Unit 2: Traffic Behaviour and Traffic Theory Fundamentals

Module 2-3

Fundamental Microscopic Relationships

Traffic Management Training Module

Austroads

Today’s presenter

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Outline of this Module

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- Trajectories
- Car Following Models
- Lane Changing Models
- Calibration and Validation of Models

Section 7 of Guide to Traffic Management Part 2: Traffic Theory Concepts Austroads (2020)

Introduction

Introduction

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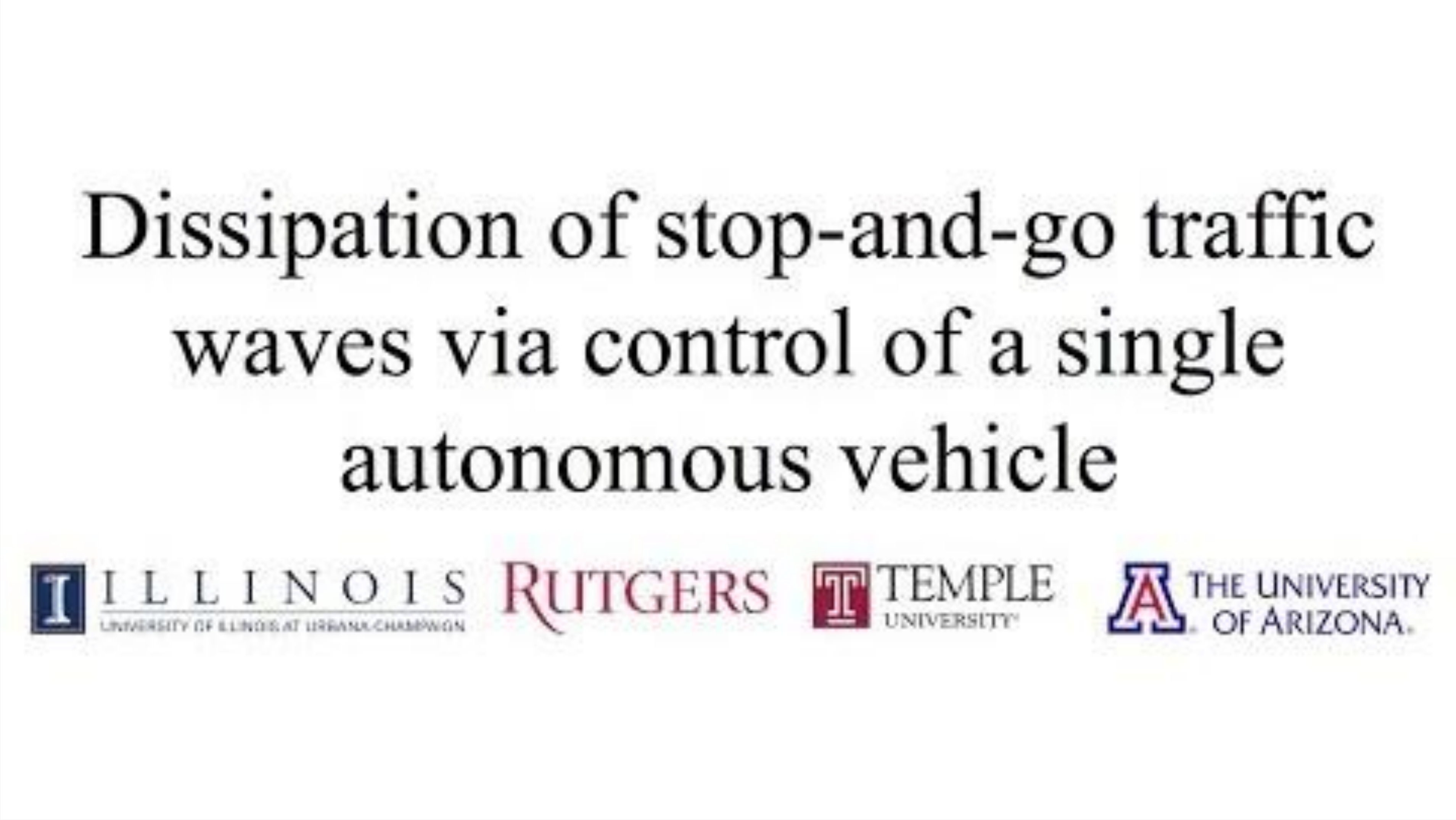

