Future Networked Car Symposium (FNC-2025)

SESSION 2: Challenges in Achieving Effective Vehicle Remote Driving

Date and Time: 25 March 2025 (13:00-16:00 CET)

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AVP/M Standards-Industry – Overview* [Background]

- Standards
  - ISO
    - ISO-23374-1 (Automated valet parking systems (AVPS) – Part 1: System framework, requirements for automated driving and for communications interface)
    - 12768-1 (Intelligent transport systems — Automated Valet Driving Systems (AVDS) Part 1: Requirements, System Framework, Communication Interfaces and Test Procedures) – Under Development
  - SAE
    - J3016 (Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles)
    - J3292 (Automated Vehicle Marshalling System) – WIP
  - ETSI
    - TS 103 882 ((Intelligent Transport Systems (ITS); Automated Vehicle Marshalling (AVM); Release 2))

- Industry Organizations
  - 5GAA
    - Automated Valet Parking Technology Assessment and Use Case Implementation Description
    - Safety Treatment in Connected and Automated Driving Functions, Phase 2
  - VDA
    - Automated Valet Parking (Systems Requirements for automated valet parking systems Version 3.0.0)

*there might be multiple standards/organizations on AVP/M which might not shown in this slide

ISO 23374-1* (Automated Vehicle Operation Functional Allocations)

Functions	Type 1	Type 2	Type 3
Destination Assignment	R & V	R	R
Route Planning	V	R	R
OEDR	V (& R)	R	R & V
SV Localization	V	R	V
Path Determination	V	R	V
Trajectory Calculation	V	R or V	V
Vehicle Motion Control	V	V	V

R = Remote Vehicle Operation, V = On-board Vehicle Operation

- Type 1 - The V sub-system carries out most of the operation functions. Depending on the system design, only portions of the destination assignment function are allocated to the R sub-system.
- Type 2 - The R sub-system carries out most of the operation functions. Means to perform the OEDR and localization functions are established by installing PFE (e.g. detection sensors, control units) in the parking facility. OEDR by SV on-board sensors (as part of the V sub-system) is not required.
- Type 3 - The functional allocation is balanced between the two operation sub-systems. Type 3 utilizes the OEDR capabilities of the SV, and also gives sufficient control to the R sub-system by allocating the destination assignment and route-planning functions.

*source-ISO-23374-1 std

SAE J3292* (Scope)

- Scope
  - Automated Vehicle Marshalling (AVM) of vehicles to enable remote control functionality for achieving SAE Level 4 driving capability at low speeds within geo-fenced controlled, private environments utilizing infrastructure-assisted sensing.
  - The standard specifies:
    - use-cases,
    - system reference architecture, system wireless logical architecture, feature flow, state flow,
    - concept of operations: the system requirements and system design,
    - multiple wireless communications protocols,
    - associated wireless messages
  - The Low Speed Automation (LSA) use-cases such as plant marshalling, depot marshalling, valet parking, electric vehicle charging etc.

- Standard Link:
  - https://www.sae.org/standards/content/j3292/

*WIP Standard

SAE J3292* (Use-Cases)

- Plant Marshalling
  - A logistic feature to improve the efficiency of production and vehicle transport within vehicle manufacturing factories/facilities.

- Depot Marshalling
  - A logistic feature for transporting goods inside a depot, improving traffic and safety, and providing additional logistic efficiencies. This will enable a fleet manager to instruct and maneuver AVs between different depot spots (loading/unloading/maneuvering etc.) by using the external infrastructure sensors.

- Valet Parking
  - A customer feature to provide automated parking services. Valet parking will enable the AV to be parked and summoned autonomously utilizing the support from external infrastructure sensors.

- Electric Vehicle Charging
  - A customer feature to provide electric charging services. An AV will be guided by infrastructure within a facility to an Electric Vehicle (EV) charging spot/s utilizing the support from external infrastructure sensors.

- .....

