Unlocking new levels of intelligence in automotive applications

Tiny edge AI on Stellar microcontrollers

AI is accelerating the shift towards SDV

The shift to SDVs and ADAS creates an environment for AI adoption

Software innovation enables adaptive vehicle behaviors

Continuous software development is essential in modern vehicles. Enabling systems that can learn, adapt, and improve over time.

AI excels with large, complex, unstructured data

Unlike traditional algorithms, AI can process and find patterns in vast datasets uncovering new insights that traditional algorithms may overlook.

AI in automotive enhances safety, efficiency, and the overall driving experience

Conversational AI
In-car intelligent assistant

- Voice recognition/Intent recognition
- Natural language generation
- Personalization
- *LLM models*

High computing power

Running locally or on the cloud

10s of TOPS, up to 100s Watt **in burst**

Vision-based AI for autonomous driving

- Object detection and classification
- Object prediction
- Route planning
- *CNN/Transformers*

High computing power

Safety and latency requirements for ADAS

10s to 100s of TOPS **continuously**

Tiny edge AI for real-time control

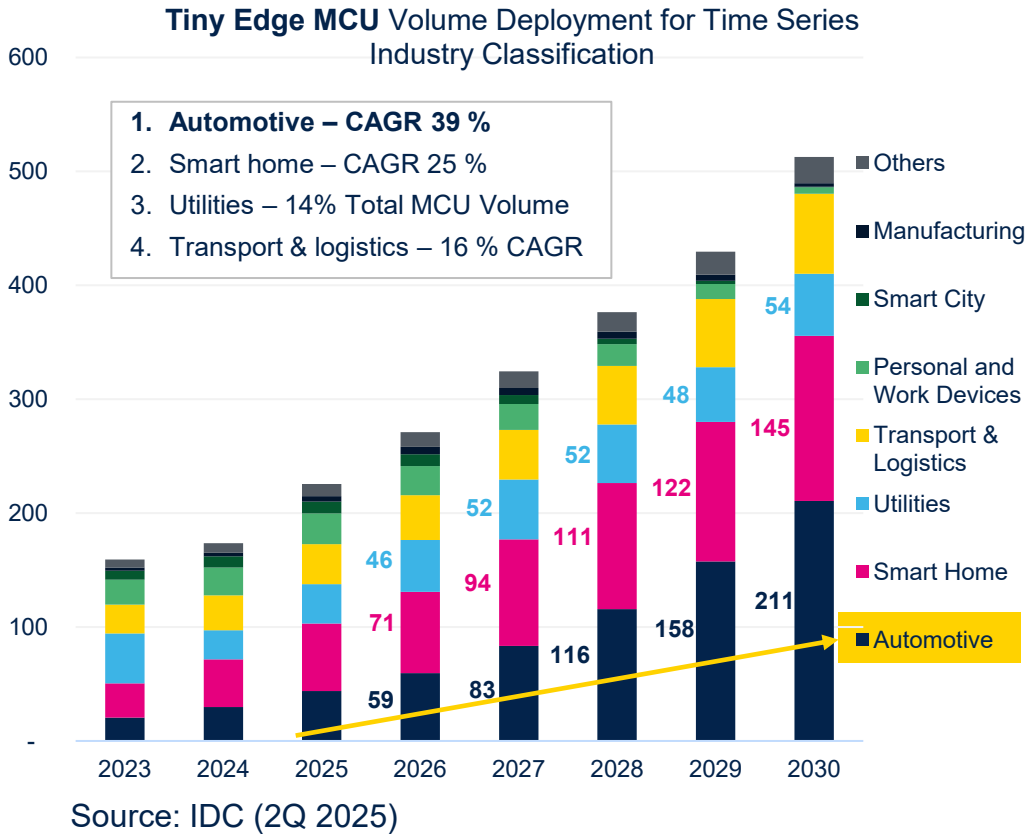
- Virtual sensors and estimation
- Anomaly detection
- Adaptive control (optimize perf)
- *Tiny edge AI (time-series)*

Ultralow latency, ultralow power

Continuous sensing and real-time control

1 to 10s of TOPS, 100s mW

Tiny edge AI in automotive: growth and problem solving



Source: IDC (2Q 2025)

