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Research Interests: Mobility, Energy and
Infrastructure

UPIISC

UNIVERSITY OF
PITTSBURGH
INFRASTRUCTURE
SENSING

COLLABORATION WORKSHOP



Advanced Research Projects Agency – Infrastructure (ARPA-I)

US Department of Transportation

Dr. Chris Atkinson

Fellow ASME, Fellow SAE

Deputy Director for Technology, ARPA-I

The U.S. Department of Transportation (DOT)

- **Mission:**

To deliver the world's leading transportation system, serving the American people and economy through the safe, efficient, sustainable, and equitable movement of people and goods.



- DOT employs almost 55,000 people across the country, in the Office of the Secretary of Transportation (OST) which includes the Office of the Assistant Secretary for Research and Technology (OST-R), 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)

CURRENT STATE

42,915 motor vehicle traffic fatalities in 2021

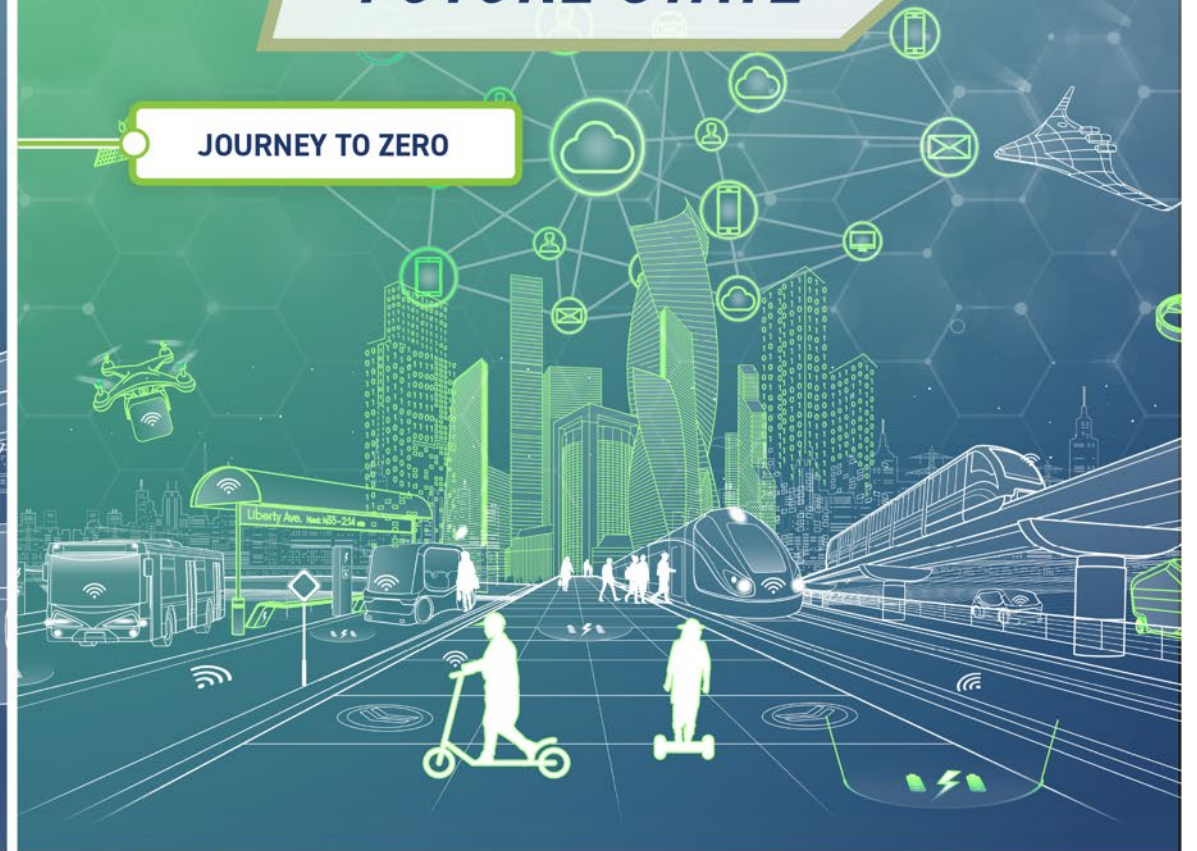
111,018 canceled flights in 2021

The Transportation Sector generates more greenhouse gas emissions than any other sector in the U.S.



FUTURE STATE

JOURNEY TO ZERO



Working together, we can *transform* transportation for a better future for all.



