Abstract
Automation in vehicles increases. Currently, SAE level 2 vehicles are on the market, allowing to drive hands and feet off on freeways. There is a need to study the effect of increasing numbers of automated vehicles on the road. In particular, how these vehicles react following each other (in a platoon) is unknown. This paper discusses how an experiment with a platoon of automated vehicles on the public road can be set up. For this, interaction with other vehicles is important. We conducted a field operational test of 465 km on Dutch freeways. We qualitatively analyze the platoon stability (or string stability) of current ACC systems. The first vehicle has a relatively constant speed, but minor changes in speed are amplified and the 7th vehicle has large speed changes. This is uncomfortable, fuel inefficient, and sometimes unsafe: the lowest speed was 40 km/h in otherwise free flow traffic on the freeways.

Aims
- Vehicles of SAE-level of automation 2: adaptive cruise control & lane centering; “hands off” driving is possible
- How should one organise a test of a platoon of automated vehicles on the public road?
- Can the vehicles drive as a platoon on the freeways?
- What are string stability effects of a platoon of SAE-level 2 vehicles?

Vehicles
- 7 vehicles, several types, year 2017
  - Tesla Model S
  - Mercedes E-class (2x)
  - BMW 5 series (3x)
  - Audi A4
- Most advanced ADAS packages, including adaptive cruise control, lane centering
- Data logged from OEM sensors (via CAN) and additional sensors for study:
  - 8 cameras per vehicle: driver and traffic
  - Mobil eye stereo camera
  - GPS
  - Accelerations

Organisation
- Wide consortium, including ministry and road authority
- Stay in one lane: left lane prevents influences of ramps
- Exemption from speed limit (+ 10 km/h as cruising speed)
  to prevent blocking and right-hand overtaking
- Trained drivers (long term users of car)
  Co-pilot by advanced driving trainers
- Co-pilots discussed required movements
  Radio-contact via co-pilots
- Advisor driving behind platoon

Other users
- Netherlands driving:
  short headways (often < 1 s)
  Shortest headway setting too long to prevent cut-in
- Speed should be > 10 km/h over speed limit
  to prevent holding traffic
- Some overtaking at the right
- No intentional “experimenting” by other vehicles

Safety and stability
- Lead vehicle at constant speed, last vehicle
  high speed fluctuations and accelerations
- Experience first vehicle: “Comfortable”
  Last vehicle uncomfortable
- Fuel consumption based on speed
  (so corrected for vehicle differences):
  15.2 liter for first vehicle
  45 liter for last vehicle

Route
- 465 km multi-lane freeway
  > 95% driving at ACC (estimate)
  > 75% as platoon (estimate)

Platoon lane changing
- Coordinated lane changing was developed to keep platoon together
- Various strategies for various movements
- General:
  - first vehicle lane change
  - speed change, limiting speed in one lane, holding traffic or increase speed
to catch up or create gaps
  - next vehicle changes lane
  - etc.

Conclusions
- Speeds of 10 km/h above speed limit
do not prevent overtaking at the right.
- Other vehicles will merge into platoon,
even with shortest headway settings.
- ACC can be used for a large part of
  the time and works as comfort tool.
- ACC does not work for platoons.
- Accelerations amplify in the platoon,
to dangerous values for longer platoons.