U.S. Department of Transportation

ADVANCED RESEARCH PROJECTS AGENCY • INFRASTRUCTURE

Council of State Governments Masterclass
Artificial Intelligence and the Future of Governing

The U.S. Department of Transportation (DOT)

U.S. Department of Transportation

- **Mission:**

  To ensure America has the safest, most efficient and modern transportation system in the world, which boosts our economic productivity and global competitiveness and enhances the quality of life in communities both rural and urban.

- DOT employs almost 55,000 people across the country, in the Office of the Secretary of Transportation (OST) and its operating administrations and bureaus, each with its own management and organizational structure.
- Includes these nine operating (modal) administrations:
  - Federal Aviation Administration (FAA)
  - Federal Highway Administration (FHWA)
  - Federal Motor Carrier Safety Administration (FMCSA)
  - Federal Railroad Administration (FRA)
  - Federal Transit Administration (FTA)
  - Great Lakes St. Lawrence Seaway Development Corp (GLS)
  - Maritime Administration (MARAD)
  - National Highway Traffic Safety Administration (NHTSA)
  - Pipeline and Hazardous Materials Safety Administration (PHMSA)

Office of the Assistant Secretary for Research and Technology

U.S. Department of Transportation

- OST-R is an office within the Office of the Secretary of Transportation (OST) that leads research, technology, and innovation initiatives across the Department.

- **Mission**:

1. **Chief Science Officer**, serving as principal advisor to the Secretary on science and technology and charged with ensuring that DOT's research development and technology programs are scientifically and technologically well-founded and conducted with integrity.
2. **Steward, coordinator, and lead collaboration facilitator** of DOT's $1 billion research, development, and technology portfolio and leader of DOT's multi-modal research and technology activities.
3. **Leads DOT on protecting transportation uses of spectrum** in *the Civil Sector* on GPS/Positioning, Navigation and Timing; and related policymaking to support safety, automated vehicles, and the U.S. technology advantage:
   - GPS Backup and Complementary PNT Demonstration
   - GPS Adjacent Band Spectrum [Ligado interference]
   - "Safety Band" for Transportation Safety [5.9 GHz Band loss]
4. **Executes the Secretary's strategic portfolio of research, development, demonstration and implementation** of intelligent transportation systems, emerging technology, data and statistics and associated programs and policies.
5. **DOT's convener of transportation research, education and training**, planning for our nation's future transportation workforce.

Annual OST-R Research and Development Investments - Highlights

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- $100 million for the SMART Grants Program
  - Demonstration projects focused on advanced smart community technologies and systems to improve transportation efficiency and safety
- $99 million to support 35 University Transportation Centers
  - Consortium of two- and four-year colleges and universities that come together to form a unique center of transportation excellence on a specific research topic
  - Advance U.S. technology and expertise in the many disciplines comprising transportation through education, solutions-oriented research and technology transfer, and the exploration and sharing of cutting-edge ideas and approaches
- $110 million for the Intelligent Transportation Systems Joint Program Office (ITS JPO)
  - Coordinate and plans multimodal ITS technology research program, working toward improving transportation safety, mobility, and efficiency and enhancing productivity through the integration of innovative technologies into the nation’s transportation system

ARPA·I

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ARPA-I's mission *is to catalyze the development of innovative technologies, systems, and capabilities that transform the nation's physical and digital infrastructure to ensure American leadership. We aim to build the future of transportation that is safe, secure, efficient and resilient, while achieving net-zero emissions and increasing equity and access for all.*

https://www.transportation.gov/arpa-i

The Goal of ARPA-I

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•Develop Innovative Infrastructure Technologies and New Solutions for Transportation

- ARPA-I will be to Transportation as DARPA is to Defense, and ARPA-E is to Energy
- Develop innovative solutions to persistent problems in infrastructure and transportation
- Unleash US innovation and creating new infrastructure R&D ecosystems
- Ensure the US has a 21st Century Infrastructure System and will reach the goal of net-zero GHG emissions by 2050
- Develop infrastructure that will create the safest, most efficient, climate friendly and resilient transportation system in the world

