The Essential & Case Study for Successful SDV Transition

Process Insights - USA

Craig Brown, Principal Consultant
09/12/2024

Within UL Solutions we provide a broad portfolio of offerings to many industries. This includes certification, testing, inspection, assessment, verification and consulting services. In order to protect and prevent any conflict of interest, perception of conflict of interest and protection of both our brand and our customers brands, UL Solutions has processes in place to identify and manage any potential conflicts of interest and maintain the impartiality of our conformity assessment services.

About Craig Brown
(GM PLM Leader – retired)

More than 45 years of experience in systems engineering and embedded software and the tools needed both in the automotive and aerospace industries; Joined GM in 1995 for controls development

Managed engineering and IT teams, developing tools to improve product engineering; earned the Boss Kettering Award for Remote Diagnostics Patents; lead powertrain simulation & KBE methods

Appointed product life cycle management leader at General Motors in 2012 and helped champion the application of Stages throughout GM

Joined the Method Park Stages team in 2020 to help others apply their knowledge, experiences and practices to the digital enterprises of the future

Published virtual engineering e-books, commentaries and white papers translated into several languages; hosted more than 100 Digital Enterprise Society podcasts; BS Aerospace Engineering - 1981

Agenda

- About UL Solutions
- SDV trends and challenges
- SDV evolution and definition
- SDV needs system-of-systems discipline
- Safest SDV Summary

What makes UL Solutions rise above

- Scientific leadership
- Collaborative partnership
- Deep industry and technical problem-solving expertise
- Comprehensive risk management approach
- Extensive global footprint
- Broad marketplace trust

"In the course of our work, we meet extraordinary people whose companies are having an extraordinary impact on the world and creating the future."

Jennifer Scanlon
CEO and president, UL Solutions

Bringing together more than 20 years of combined industry excellence

KUGLER MAAG CIE by UL Solutions

kVA by UL

methodpark by UL Solutions

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KUGLER MAAG CIE by UL Solutions kVA by UL Solutions methodpark by UL Solutions

Mobility and critical systems

Automotive innovation is all around us — and it’s driven by safety.

Advisory and training

Our comprehensive advisory and training services for functional safety, autonomy safety, Automotive SPICE®, AUTOSAR, cybersecurity, vehicle homologation, application life cycle management (ALM) and Agile methodologies help original equipment manufacturers (OEMs) and their suppliers meet the requirements necessary to achieve swift market entry.

Software-intensive, safety-critical training

Pressure for development cycles to shorten while product complexity increases exponentially requires companies to capitalize on newer technology. We help our customers, from requirements definition to verification and validation (V&V) of complex, safety-critical, real-time embedded systems; from blockchain to big data analytics, artificial intelligence (AI), machine learning (ML) and Scaled Agile Frameworks.

Automotive functional safety

We understand the challenges involved in implementing safety-related functions in microelectronics and software.

Our wide range of technical training, consulting and advisory services, based on ISO 26262, ISO/DIS 21448 and UL 4600, the Standard for Evaluation of Autonomous Products, help our customers develop safer automotive systems for:

- Hybrid/electric powertrains
- Semiconductors
- Powertrains
- Body and interior
- Steering and chassis
- Heavy trucks and buses

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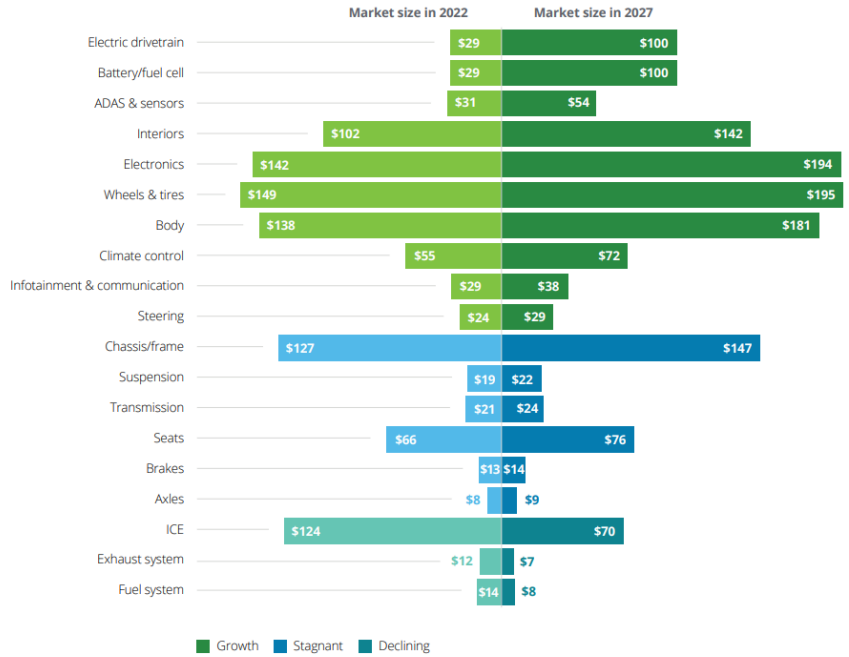
Shift toward electrically powered vehicles with more traffic sensing

More features with continuous deployment

- Embedded software and electronics within electromechanical systems is omnipresent.
- Electrical energy-powered drive units are simpler than internal combustion engines.
- New acceleration/braking performance
- New maneuvers – Collision avoidance
- **Feature upgrades possible without re-manufacturing or service appointments**

Figure 5. Automotive component segment size in $US billions (2022 vs. 2027)



