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Trust Management in Autonomous Ecosystem

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What are we talking about?

- Trust Management
- Why We Need the Trust?
- Autonomous System
- Solution for Trust Building
- Concept of Digital Twin

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Introduction (Trust Definition)

Discipline	Definition of Trust
Sociology	Subjective probability that another party will perform an action that will not hurt my interest under uncertainty and ignorance.
Trust in Ecosystem	Trust is a subjective expectation an agent has about another's future behavior based on the history of their encounters.
Trust in Automation	**Trust can be described as "the attitude that an agent will help achieve an individual's goal in a situation characterized by uncertainty and vulnerability.**
Psychology	Cognitive learning process obtained from social experiences based on the consequences of trusting behaviors.

Introduction (Autonomous ecosystem)

- A system using sensors, actuators, control units, and other physical objects to control and protect a physical infrastructure.
- Autonomous ecosystem are the tight integration of and coordination between computation with physical processes.
- Ecosystem include embedded systems and networks to monitor and control physical processes.

- **Future ecosystem will be much stronger in**
- Adaptability, autonomy, efficiency, functionality, reliability, safety, and usability.
- The challenge is the interactions between the embedded computers and the physical processes.
- Need to understand the *joint dynamics* of HW, SW, networks and physical processes.

Why we need the trust?

Connected Cars & Autonomous Vehicles

The current state of Cybersecurity

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Levels of Vehicle Automation

Six levels of vehicle automation have been defined by the Society of Automotive Engineers (standard **J3016**)

L0	Driver only	Conventional vehicle – driver manages all aspects of speed and direction
L1	Assisted	Driver receives support for specialised tasks (e.g. parking)
L2	Partial Automation	Driver receives support for coping with predefined scenarios (e.g. Traffic jam warning and avoidance)
L3	Conditional Automation	Driver can relinquish control to automated system but must be ready to take back control (e.g. Motorway Autopilot)
L4	Significant Automation	Majority of journey may automated by some driver intervention may be required (e.g. Urban motoring)
L5	Complete Automation	Complete end-to-end journey without driver intervention

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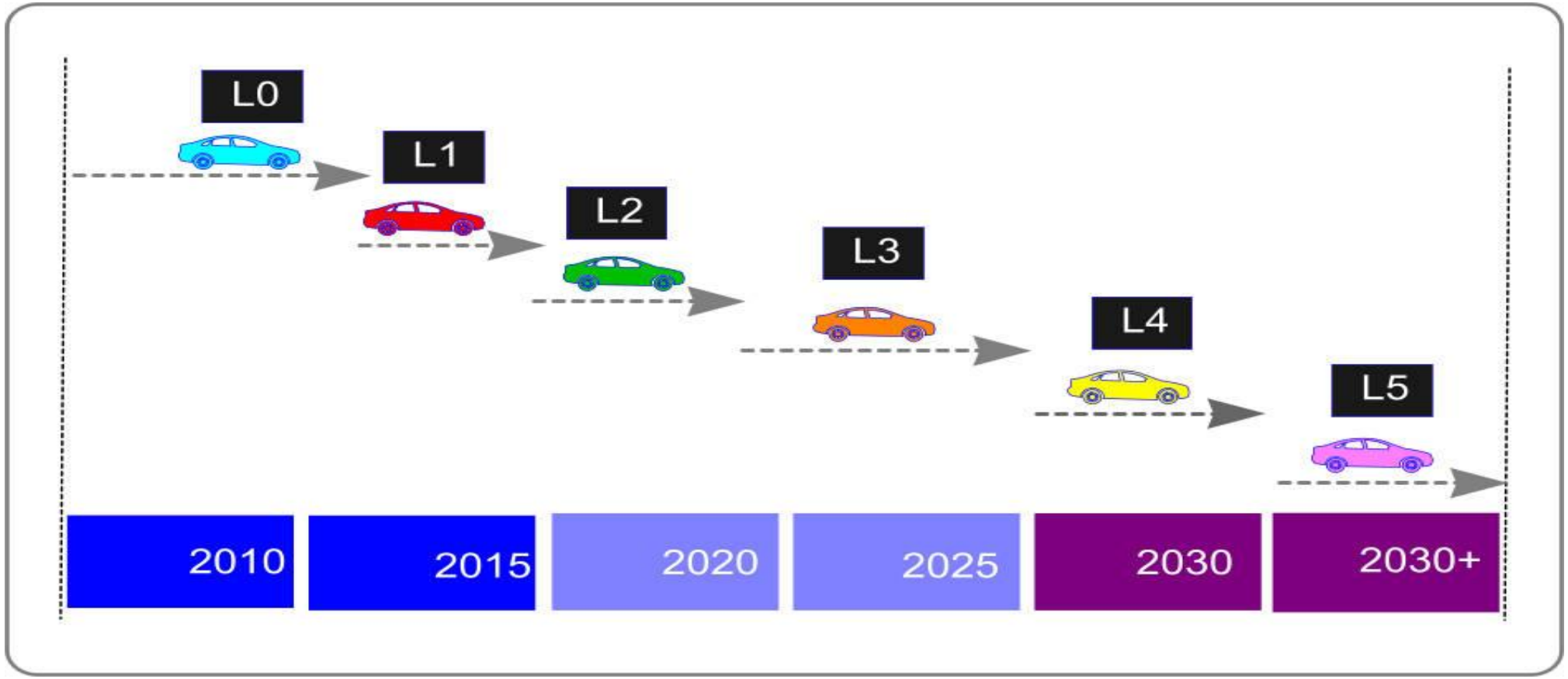
Technology Timeline



