SDV: Closing the Loop

IBM's perspective on capturing business value from vehicle data

At a Glance

01 As passenger cars and commercial vehicles become increasingly intelligent and connected, vast volumes of real-world data are generated and flow throughout the entire vehicle lifecycle.

02 IBM sees significant opportunity in using this data across the automotive value chain — in both upstream and downstream functions. Value can be realized by operationalizing vehicle data in research, engineering, quality management, warranty management, supply chain, marketing, sales, and aftersales.

03 Advancing software-defined vehicle (SDV) capabilities results in richer vehicle data sets and therefore expands the ceiling of the value that can be realized. However, capturing the maximum possible value depends on the ability to harness and operationalize that data across the enterprise. Automakers that treat vehicle data as a strategic asset will improve both customer lifetime value and vehicle lifetime value and gain operational efficiencies.

04 IBM offers an integrated value proposition spanning data strategy, data transformation, data architecture, data analytics, data governance, security, AI, and hybrid cloud technologies — helping automotive companies advance SDV maturity and turn vehicle data into measurable business outcomes.

Capturing Value from Vehicle Data

After more than a century defined by mechanical engineering and hardware excellence, automotive value creation is shifting toward software, connectivity, artificial intelligence (AI), and data. Vast volumes of real world data now flow throughout the entire vehicle lifecycle—from production and operation to service, customer use, and eventually resale or recycling. This creates a data ecosystem that, if collected, processed, harnessed, and operationalized effectively, can transform how OEMs (automotive original equipment manufacturers) design products, run their businesses, and engage customers.

Two complementary value pools are emerging:

- Downstream value, where SDV data enhances sales, marketing, aftersales, and customer experience—driving higher conversion, retention, and new digital revenue streams.

- Upstream value, where SDV data improves engineering, technical development, manufacturing, quality, and supply chain—reducing costs and increasing operational efficiency.

Together, these value pools form the foundation of the modern SDV business case. OEMs that integrate SDV data across these functions gain significant advantages in profitability, customer loyalty, and organizational agility—critical in a market with stagnant sales and intensifying competition.

In this paper, SDV data refers to all data produced by the software defined vehicle. This includes internal vehicle data (such as sensor signals, diagnostic information, battery data, onboard logs, telemetry, maintenance records), connectivity and communication data (V2X - vehicle to everything exchange data), usage or consumer data (driving profiles, infotainment and comfort system usage, navigation and location data, driving behavior, telematics, and smart city services) and aftersales and ecosystem data (workshop records, charging history, long term battery health).

Downstream Value

Today, most major OEMs make more than 80% of their revenue from physical product sales—vehicles and aftersales parts. But SDV and CASE (Connected, Autonomous, Shared, and Electric) trends are reshaping this mix. The product improves over time through over-the-air (OTA) updates, enabling new business models such as in-car transactions or Functions on Demand. At the same time, electrification is reducing aftersales revenue as electric vehicles (EVs) require less and simpler maintenance.

Industry executives predict that by 2035, 51% of revenue will come from recurring digital and software sources, with most of it generated after the initial sale. Selling a vehicle marks the start of a long-term customer journey, with spending spread across a usage period that often spans a decade.

OEMs must capitalize on these emerging opportunities, and vehicle-generated data will be central to improving the efficiency and performance of downstream functions across sales, marketing, service, and customer engagement.

Marketing and Sales
Automotive sales and marketing are increasingly digital and omnichannel. Vehicle data adds continuous, real-world insight into how customers use vehicles and features over time—something traditional sales or transactional data cannot provide. This enables OEMs to better understand customers and use these insights to refine trim structures, personalize marketing, tailor pricing, and ultimately increase sales conversion.

Aftersales
SDV data enables a growing portfolio of post-sale value creation:

- Data-driven repair and maintenance: SDV data provides continuous visibility into vehicle health and usage, enabling condition-based service and early issue detection. Predictive insights allow OEMs to identify problems sooner, resolve many issues remotely, and diagnose required repairs in advance. This improves parts planning, optimizes workshop capacity, increases first-time fix rates, and reduces downtime, unnecessary visits, and warranty or recall costs.