Anomaly detection classification

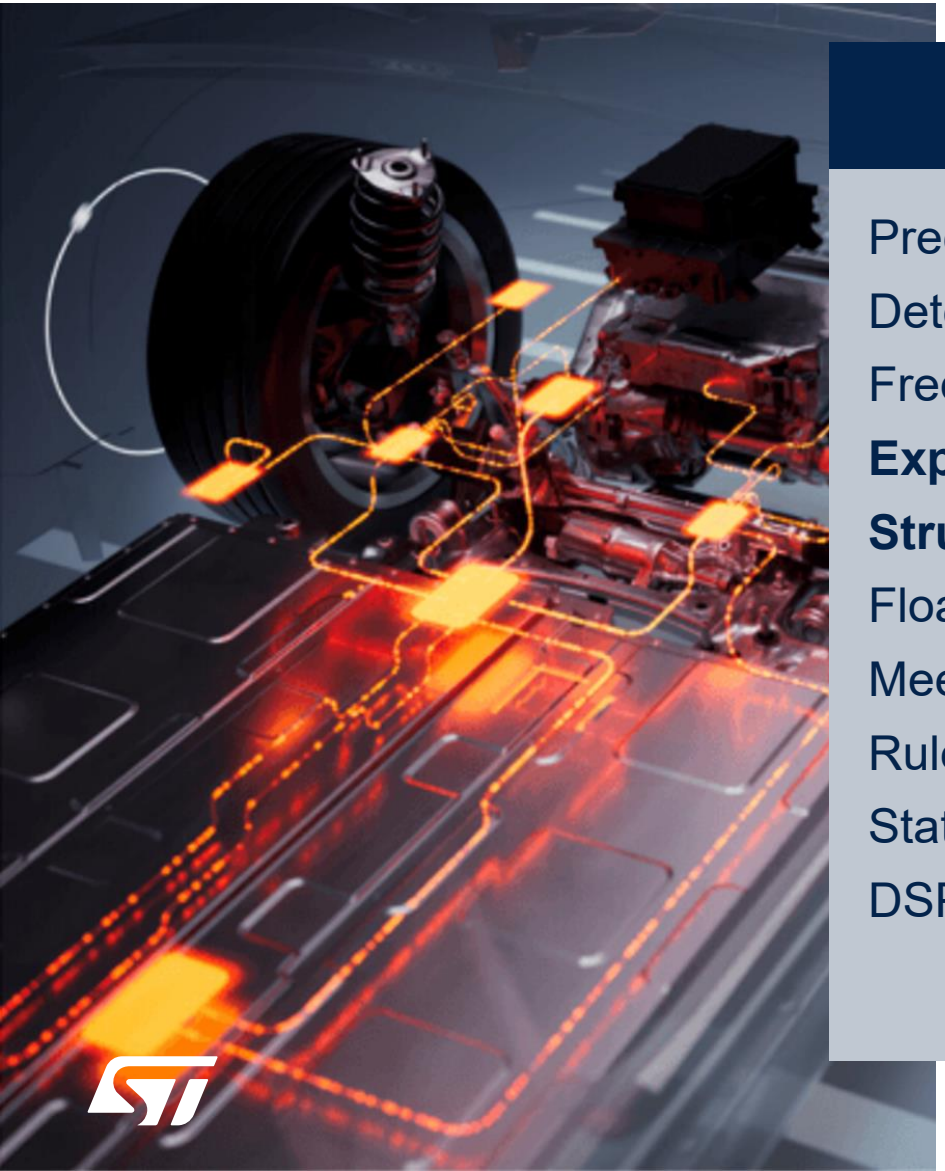
Adaptive control

Virtual sensor Sensor fusion

Addressing **classification** and **regression** problems operating from **time-series** sensor data

Intelligent real-time responses for safer and more efficient vehicle operation

A comparative approach of traditional algorithms and AI



Traditional algorithms

Precision signal transformation

Deterministic mathematical

Frequency domains

Explicit programming

Structured data stream, raw data

Floating point operations

Meet ASIL safety level (over perf)

Rule-based proof (Verification)

Static lifetime

DSP toolchain (ex MATLAB®)

AI models with deep neural networks

Adaptive pattern recognition and inference

Probabilistic behavior

Statistical outputs, not guaranteed

Model-based programming

Time-series & feature-rich data

Integer operations

Great for non-linear relationships and **ambiguous inputs** (or noisy)

Iterative training and tuning

Faster development - AI toolchain

The data-driven edge: AI speeds up development

Traditional algorithm development typically takes longer

- **Deep expertise** in the underlying physics and mathematical transformations.
- **Hand-coded algorithms** to cover all scenarios and optimized for specific hardware.
- **Complex maintenance**: code to be rewritten when adding new signals or changing environments.

