TTechAuto

THE NUMBERS

2 mio.+
Vehicles on street equipped with MotionWise

9.5 mio.+
Cars in the pipeline

1,100 +
Highly-skilled software engineers

60+
Network of OEMs, Tier 1s and technology partners

20+
Years of experience in the development of safety-critical systems

TTTechAuto

As automotive manufacturers move towards the Software Defined Vehicles (SDV), they're quickly realizing that success cannot be achieved by only focusing on software.

The key lies in a **safe** and **secure system** that combines **software** and hardware.

At TTTech Auto, we understand this critical component better than anyone, and we've worked hard to develop software and hardware that take a system-level approach to the SDV.

We ensure that the next generation of vehicles are safe & secure!

4SDV

TTTechAuto

101 granted patent families across all legal entities.

Development and deployment of safety-critical avionics networks, e.g., Boeing 787, NASA Orion spacecraft

> 1 Billion

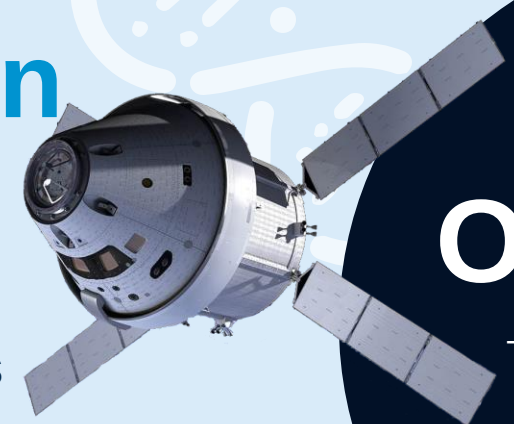
flight hours

23

different aircraft types

70 Million

passengers



OUR DNA

Transforming leading research into market-shaping, safety-critical aviation products and advanced driver assistance system (ADAS) platforms.

Dr. Hermann Hauser, a member of TTTech´s Advisory Board, has founded or co-founded companies in a range of technology sectors, such as ARM.

Professor Hermann Kopetz is one of the key architects of Time-Triggered Architecture and co-founder of TTTech

Wilfried Steiner is the Director of TTTech Labs, focused in designing Algorithms and network protocols for dependable cyber-physical systems.

TTTech has won the **Living Standards Award** 2021 and the **Emerging Technologies Best Paper Award**

Real-Time Systems Design Principles for Distributed Embedded Applications by Kopetz and Steiner is a widely used and practical textbook on real-time embedded systems.

WHERE ARE WE?

13 locations worldwide

EUROPE
HQ Vienna (AT)
Munich (DE)
Ingolstadt (DE)
Madrid (ES)
Barcelona (ES)
Novi Sad (RS)
Belgrade (RS)
Osijek (HR)
Banja Luka (BA)
Izmir (TR)

ASIA
Shanghai (CN)
Nagoya (JP)
Seoul (KR)

ECOSYSTEM AND CUSTOMERS

SHAREHOLDER STRUCTURE

Privately held joint Austrian stock company with solid equity from blue-chip shareholders

OUR MANAGEMENT

Dirk Linzmeier
Member of the Executive Board

Friedhelm Pickhard
Member of the Executive Board

Stefan Poledna
Member of the Executive Board

Harald Triplat
Member of the Executive Board

Marc Lang
Executive Vice President Business Development & Sales

Salvador Rodriguez Lopez
VP Corporate Strategy & Product Management

Bernhard Leiner
Manager Product Innovation

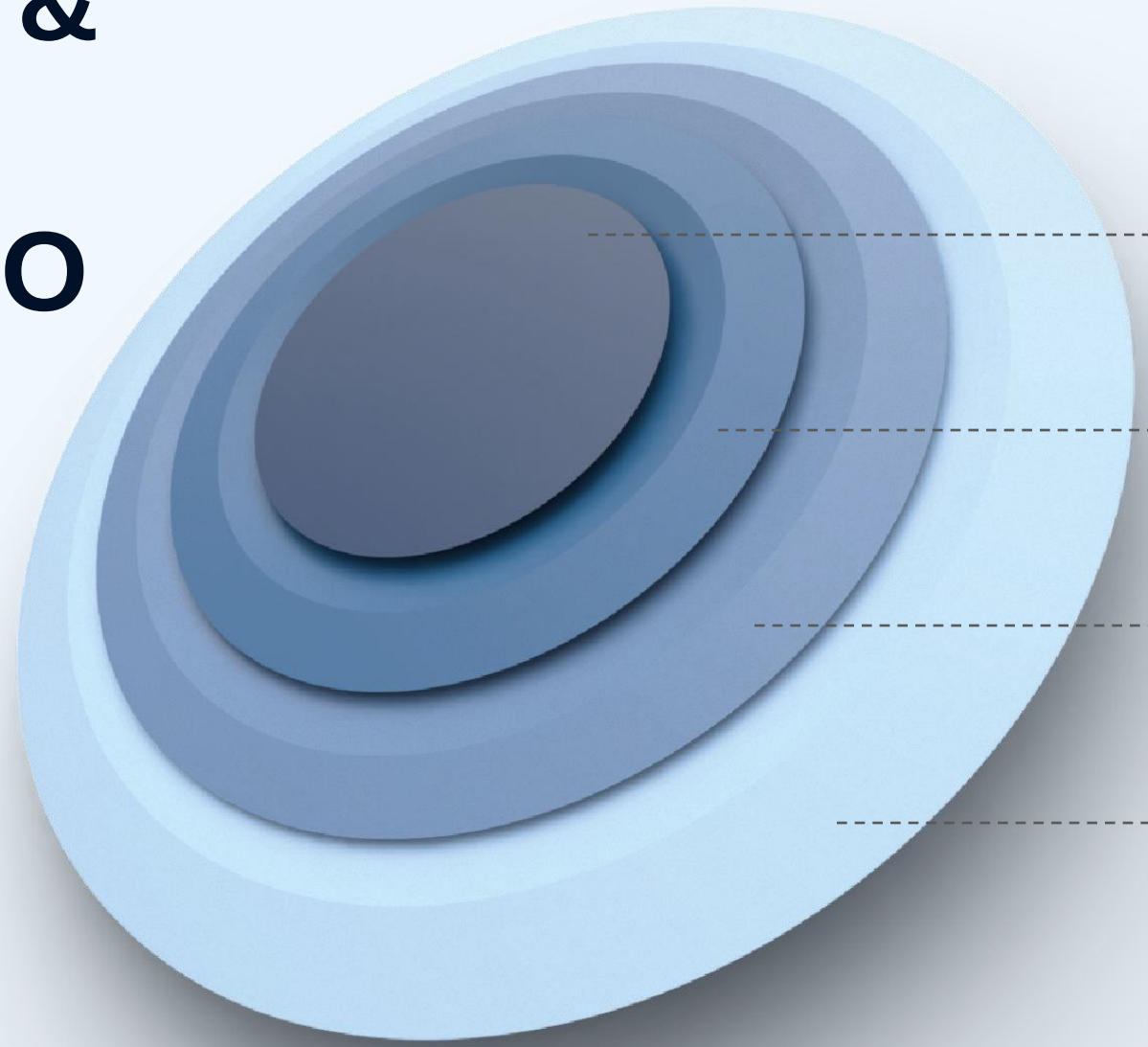
Markus von Mengden
Vice President Safety Products

Bettina Siener
Senior VP Global Human Resources

Horst Willburger
Director Electronic Controls Design House

Georg Niedrist
Senior Fellow Technology & Innovation AT • L4 Development Safety & Security Consulting

PRODUCT & SERVICE PORTFOLIO



SOFTWARE

- MotionWise
- Zetta Auto

HARDWARE

- Electronic Controls Design House
- Testing Tools

SERVICE & CONSULTANCY

- Safety Consultancy

ENGINEERING

- TCM

TTTechAuto

MotionWise

SAFETY MIDDLEWARE

A modular solution for software defined vehicles

TTTechAuto

COMPLEXITY IS OVERWHELMING THE INDUSTRY

Major OEMs are facing 3.5bn € excess cost for 6 months of SOP delay (27M €/day) mainly driven by SW integration.

