



Benefits Estimation for AV Systems

Session: Impact Assessment 3rd SIP-adus Workshop

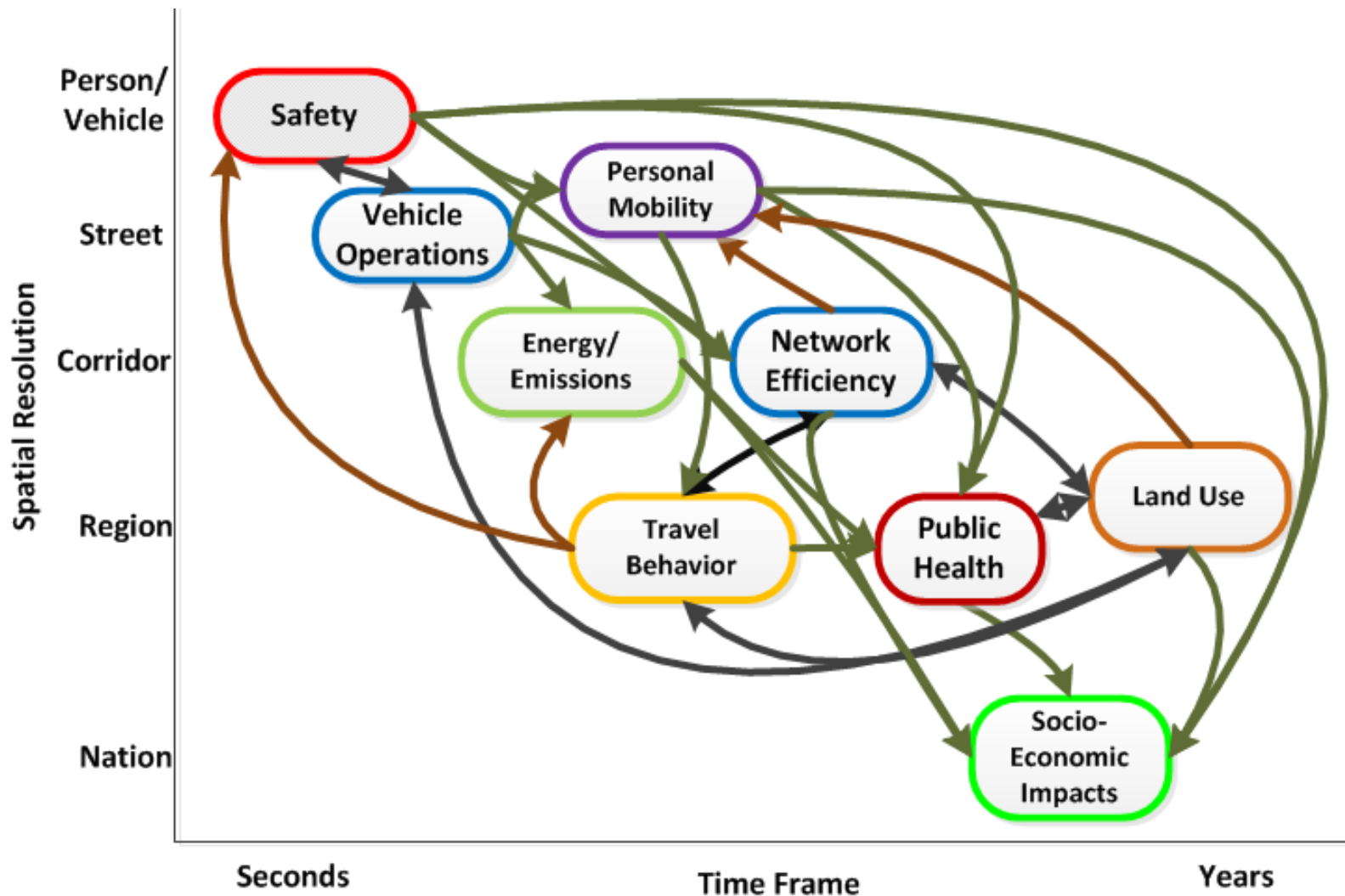
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Outline