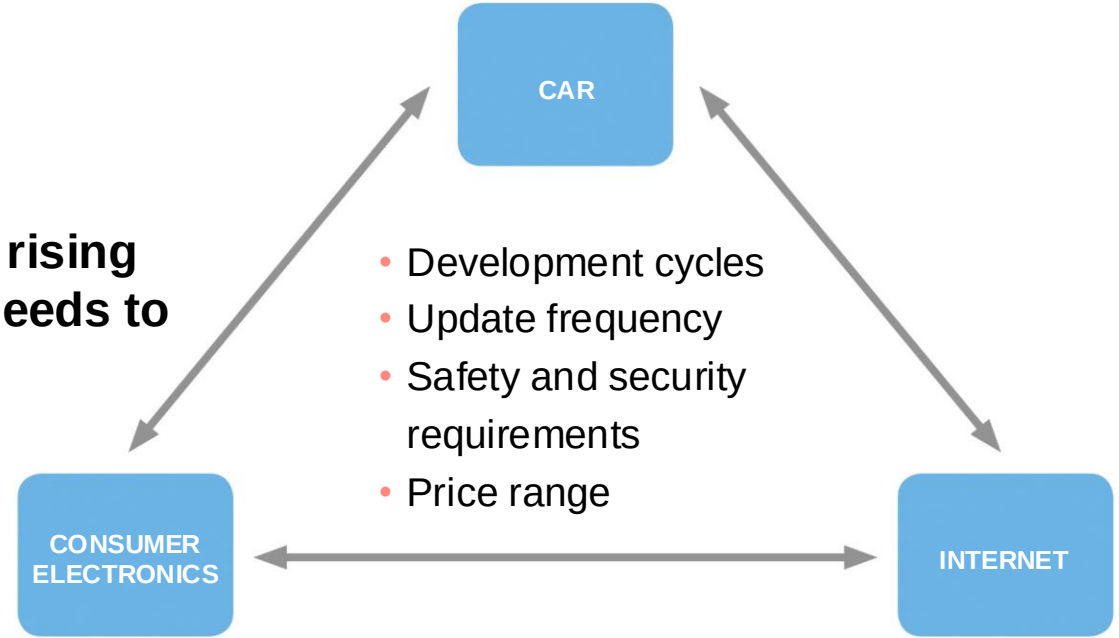
Source: Deloitte analysis of company financials. Source: 2023 Deloitte Automotive Supplier Study

SDV challenges

The automotive industry faces multiple challenges, including autonomous driving, safety, security, electrification, software-driven innovation and vehicle connectivity. None of these challenges can be solved in isolation from the others. They are interconnected challenges that require new thinking about the processes used to develop automotive products.

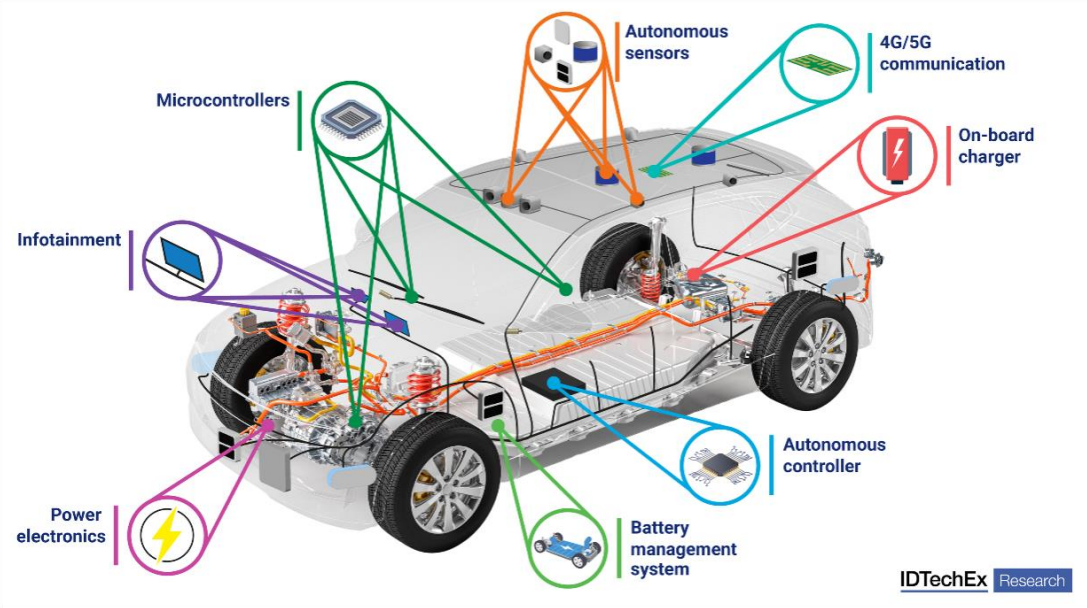
The future environment for automotive electronics development

COLLIDING WORLDS: Dramatically rising complexity needs to be managed.



Transforming mobility product development

Software-defined vehicle



Most electronics have embedded software.

- It can be installed often.
- Features drive revenue.
- Keeps customers satisfied

Mass production with factories is managed in product life cycle management (PLM) and enterprise resource planning (ERP).

Where should embedded software releases be managed?

Source: https://www.prnewswire.co.uk/news-releases/idtechex-says-buying-an-autonomous-electric-car-will-feel-more-like-buying-a-laptop-than-a-car-301851643.html?gclid=EAIaIQobChMI-p&gclid=EAIaIQobChMI-p