*WIP Standard

SAE J3292* (AVM Controlled Geo-Fenced Private Environment ODD)

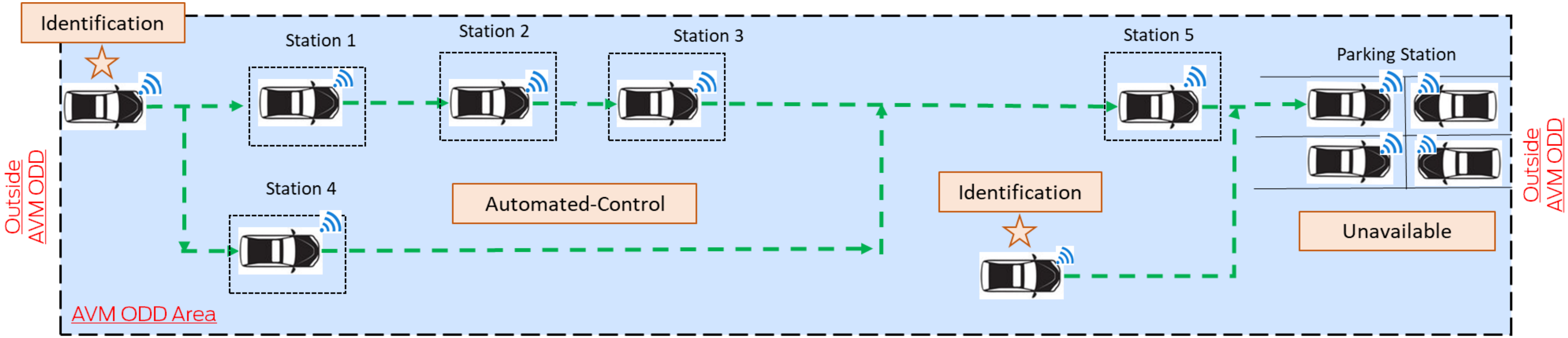


Figure - Illustration for any general AVM controlled geo-fenced private environment ODD

*WIP Standard

SAE J3292* (AVM System Reference Architecture)

