

SDV AT BMW.

HOW HARDWARE ENABLES SOFTWARE AND SOFTWARE CHANGES THE CAR.

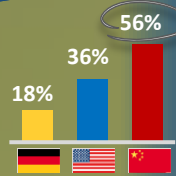
2025 Oct 8th

SOFTWARE-DEFINED VEHICLE | CUSTOMERS EXPECT A VARIETY OF SW-BASED FEATURES – FOR BMW THE SDV GOES BEYOND FUNCTIONAL REQUIREMENTS.

SDV – What customers expect



Willingness to
change brand
for features



SDV offers **top-notch innovative functions** – based on software



SDV is **continuously updated** and „fresh“ over generations



SDV **knows me, assists me**, and supports without being „patronizing“



SDV **integrates software-features into digital ecosystems**



SDV is **tailored to market requirements/ environments...**

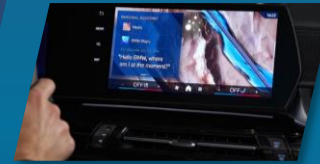
... and what we deliver as BMW



March 2024 | **BMW offers L3 autonomous driving** in the BMW 7 series in Germany



Since 2019 | **BMW first to offers Remote-SW-upgrade** – largest fleet worldwide of 7.5M cars



Since 2018 | **BMW providing Intelligent Personal Assistant** with continuously growing functions

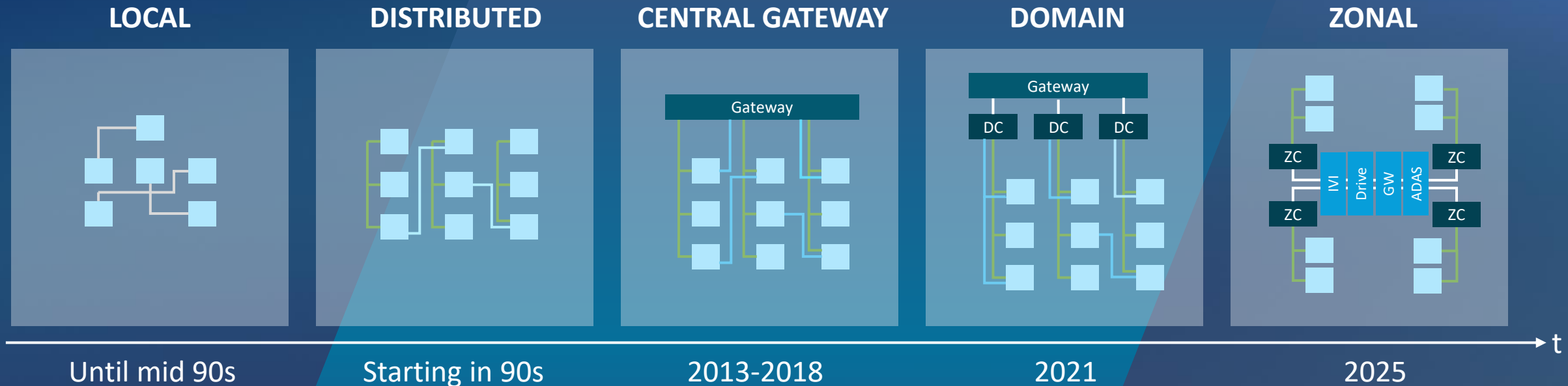


BMWs are embedded in Android, Alexa, Apple CarPlay and most other common ecosystems

