

# High speed manoeuvring of Long Combination Vehicles

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## Outline

- Introduction – Future Advanced Driver Assistance Systems (ADASs)
- Long Combination Vehicles (LCV)
- Lateral performance characteristics of LCV
- Vehicle models for manoeuvring
- Numerical example
- Summary / Conclusions

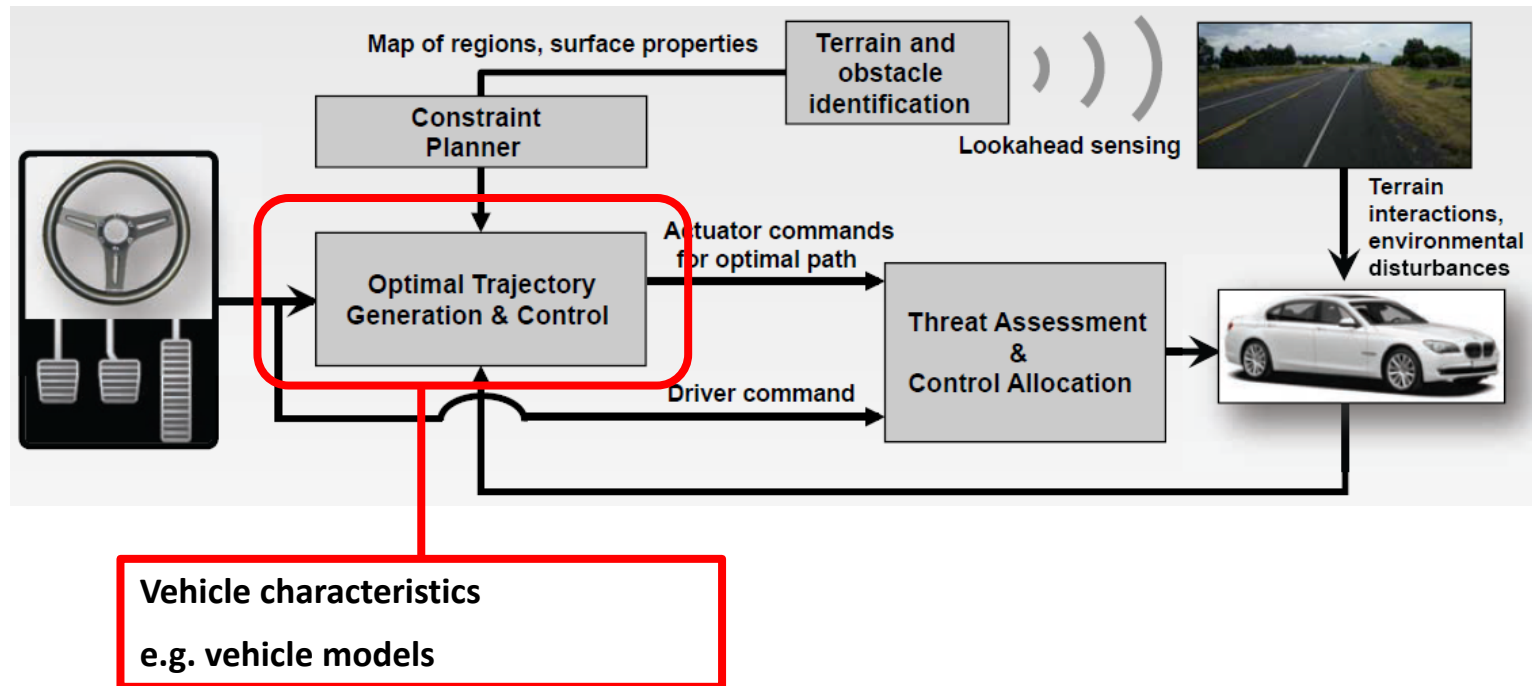
# Introduction

- Future ADASs - extended autonomous driving functionality
- The predicted ADASs for LCV - different from solo vehicles

Consideration must be taken to the length of the vehicle combinations as well as a more comprehensive longitudinal and lateral vehicle dynamics.