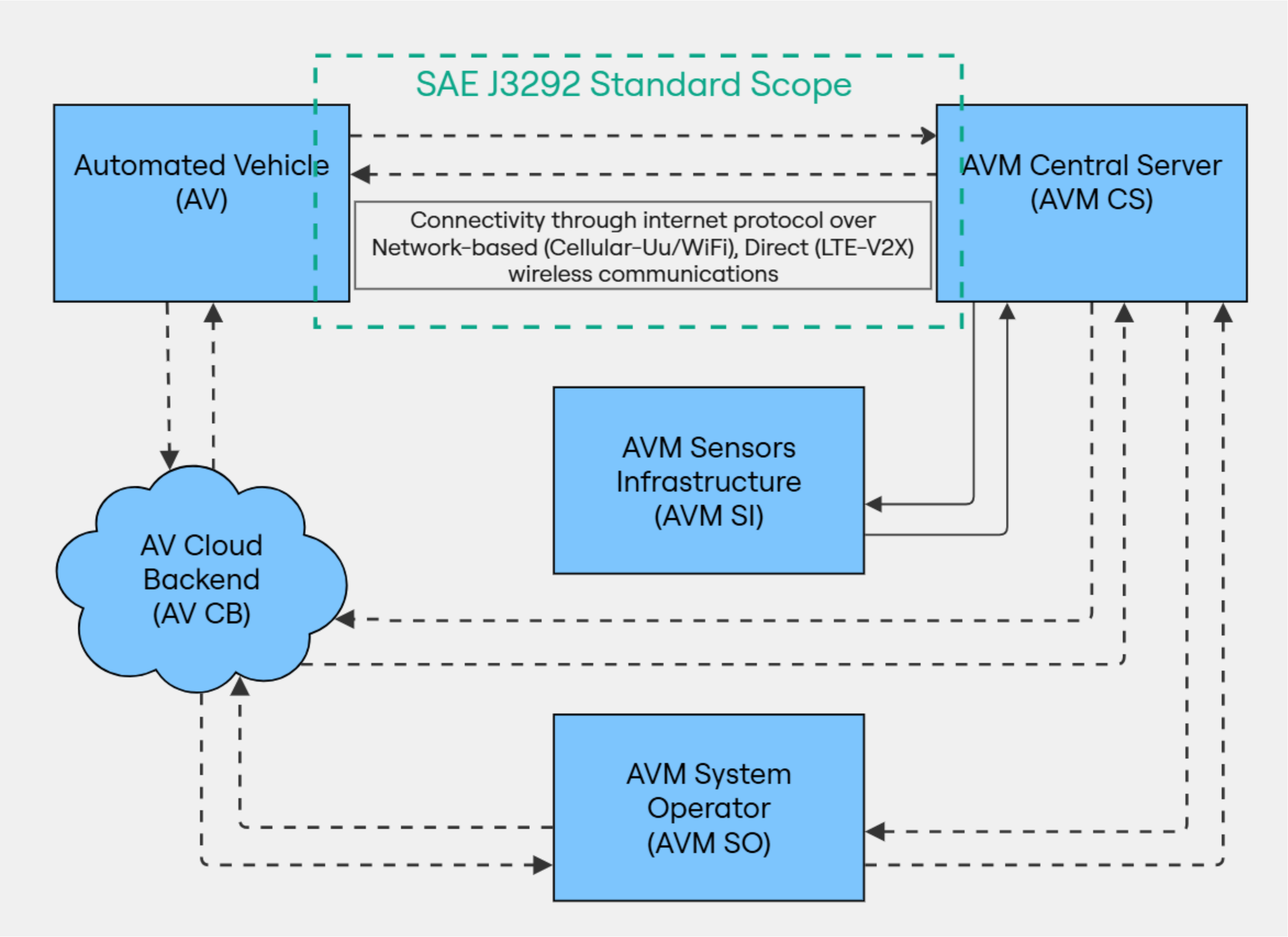


Figure - AVM System Reference Architecture

*WIP Standard

SAE J3292* (AVM System Wireless Logical Architecture)

