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Speaker :

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Impact of Ad-Hoc Telecommunication Network Coverage on Traffic for a Variable Speed Limit System



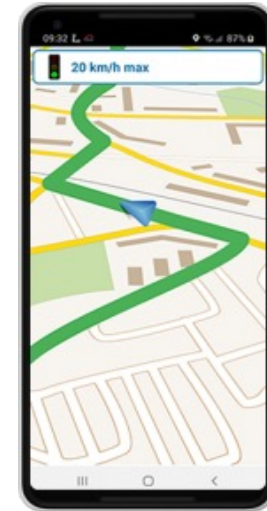
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Context and objectives

Context

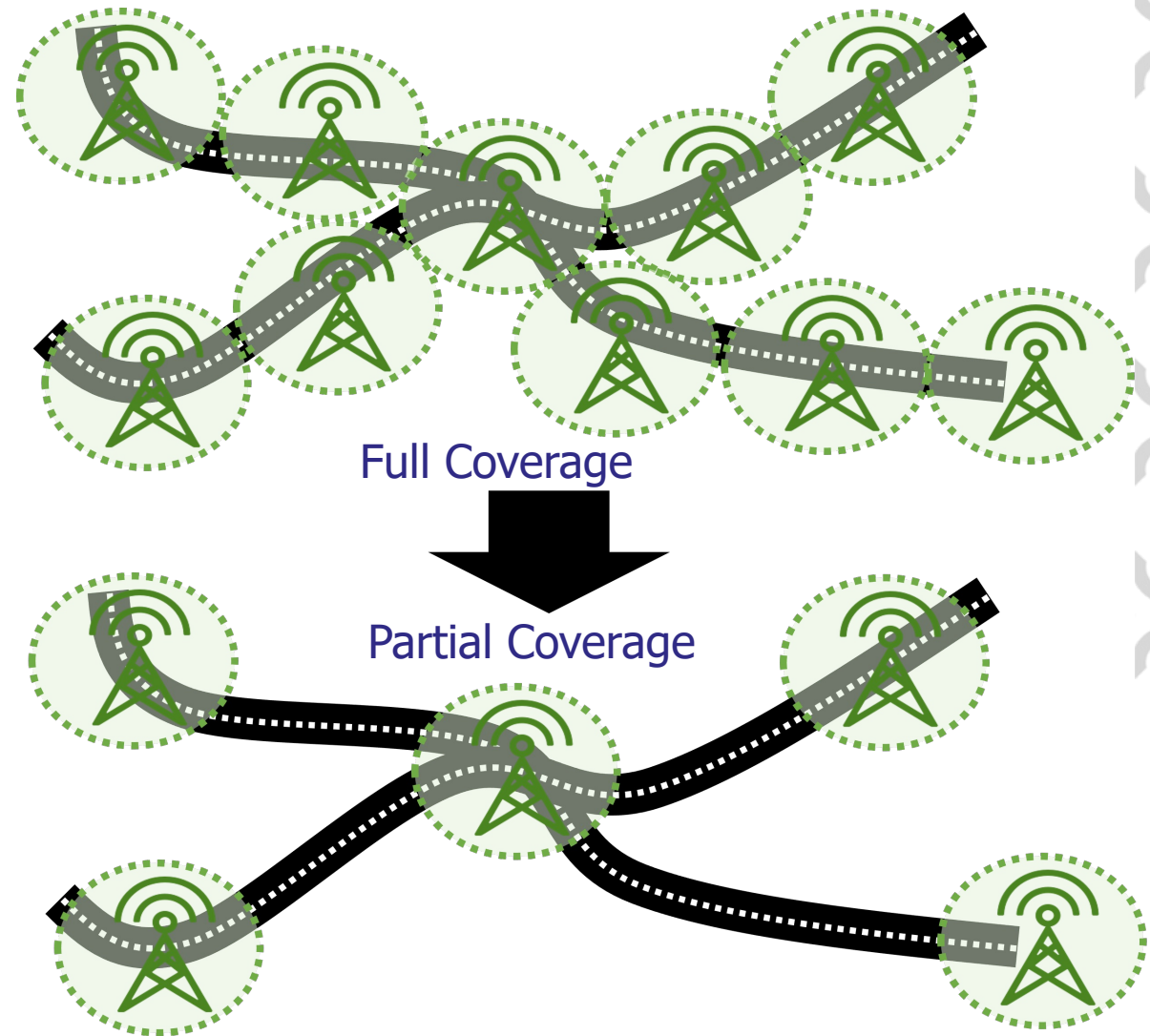
- European Projects to support the development and evaluation of C-ITS services
 - SCOOP
 - C-ROADS
 - INDID
- Intention to deploy C-ITS services at large scale in the upcoming years
- Needs for recommendation to optimize the location of telecommunication infrastructures along the road infrastructures, especially regarding Ad-Hoc technologies
 - ITS-G5 requires dedicated Ad-Hoc infrastructures along the road infrastructure to proper work



Main purpose

- Perform a **sensitivity analysis** regarding the impact of **tightness of Road Side Unit's Ad-Hoc Network** on the performances of speed control strategies
- Develop some **recommendations** regarding the **location of the Road Side Units** (for ITS-G5) along road infrastructures

