Safely Operating in Dynamic Scenarios

ADS Demonstration Grant

Program Overview

5-27-2020

Virginia Tech

TRANSPORTATION INSTITUTE

Michael Mollenhauer

Director, Division of Technology Development

GCAPS　　VDOT　　Transurban　　CAMP LLC　Ford　GM　HYUNDAI MOTOR GROUP　Mercedes-Benz Research & Development North America, Inc.　NISSAN　　VT | TRANSPORTATION INSTITUTE VIRGINIA TECH.

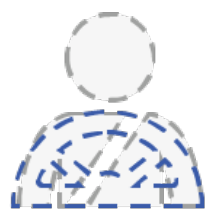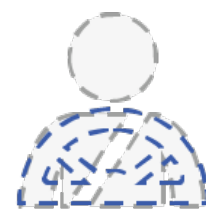# Virginia Tech Transportation Institute

- This is our 31st year
- Largest transportation research institute in the U.S. by most metrics
- Safety focus
- 300+ projects, 40+ proprietary projects
- ~520 total employees on "payroll" at any given time
  - 300 full-time
  - 300 students funded for at least part of a year
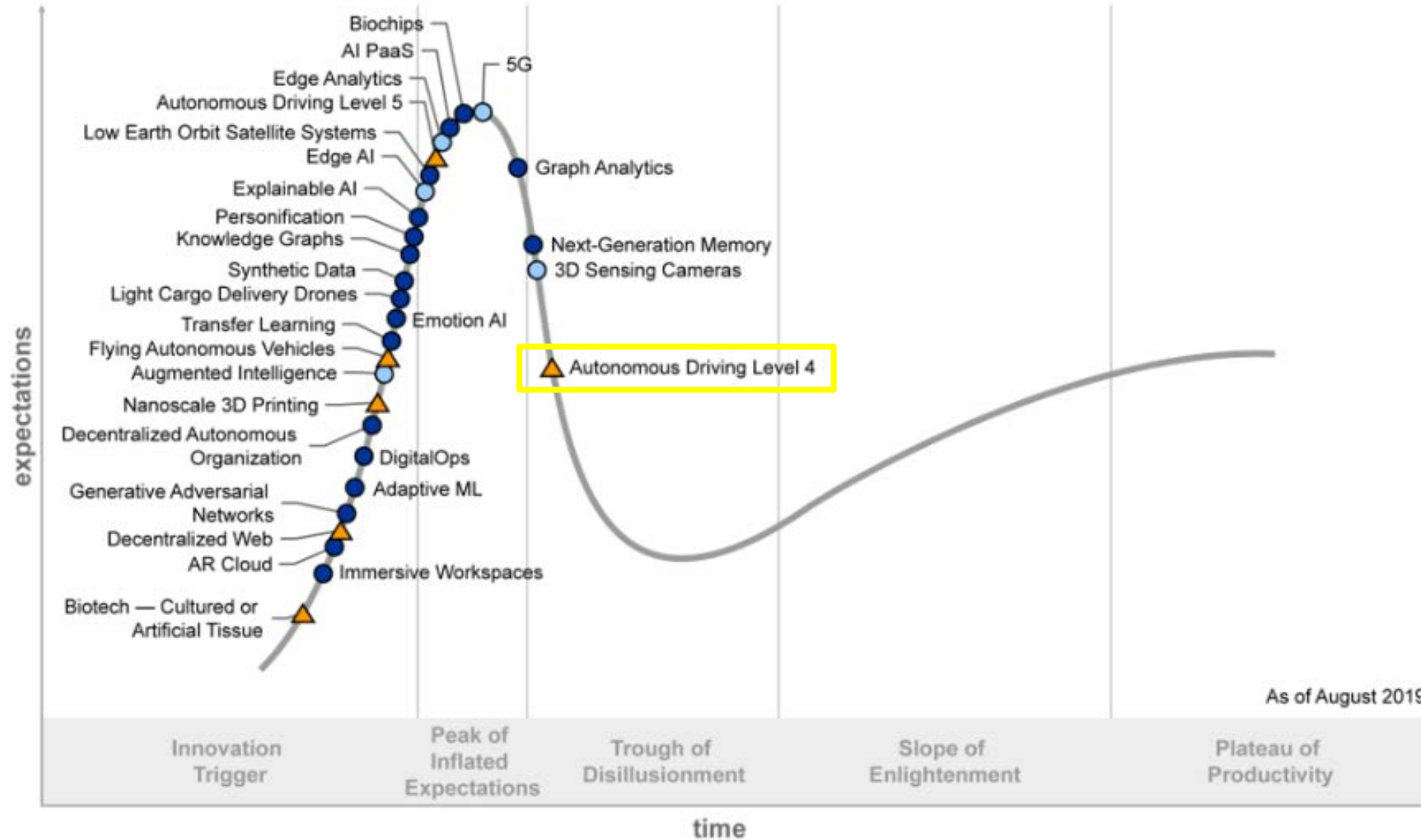- Participation from over 150 VT faculty in the last few years

