

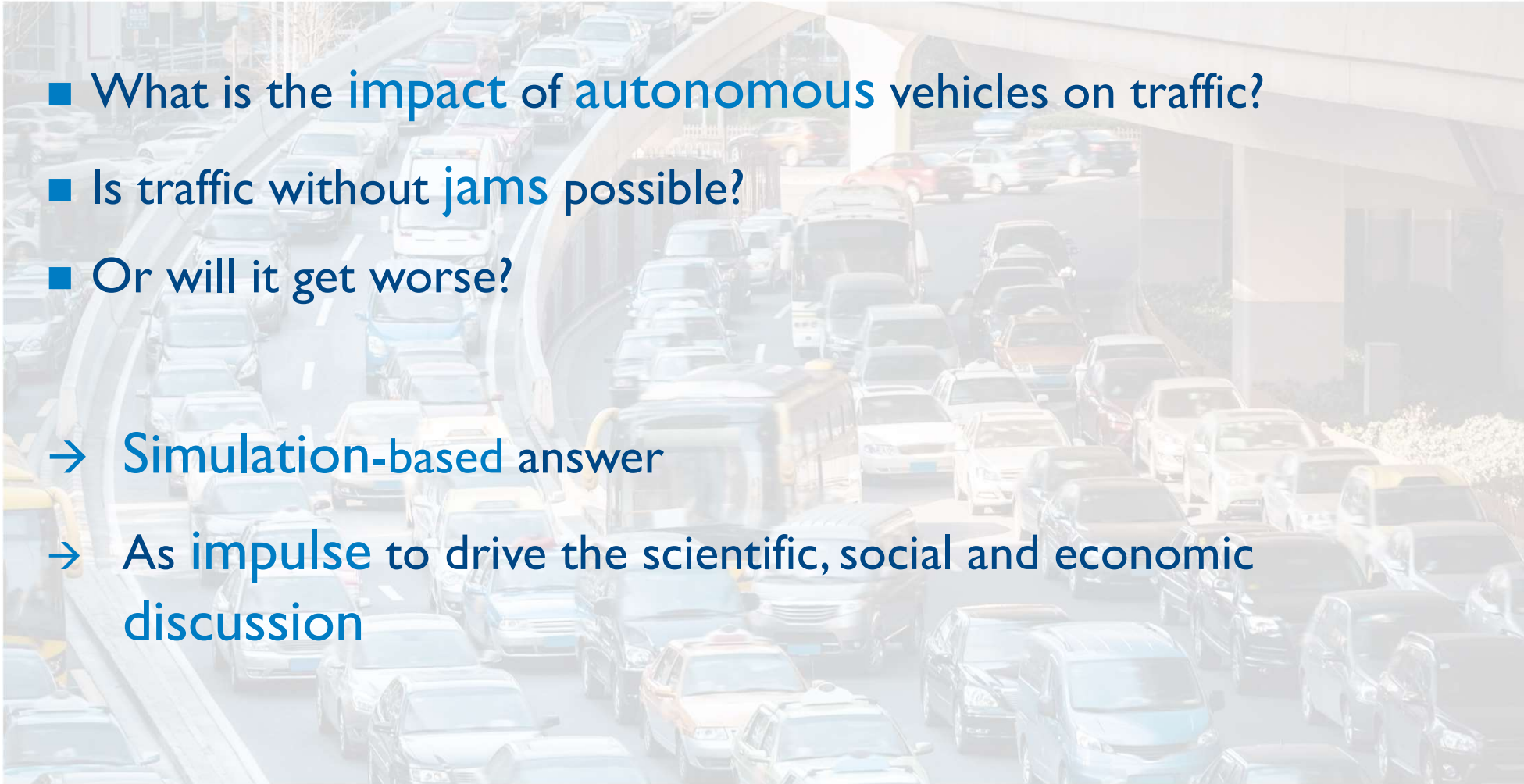
Arthur D Little

Study extract: Capacity effect of autonomous vehicles

IMPACT: Impact of autonomous vehicles on the capacity of traffic

August 2018

What is the impact of autonomous vehicles on traffic?

