Benefits Estimation for AV Systems

Session: Impact Assessment
3nd SIP-adus Workshop

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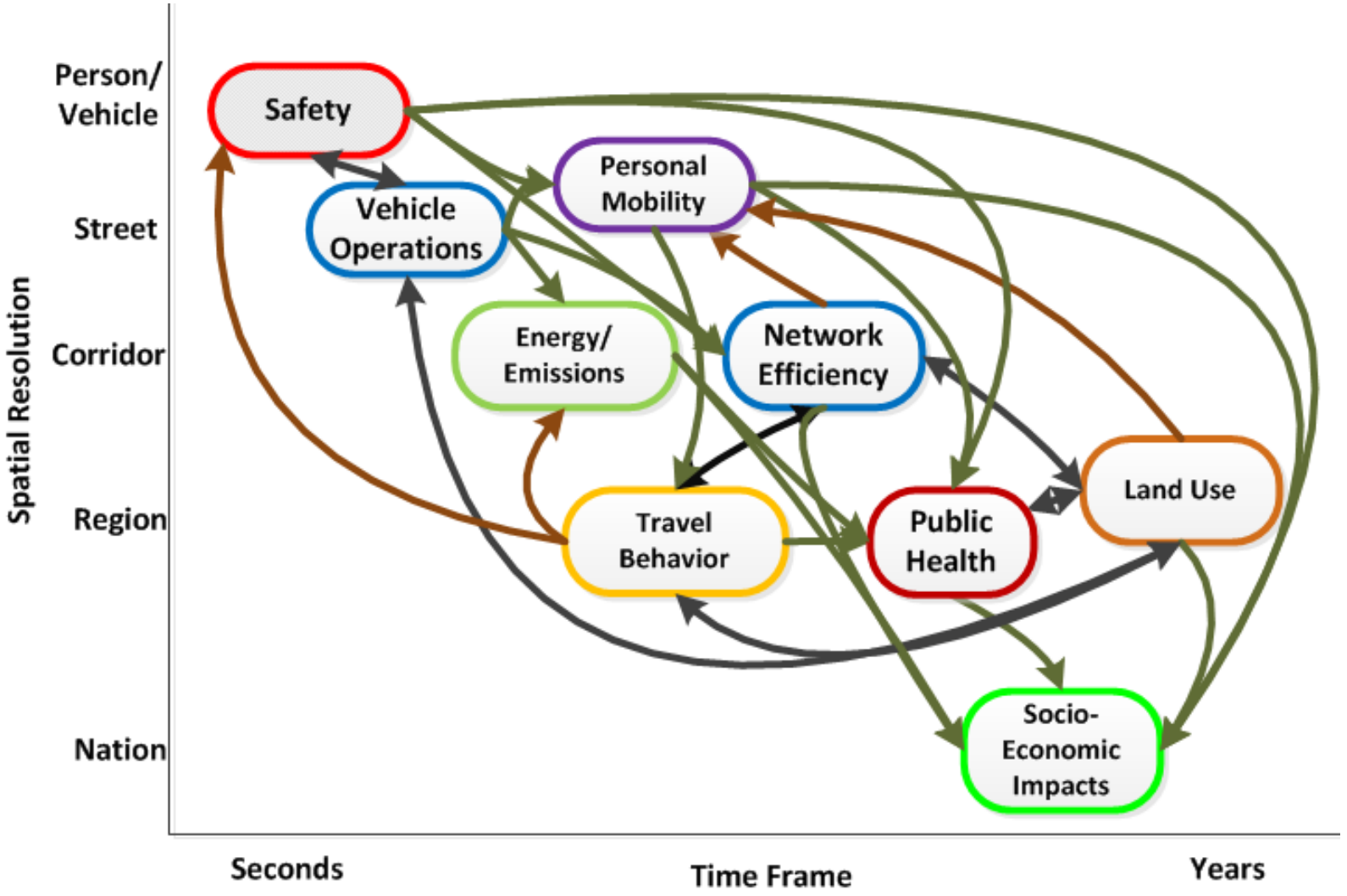
Outline

- Automated Vehicle Benefits Framework
- Research Data Exchange
- EU-US-Japan Impact Assessment Subgroup

Framework


Person/ Vehicle
Street
Corridor
Region
Nation
Spatial Resolution
Safety
Vehicle Operations
Personal Mobility
Energy/ Emissions
Network Efficiency
Travel Behavior
Public Health
Land Use
Socio-Economic Impacts
Seconds
Time Frame
Years