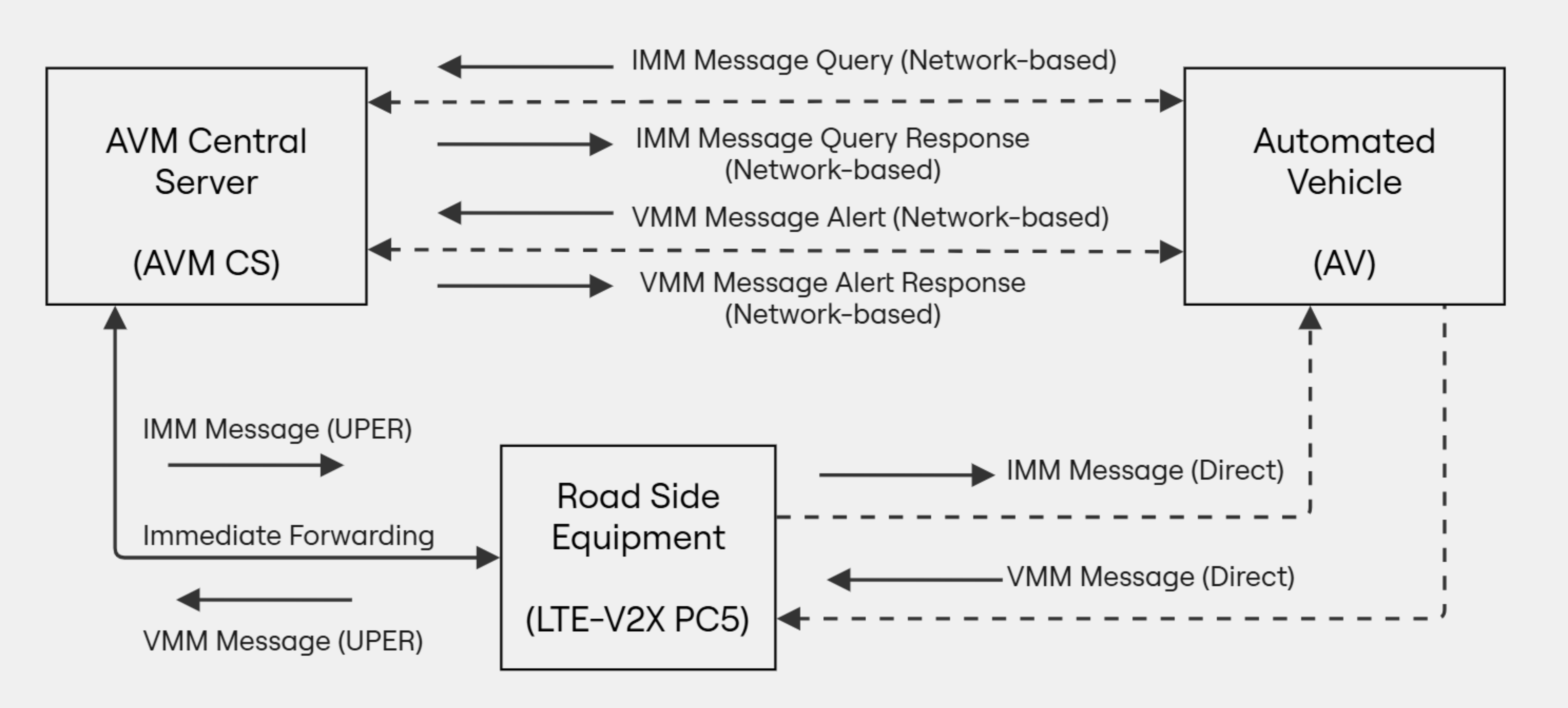


Figure - AVM System Wireless Logical Architecture

- ❑ Infrastructure Marshalling Message (IMM) - An AVM message transmitted by the AVM CS to the AV that contains the information of automated vehicle operation and acknowledgement information to the respective AV (Message Format: UPER)
- ❑ Vehicle Marshalling Message (VMM) - An AVM message transmitted by the AV to the AVM CS to update the infrastructure about its current state and acknowledged receipt of IMM messages from the CS (Message Format: UPER)

*WIP Standard

SAE J3292* (AVM System Logical Flow Overview)