# Introduction

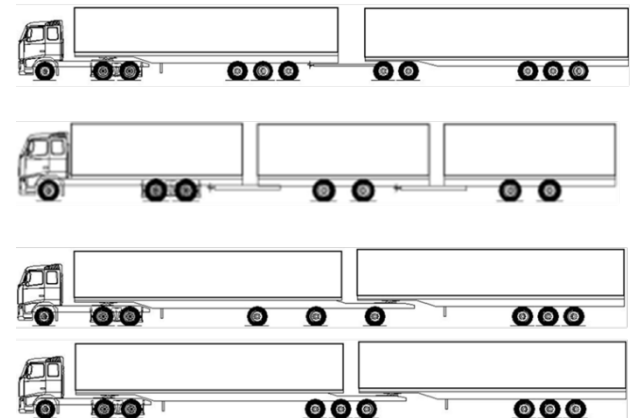
- Example of semi-autonomous vehicle system architecture [1]



[1] S Anderson, K Iagnemma

# Long Combination Vehicles (LCV)

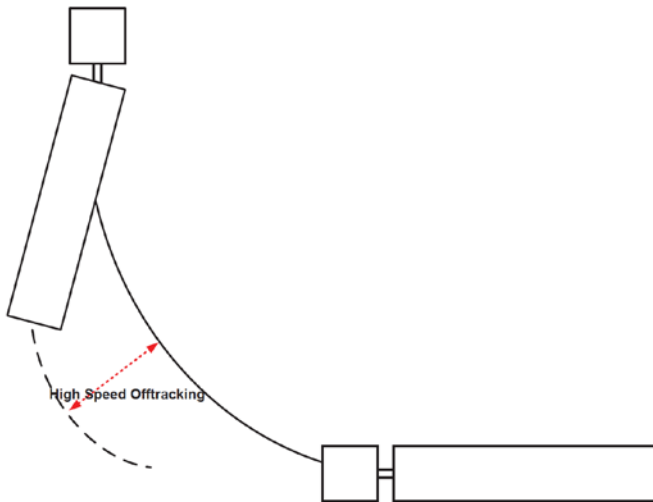
- Today the permitted length is regulated by directive 96/53 EC
  - Rigid truck with trailer - 18.75m
  - Tractor with one semi-trailer - 16.5m
  - Use of European Modular System - 25.25m
- Envisioned road transport systems for heavy vehicles 2030-
  - Vehicle combination length 25-35m



# Lateral performance characteristics of LCV

## High Speed Steady-state Offtracking (HSSO)

“The lateral offset between the paths of the center of the front axle and the center of the most severely offtracking axle of any unit in a steady turn at a certain friction level and a certain constant longitudinal speed.” [2]

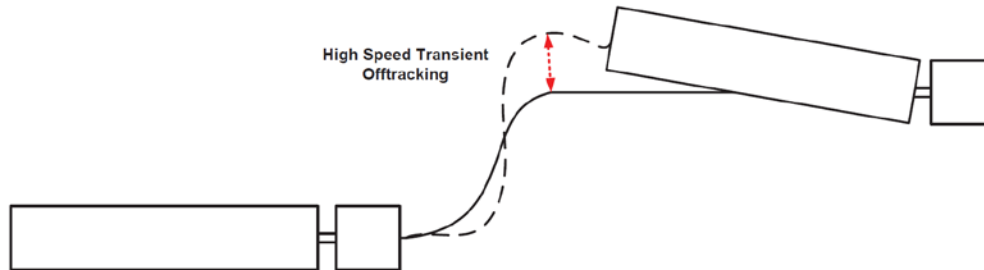


[2] M.S Kati, Definitions of Performance Based Characteristics for Long Heavy Vehicle Combinations, 2013

# Lateral performance characteristics of LCV

## High Speed Transient Offtracking (HSTO)

“High speed transient offtracking is defined as an overshoot in the lateral distance between the paths of the center of the front axle and the center of the most severely offtracking axle of any unit in a lane change maneuver at a certain friction level and a certain constant longitudinal speed.” [2]

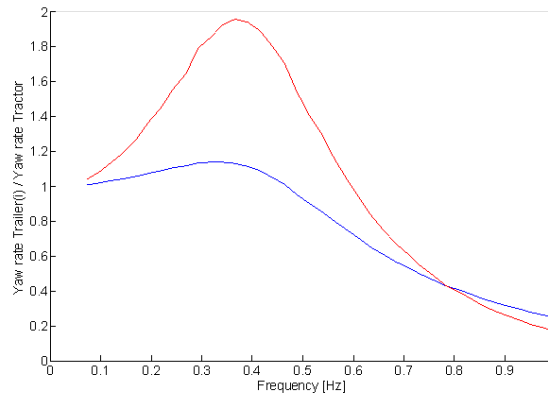


[2] M.S Kati, Definitions of Performance Based Characteristics for Long Heavy Vehicle Combinations, 2013

# Lateral performance characteristics of LCV

## Rearward Amplification (RWA)

“It is the relationship between the maximum movements of the first and the last vehicle units during some kind of manoeuvre. It is usually measured in terms of yaw velocity or lateral acceleration gain.” [3]



[3] J. Aurell and T. Wadman. Vehicle combinations based on the modular concept. <http://www.nvfnorden.org/lisalib/getfile.aspx?itemid=1589>, 2007.



