Framework for automated driving system impact assessment

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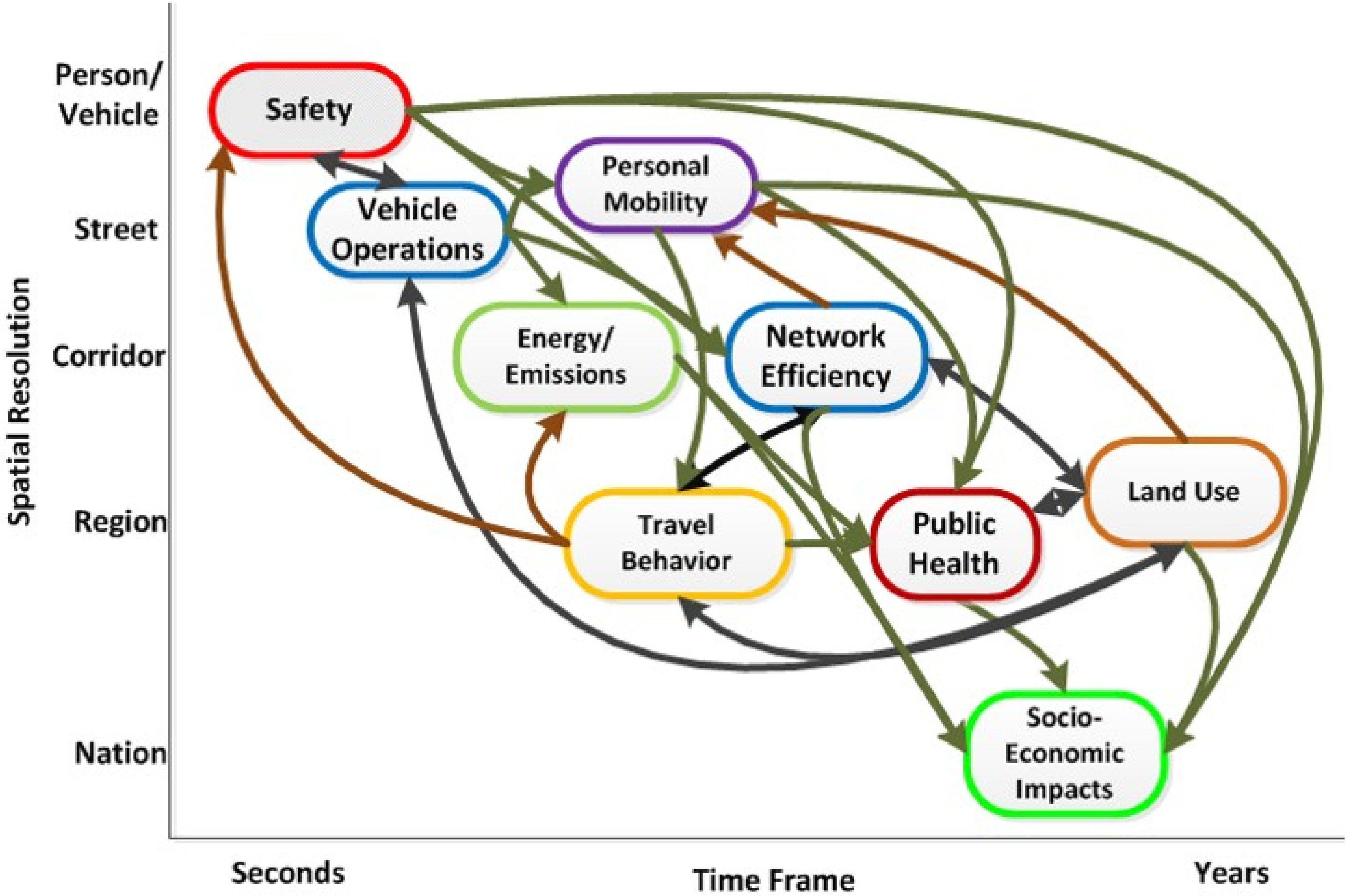
Automated driving system impacts

