Digitalization

and

Transport

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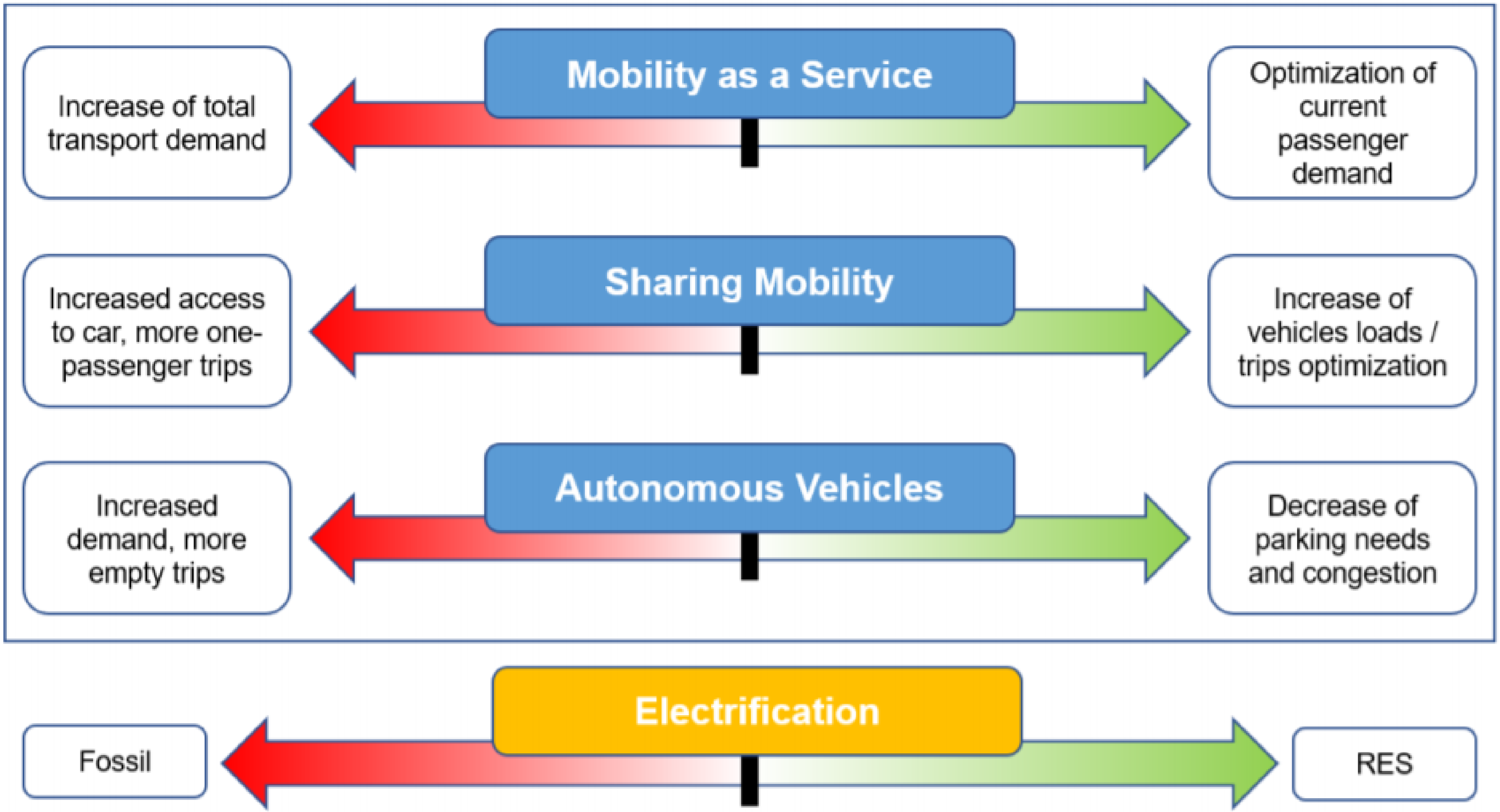
Outline

Digitalization can have multiple effects on transport:

- Unlocking the potential of **Mobility as a Service** (MaaS)
- Allowing **shared mobility** through dedicated online platforms
- Supporting the development of **autonomous vehicles**
- Improving the **transport technology**, such as electric vehicles, freight transport logistics, etc.

