

# **A Digital Twin Paradigm: Vehicle-to-Cloud Based Advanced Driver Assistance Systems**

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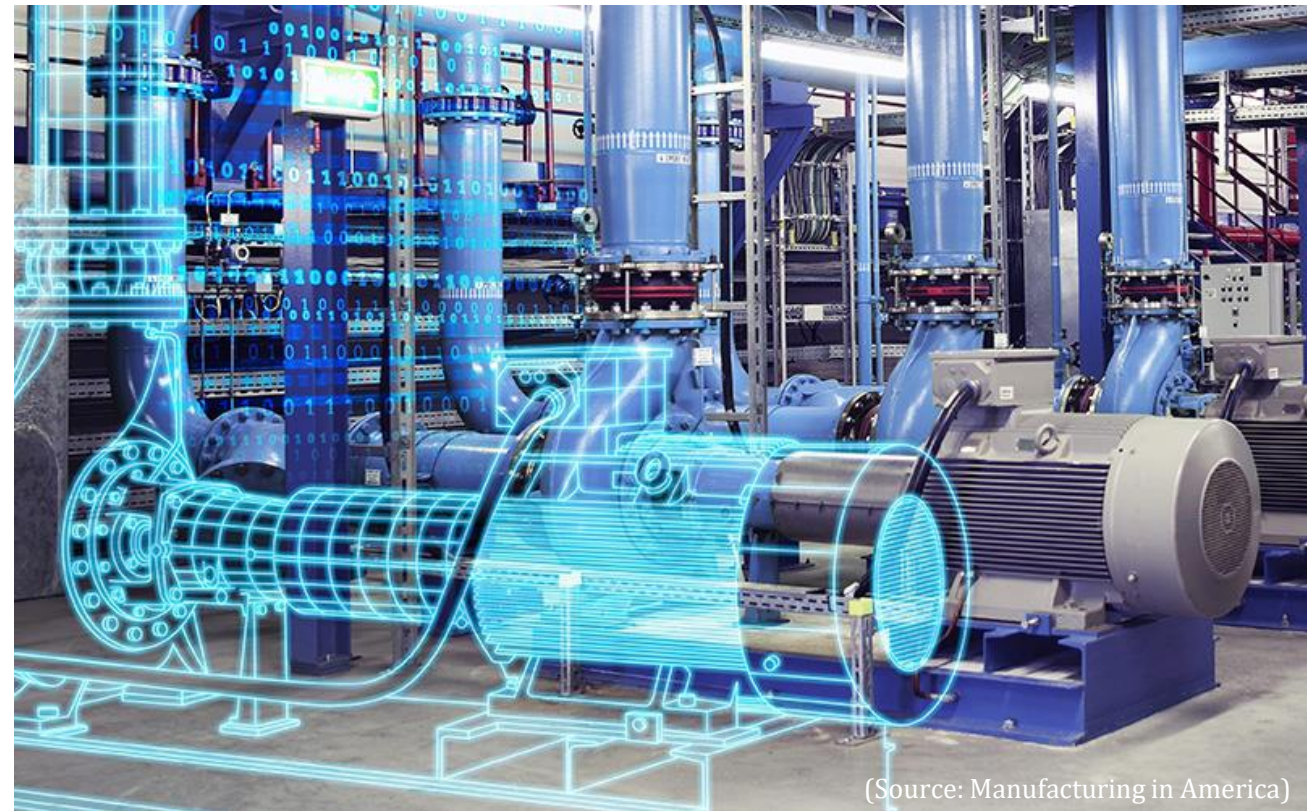
# Outline

- **Digital Twin Framework for Connected Vehicles**
- **Vehicle-to-Cloud Based ADAS**
- **Case Study on Cooperative Ramp Merging**
- **Conclusion**