AI model development follows a different, faster workflow

- **Autonomous** & **continuous learning** from datasets, fine-tuned in the cloud, delivering higher accuracy and reducing manual coding effort.
- **Flexibility** offered when conditions change with new training data, quickly adapting to new conditions.
- **A rich ecosystem** with cloud-based platforms providing developers flexibility and scalability.

Unlocking new solutions with tiny edge AI on automotive MCUs

Anomaly detection

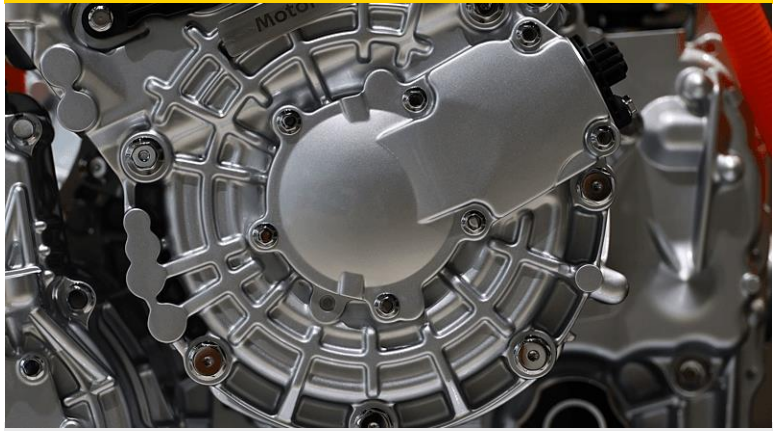
Increase safety & security by detect **anomalies** (complementary to traditional algos)

Current anomaly detection for ADAS safety companion chip

Battery vent aperture faults from motor current data

Smart anti-pinch window, seat detection

Adaptive control



Augmented processing (ex: semi-active adaptive suspensions)

Smoother and more **efficient** motor output (ex: AI soft switch inverter)

Health: accurate battery total **lifetime**

Break preconditioning

Virtual sensor Sensor fusion

Virtual temperature **sensors** (reduce the number of sensors or estimate temperature where sensors cannot be used)