Multiple generations of technology will co-exist on our roads for many years.

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Literature Timeline

Transportation Research Interdisciplinary Perspectives 7 (2020) 100201

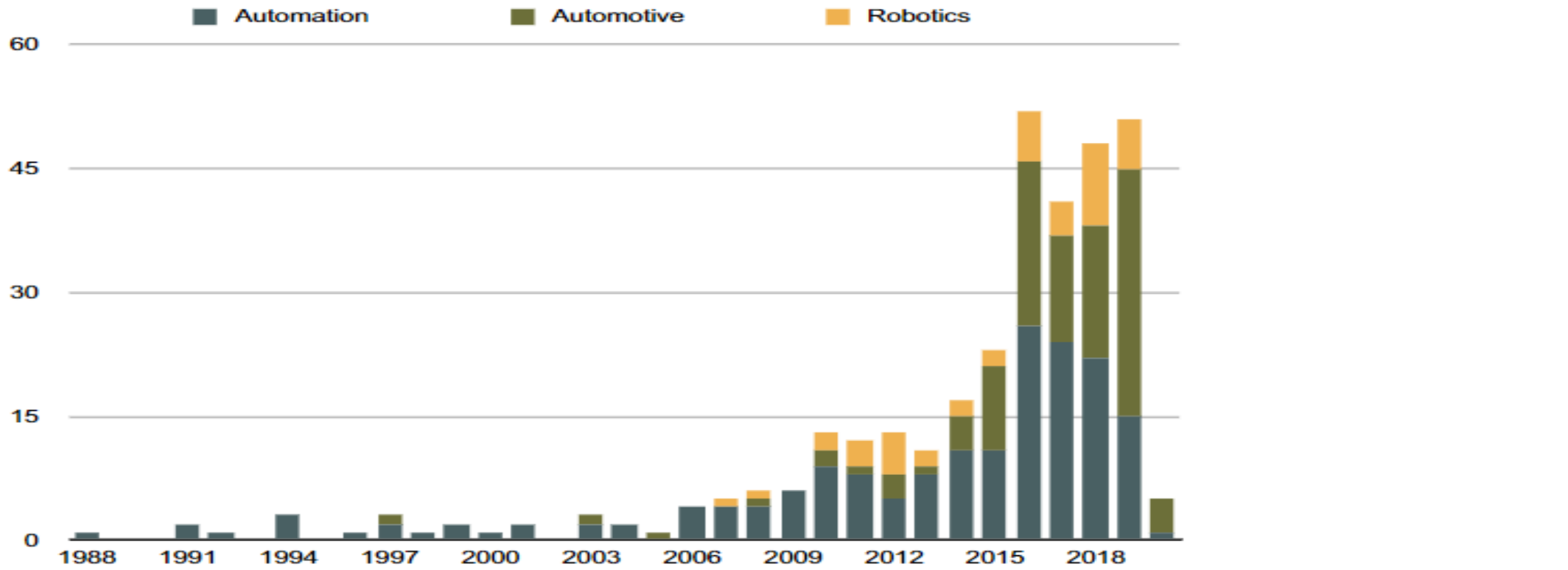

Fig. 1. Literature search results categorised into automation, automotive and robotics, and how they spread over the years.

