# Advanced Research Projects Agency – Infrastructure (ARPA-I)

## Discussion with
## President's Council of Advisors on Science and Technology (PCAST)

March 30, 2023

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# 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)

# DOT Strategic Goals

# Overview of ARPA-I

- The Infrastructure Investment and Jobs Act (IIJA) of 2021, known as the Bipartisan Infrastructure Law (BIL), authorized the establishment of the **Advanced Research Projects Agency - Infrastructure (ARPA-I)**, a new agency housed within OST-R.

- "Infrastructure" refers to "any transportation method or facility that facilitates the transit of goods or people within the United States." Includes "roads, highways, bridges, ports, airports, pipelines, marine, rail and aviation" as well as its digital or virtual infrastructure.

- The Director will be appointed by the President and report to the Secretary of Transportation.

- ARPA-I will have a separate budget request and appropriations process that is distinct from the rest of the Department.

- ARPA-I will invest in innovative technology projects that industry is unlikely to undertake due to technical and financial uncertainty.

- ARPA-I will collaborate with technology innovators from the public, private, and academic sectors – including with minority-serving institutions – to develop transformative solutions for infrastructure and transportation systems.

# ARPA-I's Mission

*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 to mobility for all.*

# The Goal of ARPA-I

**Develop Innovative Infrastructure Technologies and Solutions for Transportation**
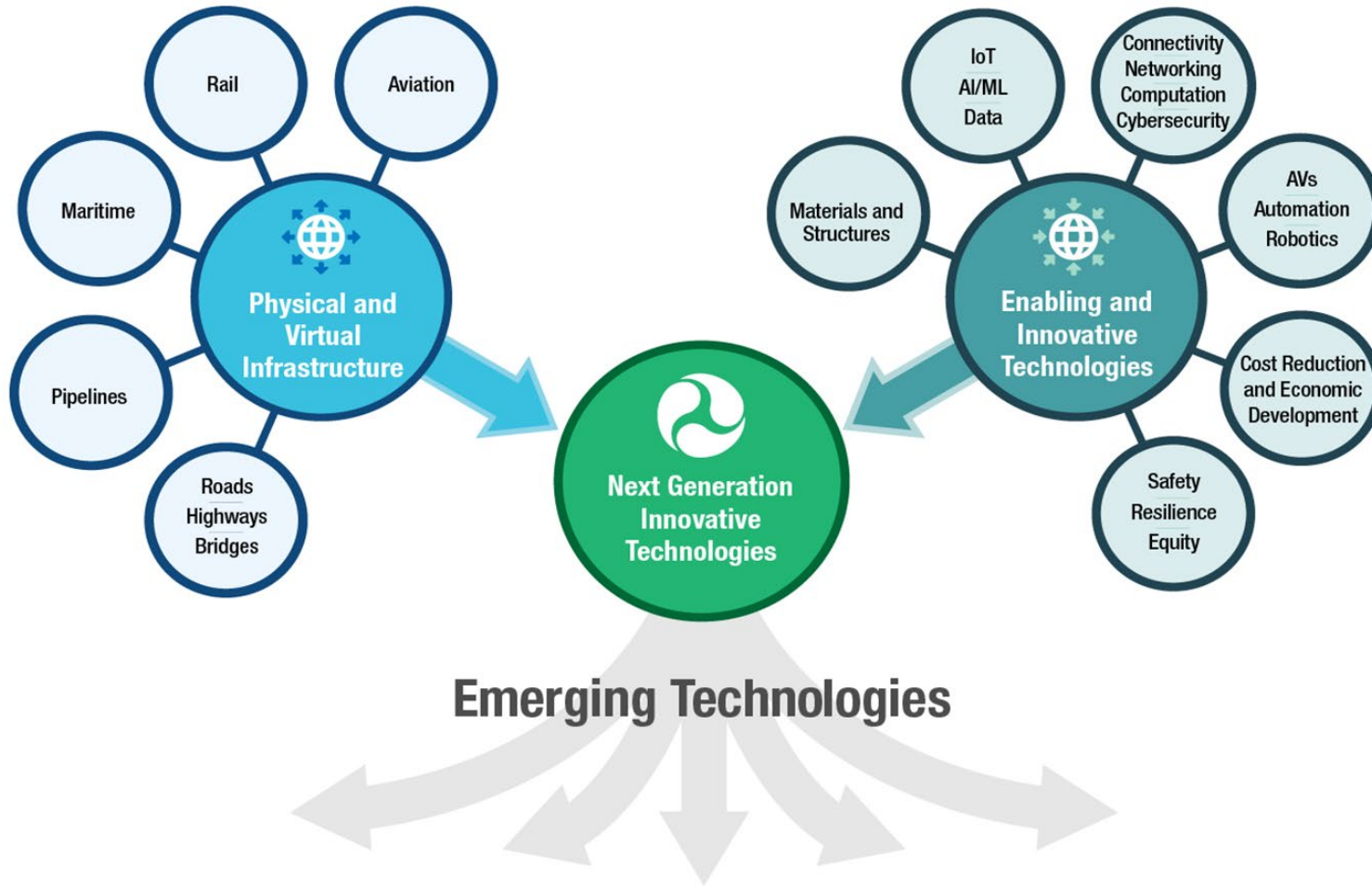