Illustration of the problem of RSU's location



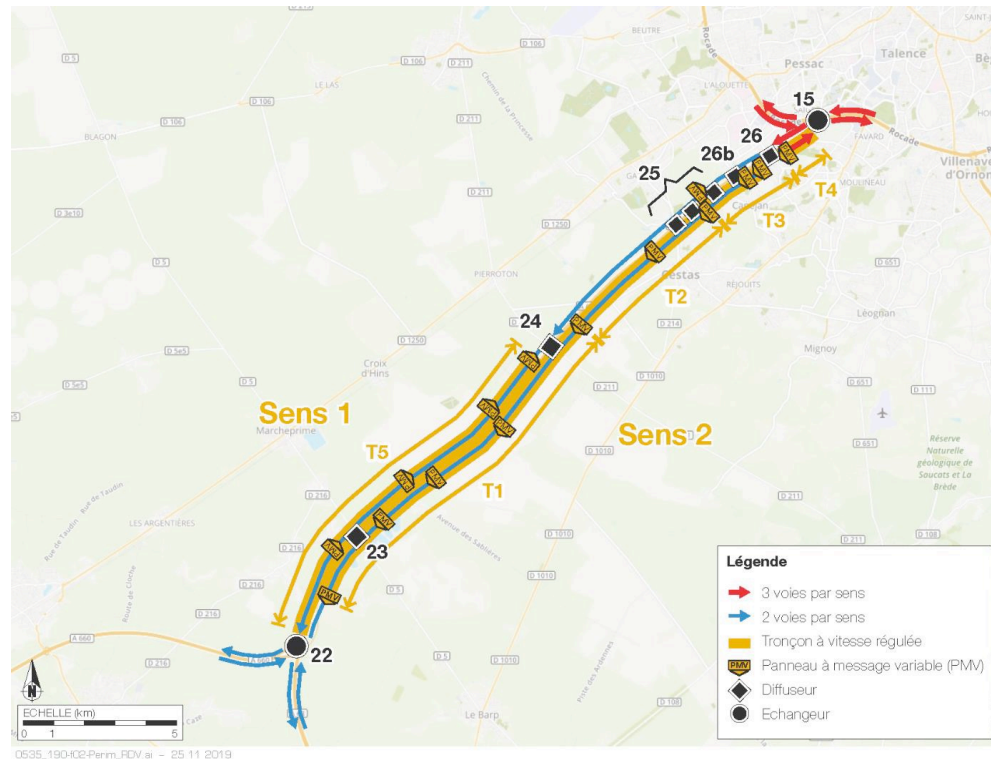
What impact on VSL performance?



Data resources & simulation framework calibration

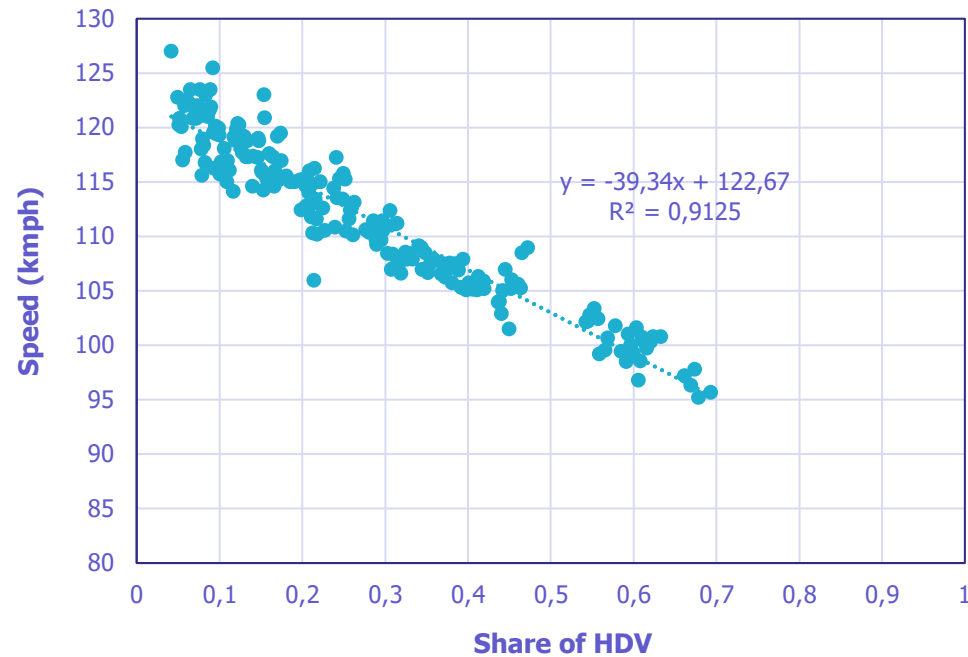
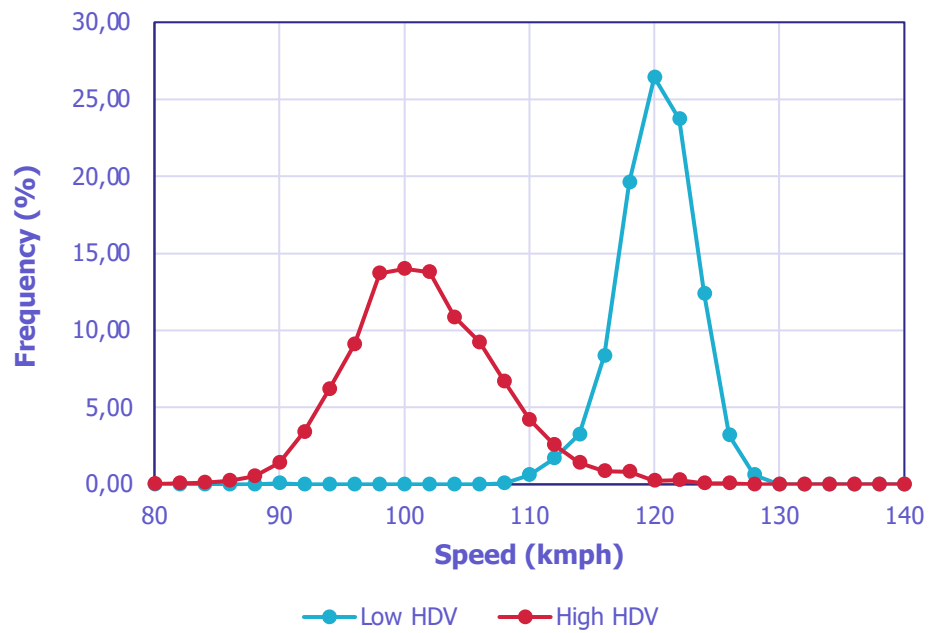
Field Test Data resources