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Trust Research

Transportation Research Interdisciplinary Perspectives 7 (2020) 100201

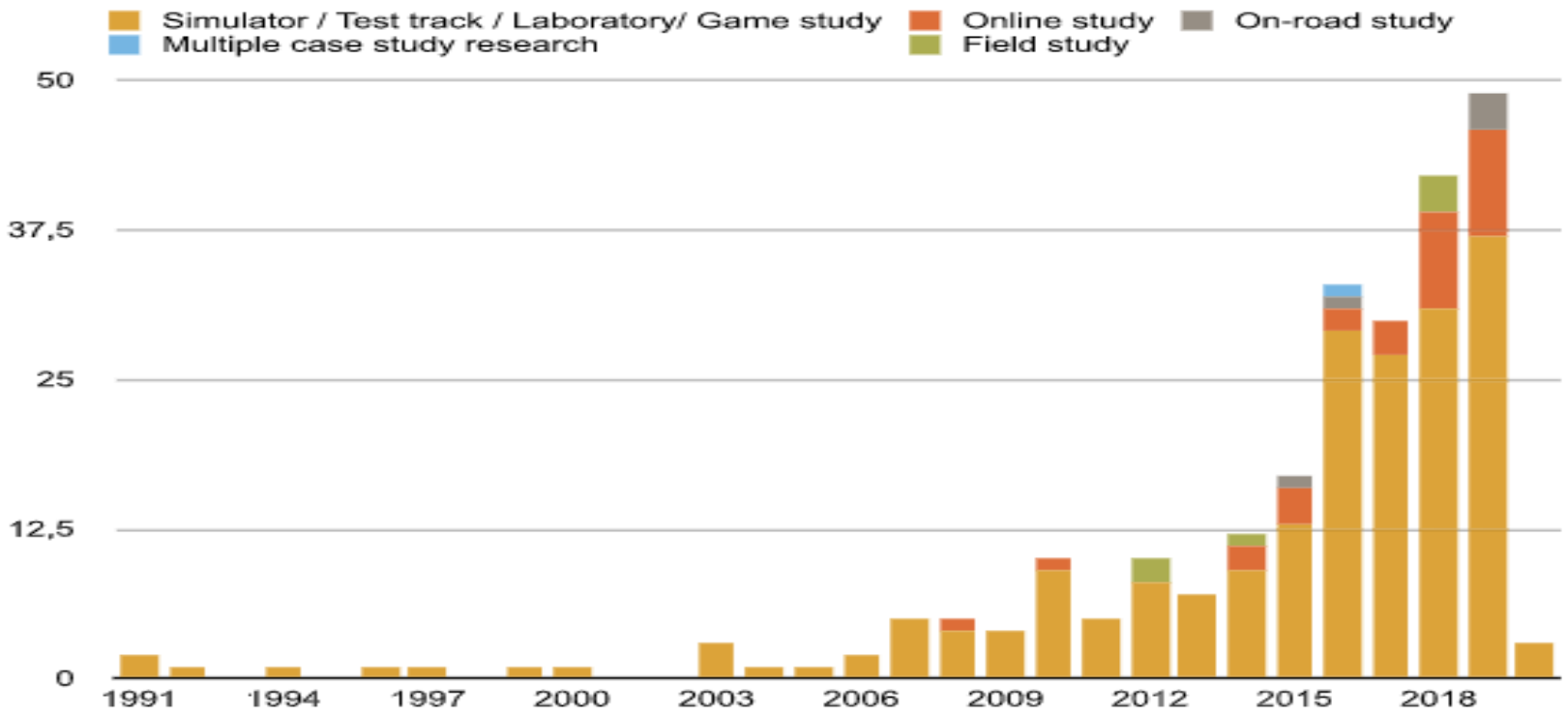

Fig. 3. Study context's chosen for trust research and how they distribute yearly.

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Recent Highlights

- **SAE J3016** has been formally validated by the US Department of Transport.
- **Tesla Motors Inc**., BMW, Ford Motor Co. and Volvo Cars have all promised to have fully autonomous cars on the road within five years.
- **Alphabet Inc.'s** (Google) autonomous test vehicles will surpass 3.5 million test miles on public roads by May 2019.
- **China** has set a goal for 10-20% of vehicles to be highly autonomous by 2025, and for 10% of cars to be fully self-driving in 2030.
- **Nvidia** and Mercedes-Benz announced intention to develop "cognitive car" using embedded AI technology.

Two Distinct Cultures

– ***Divide into two Major category:***

Major challenge to create a unified culture for these two very different industries.

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Research Problem (1/2)

- Modeling and building trust in autonomous ecosystem is a challenging pace for both the industry and academia [1].

- It requires a knowledge of both backgrounds cyber and physical field. Computer, Networks, sensors, and actuators are played a vital role in the cyber world and the physical environment that continuously communicates with each other.

- The physical environment is continuously evolving, at runtime, and in ways that cannot be completely anticipated at the design stage.