# DIGITAL TWIN FRAMEWORK FOR CONNECTED VEHICLES

# What is Digital Twin?

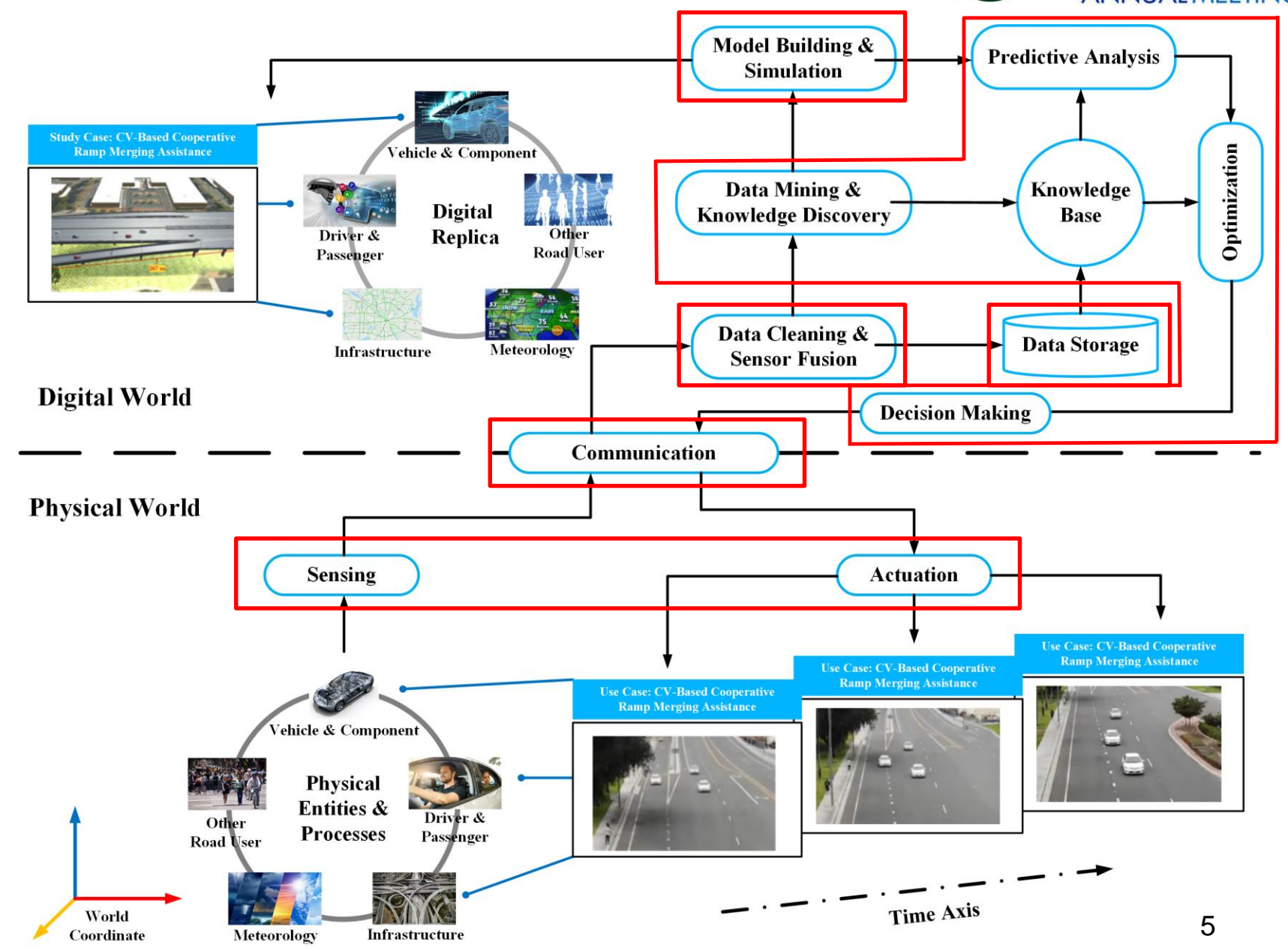
- **Definition**
  - A digital twin is a digital replica in cyber world of an entity in physical world
- **Trend**
  - Originated from aerospace field, applied to robotics, manufacturing, informatics during the past decade
  - Ranked as one of the top 10 strategic technology trends for 2019 by Gartner
- **Similar Topics**
  - IoT, CPS, parallel systems



(Source: Manufacturing in America)

# Features & Enablers

- **Connected**
  - Communication
- **Homogenized**
  - Sensing, Fusion, & Actuation
- **Abstract**
  - Modeling & Simulation
- **Traceable**
  - Data Storage
- **Smart**
  - ML/AI, Prediction, & Optimization

