Occlusions in CAV Systems: Constructing a Legal Framework

Liability, Perception, and the Architecture of Shared Responsibility

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Presentation Roadmap

1. The Legal issue of Occlusions in Urban CAV Environments
2. The Shift in Duty of Care: From Human Drivers to Autonomous Systems
3. Collective Awareness and the Architecture of Distributed Liability
4. Regulatory Landscape: EU AI Act & PLD, Vienna Convention, National Frameworks
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The Legal issue of Occlusions in Urban CAV Environments

The Technical Reality:

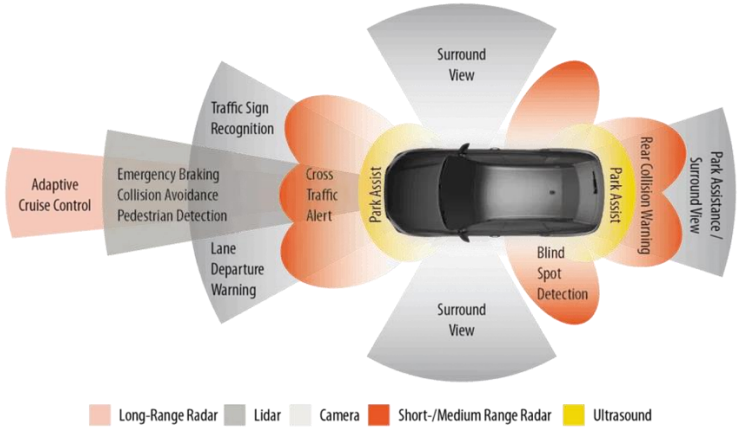
Connected and Automated Vehicles (CAVs) rely on Line-of-Sight (LoS) sensors — LiDAR, cameras, radar — that cannot perceive objects hidden behind physical obstacles. In dense urban environments, a building corner, a parked truck, or a road sign can conceal a Vulnerable Road User (VRU) entirely from the vehicle's sensor array.

The Concept of Occlusion:

An *occlusion* is not a sensor malfunction — it is a structural limitation of single-agent perception. The vehicle operates with a fundamentally incomplete picture of its environment, yet must make safety-critical decisions in milliseconds.

The Legal Issue:

Traditional liability frameworks were designed around a human driver who perceives, decides, and acts. When perception becomes collective and algorithmic, the role of the human driver is gradually being supplemented and then replaced by autonomous driving system.



The Shift in Duty of Care: From Human Drivers to Autonomous Systems

SAE level	Name of the automation level	Liability	Applicable law	Insurance Policy
0	No Automation	**Driver/Owner of the vehicle** (his similar subjects), with the right of recourse against the producer of the vehicle or of its defective component part.	**National rules of car accident liability** (if necessary, identified according to the rules of Private International Law) and eventually European and national Product liability regulation.	Car Insurance policy of the vehicle owner.
1	Driver Assistance	**Driver/Owner of the vehicle** (his similar subjects), with the right of recourse against the producer of the vehicle or of its defective component part.	**National rules of car accident liability** (if necessary, identified according to the rules of Private International Law) and eventually European and national Product liability regulation.	Car Insurance policy of the vehicle owner.
2	Partial Automation	**Driver/Owner of the vehicle** (his similar subjects), with the right of recourse against the producer of the vehicle or of its defective component part.	**National rules of car accident liability** (if necessary, identified according to the rules of Private International Law) and eventually European and national Product liability regulation.	Car Insurance policy of the vehicle owner.
3	Conditional Automation	**Owner of the vehicle** (his similar subjects) and the driver of the vehicle if he had a behaviour that does not comply with his driving tasks.	**National rules of car accident liability** (if necessary, identified according to the rules of Private International Law) and eventually European and national Product liability regulation.	Car Insurance policy of the vehicle owner.
4	High Automation	**Owner** (his similar subjects) **and/or producer** of the vehicle	**National rules of car accident liability** (if necessary, identified according to the rules of Private International Law) and/or European and national Product liability regulation.	Car Insurance policy of the vehicle owner and/or specific Professional insurance of the producer and a compensation fund for autonomous vehicles.
5	Full Automation	**Producer** of the vehicle and or Owner of the vehicle.	**New framework or rules** for autonomous vehicles	Car Insurance policy of the vehicle owner and/or specific Professional insurance of the producer and a compensation fund for autonomous vehicles.