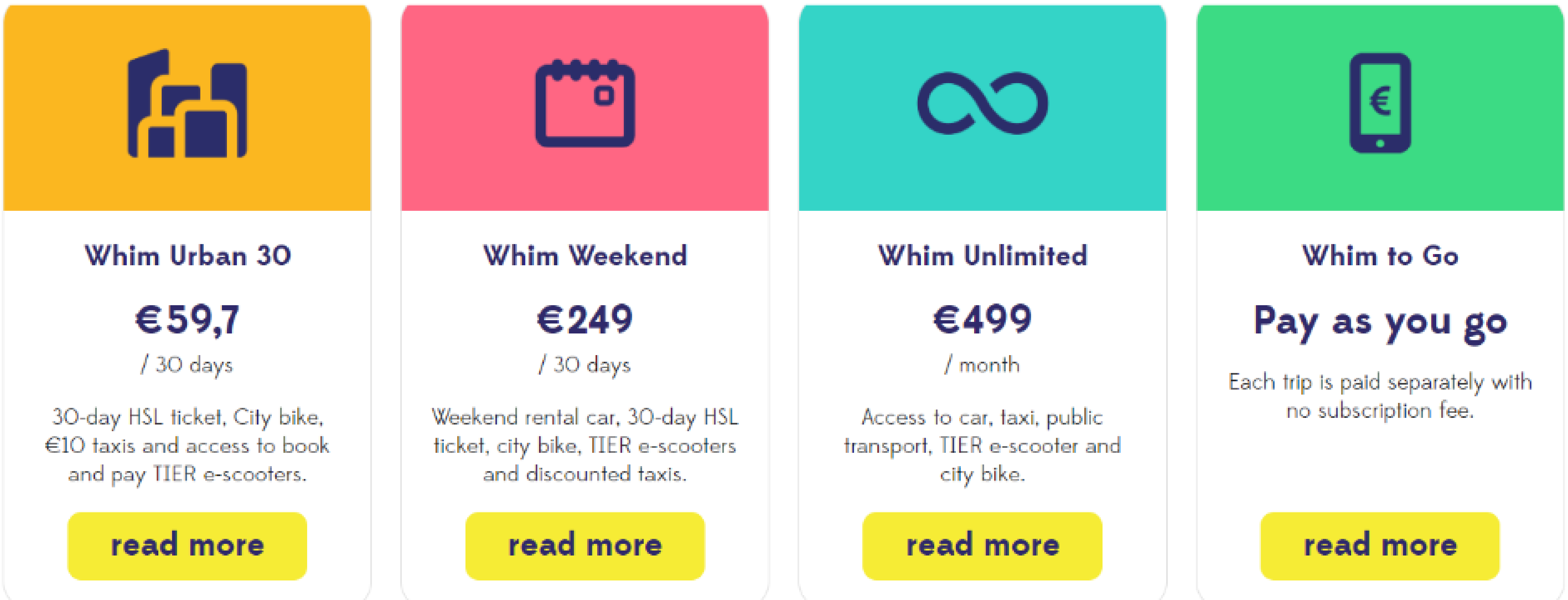
Digitalization trends in transport



Source: https://www.feem.it/m/publications_pages/ndl2019-001.pdf

MaaS in Helsinki

Whim has been among the first commercial ***mobility as a service*** solutions, operating in Helsinki since the end of 2017.



https://whimapp.com/

MaaS in Helsinki

Considering the modal mix, Whim seems not to have an impact on car usage, but the modal shift happens mainly **from walk/bike to public transport (and taxi!)**.

Whim-trips avg per person	No. Of trips	Modal share %
Public transportation	2.15	63%
Taxi (from Whim data)	0.07	2%
Car (Trips added, Travel behavior survey)	0.2	6%
Bicycle + Walking (Trips added, Travel behavior survey)	1.0	29%
Total	**3.4**	

Control group avg per person (From HSL Data)	No. Of trips	Modal share %
Public transportation	1.6	48%
Taxi	0.03	1%
Car	0.2	7%
Bicycle + Walking	1.4	44%
Total	**3.3**	

Trip numbers and modal share among control group in Helsinki metropolitan area vs. Whim-users. 2.24 trips are made with Whim per day per user, but the missing modal shares are added from the corresponding control group.

https://ramboll.com/-/media/files/rfi/publications/Ramboll_whimpact-2019.pdf

Shared mobility

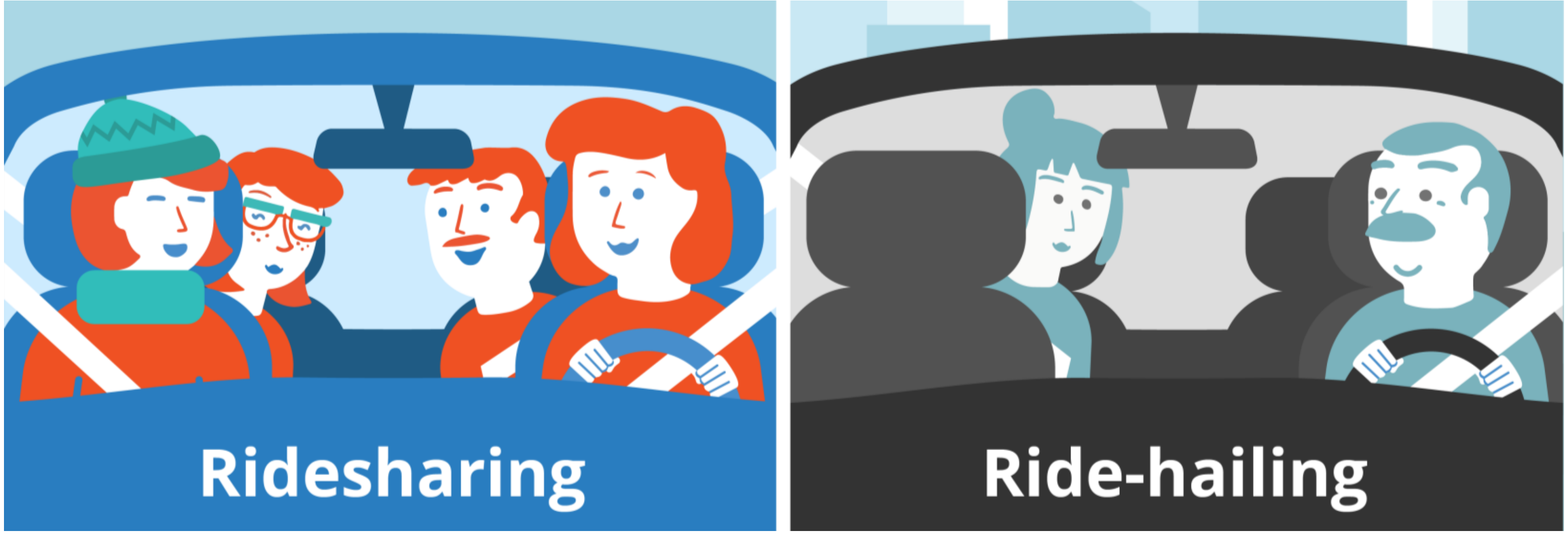
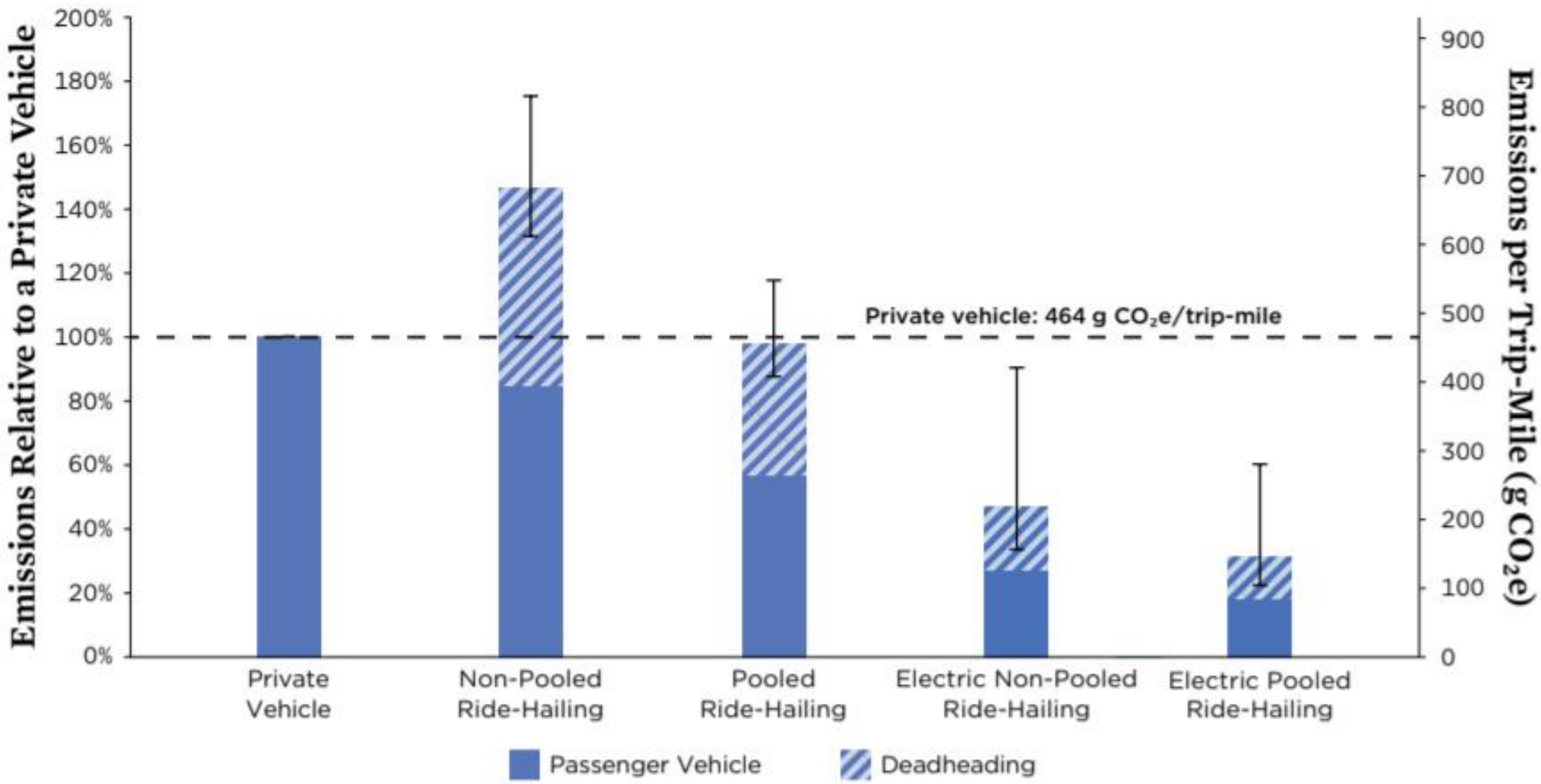