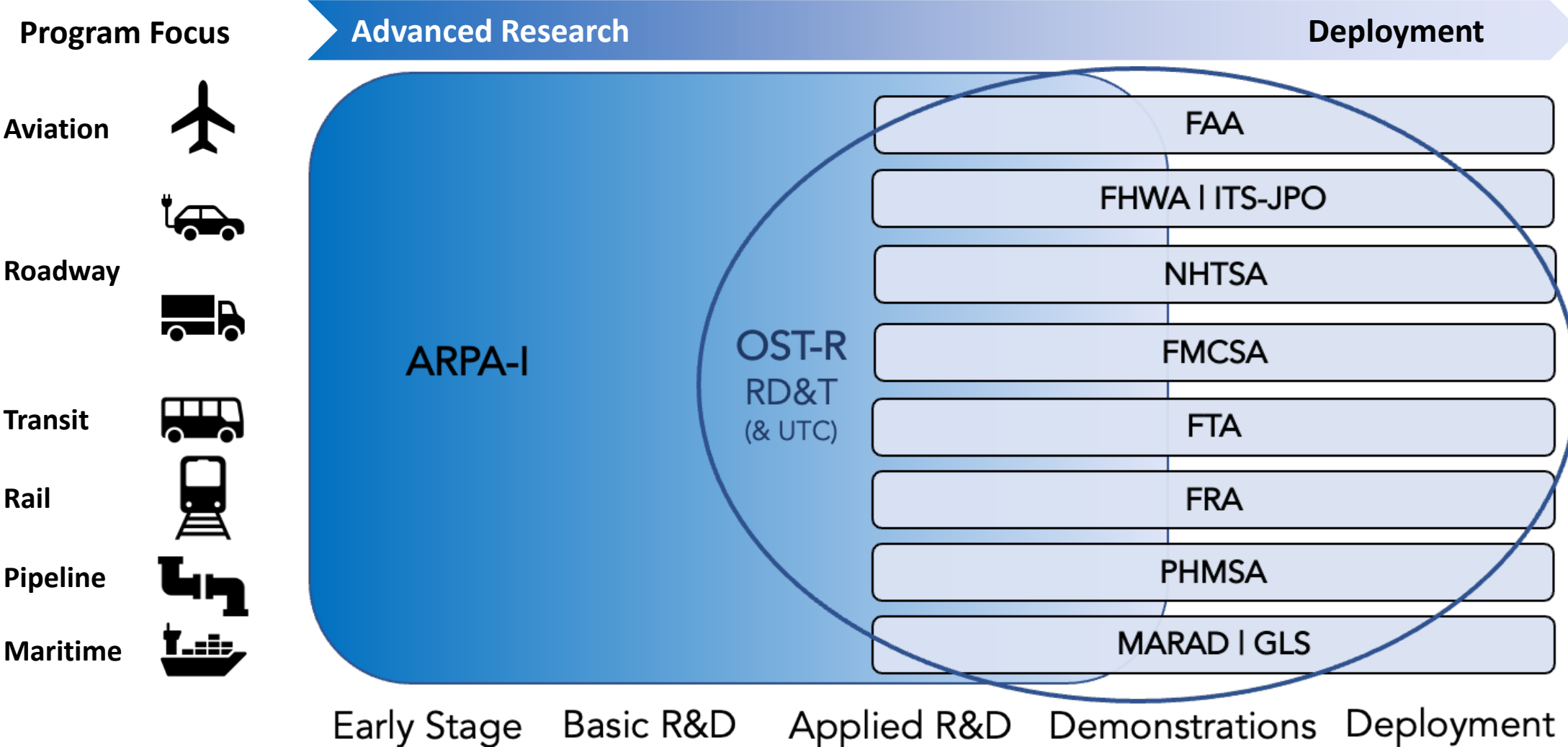
ADVANCED RESEARCH PROJECTS AGENCY • INFRASTRUCTURE

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>

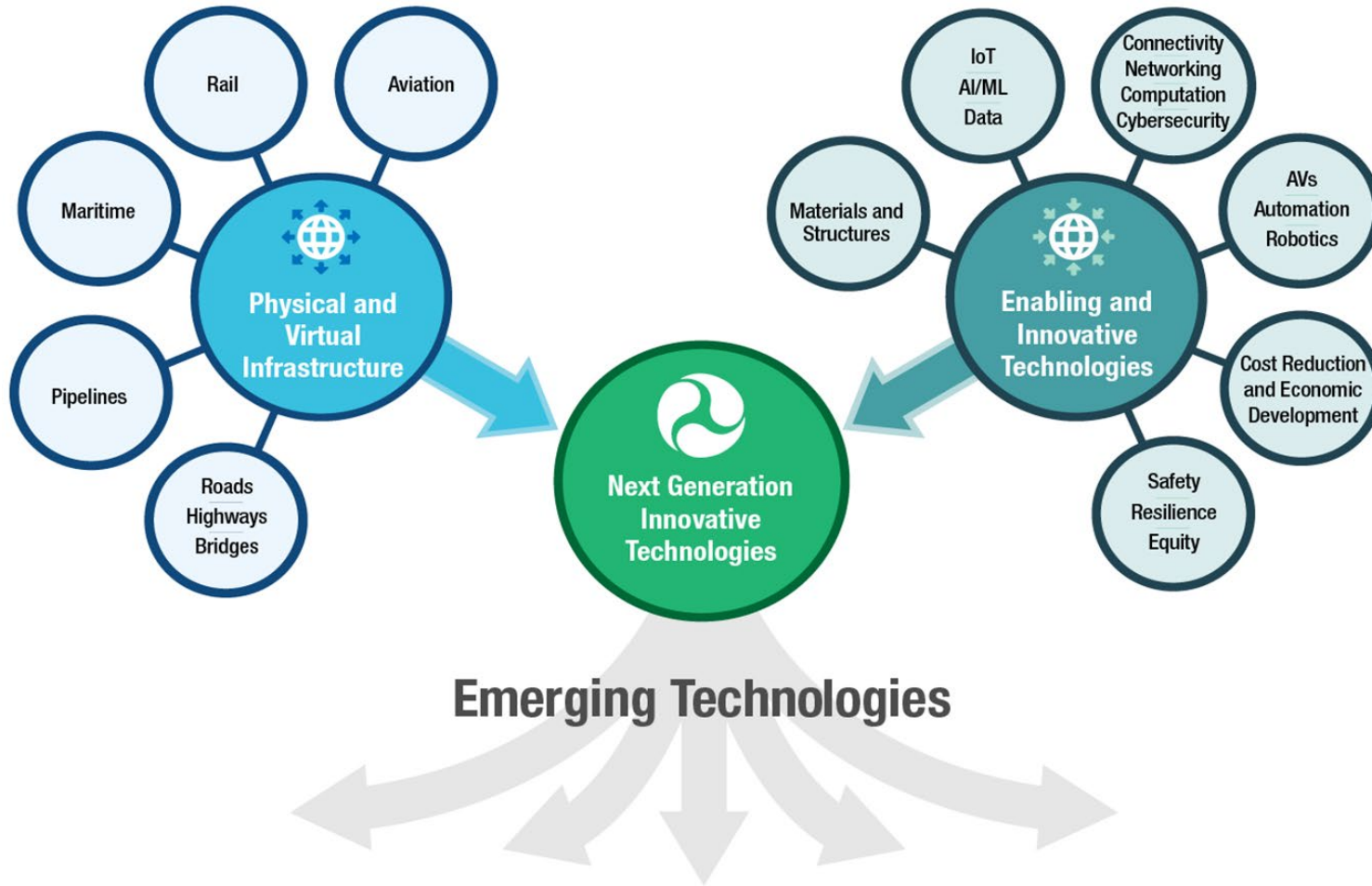
Infrastructure Technology R&D at USDOT

ARPA-I fills a gap in innovative early-stage research across transportation modes



The Goal of ARPA-I

Develop Innovative Infrastructure Technologies and 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



Topics of Interest for ARPA-I

Advancing DOT priority goals: Safety, Climate, Transformation, and Equity

Materials, Structures, and Construction

- Zero or negative carbon materials for infrastructure, extremely durable and resilient concrete, accelerated construction processes (3D printing of pavement, bridges, tunnels, pipelines, water infrastructure, and high-speed rail beds), accelerated construction of seawalls and shoreline reinforcement

Digital Infrastructure for Mobility

- 6G and edge computing for automated vehicles (AVs), intrinsically assured AI and ML for AVs, virtual LIDAR and ubiquitous machine vision, digital twins, HD mapping of infrastructure and topology (above and below the surface)

Automated Surface, Air, and Maritime Vehicles

- 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, AR and VR for travel replacement,
- Sensing, automation, control, AI, optimization



Image Source: iStock



INTERSECTION SAFETY CHALLENGE

Prize Competition

US Department of Transportation

2023



Intersection Safety System (ISS) Concept

- Emerging, low-cost sensors (e.g., cameras, radar, LiDAR, infrared) deployed at intersections to improve sensing.
- Multi-sensor data fusion/analytics to improve situational awareness and anticipate safety threats.
- System issues warnings or modifies control settings to improve safety.