Collective Awareness and the Architecture of Distributed Liability

Collective Awareness (CA):

By sharing sensor data across a network — Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) — the system constructs a "transparent" environment. A vehicle can effectively "see around corners" using data contributed by other agents.

Legal Significance:

Collective Perception System

This technical architecture creates a new paradigm: Liability can no longer be attributed solely to a single vehicle or driver. The network becomes a co-actor in every safety-critical decision.

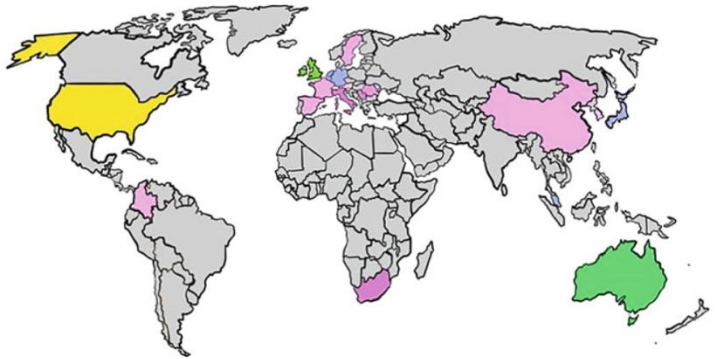


Fig. 4 Map on autonomous vehicles regulation across the world in the selected Countries (The Author of the map is Ms. Simona Latte, Law Degree and II level Master degree in DPO and Privacy Law at Università degli Studi Suor Orsola Benincasa, professional graphic designer)

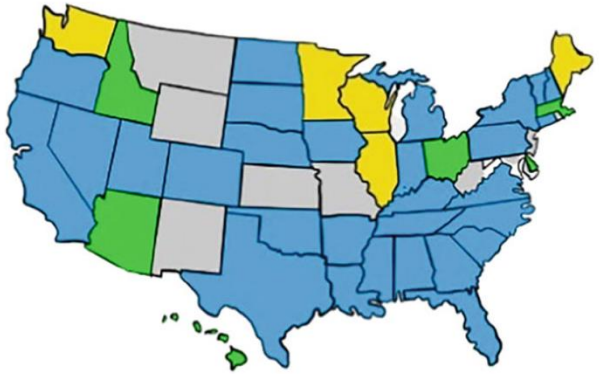


Fig. 5 Map on autonomous vehicles regulation in the United States of America (The Author of the map is Ms. Simona Latte, Law Degree and II level Master degree in DPO and Privacy Law at Università degli Studi Suor Orsola Benincasa, professional graphic designer.)

From the ‘Reasonable Person’ to the ‘State of the Art’

Classical Tort Law Standard

In traditional negligence law, the *Reasonable Person* standard asks: what would a prudent human driver have done? This standard is inherently subjective, contextual, and human-centred.

The Algorithmic Shift

For CAV systems, the applicable standard shifts to the *"State of the Art"* in perception technology (as referenced in EU Product Liability Directive 2024/2853). The question becomes: did the ADS perform at the level that the best available technology at the time of deployment would have achieved?

The Hybrid Intelligence Paradox

If a CAV uses Hybrid Intelligence to predict trajectories of occluded objects, does the legal Standard of Care now require *every* vehicle to predict the unpredictable? This creates a ratchet effect: as technology improves, the minimum legal standard rises automatically.