Image credits: https://www.poparide.com/blog/ridesharing-vs-ridehailing/

The impact of ride-hailing

FIGURE 2. **When Is Ride-Hailing Better for the Climate than Using a Private Vehicle?**



A pooled trip in an EV is the lowest-carbon option for ride-hailing, while non-pooled trips in today's ride-hailing vehicles produce about 47 percent more emissions than a trip of the same length in a private vehicle.

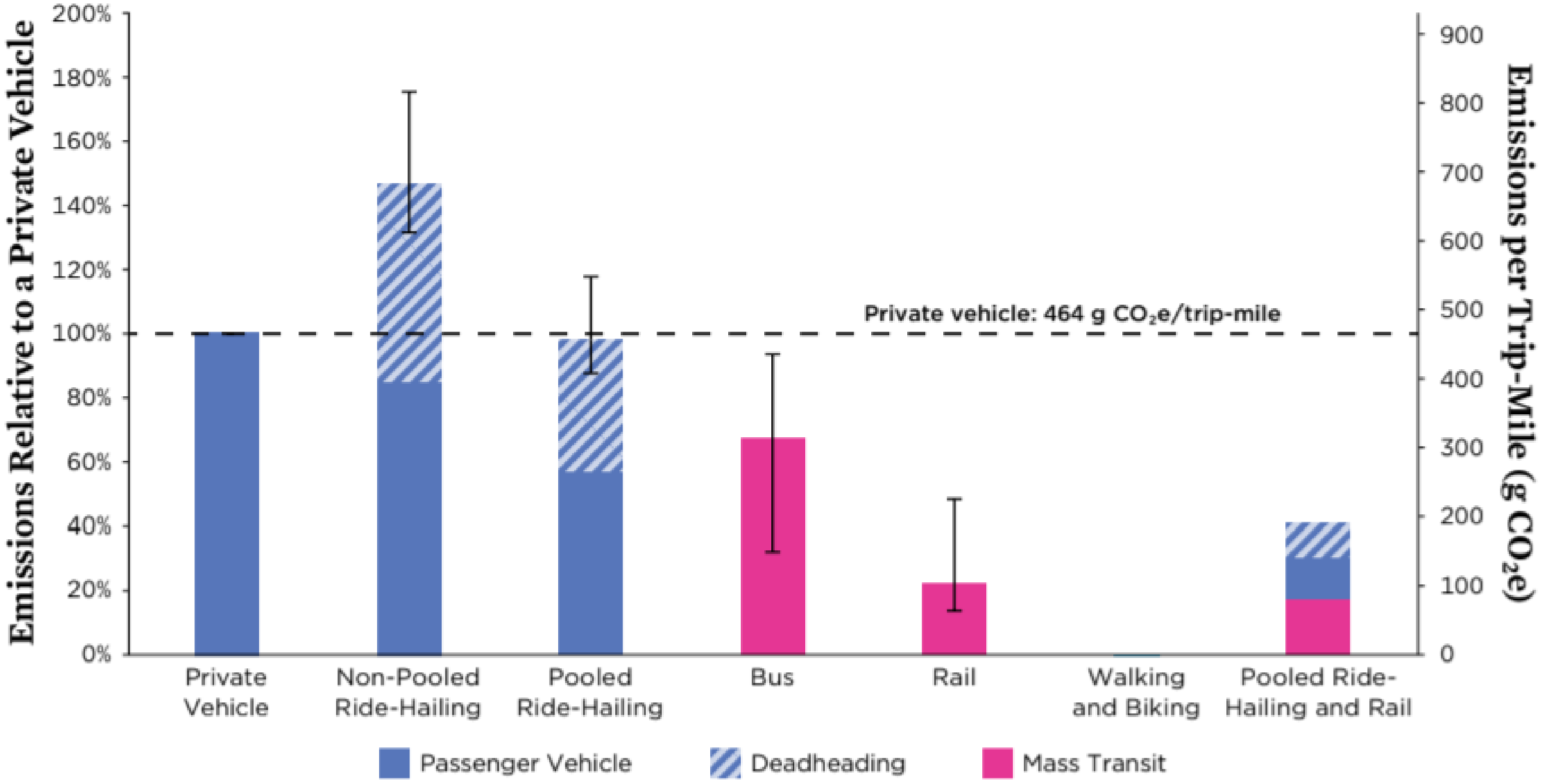
Note: Results are based on data from seven US metropolitan areas. The private vehicle trip assumes a fuel economy of 23.8 miles per gallon. A pooled trip is assumed to displace two vehicle trips, with the passengers sharing the ride for half of the distance of their trips. Error bars represent uncertainty in the percentage of deadheading miles. The error bars for electric trips (pooled and non-pooled) also include variability in electricity grid emissions among the seven metropolitan areas.