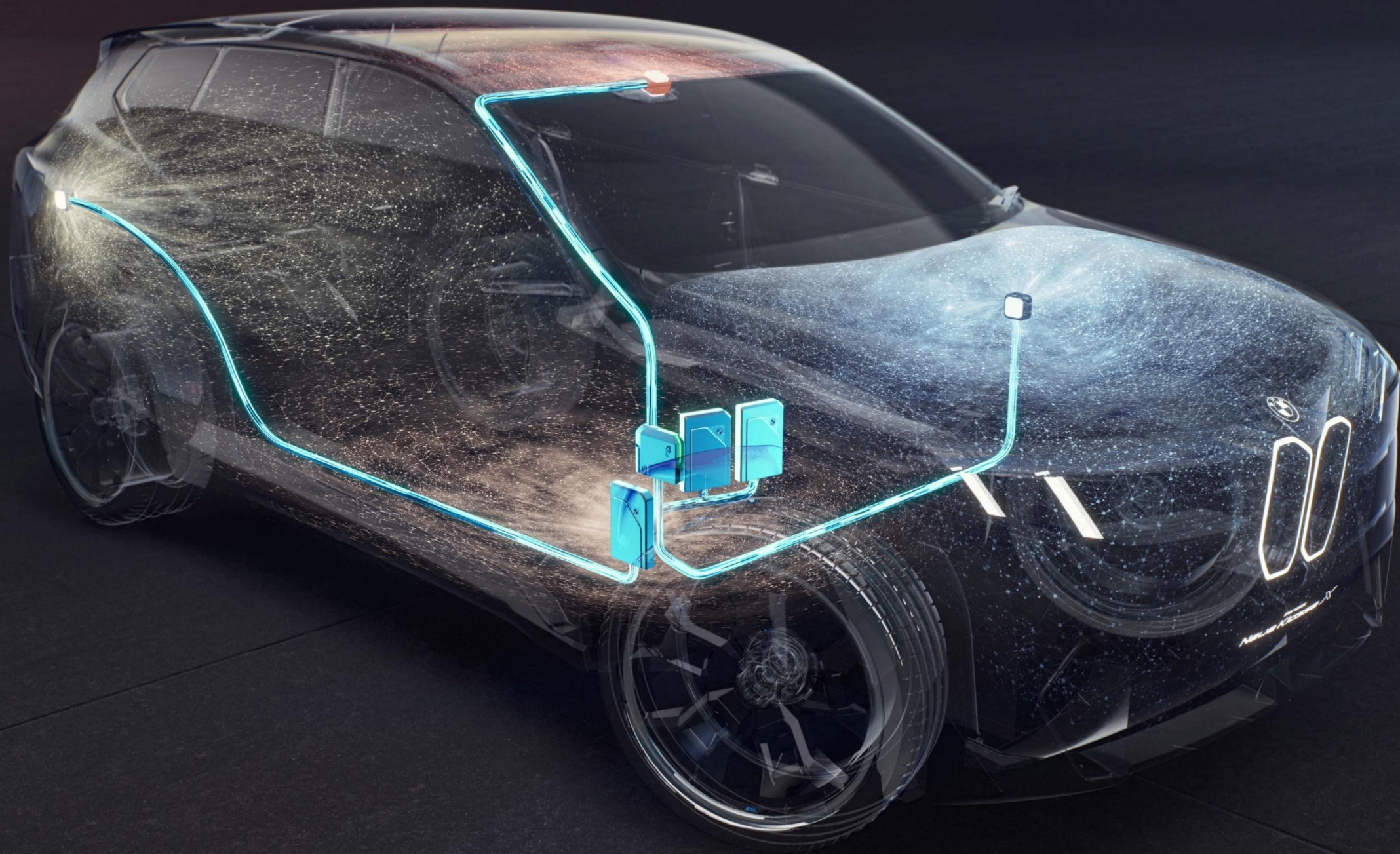


70% of BMWs digital functions in China are market-specific and localized in China

THE EVOLUTION OF E/E ARCHITECTURE SHOWS A HIGHER CENTRALIZATION OF COMPUTE POWER IN THE ZONAL APPROACH.



A zonal architecture with central compute platforms is key for SDV and innovation driver for the semiconductor industry.



BMW E/E ARCHITECTURE.

CENTRALIZATION OF COMPUTE: OUR FOUR “SUPERBRAINS”.

Centralized and intelligent computing.

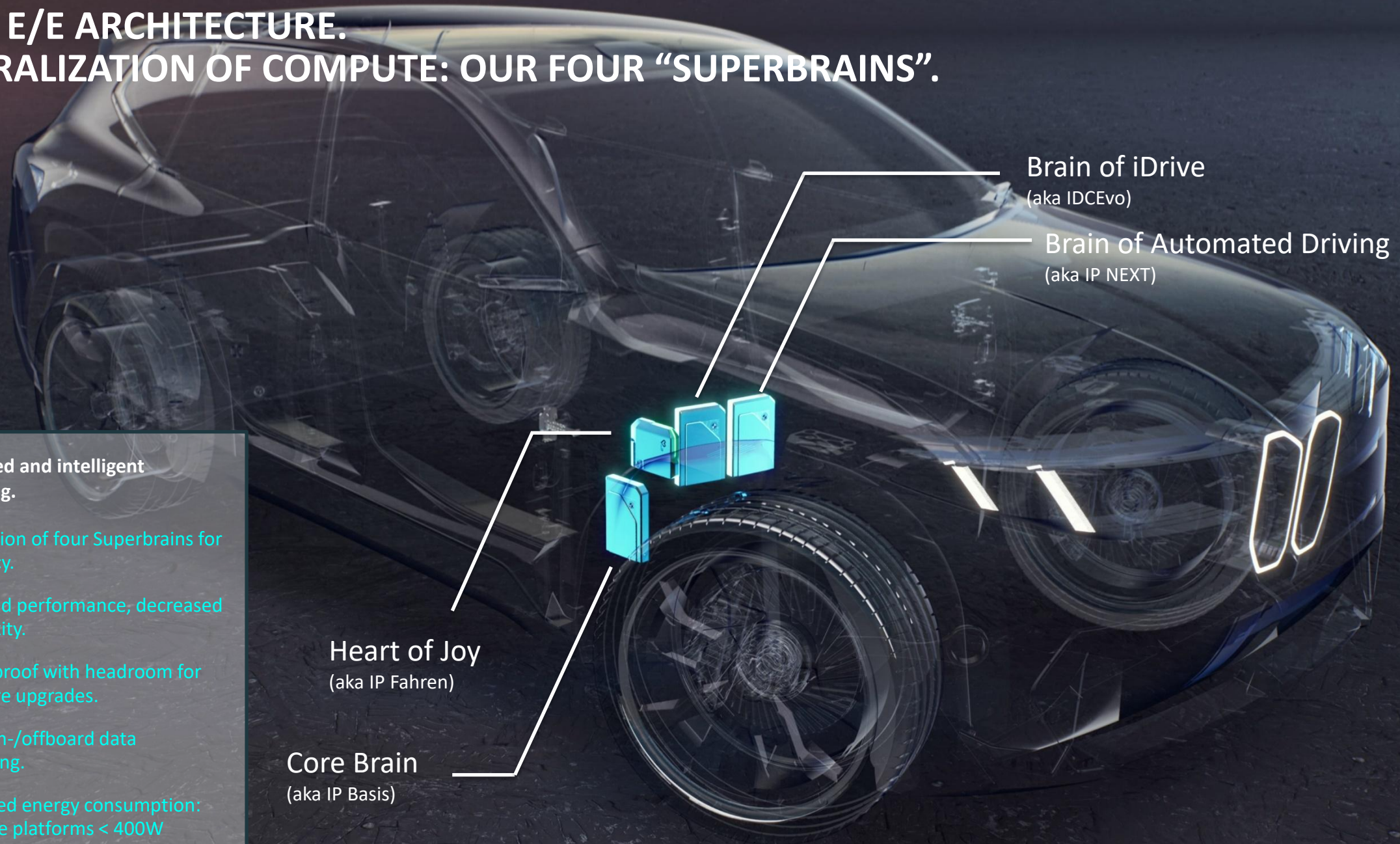
- Co-location of four Superbrains for efficiency.
- Increased performance, decreased complexity.
- Future-proof with headroom for hardware upgrades.
- Smart on-/offboard data processing.
- Optimized energy consumption: Compute platforms < 400W

