U.S. Department of Transportation
Federal Highway Administration

Turner-Fairbank
Highway Research Center

Decarbonizing Transportation with Connectivity

Smoky Mountains Mobility Conference

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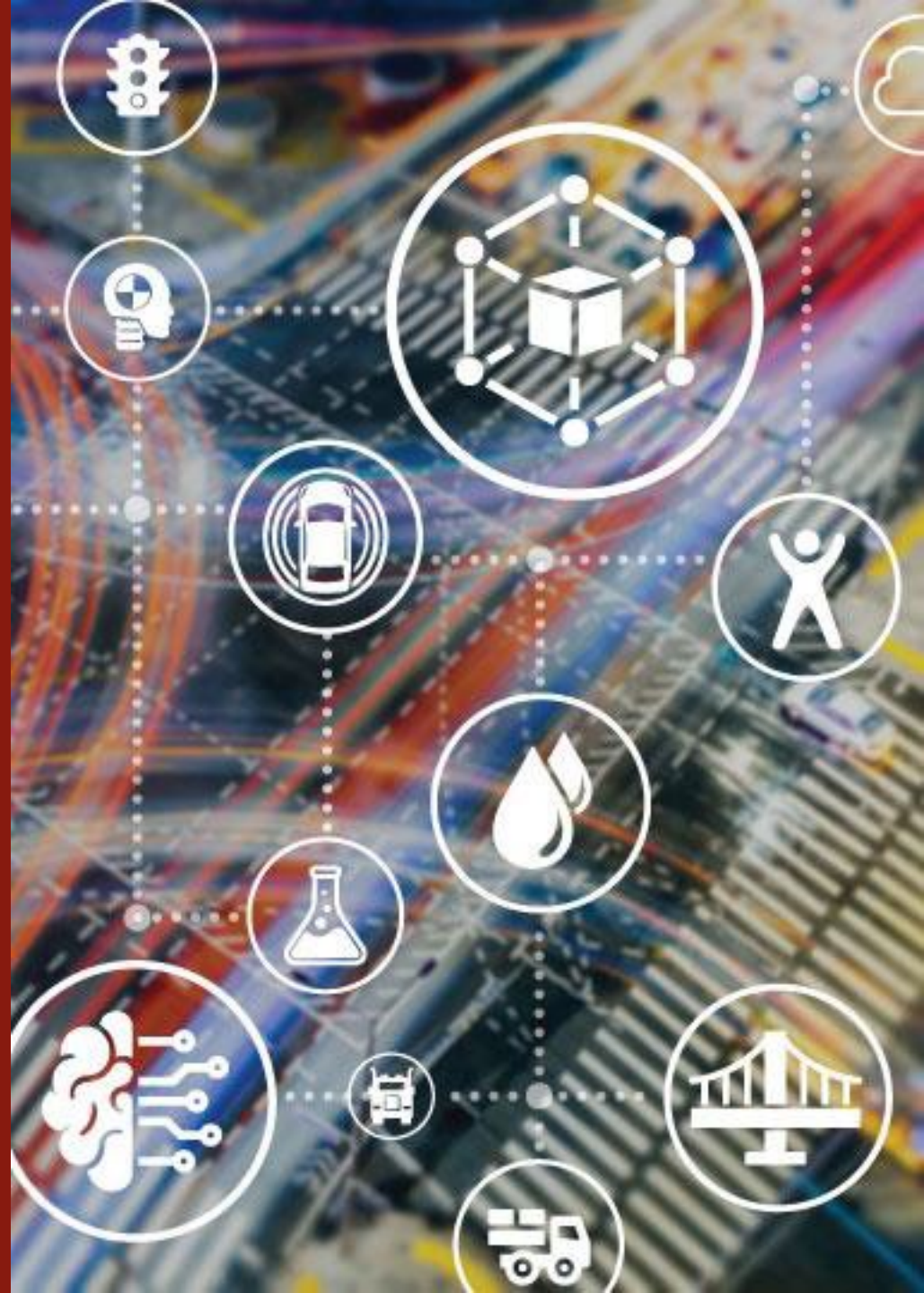
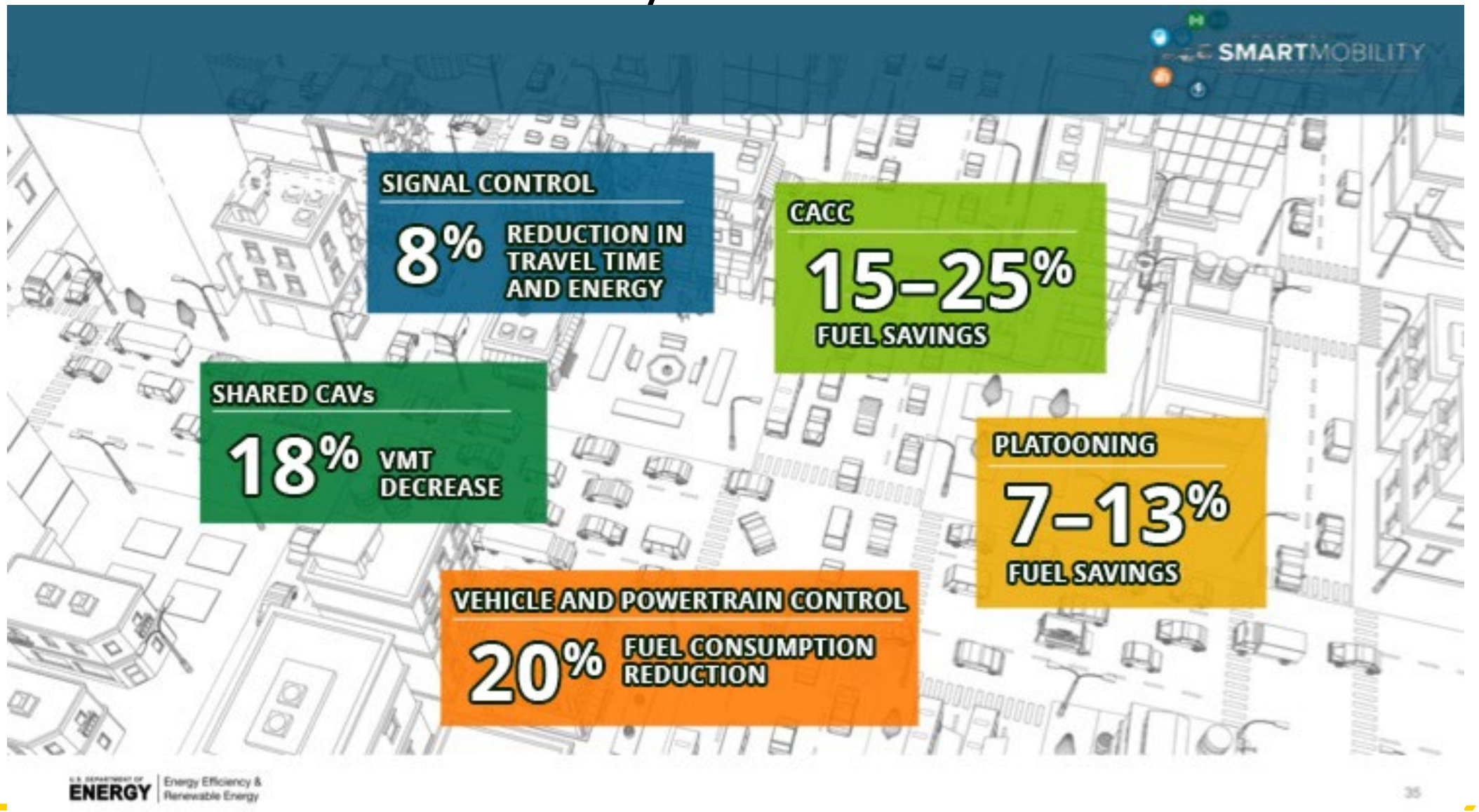