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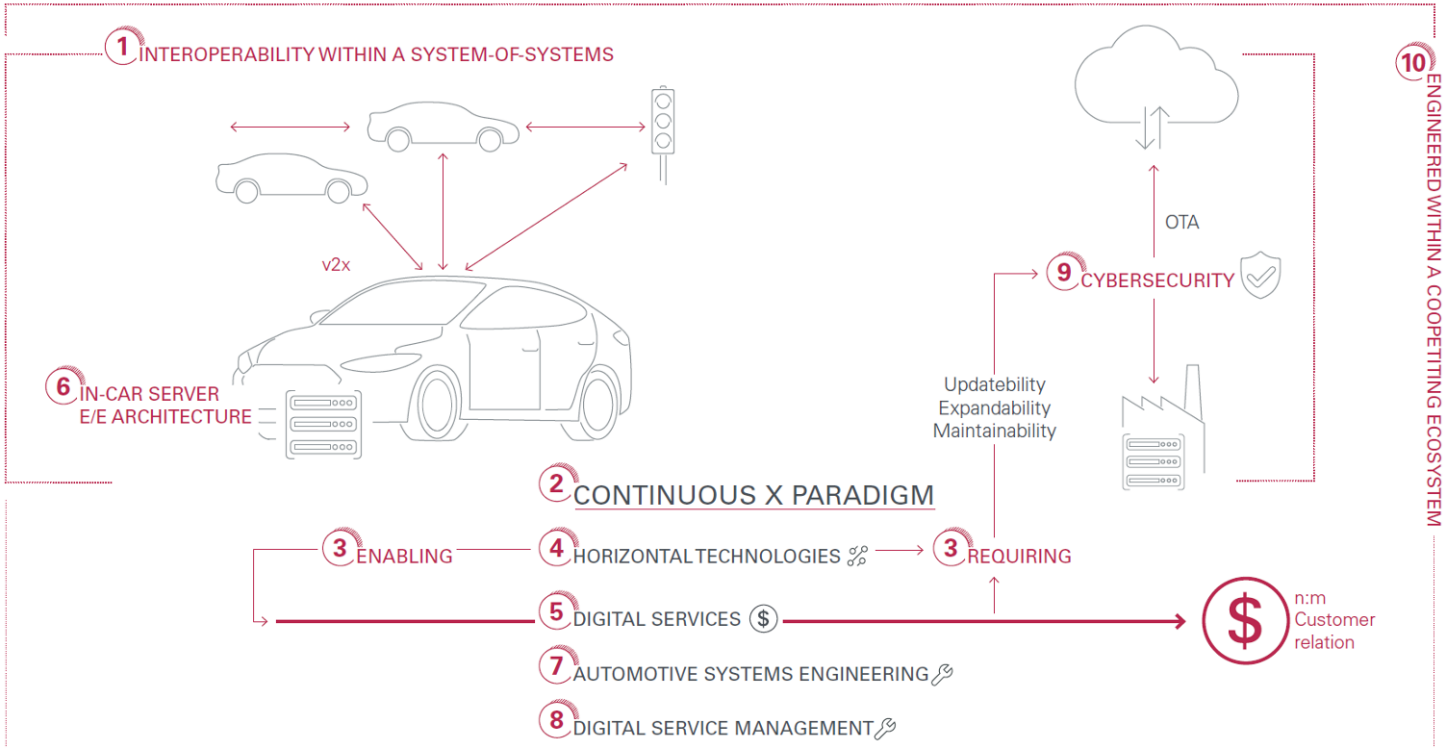
Surviving a system-of-systems environment

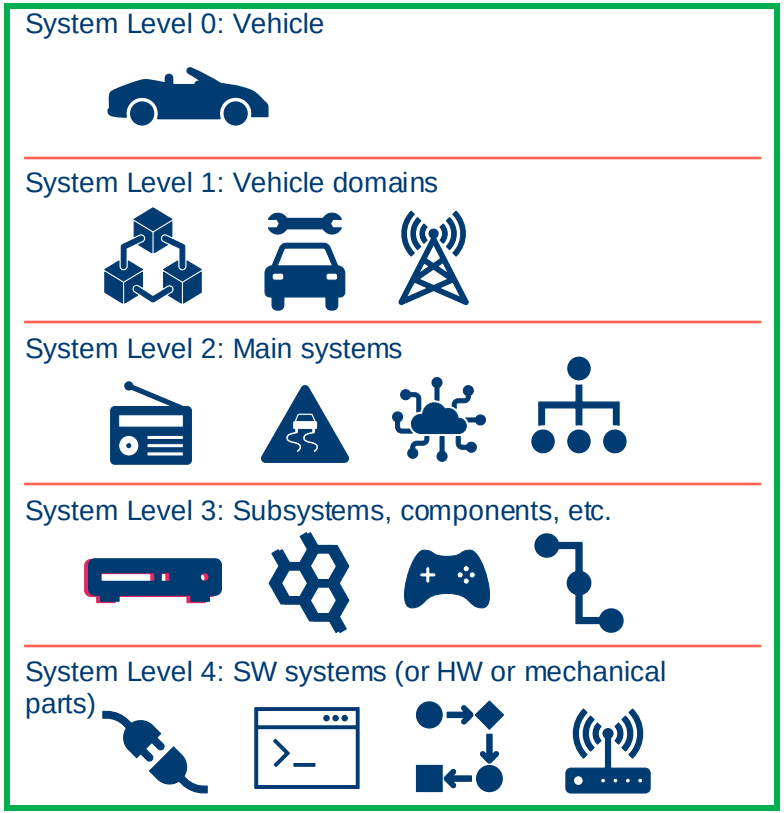
Ten drivers R&D needs to master the software-defined vehicle