- “Big picture” of automation impacts
- Direct and Indirect
- A framework breaks a complex problem into (somewhat) manageable pieces



Source: US DOT Benefits Estimation Model report and poster from 2017 Automated Vehicles Symposium

Automated driving system impacts

Impact Area	Potential Benefit	Potential Dis-Benefit
Safety	Reduction in crashes	New types of crashes
Vehicle Operations	More precise vehicle following and lane keeping	Longer following distances
Personal Mobility	More options, especially for those unable/unwilling to drive Potentially cheaper	Can ***everyone*** access the automated vehicles?
Energy Use and Emissions	Smoother speed profiles, platooning, light-weighting could improve efficiency	Increases in VMT could increase fuel use/pollution
Network Efficiency	May increase throughput	May increase congestion, via increased trips
Public Health	Improved access to medical care, work and recreation for non-motorists	May reduce use of active modes
Travel Behavior and Vehicle Ownership	May decrease need for ownership, potentially reducing fleet size	May lead to more trips, with ability to safely multi-task enroute
Land Use	May encourage density by freeing up space currently devoted to parking	May encourage sprawl

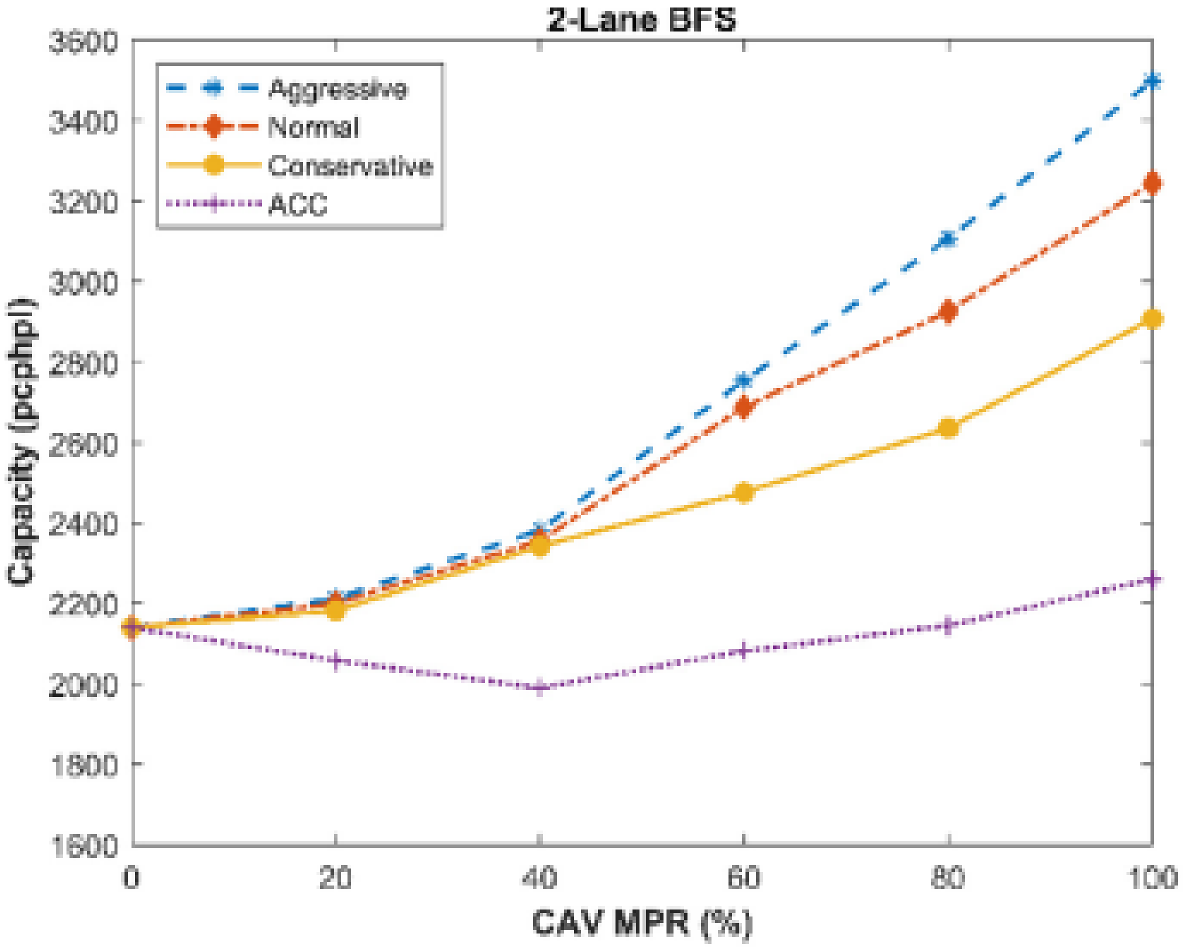
Safety - a significant potential improvement