Sensor fusion AI processing

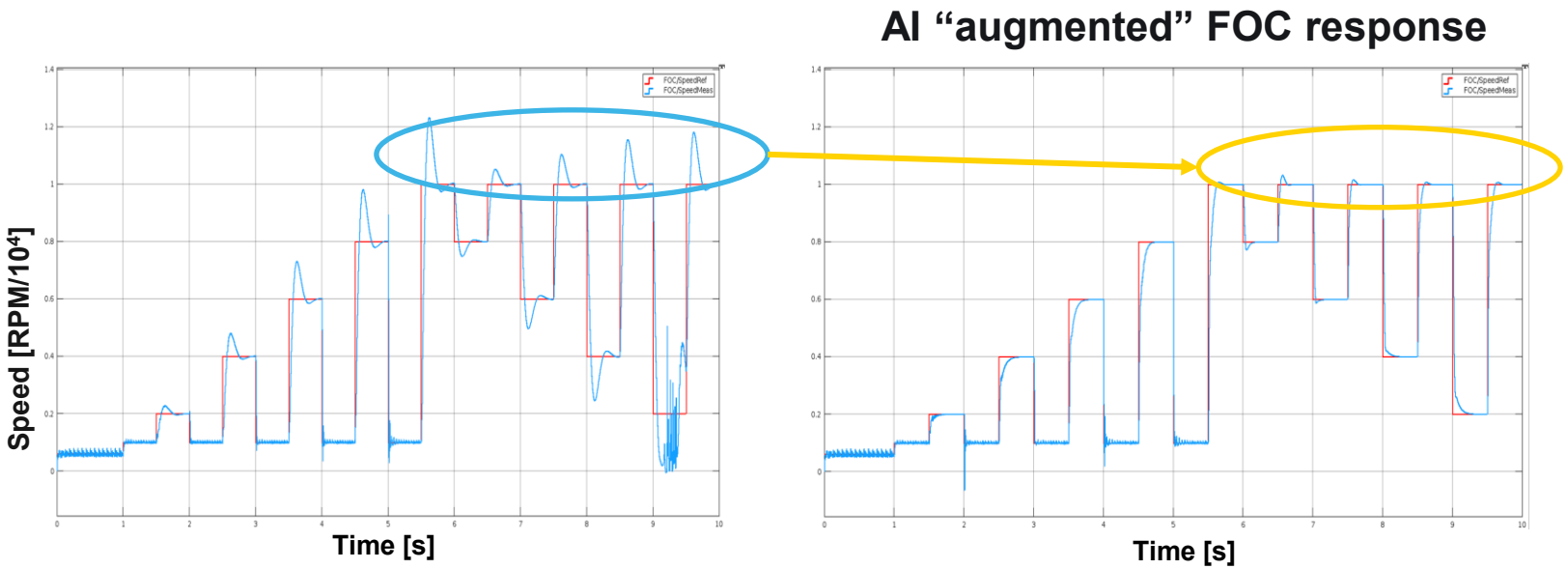
Tire thread, tire type, or pressure detection, weight load estimation

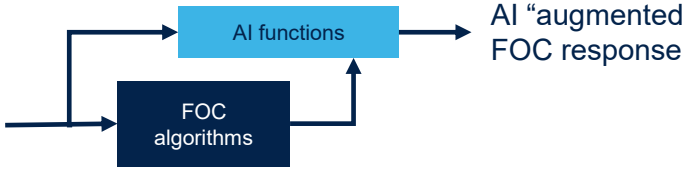
Wipers blade status, aging detection, frozen wipers …

Use case: the AI value in permanent magnet synchronous motors

AI models can be used alongside traditional FOC algorithms to enhance their performance.

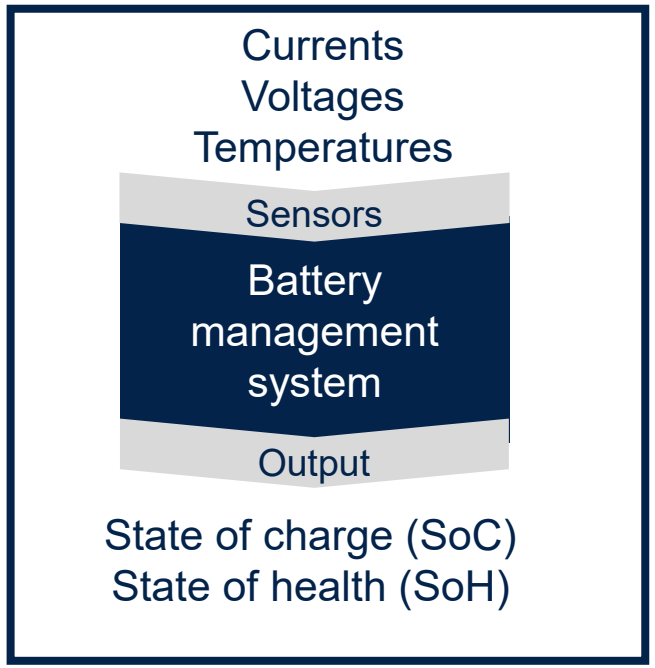
This results in **better control**, improved **accuracy**, and more **efficient** operation of electric motors in vehicles.





Application example: AI value in Battery Management

AI models reduce false positives and increase accuracy independently from battery specifications while delivering new functionalities and more reliability



Traditional approaches	Battery management with AI models
1. Preprocessing (temperature compensation, Coulomb counting algorithm…)	1. No preprocessing (work from “raw” data)
2. One specific function coded usually not upgraded	2. New functions possible like predictive maintenance
3. Margins to cover a car lifetime	3. Better accuracy with less reliance on battery specificities
4. Rely on existing and connected sensors	4. Reduced eBOM cost with virtual sensors

In-vehicle AI becoming ubiquitous

Tiny edge AI integration at the sensor and microcontroller level transforms the E/E architecture, unlocking new levels of intelligence and functionality.

