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Operational Concept Framework to support government policy &regulation on Connected and Automated Vehicles

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Key topics

- Why a CAV OpsCon Framework?
- Levels of automation
- Operational context
- Operational outcomes
- Operational use cases
- Operational migration
- Operational modes
- Operational interfaces
- Operational actors
- Operational zoning
- Operational scenarios
- Operational risks
- Conclusion

Why a CAV OpsCon Framework?

- Tells "day-in-the-life" story of how CAVs might operate
- Identifies operations and support assets and resources
- Valid reference point throughout the system lifetime
- Living document - regularly reviewed and updated
- Informs development of road policy / regulations
- Facilitates controlled introduction of CAVs onto the road
- Identifies need to re-configure existing road infrastructure
- Informs the “Need” and “Plan” phases of asset lifecycle

CAV Levels of Automation

- L0 (No Automation): Automated system has no vehicle control, but may issue warnings.
- L1 (Driver Assistance): Driver must be ready to take control at any time.
- L2 (Partial Automation): The driver is obliged to detect objects and events and respond if the automated system fails to respond properly.
- L3 (Conditional Automation): Within known, limited environments (such as freeways), the driver can safely turn their attention away from driving tasks.
- L4 (High Automation): The automated system can control the vehicle in all but a few environments such as severe weather.
- L5 (Full Automation): Other than setting the destination and starting the system, no human intervention is required in all driving modes

SAE International brochure, "Automated driving - Levels of driving automation are defined in new SAE International Standard J3016"

CAV Operational Context

- Mass transport system (intercity, metro, light rail, bus, ferry)
- “Smart City/Precinct” initiatives
- The “Internet of Things” (IoT)
- “Big Data” initiatives
- Co-operative Intelligent Transport Systems (C-ITS)
- Governance & Regulatory Frameworks
    - Risk/Safety Assurance Framework
    - Transport Regulatory Framework
    - Road Infrastructure Investment Framework

CAV Operational Outcomes

Benefits:

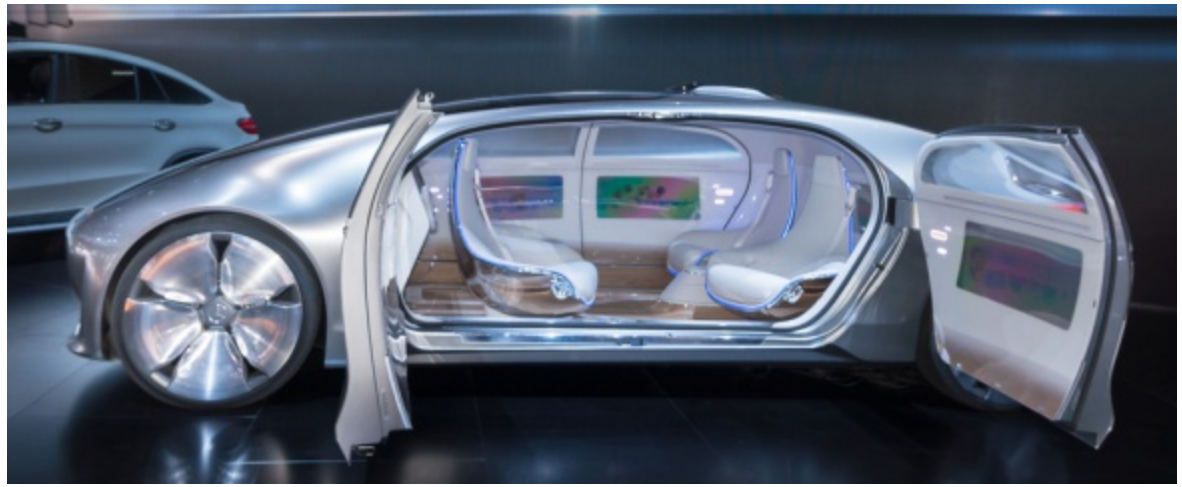
- Reduced road congestion
- Reduced road accidents (safety)
- Reduced single-user vehicle traffic
- Increased human productivity
- Improved equitable mobility access
- …and more…

Dis-benefits:

- Increasing automation replacing human jobs (taxis, truckers)
- Unexpected events that software (AI) cannot interpret
- …and more?