SHIFTING COMPLEXITY

Driven by the E/E evolution

From ECU integration	To SW Integration within Domain Control Units

From ECU	DCU	Zonal	Centralized

From ECU	To DCU	From MCU to SoCs:
		// Multi-Core CPUs // HW Accelerators: GPUs, NPUs
		High Speed communication backbones
		// Mix of Ethernet and PCIe
		Introduction of Zonal:
		// Merge of Signal to Service world // E2E properties at vehicle level

Path to Centralized	Virtualized domains

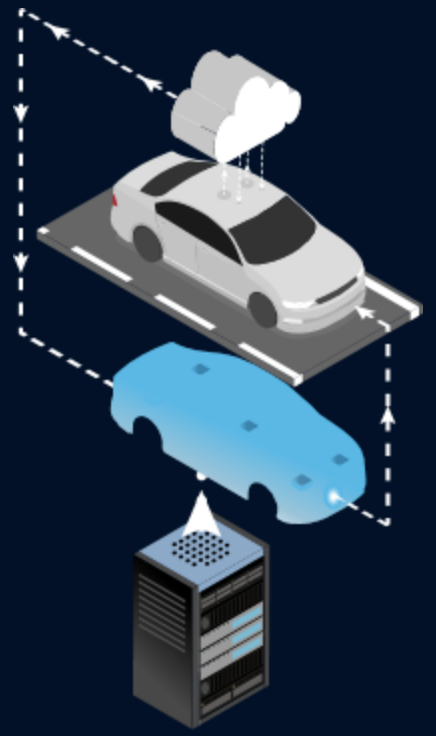
TTTechAuto

Driven by Software Defined Vehicles

Decoupling SW from HW, different innovation pace

Development continuity, leading to continuous improvement

Keeping safety and security integrity levels



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COMPLEXITY IN NUMBERS

The challenge is to efficiently search an enormous solution space to find valid configurations.

COMPUTATION UNIT RESOURCES

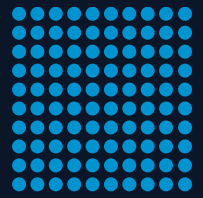
46
CPU CORES

6
HARDWARE ACCELERATORS

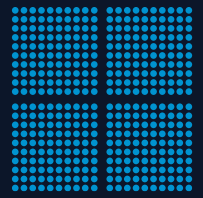
2
TSN SWITCHES

1024
VIRTUAL LINKS

SOFTWARE DEMANDS

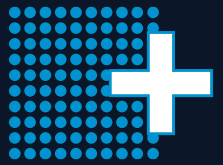


100
APPLICATIONS



400
TASKS

SYSTEM CONSTRAINTS



100+
time, latency, precedence constraints etc.

SOLUTION SPACE

10^{5000}
without any constraints

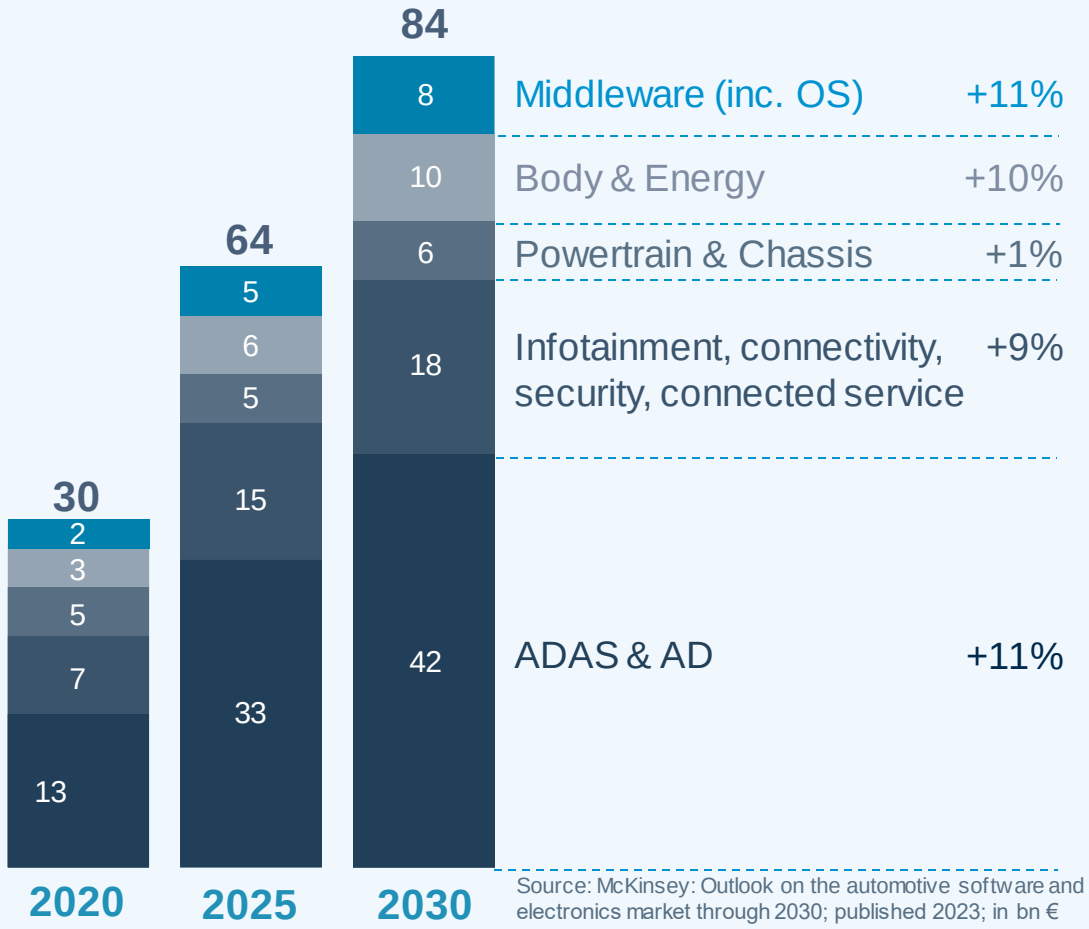
10^{500}
messages and task must not overlap

10^{80}
Atoms in the universe

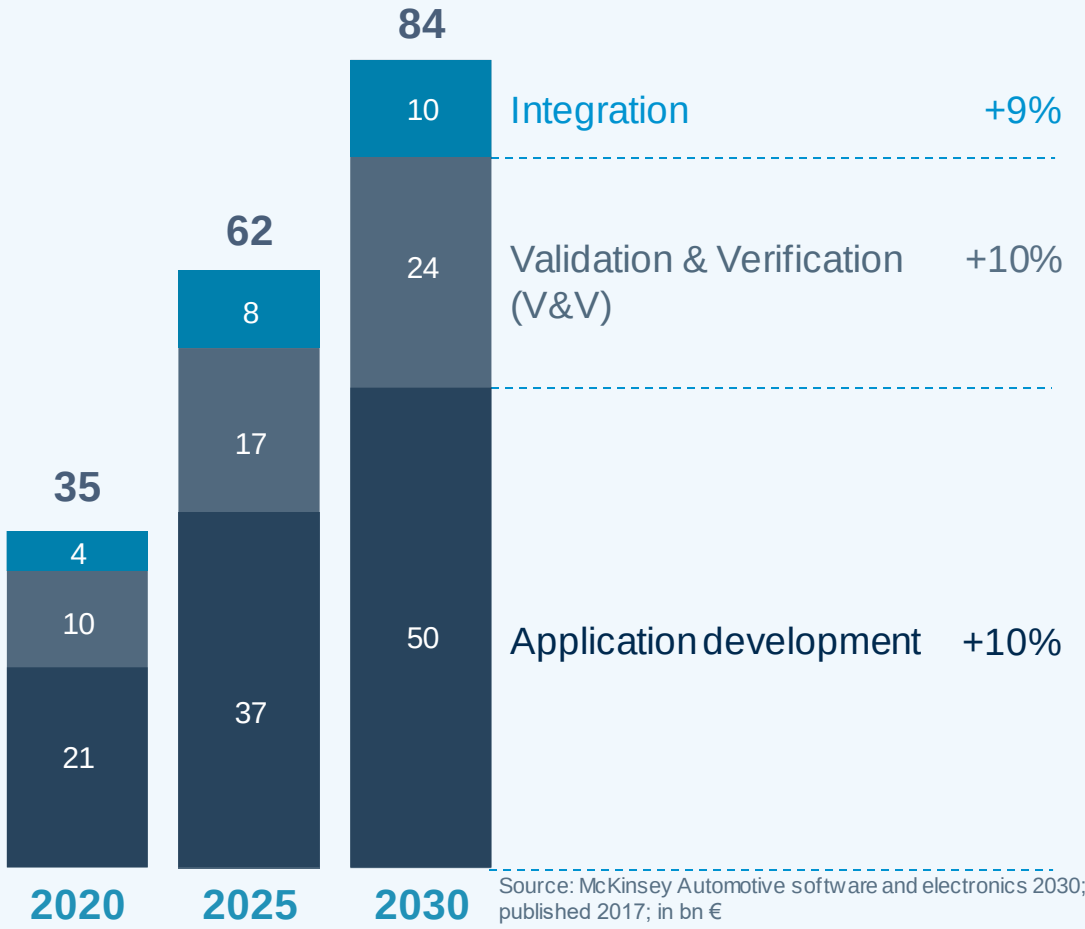
10^{5}
valid configurations with all constraints

INCREASING FOCUS ON SOFTWARE

- E/E design shift towards a more centralized architecture
- Increase in software functionality requires an orchestration layer
- Scalable architecture across vehicle models
- Enabling new business models for OEMs = SaaS
- Keeping and enhancing safety & security standards



Source: McKinsey: Outlook on the automotive software and electronics market through 2030; published 2023; in bn €



Source: McKinsey Automotive software and electronics 2030; published 2017; in bn €