- *Automated vehicles that accurately detect, recognize, anticipate, and respond to the movements of all transportation system users could lead to breakthrough gains in transportation safety -* Automated Vehicles 3.0
- Most motor vehicle crashes involve driver related factors
- Some evidence of benefit from currently available crash avoidance technologies
- But, while automation may reduce many human-caused crashes, it may contribute to other crashes
- Challenges in safety analysis
  - Need comparable operational design domains for automation and baseline
  - How safe is "safe enough"?
  - Crashes are rare events


Source: Volpe

Vehicle operations – unclear effect on road capacity

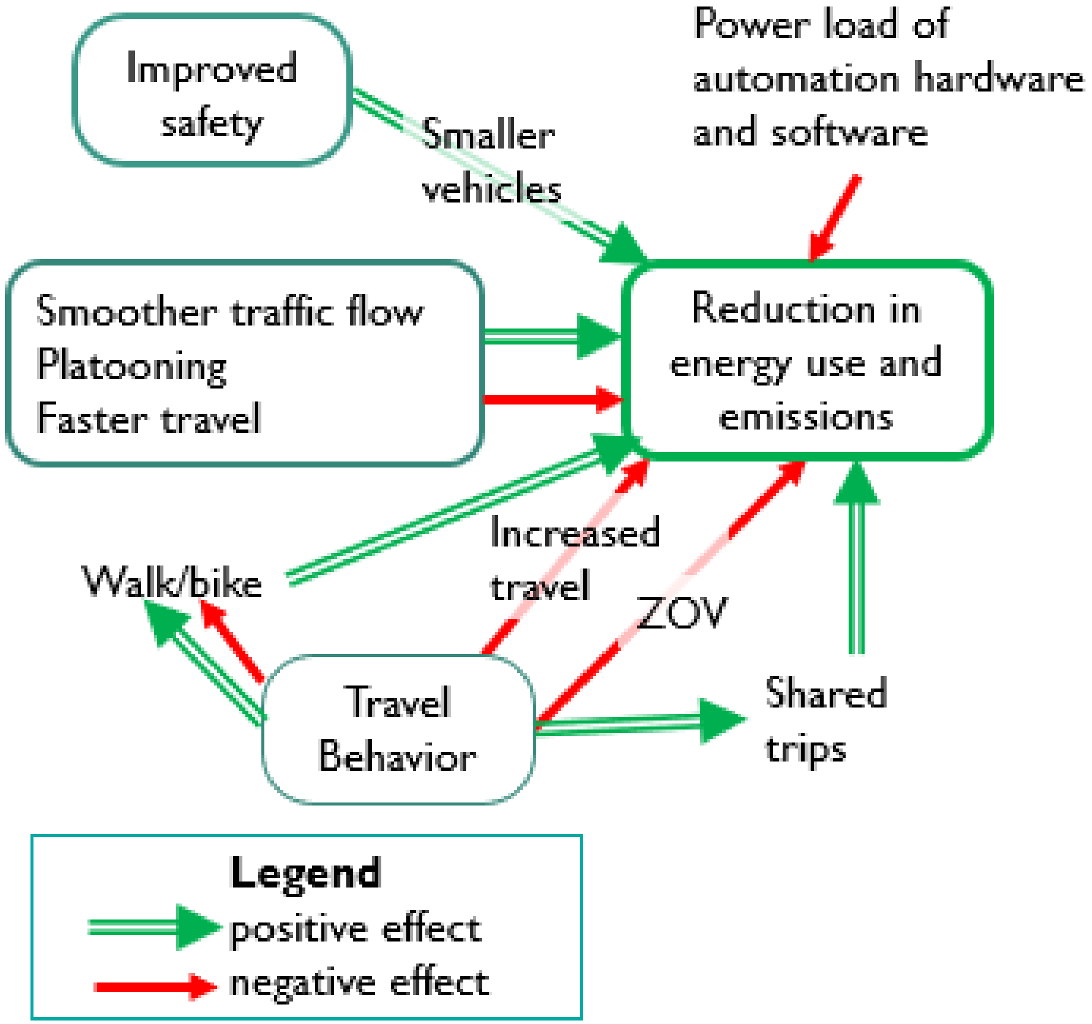
- Automated systems can affect road and intersection capacity
  - Following distance
  - Gap acceptance
  - Required lane width
- Simulation studies and field tests suggest different following distances for manual driving, adaptive cruise control (ACC) and cooperative adaptive cruise control (CACC)
  (See *Eilbert, Berg and Smith (2019)* poster *and* report)
- What happens in different operational design domains?



