

Cooperative Decision-Making for Safe On-Ramp Merging on Highway for Connected Automated Vehicles

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On-ramp merging based on cooperative decision-making

Cooperative Automated Vehicles (CAVs) advantages address many areas: *safety* with accident reduction; *health* while improving passengers' comfort; *transportation time* since it reduces road congestion; *ecology* with fuel efficiency among other advantages.

Our work aims to develop a **cooperative decision-making level** part of the architecture in Figure 2 to guarantee the *safety requirement* in the case of on-ramp merging on highway (Cf. Figure 1). The CAVs under the communication range of the Road Side Unit (RSU) in Figure 1 are put into a formation using the **virtual structure formalism** in [2]. A formation reconfiguration algorithm based on the **Constrained Optimal Reconfiguration matrix (CORM)** [1] is used to reconfigure the formation according to the passing sequence selected by **Cooperative decision-making level**.

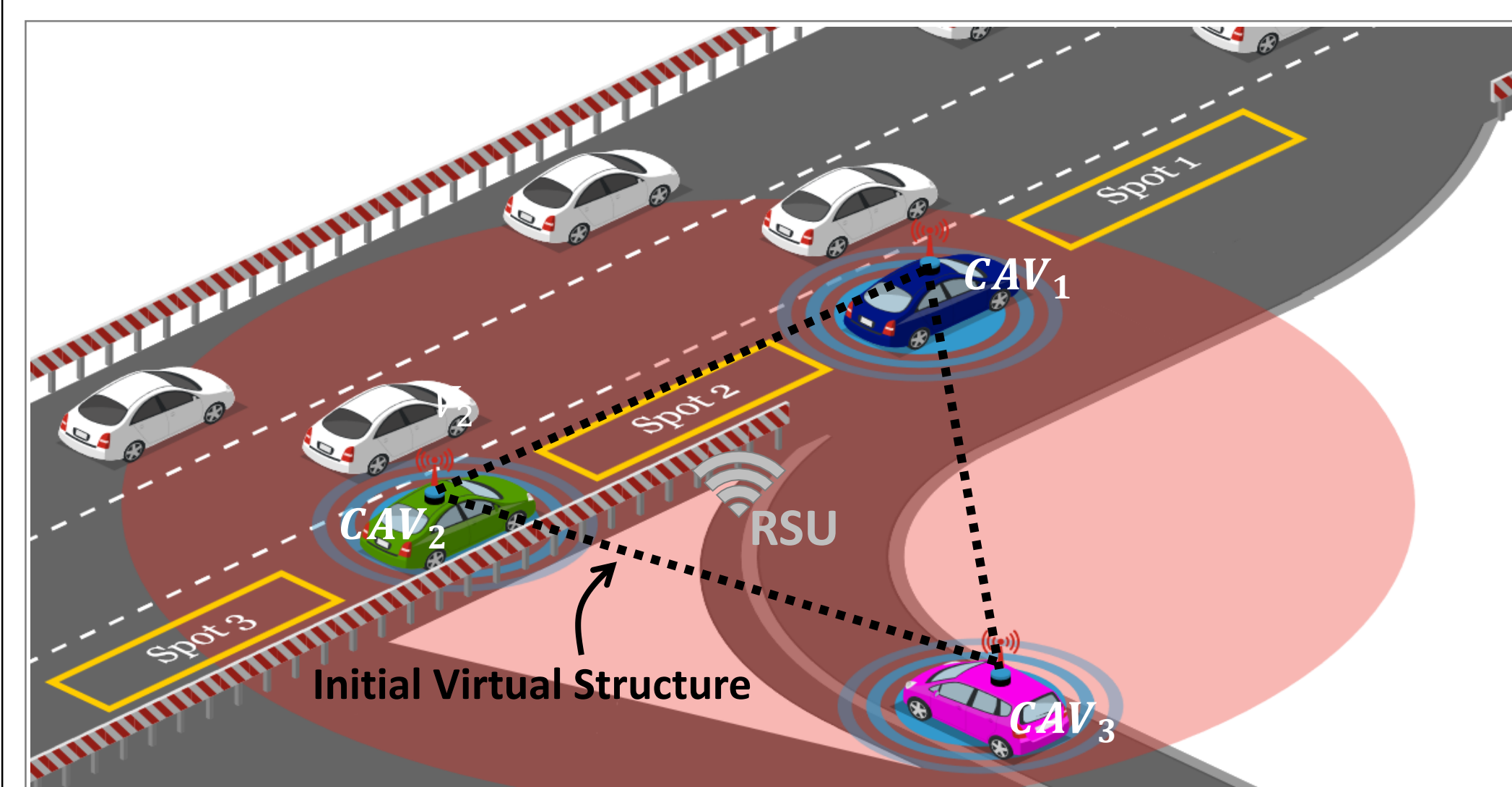


Fig 1. On-ramp merging on highway performed by CAVs.