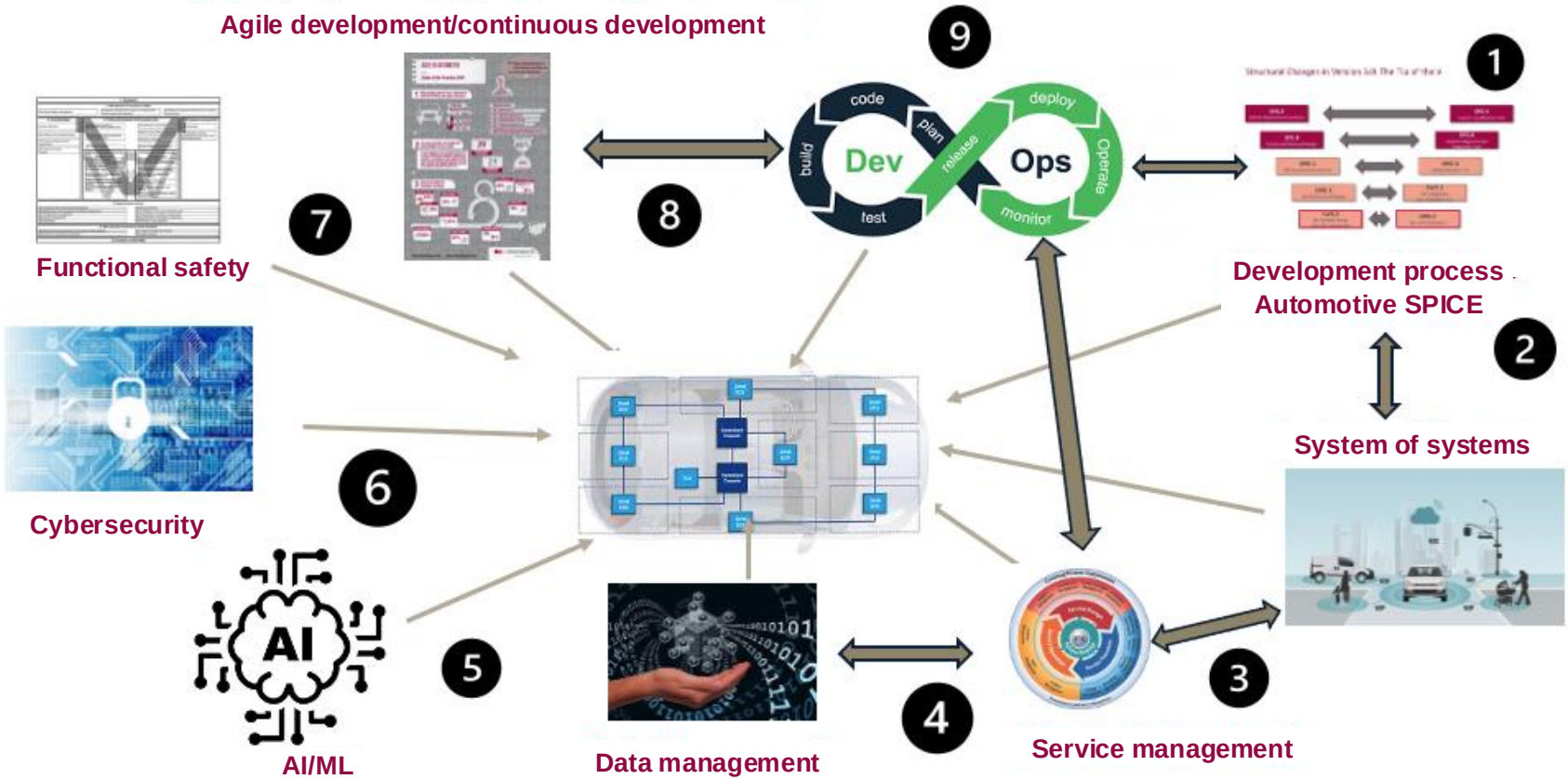
SDV is connected

- Different worlds converge with their respective standards, methods or paradigms
- Embedded electronics control unit (ECU), edge computing (on-vehicle)
- Back-end server on-premise/cloud (off-vehicle)
- Front-end (on-/off-vehicle, mobile app)
- Relevant vs. not relevant for type approval
- Relevant standards need to be applied to mobility solutions
- Automotive SPICE
- Functional safety and safety of the intended functionality (SOTIF), e.g., for advanced driver assistance systems (ADAS)
- Cybersecurity management system
- Software update management system

Service orientation management is a key systems view



SDV must manage all these technologies?



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Stages Product Development Process Motivation

Orchestration of Simultaneous Workstreams

- Need to Synchronize Work
- Co-existence of stage/gate, waterfall, agile, product line engineering processes
- Seeing the incremental earned value
- Managing Compliance to Regulations
  - Certification measures
- Assuring Compliance with Standards
  - How, who, practices producing evidence

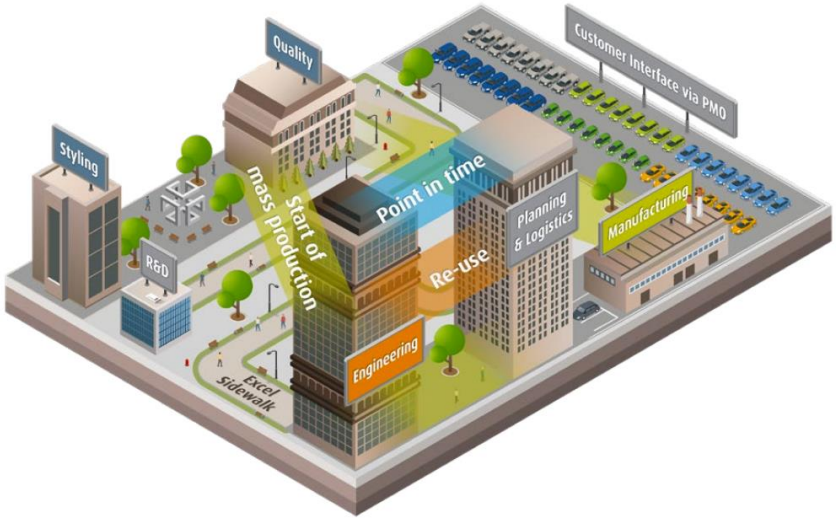
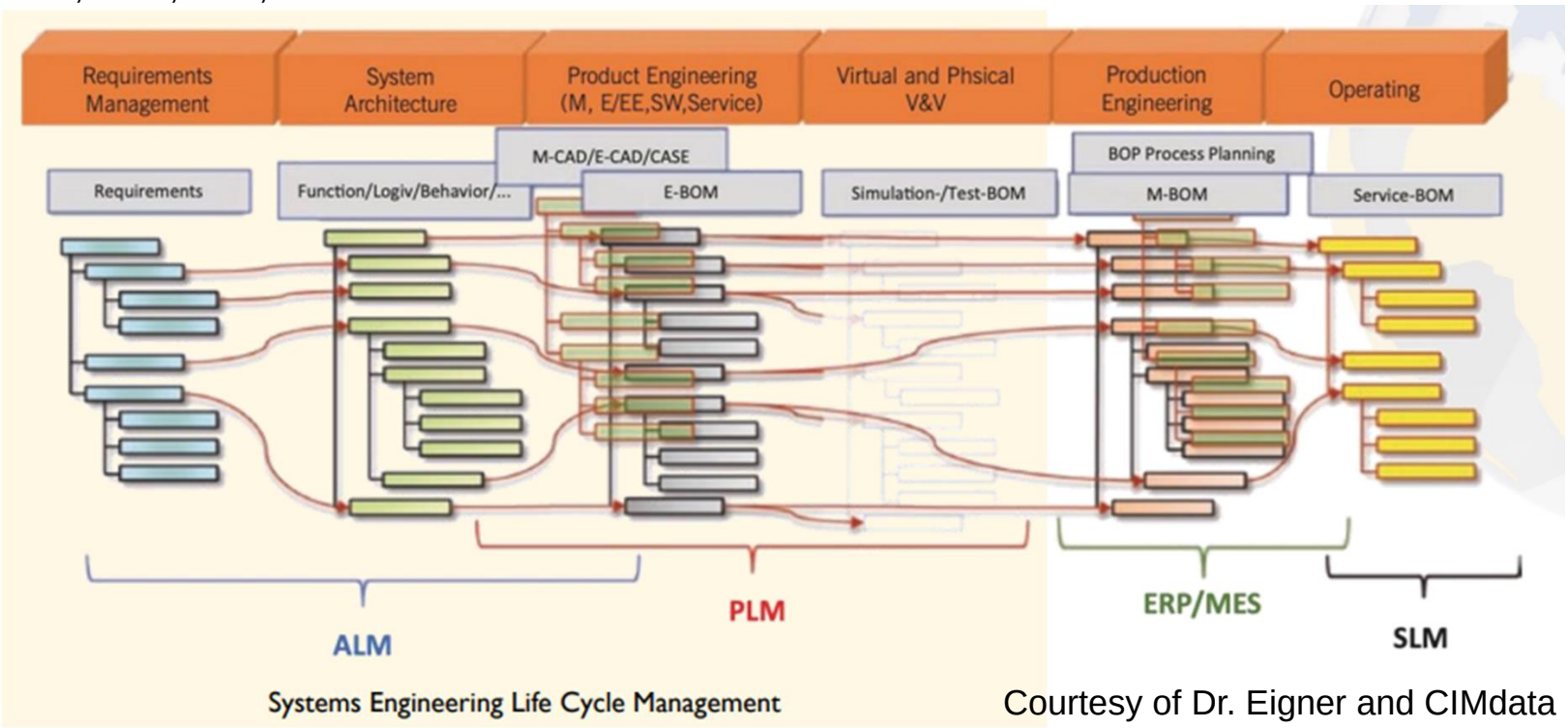