Direct and Indirect Impacts

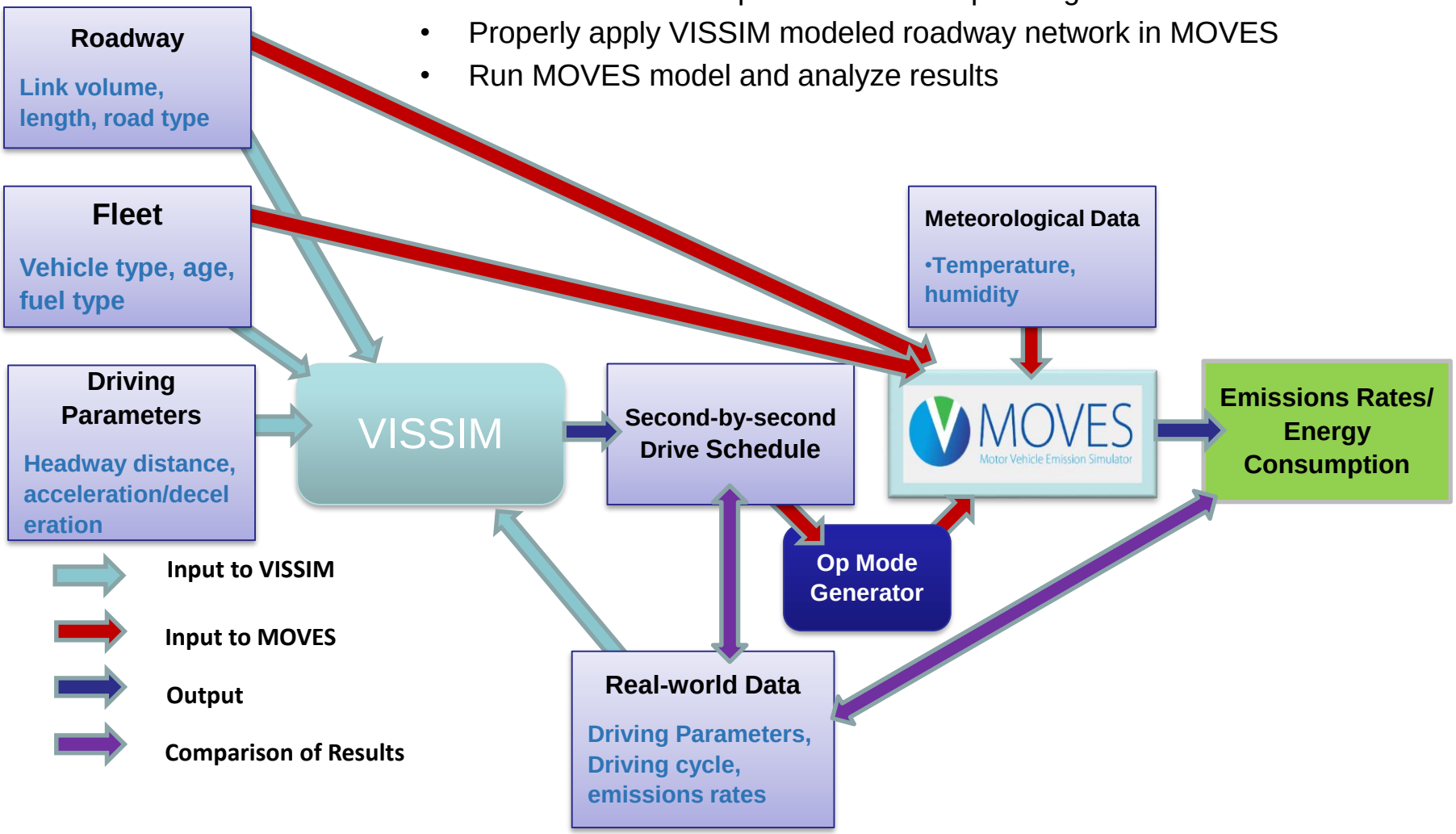
- Cost
- Infrastructure
- Safety
- Vehicle Operations
- Energy / Emissions
- Personal Mobility
  - Multi-tasking
  - Accessibility
- Asset Management
  - Lanes and lane widths
  - V2I infrastructure
  - Size and weight
- Network Efficiency
- Travel Behavior
- Public Health
- Land Use
- Socio-Economic