Trajectories

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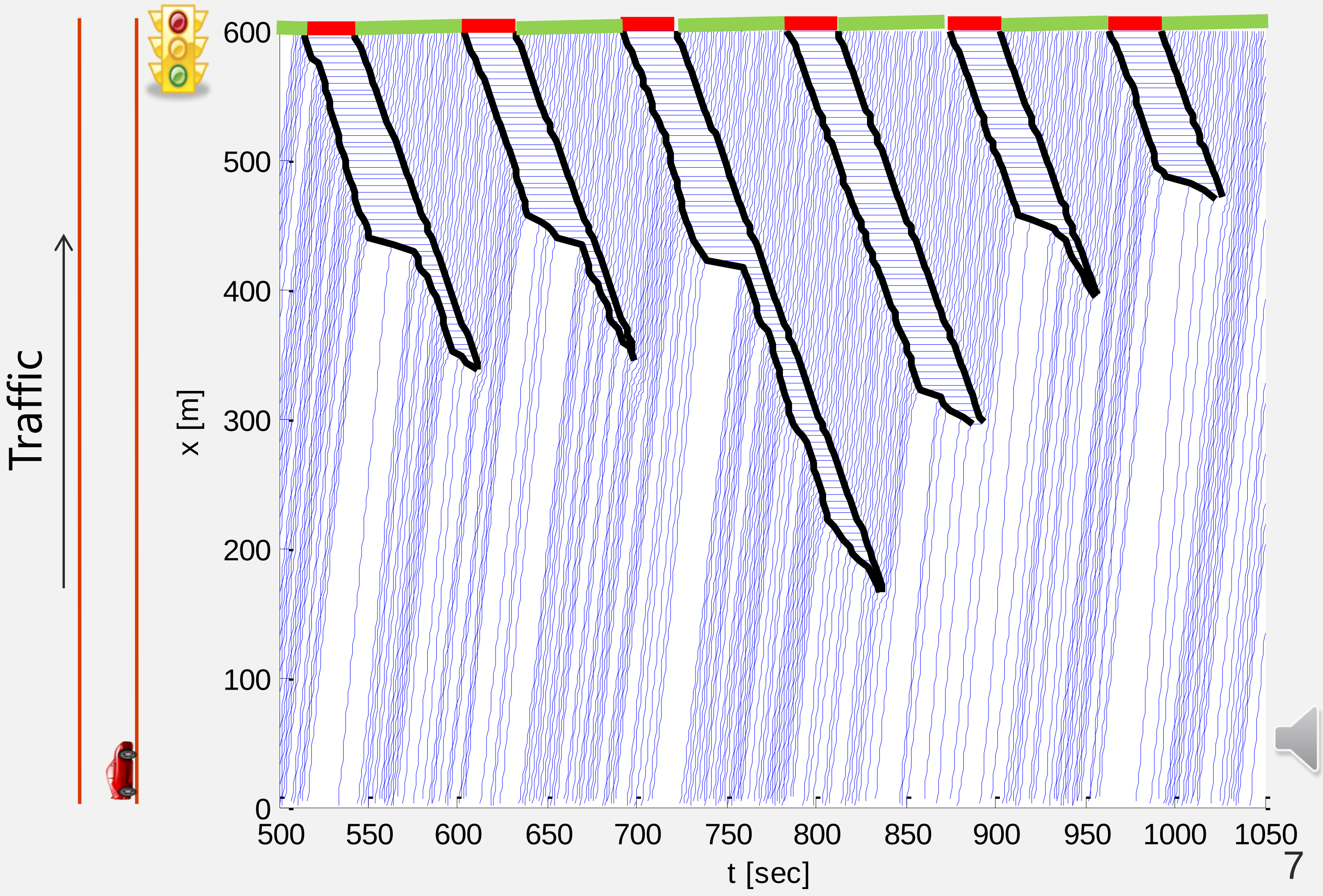
Introduction

- Time-space diagram for vehicles at a signalized intersection
- Each blue line represents the trajectory of a single vehicle



For more information on shockwaves see Section 2.5 of Guide to Traffic Management Part 2: Traffic Theory Concepts Austroads (2020)