Concept Illustration: Intersection Safety System

Safety systems informed by data fused from multiple sensors may anticipate unsafe conditions, e.g., a vehicle turning right in potential conflict with pedestrian pushing a stroller (lower right).

Image Source: U.S. DOT.

Proposed Solution:

Leverage Emerging Technologies to improve intersection safety at scale in a new way.



Data Fusion Utilizing
Existing and Emerging
Sensors

Emerging, low-cost sensors can be deployed at intersections for **improved sensing of vulnerable road users**. Data from these sensors can be fused and used in new ways by AI.



Artificial Intelligence
/Machine Learning

AI/ML can fuse data from multiple machine vision sensing modalities rapidly to **improve situational awareness** and **anticipate potential conflicts**.



Low-Cost, High-Value
Opportunity for Integration
at Scale

These existing technologies have not been deployed together at intersections broadly, offering an opportunity ripe for **innovative collaboration**.

PRIZE COMPETITION OVERVIEW

- **Stage 1A: Concept Assessment**
 - Develop an ISS Concept Paper.
 - Up to ten prizes may be awarded (up to \$100,000 each).
 - The total value of all Stage 1A prizes will be a maximum of \$1,000,000.
 - Winners may advance to Stage 1B.
- **Stage 1B: System Assessment and Virtual Testing**
 - Develop, train, and improve algorithms for the detection, localization, and classification of vulnerable road users and vehicles using DOT-supplied sensor data collected at a controlled test intersection.
 - The total value of all Stage 1B prizes will be a maximum of \$5,000,000.
 - Additional details to come following Stage 1A awards.



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