PRYSTINE will realize Fail-operational Urban Surround perception (FUSION) which is based on robust Radar and LiDAR sensor fusion and control functions to enable safe automated driving in urban and rural environments.

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Programmable Systems for Intelligence in Automobiles (Project overview)

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ECSEL Joint Undertaking

Electronic Components and Systems for European Leadership

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- **Overview of the project**
  - Project positioning
  - Vision
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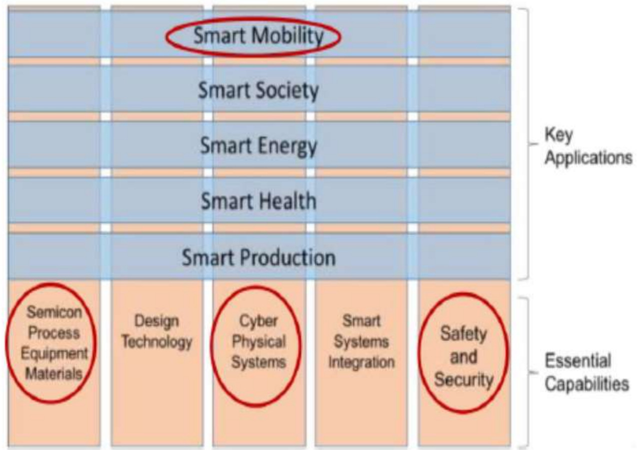
  - The PRYSTINE consortium

Positioning the project (1/2)

- EU H2020 framework
- ECSEL-2017-2 call, Research and Innovation Action (RIA)



- PRYSTINE addresses the key application “Smart mobility” and the enabling Technologies “Semiconductor Process Equipment and Manufacturing”, “Cyber Physical Systems”, and “Safety and Security” of the ECSEL Multi Annual Strategic Plan (MASP) 2017 document
- Grant Agreement No: 783190
- EU funding 14.8Meuros (+14.6Meuros national grants)

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Positioning the project (2/2)

- **Smart mobility**
  - Automation of vehicles aiming at fully autonomous driving
  - Enabler: highly automated driving functions (ADFs)
  - Major challenge (also PRYSTINE's focus area)
    - The step from SAE Level-2 (Partial automation) to SAE Levels-3 (Conditional automation) and above.

SAE Level	Name	Steering & Acceleration	Perception	Fallback	System capabilities
Human in charge of perception					
0	No Automation	Driver	Driver	Driver	None
1	Driver Assistance	Driver + System	Driver	Driver	Some driving modes
2	Partial Automation	System	Driver	Driver	Some driving modes
System full in charge of perception – PRYSTINE focus					
3	Conditional Automation	System	System	Driver	Some driving modes
4	High Automation	System	System	System	Some driving modes
5	Full Automation	System	System	System	All driving modes

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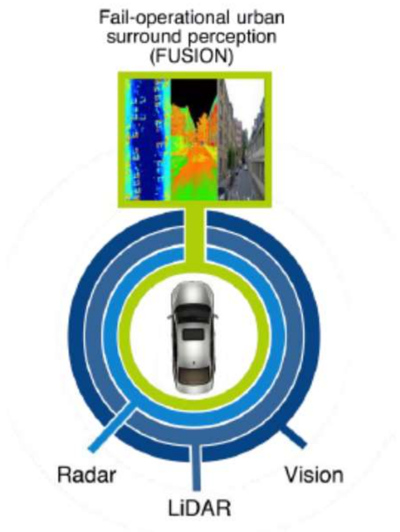
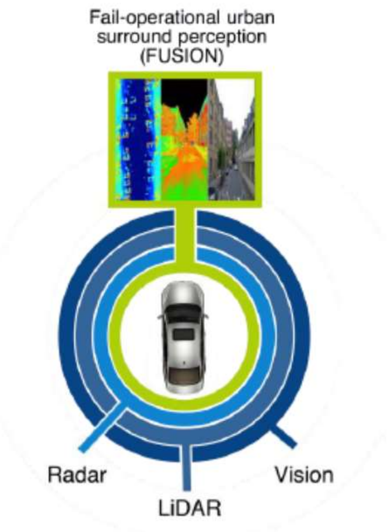
The PRYSTINE vision