- Data available from a section of A63 highway (Bordeaux) used to develop and calibrate a highway environment
- Data consists of two different periods collected through Loop sensors:
 - Year 2017 (June): without VSL (used for calibration)
 - Year 2018 (June): with VSL using Variable Message Signs (used for validation)



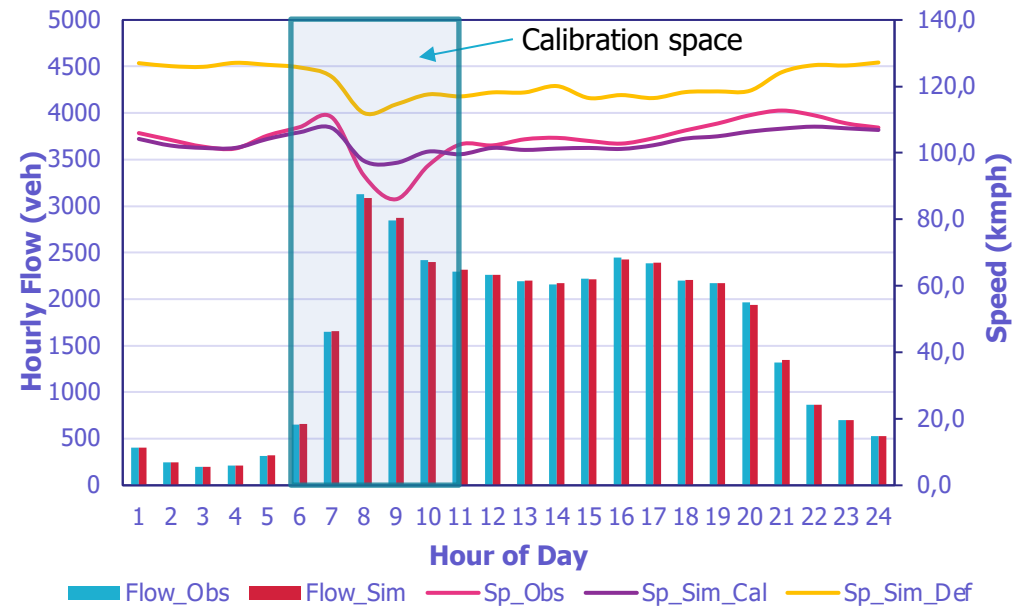
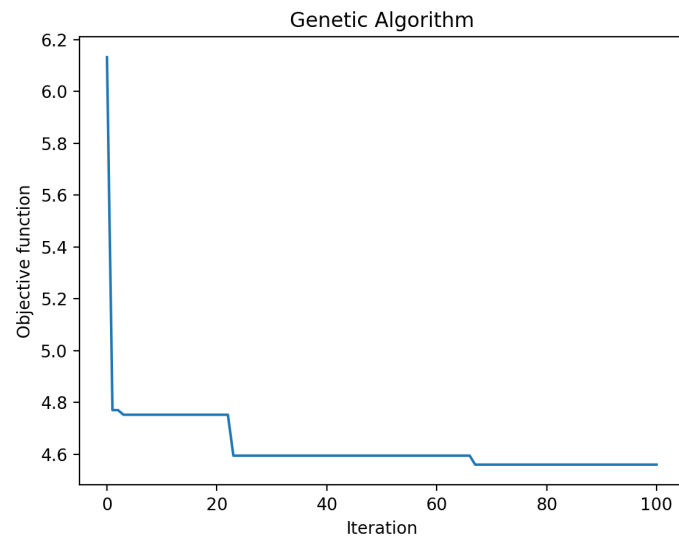
Main outlines from the Field Test Data

- Two separate vehicle classes (LV and HDV) – loop detector data does not provide information on vehicle type
- Speed distribution under free-flow condition clearly indicate two separate profiles



Simulation framework calibration

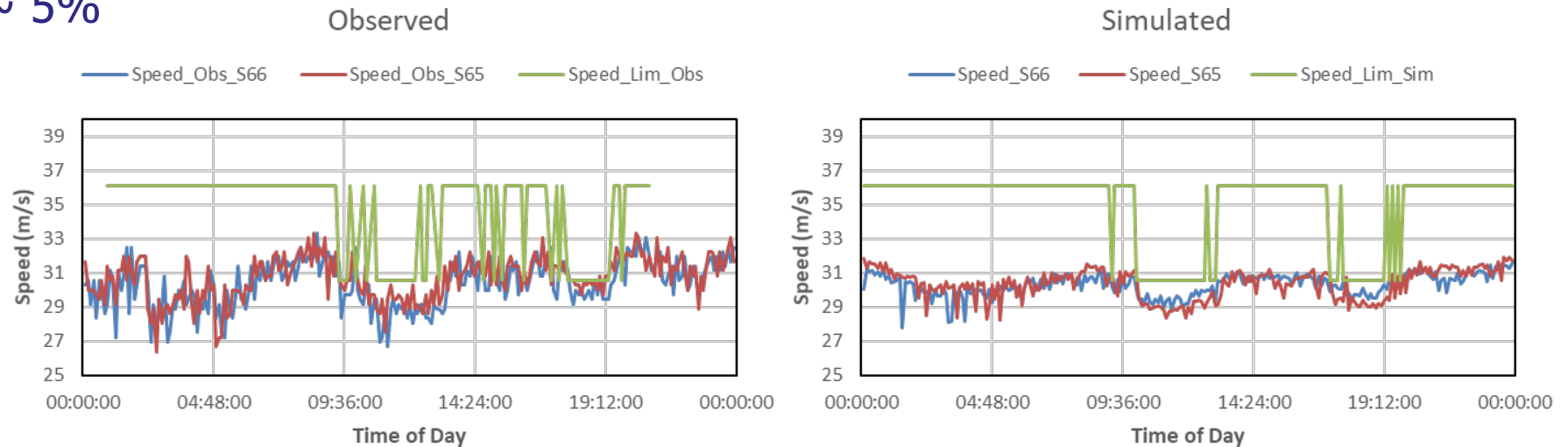
- GA-based driving behavior optimization of the two vehicle classes (MaxSpeed[car, truck], MinGap[car, truck], accel[car], decel[car], sigma[car, truck], tau[car, truck]) for baseline (year 2017 with no DSL)
- Objective function = RMSE[speed]



