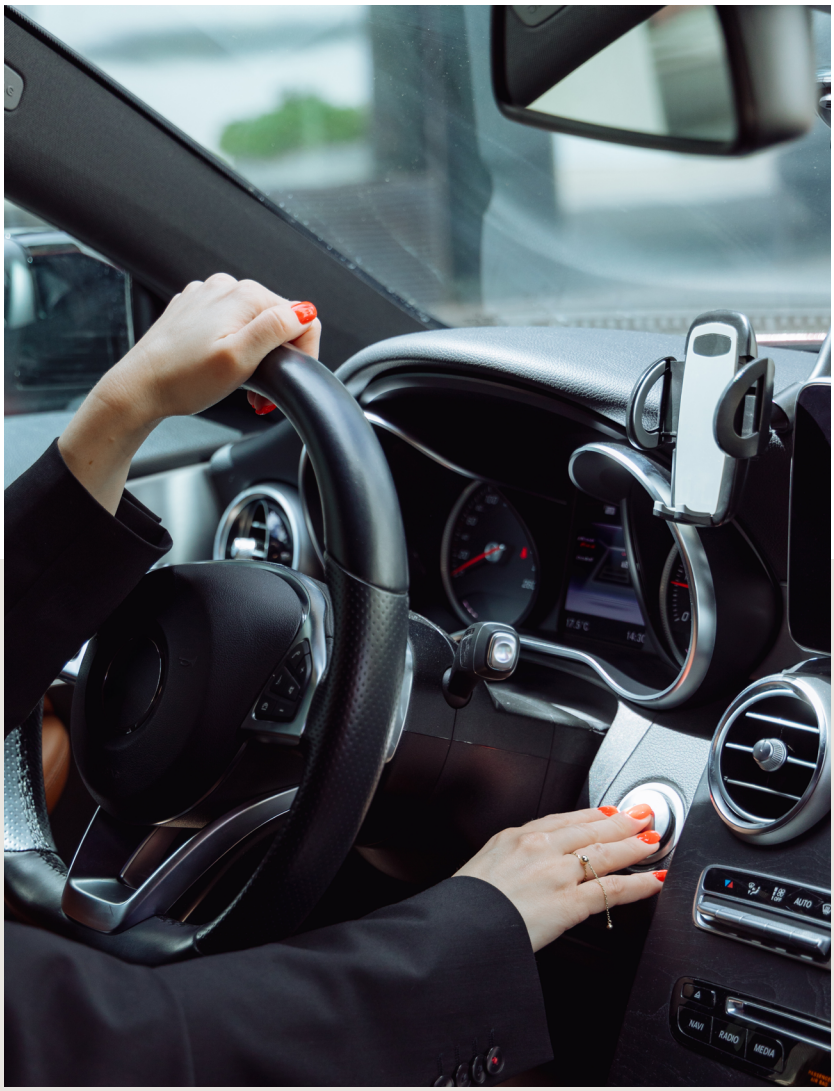
A new automotive baseline



WHITEPAPER

The intelligent, secure, and software-ready vehicle

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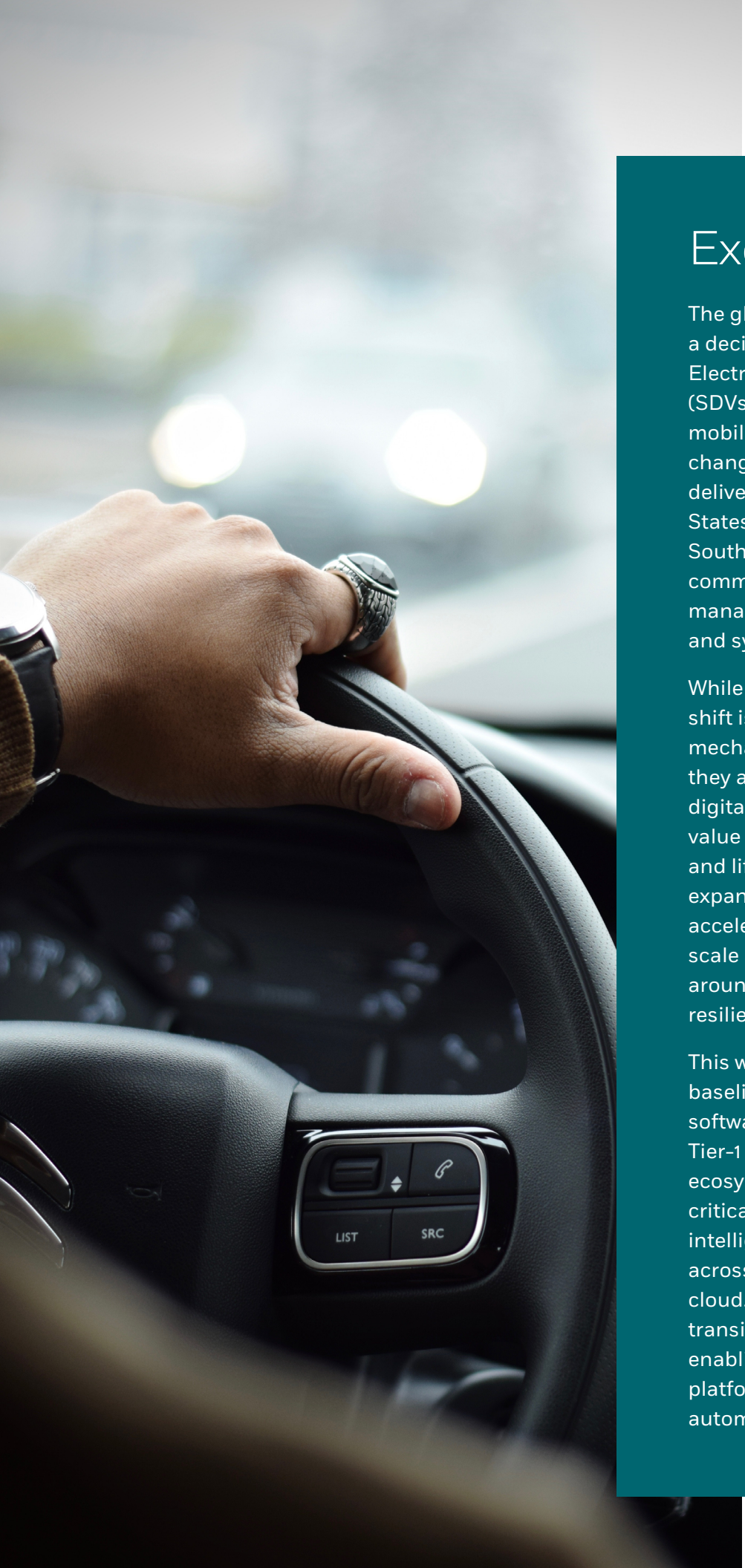
Contents



Executive summary

The global automotive industry is entering a decisive phase of transformation. Electrification, software-defined vehicles (SDVs), autonomous driving, and connected mobility are converging to fundamentally change how vehicles are engineered, delivered, and operated. Across the United States, Germany, Sweden, Japan, and Southeast Asia, automotive leaders face a common imperative: innovate faster while managing rising complexity, cost pressure, and systemic risk.

While market conditions differ, the underlying shift is universal. Vehicles are no longer mechanical systems enhanced by software; they are becoming continuously updatable digital platforms. This transition unlocks new value through intelligence, personalization, and lifecycle optimization, while also expanding exposure. Software complexity is accelerating, cyber threats are increasing in scale and sophistication, and expectations around safety, security, data protection, and resilience are intensifying across all regions.

This whitepaper introduces a new automotive baseline: the intelligent, secure, and software-ready vehicle. It outlines how OEMs, Tier-1 suppliers, mobility operators, and ecosystem partners can address today's most critical challenges by embedding AI-driven intelligence and cyber-resilient architectures across the vehicle lifecycle — from ECU to cloud. It also describes how UST supports this transition as a long-term innovation partner, enabling scalable, regionally adaptable platforms across mature and high-growth automotive markets alike.

The automotive inflection point: Shared challenges across regions

Despite differences in regulation, infrastructure maturity, and customer expectations, automotive leaders across the US, Germany, Sweden, Japan, and Southeast Asia are confronting a shared inflection point. Legacy development models — built for hardware-centric vehicles with limited software evolution — can no longer sustain the pace or complexity of modern mobility.