- ARPA-I will be to Transportation as DARPA is to Defense, and ARPA-E is to Energy

- 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

# The Characteristics of an ARPA

- Focus on **innovation-led** R&D
- **High risk – high reward** programs that align with DOT's goals (note: 'high risk' does not mean 'unsafe')
- Highly **nimble** organization – term-limited leadership and program directors, unique funding mechanisms
- Doctrine of substantial involvement – opinionated technical leadership and management
- **No fixed roadmap** – opportunistic and pragmatic in its technical outlook
- No R&D for the sake of it – understanding that without deployment, there is no success; and that deployment requires commercialization
- An understanding of both the "customer" and the end-user
- No 'solutions looking for a problem'
- Invigorate an industrial sector, catalyze and energize people, products and processes

# The ARPA Model

## The ARPA model requires unique governance and execution to succeed

ARPA mission:
Create breakthrough, paradigm-shifting capabilities for a critical public purpose

*which requires*

A high-performing agency that achieves seemingly impossible goals

*which requires*

Taking risks, managing them effectively, experimenting, learning, adapting quickly, tapping into many different talents and institutional capacities

*which requires*

Governance that holds the agency accountable for delivering on its mission and creates space for it to do so

&

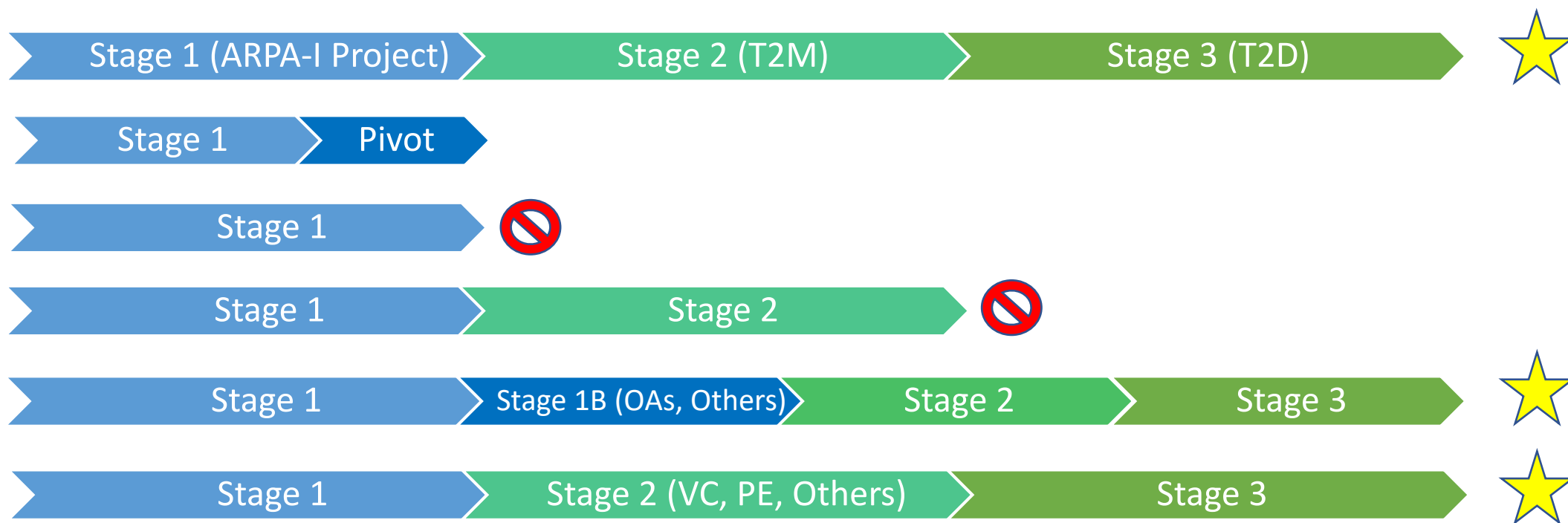Execution with people, processes, and culture that are mission-obsessed, fast, and flexible