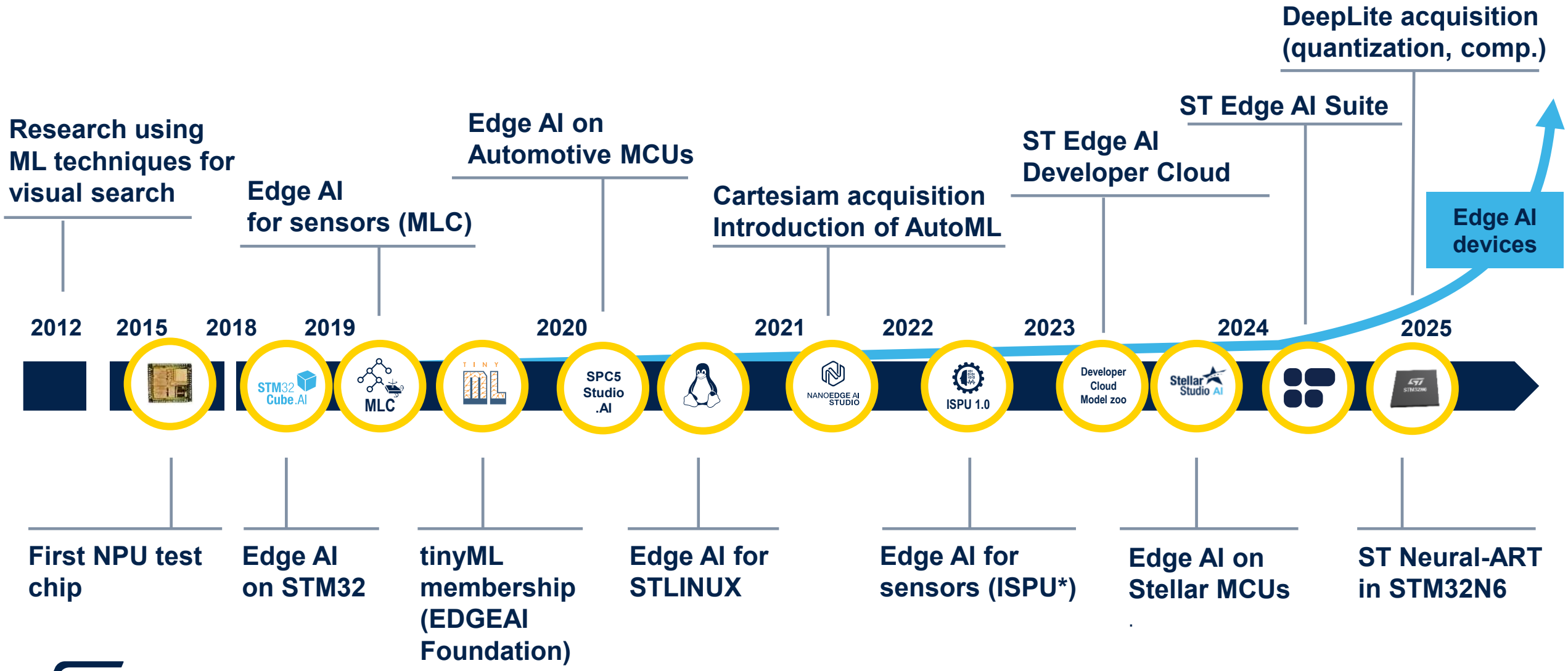
- Better driver experience
- Enhanced energy efficiency
- Safer vehicle

e.g. ***A virtual temperature sensor*** *can detect and* ***emulate failing sensors****, improving safety, and allowing the driver to continue their journey*

ST established leadership in edge AI for industrial MCUs is now extending to automotive products

ST offering for tiny edge AI in automotive

10+ years of research, development, and deployment



*Intelligent sensor processing unit

ST proven AI success in industrial applications

3x better accuracy

A washing machine uses **advanced motor control algorithms** to weigh clothes and optimize water, detergent, and energy used