A deeper dive into the regional realities

OEM executives and strategic leaders

COMMON CHALLENGES

Rapid growth in software content without proportional gains in development velocity. Software complexity is compounding across powertrain, ADAS, infotainment, and connectivity simultaneously, on disconnected timelines and toolchains. Development velocity hasn't kept pace, and the gap between what the market expects and what teams can ship is widening.

Fragmented vehicle architectures that slow SDV transformation. Most OEMs are managing transition to centralized, software-defined platforms while still supporting legacy programs never designed for that shift. Multiple generations of architecture, resistant supplier interfaces, and outdated middleware layers are creating architectural debt that slows transformation at every turn.

Persistent tension between innovation speed, safety, quality, cost, and compliance. The defining pressure of the SDV era isn't choosing between speed, safety, quality, and compliance; it's satisfying all of them simultaneously. Shorter cycles, frequent OTA updates, and ISO 26262 and UN R155 requirements don't negotiate with each other. Most organizations are still building governance to hold them together.

Expanding cybersecurity exposure across vehicles, supply chains, and OTA ecosystems. Connected, updatable vehicles have expanded the attack surface beyond the vehicle itself. OEMs must now govern cybersecurity across suppliers, OTA pipelines, and backend infrastructure. A single vulnerability can affect millions in the field. Compliance with UN R155 and R156 raises the bar but doesn't close the gap.

REGIONAL NUANCE

United States
Scaling SDVs across large vehicle portfolios while maintaining cybersecurity at a national scale

Germany & Sweden:
Preserving safety, quality, and homologation rigor as software complexity rises

Japan
Ensuring reliability, predictability, and continuous improvement across long vehicle lifecycles

Southeast Asia
Balancing speed, affordability, and localization across diverse and fast-growing markets

IMPACT

Delayed launches, rising costs, and increased exposure to safety and security incidents undermine competitiveness and brand trust across all regions.

Tier-1 engineering and product leaders

COMMON CHALLENGES

Increasing integration complexity across ADAS, infotainment, sensors, and embedded software. What was once a hardware integration problem is now a multi-layer software orchestration challenge. ADAS, infotainment, sensor fusion, and embedded software each run on different cadences and toolchains, and a change in one domain can propagate failures across all the others.

Pressure to deliver AI-enabled capabilities without scalable ML infrastructure. AI-enabled features are expected at the component level, but most Tier-1 suppliers lack the ML infrastructure, data pipelines, and model lifecycle tooling to deliver them reliably. Training and validating models in safety-critical embedded environments demands a rigor that most organizations are still building.

Limited reuse across platforms and OEM programs. Serving OEMs means rebuilding engineering work more often than necessary. Incompatible frameworks, middleware differences, and IP constraints limit reuse across programs, pulling talent into repetitive integration work & driving up costs that compound as software content grows.

Security requirements introduced late in development. Security is still too often treated as a late validation checkpoint rather than a design principle. When requirements arrive after architecture decisions are made, remediation is expensive, and fixes are tactical. UN R155 is raising the bar, but cultural change moves slowly.

REGIONAL NUANCE

Europe & Japan
High validation and reuse expectations across global platforms

United States
Alignment with rapidly evolving OEM software strategies

Southeast Asia
Margin pressure and the need for modular, cost-efficient software reuse

IMPACT

Higher defect rates, increased rework, margin compression, and growing dependence on OEM-driven software roadmaps.

Mobility operators and fleet technology leaders

COMMON CHALLENGES

Fragmented and inconsistent vehicle data across fleets. Fleets spanning multiple OEMs, powertrain types, and telematics platforms generate data in incompatible formats and protocols. Without a unified layer to normalize those signals, cross-fleet analysis breaks down, leaving operators to react to events rather than anticipate them.

Rising downtime and maintenance costs. Traditional time and mileage-based maintenance schedules weren't built for software-defined vehicles or EV powertrain variability. Gap between scheduled service and the actual condition of components is where downtime and costs accumulate, and most operators lack the tools to close it.

Limited visibility - vehicle health, battery performance, and component degradation. Most operators can monitor fault codes, but few have telemetry depth or analytical capabilities to accurately track battery degradation, thermal history, & component wear. Without that visibility, maintenance is reactive, replacement cycles are poorly timed & range reliability is hard to guarantee.