Brain of iDrive
(aka IDCEvo)

Brain of Automated Driving
(aka IP NEXT)

Heart of Joy
(aka IP Fahren)

Core Brain
(aka IP Basis)



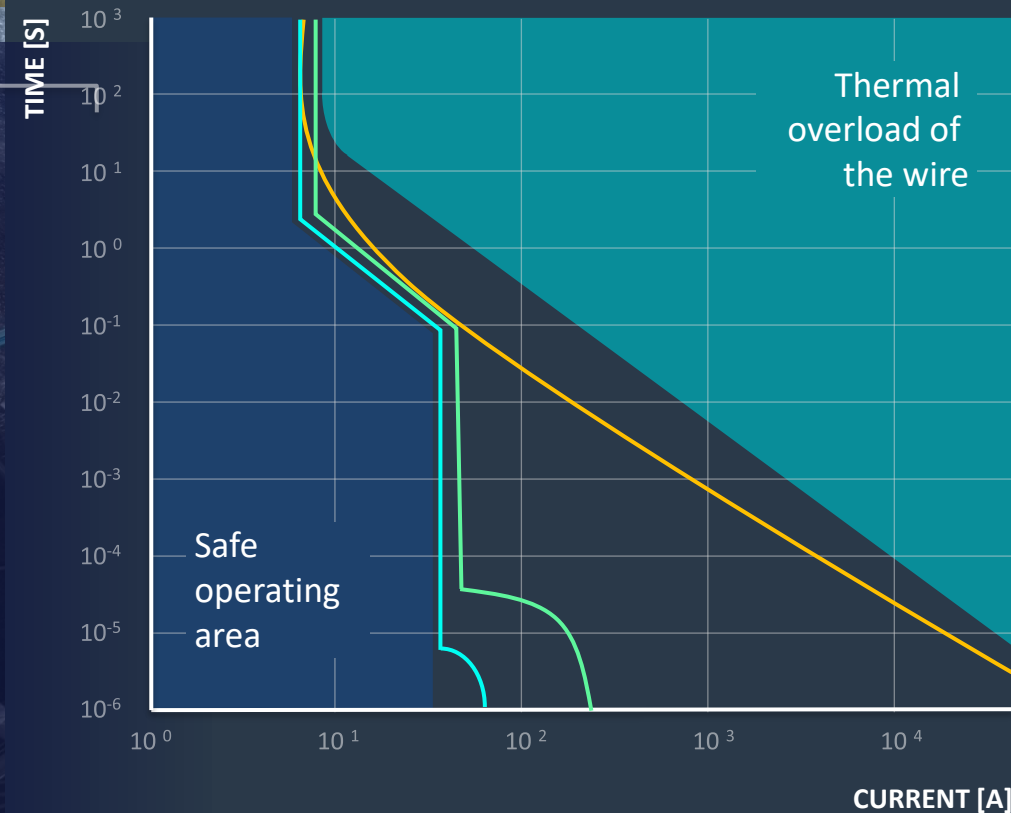
SMART ENERGY MANAGEMENT. FROM TRADITIONAL FUSES TO SMART eFUSES.

Traditional fuses

eFuses

Fuse diagram
(logarithmic / RMS)