CAV Operational Use Cases

- Privately owned P2P
- Mobility-as-a-Service (MaaS)
- Bus Mass Transit
- Human Mobility-impaired
- Commercial/Freight
- Road Maintenance
- …and others



CAV Operational Migration

Possible migration timeline:

- Current situation: Levels 0/1/2 prevalent (2017)
- Interim future situation 1: Levels 1/2/3 prevalent (2025)
- Interim future situation 2: Levels 2/3/4 prevalent (2035)
- Final future situation: Level 5 prevalent (>2050)

Note: Tesla Autopilot currently considered Level 2

CAV Operational Modes

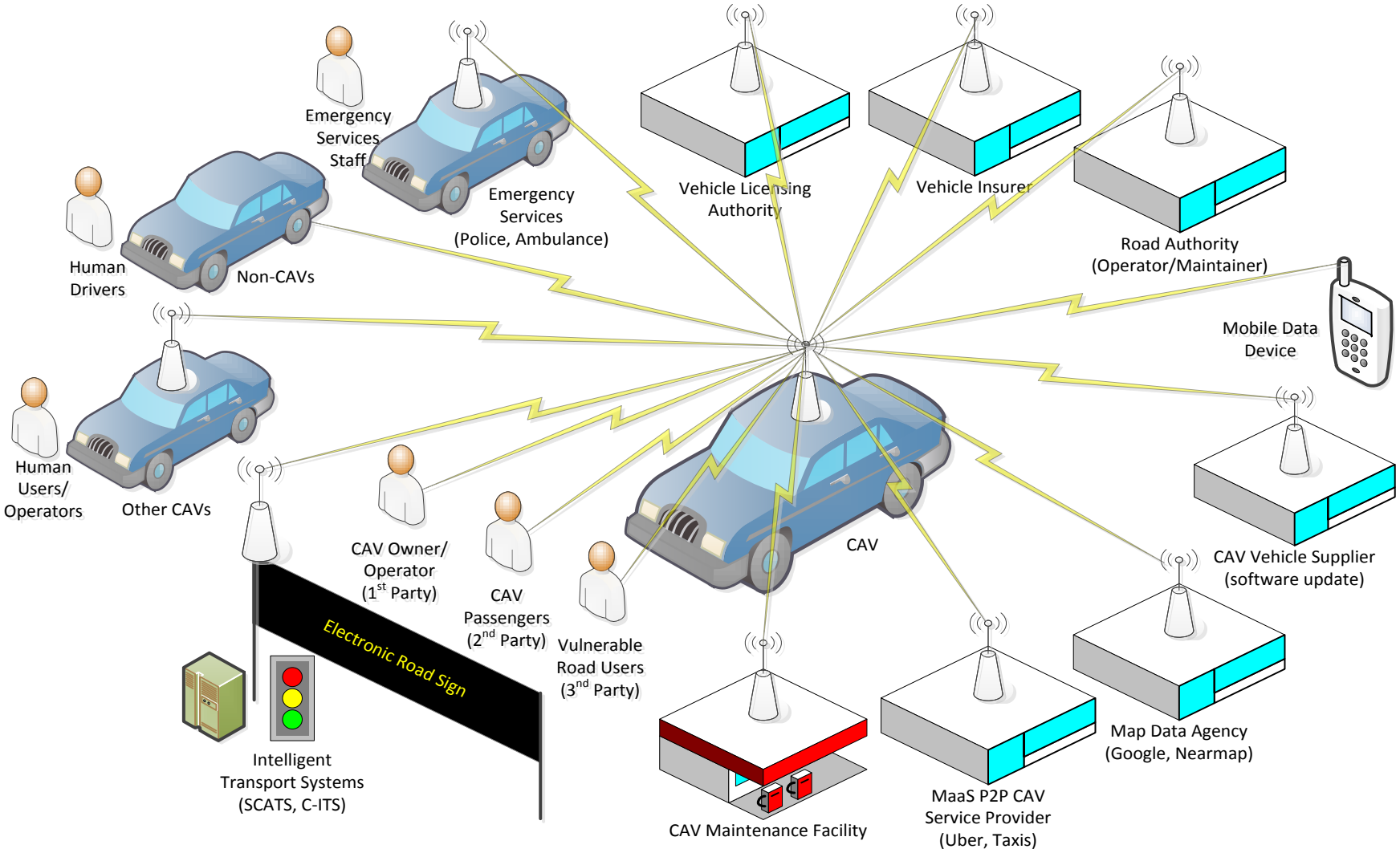
- Normal mode (all functions and capabilities available)
- Degraded mode (degradation or loss of one function)
- Emergency mode (loss of multiple functions and capability)
- Maintenance mode

Normal Mode

Degraded Mode

Emergency Mode

CAV Operational Interfaces



CAV Operational Actors

Actors include the user, as well as other entities that will need to interact with the CAV over an operational interface.