Figure 1: Technology silos of experts, connecting organizations at decision points

Orchestrating automotive product development and operations | Method Park

Mobility and Critical Systems Product Life Cycles

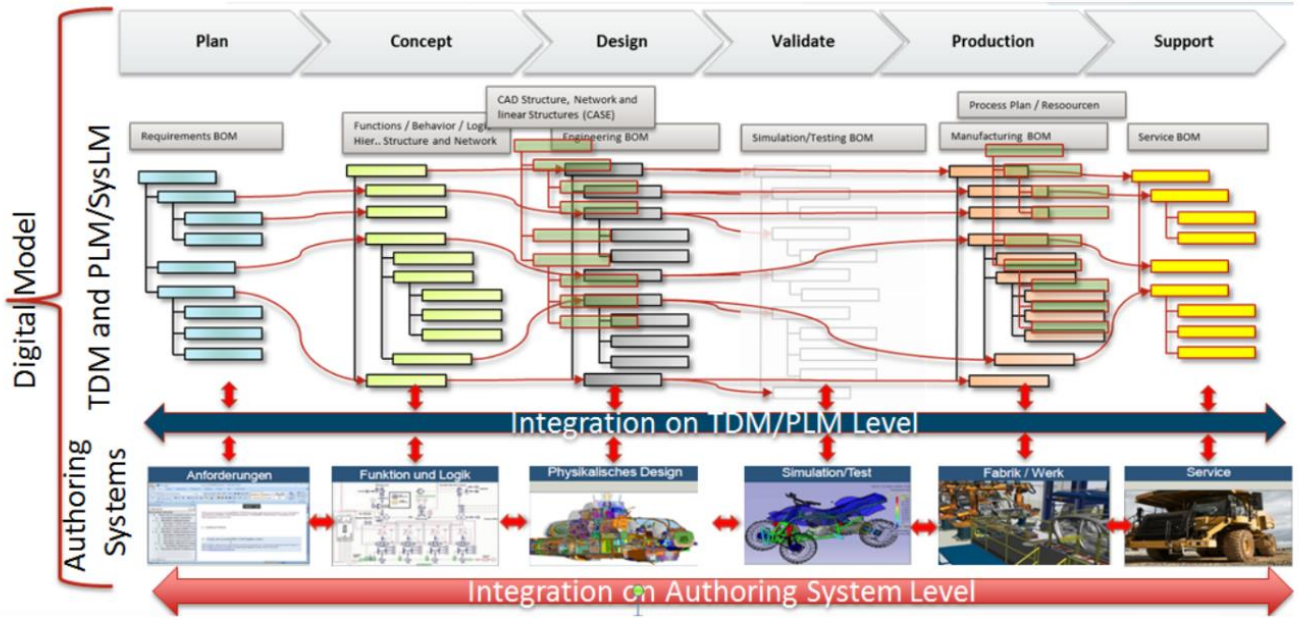
ALM, PLM, ERP, MES and SLM



Courtesy of Dr. Eigner and CIMdata

Product Life Cycles Need Integration

Dr. Martin Eigner defines System Lifecycle Management



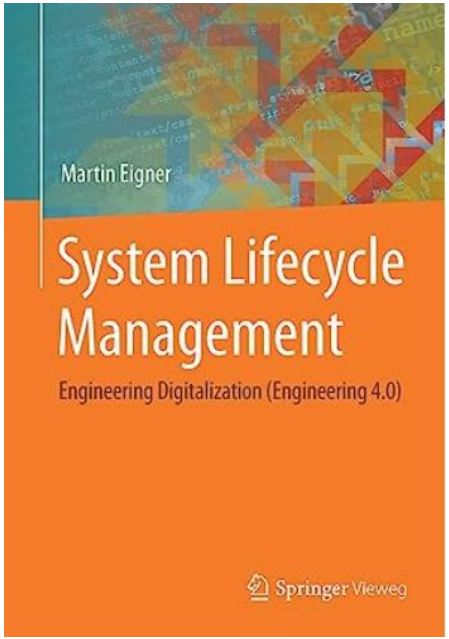
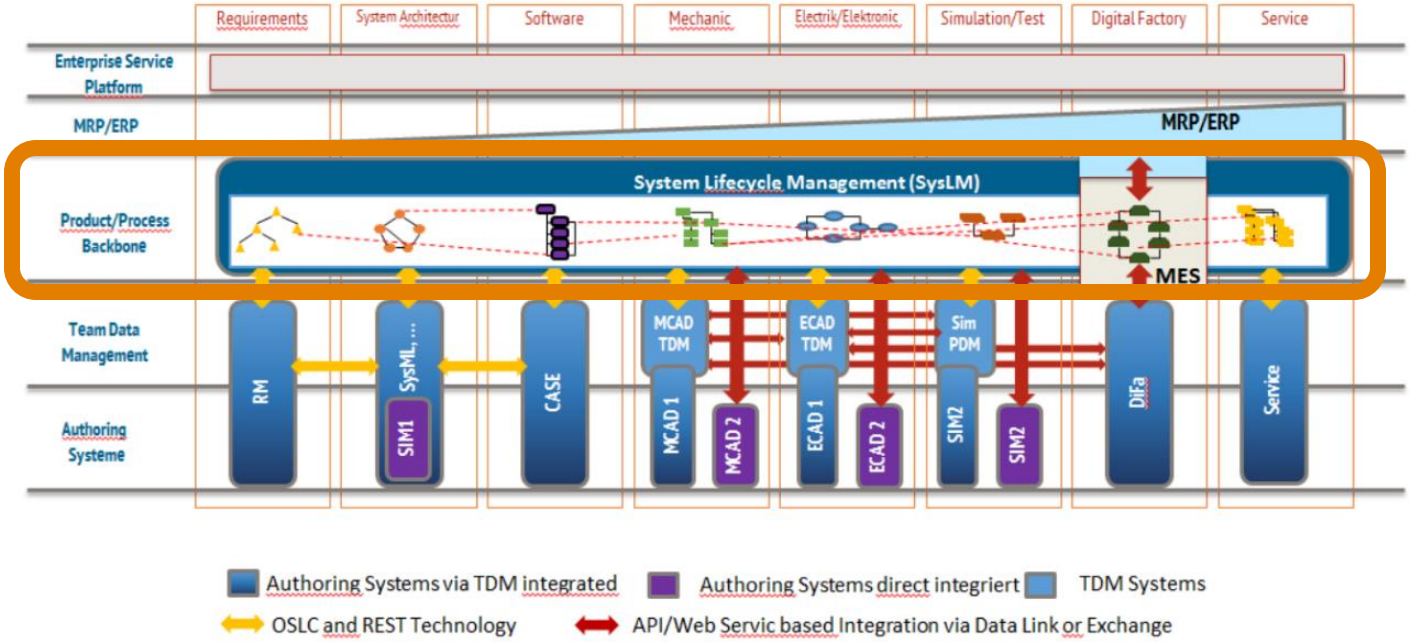