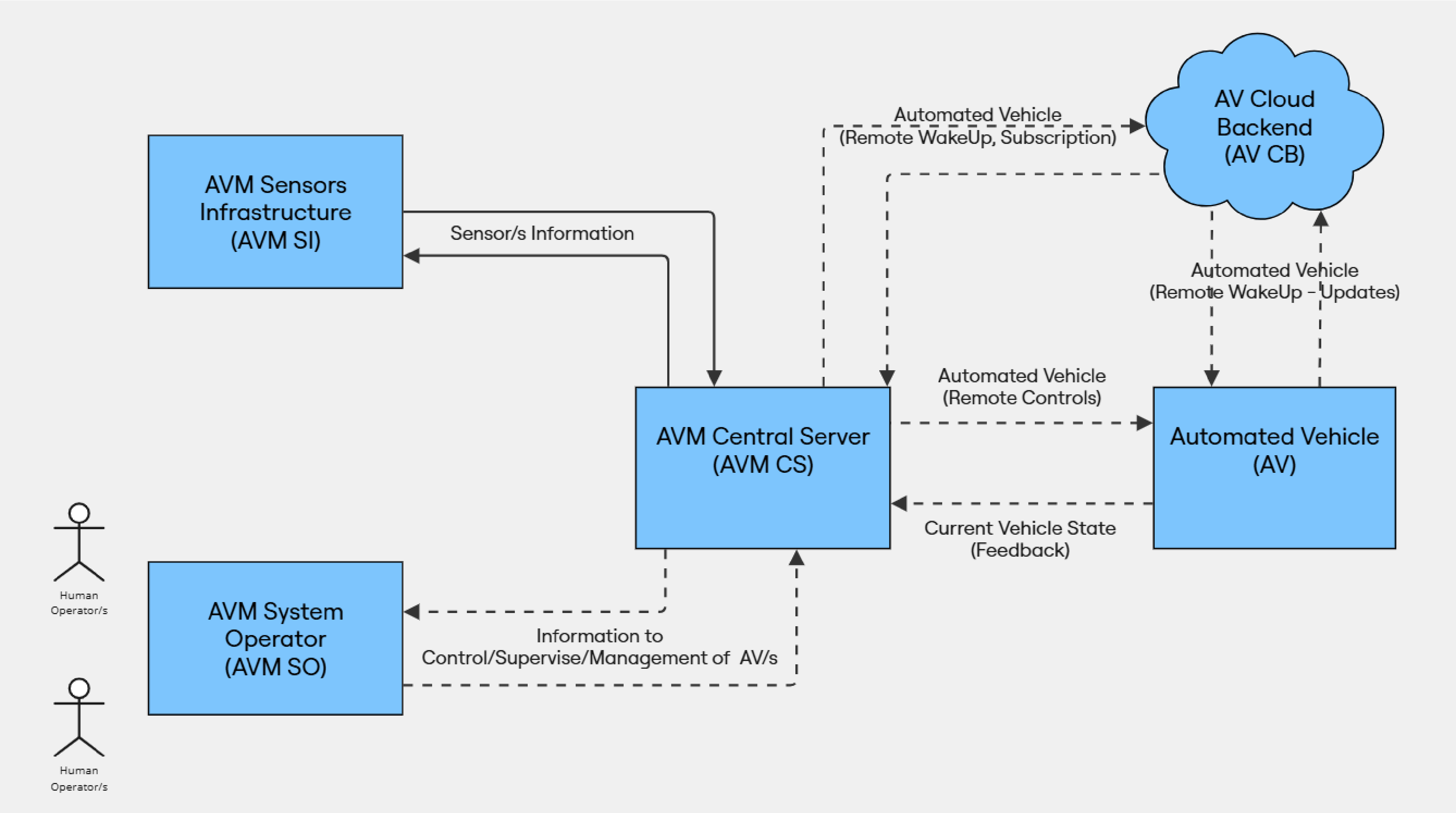
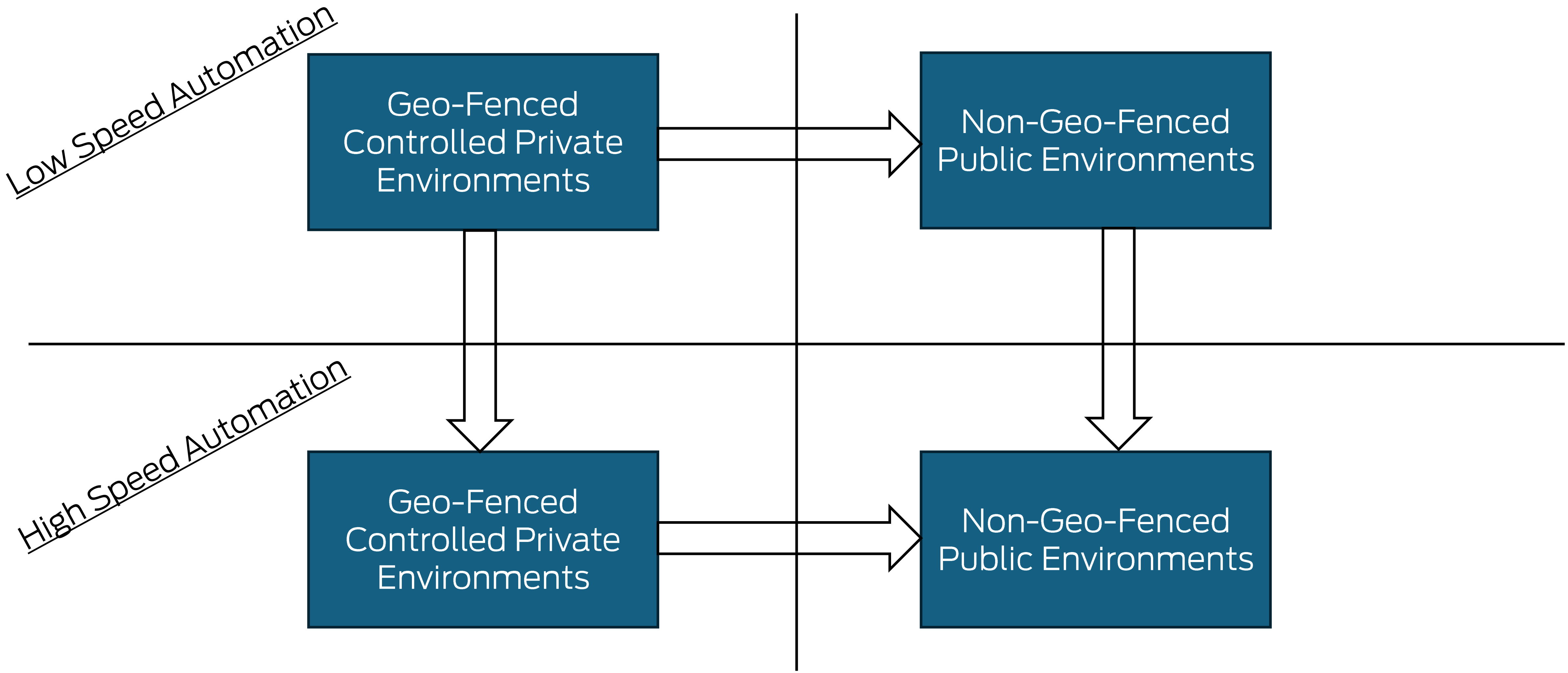