- Finance and Insurance (F&I): Usage-based insurance models adapt premiums to actual driving behavior. Integrating F&I into digital purchase and ownership journeys enables seamless pay-per-mile coverage, flexible warranties, and other personalized protection products powered by partnerships or in-house analytics.

- Customer care and loyalty: In-car and in-app onboarding features support new owners, while connected apps sustain engagement with reminders, updates, and personalized offers. CRM systems enriched with SDV data enable proactive outreach, timely service booking, tailored upgrades, and loyalty rewards—boosting retention and lifetime value.

- Accessories and personalization: SDV insights into customer usage and preferences support targeted development of brand-specific accessories, personalization packages, and high-margin seasonal offerings (e.g., wheels and tires), expanding profit pools and reinforcing brand affinity.

- Used cars and CPO (Certified Pre-Owned): Rich vehicle-level data strengthens used-car valuations, improves certification accuracy, increases buyer trust, and enables new data-driven CPO services.

- Battery lifecycle management: For EVs, SDV and battery data enable precise evaluation of degradation, remaining useful life, second-life potential, and emerging issues. These insights support warranty decisions, service planning, recycling strategies, and residual-value modeling.

Together, these capabilities transform aftersales into a data-driven, software-enabled lifetime value engine—expanding recurring revenue, improving customer satisfaction, and converting every vehicle and every interaction into a strategic, profitable opportunity.

Upstream Value

The shift toward software-defined vehicles is redefining upstream value creation across engineering, manufacturing, quality, and operations. While SDV discussions often focus on digital services, the largest economic returns from SDV data emerge upstream—through cost efficiency, faster learning cycles, and improved capital allocation.

SDVs replace the traditional "sell-and-forget" model with a continuous, data-driven lifecycle where real-world vehicle data becomes a strategic resource for innovation and operational excellence.

Historically, OEMs relied on workshop feedback, warranty claims, and limited field reports—often discovering issues only after they reached scale. With SDV connectivity, manufacturers now gain fleet-wide visibility into how components, software modules, and systems perform in real-world conditions.

IBM perceives SDVs as enablers of a bidirectional, closed loop flow of information. Real time vehicle data provides unprecedented visibility into system performance in the field, and feeding these insights back into engineering, manufacturing, and quality creates a true end to end view. This closed loop forms the foundation of indirect monetization—the use of SDV data to optimize internal value chains.

Research and Development (R&D) and Engineering

SDV data closes the gap between how vehicles are designed and how they are actually used. Feature-usage insights help prioritize engineering requirements based on real customer behavior rather than legacy assumptions, while fleet-level telemetry enables refinements such as improving drive-unit performance and optimizing thermal management.

SDV data provides a live view of component performance, feature activation patterns, edge-case conditions, and system interactions across millions of real-world miles. This improves simulation and validation accuracy, supports smarter architectural decisions, and increases platform reuse—reducing cost and accelerating innovation.

Manufacturing, Quality and Warranty

SDV data enables early identification of fault patterns, software-induced errors, and edge-case conditions that would have gone unnoticed in traditional testing. Engineers can perform root-cause analysis using fleet-level insights, isolate problematic modules, and deliver targeted updates across the affected population. In parallel, manufacturing teams can use this data to refine production processes, improve calibration accuracy, and prevent similar issues from entering the line.

By embedding SDV data into quality and manufacturing workflows, OEMs shift from one-time problem correction to continuous improvement. This reduces warranty and recall exposure, minimizes plant disruption, and strengthens long-term reliability across the fleet—delivering meaningful upstream value while improving customer trust in the brand.

Supply Chain

Forward-leaning OEMs are starting to use fleet telemetry to improve parts planning and supplier oversight. Real-world performance data—such as actuator duty cycles, thermal loads, or software module error rates—can reveal when a part is over- or under-specified. This enables more accurate forecasting, smarter inventory strategies, and better alignment between engineering needs and procurement decisions.