Potential Topics of Interest for ARPA-I

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- Materials and Structures
  - Zero or negative carbon materials for infrastructure, extremely durable and resilient concrete, accelerated construction processes (3D printing of pavement, bridges, tunnels, water infrastructure, and high-speed rail beds), accelerated construction of seawalls and shoreline reinforcement
- Sensing and Computation for Mobility
  - 6G and edge computing for automated vehicles (AVs), intrinsically assured AI and ML for AVs, virtual LIDAR and ubiquitous machine vision, HD mapping of surface/sub-surface infrastructure and topology
- Ground Vehicles, Air, and Maritime
  - AV development, testing and validation, vehicle connectivity and networking (V2X), freight and logistics automation, fully electrified transportation – in-situ charging, V2G
  - AI-enhanced ATC and ATM, assuring safety for autonomous aircraft, infrastructure modifications for AAM integration
  - Autonomous shipping
- Cross-cutting and Enabling Technologies
  - Advanced PNT – millimetric accuracy (including signals of opportunity), cybersecurity (once and for all) – intrinsically secure networking and data transmission for mobility infrastructure, digital twins of transportation systems and infrastructure

ARPA-I and AI

AI will be pervasive across all modes of transportation and infrastructure, with hundreds of potential applications that might include

- Infrastructure design and construction automation,
- Enhanced transportation operations and maintenance, and
- Real-time control of transportation systems and traffic, across all modes.
- At the individual sensor level: detecting unsafe conditions for vulnerable road users at roadway intersections with cameras, radar and LiDAR,
- At the transportation system level: the real-time optimization of a city-wide transit-on-demand system or the optimization of all traffic signals,
- At the system-of-systems level: the safe operation of a national trajectory-based ATC system, the cyber-secure operation of a complementary position, navigation and timing (PNT) system, and supply chain optimization.

U.S. DOT Intersection Safety Challenge Overview

- **VISION: Transform intersection safety** through the innovative application of emerging technologies including machine vision, sensor fusion, and real-time deci making to identify and mitigate unsafe conditions involving vehicles and vulnerable ro users.

