helium™ DSP	FPU	MPU
NVIC	32 kB I-Cache	32 kB D-Cache
HPDMA	256 kB I-TCM	256 kB D-TCM

Up to 5 MB SRAM 512 kB RRAM

Low Power CPU System

Compute Memory ML DSP

Arm® Cortex®-M33, 50-200 MHz		
NNLite	DMA	64 kB ROM
	1 MB SRAM	16 kB I-Cache

External Memory

2x Serial Memory IF, xSPI/Hyperbus, On-the-fly Encrypted XIP
2x SD Host Controller (SD/SDIO/eMMC)

ML Enhanced Next Gen HMI

Local Voice	Keyword Spotting	Vision
Cloud Voice	Wake Word Detection	Friction Free Interface and Safety
	2.5D GPU	

Peripherals & IO

12b ADC * 5/0.2 Msps	11x SCB (UART,I ² C,SPI)	MIPI-DSI/DBI
2x 12b DAC	1x SCB (I ² C,SPI)	10/100 Ethernet
2x 4b Prog. Ref.	2x TDM/I2S	2x CAN FD
2x PTCOMP	1x I3C	2x Smart IO
2x LPCOMP	6x PDM	USB HS/FS w/ PHY
4x Amplifiers	32x TCPWM	

Secure Enclave 25 JIL Pts

Secure Key Storage	Side Channel Resistance
TRNG	Crypto Accel.
OTP	Secure JTAG
Secure Boot	Tamper Protect

System Resources

Power Mgmt		Clock Mgmt	
Sleep Control		Clock Control	
POR	BOD	PILO	IHO
LVD		WCO	ECO
Reset Control		3x DPLL	
Retention LDOs		WDT RTC	
Active LDOs		3x LPTimer	
Buck Converters		16x HFCLK DIV	

* 5 Msps in Active/Sleep, 200 kpsps in DeepSleep

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

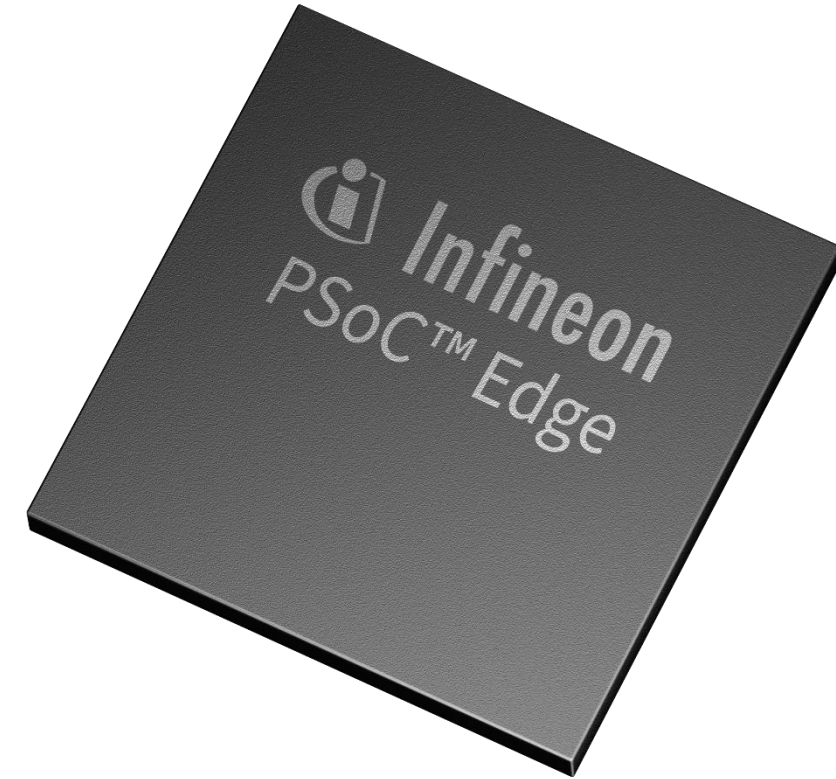
PSOC™ Edge – The Next Generation of ML Enabled MCUs



Available for Alpha Customers Now

For more information:
www.infineon.com/PSOCEdge

Customer contact:
PSOCEdge@infineon.com



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.