Figure 1: The digital model distributed along the product life cycle to authoring systems, Team Data Management (TDM) and SysLM Backbone

SDV Needs Orchestration Across Systems Life Cycles

ALM, PLM, Practices need Process Backbone



STAGES enables cross discipline and cross domain decision flows

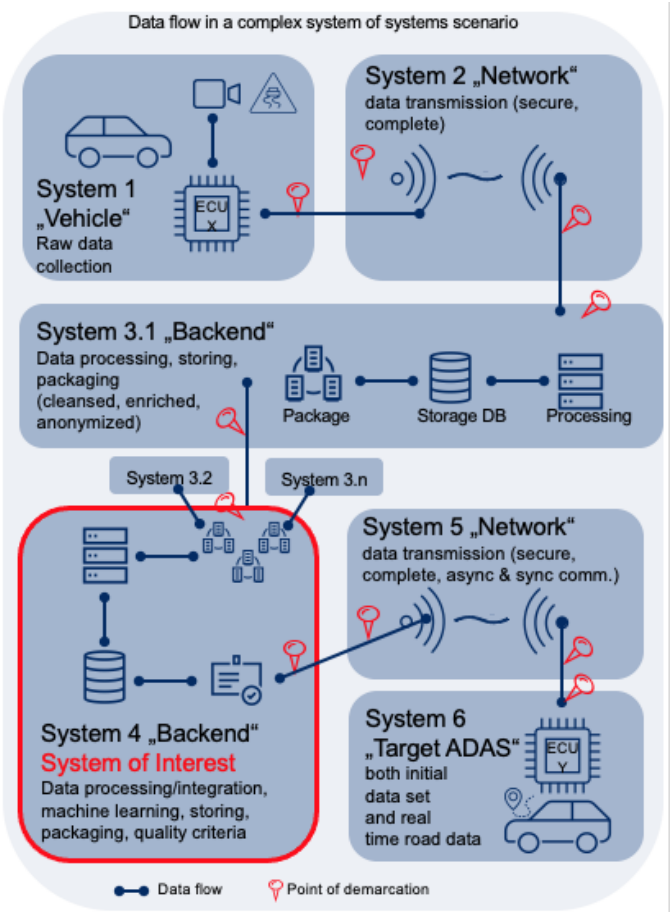
Figure 2: Mapping of the digital model to an IT architecture based on the VDA four-level approach

SDV data management: System of systems

Objective and system of interest (system 4):

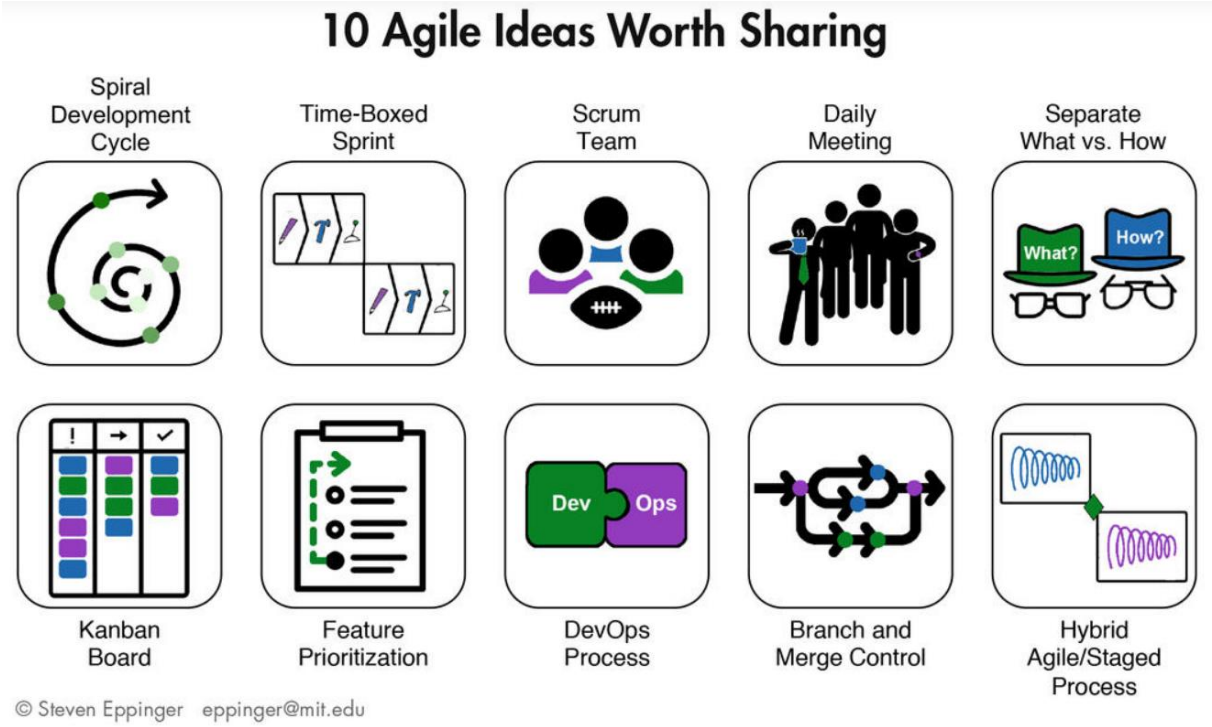
- Tier 1 wants to create high-precision maps that provide real-time data to a vehicle's ADAS.