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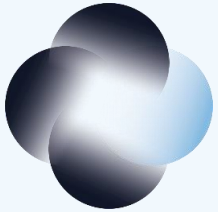
THE CHALLENGE OF SOFTWARE-DEFINED VEHICLES

- The era of software-defined vehicles has begun
- Billions of dollars lost due to SOP delays
- Delays due to immature software architectures and processes
- Exponential growth in complexity with no standard solution
- Unresolved challenges in efficient and safe workload orchestrating

THE SOLUTION

MOTIONWISE USPs

We provide a software system that ensures **safe workload orchestration** and **accelerated seamless integration.**

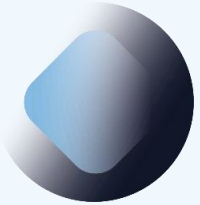


A holistic abstraction layer:

- Transparent and automated allocation of apps across HW resources
- Third-party SW abstraction (Automotive Frameworks, Operating Systems, Networking stacks)
- Integrated with the most used automotive frameworks: AUTOSAR, ROS2

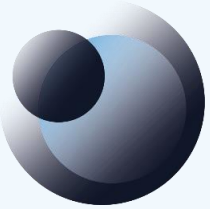
CX friendly tools from and for developers

- Integration of holistic system in
- a single step
- System-wide Application schedule
- and networking planning
- Edge to Simulation parity



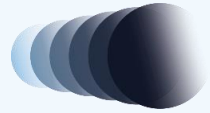
Safety, our upmost devotion

- System-wide Health Management, error management and supervision
- ISO26262 ASIL-D ready
- Fail-Operational friendly



We enable a predictable system for you:

- End-to-end time properties
- Flexible at early stages, determinism when you need it
- Seamless and assisted transition from flexible to deterministic

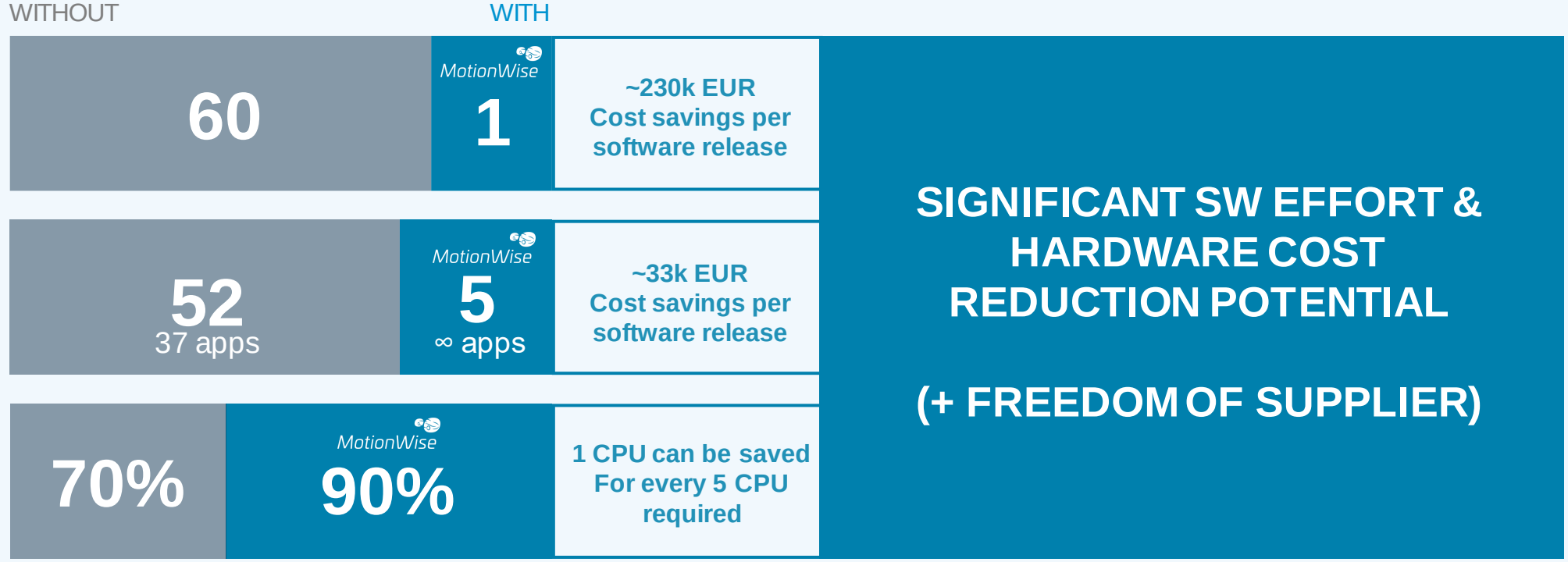


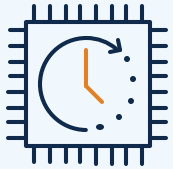
Built upon standards:

AUTOSAR (Classic and Adaptive), DDS, TSN, ROS2

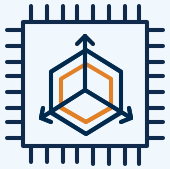
MotionWise

SAFETY MIDDLEWARE

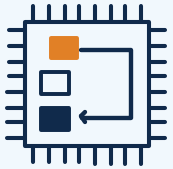




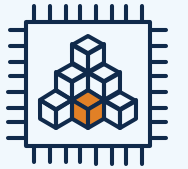
Global Time Synchronization



Safety Supervision



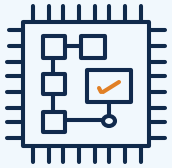
Workload Planning & Orchestration



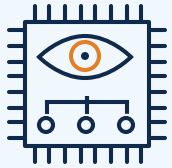
Communication

INCLUDES

The features a distributed E/E Architecture needs



Health



Emulation

Resimulation

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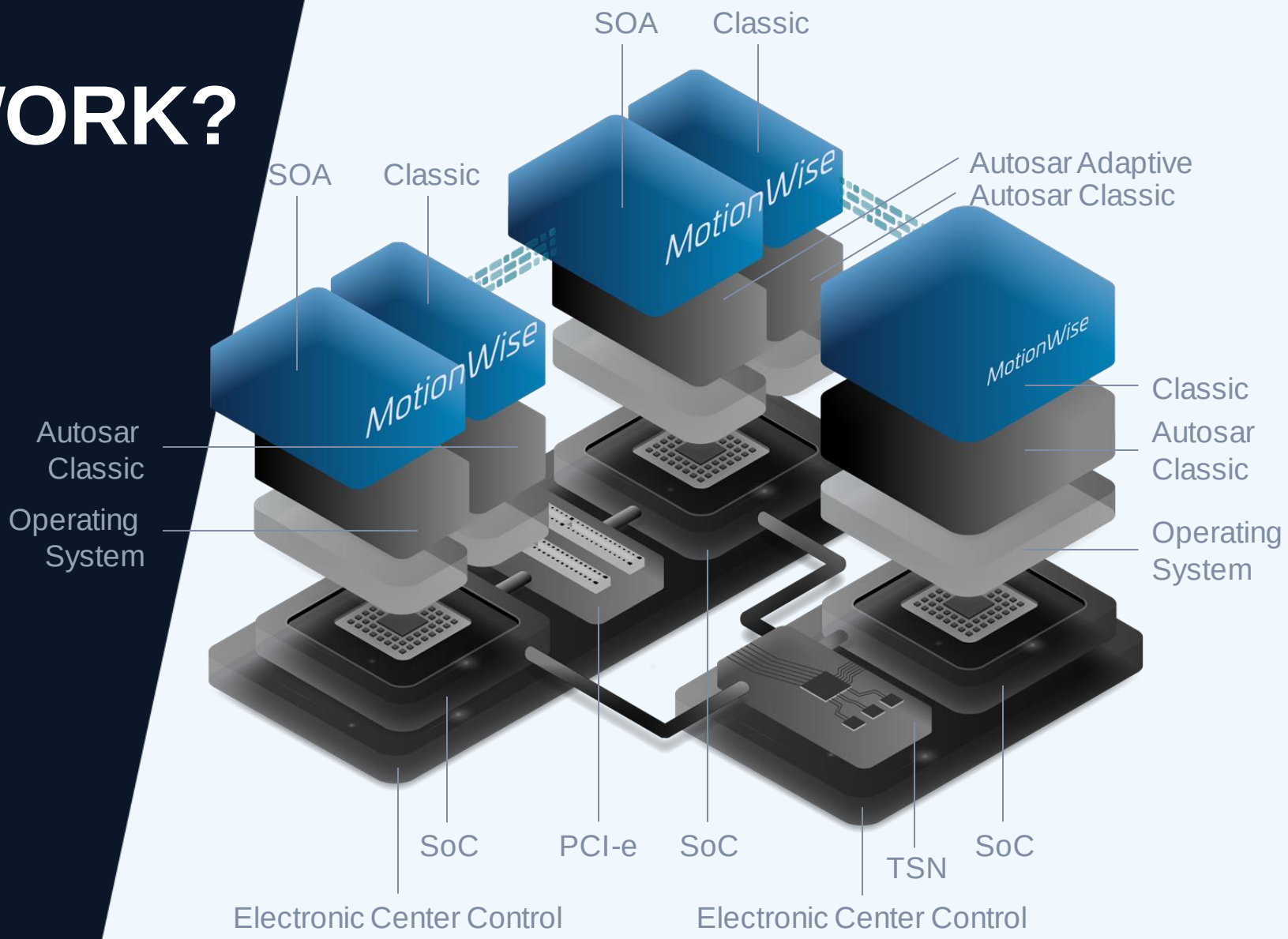
HOW DOES MOTIONWISE WORK?