Figure - AVM System Logical Flow Overview

*WIP Standard

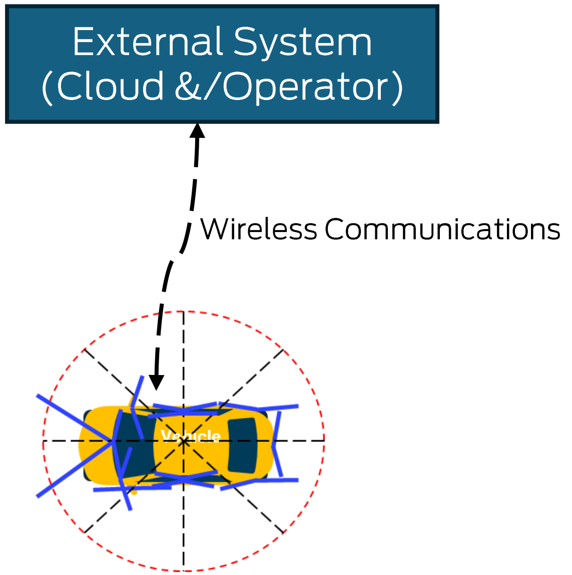
Vehicle Remote Driving Categorization View



Successful Deployments/Adoption refers to Successful Interoperability along-side with Increase in Scalability (starting from Private Environments and transitioning into Public Environments)

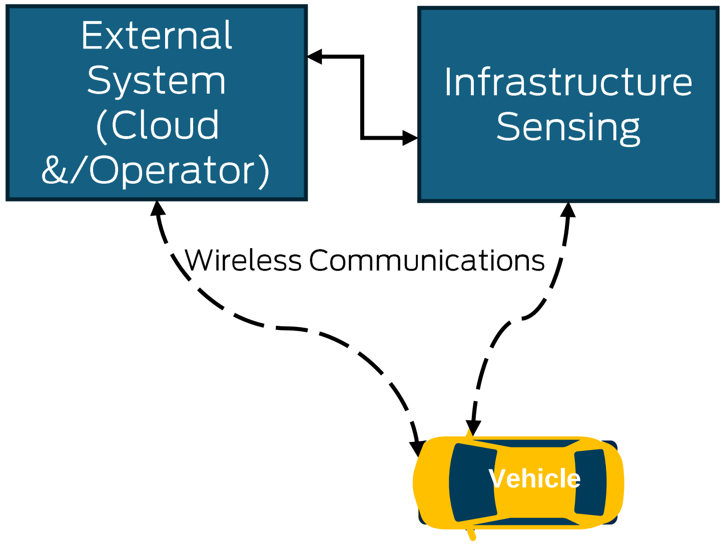
Different Vehicle Teleoperations Types Overview (Vehicle &/ Infrastructure)