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SAE Levels of Automation

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) AUTOMATION LEVELS

Full Automation

0	1	2	3	4	5
No Automation	**Driver Assistance**	**Partial Automation**	**Conditional Automation**	**High Automation**	**Full Automation**
Zero autonomy; the driver performs all driving tasks.	Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.	Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.	Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.	The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.	The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

Advancing Transportation Through Innovation

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Gartner Hype Cycle for Emerging Technologies 2019

expectations

- Biochips
- AI PaaS
- Edge Analytics
- 5G
- Autonomous Driving Level 5
- Low Earth Orbit Satellite Systems
- Edge AI
- Graph Analytics
- Explainable AI
- Personification
- Knowledge Graphs
- Next-Generation Memory
- Synthetic Data
- 3D Sensing Cameras
- Light Cargo Delivery Drones
- Transfer Learning
- Emotion AI
- Flying Autonomous Vehicles
- Augmented Intelligence
- Autonomous Driving Level 4
- Nanoscale 3D Printing
- Decentralized Autonomous Organization
- DigitalOps
- Generative Adversarial Networks
- Adaptive ML
- Decentralized Web
- AR Cloud
- Immersive Workspaces
- Biotech — Cultured or Artificial Tissue

Innovation Trigger | Peak of Inflated Expectations | Trough of Disillusionment | Slope of Enlightenment | Plateau of Productivity

time

As of August 2019

Plateau will be reached:

○ less than 2 years   ◯ 2 to 5 years   ● 5 to 10 years   △ more than 10 years   ⊗ obsolete before plateau

Gartner.com/SmarterWithGartner

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ADS-Equipped Light Vehicle Testing Examples

Technically, most companies are just testing, but this testing involves more than engineers monitoring ADS performance and tracking disengagements:

Waymo

- launched a driverless service in the **Phoenix** area and is testing in **Atlanta**, **Kirkland**, **Detroit**, **Austin** and **Mountain View**

Ford/Argo

- is testing pizza, floral, dry cleaning delivery services in **Miami** with additional testing in **Austin**, **Dearborn**, **DC**, **Palo Alto** and **Pittsburgh**

Aptiv and Lyft

- have a partnership "driving" riders in **Las Vegas**

Toyota

- is driving safely in Michigan and California

GM/Cruise

- is testing a food delivery service in **San Francisco** and is also testing in **Warren** and **Scottsdale**

Other ADS-Equipped Vehicle Testing Examples

Shuttles

Easy Mile

Local Motors

Perrone Robotics

Optimus Ride

Package Delivery

Starship

Amazon

Nuro

Trucking

TuSimple

Torc & Daimler

Kodiak

Work Zones and Crash Scenes Present Challenges for Automation

- Temporary, unconventional layout
  - Alteration of roadway
  - Level of standardization depends on operator and jurisdiction
  - Detailed data may be fragmented or unavailable
  - Real time HD maps
- Audio, visual, and gesture commands may be given onsite
- Novel pathfinding directions – driving against rules may be required
- Chaotic scenes with debris, random vehicle orientations, unexpected pedestrian activity
- Emergency lighting, fire, dust, smoke, etc. may affect sensor perception