Imagimob Studio

Story of Imagimob Studio

- Started early on in 2015 – there were no good tools to help us
- Developed our own platform that would help us to build solutions faster

The idea is the following;

- Make data collection easier
- Have the tools for analysing data
- Easily train models
- Get the models ready for deployment
- Have the flexibility to do this for different customer projects

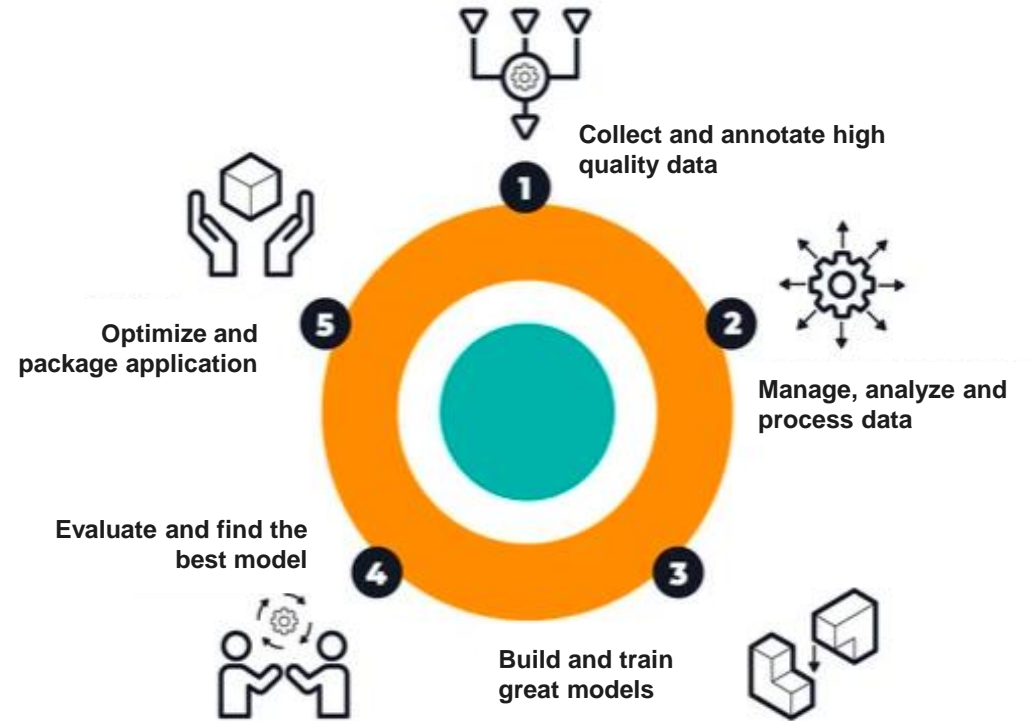


Deep Dive into Imagimob Studio

Imagimob Studio helps you to take your edge AI ideas to production. The platform supports you from end to end in the ML development journey

End to end flow

- Data Collection
- Importing Data
- Labelling and annotation
- Data Management
- Pre-processing
- Model Generation
- Model Evaluation & Selection
- Packaging the Model
- Deployment