- **PROGRAM STRUCTURE:**

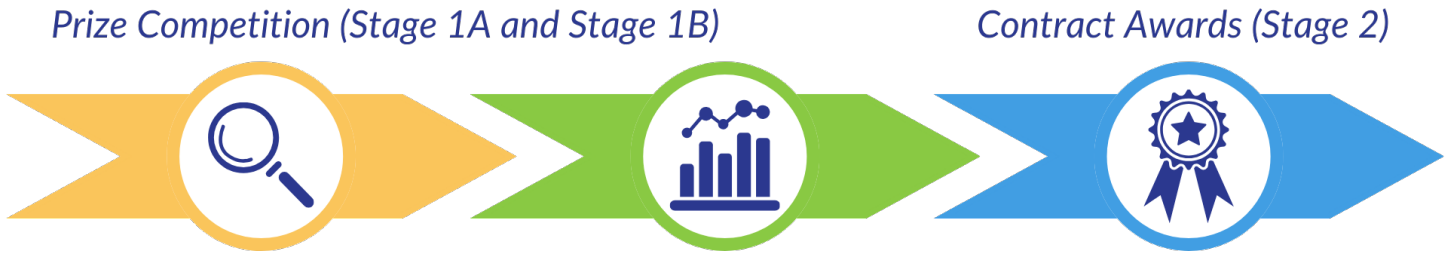


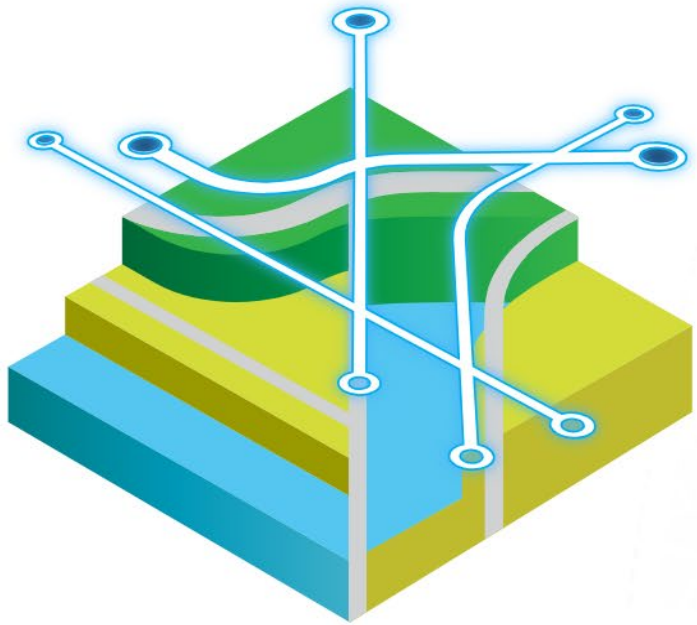
Image Source: U.S. DOT

- **PRIZE COMPETITION:** Encourage teams of innovators and end-users to develop and virtually test their intersection safety systems to compete for prizes.

Concept Illustration: Intersection Safety System (ISS)

- Deploy emerging, low-cost sensors (e.g., cameras, radar, LiDAR, infrared) at intersections to improve sensing.
- Use multi-sensor data fusion/analytics to improve situational awareness and anticipate safety threats.
- Issue warnings and/or modify control settings to improve safety.