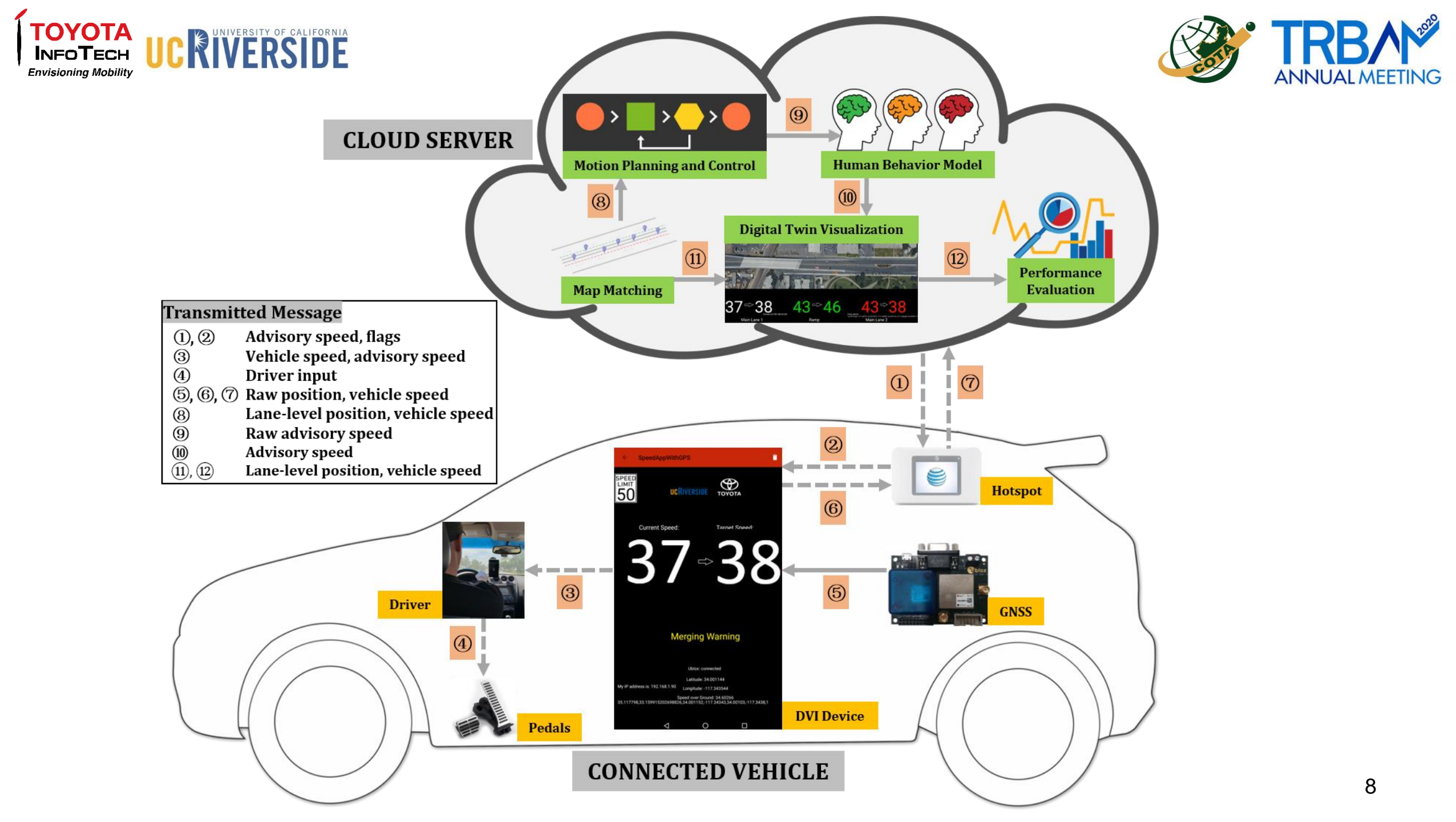




# VEHICLE-TO-CLOUD ADAS

# Paradigm of Digital Twin: V2C Based ADAS

- **Advanced Driver Assistance Systems**
  - Provide advisory speed information to the drivers of equipped vehicles
  - Utilize vehicle-to-cloud (V2C) communication
- **System Specifications**
  - No level of vehicle automation is needed
  - No vehicle on-board computer is needed
  - All computations are conducted in the cloud server by digital twin of vehicles