Direct Impacts: Vehicle Operations, Energy, Emissions

- Vehicle operations: acceleration, deceleration, lane keeping, car following, lane changing, gap acceptance
- Energy and emissions: affected by changes in the driving cycle
  - Fuel Consumption
  - Criteria Pollutants (CO, NOx, PM_{10}, $PM_{2.5}$, and SO_2)
  - Other Pollutants (HC and VOCs)
  - GHGs (CO_2 and other greenhouse gases)
- Importance: societal cost of congestion, air pollution and GHG emissions

Energy/Emissions Approach

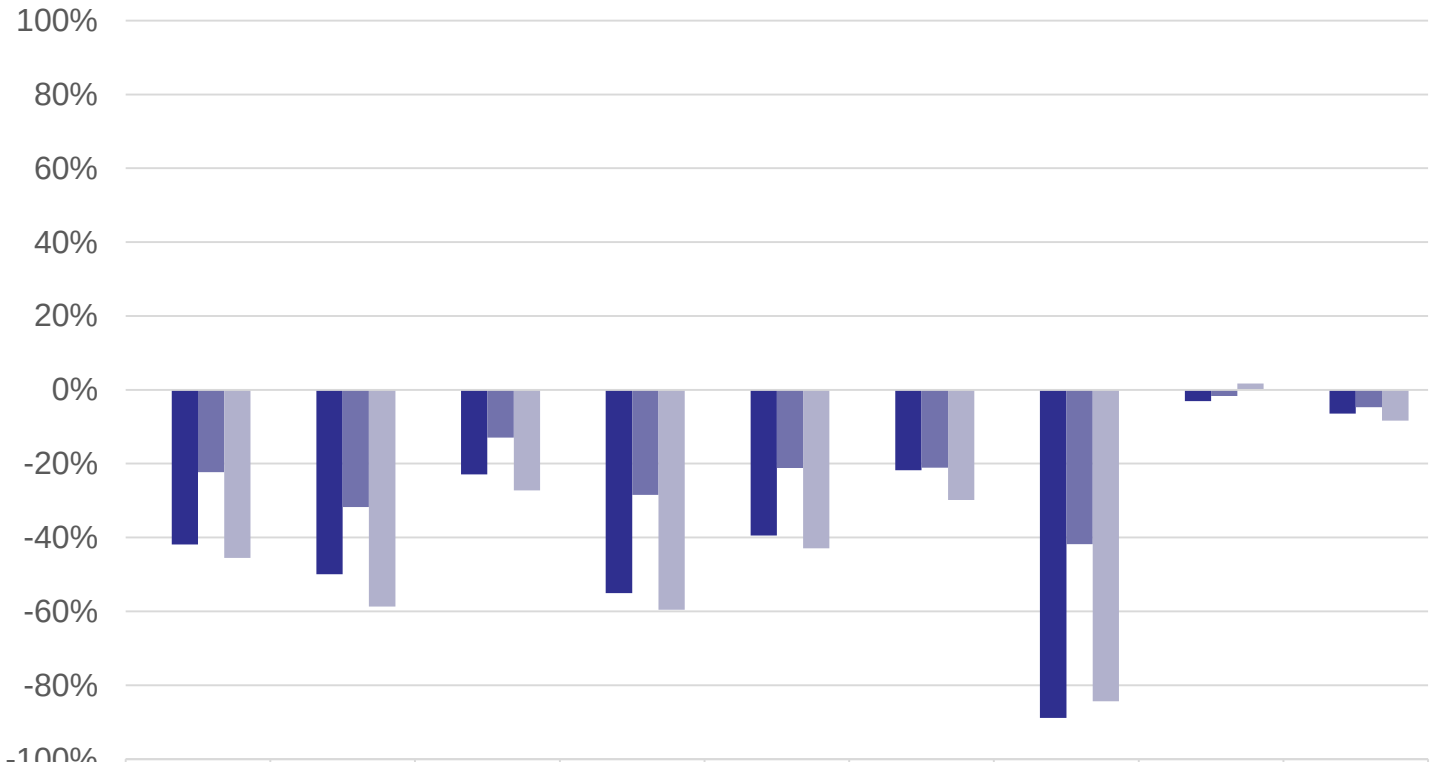
- Process VISSIM output to create an operating mode distribution
- Properly apply VISSIM modeled roadway network in MOVES
- Run MOVES model and analyze results