We automatically allocate applications and their networking needs across the E/E network, orchestrating them during runtime, providing a safe execution environment while meeting end-to-end real time guarantees

MotionWise communication stack provides a SOA capable communication stack along with a standardized API supported by high efficient transport layers: Ethernet, Time Sensitive Networking (TSN), PCIe

A global supervision and health management provides the required mechanisms to keep the system under surveillance

Accompanied by a tool-suite, enabling the generation of software releases boosting the SW integration in a predictable manner



ECOSYSTEM

SEMICONDUCTOR SUPPORT

Texas Instruments · Infineon · NXP · Horizon Robotics · Qualcomm · NVIDIA

OPERATING SYSTEMS

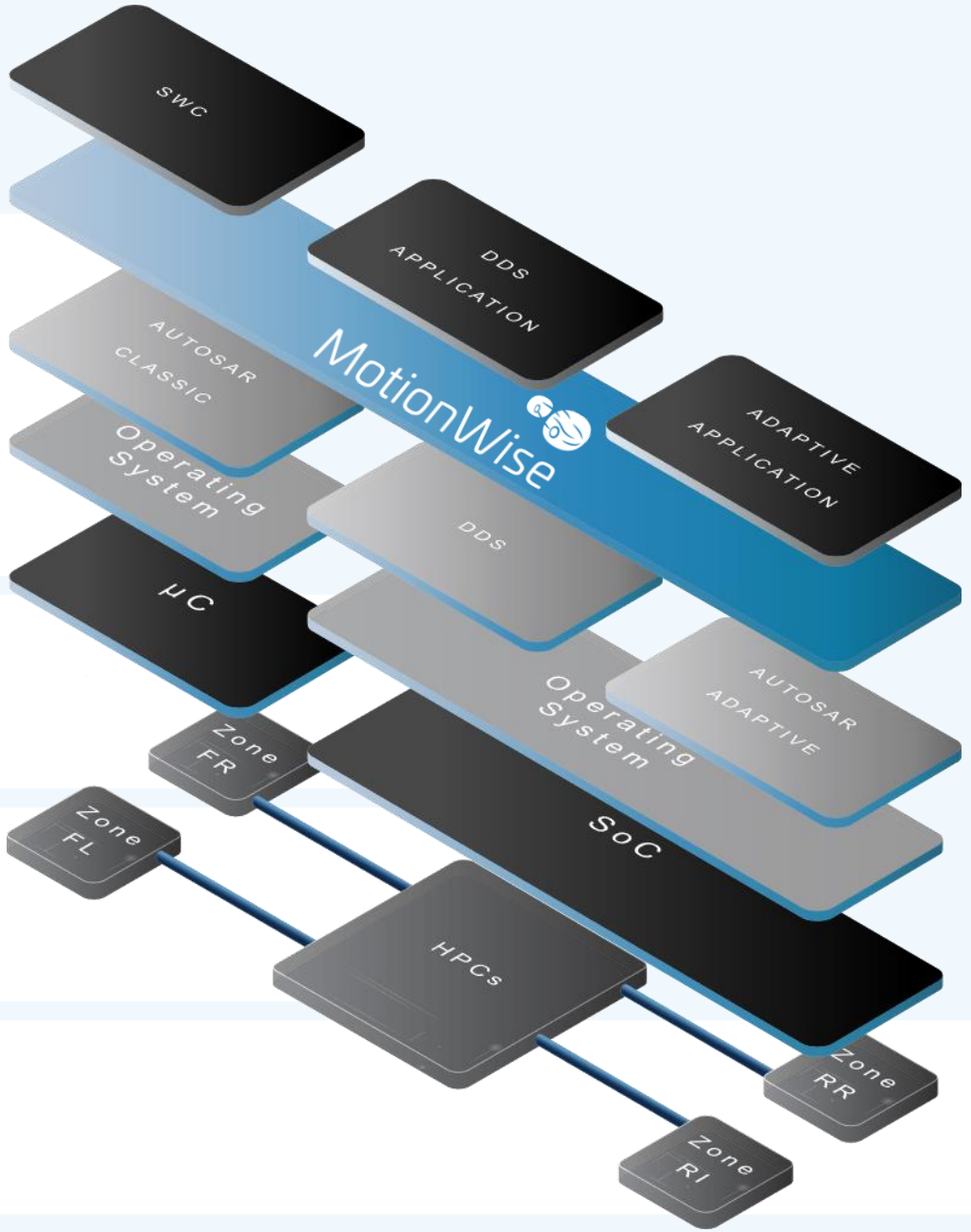
QNX · Linux

FRAMEWORKS

ROS · AUTOSAR

TOOL

MATLAB & SIMULINK · ROS



TODAY

Design Principles:
- // Fail Silent
- // Signal Based Architecture

Features:
- // System-wide Error Management
- // System-wide Supervision system
- // Global app and network scheduling
- // QNX support

Standards:
- // Classic AUTOSAR
- // POSIX

Architectures:
- // Domain Control Units (DCU)

2023 - 2024

Design Principle:
- // Service Oriented Architecture
- // Fail Operational friendly

Features:
- // Data Driven
- // HW Acceleration management
- // PCIe infrastructure
- // Virtual ECU
- // Re-simulation
- // High availability framework
- // Linux support

Standards:
- // Adaptive AUTOSAR support
- // ROS2 support (development only)
- // Data Distribution Service (DDS)
- // Time Sensitive Networking (TSN)

Architectures supported:
- // Multiple DCUs support
- // Hypervisor

2024 - 2025

Design Principle:
- // Modular deployment

Features:
- // Scheduling Modes
- // Event Driven
- // Cloud-based platform emulation
- // Resource Performance and prediction framework
- // System Synthesis
- // Consistent Re-simulation

MotionWise, the **1st series proven** safe vehicle software platform for DCUs deployed already on more than **2.000.000** cars. **9.500.000** cars in the pipeline

2018 - 2023	2024/5	2026/7	2028

TTTechAuto

zetta auto

Our answer to cutting-edge communication technologies for the future of the automotive industry.

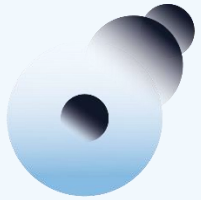
ZETTA AUTO USPS

Suitable for prototype and production systems, enabling seamless transition between development phases

ISO26262 ASIL-D certification in progress

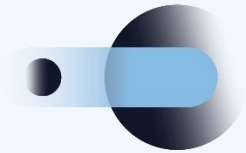
Safe and performant inter-process communication

Build upon a cross-industry proven open core



End-to-end timing properties exploiting Time Sensitive Networking (TSN)

Integrated tool suite: Configuration, Monitoring, Capture & Replay of DDS communication



Network planning tool boosts integration of new network configurations

BUILT FOR AUTOMOTIVE ON AN OPEN CORE

Bring the power of the Zetta Platform to Automotive with Automotive-grade DDS and Zenoh implementations, ASIL-D certification coming soon, along with integration in AUTOSAR Classic and Adaptive

One solution to deal with in-vehicle communication from safety critical environments to the digital cockpit

Full interoperability with the Zetta PaaS on the horizon to bridge the gap between in-vehicle, edge and the cloud

- DDS Tooling
- TSN integration incl. Network Planning tool
- Compatible with MotionWise
- Compatible with standardized frameworks: ROS2, AUTOSAR Classic and Adaptive
- Certified Edition coming soon: safe Automotive profile subset incl. E2E protection as ISO26262 ASIL-D SEooC

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ROADMAP

2023 2024

zetta auto

Q2 Product Launch

Embedded features

- Cyclone DDS stack
- TSN support
- MCU integration
- Linux OS support
- QNX support
- **DDS Tooling**
- NetLens
- **TSN Tooling**
- Slate

Q3

TSN Tooling improvements

- Automatic TSN configuration
- **DDS Tooling**
- Revamped UX
- Record and replay

Q4

Embedded Updates

- Automotive-grade zero-copy shared memory
- Static behavior
- ASPICE compliance
- Full support for MotionWise and Autosar Adaptive

CERTIFIED zetta auto

Certified Embedded stack launch

Certified embedded features

- Safe subset of Cyclone DDS stack as a library
- ISO 26262 SEooC
- ASIL-D Certified zero-copy shared memory
- QNX OS support

DDS Tooling

- NetLens

TSN Tooling

- Slate
- Automatic TSN configuration

KEY TECHNOLOGIES

DDS, the OMG standard for data-centric connectivity.