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- What is the impact of autonomous vehicles on traffic?
 - Is traffic without jams possible?
 - Or will it get worse?
- Simulation-based answer
- As impulse to drive the scientific, social and economic discussion

Can autonomous cars be the solution for the increasing urban mobility demand, or will they be part of the problem?

Question

- Traffic jams are a severe problem in many (mega) cities
- Higher mobility demand is forecasted, e.g., due to further urbanization (see, e.g., Arthur D. Little study *Future of Mobility 3.0, 2018*)
- On top of that, robo-taxi concepts could potentially induce even higher demand (e.g., empty trips, high convenience; compare Arthur D. Little study *Future of automotive mobility, 2017*)
- What impact on traffic capacity do autonomous vehicles have?
 - In mixed scenarios
 - In autonomous-only scenarios

Answer

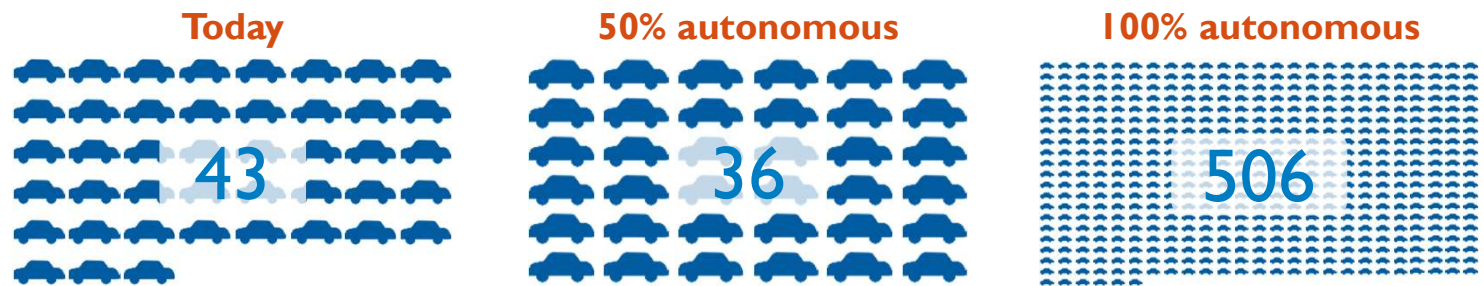
- To start a forward-looking and objective discussion, we simulated one urban-drive case based on a micro-simulation deducted from the real world
- Our result needs now to be broadened by the interested community (e.g., simulate more drive cases) and validated
- A social and economic discussion about prerequisites and priorities needs to start
 - If vehicles will be clean, nearly error-free and probably jam-free, aren't they an ideal mobility solution?
 - Is society willing to exploit this potential by fulfilling the disruptive prerequisites?
 - If not, what is the price for this in comparison to societies that will do this?

Our simulation result: With 50% autonomous driving (AD), street capacity is reduced by 23%, but with 100% AD street capacity, it is tenfold

Setting

- City-like road with cars only
- Two lanes, turn lanes not considered
- Traffic light is bottleneck
- 80 km/h speed limit
- B3 in Frankfurt am Main with direction to Bad Vilbel
- >1 km free & straight road after traffic light

Simulation results: # of vehicles each green phase



- Randomization of driving behavior taken from real-life scenario (B3 in Frankfurt)
- Drivers do not fully abide by law