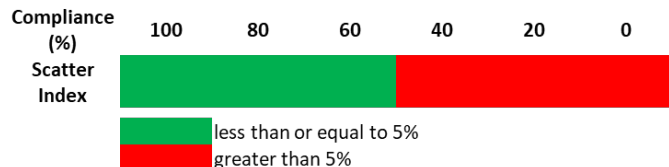
Default Parameters

Simulation framework validation

- DSL logic for variable speed signs developed as a python script and implemented using traci
- Applied to two separate sections (T1 and T5) of A63 highway near Bordeaux and compared with 2018 data (with DSL)
- $RMSE[speed] \sim 5\%$



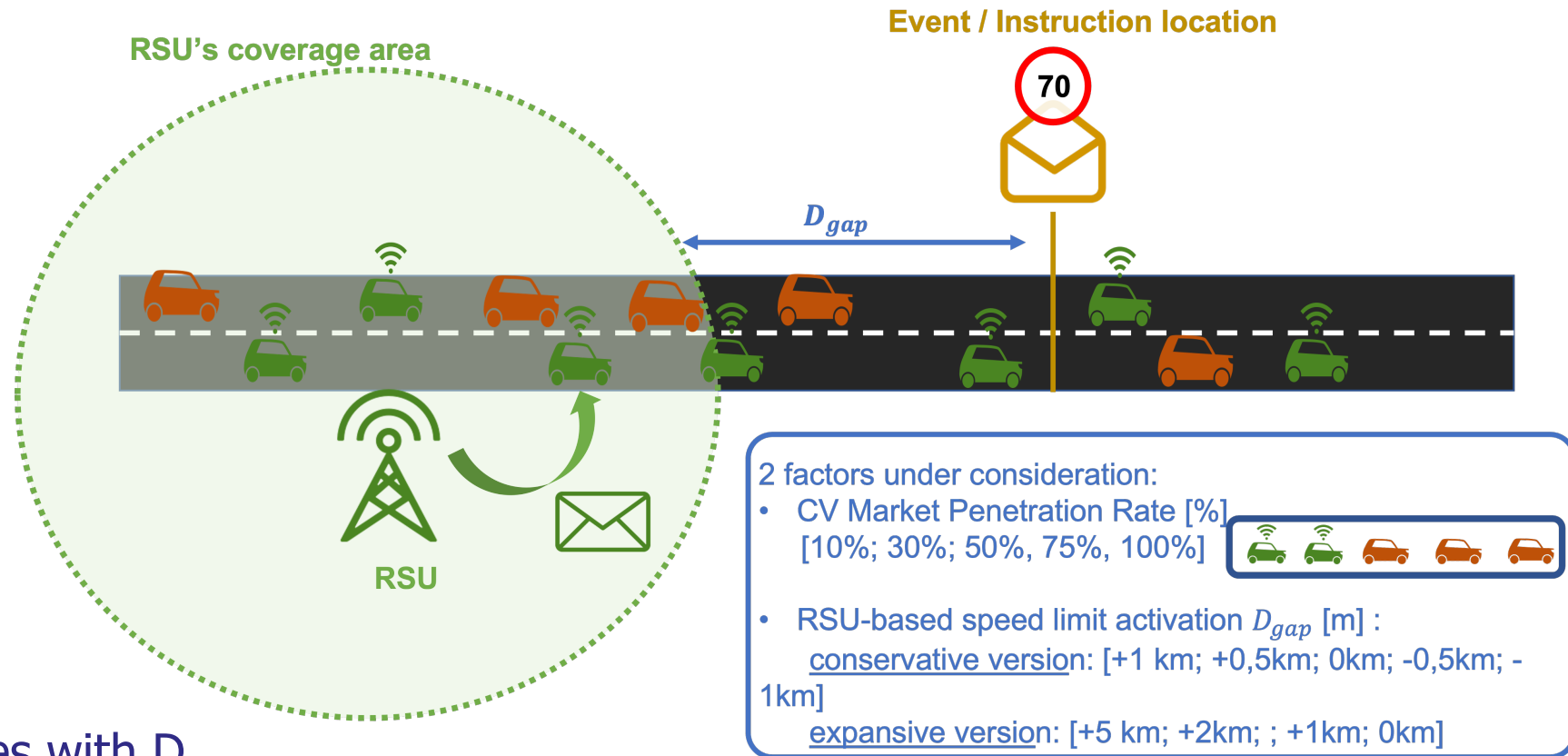
- Calibration works effectively upto a compliance rate of 60% to VMS.





Evaluation methodology

Experimental Design – Two factors under consideration



- Two possible cases with D_{gap}

- **Case A:** The connected vehicle receives speed instruction at D_{gap} distance from event location.

- **Case B:** The connected vehicle is identified by RSU at D_{gap} but the vehicle receives the delayed speed instruction when it reaches event location.