- **Context:**
  - The serial vehicle collects sensor and camera data, including information about road geometry, lane markings, traffic signals and speed limits (System 1).
  - The data is pre-processed by an ECU in the vehicle and is securely transmitted (System 2) to be processed further by a back-end system (System 3).
  - Different back-end systems deliver data packages (System 3.x) to our system of interest (System 4).
  - This back-end system integrates data packages and identifies events, analyses trends or creates data sets for machine learning systems; it checks data to be sent (System 5) to the potential user of the data, the ADAS (System 6).



SDV needs agile practices across enterprise

Dr. Steven Eppinger @ MIT 10 Agile Ideas Worth Sharing

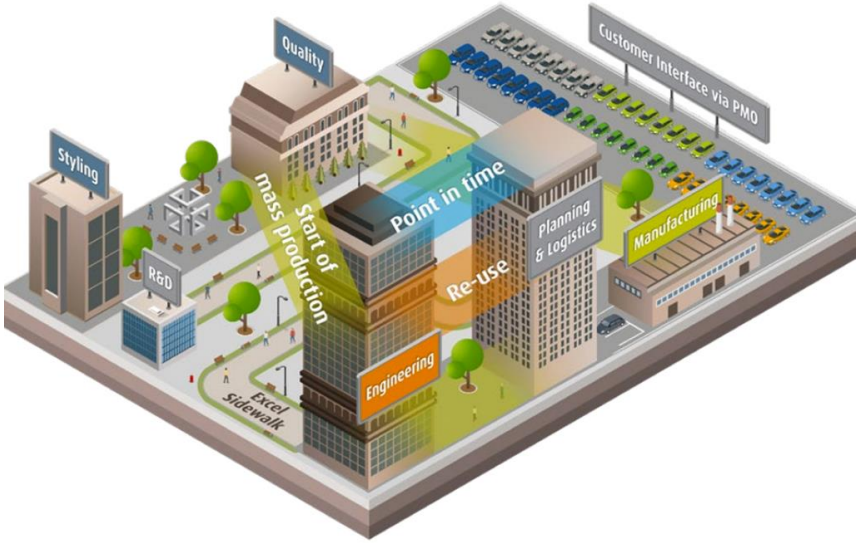


STAGES manages agile process evolution across disciplines and domains, anywhere in SDV the life cycles

Exchanges are happening faster using Agile Principles

Orchestration within a company is accelerating

- **Mass producing** safe, reliable products drove processes
  - Standards exist which help a company assure safety
  - Compliance to these standards needs a process model to clarify contexts
- **Validation processes** become continuous and agile, learning across multiple products
- **Processes** evolve faster with learning
- **Faster SDV changes**, after mass production, requires the same rigor to assure product safety



STAGES enables adaptive processes

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Advancing innovation in safety-critical products

Functional safety, autonomy safety, and safety of the intended functionality (SOTIF)

Evaluation for the performance and safety of electronic and electromechanical systems

Automotive cybersecurity

Holistic security strategies to deploy innovations that connect people and technology

Automotive SPICE, AUTOSAR, process improvement

Process and project support to improve quality and development efficiency

Application life cycle management

Profound expertise in systems and software engineering processes and tool know-how

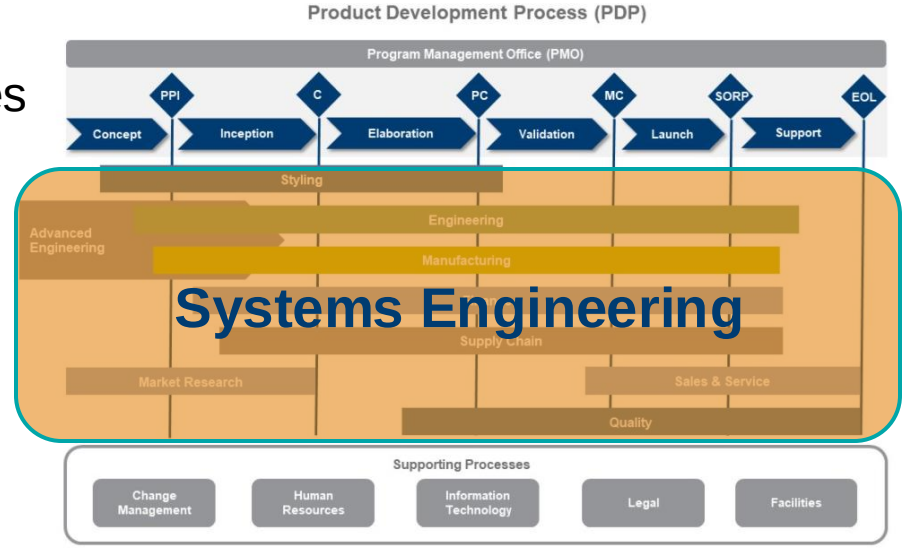
Agile transformation

Agile coaching, engineering and a software platform that accelerates rolling out an Agile process landscape

SDV Functional Safety and Growing Complexity

Successful Companies have Safe Products

- **Customer Feedback and Recalls**
  - –PDP based on decades of experiences
- **Product Complexity is Increasing**
  - –Product regulations follow complexity growth, assuring consumer safety
- **Systems Engineering**
  - –Be aware of all in decision contexts
- **SDV Processes expand Proven Processes**
  - – ….. anything else?