Introduction

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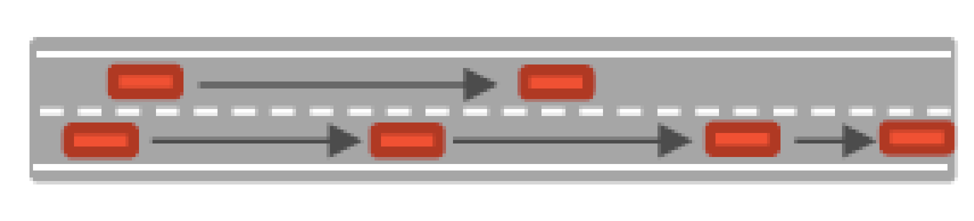
Microscopic representation of traffic flow

- Individual vehicle
- Relevant to details
- Behavioural (driving characteristics)

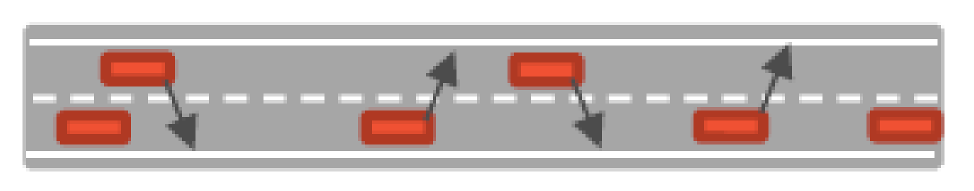
Longitudinal driving task (speed choice)

- Car Following



Lateral driving task (lane choice)

- Lane Changing



Car Following Models

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Preliminaries

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Relevant factors of vehicle speed choice:

- Space headway (distance to the vehicle in front)
- Time headway (time to the vehicle in front)
- Current speed
- Speed of vehicle in front
- Maximum allowed speed
- Maximum acceleration of vehicle
- Maximum deceleration of vehicle
- Driving comfort
- Weather conditions

Preliminaries

Common Assumptions:

- One lane is considered
- No lane changes and passing
- Driver’s behavior is consistent over time
- Crash-free

Pipe's Model

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- Type: Safety-distance model
- Assumption: drivers maintain a minimum safe space headway

Desired speed: $$v_n(t+\tau) = \begin{cases} \max\{v_n(t) - \tau D_n, 0\}, & \text{if } h_n^{\text{space}}(t) < h_n^{\text{space,min}}(t) \\ v_n(t), & \text{if } h_n^{\text{space}}(t) = h_n^{\text{space,min}}(t) \\ \min\{v_n(t) + \tau A_n, v_n^{\max}\}, & \text{if } h_n^{\text{space}}(t) > h_n^{\text{space,min}}(t) \end{cases}$$

with safe space headway: $$h_n^{\text{space,min}}(t) = L_n + \tau v_n(t)$$

$A_n =$ maximum desired acceleration of vehicle n (m/s^2)

$v_n(t) =$ speed of vehicle n at time t (m/s)

$h_n^{\text{space,min}}(t) =$ minimum (safe) desired space headway (m)

$D_n =$ maximum desired deceleration of vehicle n (m/s^2)

$v_n^{\max} =$ maximum desired speed of vehicle n (m/s)

$\tau =$ reaction time (s)

$L_n =$ length of vehicle n (m)