Traditional fuse eFuse min eFuse max



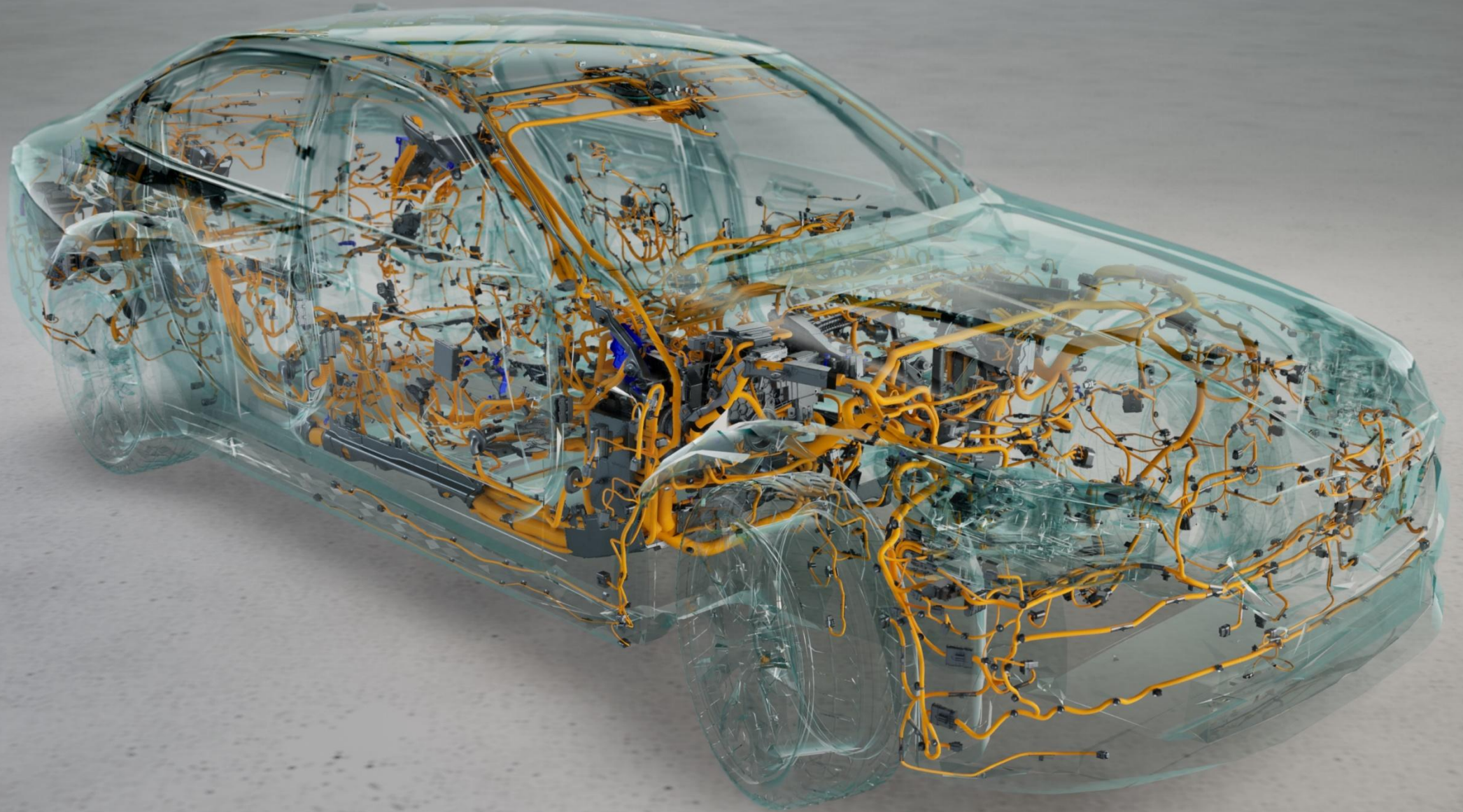
CHANGING PARADIGMS FOR eFUSES

- **REVERSIBLE:** From irreversible melting to self-healing protection
- **FAST:** From ms degradation in each component to μ s degradation
- **SMART:** From analog protection to (remote) diagnosable systems
- **ZONAL INTEGRATION:** From relay-based distribution boxes to switchable eFuses in zone modules