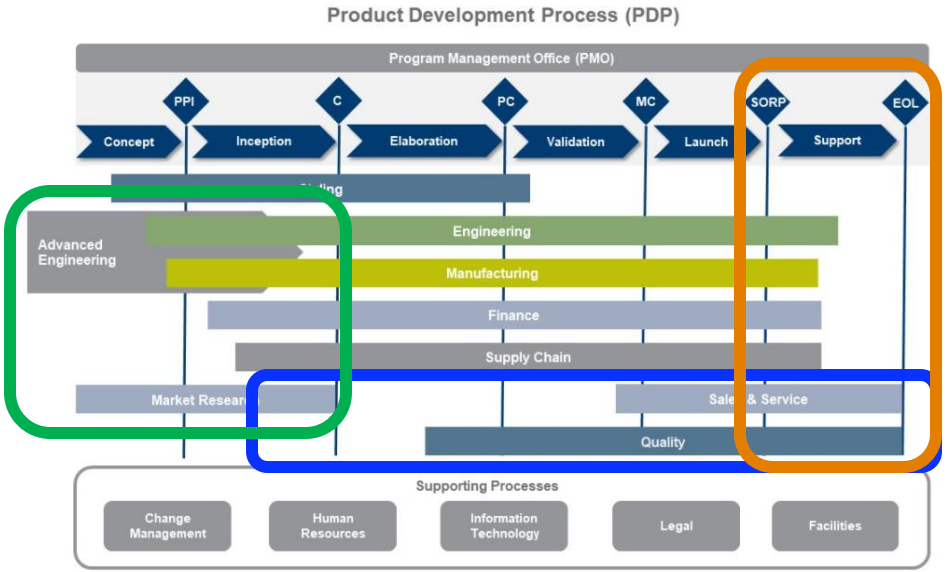
SDV Safe Innovation Requires Trusted Agile Processes

Existing processes should evolve to assure safest SDV

- The future mobility and critical systems challenges are interconnected and have a common denominator:
  – *the **processes** used to manage the products across their lifecycles*.
- Evolving processes need to remain trusted for safety and security
  – While they need to become more agile to cope with the pace of innovation.
- Verification / validation testing and certification must be continuous
  – Affordable with digital models of mechanical and electrical systems
- SDV releases must be managed beyond mass production and show ***traceability***

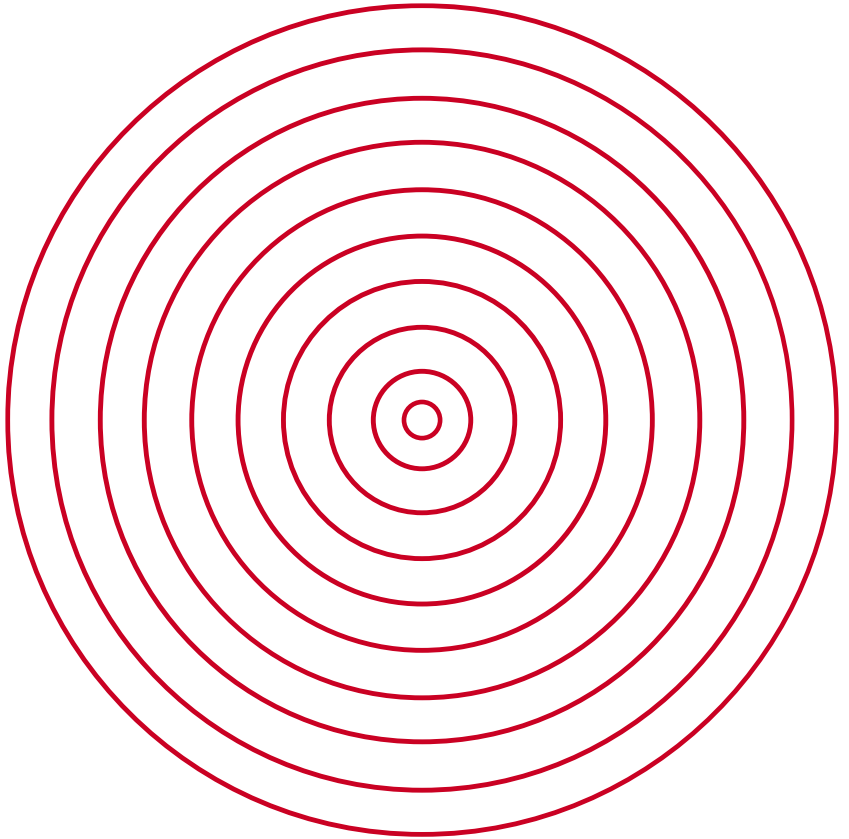
Summary: Successful SDV transitions manage complexity while accelerating product development

- Advanced and systems engineering
  - Embrace safety analysis as a design considerations at the beginning, when technology is introduced.
  - Embrace rigorous experimental methods — the scientific process — to improve technology readiness.
- Quality management evolves beyond statistical process control of mass production
  - Development and operations (DEVOPS) mindset, taking advantage of continuous feedback from customer's product use
  - Continuous V&V, with evolving usage scenarios
- SDV upgrades with SOTIF evidence



Stages enables Agile processes fostering safest SDV innovations

Questions?



Craig Brown
Principal Consultant

UL.com/Solutions

SAFEST SDVS - THE ESSENTIAL & CASE STUDY FOR SUCCESSFUL SDV TRANSITION

Companies developing complex mobility products containing more embedded software are dealing with increasing pressures for innovation, agility, maturity, coordination, and time to market. This evolution is often called the Software Defined Vehicle (SDV).

Historically in mass production companies, the important data items are managed in Product Lifecycle Management (PLM), that cater to mechanical and electrical engineering for both products and their factories. SDV needs Application Lifecycle Development (ALM) tools that cater to software and systems engineering. A “factory” for SDV is performed with Over the Air (OTA) updates, often after mass production, relying on commercial communications instead of capital-intensive factories.

Development pressure fosters thinking and acting in discipline and domain silos, worsening data sharing and knowledge exchanges. More than ever, it is important that ALM and PLM cooperate. They need the orchestration of development activities, which is where Stages comes in. Re-engineering and inventing streamlined processes and information flow across mobility product development lifecycles is necessary. New knowledge from gathered usage data drives system of systems complexity.

This presentation describes benefits of a harmonized ALM, PLM, & process management systems. It points out user/engineer ease is key to success, while turning the systems from a “tool for aid” towards a focal point of applied knowledge and best practices throughout mobility product development. Stages is the tool for managing evolving cross-discipline and cross domain processes bringing safest SDVs to market.