Image Source: FHWA

aTech
Transportation Institute

FHWA ADS Demo NOFO Overview

- Focus
  - Demonstrate L3+ ADS technologies and obtain targeted deployment feedback
  - Evaluate and identify key aspects for the safe integration of ADS into the Nation's on-road transportation
- Goals
  - Demonstrate the safe integration of ADS into the Nation's transportation system
  - Inform safety analysis and rulemaking with data
  - Create a collaborative environment that harnesses the collective expertise to advance the deployment of ADS
- Awards
  - USDOT made 8 awards, $60M total awards
  - Up to 4 year duration

USDOT Goals and Focal Areas of Program

- Improve Safety
- Foster Collaboration
- Data for rule making and system development
- Significant public benefit
- Addressing an area where the market may not develop in isolation
- Fostering economic vitality
- Developing complex technology
- Contributing to a diverse set of ADS projects at the USDOT
- Addressing transportation-challenged populations
- Developing prototype systems

USDoT Grant Funding

~$60 million to test the safe integration of automated driving systems (ADS)

U.S. Department of Transportation

City of Detroit, Michigan
"Michigan Mobility Collaborative-ADS Demonstration"

University of Iowa
"ADS for Rural America"

Pennsylvania DOT
"Safe Integration of Automated Vehicles (AV) in Work Zones"

Contra Costa Transportation Authority, California
"ADS Demonstration Program"

Ohio DOT
"D.A.T.A. in Ohio: "Deploying Automated Technology Anywhere"

Texas A&M Engineering Experiment Station
"AVA: Automated Vehicles for All"

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Virginia Tech Transportation Institute
"Trucking Fleet CONOPS for Managing Mixed Fleets"

Virginia Tech Transportation Institute
"Safely Operating ADS in Challenging Dynamic Scenarios: An Optimized Automated Driving Corridor Demonstration"

Our Demonstration Concept

Safe L4 ADS Interactions
with Public Services
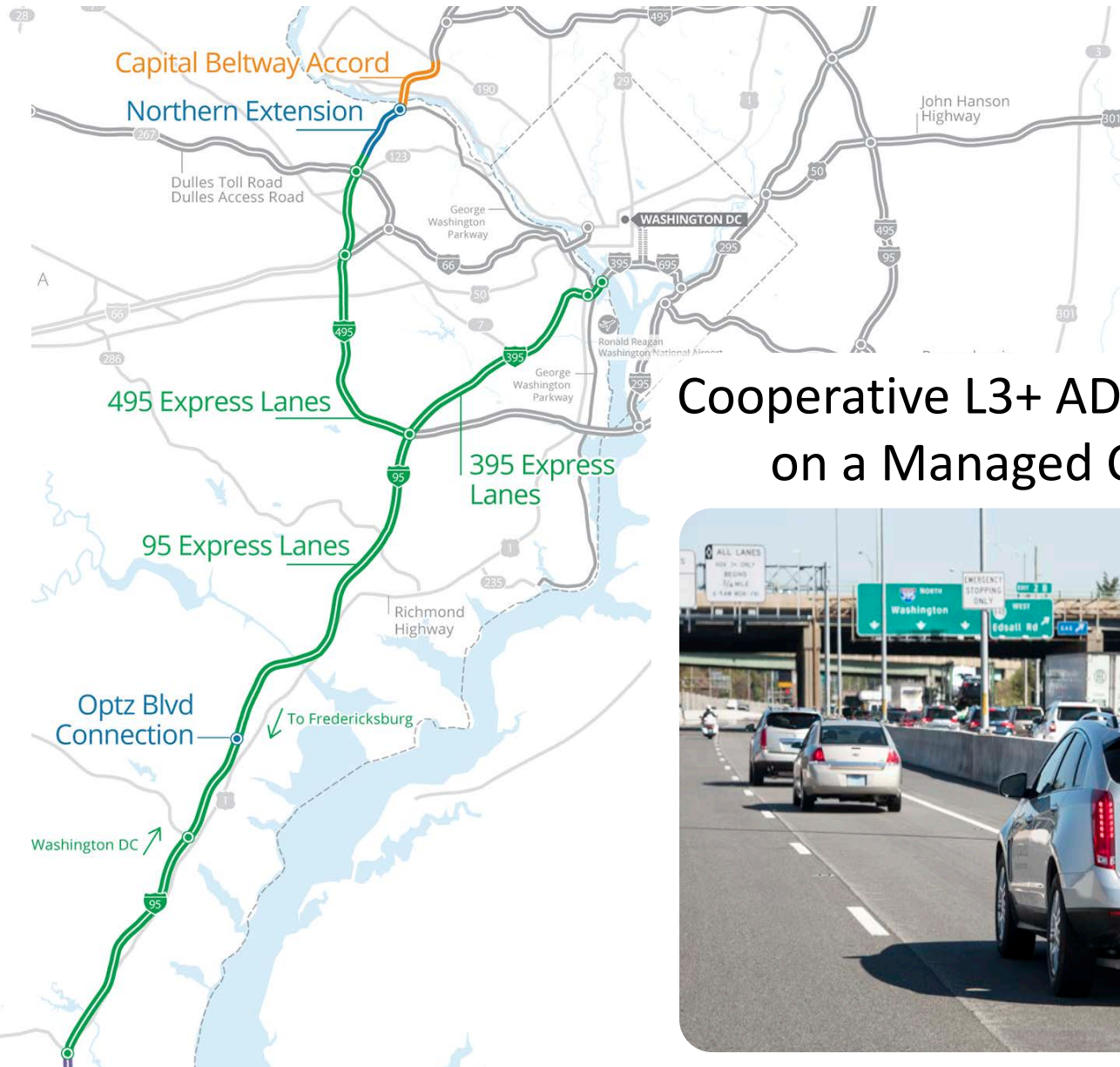
Cooperative L3+ ADS Operation
on a Managed Corridor