Optimized solution for DDS pub/sub on MCUs

More information https://zenoh.io/

SAFETY IS THE GRAND CHALLENGE FOR LEVEL 4 AUTOMATED DRIVING

TTTechAuto

FROM LVL 2* TO LVL 4**

*

Until L2 systems, the human is driving (the machine assist) and monitoring the environment. Hands and Eyes On.

**

Starting from L3 systems, a Fail Operational design is required. L4 means hands and eyes off.

THE CHALLENGES

PERCEPTION AND "WORLD UNDERSTANDING"

- To understand what's around the car and how to interpret it
- How to ensure that DNN's are safe in all corner cases and don't fail unexpectedly (e.g., patterns and pixel that fool the system)

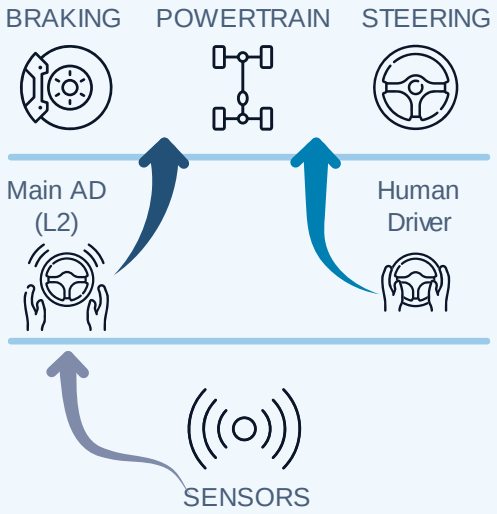
FAIL-OPERATIONAL SAFETY ARCHITECTURE

- Defining a robust safety architecture that ensures the necessary level of redundancy and prevents common cause failures
- "Innovation friendly" architecture allowing to introduce feature upgrades quickly, while ensuring rigorous safety claim

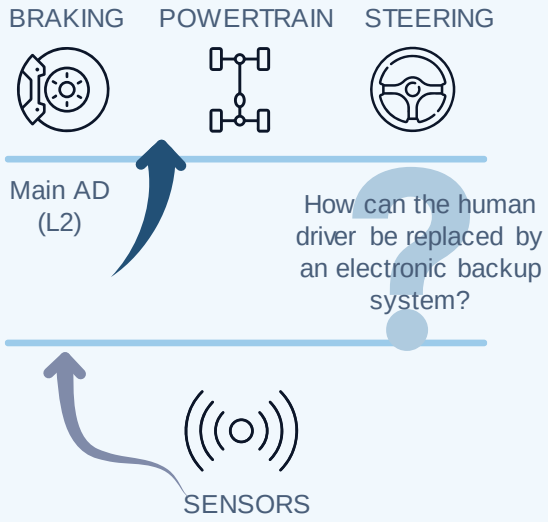
SYSTEM VALIDATION

- A validation approach which ensures that L4 features can be brought to market fast (innovation speed) at class leading cost
- Simulation is key but needs to reproduce the behavior in such a way that safety conclusions can be derived

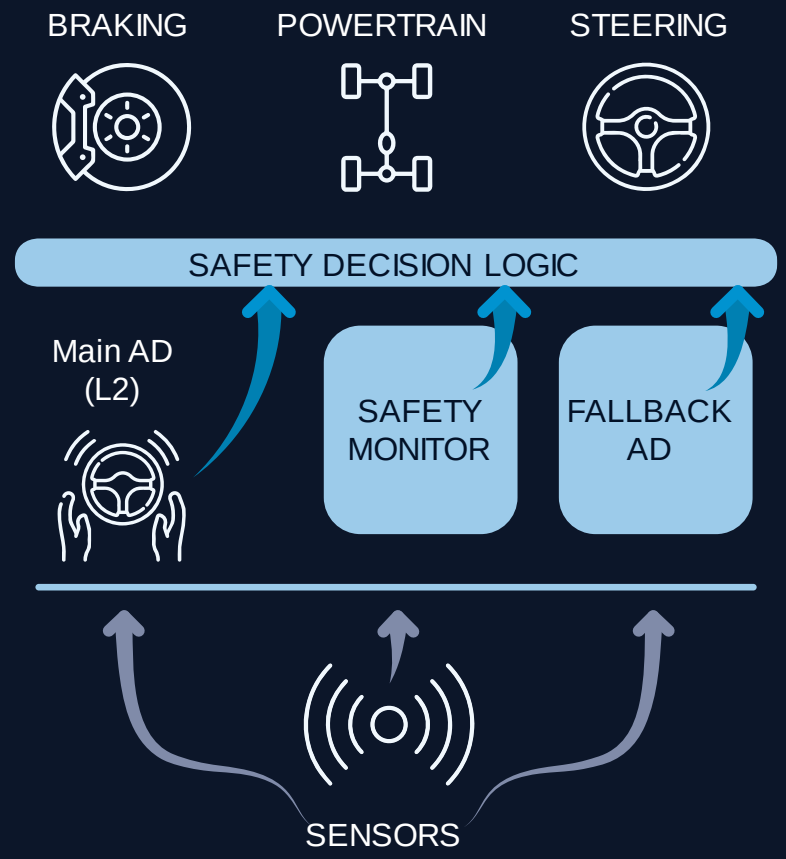
LVL 2 (FAIL-SILENT)



LVL 4 (FAIL-OPERATIONAL)



CONCEPTUAL ARCHITECTURE



CLEAR SYSTEM PARTITIONING TO SOLVE L4 CHALLENGE

Systematic partitioning into independent Fault Containment Units, to address the „impossibilities“:

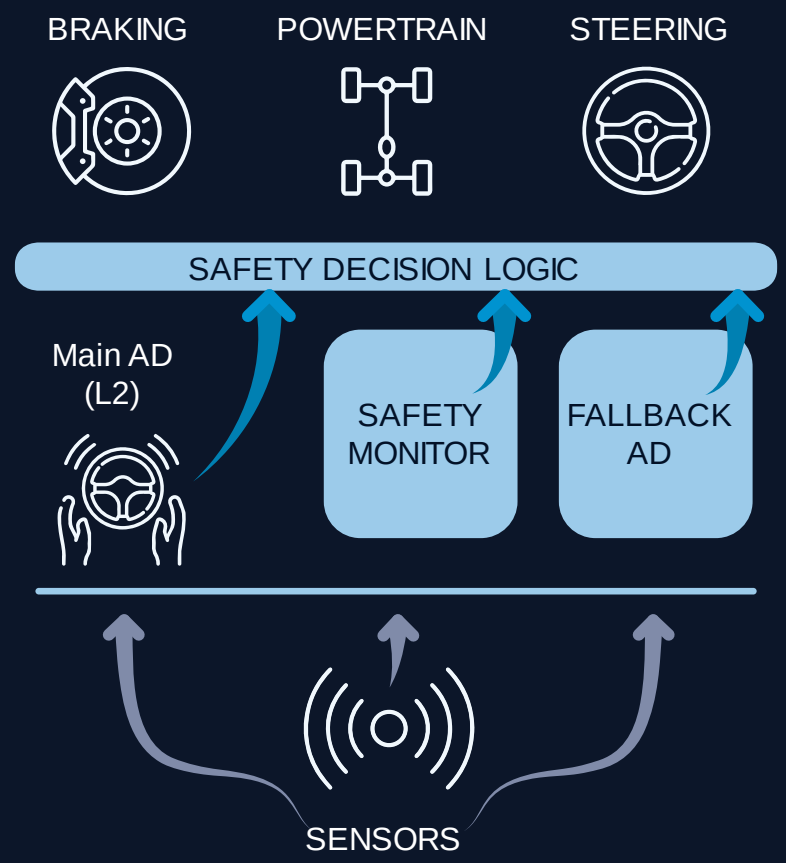
It is impossible to avoid single event upsets (e.g., bit flip) in non-redundant hardware during the life-time of an ultra dependable system

It is impossible to establish the ultra-high dependability of a large monolithic system by testing and simulation

It is impossible to find all design faults in a large and complex monolithic software system

It is impossible to precisely specify all edge cases that can be encountered in driving situations

CONCEPTUAL ARCHITECTURE



L4 “SAFETY TOOLBOX”

We support analyzing and ensuring the robustness of the architecture (ASIL D Fail-Operational):

- Show sufficient independence between redundant channels
- Tolerate all single point faults
- Achieve the target for the system failure rate

The Toolbox provides relevant answers:

Fault-tree & dependent failure analysis:

- What causes the ADS to fail?
- Are there any dependent failures?