Overall vision
Realize Fail-operational Urban Surround perceptION (FUSION), based on robust Radar and LiDAR sensor fusion and control functions, so as to enable safe automated driving in urban and rural environments. <u>Therefore achieve:</u> 1. Enhanced reliability and performance, reduced cost and power of FUSION components 2. Dependable embedded control by co-integration of signal processing and AI approaches for FUSION 3. Optimized E/E architecture enabling FUSION-based automated vehicles 4. Fail-operational systems for urban and rural environments based on FUSION

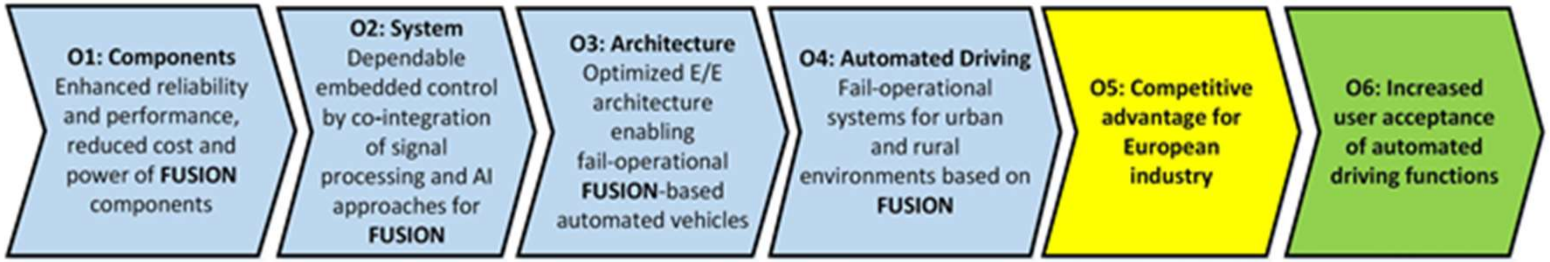


PRYSTINE expected outcomes

- Fail-operational sensor-fusion framework at component level
- Dependable embedded E/E architectures
- Safety compliant integration of Artificial Intelligence (AI) approaches for object recognition, scene understanding, and decision making within automotive applications.
- The resulting reference FUSION hardware/software architectures and reliable components for autonomous systems will be validated in numerous industrial demonstrators



PRYSTINE mission (how to realize the vision): project objectives and KPIs



Objective 1: Enhanced reliability and performance, cost and power of FUSION components

- 25% less data communication required compared to state-of-the-art
- 30% less false-positive detections compared to separate sensing approach
- Fail operational sensor compound vs. fail silent individual sensing approaches
- Power reduction of 25% through semiconductor material improvements and functional convergence in sensor modules
- Up to 30% cost reduction and 10% margin improvement for perception sub-systems

Objective 2: Dependable embedded control by co-integration of signal processing and AI approaches for FUSION

- Fail operational system approach for ADF (SAE Level 3+) vs. fail silent advanced driver assistance system (ADAS) approaches (SAE Levels up to 2)
- Proposed Certification Approach for AI based sensor fusion, diagnostic, and control

Objective 3: Optimized E/E architecture enabling FUSION-based automated vehicles

- Fail operational system architecture demonstrator for ADF (SAE Level 3+) vs. fail silent ADAS approaches (SAE Levels to 2)
- LiDAR / RADAR sensor compound demonstrator

Objective 4: Fail-operational systems for urban and rural environments based on FUSION