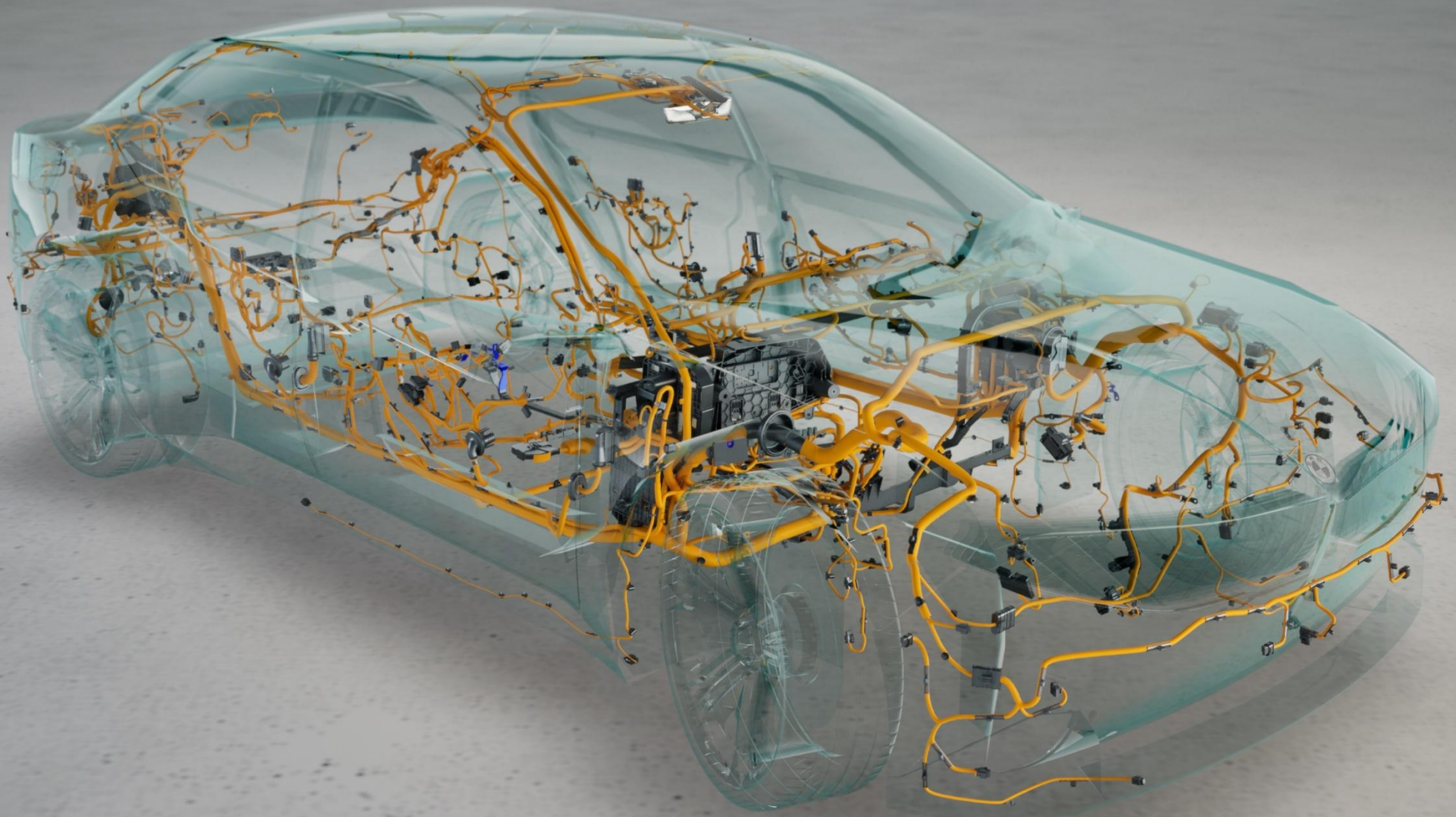
BENEFITS TO BMW NEUE KLASSE

- **LONGEVITY:** Self-healing eliminates fuse replacements, enables easy diagnosis
- **ENERGY SAVING:** Selective activation of components reduces power consumption
- **DEGRADATION:** Fast fault isolation enables safe functional degradation
- **COST REDUCTION:** Benefits from zonal design and automated harness production

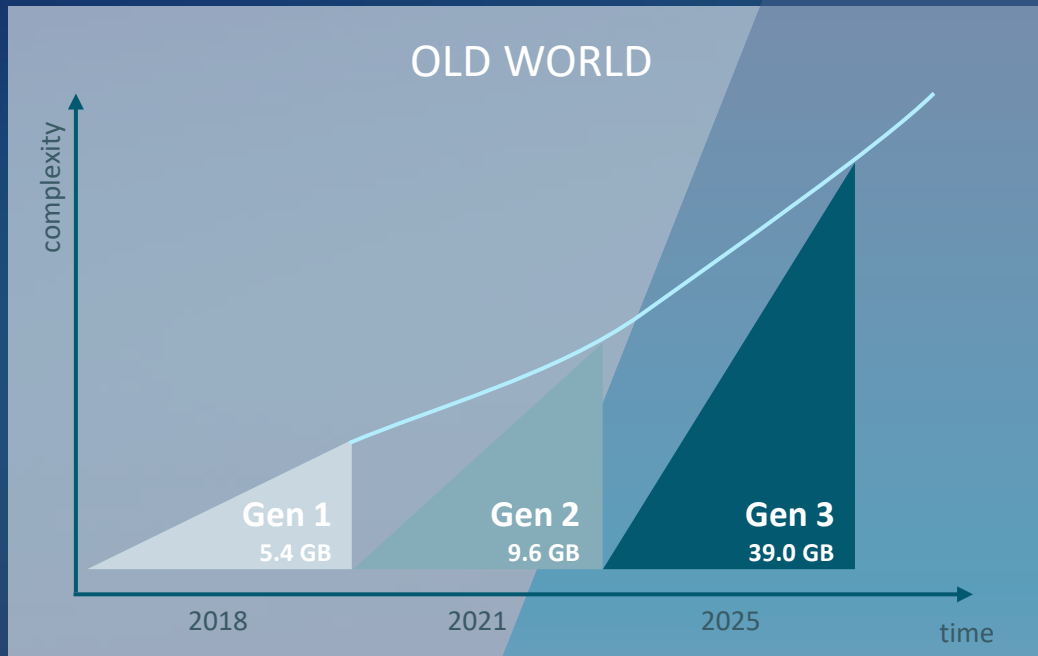
BMW E/E ARCHITECTURE: GENERATION 2021 – BMW i5.



BMW E/E ARCHITECTURE: GENERATION 2025 – BMW NEUE KLASSE.



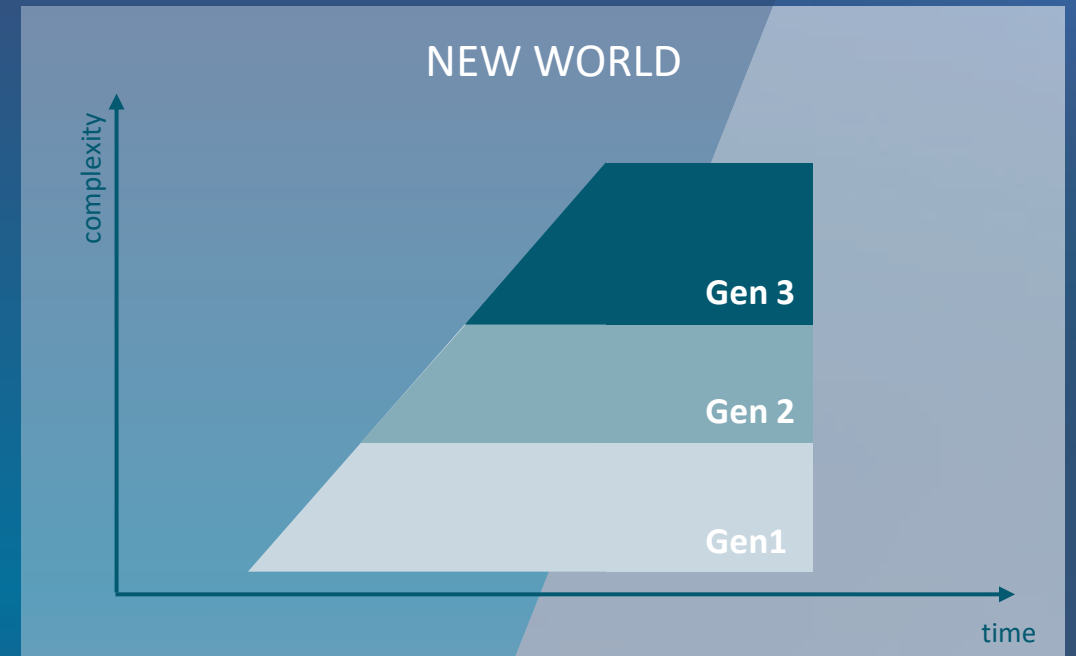
EVOLUTIONARY, SCALABLE AND OPEN HARDWARE IS ESSENTIAL TO REDUCE COMPLEXITY AND COSTS.