# Vehicle models for high speed manoeuvring

## Vehicle model concepts

- Transient non-linear two-track model

Non-linear geometry, non-linear tyre model, variable  $v_x$

- Transient linear one-track model (linear bicycle model )

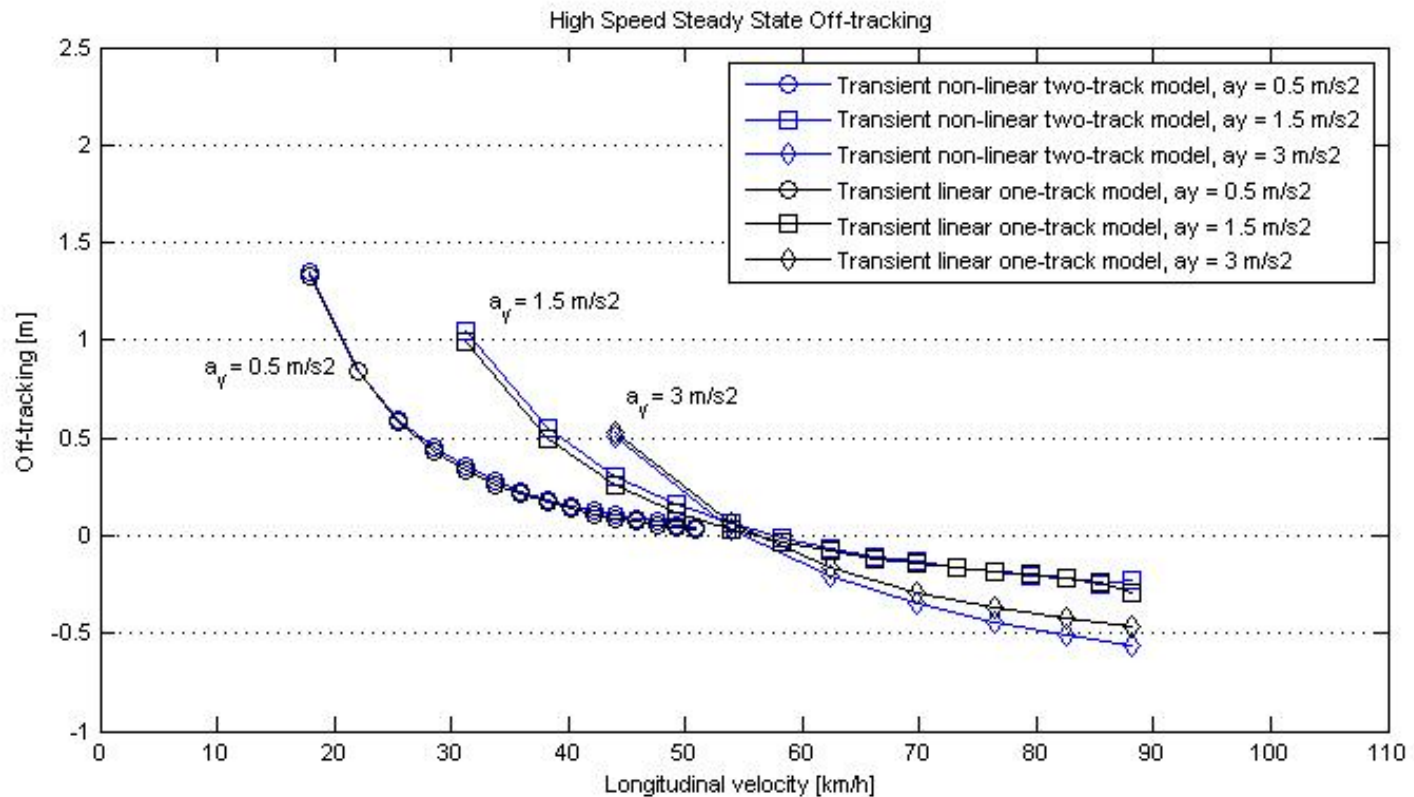
Linear geometry, linear tyre model, constant  $v_x$

- Ideally tracking one-track model (kinematic bicycle model)

Non-linear geometry, no tyre slip model, constant  $v_x$

# Numerical example

## High Speed Steady-state Offtracking (HSSO)



# Summary / Conclusions

- Future driver assistance systems for LCV - different from solo vehicles
- Use of Performance Characteristics for LCV
- Vehicle models important for autonomous driving functionalities for LCV
- Different vehicle models needed for different driving scenarios, velocities etc.