Lane Changing Models

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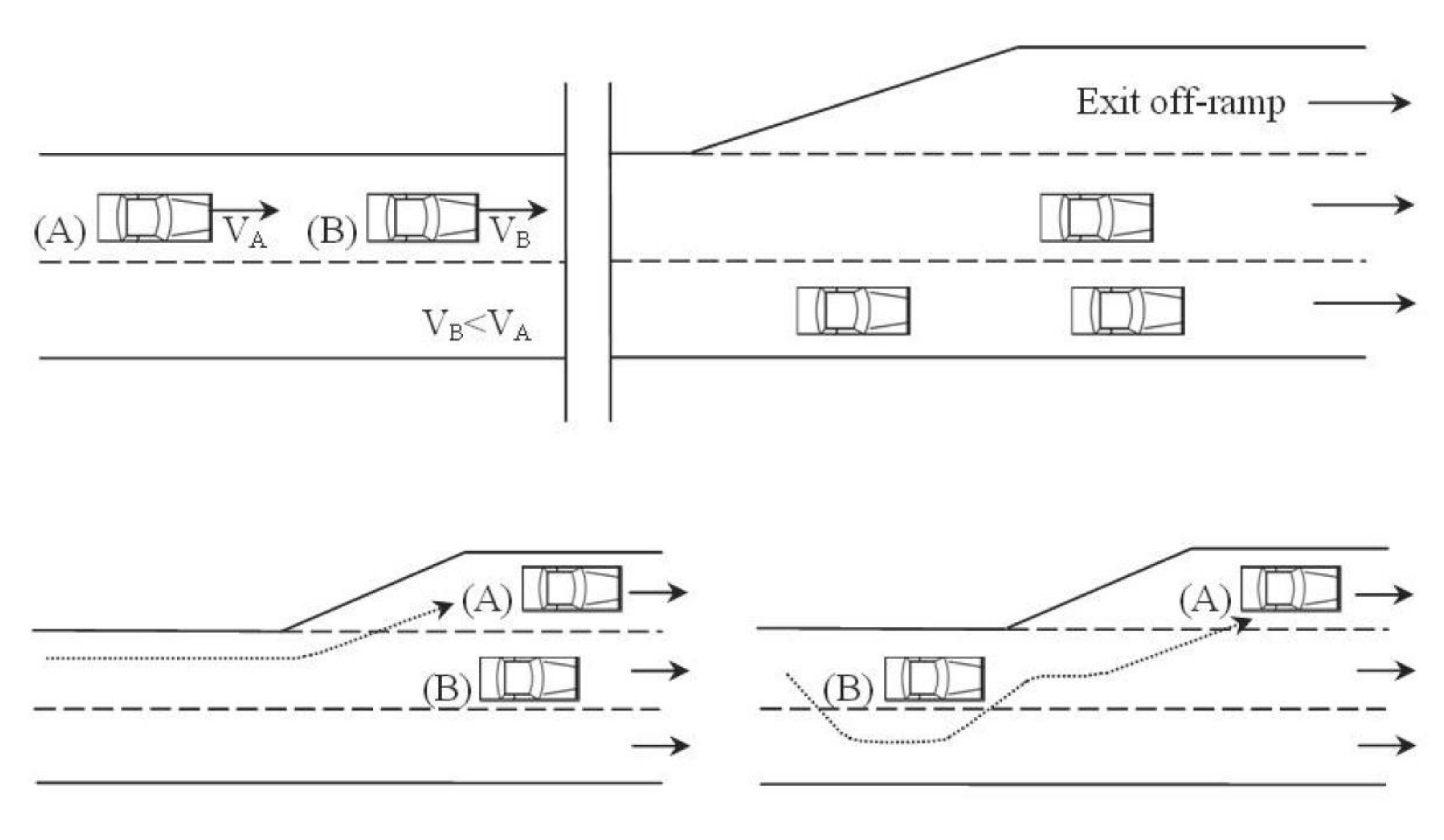
Preliminaries



Types of Lane Changing

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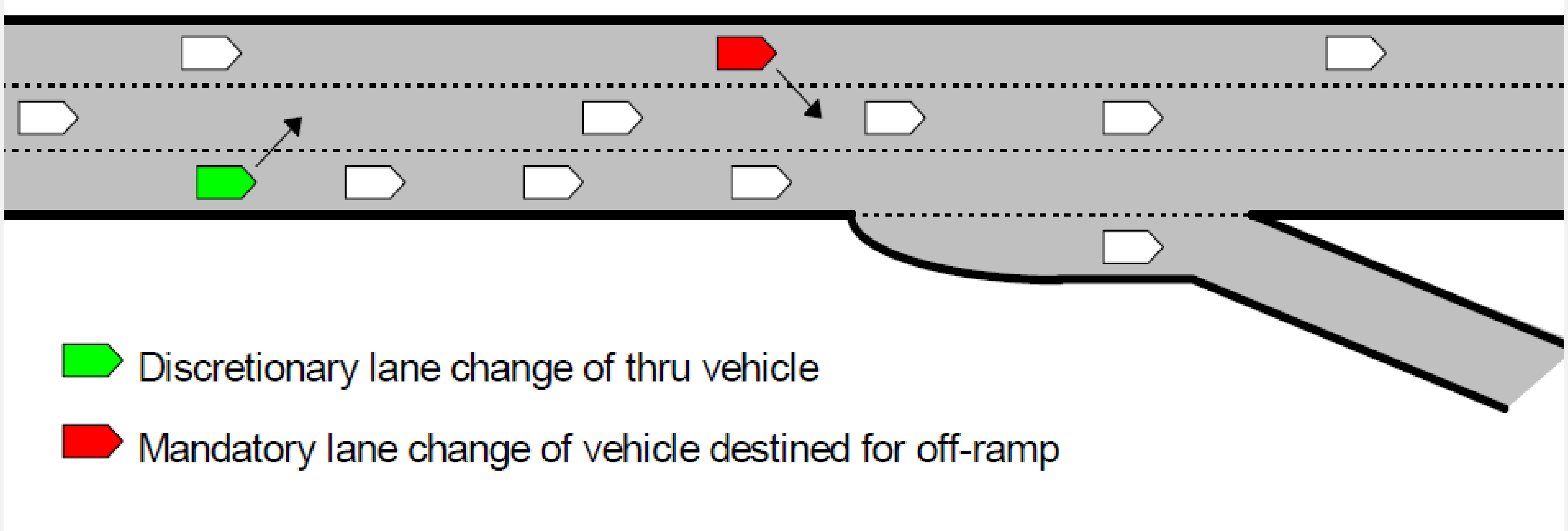
- Mandatory: a vehicle MUST change its current lane
- Discretionary: a vehicle attempts to change lanes if is moving below its desired speed and adjacent lane(s) move faster