# CASE STUDY

## COOPERATIVE RAMP MERGING

# Motivation of Cooperative Ramp Merging



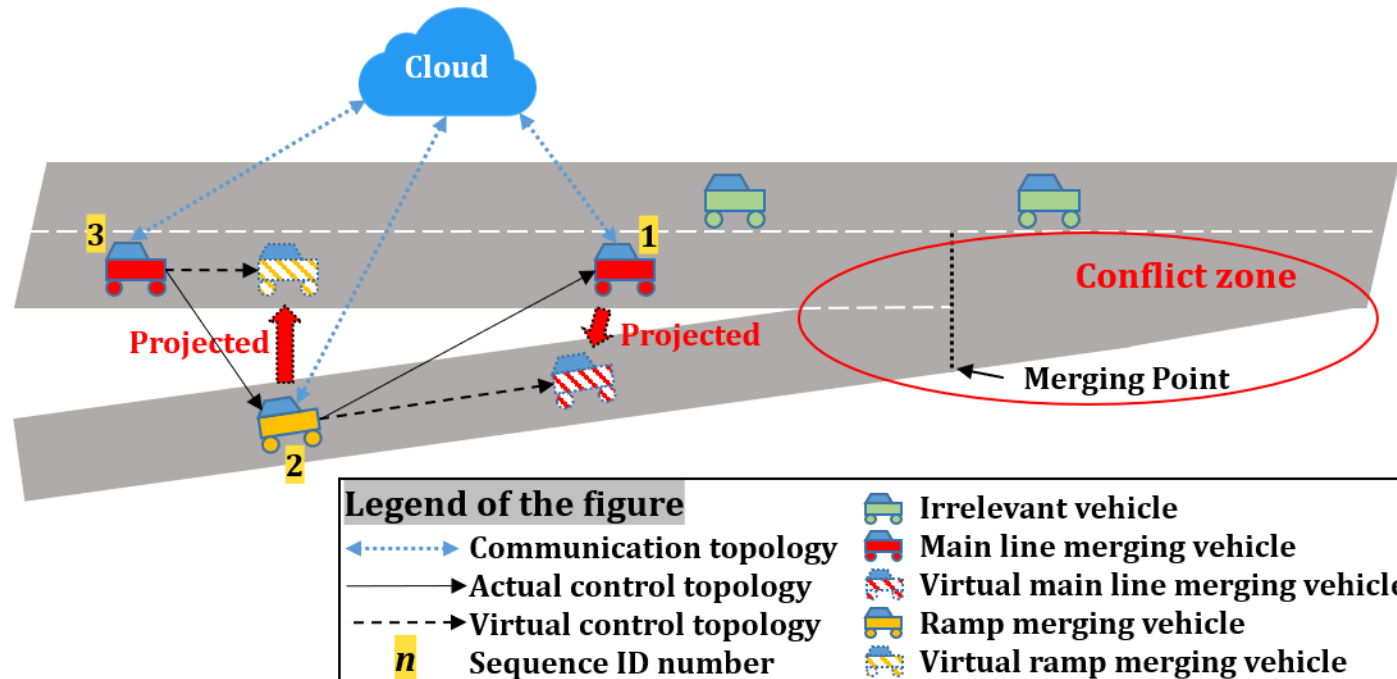
## Some existing merging at on-ramps

- Limited vision
- Limited acceleration distance
- Cause **congestion**, and even **collision**



# Cooperative Merging at On-Ramps

- Cooperative merging at on-ramps
  - Take advantage of V2C communication
  - Adopt “virtual vehicle” concept
  - Complete longitudinal formation before merging





# Field Implementation in Riverside, CA



# CONCLUSIONS AND FUTURE WORK



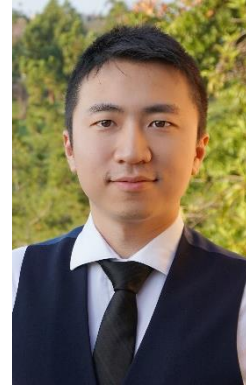
# Conclusions and Future Work

- Digital twin benefits ADAS since it decreases vehicles' on-board computation demand
- Digital twin empowers real-time modeling for various purposes
- Further study the effect of communication delay on digital twin
- Apply this digital twin paradigm to other traffic scenarios besides cooperative ramp merging

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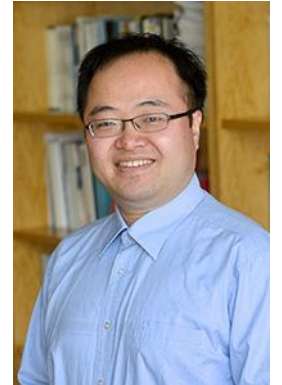
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**THANK YOU!**