(from Actuate, 2022)

# Typical Lifecycle of ARPA-I Projects

- Illustrate the various scenarios of an ARPA-I project over its lifecycle:

  From **ARPA-I Funding** (Stage 1)…to **Commercialization** (Stage 2)…to **Deployment** (Stage 3)



Notes:  T2M – Tech to Market, T2D – Tech to Deployment, OAs - Operating Administrations, VC – Venture Capital, PE – Private Equity

# Why ARPA-I

## ARPA-I will fill a Key Gap* in Transportation and Infrastructure

- The Transportation and Infrastructure sectors are being left behind as other industries transform through *Fourth Industrial Revolution* technologies (AI, Robotics, IoT, Advanced Manufacturing and Materials)

- Transportation and Infrastructure suffer from fragmentation, limited competition, and sluggish commercial markets

- American's global competitiveness and security are at risk due to lagging and vulnerable infrastructure

- Overcoming these dynamics requires a mechanism to dramatically accelerate the research-to-deployment process

- ARPA-I offers the solution that supports advanced research, fosters internal and external partnerships, and facilitates commercialization to enable transformation in these sectors

- ARPA-I will NOT duplicate or replicate existing programs across the DOT Administrations or modes (or elsewhere in the Federal R&D sphere) but will complement and supplement these.

*ARPA-I was authorized in the Bipartisan Infrastructure Law (2021) and has received initial appropriation of $3.2M in FY23.