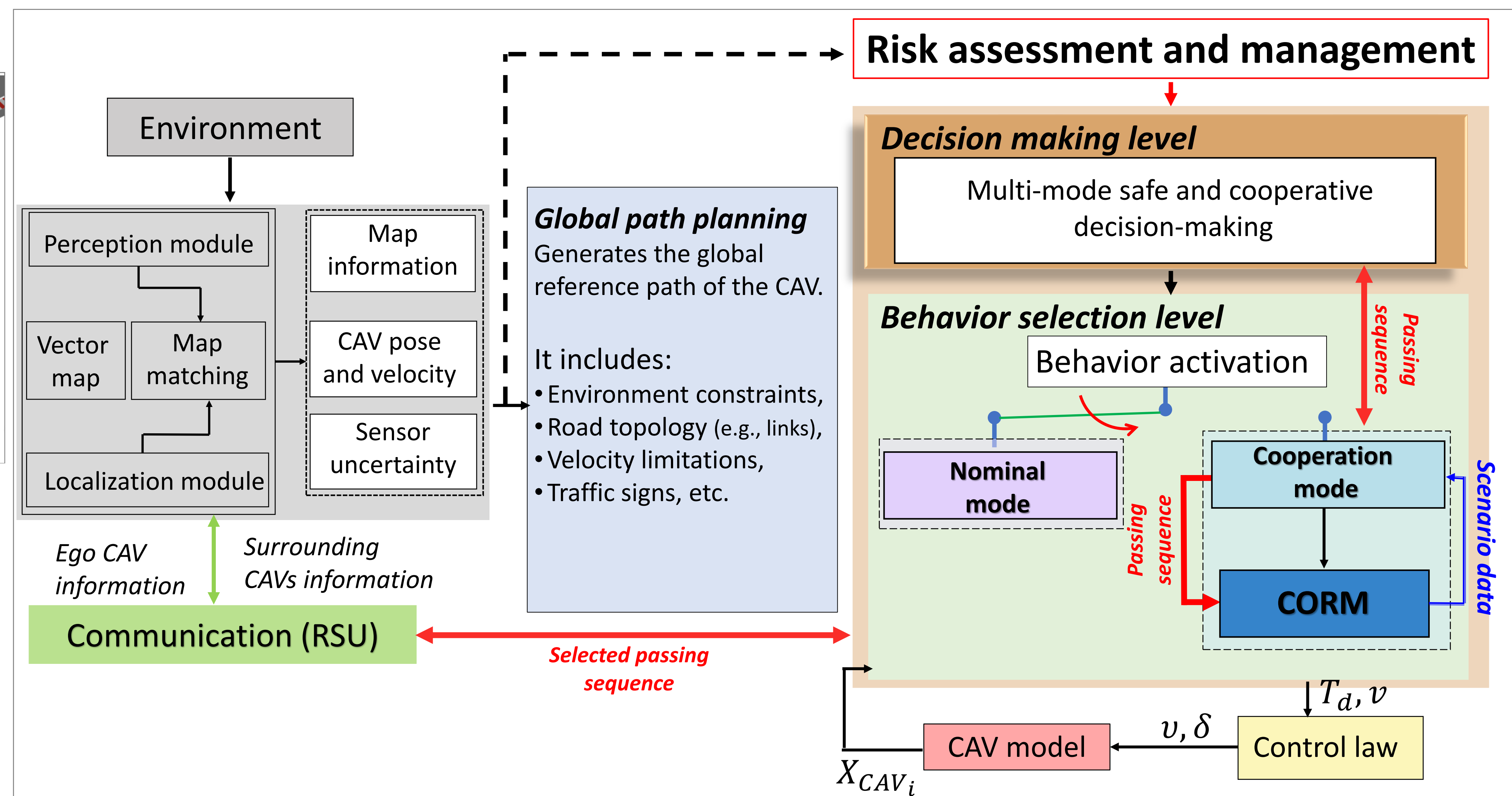


Fig 2. Overall architecture of the proposed safe cooperative on-ramp merging on highway.