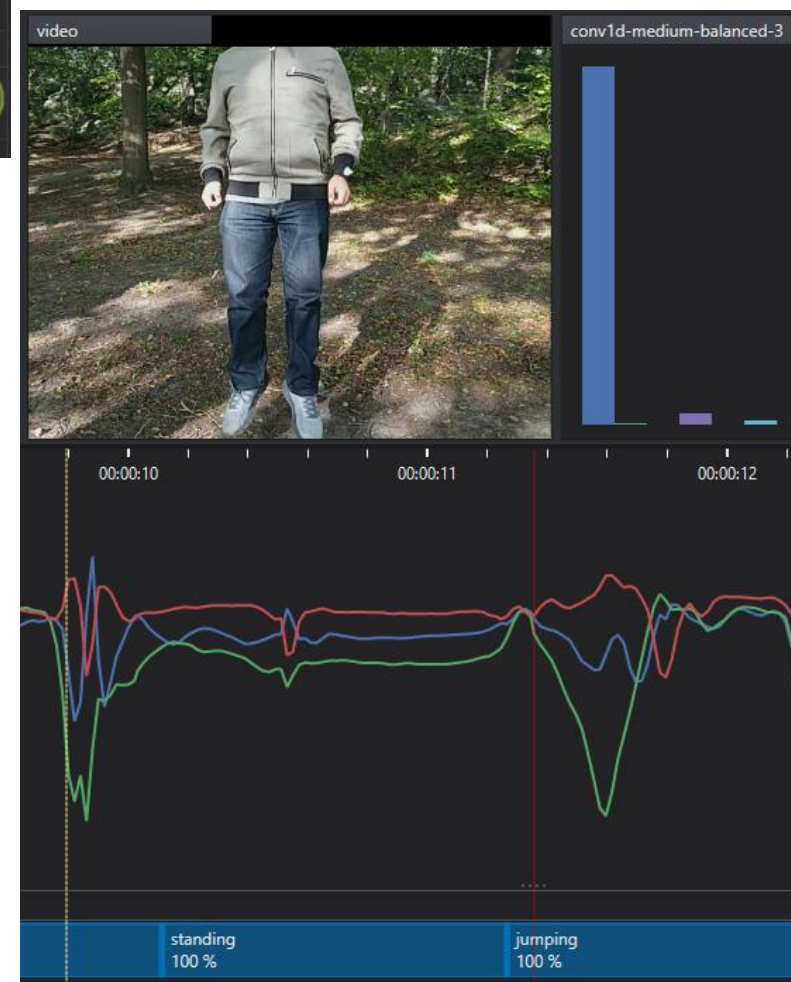
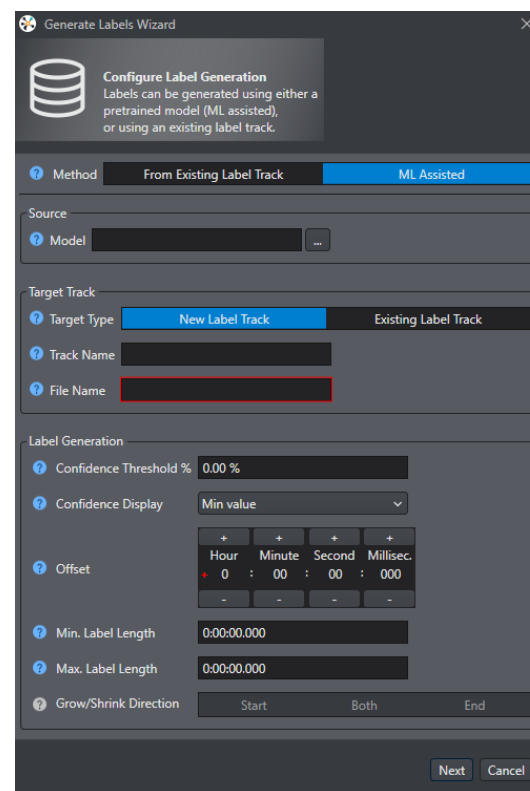
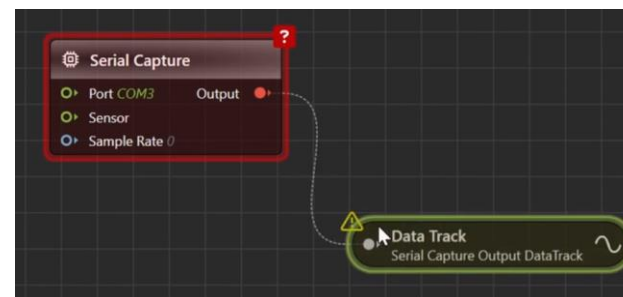
Data Collection & Labelling

Problem:

- How to get data from devices out in the field?
And, from different sensor types?
- How to synchronise different signals?
- Establishing the ground truth & labeling data?