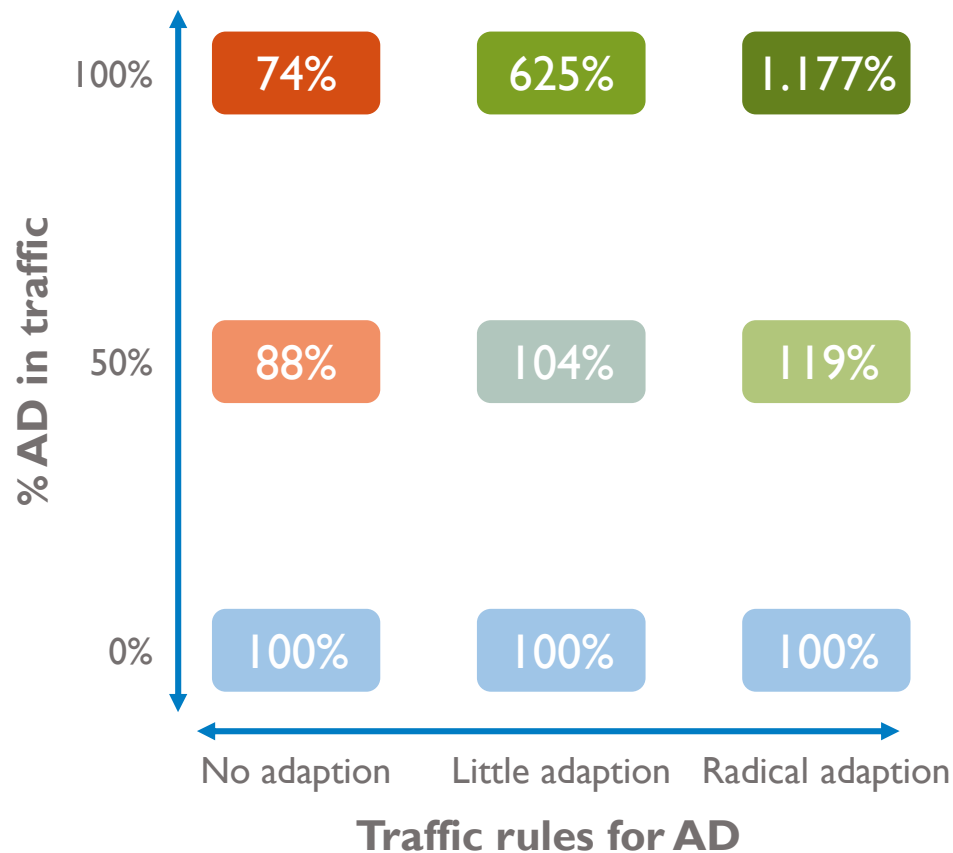
- Autonomous vehicles abide by law
- 1.2 s + 0.75 m safety gap at 80 km/h speed
- No randomization, no significant reaction time

- 2.5 m minimal distance
- 90 km/h speed
- 3 m vehicle length
- No randomization, no significant reaction time

- ▶ ■ Simulation shows capacity increase with 100% AD & decrease with mixed
- ▶ ■ Not applicable to other traffic situations; scenario probably in favor of AD
- ▶ ■ Traffic regulations & flow likely to change with 100% AD
- ▶ ■ Traffic light with >100 vehicles unlikely (results in part theoretical)

ADs with today's rules hinder traffic; with some rule adaption they don't make a difference; there is dramatic effect with AD-only & optimized rules

Scenario analysis for capacity impact



- Adaption of traffic rules has highest impact on traffic capacity
- Platooning with a low fixed distance, e.g. 2.5 m, has the greatest impact
- With adapted traffic rules, capacity increases exponentially when the proportion of AD increases – from 99% AD to 100% AD, capacity is roughly doubled
- Without adaption in traffic rules, traffic capacity is reduced

We believe some societies will exploit the potential of scenario 3 (100% AD with adapted rules)

- Will there be societies taking disruptive action to exploit the full potential?
 - Social benefit would be dramatic
 - Pressure in megacities will be high
 - Investments in alternatives to this model will be huge
 - Societies differ in their will and capability to take disruptive and disputed action
 - If some cities/societies start, pressure for others will rise
- Therefore, we believe that some societies will do so

Thus, it seems that (mega) cities relying on vehicles for transportation but without traffic jams is possible



Source: Arthur D. Little

- The technology will be available
- It's a social and political decision if we want to use it to the full degree
- If someone will do it, the effects will be disruptive
- Social benefits would be huge
- Results to be validated

Credits

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Contribution (underlying master thesis with support of ADL)

- Prof. Dr. Oliver Kolb, University of Mannheim (supervision of master thesis)
- Marc Degner, University of Mannheim (master thesis “Microscopic traffic modelling and analysis in the context of autonomous driving”)

References

- Arthur D. Little study 2017 “Future of automotive mobility”
- Arthur D. Little study 2018 “Future of mobility 3.0”

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