SDV data also enhances supplier management. By monitoring the performance of software modules across the fleet, OEMs gain objective evidence to support make-versus-buy decisions and evaluate supplier quality. Continuous validation of supplier updates ensures that changes made outside the OEM's four walls meet reliability and safety standards before reaching customers.

Integrating SDV data into supply-chain operations strengthens negotiation leverage, reduces dependency risks, and creates a more resilient and efficient value chain. With clearer visibility from field performance back into sourcing and planning, OEMs can build supply networks that are not only cost-effective but also responsive to the real demands of the vehicle fleet.

Prerequisites

SDV data offers tremendous opportunities for automakers, but business impact depends on the quality, availability, completeness, and consistency of the underlying data sets. These attributes are determined by the strength of SDV architectures and platforms, as well as the ability to access, manage, govern, harness and operationalize data at scale.

IBM sees four dimensions that determine an OEM's ability to effectively capture value from vehicle data:

Essential SDV capabilities
To enable essential SDV capabilities such as connectivity, OTA updates, AI driven diagnostics, and personalized interactions, OEMs must modernize their E/E (Electrical/Electronic) architecture, software architecture, and underlying technology stack—including hybrid cloud, data platforms, and AI platforms. They must also adopt DevOps practices and embed security and privacy by design. In general, advancements in this area improve the richness and reliability of vehicle generated data and therefore raise the ceiling of the value that can be captured.

Data access
Given the significant value embedded in vehicle-related data, OEMs need strategies to capture data across their entire fleet and from the broader ecosystem. To maximize fleet coverage, OEMs can incentivize owners to retrofit older vehicles with connectivity and digital capabilities, expanding feature delivery and data collection across a larger share of the installed base. Integrating dealers and independent service providers into the data sharing ecosystem further enhances visibility and enables more complete vehicle histories. Some data-driven applications require access to information beyond an OEM's own fleet, but the variety of proprietary formats and protocols remains a major barrier. Adopting common data standards simplifies aggregation and processing, and enables seamless reuse of data.

Data management and governance
Data management encompasses how OEMs collect, process, and use data securely and efficiently across the enterprise. To make vehicle data usable at scale, OEMs must break down organizational data silos, establish real time data architectures, and ensure data consistency across R&D, manufacturing, supply chain, sales, and aftersales. They must also enforce strong privacy and cybersecurity controls to meet customer expectations and comply with regional legislation. Beyond GDPR and ISO 21434 compliance, OEMs should provide transparent governance and customer centric data controls—especially in privacy sensitive markets like Germany, where data concerns often influence brand loyalty.

Data harnessing and operationalization
Data delivers value only when it is transformed into insight and action. To process and analyze the full breadth of SDV data, OEMs rely on onboard storage, edge and cloud backends, data lakes, and modern data platforms. AI powered technologies—including machine learning, predictive modeling, and generative AI—play a central role in interpreting large, complex data sets and converting them into meaningful, actionable outputs. AI also enhances data usability through automated cleansing, enrichment, structuring, and contextualization, making high volume SDV data easier to integrate with CRM (Customer Relationship Management), PLM (Product Lifecycle Management), ERP (Enterprise Resource Planning), and other enterprise systems.

These are the key prerequisites for turning SDV data into measurable business outcomes. Value emerges only when high quality vehicle data is systematically captured, managed, harnessed, and operationalized across the enterprise. OEMs that invest early in these foundational dimensions will be best positioned to unlock the full business potential of the software defined vehicle.

For more information:

We have detailed the core hardware and software foundations of the SDV, as well as the role of DevOps in unifying software development and IT operations, in our publication "End-to-End DevOps for the Software-Defined Vehicle"

In our "Automotive 2035" study, we highlighted three priority areas for OEMs to stay ahead: using software as a key differentiator, addressing the technical barriers slowing SDV progress, and closing the skills gap by building a software-driven culture across the enterprise.