Partners

Rationale

Interaction with public services is a key aspect to the safe integration of ADS-equipped vehicles on roadways

The mobility benefits of ADS-equipped vehicles may only be realized through cooperative operations

Collaboration

OEMs and ADS Developers

Are there opportunities to improve ADS interaction with public safety operations?

Infrastructure Owner Operators

How can we facilitate safe ADS deployment?

Public Safety Providers

How should we interact with ADS and how will they respond?

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- Build consensus on requirements and technological solutions
- Leverage infrastructure data to ensure safe ADS operation
- Develop L4 ADS capabilities to demonstrate safe interactions, cooperative operation, and collect data
- Create simulations of interactions and distribute data to OEMs and ADS developers
- Develop recommendations, data, and educational materials for OEMs, IOOs, and Public Safety Providers

Task 1: Develop Solutions for Corridor Optimization

- Evaluate Express Lanes for Demo
  - Communications requirements and technology options
  - Assess signage, striping, TOC capability, etc.
- Develop spec for real time Operational Design Domain (ODD) support system
  - Investigate source data available
  - Develop messages to provide data to vehicles
  - OEM stakeholder review of messages and content
  - Spec architecture for message flow and management
  - Spec full ODD TOC-side tool
- Develop high-level CADS demo concept
  - Dynamic speed harmonization solution with CACC
  - High level vehicle-side requirements to support demo
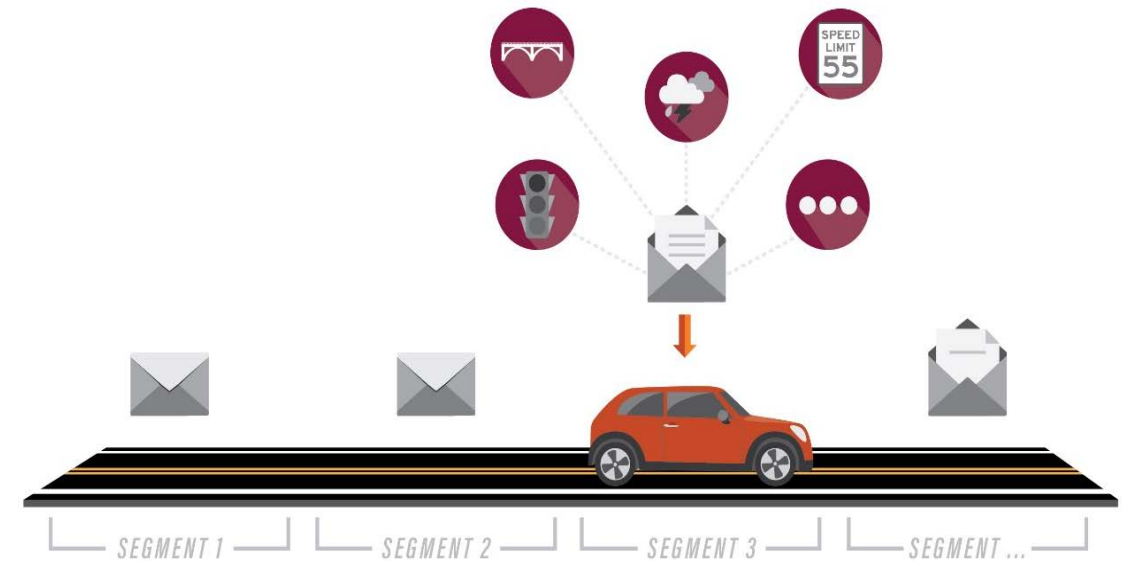
Task 2: Dynamic Scenario Definition and Development of Technological Solutions

