Digitalization in automotive and industrial systems

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Abstract - **Autonomous systems are an important part of todays and future solutions for the automotive and industrial sector. The research and development activities to enable high/full automated driving and industry 4.0 have to deal with a lot of new requirements (e.g. fail operational, cyber security), technologies (connectivity over 5G, neuronal networks, future computing platforms) and topics (data analytics, artificial intelligence). Furthermore processes, methods und tools lack behind and need to speed up to cope with all the consequences in validation and verification. The short paper will give an overview over these challenges and the actual state of research and the development in the field of digital autonomous systems.**

Keywords- Agile, Automotive, computing platforms, connectivity, digitalization, Internet of Things, Industry 4.0, LeSS, smart, Vehicle-2-X, 5G. .

I. Introduction

Digitalization is creating opportunities that will change our understanding of mobility and industrial production possibilities. For example the automobile as part of the networked world will not only offer new possibilities for informing and entertaining customers but also lead the way by increasing the automation of comfort and assistance functions, moving toward autonomous vehicles. In the industrial domain the smart connectivity between different production devices.

These innovations will require an ever-faster increase in electronics, software, and communication capabilities. Both the physical architecture and the functional electrical and electronic (E/E) architecture will be the keys to managing the growing complexity. Software quality, remote software updates, in-house software development, and security will become critical success factors. Furthermore the processes, methods and tools, which are used in the development process, are a key factor. New methodologies like agile software development over sprint teams replace the established waterfall model. Over LeSS bigger project settings can be realized over several sprint teams [2].

Here, we discuss the major opportunities resulting from transferring IT, consumer-electronics and new technologies to the automotive and industrial domains especially with focus on autonomous systems (see Fig. 1). For each opportunity, we show the current status and the benefits it could provide. Players from the digital world (for example, Google, Apple, and Amazon) are showing us opportunities and solutions that can be adapt to the automotive and the industrial domains [1].

The formally closed eco-systems in the automotive domain as well as in the industrial domain become more and more part of the Internet of Thing (IoT). Due to that a seamless connectivity with a high quality of service is a very important factor. Security is one of the main design pattern for the future autonomous systems.

II. Digitalization in automotive Systems

Upcoming architectures for vehicular electrics, electronics, communication and software will face – among others - technological challenges driven by strong strategic trends. Those trends – Automated Driving, Artificial Intelligence, Drivetrain Electrification and Connected Systems and Services – are driving increasing system complexity, demanding formal verifiability and semantically rich system integration; and they are driving innovation, requiring new technologies, subsystems and components to be integrated as well as new novel approaches in system integration and operation.

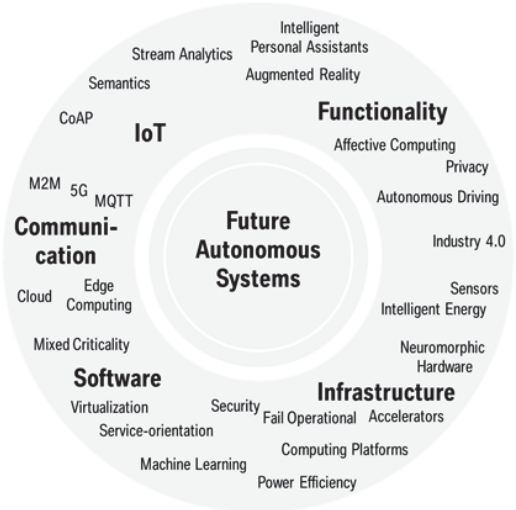

Fig. 1. Main technology fields, which are influencing and enable future autonomous systems in the automotive and industrial domain.

Automation, in particular, not only introduces a plethora of additional sensors, compute-heavy algorithms, and the corresponding load on the vehicle's physical network, but also requires formalized functional safety engineering to a much greater extent than previous vehicle generations.

Moreover, intelligent algorithms not only help automated vehicles drive safely, but artificial intelligence will be making its way into quite every aspect of functional vehicle design with the advent of intelligent personal assistants, affective multi-modal natural user interaction, situational awareness and augmented reality. The vehicle's self-awareness required is further driving architectural design challenges.

Introduction of electrical drivetrains while maintaining or gradually phasing out conventional combustion engines from product line architectures is on the one side of the electrical power coin. On the other side, compute hungry algorithms are also raising questions of power consumption and power dissipation.

Besides, next-generation wireless communication with antenna array placement requirements, as well as questions of information security and privacy are among technological drivers dominating automotive discussions. They are part of the foundation to deliver services and help organize people's mobile lives.

As already mentioned the agile development process are more and more introduced. One of the main challenges is to realize an optimal cooperation of the existing development processes, which are still necessary, and the new development methods.

III. Digitalization in industrial Systems

Solutions in the industrial domain are becoming increasingly intelligent and incorporate more and more software-based applications as well as the ability to integrate embedded functions. Smart products optimize themselves, adapt to external influences, identify themselves and have a digital map in the form of a product key. Integrated sensor technology ensures that processes are transparent and self-diagnosing, thus enabling preventive maintenance. Universal standards and interfaces such as TSN and OPC UA fulfil the requirements for smart products suitable for plug&produce applications and Industry 4.0.

IV. Example: Vehicle2X Communication

One main enabler for digitalization in the automotive domain is the establishment of a seamless vehicle2x communication (V2X). Two technologies, Wifi and Cellular, will be available to enable V2X communications for future digitalized industrial systems.

The Wifi-based V2X Communication technology ITS-G5 (a.k.a DSRC in the US) is a market-ready solution to provide safety-critical V2X communications in a digitalized industrial automotive system, such as road hazard warning, lane-change warning or intersection-collision warning. ITS-G5 is fully integrated in the ETSI ITS architecture providing industry-grade spectrum protection, resilient decentralized channel access, dynamic networking protocols as well as state-of-art security mechanisms.

In 2017, the cellular industry proposed Cellular extension supporting direct V2X communication in full ad-hoc mode. The cellular-based V2X is arising as a compelling technology to support V2X communications. While already providing vertical connectivity via the Cellular infrastructure network, standard extensions have been proposed support horizontal, direct V2V and V2P (Vehicle-to-Pedestrian) communications. A dedicated Slidelink (SL) has been defined for this purpose, and distributed resource allocation specifications have been proposed to provide reliable Cellular V2X communications.

Yet, future digitalized industrial systems are expected to require ultra-reliable and low latency connectivity that neither the current WiFi technology nor even the new Cellular V2X technology can provide. [4].

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