Source for the chart: Adebisi, Adekunle, et al. 2020. "Developing Highway Capacity Manual Capacity Adjustment Factors for Connected and Automated Traffic on Freeway Segments".

Energy/emissions – complex impacts

- Vehicle fuel consumption per mile
  - Vehicle / powertrain resizing
  - Smoother traffic flow
  - Faster travel may increase fuel use
  - Power load of automation hardware and software
- Vehicle-miles traveled
  - Increased travel
  - Shared or not shared
  - Zero-occupant vehicles (ZOV)
- Self-repositioning of AVs can facilitate electric vehicle use



Personal mobility and accessibility

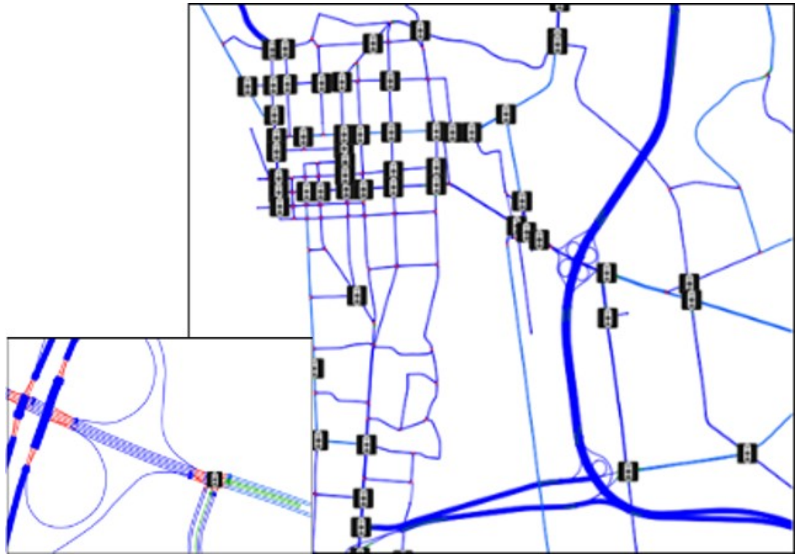
"Automation has the potential to improve our quality of life and enhance the mobility and independence of millions of Americans, especially older Americans and people with disabilities." – Automated Vehicles 3.0