- Extend existing task analysis to support SSP and Work Zone use cases (VTTI)
- Candidate scenarios
- Interaction requirements
- Technological concepts
  - Scan for available technologies or development opportunities
  - Cost/feasibility/practicality/acceptance, etc.
- ADS requirements to support technological concepts
- Public safety requirements to support technological concepts
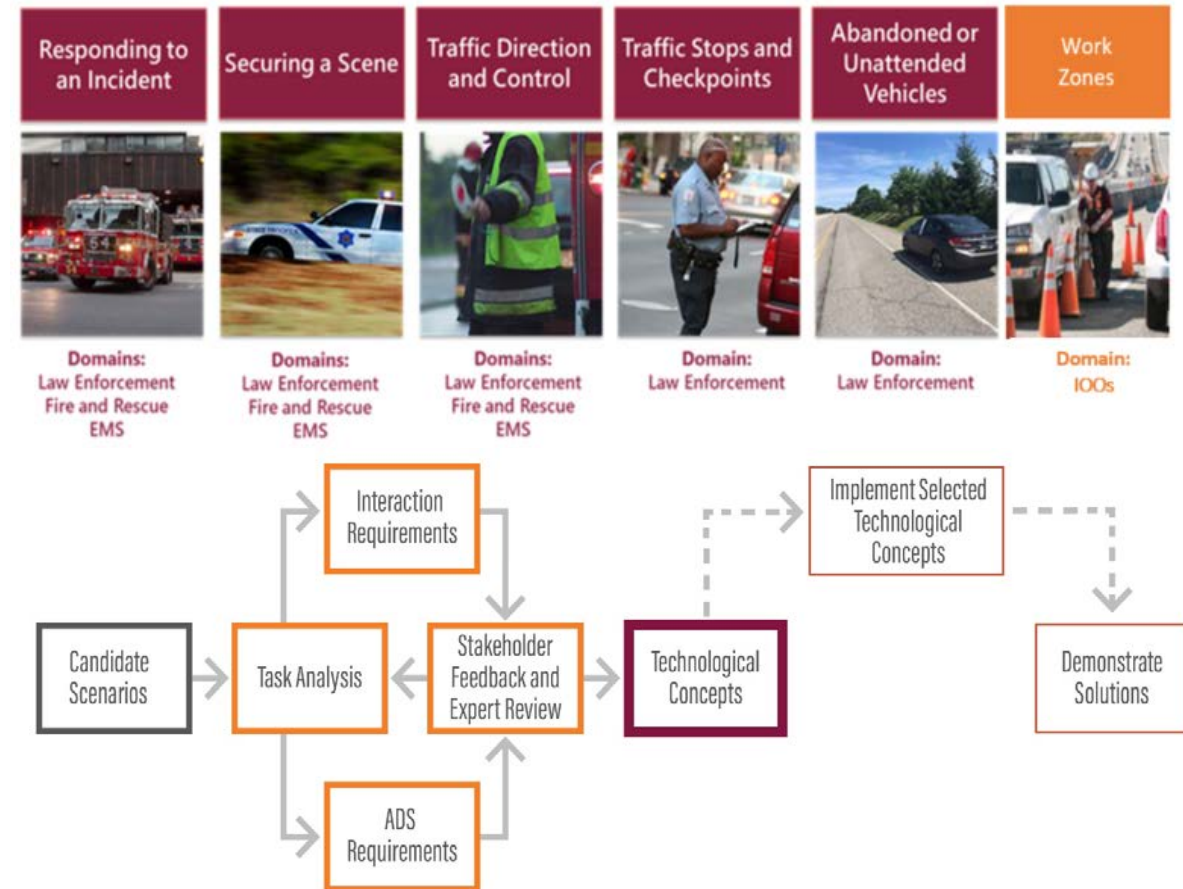
Task 3: Build Reference Demonstration Vehicles