Increasing effort across generations with increasing code size ...

New supplier constellations bring new HW platforms with new semiconductors.

VS.



... **continuity** and **reuse of software**.

... **evolution of hardware & semiconductors**.

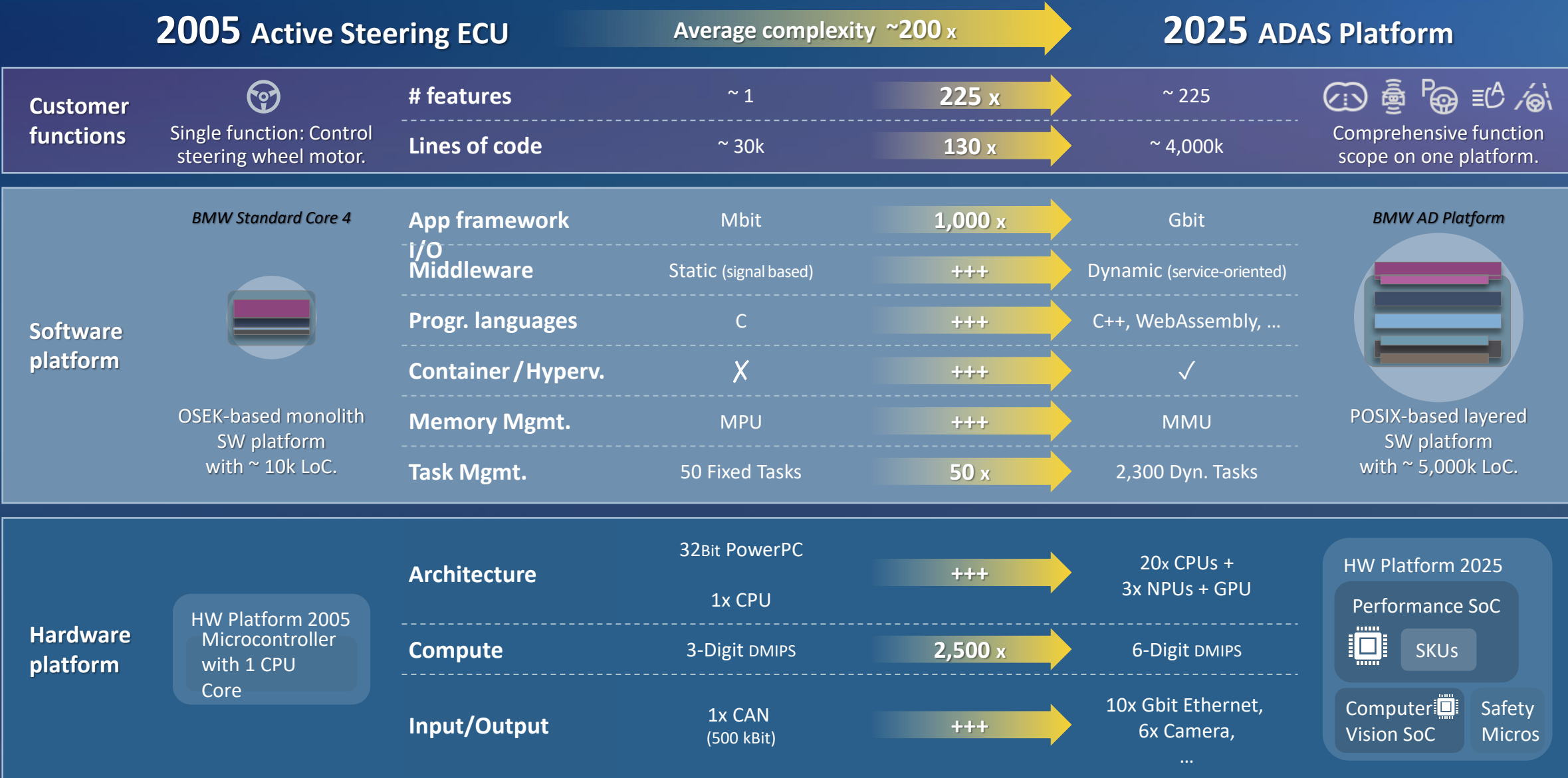
Stronger reliance on de facto standards and open ecosystems.

NEUE KLASSE HARD- AND SOFTWARE TECH STACK*



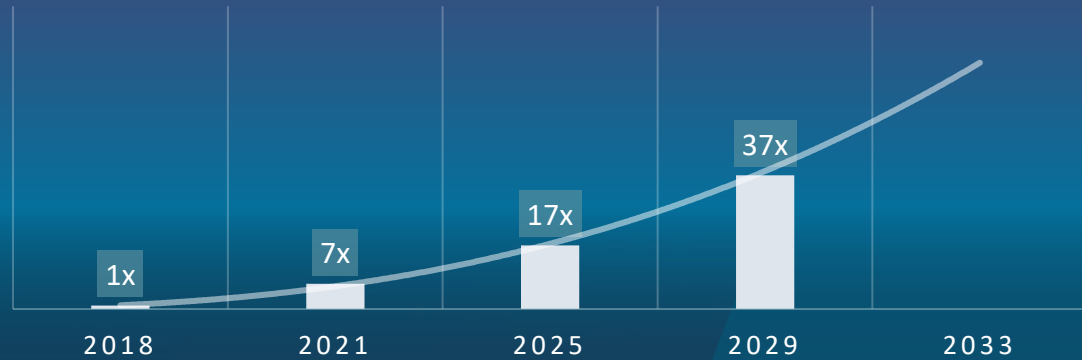
*Simplified visualisation.