IBM's Role in Enabling SDV Success

IBM supports clients end to end—defining strategy, designing and implementing technical solutions, leveraging our open-source and AI ecosystem, and ensuring stable, scalable delivery environments. IBM's integrated value proposition is built upon four core elements:

01 First, IBM Consulting brings strategy, business transformation, system integration, and ecosystem orchestration capabilities to help OEMs define and operationalize SDV business models.

02 Second, IBM Technology and Red Hat, provide the open, scalable technology foundation required to run SDV workloads and manage vehicle data securely across cloud, edge, and in-vehicle environments.

03 Third, IBM Institute for Business Value and IBM Research offer unmatched industry insights and scientific depth. The Institute for Business Value conducts systematic analysis of automotive trends, large-scale executive research, and maintains a unique database of industry benchmarks. IBM Research advances foundational technologies—including AI, quantum computing, semiconductors, and cybersecurity— that will shape next-generation SDV architectures and long-term product strategies.

04 Finally, IBM has forged strategic partnerships with leading organizations like AWS, Microsoft, SAP, Adobe, Salesforce, or Palo Alto. Its broader ecosystem includes a diverse network of partners across both information and operational technology. This ecosystem provides OEMs with the flexibility and scale to integrate best-of-breed solutions, adopt open standards, and compete effectively in the increasingly complex SDV landscape.

Together, IBM Consulting, IBM Technology, IBM Research, and IBM's partner ecosystem enable OEMs to navigate SDV complexity, orchestrate partnerships, and capture the full business value of SDV data—across both upstream operational efficiencies and downstream digital revenue opportunities.

Selected examples of how IBM helps automotive OEMs advance their SDV maturity and capture value:

- **Turning SDV data into actionable value** - IBM data and analytics services bring structure, governance, and intelligence to the fragmented "data mess" created by disparate infotainment, telematics, sensor, and backend systems. IBM helps clients (re)define data strategy, build modern data environments, and maintain and evolve their data estate cost-effectively. Watsonx provides unified data governance across cloud, edge, and in-vehicle environments, while IBM's data-fabric and AI capabilities transform raw vehicle data into actionable insights that enhance engineering, quality, operations, and customer experience. IBM's Modern Data Accelerators integrate data science and provide an open-source, cloud-native toolkit for establishing a strong data foundation.

- **Boosting software development efficiency** - IBM helps OEMs mature in-house software capabilities via advisory support and Build-Operate-Transfer models, software factories, DevOps, and AI-driven tools.

- **Hybrid AI architectures for balancing in-vehicle, surrounding edge and cloud intelligence** - IBM offers a secure and scalable foundation for enhancing in-vehicle digital experiences using generative, agentic, and edge AI combined with hybrid cloud capabilities. The watsonx platform enables OEMs to train and govern their own language models, including the open-source Granite model, which can be fine-tuned with vehicle-specific data.

- **Hybrid multi-cloud for integration of vehicle onboard and offboard systems** - IBM helps OEMs integrate onboard and offboard vehicle systems through a hybrid multicloud architecture that deploys applications consistently across all environments and supports rapid over-the-air updates. Red Hat OpenShift and Red Hat Enterprise Linux provide a unified, scalable platform for cloud-native development and hybrid data processing, eliminating silos across the automotive ecosystem.

- **Red Hat In-Vehicle Operating System** (RHIVOS) - is a Linux-based operating system built for automotive workloads.

- **Development, certification, and integration of AAOS** - IBM partners with P3 Group to deliver end-to-end AAOS (Android Automotive Operating System) solutions, from system architecture and frontend adaptation to testing and certification, enabling OEMs to bring high-quality in-vehicle experiences to market faster, with additional enhancements supported by Red Hat technologies.

- **Cybersecurity** - IBM helps OEMs address today's threats by embedding security and privacy throughout the vehicle lifecycle. IBM Quantum Safe further prepares them for future risks related to quantum-capable attacks that may arise within the lifecycle of vehicles being designed today.

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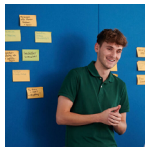
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