SOURCE: UCS METHODOLOGY DOCUMENT ONLINE, SECTION 2.

Source: https://www.ucsusa.org/sites/default/files/2020-02/Ride-Hailing%27s-Climate-Risks.pdf

The impact of ride-hailing

FIGURE 3. **Emissions Impact of Ride-Hailing vs. Other Travel Modes**



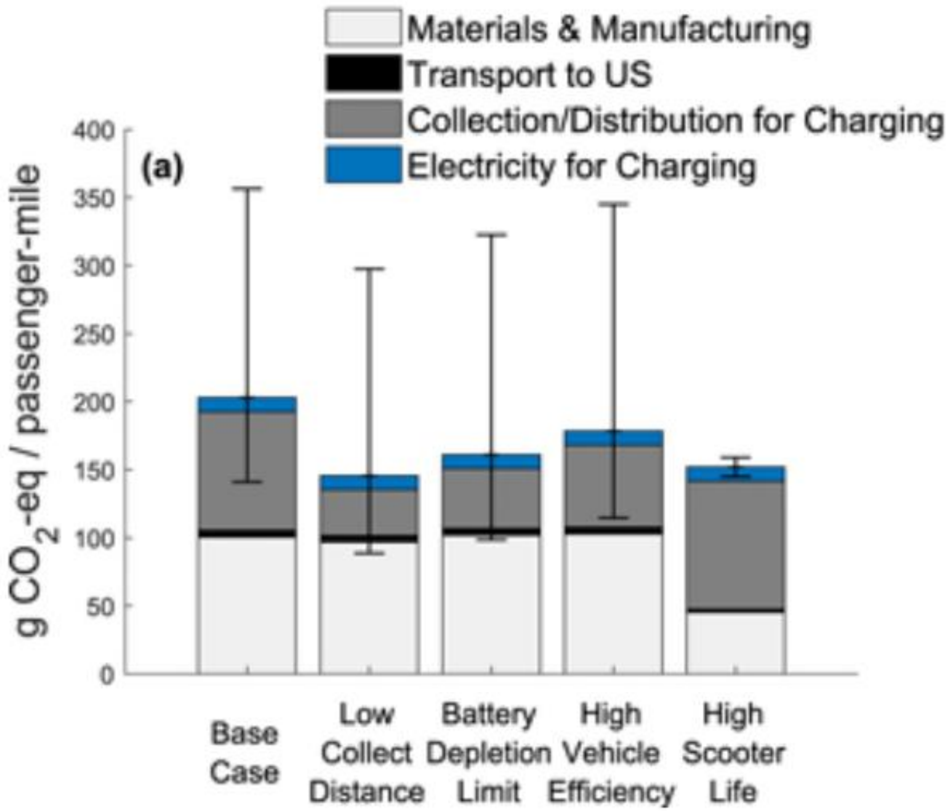
In urban areas, rail, bus, walking, and biking are lower-carbon alternatives to ride-hailing. Rail and bus also help reduce congestion. Using ride-hailing to enable a passenger to use mass transit instead of driving is also a lower-carbon alternative.

Note: Car and ride-hailing emissions are per trip-mile, regardless of how many people are in the vehicle on the same trip, but emissions are adjusted for pooled trips. Bus and rail data are emissions per passenger based on average occupancy in the same seven metropolitan areas as in Figure 2. The error bars for ride-hailing represent uncertainty in the percentage of deadheading miles. Error bars for bus and rail emissions represent variability among cities. Mass transit emissions do not indicate how emissions would change with increased ridership. Bus and rail operate on fixed schedules and are often less than fully utilized, so additional passengers do not always increase emissions.

Source: https://www.ucsusa.org/sites/default/files/2020-02/Ride-Hailing%27s-Climate-Risks.pdf

Scooter sharing

Impact of electric scooters on GHG emissions



Mode	gCO_{2eq}/pass-mile
Car	414
Shared dockless bicycle	190
Electric moped	119
Bus (high load)	82
Electric bicycle	40
Bicycle	8

Source: https://iopscience.iop.org/article/10.1088/1748-9326/ab2da8

Basics of Autonomous Vehicles

Autonomous Vehicle Potential Benefits and Costs

	Benefits	Costs/Problems
Internal (user Impacts)	*Reduced drivers' stress and increased productivity.* Motorists can rest, play and work while travelling. *Mobility for non-drivers.* More independent mobility for non-drivers can reduce motorists' chauffeuring burdens and transit subsidy needs. *Reduced paid driver costs.* Reduces costs for taxis services and commercial transport drivers.	*Increased vehicle costs.* Requires additional vehicle equipment, services and fees. *Additional user risks.* Additional crashes caused by system failures, platooning, higher traffic speeds, additional risk-taking, and increased total vehicle travel. *Reduced security and privacy.* May be vulnerable to information abuse (hacking), and features such as location tracking and data sharing may reduce privacy.