Vehicle



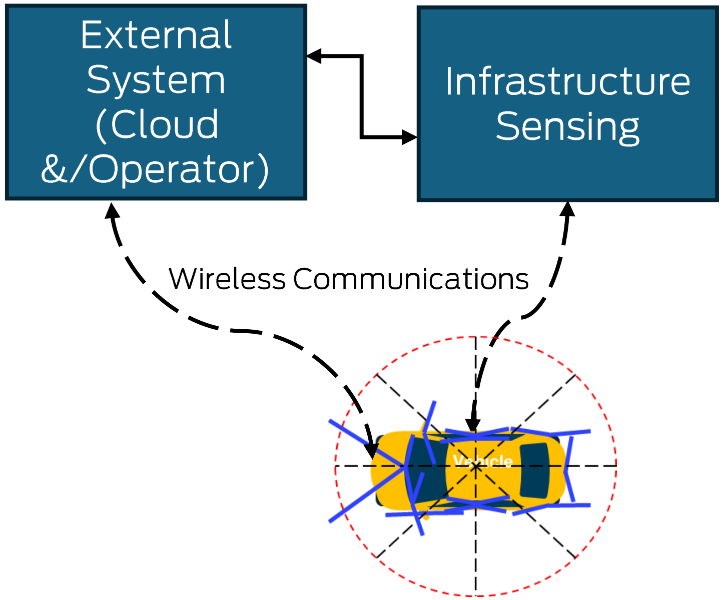
- System using on-board vehicle sensing drives autonomously
- Vehicle is being taken into control remotely when needed

Infrastructure



- System using remote infrastructure drives autonomously (no-vehicle sensing)
- Vehicle is always being remotely Controlled

Vehicle & Infrastructure



- System using both on-board vehicle sensing and remote infrastructure drives autonomously
- Vehicle is being monitored and taken Into control when needed (or) always

Depending on the use-case of Vehicle Teleoperation- respective Vehicle Teleoperations Types shall be utilized

Overview of Different Challenges in achieving effective Vehicle Remote Driving

Categories	Brief Description of Challenges
Wireless Communications	• Cannot reliably achieve >99.7 % efficiency of remote driving using single wireless communications technologies (with consideration of all wireless technologies impacts). • There is need for at least two (one is primary and other one is secondary) wireless communications required.
Time Synchronization	• Need one or more ways/sources to effectively have all the time sources within the end to end system to be synchronized to ~ 1-msec UTC time reference.
Secure Emergency Stop	• Requires precise definition/rules when, who and what gets the emergency stop triggers within the end to end system to avoid any collisions.
ASIL rated Hardware and Software	• To achieve functionally safe remote driving requires highest level of ASIL rated Hardware and Software within the end to end system.
Messages-Protocols	• Always need to ensure that every-one within the end-to-end system does follow the same message format and protocols as expected when exchanged over wired and/or wireless networks communications.
Functionally Safe Messages	• Need alignment for usage of end to end protection/checksum for safe and secure functional safety point of view operations.
Standards-Interoperability	• Requires definition of which standards to be followed from interoperability operational point of view to avoid any gaps from operational point of view from the end to end system.
Liability-Responsibility	• Need consolidated rules from who is Liable from what module of the end to end system and who takes responsibility when any collision is involved.
Teleoperations Types	• Requires clear rules/definitions/prioritizations defined about when the vehicle needs to be teleoperated under what circumstances especially when system is using on-board vehicle sensing along side of Infrastructure sensing.
Regulations	• System needs to be aware and shall adhere in following all the regulations in order to achieve safe and secure vehicle remote driving functionalities.
Messages-Security	• Requires definition of security impacts over usage with respect to Signing/Encryption using HSM or SW based, Verification/Decryption using HSM or SW based for implementation over different wireless communications for secure interoperability.