Connectivity and Automation

- Connectivity and automation are components of what author Daniel Yergin calls the “fifth fuel”: energy efficiency[1].
- The net energy impact from these technologies remains to be seen:
  - A 2016 U.S. Department of Energy (DOE) bounding study suggested that the introduction of connected and automated vehicles (CAVs) could change light-duty vehicle energy use to as low as 40 percent and as high as 300 percent of baseline levels[2].
  - The huge variability in energy use is driven by:
    - Vehicle fuel efficiency—Smoother drive cycles and traffic, as well as vehicle resizing due to improved safety.
    - Induced travel demand—Reduced barriers to travel results in more travel.
    - Vehicle ownership models—Privately owned versus shared fleets.

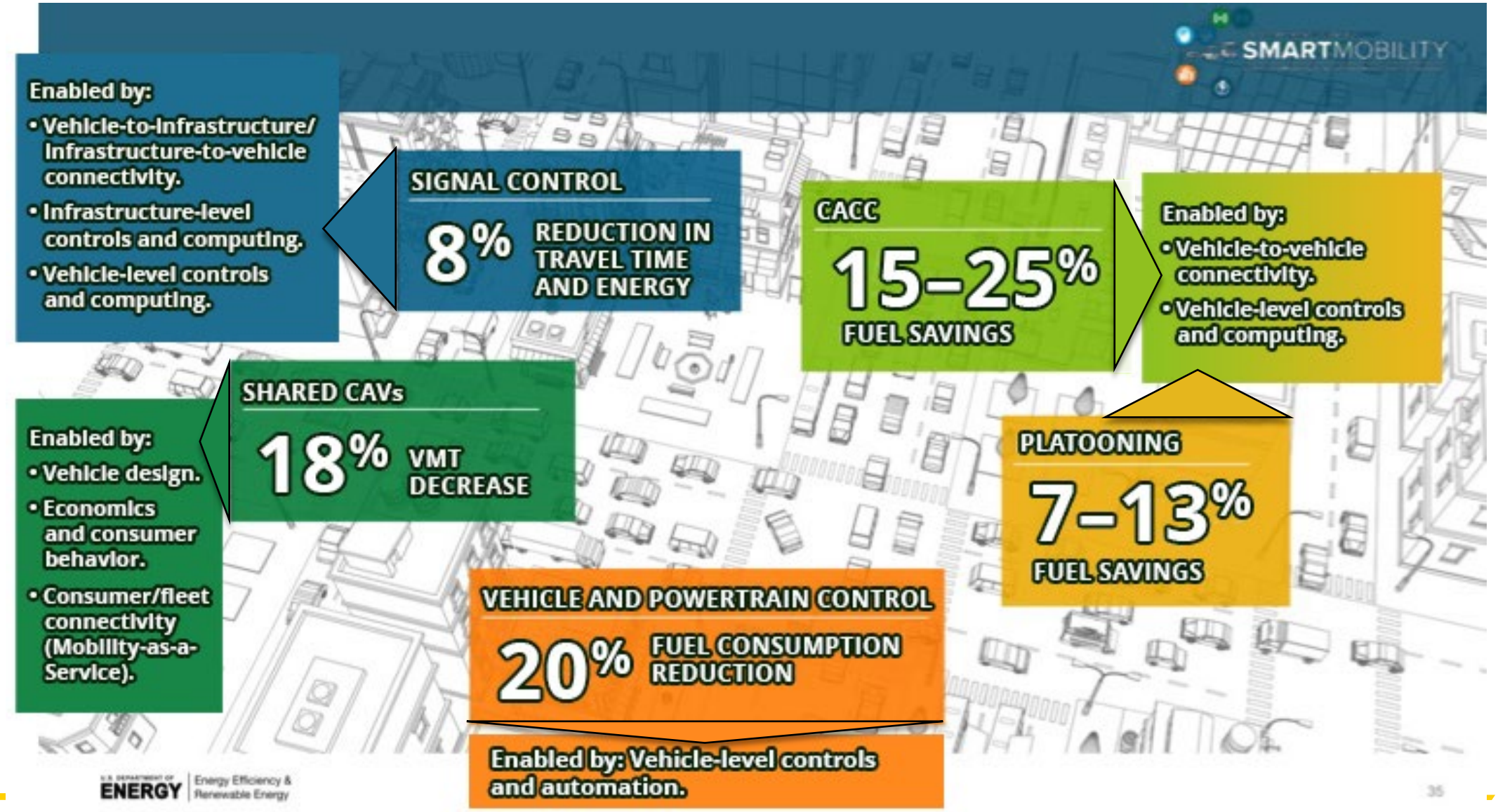
DOE SMART Mobility 1.0 Conclusions[3]



SMART = Systems Modeling to Accelerate Research in Transportation;
VMT = vehicle miles traveled;
CACC = cooperative adaptive cruise control.

Source: Department of Energy.

DOE SMART Mobility 1.0 Conclusions[3] (continued)



Source: Department of Energy.

How Are the U.S. Department of Transportation (USDOT) and DOE Investing in Enabling Technologies?

- Vehicle-to-everything connectivity:
  - Radio frequency spectrum.
  - Cybersecurity.
  - Communications standards development and interoperability testing.
- Infrastructure- and vehicle-level controls and automation:
  - Artificial intelligence/machine learning.
  - Data fusion.
  - Computing.
- Economics and consumer behavior (technologies at scale):
  - Traveler behavior modeling.
  - Computing.
  - System-level metrics.
- Vehicle design (limited—mostly in the private sector):
  - Human factors.
  - Pilot demonstrations.

What are we doing to advance R&D and improve understanding of impacts?