- Personal mobility for non-motorists
- First / last mile services for transit
- "Complete Trip" to enable independent and spontaneous travel for those who are underserved now
  - Planning the trip
  - Getting to the vehicle
  - Using the vehicle
  - Getting to the final destination

Source: USDOT

Indirect impacts – network efficiency

- Primarily from changes in vehicle operations
  - Car following
  - Intersection
  - Needed lane widths
- Are vehicles also connected?
- Interactions with other road users
  - Non-automated vehicles
  - Bicyclists, pedestrians



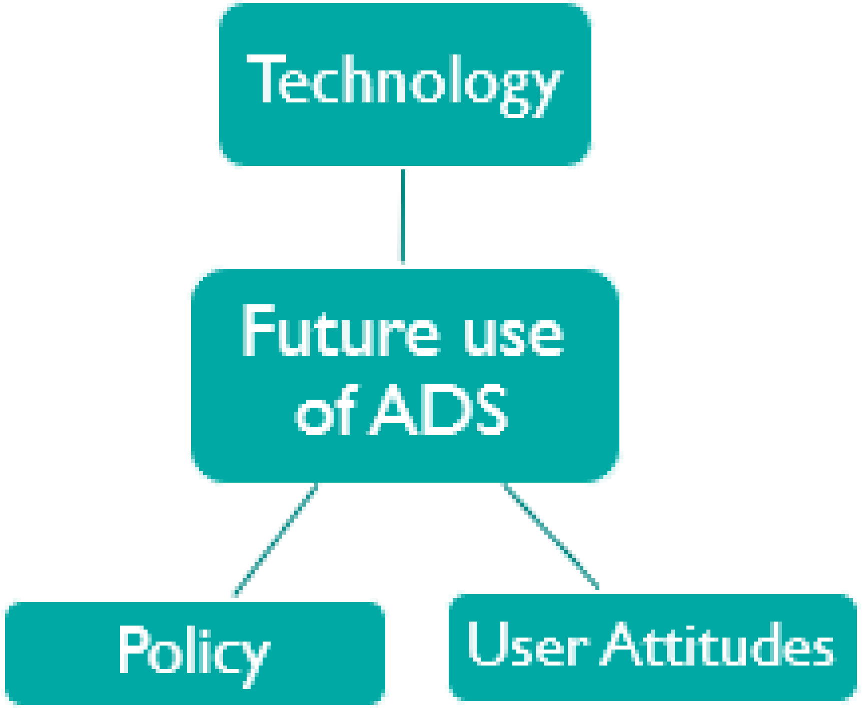
Indirect impacts – travel behavior

Personal travel

- Privately owned automated vehicles (POV)
  - Long trips become less onerous
- Shared automated vehicles
  - Self-delivery makes this option more convenient than car-sharing today
  - Replaces some POVs?
  - Provides improved accessibility for non-motorists
  - Zero-occupant trips
  - Vehicle occupancy: one to many

Freight

  - Possibility of new business models, enabled by automation



Indirect impacts – public health

Public health is the science of protecting and improving the health of families and communities through promotion of healthy lifestyles, research for disease and injury prevention and detection and control of infectious diseases.
– CDC Foundation

Elements of automation that affect public health

- Safety: vehicle occupants and non-occupants
- Effect of automation on active transportation
- Air pollution
- Access to opportunities for healthy lifestyles


Source: US DOT Volpe Center

U.S. Department of Transportation Volpe Center

Indirect impacts – land use

- Parking
  - Privately owned vehicles are parked most of the time
  - Less need for parking for shared vehicles, because of their higher utilization
  - Option of self-repositioning to remote parking?
- Sprawl
  - Ability to engage in other tasks enroute may make long commutes more attractive

Source: Wikimedia commons

Questions?

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Selected references (1/2)

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