Source: https://www.vtpi.org/avip.pdf

Basics of Autonomous Vehicles

Autonomous Vehicle Potential Benefits and Costs

	Benefits	Costs/Problems
External (Impacts on others)	*Increased safety.* May reduce crash risks and insurance costs. May reduce high-risk driving. *Increased road capacity and cost savings.* More efficient vehicle traffic may reduce congestion and roadway costs. *Reduced parking costs.* Reduces demand for parking at destinations. *Reduced energy consumption and pollution.* May increase fuel efficiency and reduce emissions. *Supports vehicle sharing.* Could facilitate carsharing and ridesharing, reducing total vehicle ownership and travel, and associated costs.	*Increased infrastructure costs.* May require higher roadway design and maintenance standards. *Additional risks.* May increase risks to other road users and may be used for criminal activities. *Increased traffic problems.* Increased vehicle travel may increase congestion, pollution and sprawl-related costs. *Social equity concerns.* May reduce affordable mobility options including walking, bicycling and transit services. *Reduced employment.* Jobs for drivers may decline. *Reduced support for other solutions.* Optimistic predictions of autonomous driving may discourage other transport improvements and management strategies.

Source: https://www.vtpi.org/avip.pdf

Private or shared AVs?

Vehicle Types Compared

	Private Human-Driven Vehicles	Private Autonomous Vehicles	Shared Autonomous Vehicles	Shared Autonomous Rides
	Motorists own or lease, and drive, a vehicle.	*Motorists own or lease a self-driving vehicle.*	*Self-driving taxis offer serve individuals.*	*Micro-transit serves multiple passengers.*
Advantages	Low costs. Always available. Users can leave gear in vehicles. Pride of ownership.	High convenience. Always available. Users can leave gear in vehicles. Pride of ownership.	Users can choose vehicles that best meet their needs. Door to door service.	Lowest total costs. Minimizes congestion, risk and pollution emissions.
Disadvantages	Requires driving ability, and associated stress.	High costs. Users cannot choose different vehicles for different uses. Likely to increase vehicle travel and associated costs.	Users must wait for vehicles. Limited services (no driver to help passengers carry luggage or ensure safety.	Least speed, convenience and comfort, particularly in sprawled areas.
Appropriate users	Lower- and moderate-income suburban and rural residents.	Affluent suburban and rural residents.	Lower-annual-mileage users.	Lower-income urban residents.

Autonomous vehicles can be private or shared. Each model has advantages and disadvantages.

Source: https://www.vtpi.org/avip.pdf

Problems of safety and algorithms

The Autonomous Vehicle Trolley Problem

"The trolley problem" refers to various scenarios that ethicists use to consider who should be protected from an out-of-control vehicle, for example, if it should be directed to kill fewer rather than more, older rather than younger, or more rather than less productive people.

Although all vehicles face these trade-offs, decisions by human drivers are generally spontaneous; with autonomous vehicles they are explicitly programed. This raises a public policy issue: who should decide how vehicles are programed when making risk trade-offs.

For example, should autonomous vehicles operate at legal speed limits or to match average traffic speeds on a roadway? How should they prioritize risks to vehicle occupants over risks to other road users? How should an autonomous vehicle respond if faced with unexpected conditions?

At a minimum, professional organizations should provide guidance concerning how autonomous vehicles should be programed to trade-off costs and risks, or it may be necessary for governments to establish detailed regulations to ensure that autonomous vehicles are programed to protect other road users and minimize other external costs.

Source: https://www.vtpi.org/avip.pdf

Test for choices on AVs

http://moralmachine.mit.edu/

We show you moral dilemmas, where a driverless car must choose the lesser of two evils, such as killing two passengers or five pedestrians. As an **outside observer**, you judge which outcome you think is more acceptable. You can then see how your responses compare with those of other people.

scalable cooperation

mit media lab

Massachusetts Institute of Technology

Ethical choices for AVs

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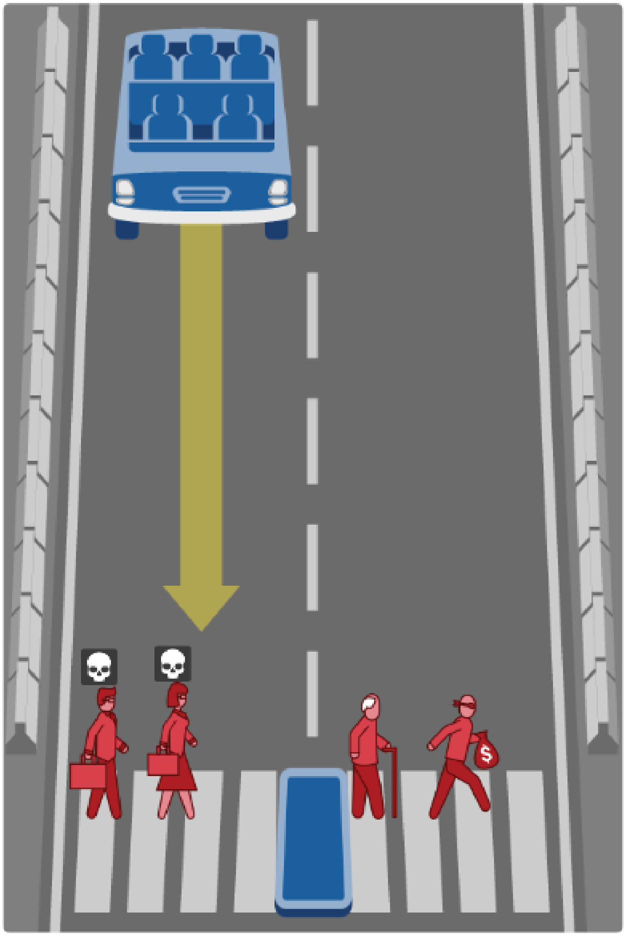