- Demonstrators for fail-operational SAE Level 3+ ADFs in urban environments

Objective 5: Competitive advantage for European industry

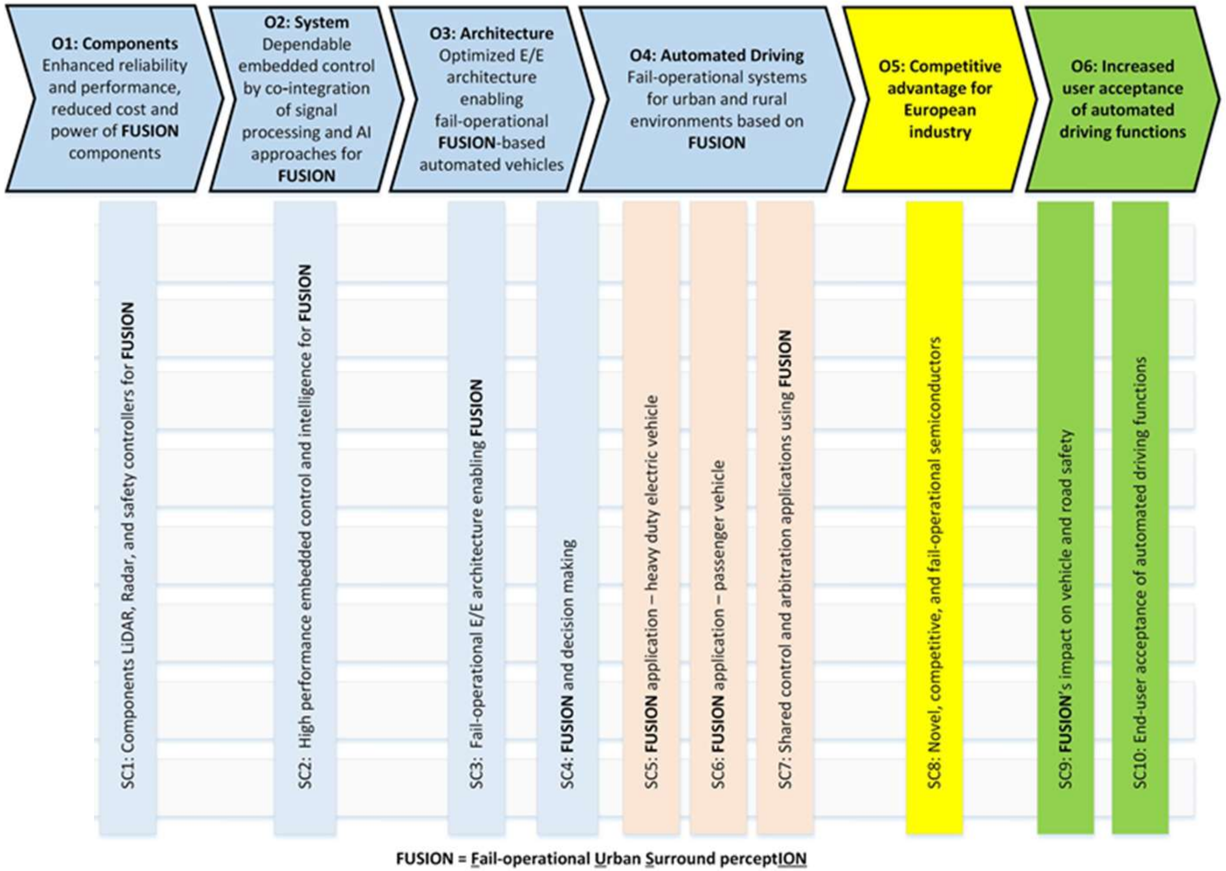
- Increasing market share and revenue of European companies through PRYSTINE's groundbreaking technological advancements (O1-O4)

Objective 6: Increased user acceptance of automated driving functions

- Increasing user acceptance of automated driving functions through PRYSTINE's groundbreaking technological advancements (O1-O4)

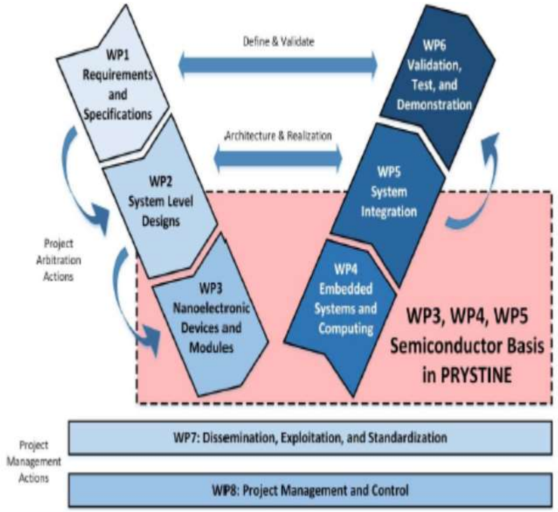
Objectives are reached by working in Supply Chains (SCs)