# The Problem: Underinvestment in Transportation R&D

Transportation R&D funding is significantly lower than in other sectors of the economy
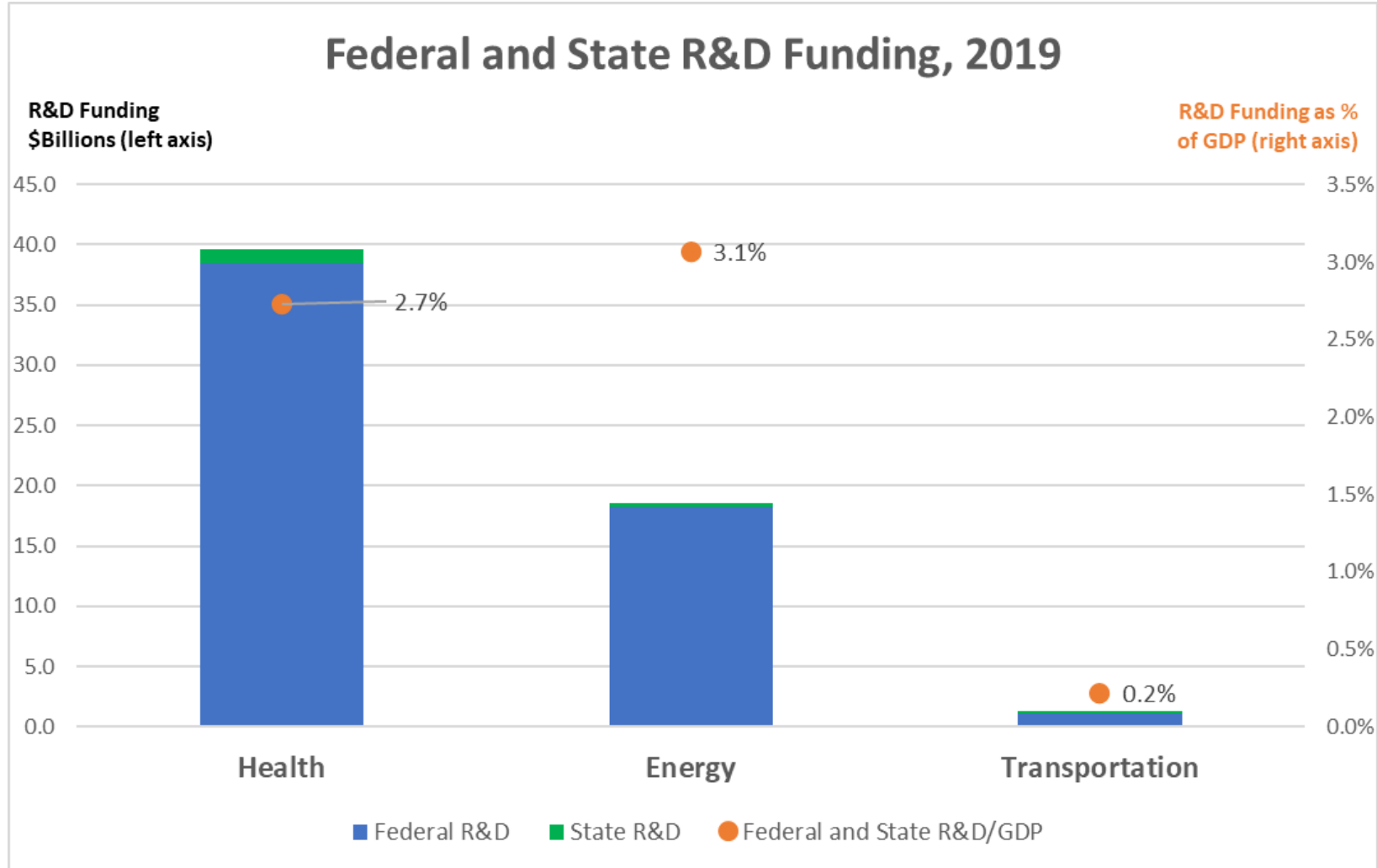


Data and Source:
- Similar data for 2020 and 2021
- NSF, CRS, and BEA

# 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)

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

# ARPA-I Opportunities

**Potential ARPA-I First Program Opportunities (for discussion)**

- Intersection Safety Systems to reduce fatalities at intersections (over 10,000 fatalities per year in the U.S.) using machine perception, artificial intelligence and machine learning, real-time decision-making, and active warning systems.

- New Construction Methods and materials for built infrastructure, including pavement materials that self-heal, absorb carbon, allow for water drainage, and reduce heat island effect, addressing maintenance issues as well as climate adaptation and mitigation.

- Digital and Virtual Infrastructure for vehicle and pedestrian safety, traffic management, transportation digital twins, and transportation logistics optimization for supply chain improvements, including cyber-physical resilience and cybersecurity.

# Future of ARPA-I

## Questions for Discussion:

1. What are the most important or critical topics for ARPA-I to prioritize (when fully funded)?

2. How could ARPA-I best engage with the broader R&D ecosystem and stakeholders?

   (Initial engagement has been conducted with with WH OSTP, DARPA, ARPA-E, DOE EERE, TRB, AASHTO, SAE, ITS America, National Laboratories Directors Council, 50+ companies, 10+ universities, trade groups, and others)

3. How can ARPA-I ensure that its programs will deliver meaningful benefits for the American public?

# Thank You!

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