Solution:

- Standard protocol for devices to connect to
- Graphical UI for work with different components both hardware and software, on device or in the cloud
- Video used as meta data and as ground-truth
- Easy to use labelling; manual, ML-assisted and algorithm based



Data Management

Problem:

- How to manage large datasets?
- How do you categorise your data?
- How to identify issues in your data?

Solution:

- Dashboard view of dataset
- Displaying all properties and metrics
- With grouping and filtering functionality
- Assign to different sets and leave unassigned

The screenshot displays the Infineon data management software interface. The top section shows a summary table for the dataset, and the bottom section shows a detailed list of sessions with various properties and metrics.

Class	ID	Unassigned	Train (60 %)	Validation (21 %)	Test (19 %)	Weight	Total
standing	1	0 % (00:00)	66 % (16:41)	8 % (02:07)	25 % (06:24)	1	25:14
running	2	0 % (00:00)	56 % (09:01)	25 % (04:06)	19 % (03:02)	1	16:11
walking	3	0 % (00:00)	59 % (13:52)	19 % (04:25)	22 % (05:01)	1	23:19
sitting	4	0 % (00:00)	63 % (16:01)	21 % (05:15)	16 % (04:10)	1	25:28
jumping	5	0 % (00:00)	83 % (12:39)	7 % (01:05)	10 % (01:28)	1	15:12
Total Annotated	-	0 % (00:00)	65 % (68:17)	16 % (17:00)	19 % (20:08)		105:25
Unlabeled Data	0	0 % (00:00)	77 % (00:56)	4 % (00:02)	19 % (00:13)	1	01:13
Total Data		0 % (00:00)	65 % (69:13)	16 % (17:03)	19 % (20:22)		106:39

Name	Set	Status	Active Label Track	Active Data Track	Sample Shape	Frequency	Labels	Length	Labeled	Labeled (%)	standing	running	walking
b8c556a90831cbe4_09_17_2019_15_15_05	Validation	✓	label	accel	[3]	51 Hz	1	01:04	01:04	100 %	1		
b8c556a90831cbe4_09_17_2019_15_18_27	Train	✓	label	accel	[3]	51 Hz	4	01:03	01:03	100 %	2		
b8c556a90831cbe4_09_17_2019_15_21_09	Train	✓	label	accel	[3]	51 Hz	47	01:03	01:03	100 %	24		
b8c556a90831cbe4_09_17_2019_15_24_13	Test	✓	label	accel	[3]	51 Hz	46	01:04	01:04	100 %	23		
b8c556a90831cbe4_09_17_2019_15_26_49	Train	✓	label	accel	[3]	51 Hz	1	01:03	01:03	100 %	1		
b8c556a90831cbe4_09_17_2019_15_41_54	Train	✓	label	accel	[3]	51 Hz	1	01:04	01:04	100 %		1	
b8c556a90831cbe4_09_17_2019_15_43_16	Test	✓	label	accel	[3]	51 Hz	1	01:04	01:04	100 %		1	
b8c556a90831cbe4_09_17_2019_15_45_34	Validation	✓	label	accel	[3]	51 Hz	1	01:04	01:04	100 %		1	
b8c556a90831cbe4_09_17_2019_15_46_59	Train	✓	label	accel	[3]	51 Hz	1	01:03	01:03	100 %		1	
b8c556a90831cbe4_09_17_2019_15_53_45	Train	✓	label	accel	[3]	51 Hz	1	01:05	01:05	100 %			1
b8c556a90831cbe4_09_17_2019_15_54_58	Train	✓	label	accel	[3]	51 Hz	1	01:03	01:03	100 %			1
b8c556a90831cbe4_09_17_2019_15_56_30	Test	✓	label	accel	[3]	51 Hz	1	01:04	01:04	100 %			1
b8c556a90831cbe4_09_17_2019_15_57_49	Train	✓	label	accel	[3]	51 Hz	1	01:04	01:04	100 %			1
b8c556a90831cbe4_09_17_2019_15_59_09	Train	✓	label	accel	[3]	51 Hz	1	01:04	01:04	100 %			1
b8c556a90831cbe4_09_17_2019_16_07_23	Test	✓	label	accel	[3]	51 Hz	1	01:03	01:03	100 %			1
b8c556a90831cbe4_09_17_2019_16_08_29	Train	✓	label	accel	[3]	51 Hz	1	01:04	01:04	100 %			1

