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Source: https://www.sciencedirect.com/science/article/pii/S1877050921002581

Towards a Data-Centric Architecture in the Automotive Industry

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Keywords: Connected vehicles; data-centric architecture; standardized data; semantic AI; modern data architecture

In the last two decades, there has been notable evolutions in the automotive industry, particularly with connected vehicles that increase massively the volume of data to be managed. Various enterprises are actively redefining their data models to enhance data architectures, primarily aiming to improve the support for analytics and artificial intelligence. The paper discusses ongoing research by the BMW Research Department on the design of software architectures and the adoption of standardized data models to establish a data-centric architecture in the automotive sector. A data-centric approach aims to place data at the heart of the organization activity, while a data architecture is all the practices and rules surrounding data in a company.

Modern Data Architecture (MDA) responds to business demands for speed and agility in handling data. MDA involves focusing on key principles: treating data as a shared asset, eliminating data copies, using a flexible unified data model, providing user-friendly interfaces, defining data governance policies, and adopting standards. In the context of vehicle software architectures, adopting standards enhances flexibility, scalability, and data correctness without compromising brand-specific solutions. Each automobile company develops, indeed, its own software architectures to meet specific needs and requirements.

Digital transformation is reshaping industries, necessitating a shift in mindset and a redesign of the overall software architecture for companies to stay competitive. Examples, such as Kodak, shown that ignoring the disruptive change could lead to terrible loss. The Kodak' story serves as a lesson for the automotive industry to recognize the pivotal role of data and analytics. The paper's authors advocate for a digital transformation for the automotive industry that begins with a shared understanding of data and progresses through four stages, transitioning from isolated data silos to a cutting-edge AI factory.

Stage 1 (Siloed data): Limited access to data sources per group in an organization.
Stage 2 (Pilot): Demonstrates analytics value without organizational and cultural changes.
Stage 3 (Data Hub): Redesign architecture to effectively gather and categorize data from various origins.
Stage 4 (AI Factory): Involves establishing a standard operating model for AI, enabling full exploitation of existing data.

In terms of software architectures, companies have traditionally adopted an application-centric paradigm, which however wastes resources. The proposed data-centric paradigm from the authors advocates making data self-describing, with explicit context and adoption of standards. To achieve that, one effective approach involves employing the well-established hierarchy of Data, Information, Knowledge, Wisdom (DIKW), as depicted in Figure 2. The DIKW hierarchy serves as a good foundation for organizing data in a hierarchical structure, which allows better management and utilization of information. Using vehicle data as an example, the DIKW works as follow: from the vehicle sensor observations (data), a structured ontology is created (knowledge), which finally allows to contextualize informed actions (wisdom). The approach aims to enhance data management and utilization in the automotive domain.

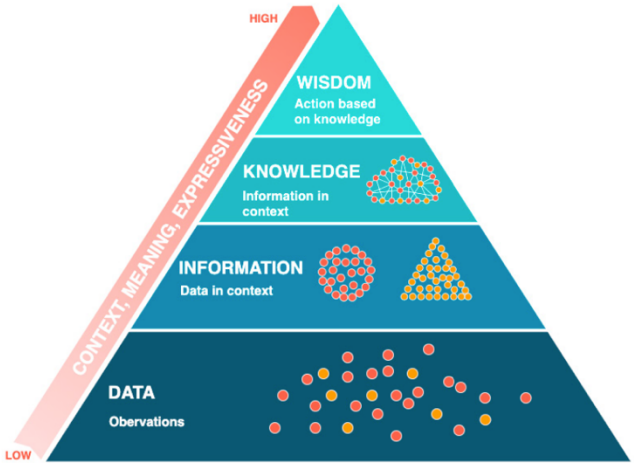

Fig. 2. Data, Information, Knowledge, Wisdom (DIKW) hierarchy [18][19]. Differences between layers are given by the amount of explicit context (i.e., meaning, value, structure, applicability, and expressiveness). Information is defined in terms of domain taxonomies, whereas knowledge covers relationships and interactions between taxonomies from different domains and conceptualize them into a domain ontology.

Conclusion: Adopting modern data architecture is vital for a digital transformation, while unmanaged complexity poses a major obstacle to achieving an AI factory. The authors think that a collaborative approach will be the most successful and that the only way to succeed is to take one step at a time. The foundations of a modern automotive data architecture presented in this document can be applied to facilitate transformation.