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

Framework





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



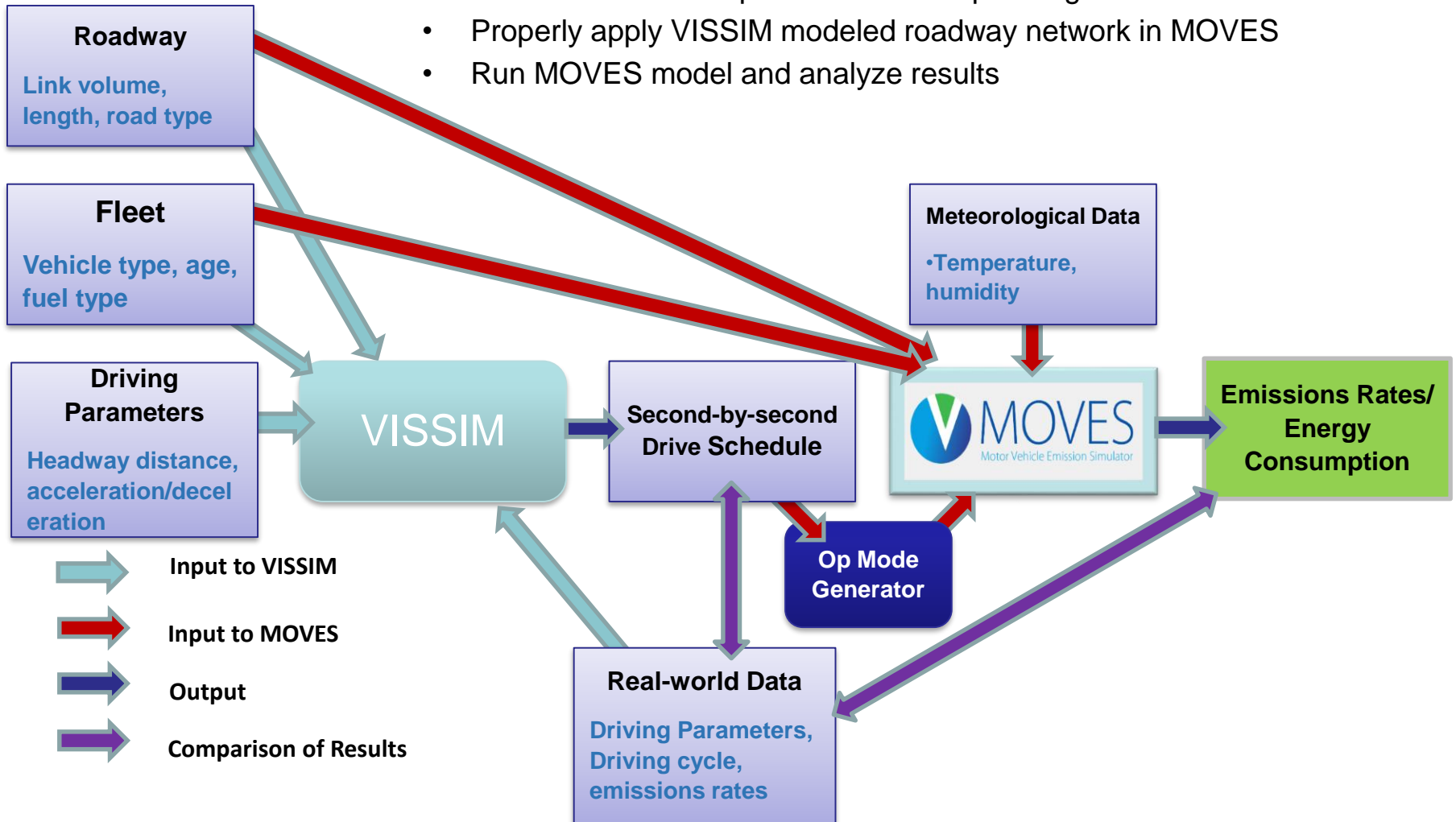
Direct Impacts: Vehicle Operations, Energy, Emissions

- 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, NO_x, PM₁₀, PM_{2.5}, and SO₂)
 - Other Pollutants (HC and VOCs)
 - GHGs (CO₂ 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