Pre-Processing & Model Generation

Problem:

- Creating a framework that ensures you don't have to recreate the wheel every-time whilst also being easy to use
- Keeping track of important valuable data processing functions
- Easy to use ML and maintaining the training loop

Solution:

- Layer library; anyone can create and add their own custom units
- Model wizard makes it easy to use models and architectures we've found to be successful

The screenshot displays the Infineon ML Studio interface, divided into several functional panels:

- Preprocessor:** A list of data processing steps with their respective parameters:

Name	Shape	Frequency	Rate	Properties
Sliding Window (data points) Window Shape: [512] Stride: 160 Buffer Multiplier: 1	[512]	@ 100 Hz	204.8 KB/sec	Properties
Hann smoothing Symmetric: True	[512]	@ 100 Hz	204.8 KB/sec	Properties
Real Discrete Fourier Transform Axis: 0	[257,2]	@ 100 Hz	205.6 KB/sec	Properties
Frobenius norm Axis: 0	[257]	@ 100 Hz	102.8 KB/sec	Properties
Mel Filterbank Number of Filters: 20 Sample Rate (Hz): 16000 Low Frequency Cutoff (Hz): 300 High Frequency Cutoff (Hz): 8000 HTK formula: True Librosa formula: False	[20]	@ 100 Hz	8 KB/sec	Properties
Clip Min: 0.000316227766016 Max: 3.40282347E+38	[20]	@ 100 Hz	8 KB/sec	Properties
Logarithm Logarithm base: 0	[20]	@ 100 Hz	8 KB/sec	Properties
Sliding Window (data points) Window Shape: [60,20] Stride: 660 Buffer Multiplier: 1	[60,20]	@ 3.03 Hz	14.55 KB/sec	Properties
- Training:** A table listing generated models:

Name	Class Weights	P	Layers	Epochs	Learning Rate	Weight Decay	Patience	Properties
conv2d-medium	Shared	38	15	100	0.00400	0.00100	20	Properties
conv2d-medium	Shared	27	15	100	0.00400	0.00100	20	Properties
- Settings:** Includes an **Auto ML** wizard for configuring model generation:
 - Hardware Type:** Default
 - Model Family:** Conv2D
 - Model Flavor:** LargeKern
 - Classifier:** GlobalAveragePool
 - Model Size:** Small, Medium (selected), Large
 - Optimization:** Accuracy, Balanced, Speed (selected)
 - Downscale:** Off
 - Pooling:** On
 - Learn Rate:** Low, Mid (selected), High
 - Regularization:** Low, Mid (selected), High
 - Append Models:**