SW PLATFORMS | TODAY'S REQUIREMENTS DWARF YESTERDAY'S PLATFORMS ...

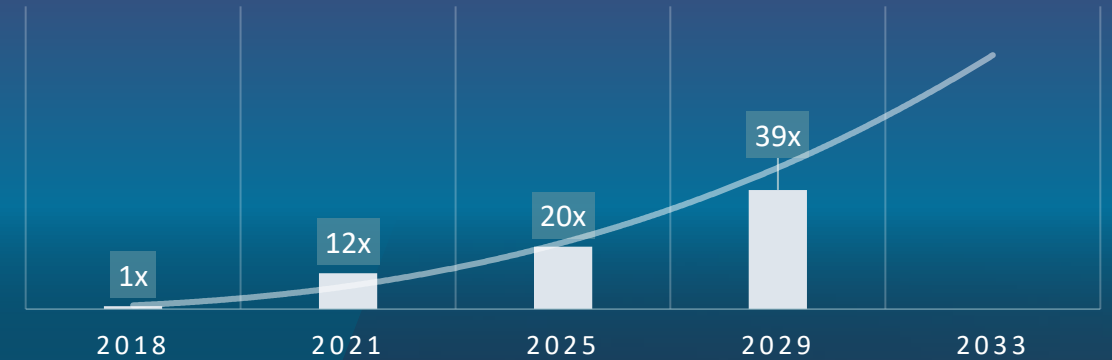


PERFORMANCE REQUIREMENTS IN INTEGRATION PLATFORMS ARE CHALLENGING THE SYSTEM ARCHITECTURE BECAUSE OF ENERGY CONSUMPTION.

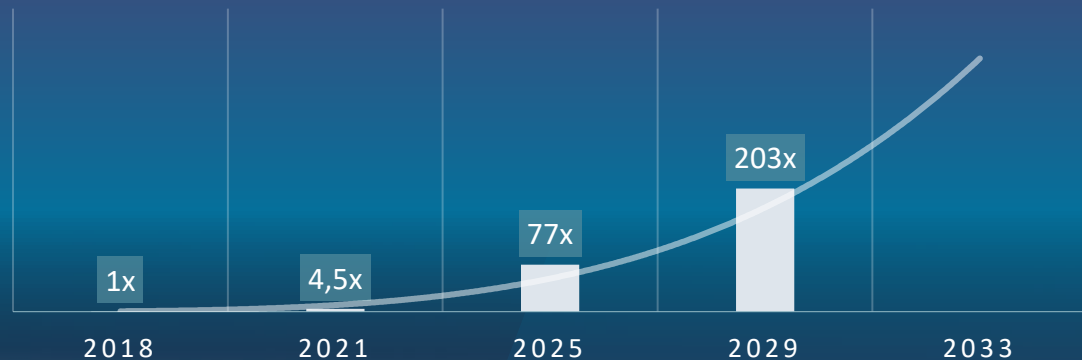
DMIPS



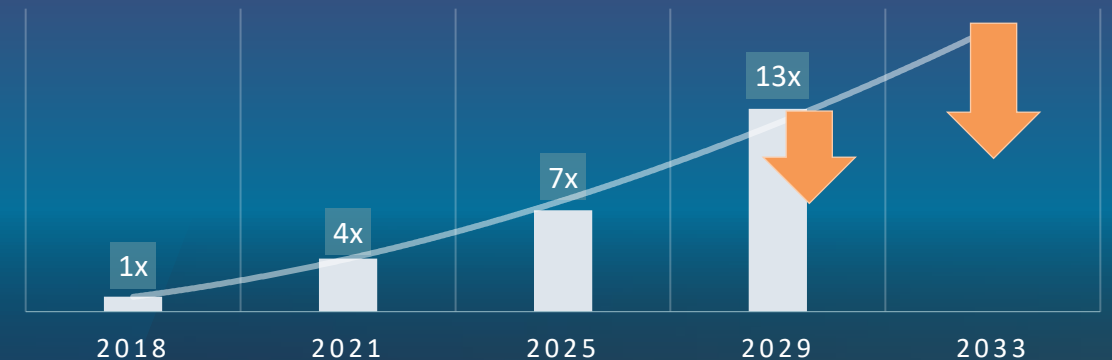
GFLOPS [FP32]



TOPS [INT8]