Expanding cyber risk across vehicles, charging infrastructure, and cloud platforms. The attack surface now spans vehicles, charging networks, fleet platforms, and cloud infrastructure. Every integration point is a potential entry vector, and a breach means more than data loss; it means operational disruption and safety risk. Most fleets are still building posture to govern it.

REGIONAL NUANCE

United States & Europe
Large mixed fleets with complex regulatory requirements

Japan
High expectations for uptime and operational predictability

Southeast Asia
Dense urban mobility, shared fleets, and high utilization intensity

IMPACT

Reduced fleet efficiency, unpredictable operating costs, and constrained scalability of new mobility services.

Technology and ecosystem partners

COMMON CHALLENGES

Fragmented integration standards across OEMs and regions. No single integration standard exists, and none is emerging. Every OEM brings different middleware, protocols, and certification requirements. Regional frameworks add further variation. For technology partners, what works for one program rarely transfers to another, and compatibility costs compound with every new engagement.

Growing demand for automotive-grade, secure-by-design AI solutions. Demand for AI across the vehicle stack is outpacing the industry's ability to deliver it to automotive-grade standards. ISO 26262, UN R155, and deterministic embedded constraints are fundamentally different from enterprise AI contexts, and OEMs expect production-ready solutions, not research-grade prototypes.

Difficulty aligning roadmaps with rapidly evolving SDV architectures. SDV architectures are diverging, not converging. Centralized, zonal, and hybrid transitions are all in play simultaneously across different OEMs. Partners who couple too closely to a single architectural direction risk stranded investments, making interoperability and abstraction strategic necessities rather than design preferences.

IMPACT

Slower ecosystem innovation and missed opportunities to scale the differentiated solutions globally.

Why the current automotive baseline falls short

The expansion of ADAS, connectivity, infotainment, and electrification has driven software complexity beyond the limits of legacy, hardware-centric vehicle architectures. Tightly coupled hardware and software lifecycles and late-stage integration no longer scale safely, economically, or predictably.

Cybersecurity has become a systemic concern in every region. Vehicles now operate as continuously connected platforms, interacting with cloud services, mobile applications, charging infrastructure, and third-party ecosystems. Each connection increases the attack surface, making cybersecurity a core business risk rather than a technical afterthought.

These challenges are compounded globally by shortages of AI, software, and cybersecurity talent. Across mature and emerging markets alike, traditional development approaches struggle to meet time-to-market, cost, and quality expectations. Platform-based architectures, software reuse, automation, and security-by-design are no longer optional but foundational.

The conclusion is consistent across regions: the industry needs a new baseline purpose-built for intelligence, security, and software-driven engineering.

The new automotive baseline

The intelligent, secure, and software-ready vehicle establishes a foundation for continuous innovation while controlling complexity and risk. This baseline is defined by four principles:

Intelligent: AI-driven systems that learn from real-time vehicle, sensor, and fleet data

AI-tested: Production-grade AI validated across edge and cloud environments

Software-defined – Architectures that decouple hardware and software lifecycles

Secure: Cyber-resilient systems designed end to end

UST enables automotive organizations worldwide to design, build, and secure next-generation vehicles using AI-driven insights, predictive analytics, and cyber-resilient architectures, from ECU to the cloud, while meeting regional safety, regulatory, cost, and operational requirements.

Value delivered by the new baseline

Performance and safety
AI-enhanced decision-making improves driving assistance and system reliability

Speed to innovation
Faster deployment of ADAS and AI-enabled features through software updates

Customer experience
Adaptive, personalized in-vehicle interactions across markets

Operational efficiency
Reduced downtime and lifecycle cost through predictive, data-driven operations

This value applies equally to premium vehicles in Europe, large-scale platforms in the US, reliability-focused programs in Japan, and cost-sensitive, high-volume mobility solutions in Southeast Asia.