Formal model in SAL and exhaustive failure simulation:

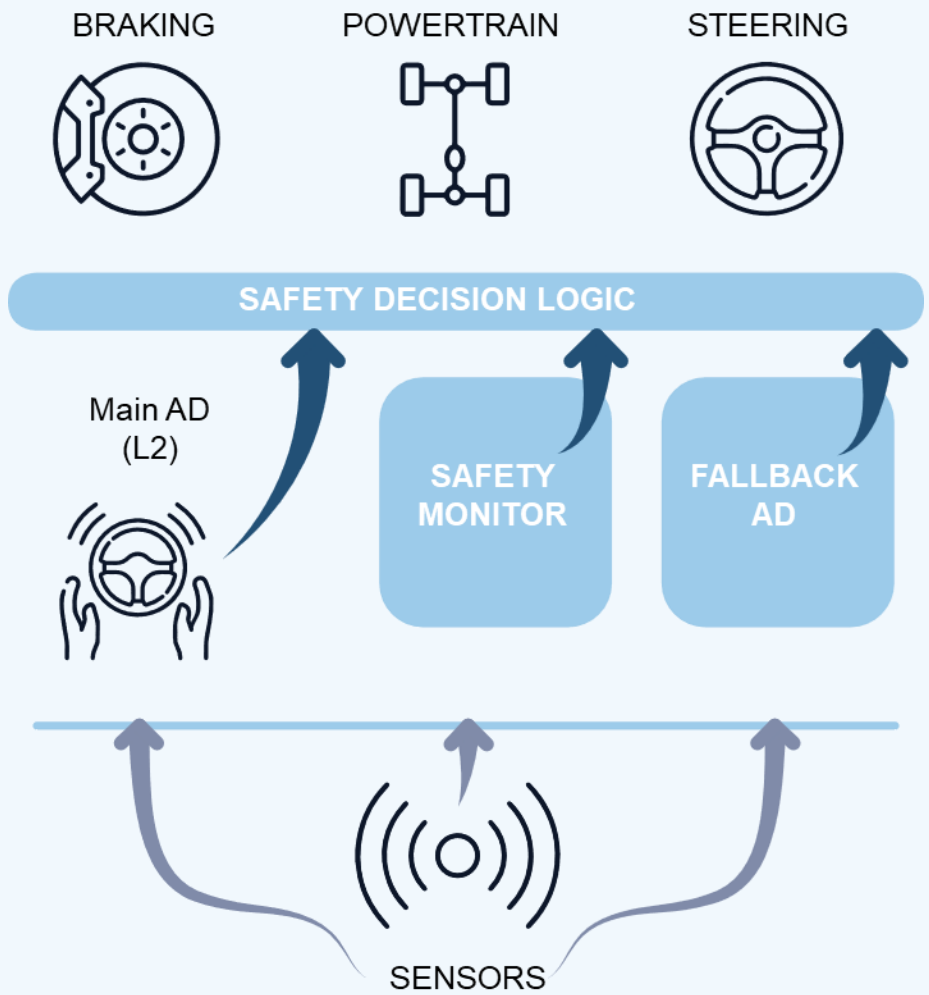
- Does the ADS tolerate a single faulty ECU?
- Formal proof from a mathematical model

Markov Model in PRISM:

- What is the ADS system failure rate (mean-time-to-failure for two ECUs)?

Sufficient Independence Methodology:

- How to ensure fail-operational with homogeneous redundancy (identical ECUs)?



SAFETY CONSULTING SERVICES

SAFETY ACTIVITIES

- Safety management
- HARA
- Functional safety concept
- Safety analyses
- Safety reviews
- Safety case construction and/or review

SAFETY DEVELOPMENT

- Technical safety concept
- ASIL decomposition
- Design of safety mechanisms
- Integration of safety manuals of third-party software and hardware
- Architecture and code reviews
- ECU-level test cases

POST-PRODUCTION

- Forensics (“black box” data recording and analysis)
- Analysis of field data

TRAINING

- Enable compliance with ISO 26262 (FuSa)
- Enable compliance with ISO 21448 (SOTIF)
- Enable compliance with ANSI / UL 4600
- Train development and management teams

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DEFINING FUTURE VEHICLES WITH
FORWARD THINKING TECHNOLOGY

ELECTRONIC CONTROLS DESIGN HOUSE

CUSTOMIZED COLLABORATION

HARDWARE-AS-A-SERVICE PACKAGE

Allows the separate contracting of design- and production-services

PROTOTYPING PACKAGE

Start externally with A- and B-samples, take over at industrialization

TIER 1 PACKAGE

Typical scenario, everything is provided from a single supplier

OPEN ECU PACKAGE

Take an Off-The-Shelf ECU with customized software

TTTechAuto

N4 NETWORK CONTROLLER

This unique ECU – which has been designed & tested according to strict automotive standards – offers flexibility and can be used for multiple use cases:

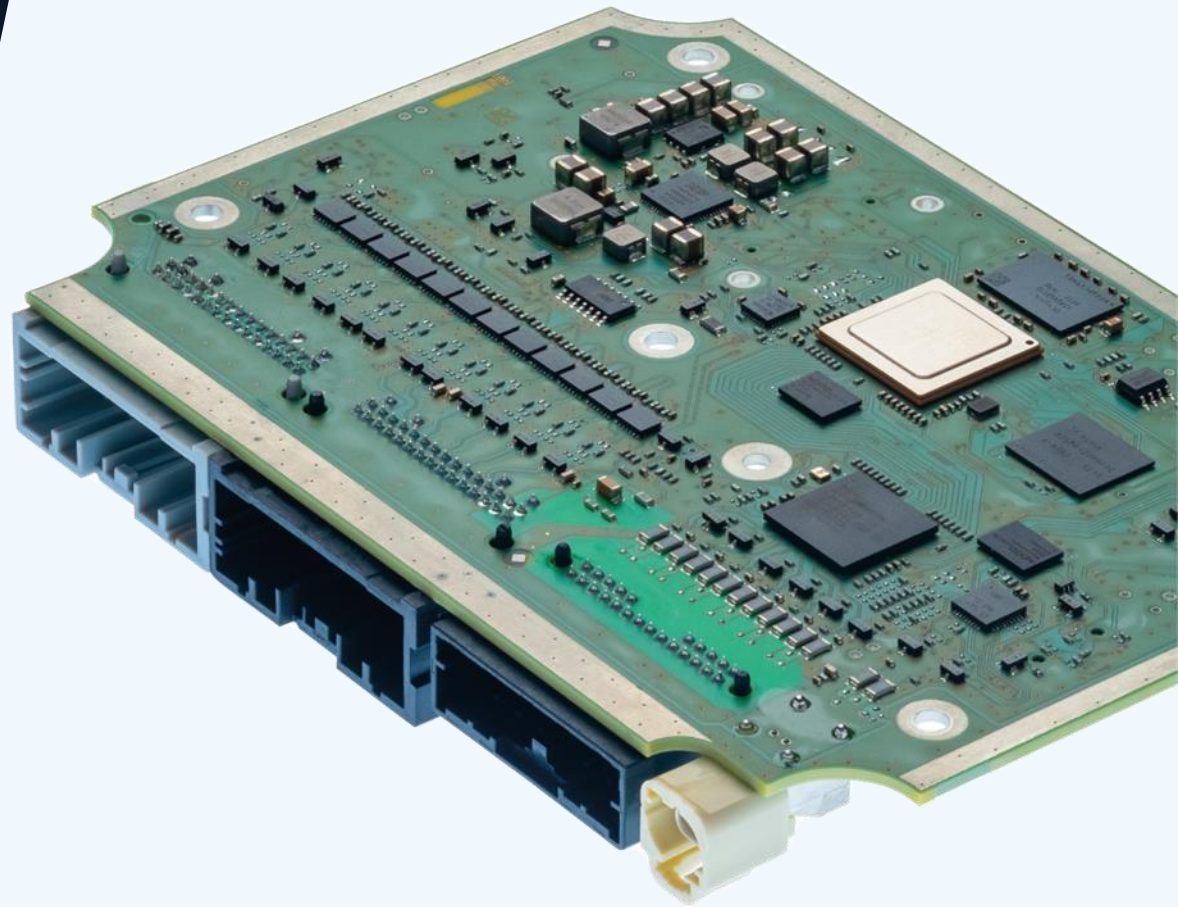
- A Secure Gateway and Telematics
- Firmware-Over-The-Air (FOTA) update master
- Domain controller
- Central and Zonal computing

A wide range of OSes and software stacks can be used.

It has two CPU clusters: Arm Cortex-A53 and Cortex-M7.

Microcontroller-style and advanced OS can run in parallel (example: AUTOSAR Classic and Linux).

A reference software and demo apps will be provided with the starter kit.