- **Supply chain (SC)**
  - The logical / virtual combination of partner activities fitting together within a specific topic leading to a combined result (e.g., demonstrator).
  - A supply chain supplies other supply chains and project activities with its results.
  - Each supply chain addresses a specific PRYSTINE objective.
  - 3 types of SCs
    - Technology enabler SCs (1-4)
      - develop the fundamental core technology required by other supply chains
    - Output enabler (also known as applications) SCs (5-7)
      - employ and validate the results achieved within the technology enabler supply chains.
    - Impact SCs (8-10)
      - form the basis in order to generate “European Values”.



How we work, monitor and report: work-packages (1/2)

- WP1
  - The system requirements driven by the OEMs will gradually be refined into specifications for sub-systems, modules, and components also taking into account the application constraints
- WP2
  - WP2 aims at establishing a comprehensive, in-depth quantitative understanding of the subsystems that will be integrated into higher level systems and demonstrators, by performing modelling and simulation at different levels
- WP3
  - The objective of this WP3 is to develop semiconductor solutions on low-level component level. The focus will be on novel fail-operational sensors and embedded control devices that will be integrated



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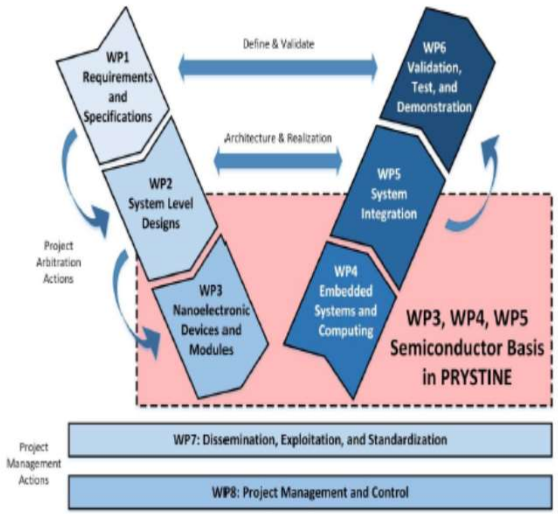
How we work, monitor and report: work-packages (2/2)

- WP4
  - The objective of WP4 is to develop and provide embedded components, i.e. computational HW including firmware, middleware and application software executing algorithms for robust operation even under faulty conditions of individual vehicle components or the computing platform itself
- WP5
  - WP5 will Integrate and implement a fail-operation system capable to detect and avoid any emergency safety risks faults
- WP6
  - WP6 will verify and validate the designed solutions.
- WP7
  - Caters for dissemination, exploitation and standardization