- CAV owner/operator (the direct user)
- Vulnerable road users (e.g. pedestrians, cyclists)
- Roadside ITS infrastructure
- Emergency services (e.g. police, ambulance, vehicle recovery)
- Road operator/maintainer (public & private/toll)
- Vehicle service centre (e.g. “over the air” diagnostic data download)
- Vehicle supplier (e.g. “over the air” software updates)

CAV Operational Zoning

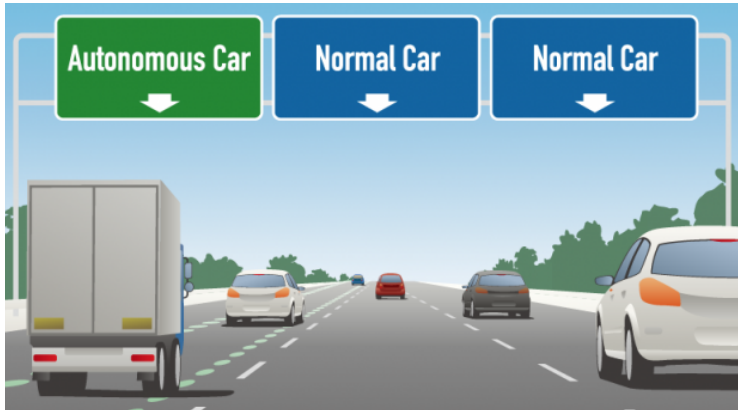
Physical zones where a CAV may be permitted to operate at a certain level of automation

Until CAVs are ubiquitous, zoning may be based on:

- Segregated geographic areas (e.g. Level 4/5 on campus areas only)
- Separate lanes (e.g. CAV use of existing bus/taxi lanes)
- Separate road types (e.g. >= Level 2 automation on motorways only)

May need to plan for new or altered zones to accommodate CAVs at specific levels of automation:

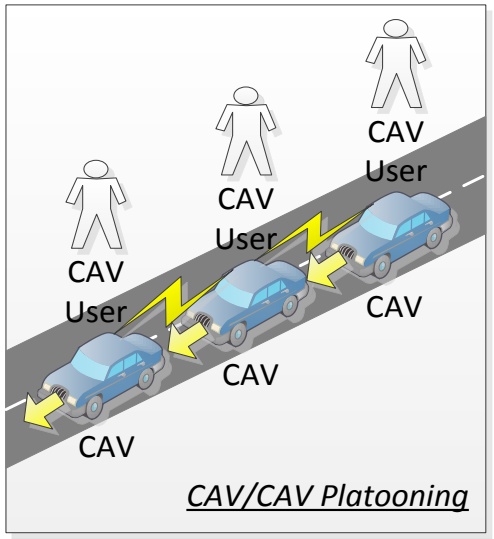
- Physical barriers
- Lane markings (e.g. “CAV only” or “Level 2 only”)
- Signage (e.g. “Select Level 3”)
- Virtual (electronic) barriers

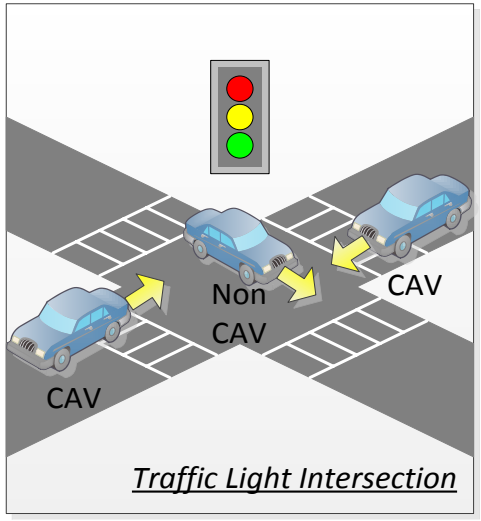


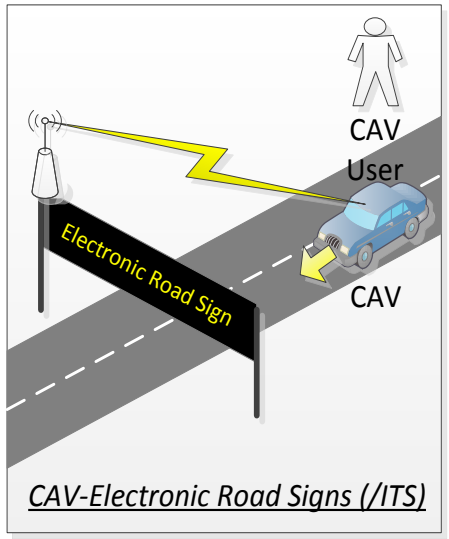
CAV Operational Scenarios (1)