Percent Reductions in Emissions from 100% Human Driving

Multi-lane freeway segment

Baseline: 100% Human, 2400 vehicles / hour



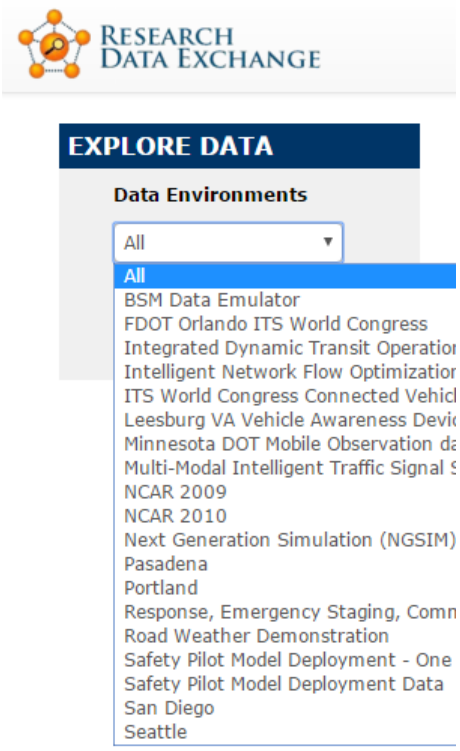
	Total Hydrocarbons (THC)	Carbon Monoxide (CO)	Nitrogen Oxides (NOx)	Methane (CH4)	Volatile Organic Compounds (VOC)	Particulate Matter < 2.5µm (PM2.5)	Brakewear (PM2.5)	Tirewear (PM2.5)	Energy/ Carbon Dioxide (CO2)
100% Human - 2400 vlh	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
100% CACC - 2400 vlh	-41.93%	-49.99%	-22.87%	-55.03%	-39.49%	-21.75%	-88.84%	-3.05%	-6.42%
50% Human/50% CACC - 2400 vlh	-22.34%	-31.72%	-12.96%	-28.48%	-21.19%	-21.07%	-41.81%	-1.69%	-4.70%
100% CACC - 4000 vlh	-45.56%	-58.69%	-27.25%	-59.57%	-42.96%	-29.83%	-84.40%	1.69%	-8.35%

Framework: Lessons learned and next steps

- **Need for a clearinghouse on research, to facilitate sharing**
  - What data are collected?
  - What methods (models) are used?
  - What results are reported?
- **Understand the big picture, to ensure the right data are collected**
  - For example, a mobility project may affect safety and vice versa
- **Next steps**
  - Identify data sources and automation applications for initial modeling
  - Examine connections between micro and regional mobility models
  - Develop AV impact models
    - Start with Safety, Mobility and Energy/Emissions
    - Continue to other areas
  - Coordinate with U.S. and international evaluation efforts

Research Data Exchange

- **Purpose**
  - To provide a variety of data-related services that support the development, testing, and demonstration of multi-modal transportation mobility, weather, and environmental applications.
- **Objectives**
  - Enables systematic data capture from connected vehicles, mobile devices, and infrastructure
  - Performs data quality checks and provides clean, well- documented data sets
  - Integrates data from multiple sources into data environments



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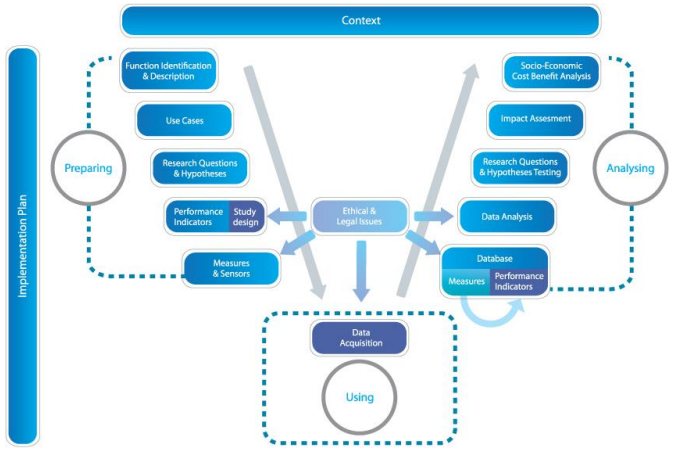
International Coordination