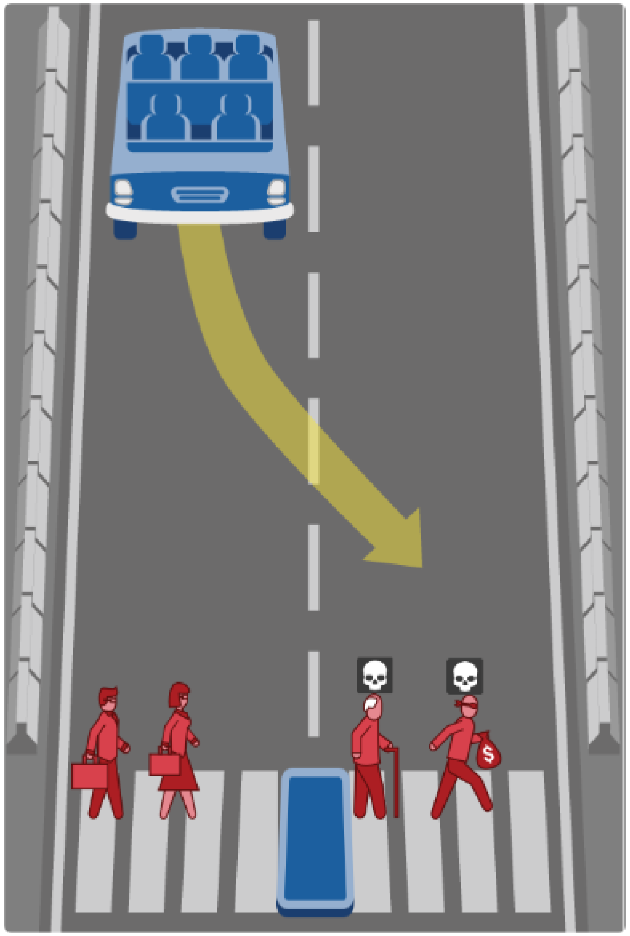

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http://moralmachine.mit.edu/

Ethical choices for AVs

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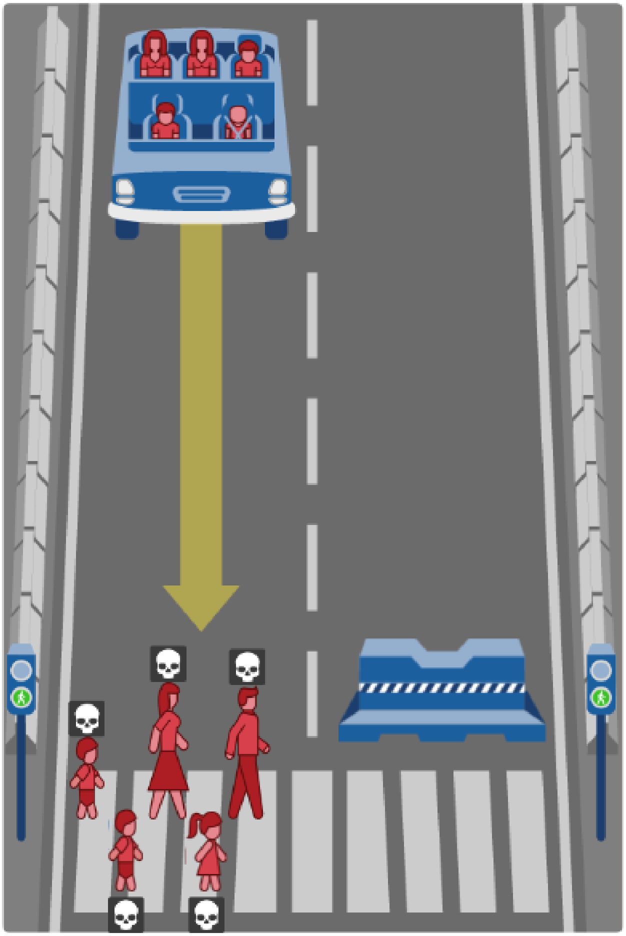

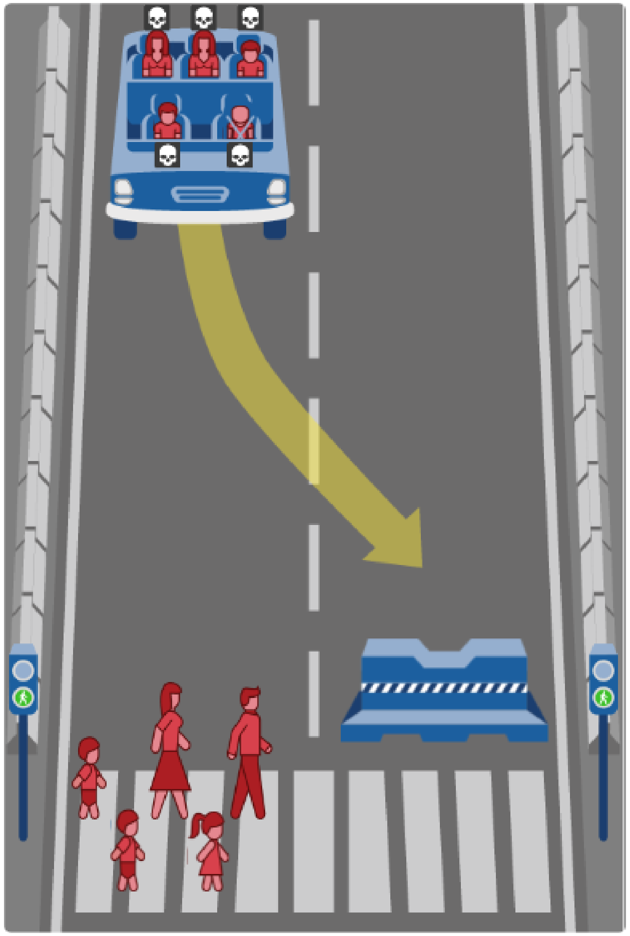

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http://moralmachine.mit.edu/