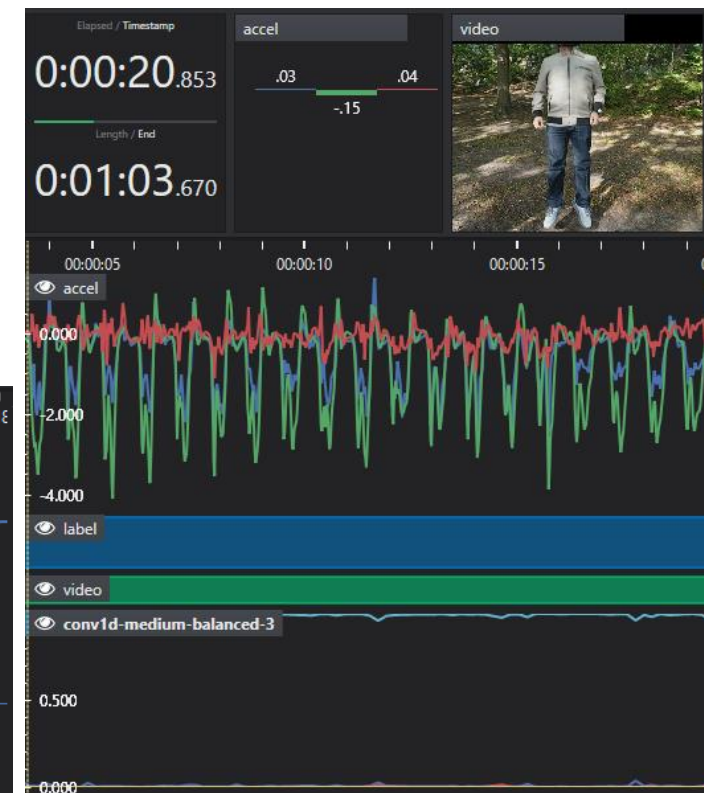
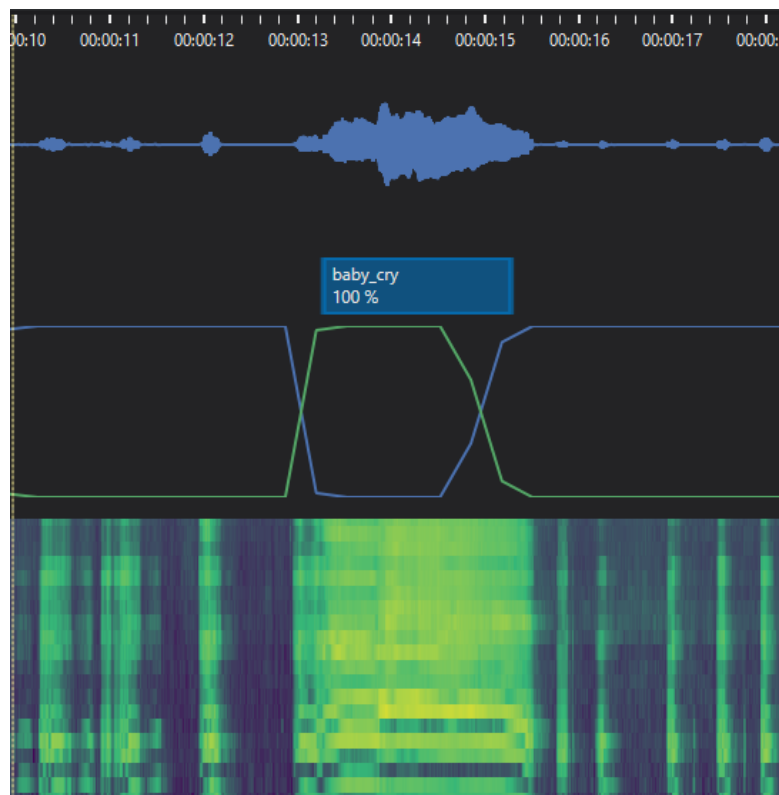
Visualisation is everything!

Problem:

- Every problem or use-case can be quite complex
- Need to robust analysis tool

Solution:

- Ability to play through files and compare the video of the event against the sensor data for deeper understanding
- Visualising different parts of the system; from time-series data to pre-processing, labels, model output etc.