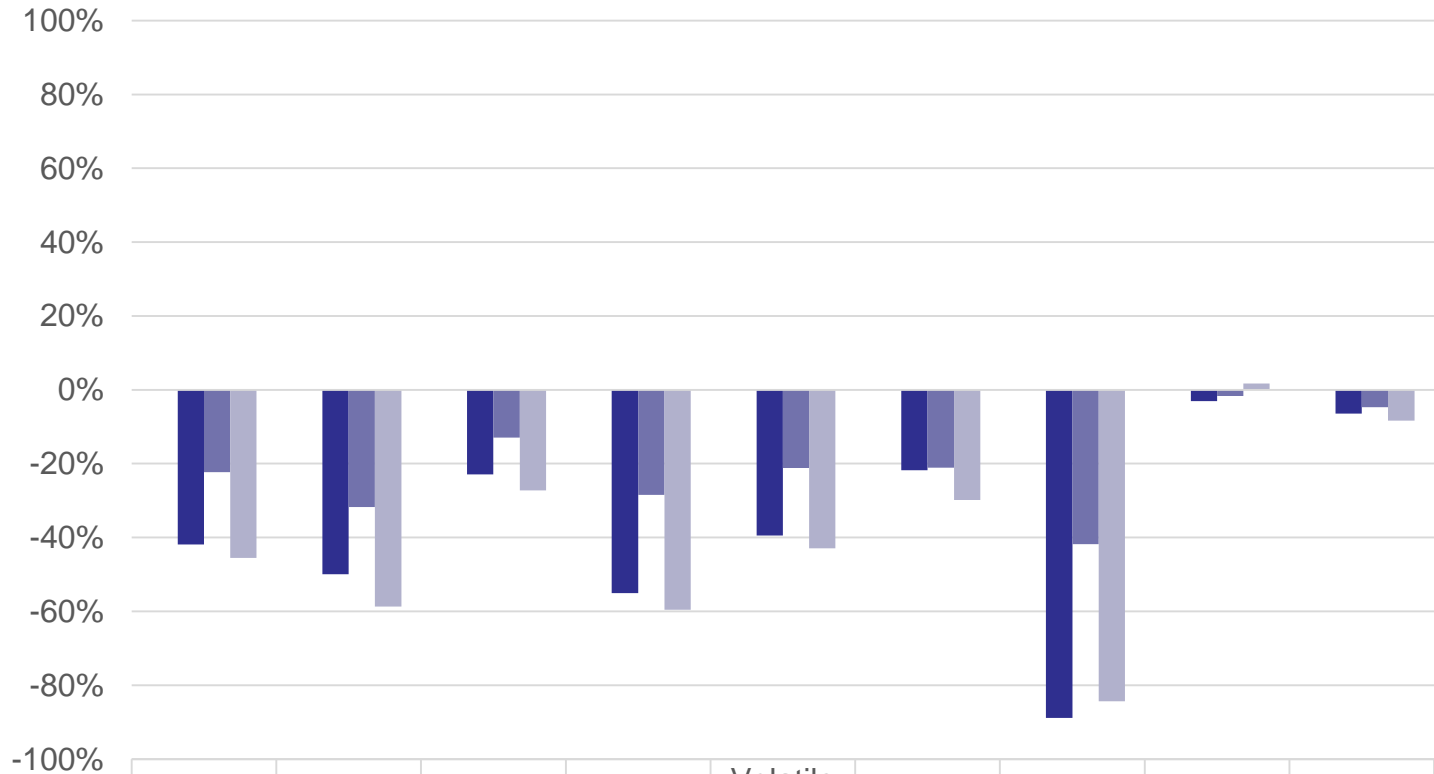




Percent Reductions in Emissions from 100% Human Driving

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

www.ite-rde.net



EXPLORE DATA

Data Environments

All

All

BSM Data Emulator
FDOT Orlando ITS World Congress
Integrated Dynamic Transit Operator
Intelligent Network Flow Optimizator
ITS World Congress Connected Vehicl
Leesburg VA Vehicle Awareness Devic
Minnesota DOT Mobile Observation d
Multi-Modal Intelligent Traffic Signal
NCAR 2009
NCAR 2010
Next Generation Simulation (NGSIM)
Pasadena
Portland
Response, Emergency Staging, Comm
Road Weather Demonstration
Safety Pilot Model Deployment - One
Safety Pilot Model Deployment Data
San Diego
Seattle

International Coordination

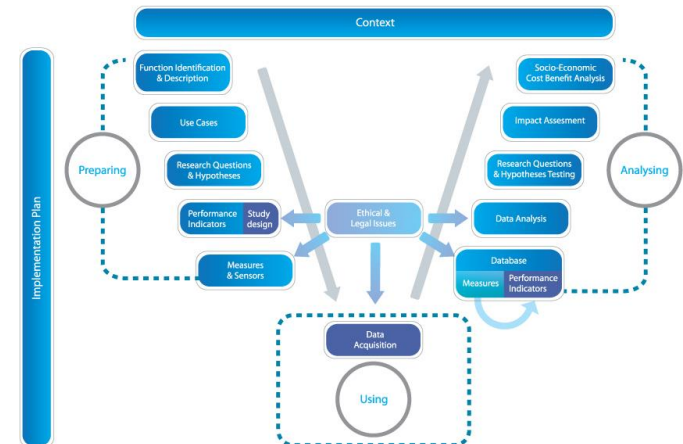
Impact Assessment subgroup of the EU-US-JAPAN trilateral road automation in road transportation working group