Simulation results

The following simulation results present the cooperation importance to solve a conflicting situation (collision) in the case of on-ramp merging on highway.

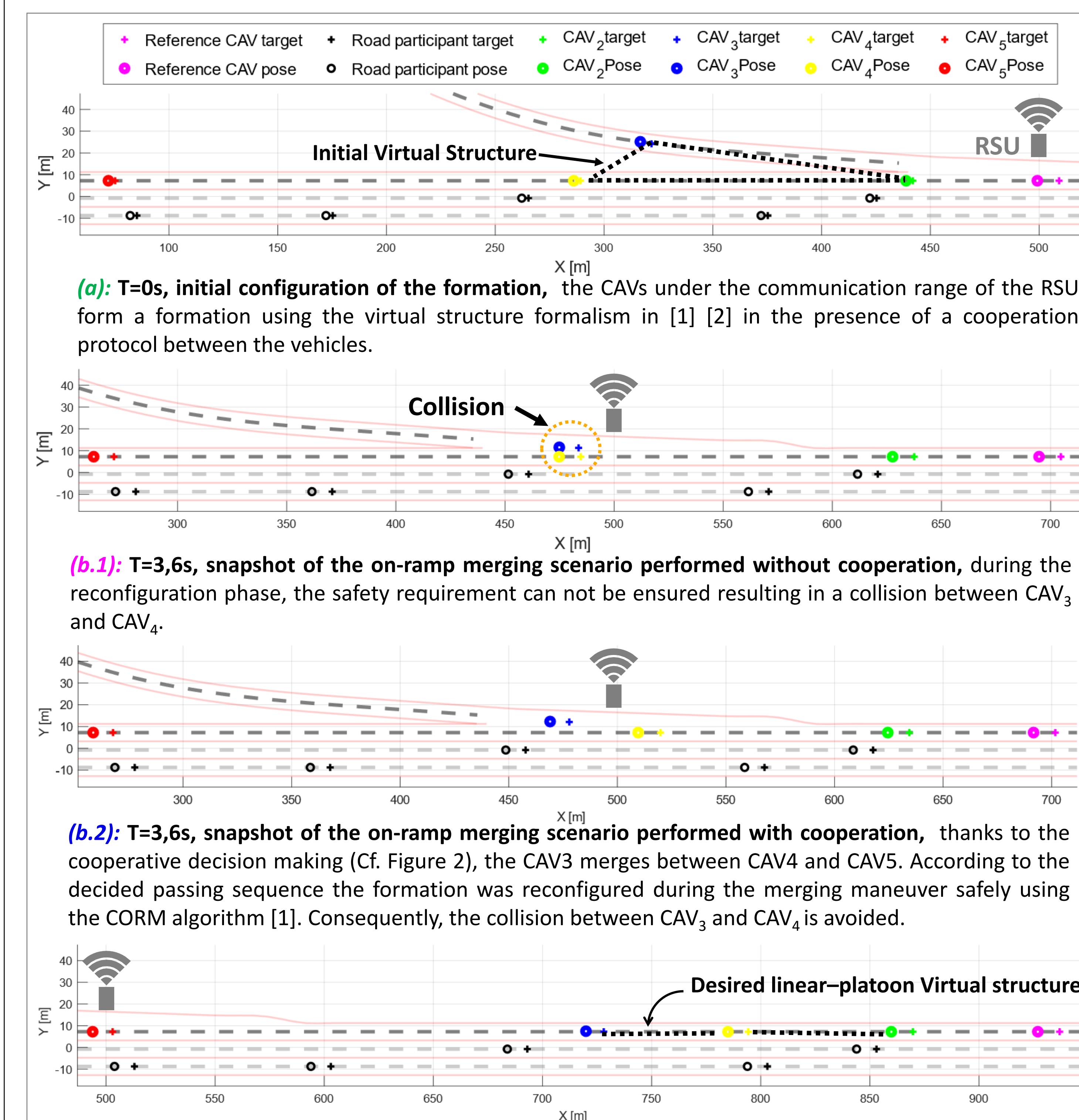


Fig 3. Snapshots during the on-ramp merging on highway with and without cooperation.