The Infrastructure Variable

When Road-Side Units (RSUs) provide data to resolve an occlusion, the Duty of Care is *bifurcated* :

- **OEM / ADS Developer:** responsible for correct integration and processing of external data
- **Infrastructure Provider:** responsible for data accuracy, latency, and availability

Regulatory Landscape: EU AI Act & PLD, Vienna Convention, National Frameworks

EU AI Act (Regulation 2024/1689)

CAV perception systems qualify as *high-risk AI systems* . Obligations include conformity assessment and human oversight. Crucially, the Act regulates the system compliance, not civil liability for harm.

EU Product Liability Directive (2024/2853)

Extends product liability to software. A defective ADS failing to process occlusion data correctly may constitute a *product defect* , shifting strict liability to the manufacturer.

Vienna Convention on Road Traffic

Permits automated driving only if the system can be overridden by the driver. This creates a residual human liability layer that is increasingly difficult to sustain in practice.

National Divergence

National Legal systems regulates accidents caused by (semi-)autonomous vehicles differently

Framework	Scope	Liability Model
EU AI Act 2024	AI system compliance	Administrative / Regulatory
EU PLD 2024	Product defects (incl. driving software)	Strict liability (manufacturer)
Vienna Convention 2016	Road traffic rules	Driver / operator residual liability
National regulations	Automated driving liabilities	Manufacturer / Authorised Self-Driving Entity / Insurer

The Policy Dilemma: Do Safety Benefits Justify Residual Occlusion Risks?

The Safety Argument (Pro-CAV):

Statistical evidence consistently shows that human error accounts for approximately 94% of road traffic fatalities (NHTSA, 2023). CAV systems, even with occlusion limitations, are projected to reduce accident rates significantly in controlled environments.

The Residual Risk Problem:

Occlusion-related accidents represent a *tail risk* — rare but catastrophic. Legal systems are poorly equipped to handle low-probability, high-consequence harms, particularly when causation is distributed across a network of autonomous agents.

The Precautionary Principle:

EU environmental and product safety law applies the precautionary principle: where scientific uncertainty exists about a risk, preventive action is justified. Should this principle apply to CAV occlusion scenarios, requiring mandatory V2X infrastructure before deployment?

The Proportionality Test:

Any legal framework must balance:

- The societal benefit of reduced human-error accidents
- The residual risk of algorithmic and network failures
- The chilling effect of strict liability on innovation

Towards a Coherent Legal Framework: Four Structural Pillars

A workable legal framework for CAV occlusion liability must rest on four pillars:

Pillar 1
Layered Liability Attribution

Establish a statutory hierarchy: **OEM** (ADS defect) → **Infrastructure Provider** (data failure) → **Network Operator** (communication failure) → **Residual human operator**. Each layer bears liability proportional to its contribution to the harm.

Pillar 2
Mandatory Data Logging

Require tamper-proof event data recorders (EDR) that capture V2V/V2I data streams, sensor inputs, and ADS decision logs. Without verifiable data, causation in multi-agent accidents is legally unprovable.

Pillar 3
Standardised Benchmarks

Establish EU-level technical standards (via UNECE or CEN/CENELEC) defining minimum occlusion detection and response performance. These standards become the legal baseline for the duty of care.

Pillar 4
Compulsory Insurance

Mandate sector-specific insurance covering distributed-liability scenarios. Establish a compensation fund (analogous to the Motor Insurers' Bureau) for cases where liability cannot be attributed to a single actor.

Conclusions: Perception is Now a Legal Duty

Core Argument:

The shift from individual to collective perception in CAV systems is not merely a technical evolution — it is a legal reform. The traditional driver-centric liability model is structurally inadequate for a world in which 'seeing' is a networked, algorithmic, and distributed act.

1. **Duty of Care must be reconstructed** around the "State of the Art" in collective perception technology, with clear allocation between OEMs, infrastructure providers, and network operators.

2. **"Machine Knowledge" must be legally defined** — the scope of what a CAV "should have known" via the network must be bounded by verifiable data availability, not theoretical network omniscience.

3. **Regulatory harmonisation is urgent** — the current patchwork of EU, international, and national frameworks creates legal uncertainty that impedes both innovation and victim protection.

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