Experimental design – KPI and scenarios under consideration

- Factors:

- CV's Market Penetration Rate (MPR - %)
- D_{gap} with 2 options:
 - case A: conservative and restricted broadcasting abilities for RSU
 - case B: expansive and extended broadcasting abilities for RSU

- Key Performance Indicators :

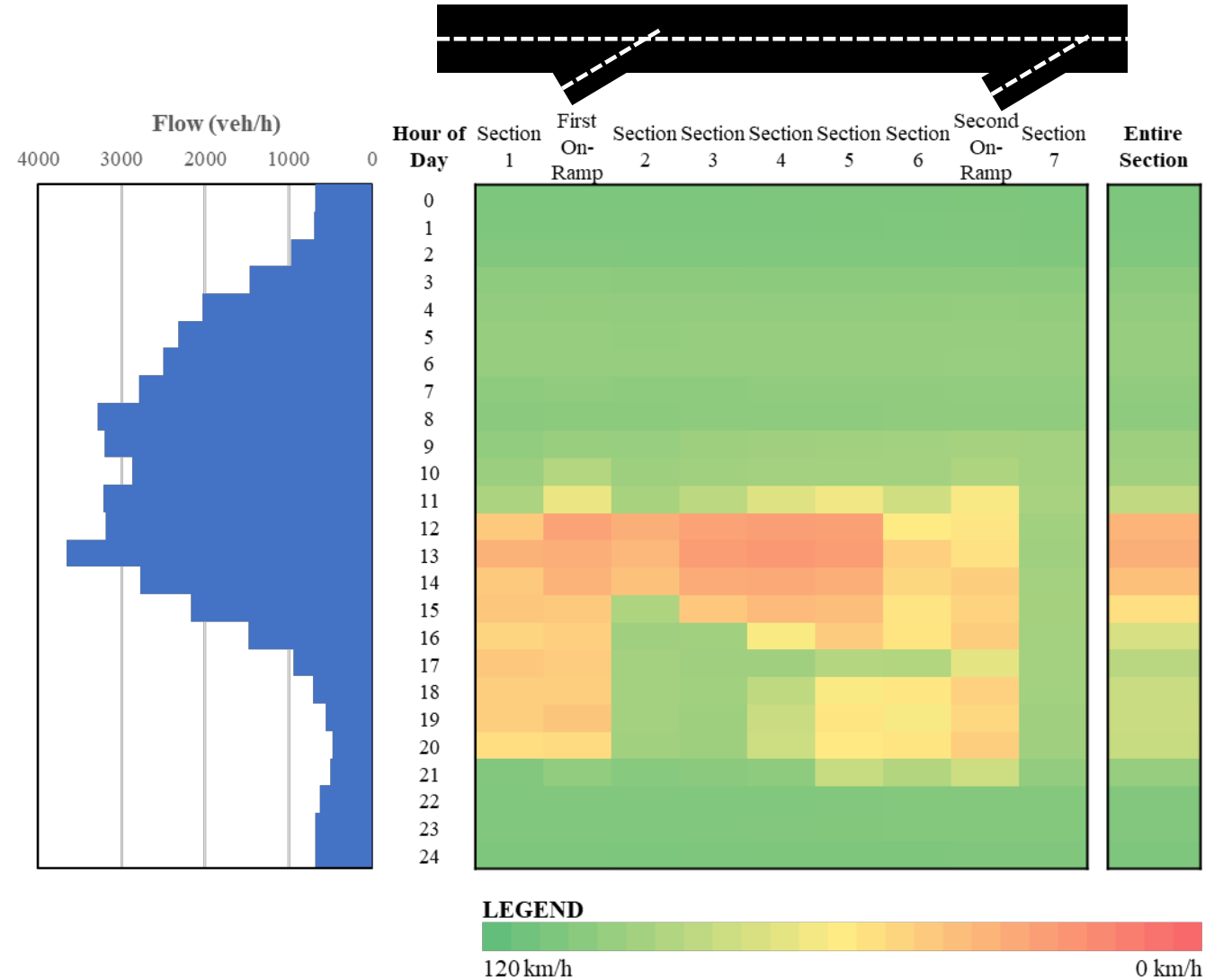
- Average speed (km/h)
- CO₂ emissions (kg/veh)

- Scenarios under comparison :

- Baseline, i.e. Realistic flow without VSL
- VMS-based VSL approach, i.e. VSL applied through Variable Message Signs
- CV-based approach, i.e. VSL applied to Connected Vehicles only

- Event/instruction location =

- VMS location



Baseline – no VSL

Congestion and corresponding shockwaves due to high merging conflicts at the on-ramps