N4 HIGH-PERFORMANCE ECU WITH ADVANCED NETWORKING CAPABILITIES

N4

THE COMPUTING, COMMUNICATION AND NETWORKING ECU

Sufficient performance for demanding applications – up to 11970 DMIPS* on 4x Arm Cortex-A53 and 3x Arm Cortex-M7

Future-proof memory size for advanced operating systems, failsafe updates and logging – 2 GB RAM, 8 GB Flash

Modern automotive connectivity –1x1000BASE-T1, 6x100BASE-T1, 1x100BASE-TX, 12xCAN (FD), 2xLIN, high bandwidth data routing with hardware acceleration, firewall capability

Safe and secure automotive platform – fail-safe application hosting and signal-based routing up to ISO26262 ASIL B, ASIL D safety requirements can be considered on request, hardware support for secure boot, secure flashing, authenticated diagnostics, key management, authenticated communication, and 3rd party integration of IDS and OTA solutions

TESTING PRODUCTS

POWER FAMILY

PM-200 DATA LOGGER

OVERVIEW

THE POWER TO LOG

- Comprehensive data logging with **central timestamp** (1 µs) and 120 MB/s data speed
- Open data format for evaluation purposes on numerous applications
- The all-in-one data logger for the entire vehicle networking
- Configurable **power management** (sleep mode up to 100 µA)
- Extensive interfaces & extension modules via Ethernet
- Support from **debugging/multimedia protocols**
- Selective data logging with trigger and filter
- (CCP/XCP, ESOtraces, GNLogs, DLT)
- Logging of **wakeup process**
- Freely **programmable**
- Flexible upgrades
- Replaceable SSD

LOGGING INTERFACES

- (12+12)x CAN / CAN FD
- 12x LIN
- 3x Flex Ray
- 2x Ethernet
- Automotive Ethernet extensions
- PT-15B – 100BASE-T1 (BroadR-Reach)
- PT-20MG – 1000BASE-T1
- Clamps 15 and 30
- Additional debug interfaces
- 6x Serial (RS-232)
- 15x Analog In/Out
- 15x Digital In/Out

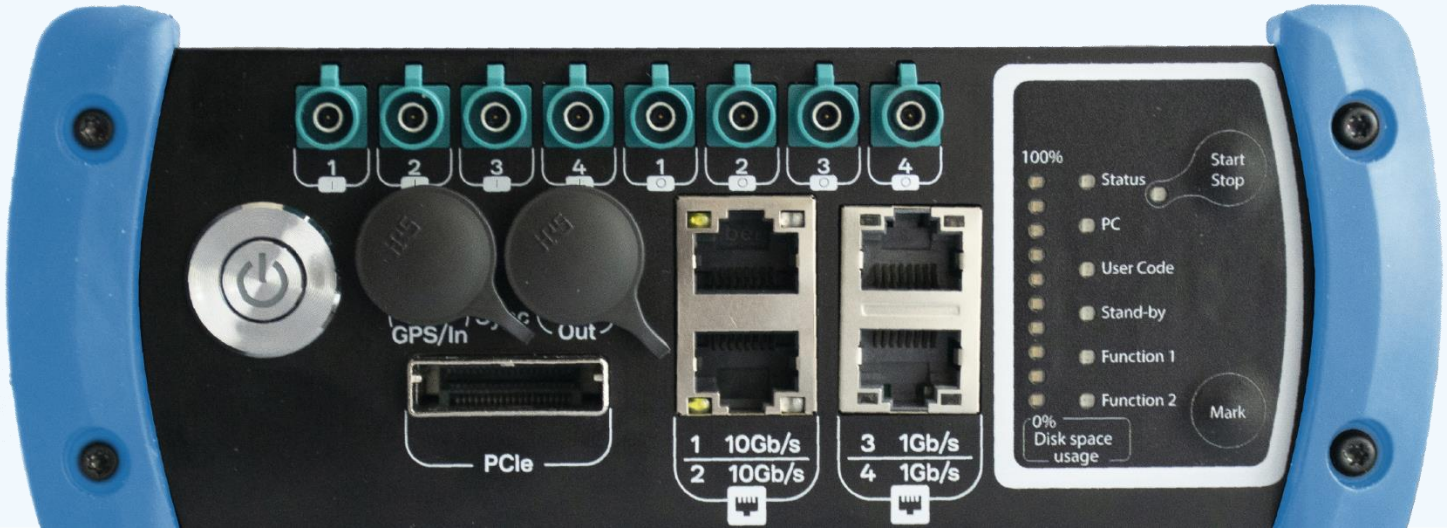
THE POWER FAMILY PRODUCT PORTFOLIO

PM-200

- Automotive data logger
- Data speed up to 120MB/s
- SSD removable media
- Various diagnostic protocols support
- Custom programmability & upgrade

PT-15B, PT-20MG

- Expansions for
  - BroadR-Reach® inter. – 100BASE-T1
  - Automotive 1GbE inter. – 1000BASE-T1
- Constant & low traffic latency
- Data timestamping & filtering
- Real-time data forward via 1Gb ETH

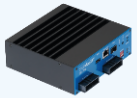


PM-300

- Flexible all-in-one automotive data logger solution
  - Automotive Ethernet
  - Traditional auto interfaces
  - Capture AD/ADAS cameras content
- Recording Seep up to 16GB/s
- High-capacity SSD
- Compact design

EXTENSION MODULES

BroadR-Reach® / Automotive Ethernet | Loop through with constant latency (independent of the frame size)
High performance for full network utilization | Ethernet filter function | Cascadable

	PT-15B 	PT-20MG 
VEHICLE INTERFACE	12x 100Base-T1 (BroadR-Reach®) 6x Ethernet lines can be recorded	6x 1000Base-T1 3x Ethernet lines can be recorded
	2x CAN for WakeUp	5x CAN(FD) for WakeUp
LOGGING INTERFACES	1x Ethernet 1000Base-T 1x Ethernet SFP	
LATENCY	1,6 µs (irrespective of packet size	
OPERATING TEMPERATURE	-40°C to 75°C	
ELECTRICITY CONSUMPTION	10W	
OPERATING VOLTAGE	6 V to 32 V	

BENEFITS

PM-300 DATA LOGGER

1

The solution for complete vehicle network: logging data from traditional interfaces (CAN FD, LIN, FlexRay), Automotive Ethernet and cameras

2

Multiple use cases: Fleet testing, HIL simulations, Lab testing, Testing vision-based ECUs (autonomous driving)

3

Flexibility - expandable and future-proof solution supporting high data bandwidth

4

Precise measurements & data timestamps (0.012 microseconds)

5

The smallest high-performance data logger on the market

6

Easy replacement for the existing TTTech devices

7

Forward Data in real-time (TAP functionality)