- **Collection of impact assessment approaches on projects**

- http://wiki.fot-net.eu/index.php/Trilateral_Collection_of_Impact_Assessment_Methods

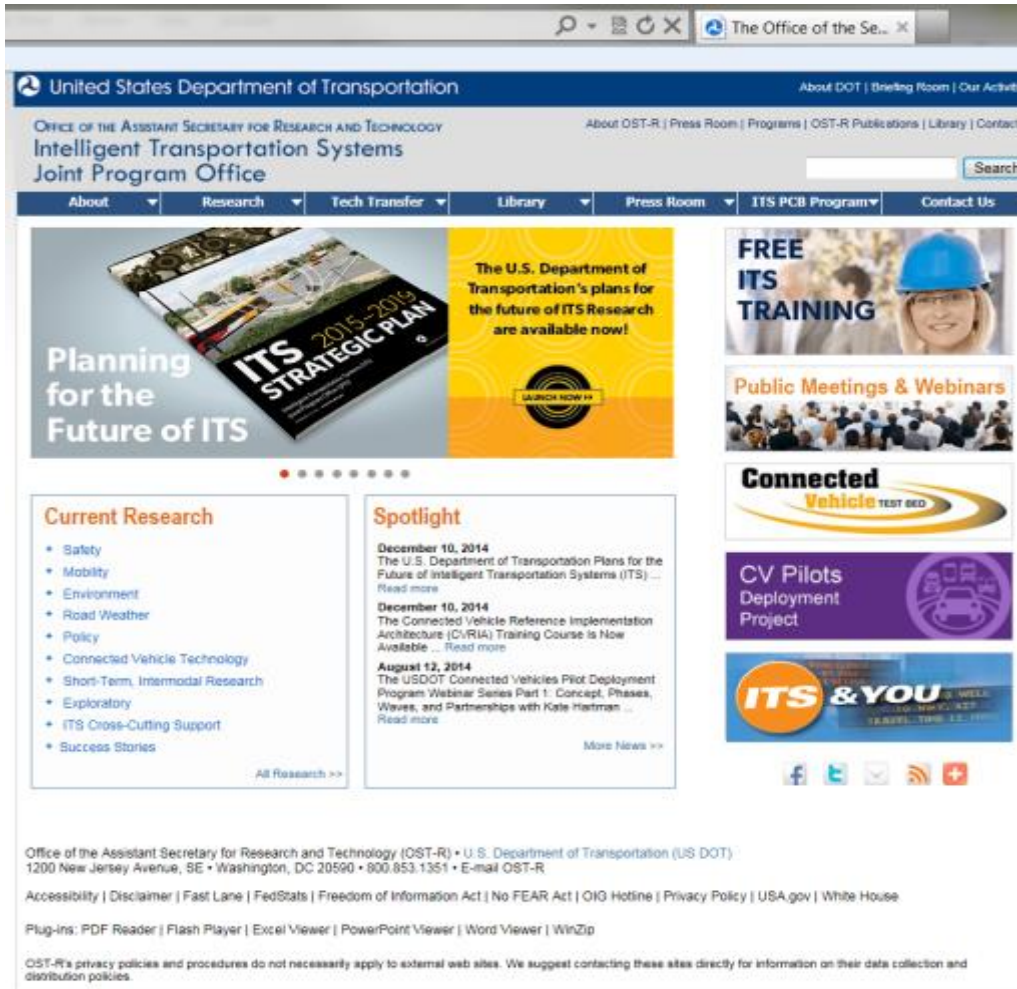
- **Planned activities (first priority)**

- 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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The screenshot shows the website for the Office of the Assistant Secretary for Research and Technology, Intelligent Transportation Systems Joint Program Office. The page features a navigation menu with options like About, Research, Tech Transfer, Library, Press Room, ITS PCB Program, and Contact Us. A main banner highlights the 'ITS 2015-2019 STRATEGIC PLAN' with the text 'Planning for the Future of ITS'. Below this, there are sections for 'Current Research' (listing Safety, Mobility, Environment, Road Weather, Policy, Connected Vehicle Technology, Short-Term, Intermodal Research, Exploratory, ITS Cross-Cutting Support, and Success Stories) and 'Spotlight' (featuring news from December 10, 2014, and August 12, 2014). Other featured content includes 'FREE ITS TRAINING', 'Public Meetings & Webinars', 'Connected Vehicle TEST BED', and 'CV Pilots Deployment Project'. The footer contains contact information for the OST-R office and various accessibility and utility links.

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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