Ethical choices for AVs

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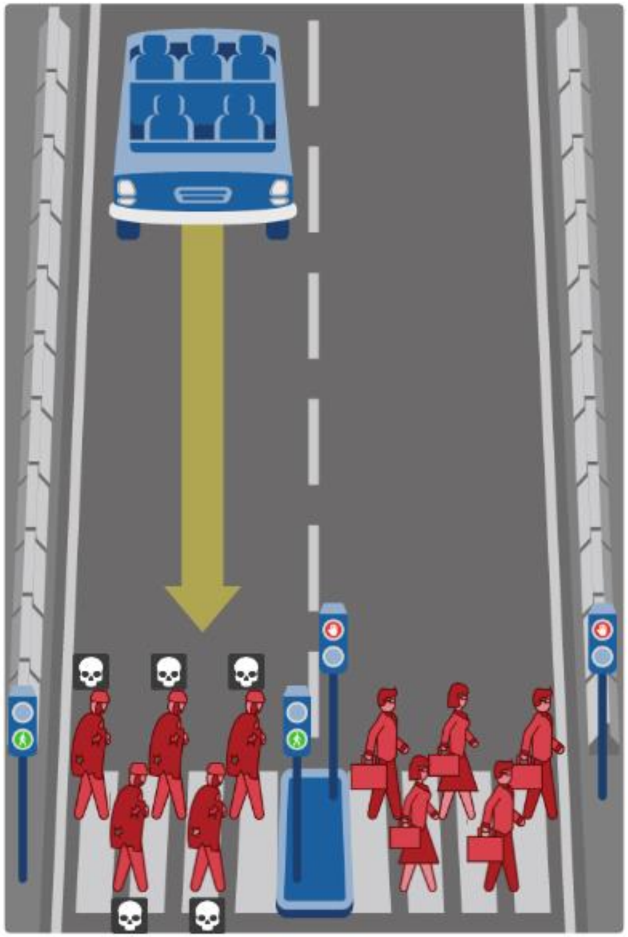

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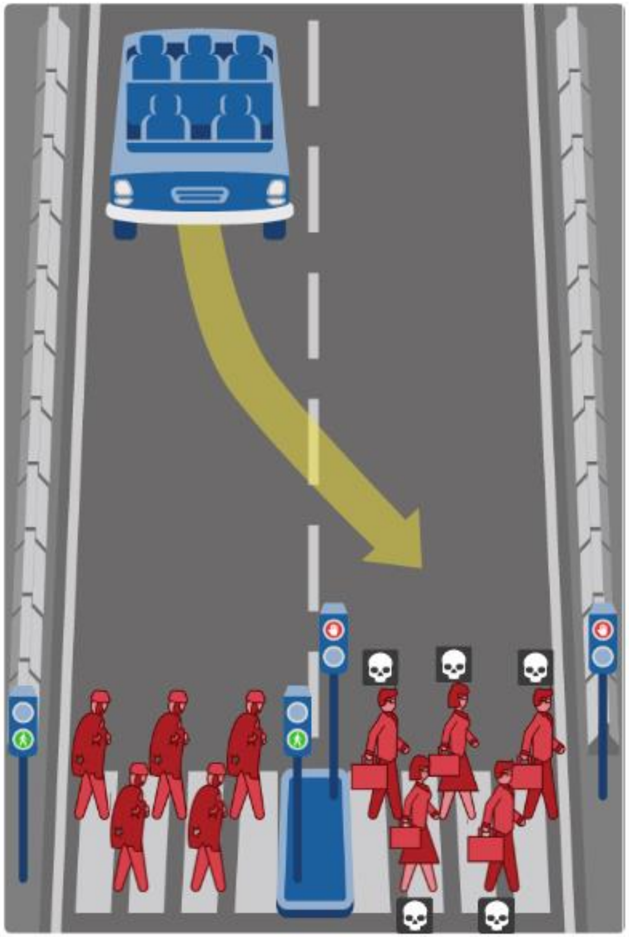
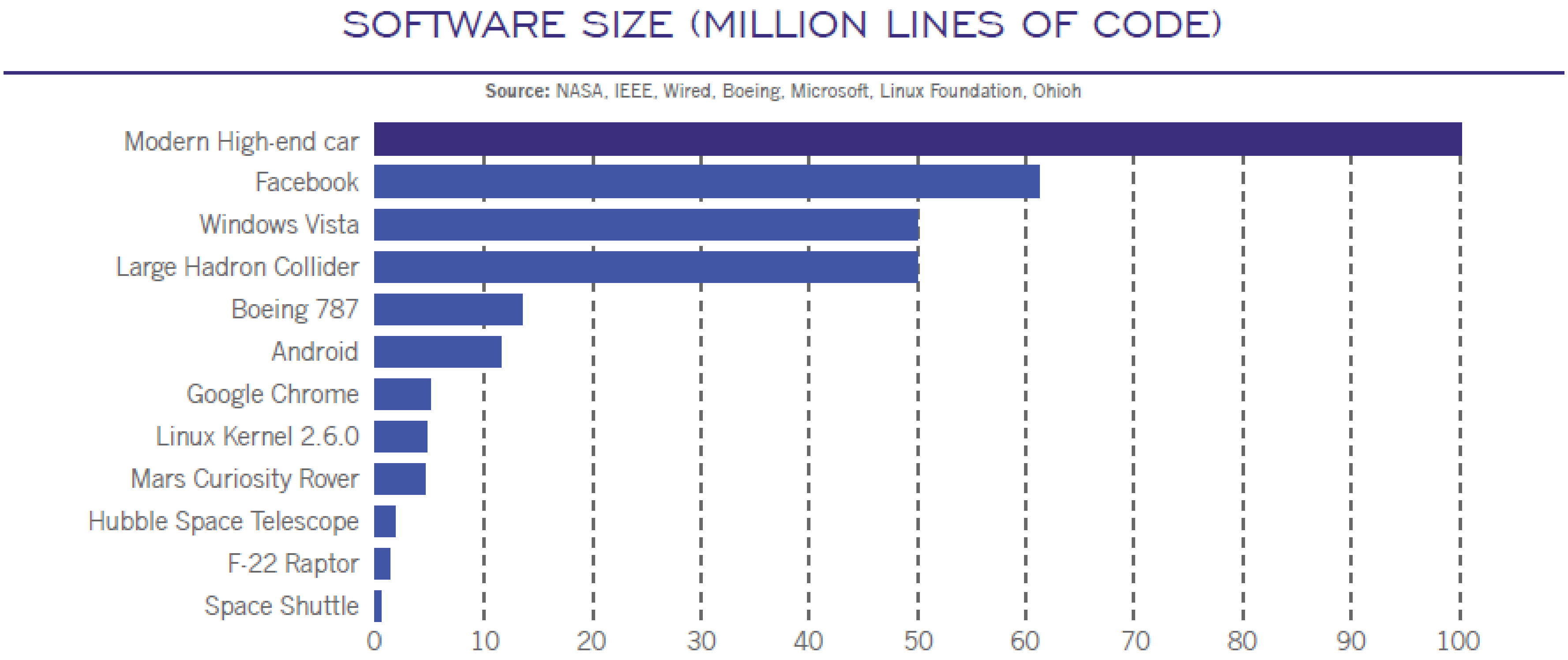