Image Source: U.S. DOT

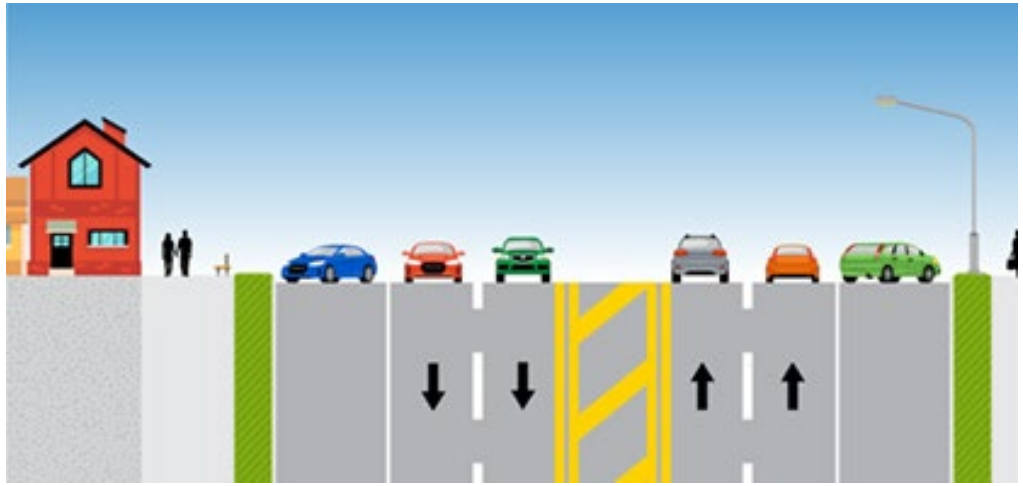


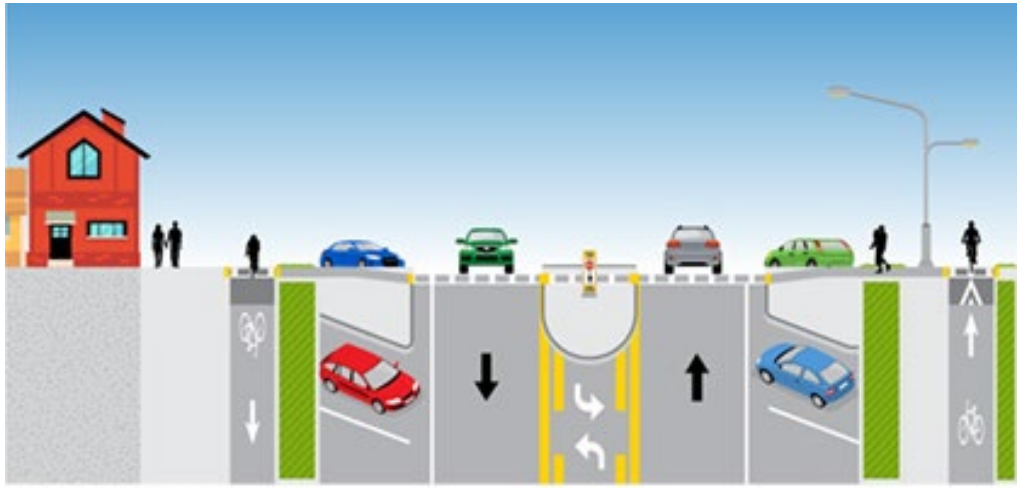
COMPLETE STREETS | AI

Generating, Integrating, and Activating Data for Mobility

What are Complete Streets?

"Streets and networks that prioritize safety, comfort, and connectivity to destinations for all people who use the street network."





Source: FHWA.

Novel methodologies to fill data gaps

Leverage new AI, ML, and computer vision approaches

Data sources may include photography, lidar, sensor-based, crowdsourced, vehicle probe, telemetry, counter, among others

Data & Analysis

CS Report to Congress Opportunity Area A:
"Improve data collection and analysis to advance safety for all users"

SBIR 24.2 Data Element Categories:

- Infrastructure
- Traveler Behavior/Safety
- Context

Decision Support Tool

- Produce software tool(s)
- Provide quantitative, segment-scale and network-scale insights
- Serve state, local, and tribal practitioners

How do we take this further?

IMAGINE IF WE CAN

- Use advances in sensing and mapping to speed up the **surveying** process
- Use generative design offer options ***for initial design drafts*** to planners based on the most current safest street designs and principles
- ***Spur domestic industrialized construction*** using new production methods to build or retrofit streets and civic infrastructure
- Integrate ***green infrastructure*** elements

Background

U.S. Department of Transportation

OCTOBER 30, 2023

Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence

BRIEFING ROOM ▸ PRESIDENTIAL ACTIONS

The Secretary of Transportation shall further encourage ARPA-I to prioritize the allocation of grants to those opportunities, as appropriate. The work tasked to ARPA-I shall include soliciting input on these topics through a public consultation process, such as an RFI.

Questions

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The RFI was released on May 3rd and closed on August 3rd including the following questions:

- What are the relevant current or near-term applications of AI in transportation?
- What are the future potential opportunities in transportation that AI can facilitate?
- What are the current or future challenges of AI in transportation, including risks presented by the use of AI in transportation and potential barriers to its responsible adoption?
- What are the opportunities, challenges, and risks of AI related to autonomous mobility ecosystems, including software-defined AI enhancements?

Responses

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DOT received 112 responses including submissions from industry, labor, academia, associations, and infrastructure owner operators. Notable respondents included:

Microsoft

MTA

ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

UCLA
University of California, Los Angeles

Texas Department of Transportation

intel

International Brotherhood of Teamsters

United Spinal Association

alpa

Key Themes

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Crosscutting:

- Trust
- Safety
- Regulatory concerns
- Ethics
- Bias in training data
- Workforce and displacement
- Training
- Cybersecurity
- Climate and sustainability
- Economic competitiveness
- Accessibility and equity
- Human machine teaming

Use Cases:

- Traffic signal optimization
- Autonomy
- Machine vision
- Enhanced modeling and forecasting for demand, weather, climate, etc.
- Predictive maintenance
- Infrastructure and vehicle inspection
- Air traffic control applications for drones and advanced air mobility
- Advanced manufacturing and construction
- Emergency and disaster response

Novel Ideas Included

nPlan

AI driven risk assessment for construction plans, schedules, and costs using a large database of past projects

cambridge consultants
Part of Capgemini Invent

“Safety moonshot" initiative focused on comprehensive, human-centered AI deployment to achieve zero fatalities and foster innovation

THE UNIVERSITY OF ARIZONA

AI enabled material science for the discovery, testing, and validation of construction materials

Thank You!

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