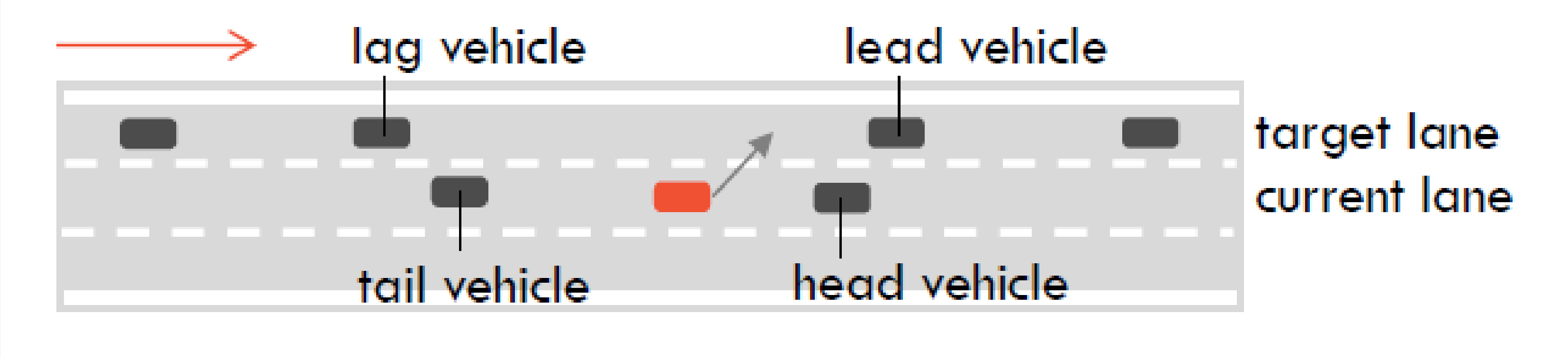


Lane Changing

Process: The lane changing vehicle evaluates lead and lag gaps in adjacent lane(s)

Supply side: availability of lead and lag gaps

Demand side: acceptability of lead and lag gaps



Calibration and Validation

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- Calibration is the estimation of parameters to maximize the models descriptive power.

- Validation can be defined as a comparison of model outputs with observed data independent from the calibration procedure. The general goal for validation is to show whether the calibrated model can be used for prediction.

- It is crucial to collect sufficient input data such that a portion of the input data is for calibration and the rest is for validation.

Calibration and Validation

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- Select parameters to be calibrated
  - Global
  - Vehicle specific
- Collect field data
- Set calibration targets (Measure of Performance)
- Find optimal parameter values
- Validation

Section 8.2 of Guide to Traffic Management Part 3: Transport Study and Analysis Methods Austroads (2020)

Time to Reflect

Q1. True/False: Calibration process requires availability of field data.

A. True

B. False

Q2. True/False: Same data set should be used for calibration and validation of models.

A. True

B. False

Time to Reflect

Q1. True/False: Calibration process requires availability of field data.

True

Q2. True/False: Same data set should be used for calibration and validation of models.

False

References

Austroads (2020). Guide to Traffic Management Part 2: Traffic Theory Concepts. AGTM02-20, Austroads, Sydney, NSW. https://austroads.com.au/publications/traffic-management/agtm02/media/AGTM02-20-Part-2-Traffic-Theory-Concepts.pdf

Knoop, Victor L., and Christine Buisson. "Calibration and validation of probabilistic discretionary lane-change models." IEEE Transactions on Intelligent Transportation Systems 16.2 (2015): 834-843.

Thank you for participating

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