Core capabilities that enable the baseline

- **Advanced Driver Assistance Systems (ADAS)** AI-driven perception, sensor fusion, and decision-making improve active safety and support autonomy roadmaps. Modular ADAS architectures enable reuse and selective feature deployment, supporting diverse regulatory, cost, and maturity requirements across regions.
- **ML model development (edge and cloud)** Scalable ML pipelines support coordinated development and deployment across ECUs, domain controllers, and cloud platforms. Edge-optimized models enable real-time decision-making in all markets, while cloud learning supports continuous improvement across global fleets.
- **Digital twins for performance optimization** Digital twins enable simulation-driven engineering across vehicle platforms and regional conditions, supporting earlier validation, faster localization, and lower development risk across climates, road environments, and usage patterns.
- **Predictive maintenance and fleet analytics** AI-driven analytics transform vehicle data into operational intelligence, reducing downtime and total cost of ownership for fleets worldwide — from commercial vehicles in the US and Europe to shared mobility and logistics fleets in Southeast Asia.

Business impact

Adopting the new automotive baseline delivers measurable value across engineering, production, operations, and customer experience:

- Accelerated SDV and AI adoption through decoupled hardware–software lifecycles
- Improved safety, security, and trust across vehicles, data, and digital services
- Reduced development and operational risk via secure-by-design and AI-tested systems
- Scalable global platforms with regional adaptability, balancing standardization and localization

This approach enables OEMs and mobility providers to operate efficiently across the US, Germany, Sweden, Japan, and Southeast Asia without fragmenting core platforms.

UST as a long-term innovation partner

The automotive baseline has shifted. Leadership depends on how intelligently and securely vehicles are built as software platforms. UST partners with OEMs, Tier-1 suppliers, mobility operators, and ecosystem stakeholders to accelerate innovation and deliver engineering solutions that improve speed to market across the full vehicle lifecycle — from architecture modernization and AI integration to cyber resilience and scaled regional deployment.

UST empowers clients to move rapidly from concept to scalable delivery, reducing time-to-market and risk with proven engineering patterns, robust platforms, and end-to-end execution support across eight capability areas:

Architecture and migration
UST accelerates SDV transformation by defining target architectures for ECU, domain, zonal, and cloud environments; establishing integration boundaries; and executing phased legacy migration strategies designed to minimize program disruption and downtime.

Platform engineering
UST reduces development cost and cycle time by building modular, reusable software platforms — including middleware, services, data pipelines, and observability tooling — engineered for deployment and reuse across multiple programs and OEM relationships.

AI lifecycle across edge and cloud
UST improves in-vehicle and fleet intelligence by establishing data strategies, streamlined model development and validation workflows, and continuous update mechanisms — enabling production-grade AI across resource-constrained edge systems and cloud learning environments simultaneously.

Safety and compliance
UST supports evidence-based engineering and end-to-end traceability for safety and cybersecurity requirements, reducing liability exposure and simplifying certification audits across ISO 26262 and regional homologation frameworks.

Cyber-resilient design and operations
UST reduces systemic risk by embedding security-by-design from the earliest architecture decisions — including threat modeling, secure interface design, OTA hardening, and identity management — aligned with ISO/SAE 21434, UN R155, and R156 requirements.

Regional adaptability
UST implements variant and configuration strategies that address regional regulations, connectivity standards, cost targets, and operational constraints — enabling core platforms to scale consistently across mature and high-growth markets without architectural fragmentation.

Validation at scale
UST accelerates the verification and validation through simulation, SIL (Software-in-the-Loop) and HIL (Hardware-in-the-Loop) strategies, automated regression testing, and AI-aware test coverage — compressing validation timelines without compromising automotive-grade rigor.

Program delivery
UST strengthens delivery teams with cross-disciplinary expertise spanning validation, engineering, cybersecurity, and operations — providing the depth and continuity needed to sustain complex, multi-release programs across global markets.

UST combines global scale with regional delivery precision to help automotive organizations industrialize software-defined and AI-enabled mobility — reliably, securely, and consistently.

Build the future of mobility with UST: ust.com/en/automotive-solutions

Together, we build for boundless impact

Since 1999, UST has worked side by side with the world's best companies to make a powerful impact through transformation. Powered by technology, inspired by people, and led by our purpose, we partner with our clients from design to operation. Our digital solutions, proprietary platforms, engineering, R&D, products, and innovation ecosystem turn core challenges into impactful, disruptive solutions. With deep industry knowledge and a future-ready mindset, we infuse expertise, innovation, and agility into our clients' organizations—delivering measurable value and positive lasting change for them, their customers, and communities around the world. Together, with 30,000+ employees in 30+ countries, we build for boundless impact—touching billions of lives in the process.

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