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Analysis and findings

VMS-based approach performances

Baseline – no VSL



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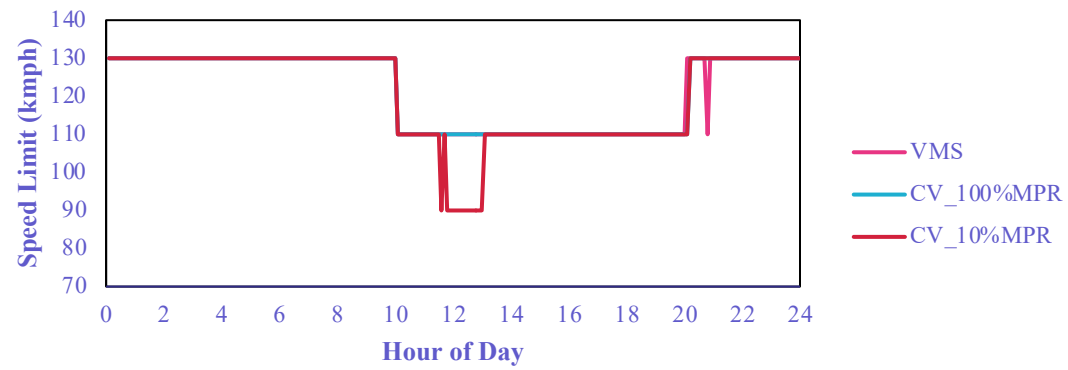
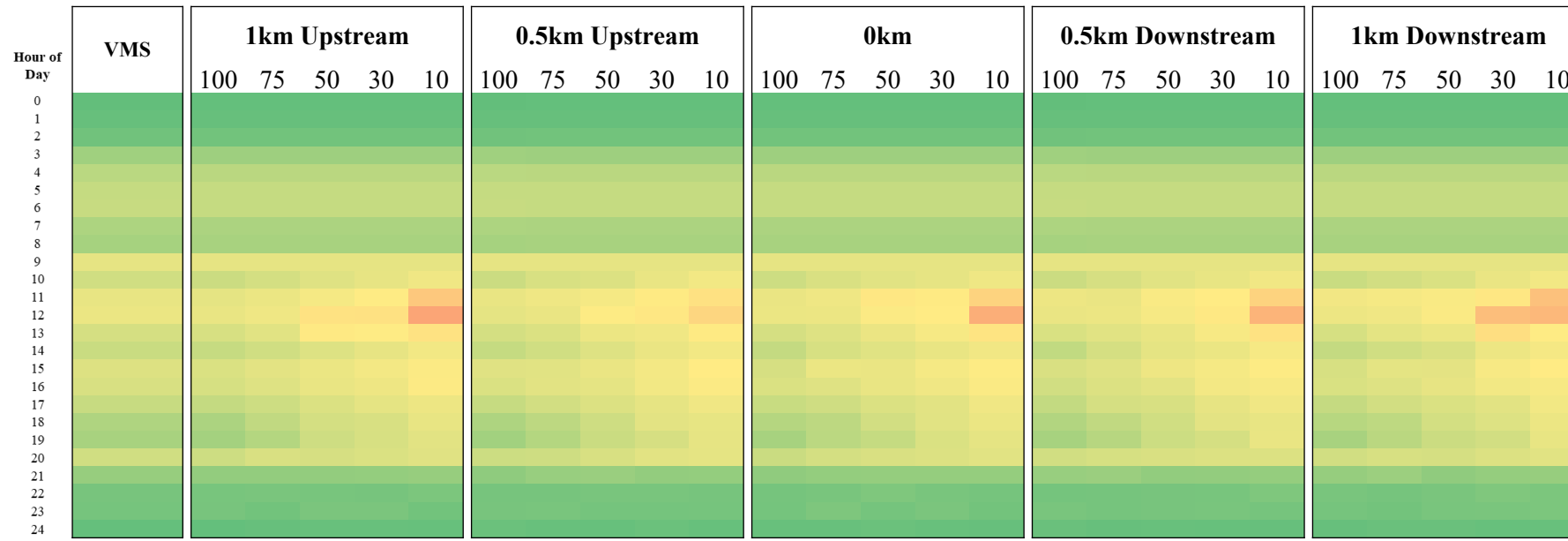
VMS-based approach