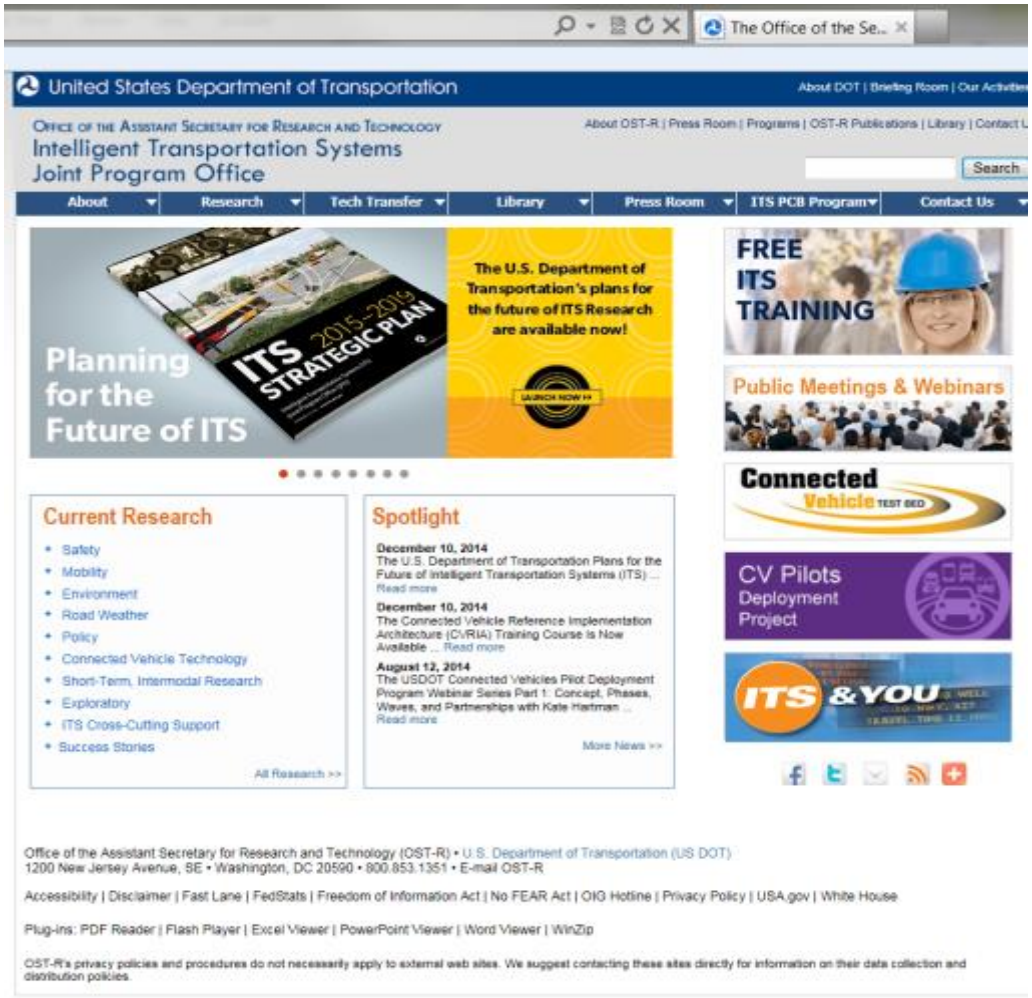
Impact Assessment subgroup of the EU-US-JAPAN trilateral road automation in road transportation working group

- **Collection of impact assessment approaches on projects**
  - *http://wiki.fot-net.eu/index.php/Trilateral_Collection_of_Impact_Assessment_Methods*

- **Planned activities (first priority)**
  - Define which impact areas we recommend to cover
  - Define what we mean by each impact area (common vocabulary)
  - Define key performance indicators (KPIs) with which we recommend the impact to be expressed
  - Provide recommendation for baseline
  - Provide examples of anticipated impact mechanisms



Sponsorship: US DOT Intelligent Transportation Systems Joint Program Office (ITS JPO)



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Backup slides

Direct Impacts: Cost & Infrastructure

- Capital and operating cost estimate for a production system
- Infrastructure requirements (road markings, signs, signals, mapping, V2V, V2I, V2P communications)
- Importance: supports the business case for widespread adoption

Direct Impacts: Safety

- Ultimately measured as fatalities, injuries and property damage for vehicle occupants and other road users
- Challenging to measure because crashes are rare events
- Proxy measures
  - Traffic violations (e.g., lane departure, following too closely)
  - Extreme maneuvers (e.g., sudden braking, steering, acceleration)
  - Instances where the human driver must take control
  - Exposure to near-crash situations
  - Response to near-crash situations
- Importance: human-caused crashes have a huge societal cost

Direct Impacts: Personal Mobility

- Is a travel option available to someone (e.g., a non-motorist)
- Journey quality (comfort), travel time, out of pocket cost
- Ability to engage in other activities while en-route
- Different effects on different sub-populations (e.g., non-motorists)
- Fleet (truck or bus) driver productivity
- Importance: higher levels of automation may significantly improve personal mobility, particular for populations that are not well-served today.

Going from Direct to Indirect Impacts, an example

Example of an AV that can deliver itself to a user