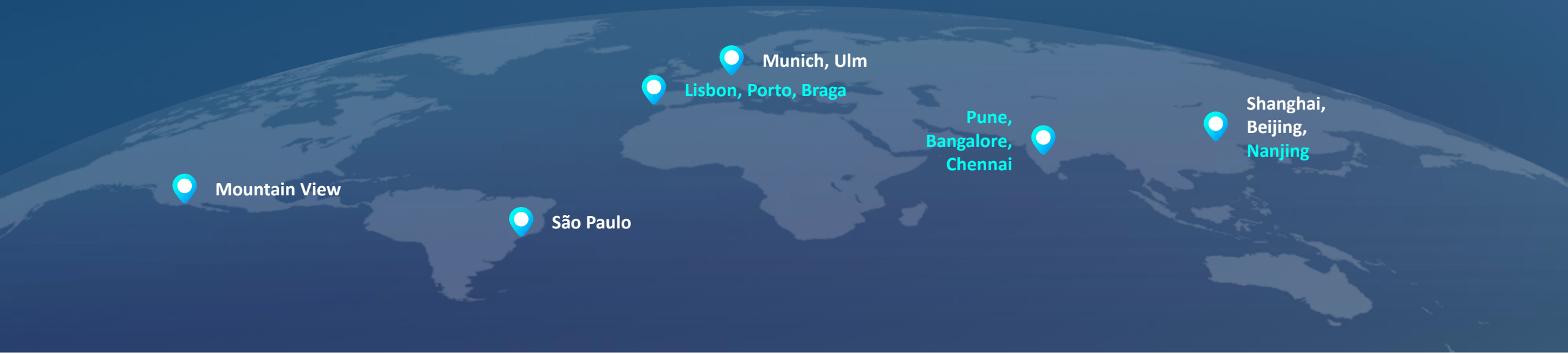


POWER



SW TOOLCHAIN | BMW SW DEVELOPMENT HAS SCALED TO A GLOBAL NETWORK ENABLED BY CODECRAFT – DEVELOPMENT ENVIRONMENT FOR >10K DEVELOPERS.

REFLECTING OUR PROJECTIONS FOR GROWING DEMAND FOR SW TALENT, WE SET UP A GLOBAL DEVELOPMENT NETWORK.



2018  **Critical Techworks**
A BMW GROUP & CRITICAL SOFTWARE COMPANY

- Portugal: Lisbon, Porto, Braga
- Automotive SW for global, Digital Company DevOps

2021  **BA TechWorks**
A BMW and Bosch Technology Company

- China: Nanjing
- Automotive SW for China & global

2024 **BMW TECHWORKS INDIA**

- India: Pune, Bangalore, Chennai
- Automotive SW for global, Digital Company DevOps

SW TOOLCHAIN | BUILD TOOLCHAIN GREW RAPIDLY TO ENABLE DELIVERY OF INCREASING SOFTWARE COMPLEXITY – STANDARDIZATION OFFERS POTENTIAL.



CODECRAFT DELIVERS SCALABILITY

	2015	2024
# builds / day	~ 2.5k	~ 150k
# jobs per hour	~ 150	~ 14k
# CPUs in use	~ 1.0k	~ 75k (virtual)

50-100x performance in 10 years, enabling ...

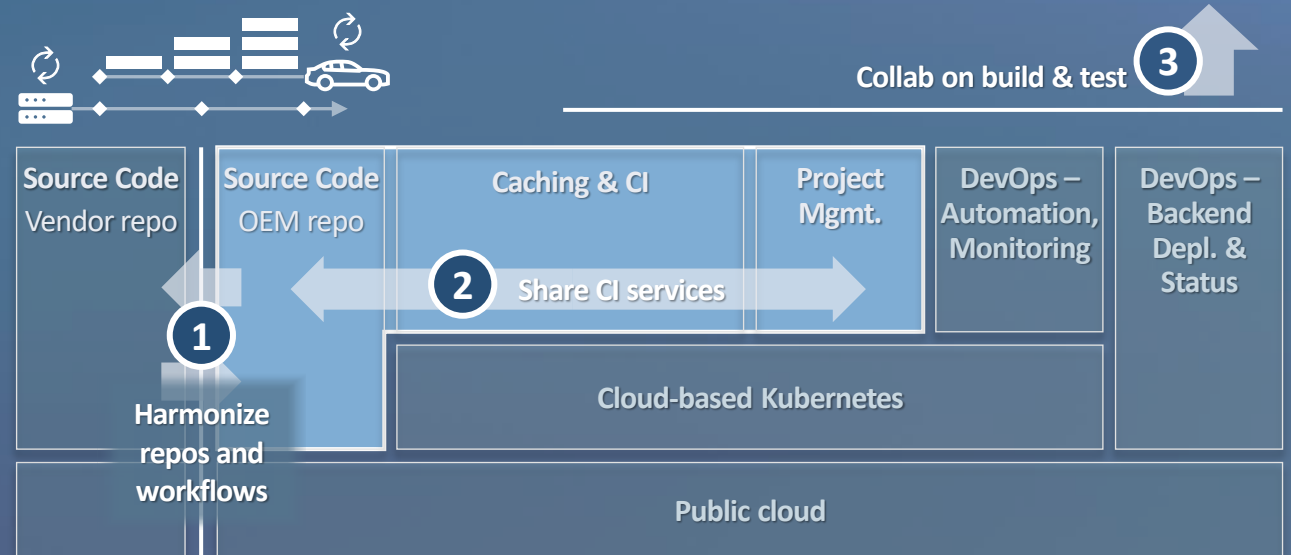
... **75% error reduction** (SiL) via shift to CI, realizing ...

... **20 min feedback** cycles reliably, despite ...

... **200x SW platform complexity** (previous section).

Source: BMW estimates

BUT STANDARDIZATION HOLDS FURTHER POTENTIAL



- 1 Harmonize workflows and repos:** Establish seamless interface between vendor product repos and OEM project repos for efficient collaboration, e.g., on signing
- 2 Share scaled & integrated CI service:** Propagate scalable CI services for SDV, e.g., OSS Zuul, and drive services integration – BMW is already contributing.
- 3 Collaborate on build & test methodology:** Share approaches for automotive ECU software development, e.g., on Bazel rules

BMW GROUP IS PIONEERING THE SOFTWARE DEFINED VEHICLE. OUR VEHICLES OF THE PRESENT AND FUTURE ...

OFFER A SEAMLESS USER INTERFACE



ARE ALWAYS CONNECTED



ARE PERFECTLY ASSISTED



INTEGRATE 3RD PARTY CONTENT



ARE FULLY UPDATEABLE (OTA)





THANK YOU FOR YOUR ATTENTION.