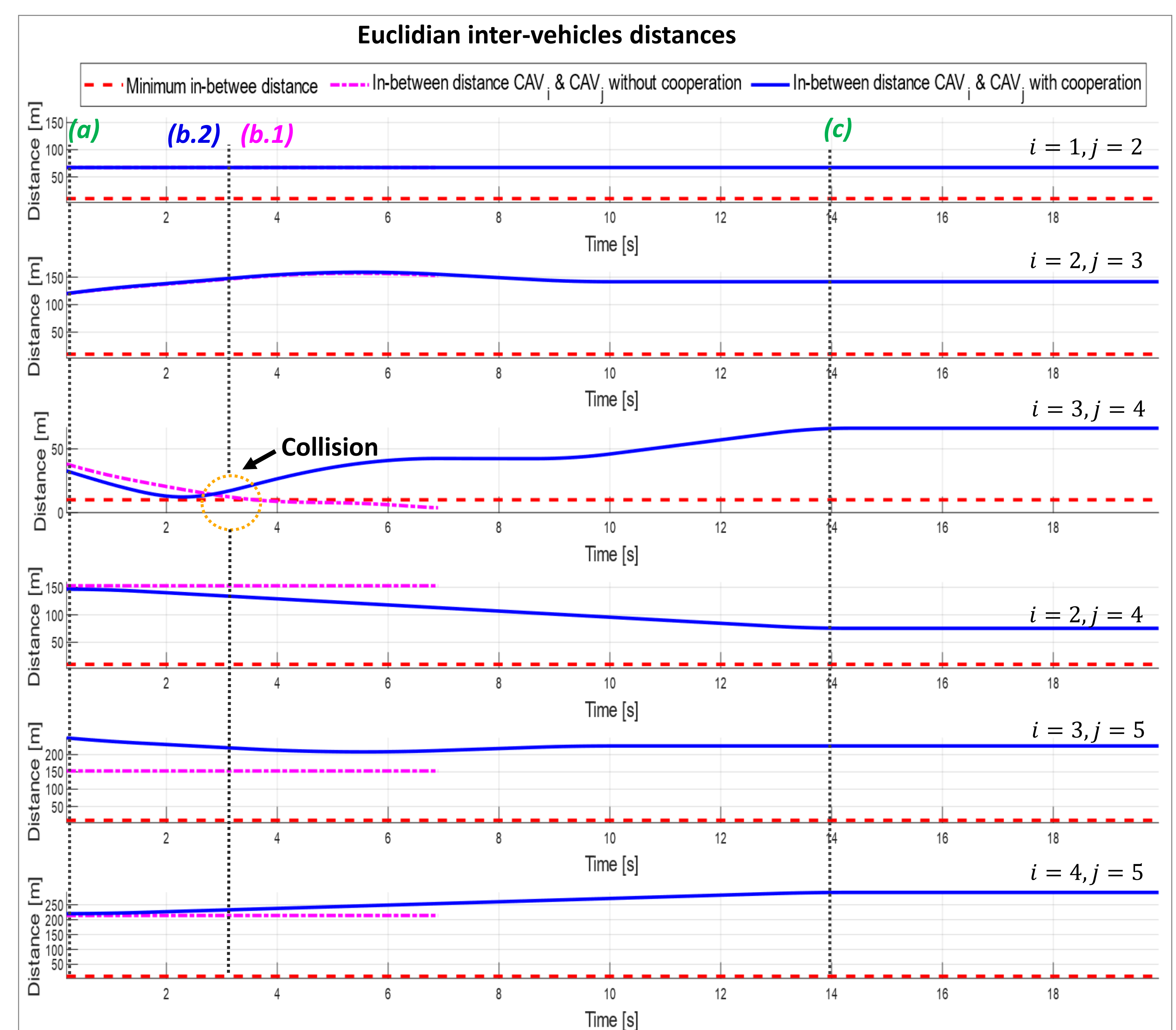


Fig 4. Resulting Euclidian inter-vehicles distances with and without cooperation.

References:

- [1] L. Saidi, L. Adouane and R. Talj, "CORM: Constrained Optimal Reconfiguration Matrix for Safe On-Ramp Cooperative Merging of Automated Vehicles," *IEEE 25th International Conference on Intelligent Transportation Systems (ITSC)*, Macau, China, 2022.
- [2] J. Vilca, L. Adouane, and Y. Mezouar, "Stable and flexible multivehicle navigation based on dynamic inter-target distance matrix," *IEEE Transactions on Intelligent Transportation Systems*, vol. 20, no. 4, pp. 1416–1431, 2019.

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