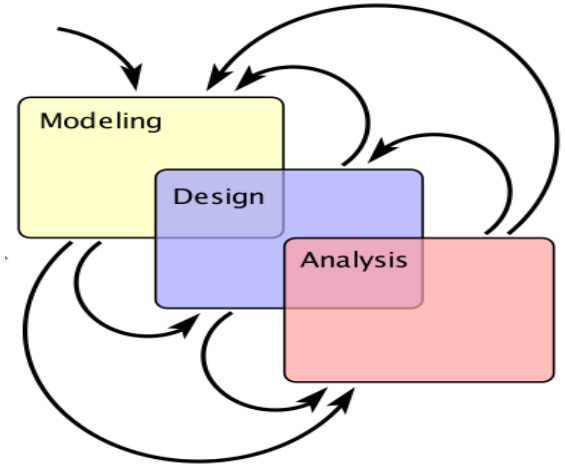
Research Problem (2/2)

- The US National Academy of Engineering [2] has accumulated 14 major challenges in Engineering of the 21st century that one of them is the verification of the CPS system in the physical environment at runtime.

- The statistic report of the National Highway Traffic Safety Administration stated that there is more than 5 million car accident annually in the united states and more than 2 million injuries or fatalities. These ratios will be increased in the coming days because of overpopulation [3].

Modeling, Design, Analysis: Proposed Methodology

- ***Modeling*** is the process of gaining a deeper understanding of a system through imitation. Models specify **what** a system does.



- ***Design*** is the structured creation of artifacts.
- It specifies **how** a system does what it does. This includes optimization.

- ***Analysis*** is the process of gaining a deeper understanding of a system through dissection. It specifies **why** a system does what it does (or fails to do what a model says it should do).

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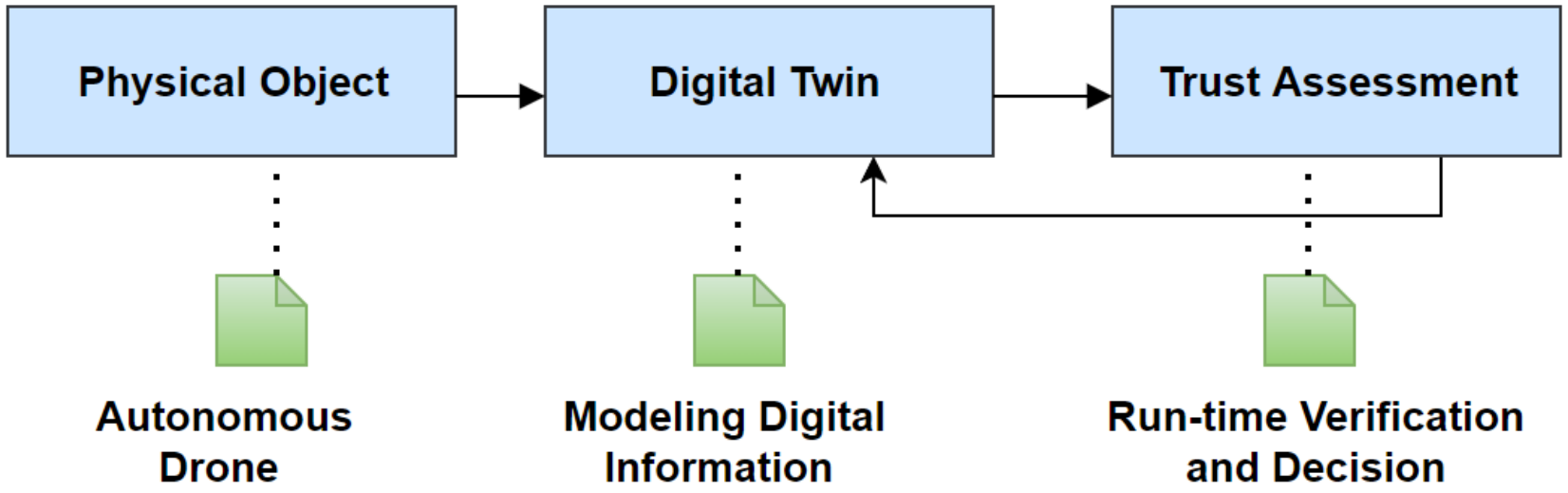
Proposed Solution

- **Concept of Digital Twin and Trust Assessment (Run-time verification)**
- NASA was the first to propose the concept of digital twins for the cyber-physical systems. The present objective is to advance the ideas and practice of digital twins across various industries, from manufacturing to healthcare.



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“Thank You”

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