New applications

After-market predictive maintenance
intelligent sensor with wireless connectivity

Cost savings

Adding tire pressure detection capability to e-bikes **without adding new hardware**

Extend lifetime

Industrial pumps learn their own optimal mode of operation and **detect anomalies**

Complete portfolio to develop AI solutions on Stellar MCUs

Software tools to develop **Stellar AI** features

NANOEDGE AI STUDIO

User-friendly AutoML tool

ST Edge AI Developer Cloud

Stellar Studio AI

ST Edge AI Core

AI model benchmarking, optimization, and code generation

ST Edge AI Suite

A broad range of **evaluation** & **prototyping** tools

Model zoo and growing number of **partners**

MathWorks®

Partner Program

Available on all **Stellar** MCUs

Stellar E1

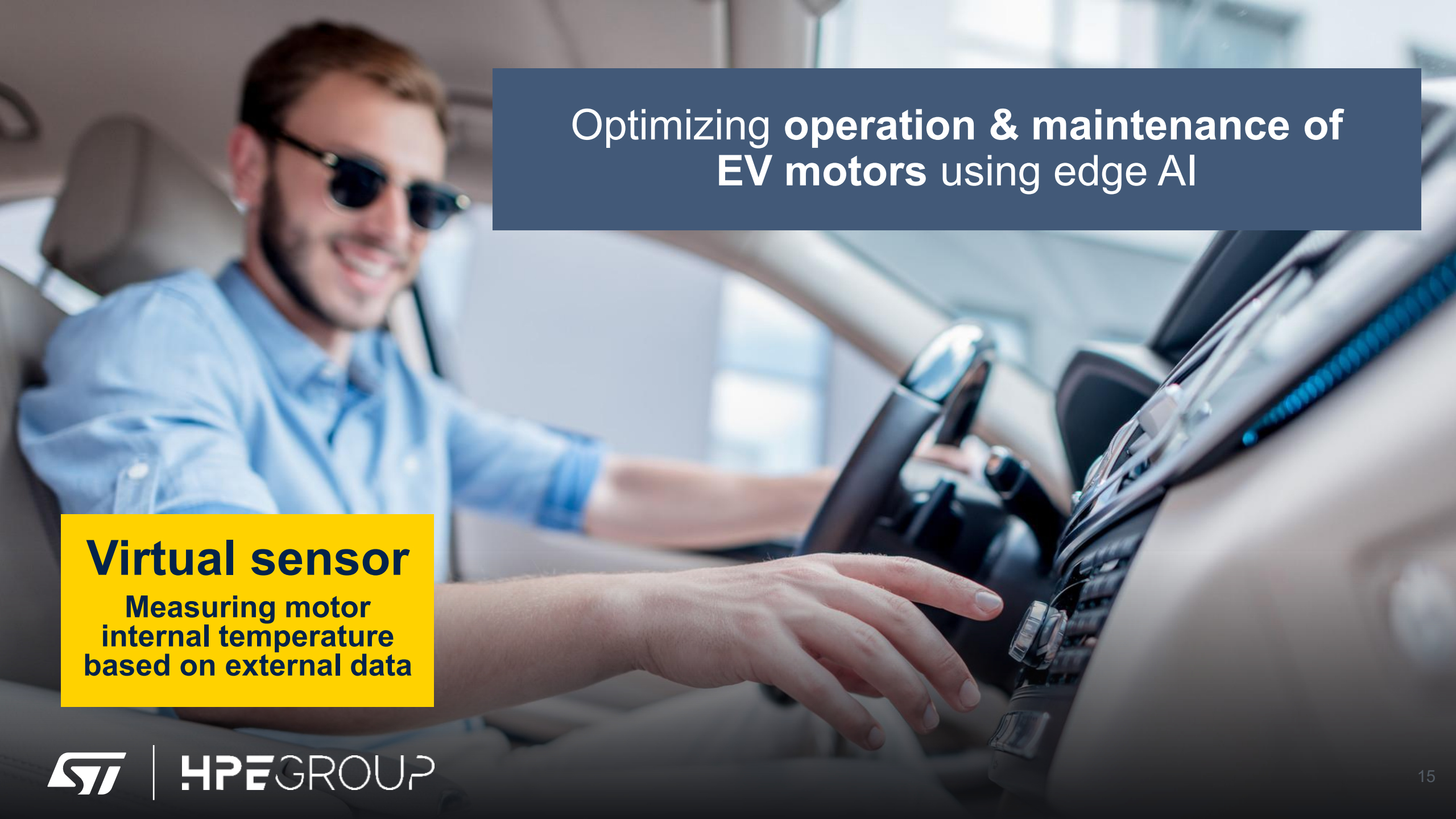
Electrification MCU

Stellar P

Electrification & drivetrain integration MCU

Stellar G

Zonal & body domain integration MCU
Safety processor companion



Optimizing **operation & maintenance of EV motors** using edge AI

Virtual sensor

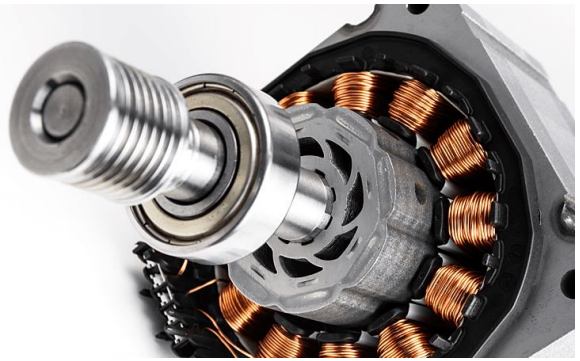
Measuring motor internal temperature based on external data

Stellar MCU & ST edge AI technology improve EV performance

Virtual sensor

Thermal sensor in action on stator → INPUT → Edge AI model inference → OUTPUT → Temperature estimation

- Rotor temperature estimate with same accuracy as physical sensor
- Simplified system design and reduced costs



Predictive maintenance

Vibration sensor bearing temperature → INPUT → Edge AI model inference → OUTPUT → Health status of e-motor Anomalies classification