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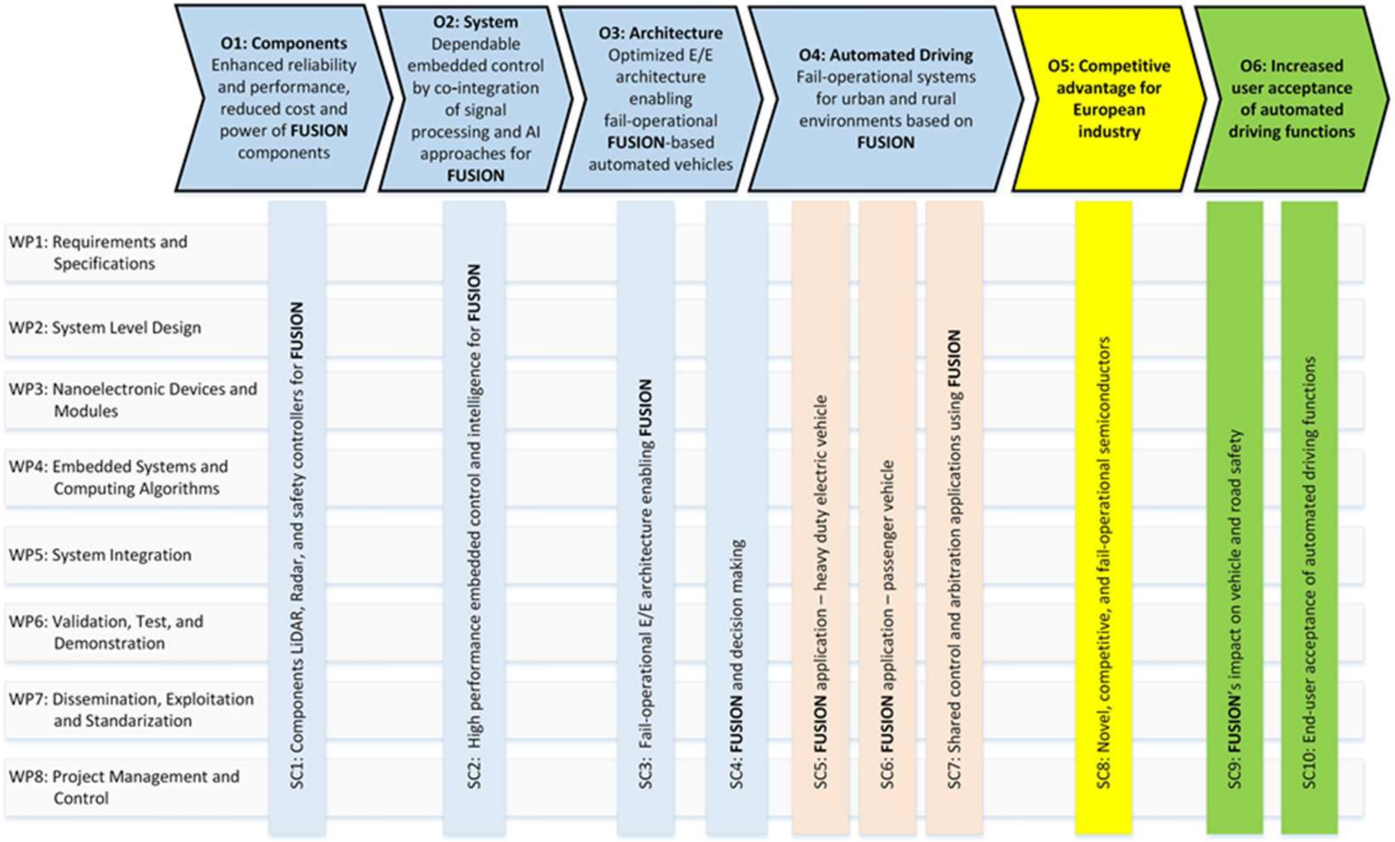
How we work, monitor and report: mapping of SCs to WPs and objectives



FUSION = Fail-operational Urban Surround perceptION

How we showcase that we have reached the objectives (therefore realized the vision) (1/2)

- The ***PRYSTINE*** demonstrators
  - SC1
    - Innoluce, 1D LiDAR & AURIX 2G
    - Murata 2D LiDAR
    - IMEC power / sensitivity scaling
    - NXPNL, integrated System-in-Package
    - IFAG, DICE, EPOS, high-resolution Radar
    - FAU, interference mitigation, MIMO radar concept
    - NXPNL, vehicle-level health monitoring
    - Videantis, FPGA-based fail-operational signal processing
  - SC2
    - Fail-operational autonomous driving platform
Drive-by-wire car (EDI): acronym
Data Fusion and Fall-back
    - Passenger vehicle for low speed autonomy
    - Fail-operational AI Inference Processing
  - SC3
    - E/E architecture demonstrator for automotive electronics enabling automated driving
    - Simulation, development and validation framework for fail-operational sensor-fusion E/E architecture
    - Dynamically shaped reliable mobile communication

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How we showcase that we have reached the objectives (therefore realized the vision) (2/2)