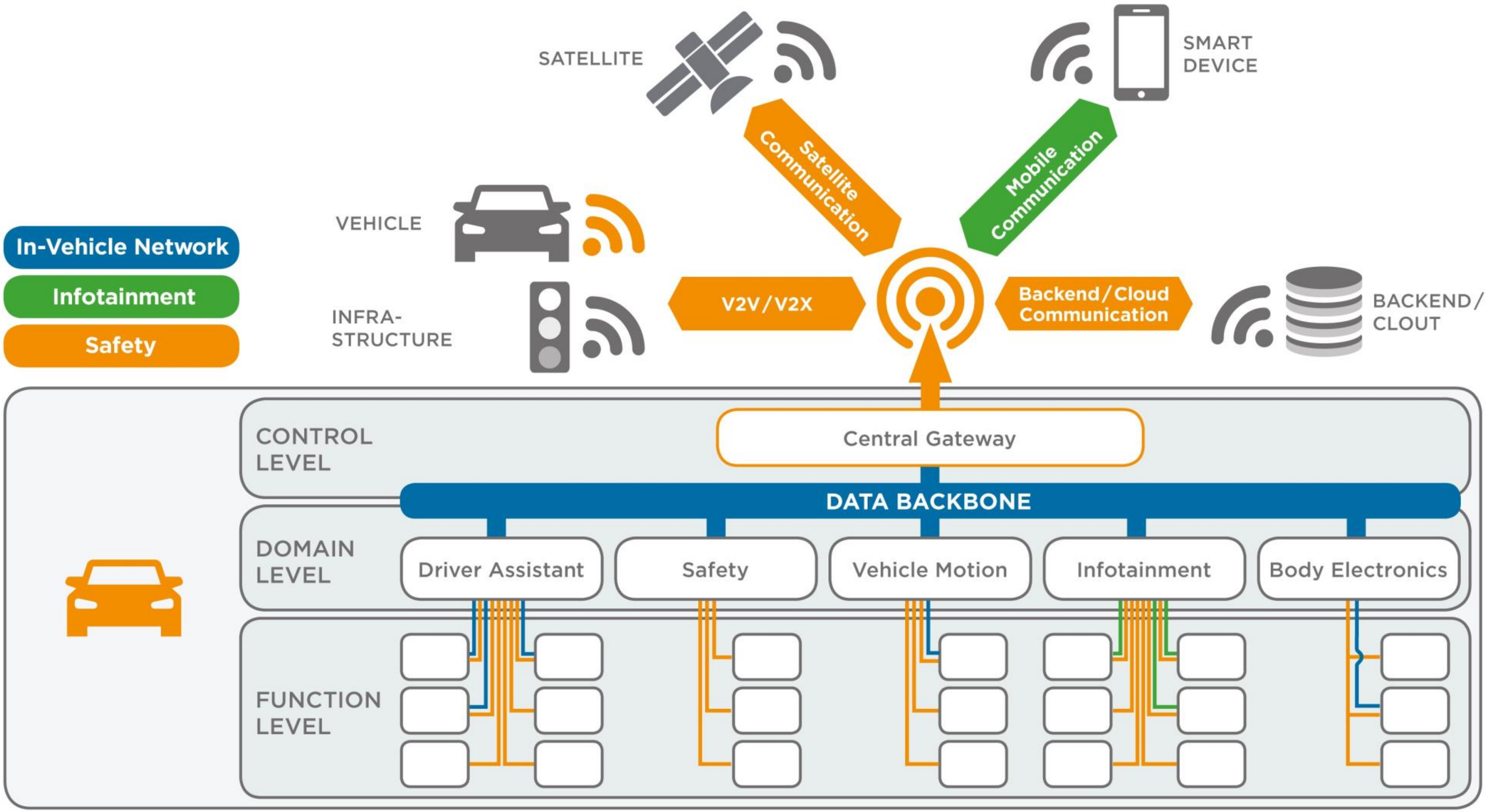
http://moralmachine.mit.edu/

Software complexity for cars (as of 2016)



Source: http://qnxauto.blogspot.com/2016/10/autonomous-cars-part-3-technology.html

Data infrastructure for AVs



https://spectrum.ieee.org/transportation/advanced-cars/6-key-connectivity-requirements-of-autonomous-driving

Thank you for your attention!

If you have further questions:

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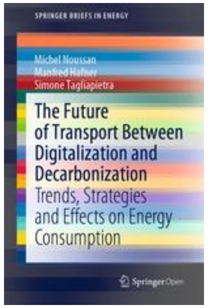

Book **"The Future of Transport Between Digitalization and Decarbonization"**

Open Access: https://link.springer.com/book/10.1007%2F978-3-030-37966-7