Package for the edge

Problem:

- A way to deploy our models with minimal effort
- Certainty that what you see is what you get

Solution:

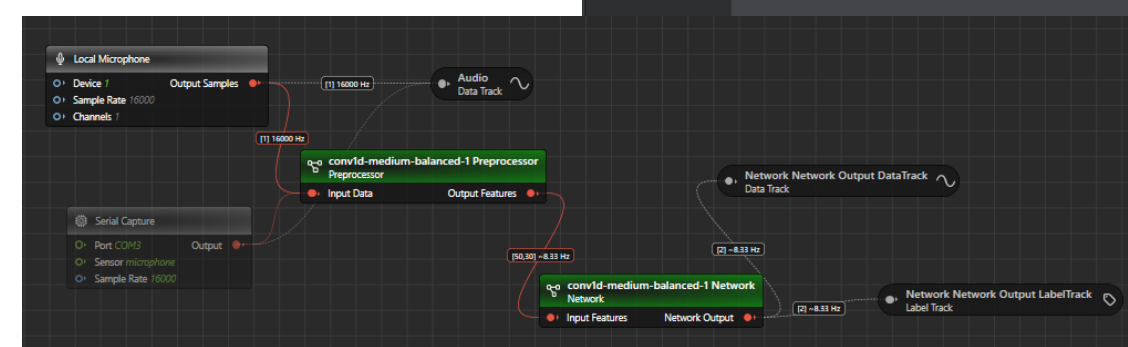
- Model translation for all common layers
- Easy to use UI
- Easy to use API
- Ability to stream data and analyse the model in real-time on live data

```

model.h  conv2d-medium-speed-0.h5*  Main.imsession*
333 #define IMAI_DATA_OUT_TYPE float
334 #define IMAI_DATA_OUT_TYPE_ID IMAGINET_TYPES_FLOAT32
335 #define IMAI_DATA_OUT_SCALE (1)
336 #define IMAI_DATA_OUT_OFFSET (0)
337 #define IMAI_DATA_OUT_IS_QUANTIZED (0)
338
339 #define IMAI_KEY_MAX (48)
340
341
342
343 // Return codes
344 #define IMAI_RET_SUCCESS 0
345 #define IMAI_RET_NODATA -1
346 #define IMAI_RET_NOMEM -2
347
348 // Exported methods
349 int IMAI_dequeue(float *restrict data_out);
350 int IMAI_enqueue(const float *restrict data_in);
351 void IMAI_init(void);
352
353 #endif /* _IMAI_MODEL_H_ */
354

```

The screenshot shows the configuration interface for a project named 'conv1dstm-medium-balanced-1.h5*'. The 'Preprocessor' tab is active, showing settings for Architecture (Infineon), Target Device (PSoC 6), Output Directory (Infineon), and Output File Prefix (model). Under the 'Optimization' section, 'Enable Quantization' is checked, and 'Enable Sparsity' is also checked. The 'Validation' section shows 'None' selected for validation options, and 'Max Data Files' is set to 1000.