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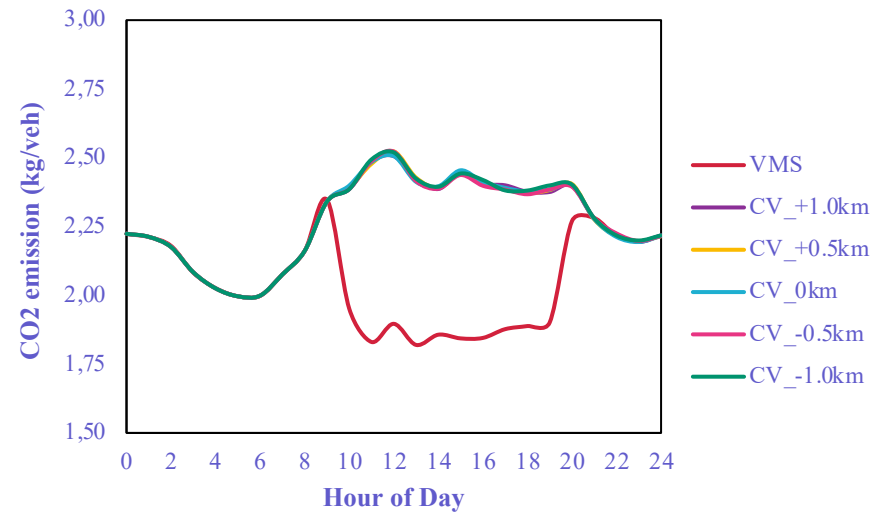
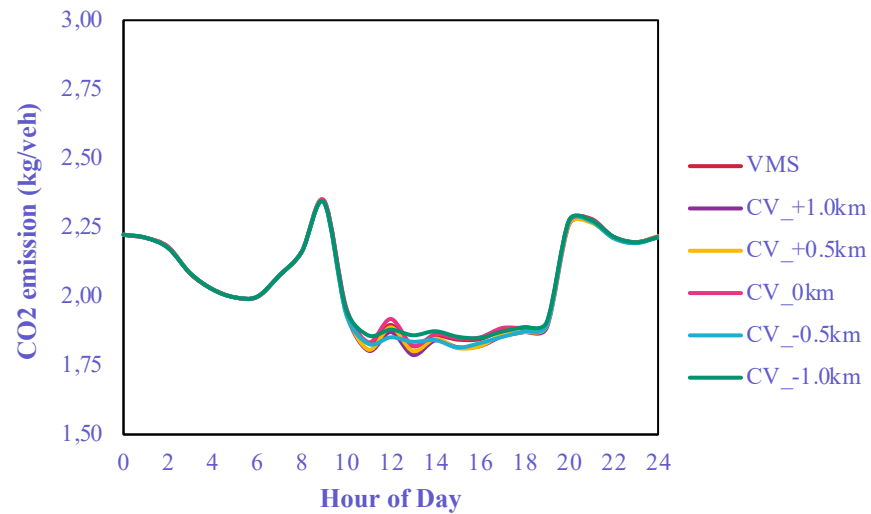
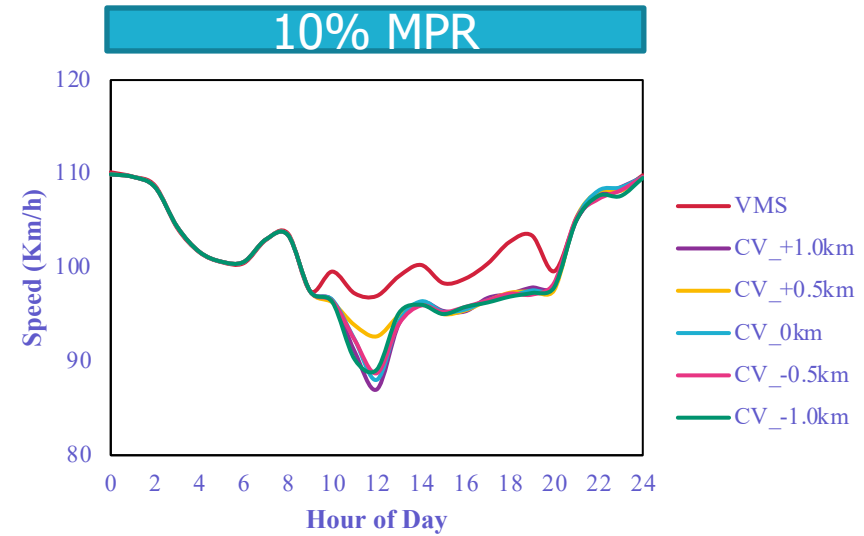
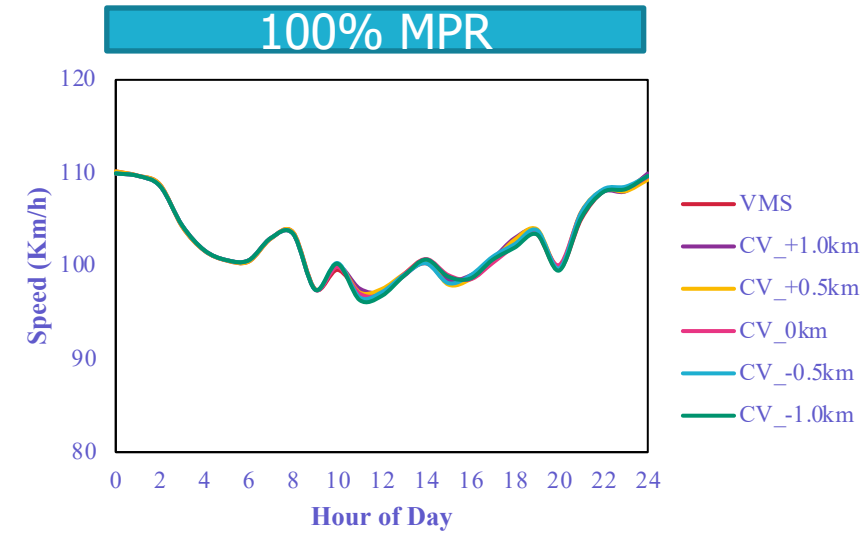