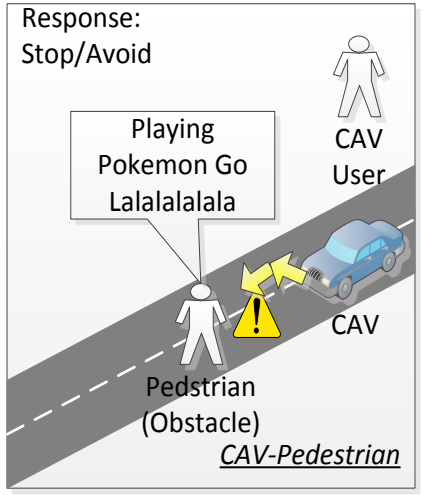
- “Platooning” of CAVs
- Traffic light intersection scenario
- CAV/non-CAV overtaking scenario
- Pedestrian encounter
- Police encounter (static or moving)
- Roadworks encounter
- …and many more (39 scenarios identified so far…)

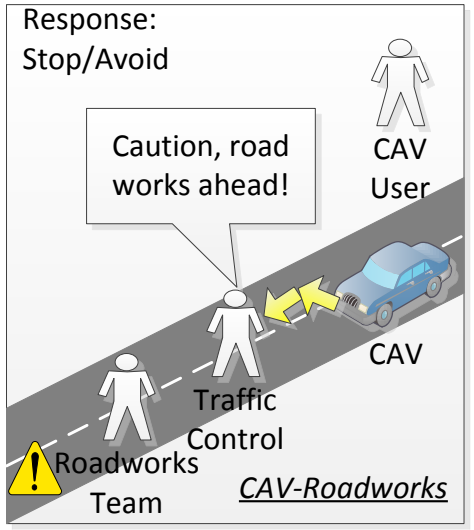
CAV Operational Scenarios (2)