- Vehicle fuel efficiency—Smoother drive cycles and traffic ~~as well as vehicle re-sizing due to improved safety~~ [vehicle resizing considered out-of-scope and purview of private sector]
  - DOE: Traffic smoothing (e.g., CIRCLES, platooning), variations of eco-approach and departure (e.g., Nimitz Highway, cloud-based traffic cohort energy optimization, Eco-ATCS), etc.
  - USDOT: CARMA℠.
- Induced travel demand—Reducing barriers to travel will result in more travel:
  - USDOT: Center of Excellence (COE) on New Mobility and Automated Vehicles (Mobility COE) will examine impacts on land use and urban design.
  - DOE: POLARIS[4] and BEAM[5] (regional agent-based models).
  - USDOT: GEMS[6] (meso/macroscopic travel supply/demand model).
  - DOE/Environmental Protection Agency (EPA): GCAM[7] (macroscopic economic model).
- Vehicle ownership models—Privately owned versus shared fleets.
  - USDOT—SD model.

CIRCLES = Congestion Impacts Reduction via CAV-in-the-Loop Lagrangian Energy Smoothing;
Eco-ATCS = Ecological Adaptive Traffic Control System;
POLARIS = Planning and Optimization Language for Agent-based Regional Integrated Simulations;
BEAM = Behavior, Energy, Autonomy, and Mobility;
GEMS = Geospatial Economic Multimodal Systems;
GCAM = Global Change Analysis Model;
SD = System Dynamics.

How can ART technologies become part of the (urban) “climate agenda”?

Net zero cities with automated vehicles

Basic policy options	Cooperative, Connected, Automated Mobility Solutions: “Business as usual”	Cooperative, Connected, Automated Mobility Solutions: “Net zero automation”	Expected CCAM impacts
AVOID travel (or reduce need for travel)	• increased urban sprawl • induced new demand • car culture continued • better safety	• shared mobility solutions (for low-serviced areas, e.g. peri-urban)	• compact green metropolitan areas • people-friendly urban space & infrastructure
SHIFT transport to more sustainable modes		• attractive & accessible collective services (quality, price)	• better safety, lower cost, fair access • private-public coordination • digitised mobility services
IMPROVE resource efficiency of transport	• modest fuel savings • improved traffic flow	• electric vehicles (powered by clean energy, e.g. local renewable sources)	• more efficient traffic flows • most effective energy use • low emissions
Make **RESILIENT**	• lower/higher vulnerability?	• highly integrated (other policies, infrastructure)	• robust transport system able to recover quickly from disruptions

From *Planning for Net Zero*[8].
ART = automated road transportation;
CCAM = cooperative, connected, automated mobility.

References

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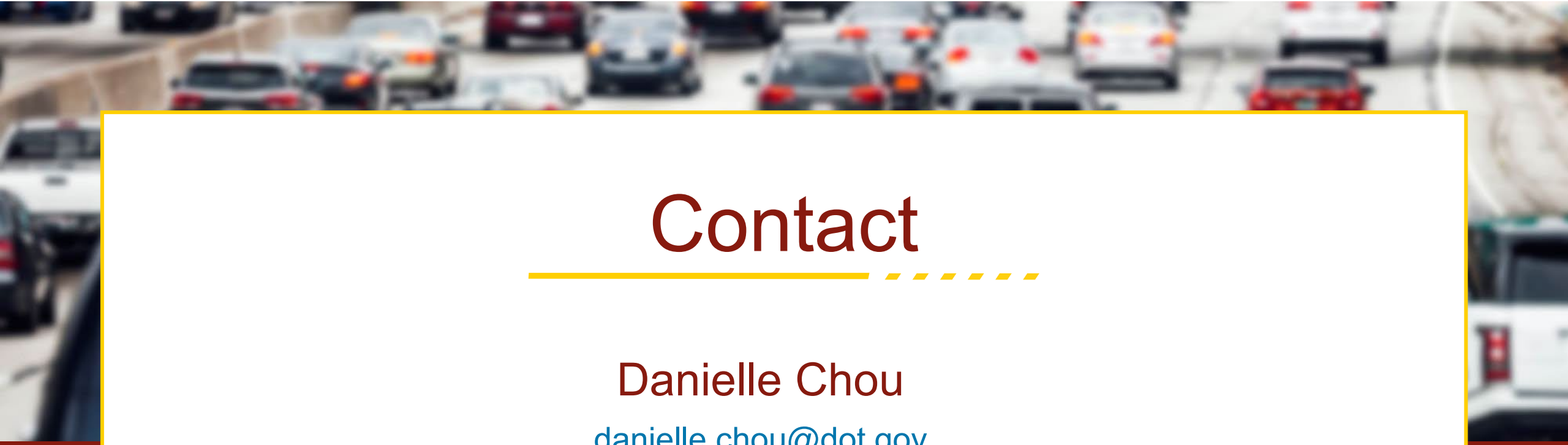

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