- Preventing e-motor failures by detecting anomalies
- Operational continuity & reliability while maintaining performance

What's NEXT?

AI - real time modeling use cases

- Inverter automatic calibration
- Soft switch control technique
- Intrusion detection
- Vehicle dynamic behavior modelling

The foundation for deploying AI in automotive Stellar MCUs

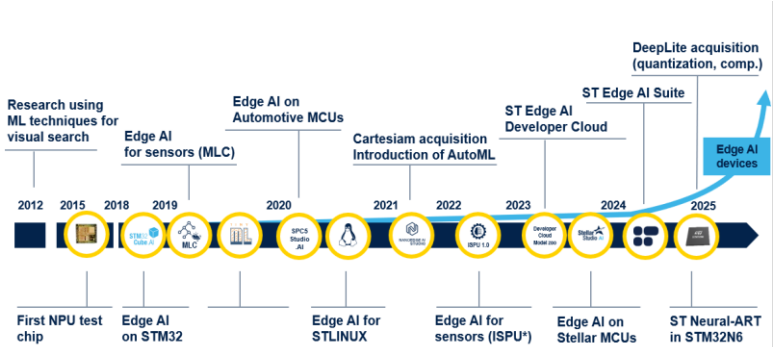
1. AI-ready architecture

- **Arm** CPUs (with extensions) accelerating AI workloads
- System optimized to achieve **efficiency and ultralow latency**
- Up to ASIL-D system-level **safety**

2. Expanding AI ecosystem

- Exhaustive and optimized set of tools to rapidly develop, test, and deploy AI models: **ST Edge AI Suite**
- Fast growing network of automotive partners, model zoo, and dedicated tools

3. 10+ years MCU AI experience



- ST proven ecosystem with **10+ years** of development for AI on MCUs, MPUs, and sensors (hardware/software and support)
- Now expanding rapidly into the automotive market.

ST’s strategic positioning in edge AI for automotive

New edge AI use cases are set to **transform the automotive industry** with better driving experiences, higher reliability, and safer cars.

The automotive roadmap will feature AI-optimized hardware and streamlined software tools for Stellar to support the shift towards SDVs.

ST is poised to lead in automotive AI development

Proven experience with the leading edge AI ecosystem now extending into automotive

Our technology starts with You

Find out more at www.st.com/st-edge-ai-suite