CV-based approach – Case A Findings



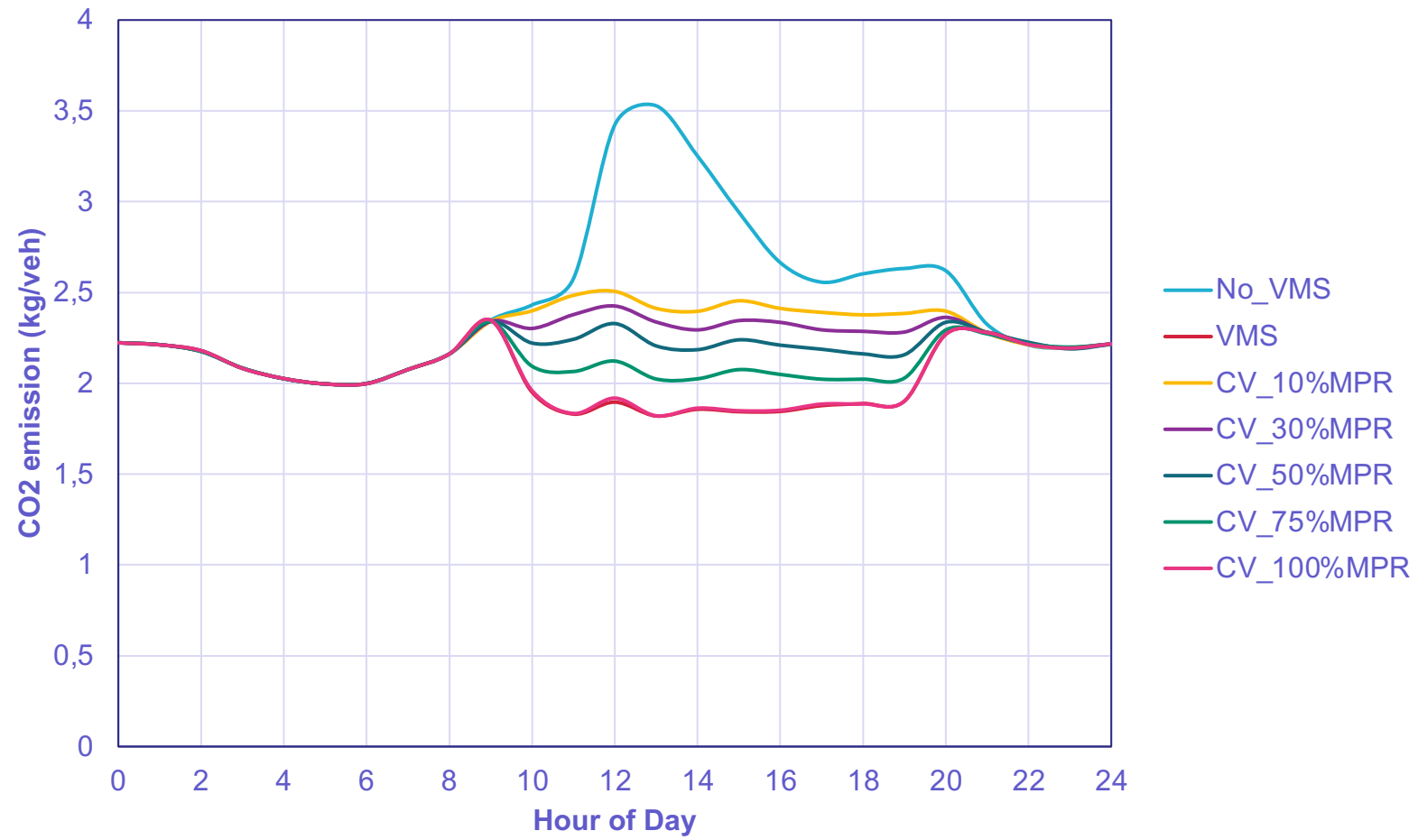
CV-based approach – Case A

KPIs Analysis



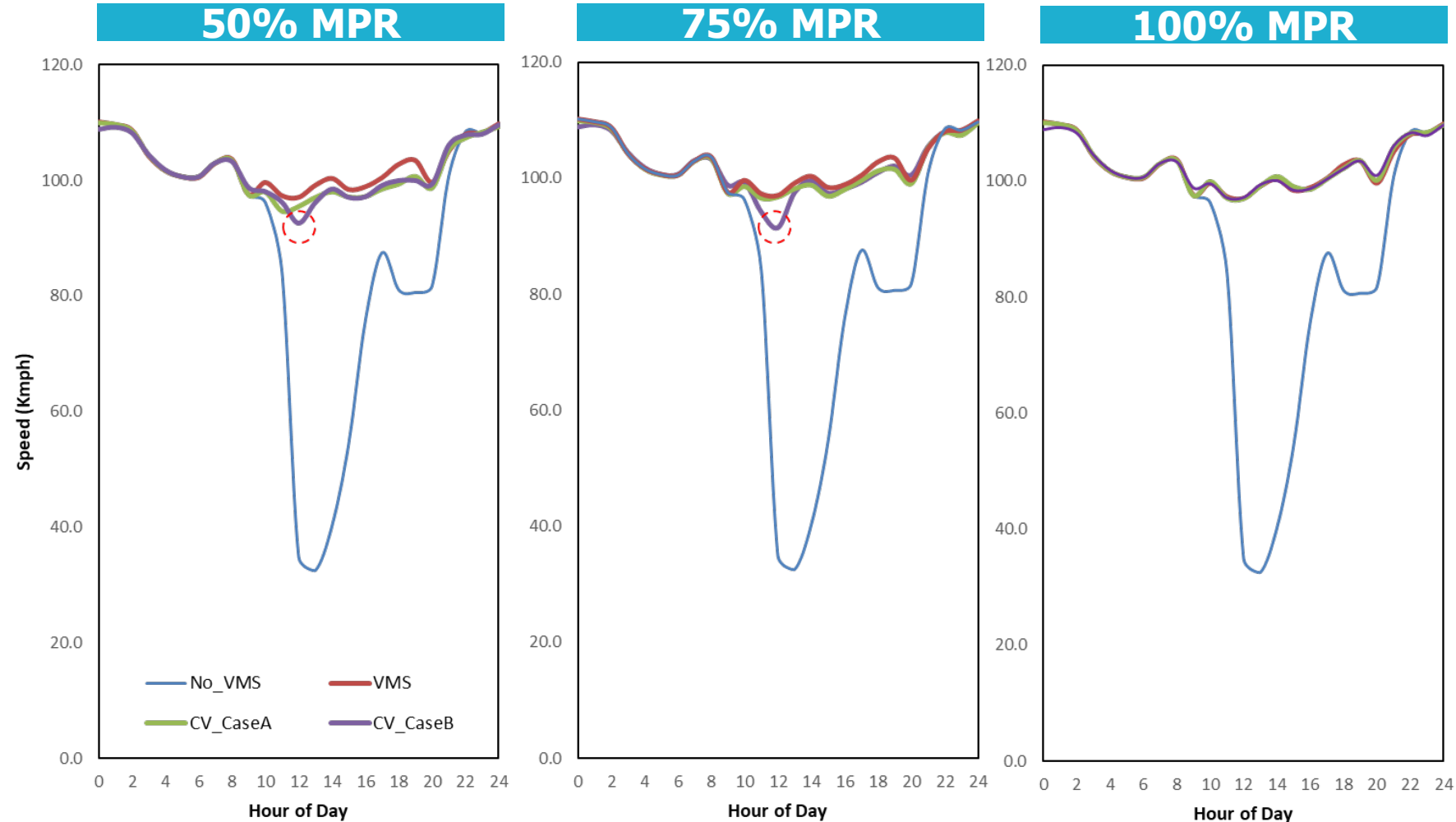
CV-based approach – Case B

Findings



CV-based approach – Case B

KPIs Analysis



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Conclusions & Perspectives

Conclusions

- Even at low MPR, the DSL algorithm is considerably effective in terms of traffic efficiency.
- However, the effectiveness in terms of environmental efficiency improves significantly with increased MPR of CV.
- Providing speed instructions upstream of the event location is more effective than providing downstream.
- However, providing the same too further upstream of the event location reduces effectiveness at low MPR.
- The effectiveness of Case B is more or less similar to Case A, except at very high flow levels along with high share of merging traffic.
- **Main limits of current work:**
 - No investigation of delays caused in the wireless communication between RSU and CV
 - No integration of reduced compliance of human drivers with speed recommendations

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