- The ***PRYSTINE*** demonstrators (continued)
  - SC4
    - HIL for lidar sensor data processing (Innoluce)
    - HIL for back-maneuver assist (Ford, AVLTK, VIF)
    - HIL for data fusion based VRU detection (IMEC)
    - HIL for AI based VRU detection (ITI)
    - CiThruS field test (TAU, MTS, Nokia)
    - Trajectory planning and vehicle dynamics control (Polito, CRF, Unimore)
    - Fusion of real and virtual sensor data for chassis control (Tenneco)
    - Traffic state prediction (DAT.Mobility)
    - Lab demo for Programmable Accelerator Architecture for multi-sensor data fusion and perception (TUD)
  - SC5
    - FORD Heavy Duty Truck
    - TTS Truck
  - SC6
    - Demonstration of the use-case "Traffic light time-to-green“
    - Demonstration of the use-case "VRU detection and Trajectory recognition“
    - Demonstration of the use-case "Driver monitoring and emergency manoeuvre“
  - SC7
    - (TECN): Shared control and arbitration (Level 2-3), studying driver-automation interaction and methods for vehicle authority transition (DiL Simulator)
    - (CSIC): Layered Control (Level 2-3-4), studying cooperation between a passenger car and a bus, and driver role in supervising or controlling the vehicle when requested.
    - (TNO): Highly automated vehicle (Level 3-4), study AI-based decision algorithms for urban and highway scenarios.

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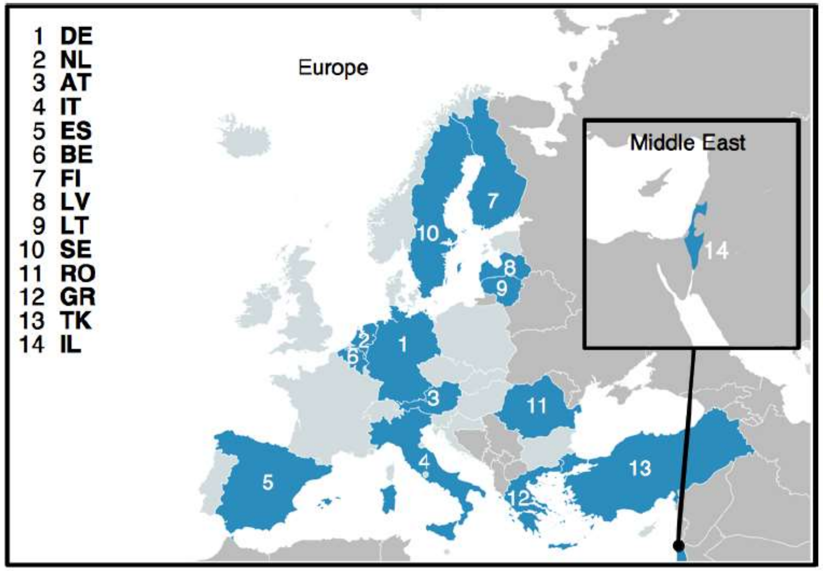
The PRYSTINE consortium



- **59 partners**
  - Project partners span across 14 European and non-European countries

- **Coordinator**: Infineon Technologies A.G. (DE)

- **The consortium and its value chains**

OEM	Tier-1	Tier-2	Semi-conductor	University	R&D Institutes
Ford Otosan	AVL	videantis	Infineon	TU Delft	virtual vehicle
Maserati	Ficosa	Daitek	NXP	Tampere University of Technology	TNO innovation for life
		dat.mobility		TU/e	tecnalia
		AnyWi			imec
CRF	Tenneco	Starhome Mach	innoluce	TU Graz	CSIC
		Nokia	muRata	GNT	VTT
Irizar	Applus+ IDIADA	CISC semiconductor	OKMETIC		TTS
		RE:Lab	DICE	Università degli studi di Modena e Reggio Emilia	MetisBaltic
Scania		Rovimatica		Turun yliopisto University of Turku	ITI Instituto Tecnológico de Informática
		i&m Ideas&Motion	EPOS	FAU	mobility movez.nl
BMW		Mattersoft			
		TTTech		KTH	
		Autocar			

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- **Thank you very much for your attention!**

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PRYSTINE will deliver
(a) fail-operational sensor-fusion framework on component level
(b) dependable embedded E/E architectures
(c) safety compliant integration of AI approaches for object recognition, scene understanding, and decision making

PRYSTINE has been accepted for funding within the Electronic Components and Systems For European Leadership Joint Undertaking in collaboration with the European Union's H2020 Framework Programme (H2020/2014-2020) and National Authorities, under grant agreement n° 783190.

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