8

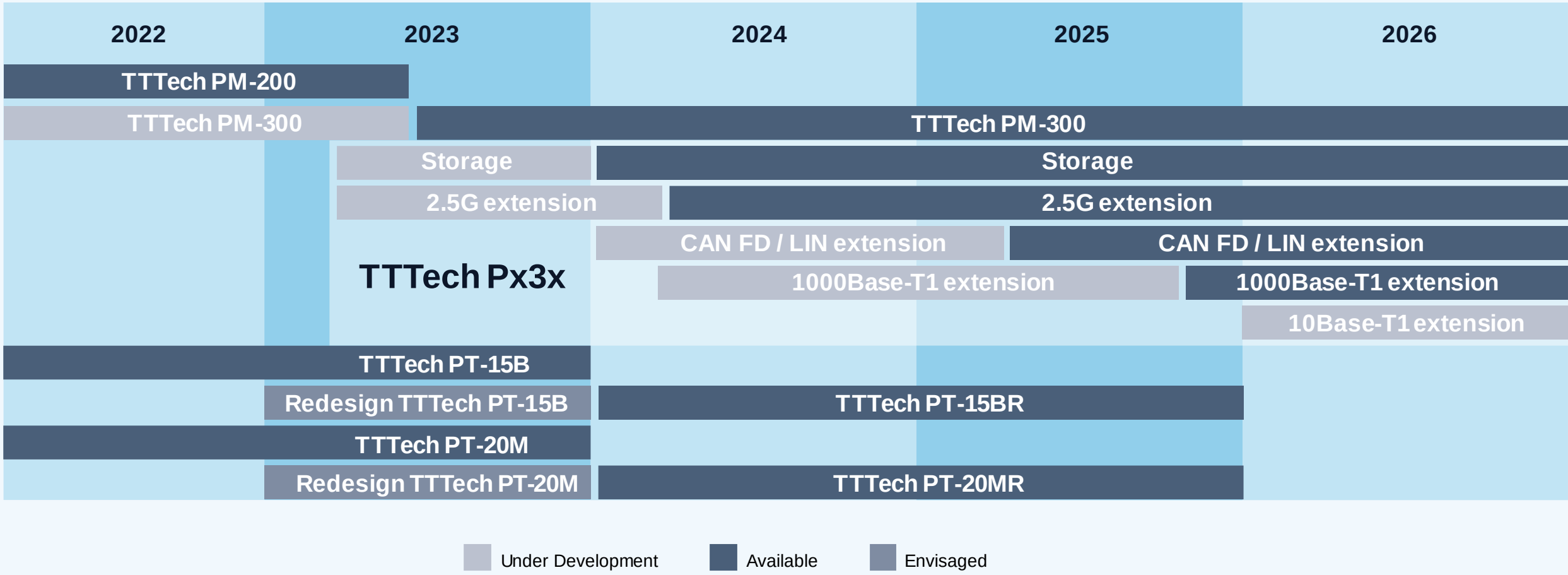
Easy-to-use, hassle-free configuration

9

The possibility to use third party tools

TESTING TOOLS

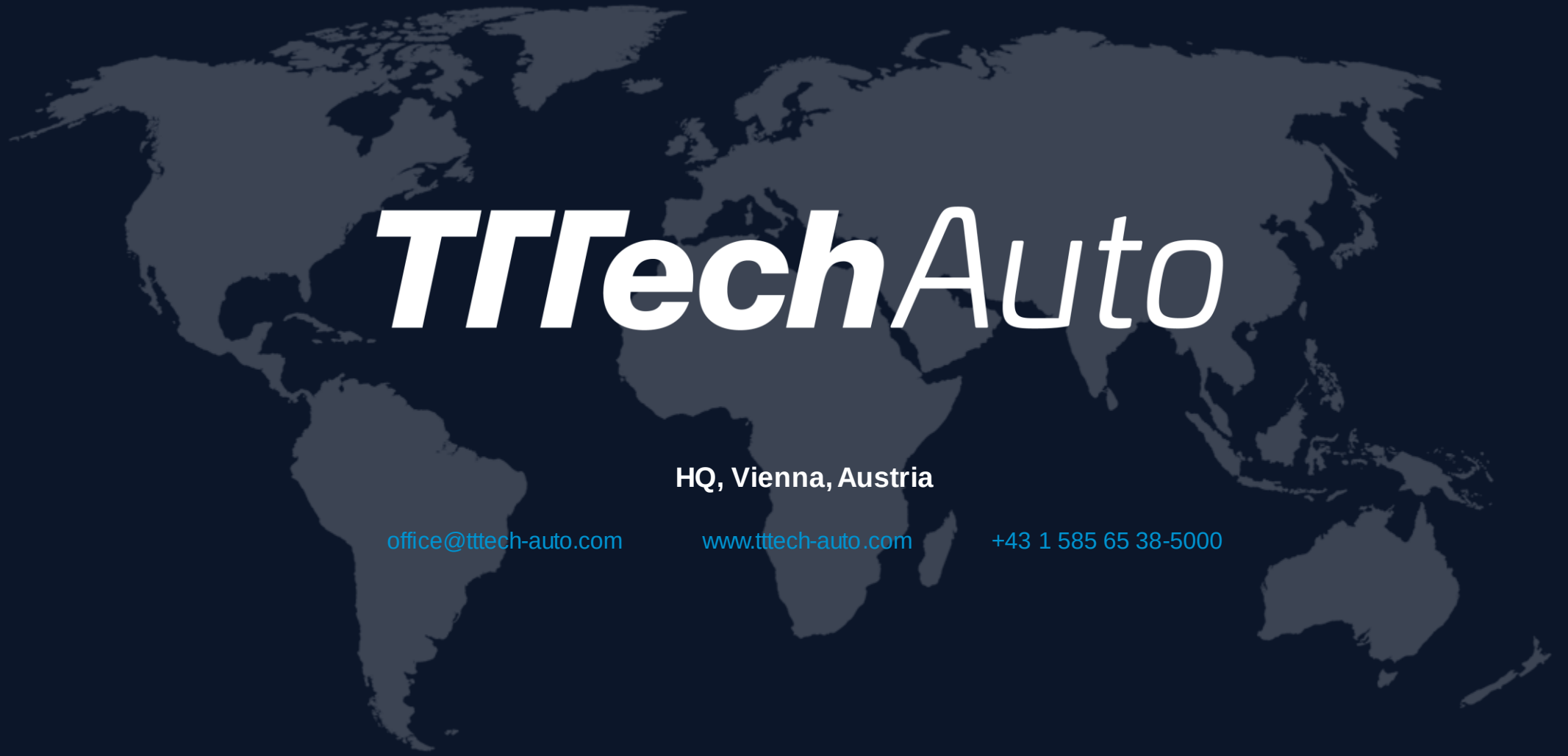
PLANNED ROADMAP



USE CASES

PM-300 DATA LOGGER

- Debug output logging
- Test drives in real-life driving conditions and at proving grounds
- Functional verification in prototype vehicles and on HIL
- Triggered recording and data filtering
- Development and validation of ADAS algorithms: surround view, camera mirror replacement, object and lane detection, etc.
- To evaluate the performance of vision algorithms ported to embedded devices



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THE | AUTONOMOUS

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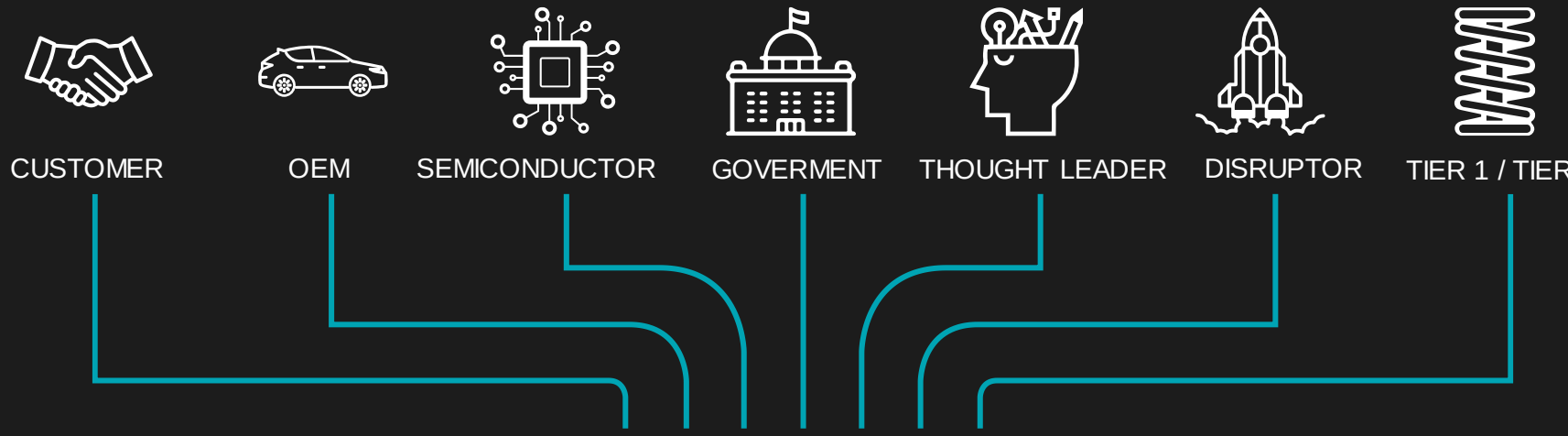
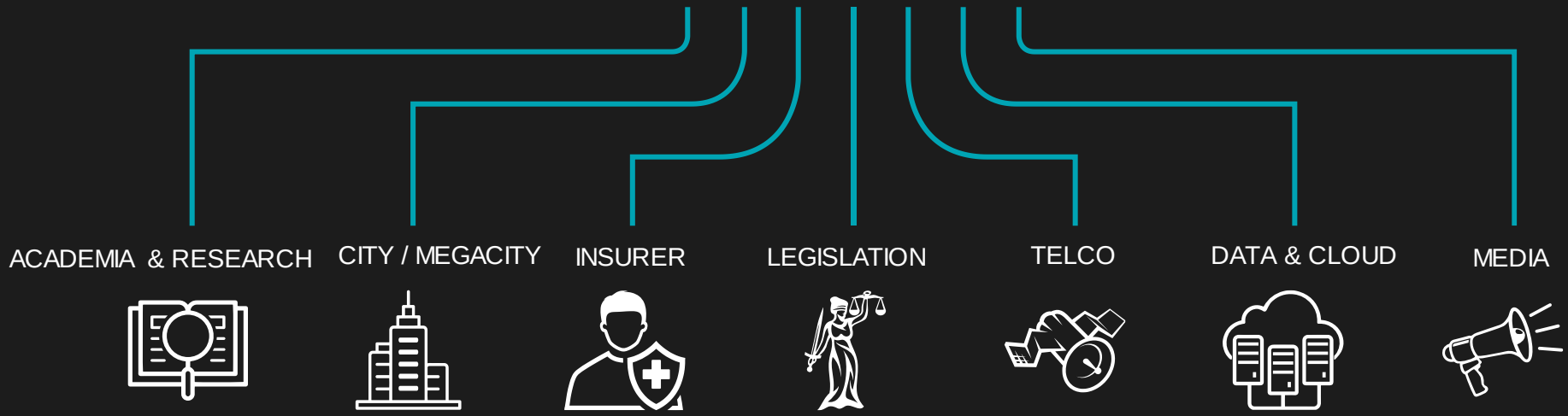


THE AUTONOMOUS ECOSYSTEM



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THE | AUTONOMOUS

SUPPORTERS 2022

THE | AUTONOMOUS

THE MAIN EVENT

Where
Hofburg Imperial Place Vienna, Austria and virtually

When
September 14,2023

- // Flagship event of The Autonomous initiative
- // Keynotes & panel discussions on the executive track
- // Specific classes and workshops on the expert track
- // Networking with 500+ top international executives & experts
- // Side-events and receptions for further networking