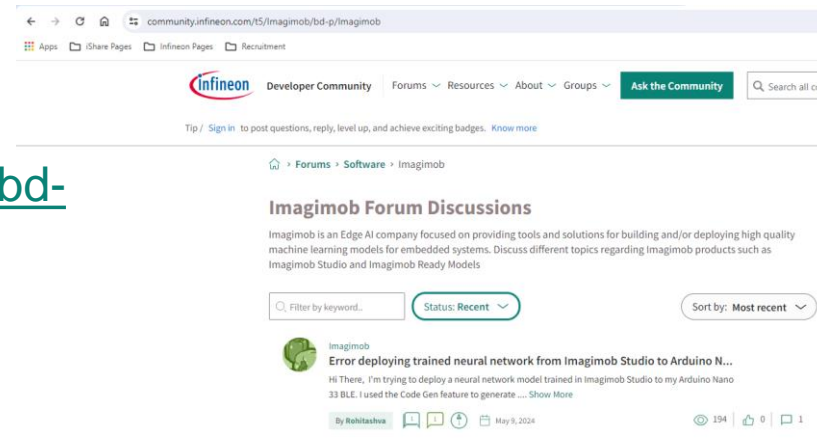
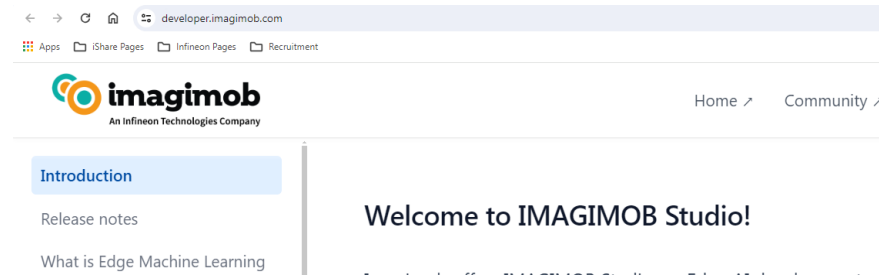
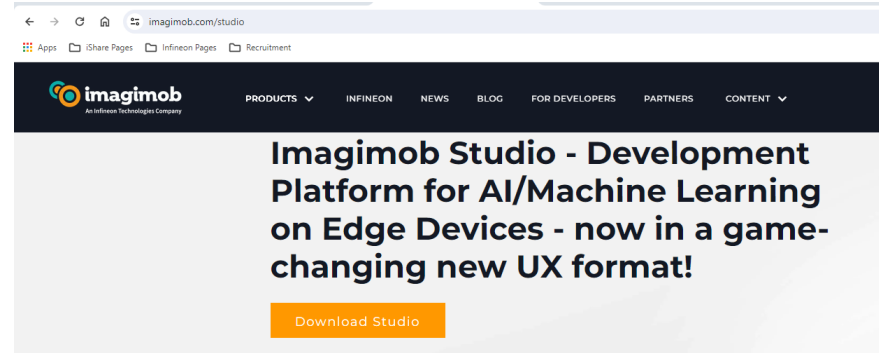


Resources

– Download Imagimob Studio at <https://www.imagimob.com/studio>

– Find the documentation at <https://developer.imagimob.com/>

– Ask questions in the community at <https://community.infineon.com/t5/Imagimob/bd-p/Imagimob>



It's free for prototyping and development



Q&A

Thank you for attending

Infineon and you - driving the AI revolution

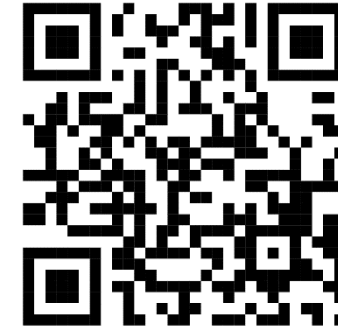
<https://www.infineon.com/cms/en/product/promopages/artificial-intelligence>

PSOC™ Edge

<https://www.infineon.com/cms/en/product/microcontroller/32-bit-psoc-arm-cortex-microcontroller/32-bit-psoc-edge-arm/>

Imagimob

<https://www.imagimob.com/>





Copyright Notice

This multimedia file is copyright © 2024 by tinyML Foundation. All rights reserved. It may not be duplicated or distributed in any form without prior written approval.

tinyML[®] is a registered trademark of the tinyML Foundation.

www.tinyml.org



Copyright Notice

This presentation in this publication was presented as a tinyML® Talks webcast. The content reflects the opinion of the author(s) and their respective companies. The inclusion of presentations in this publication does not constitute an endorsement by tinyML Foundation or the sponsors.

There is no copyright protection claimed by this publication. However, each presentation is the work of the authors and their respective companies and may contain copyrighted material. As such, it is strongly encouraged that any use reflect proper acknowledgement to the appropriate source. Any questions regarding the use of any materials presented should be directed to the author(s) or their companies.

tinyML is a registered trademark of the tinyML Foundation.

www.tinyml.org