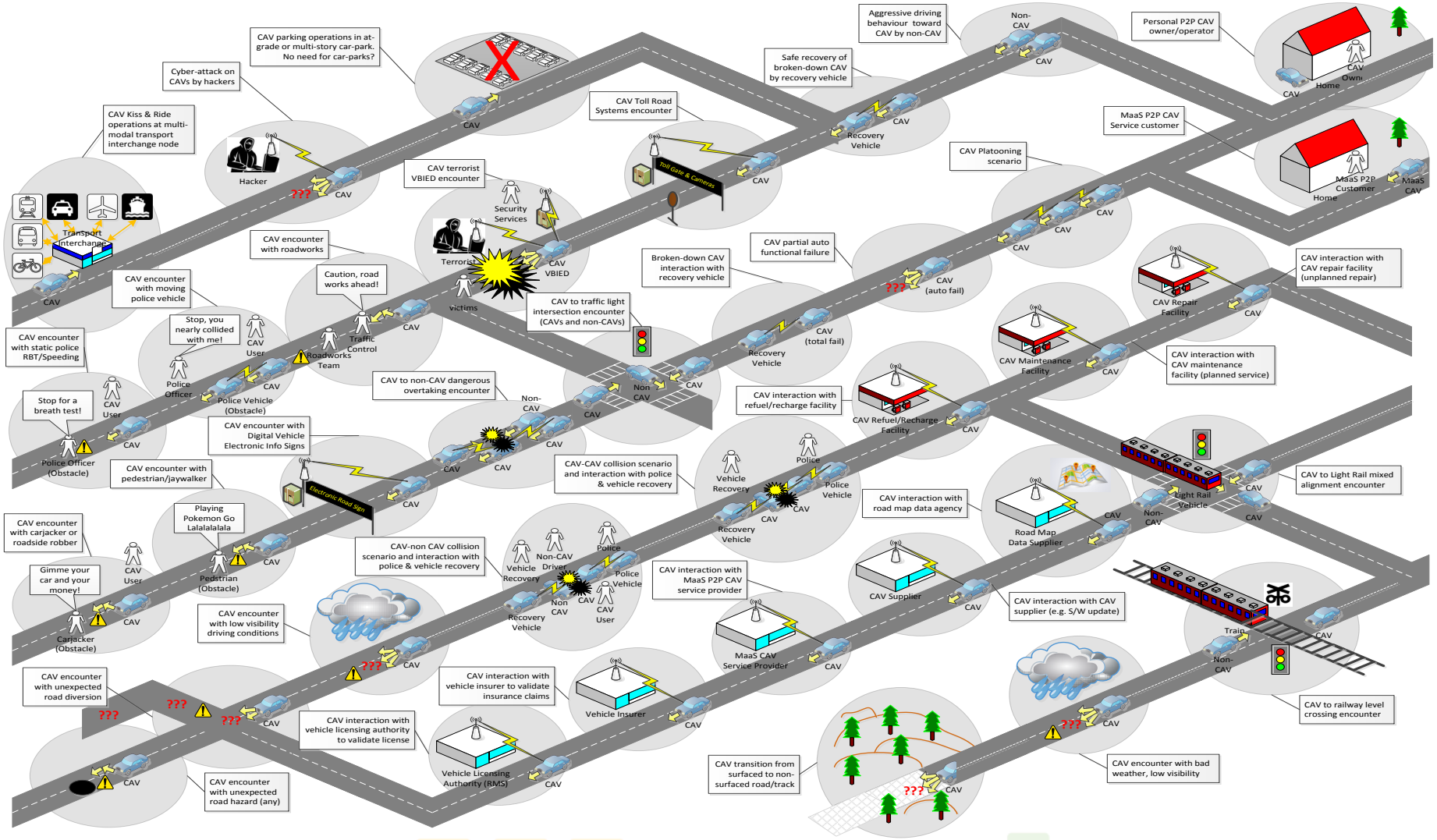








CAV Operational Scenarios (3)



CAV Operational Risks

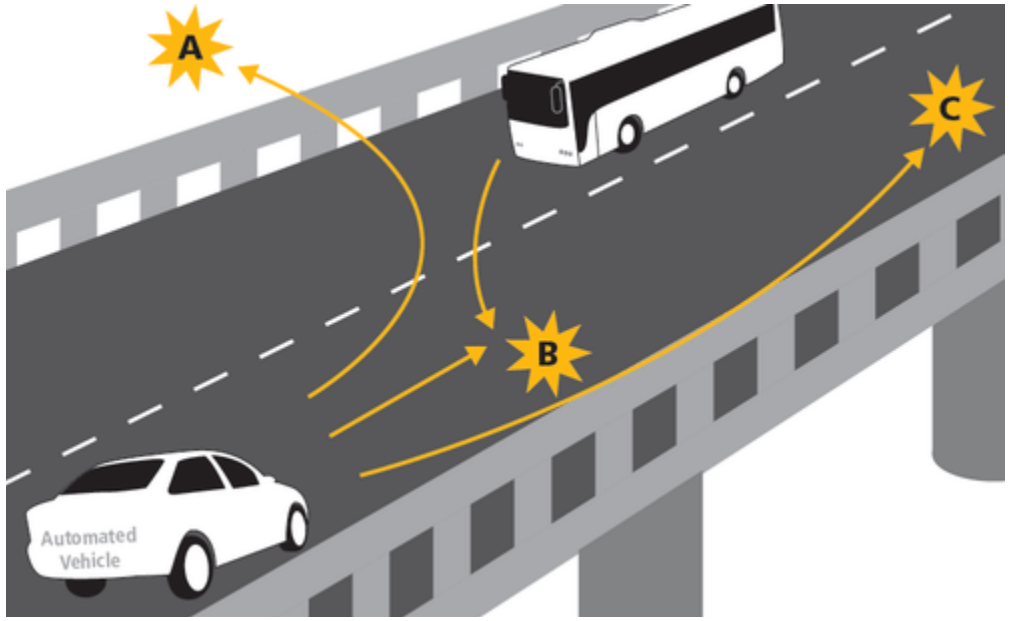
Example: "*loss of lane-keeping function leading to undesired and uncontrolled change of lane by the CAV*"

Possible outcomes (consequences) for this risk:

A. CAV crosses multiple lanes and runs off the road (single vehicle V2I collision)

B. CAV crosses one or more lanes and collides with one or more other vehicles (multiple vehicle V2V collision)

C. CAV crosses into, and remains in, adjacent same-direction lane with no collision (no loss)



Conclusion

The CAV Operational Concept Framework can be used to:

- identify scenarios that require new or updated policy and regulations, as well as to plan road infrastructure upgrades
- systematically analyse the rapid rate of CAV-related innovations to assist transport policy-makers to respond
- Have a platform that can be expanded and adapted to accommodate future new CAV innovations as they are delivered from the industry

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