- Vehicle platform goals
  - Capable of performing L4 operation within the ODD of the selected scenarios
  - Capacity for ride-along participants
  - Significant data collection capability
- Platform selection
  - Significant time has passed since proposal
  - New options are available
  - Evaluate CARMA to identify opportunities to incorporate
- Build and test the vehicle(s) for selected scenarios
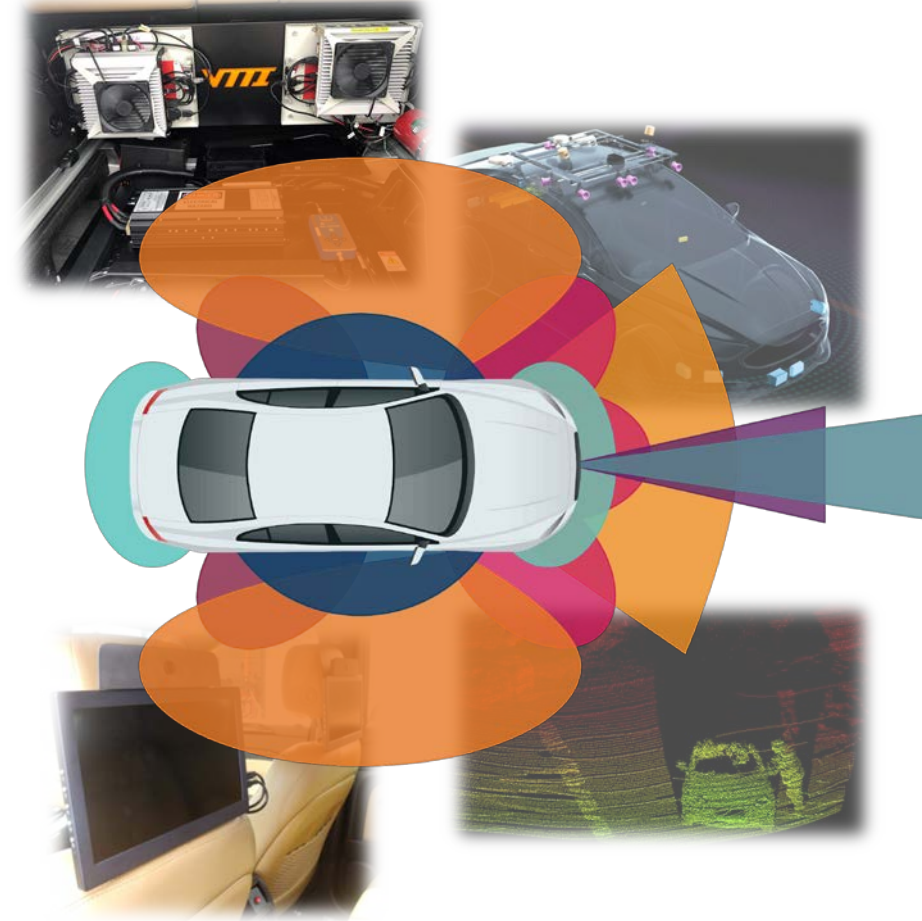
Task 4: Build TOC Applications

- Build and test ODD support tool specified in Task 1
  - Traffic conditions
  - Weather
  - Work zones
  - Incidents
  - Build upon AMCD/EDCM concepts
- Dynamics speed harmonization application
- Build and test TOC side of cooperative automation applications
  - Recommended speed
 - Recommended lane selection
  - Platoon configuration
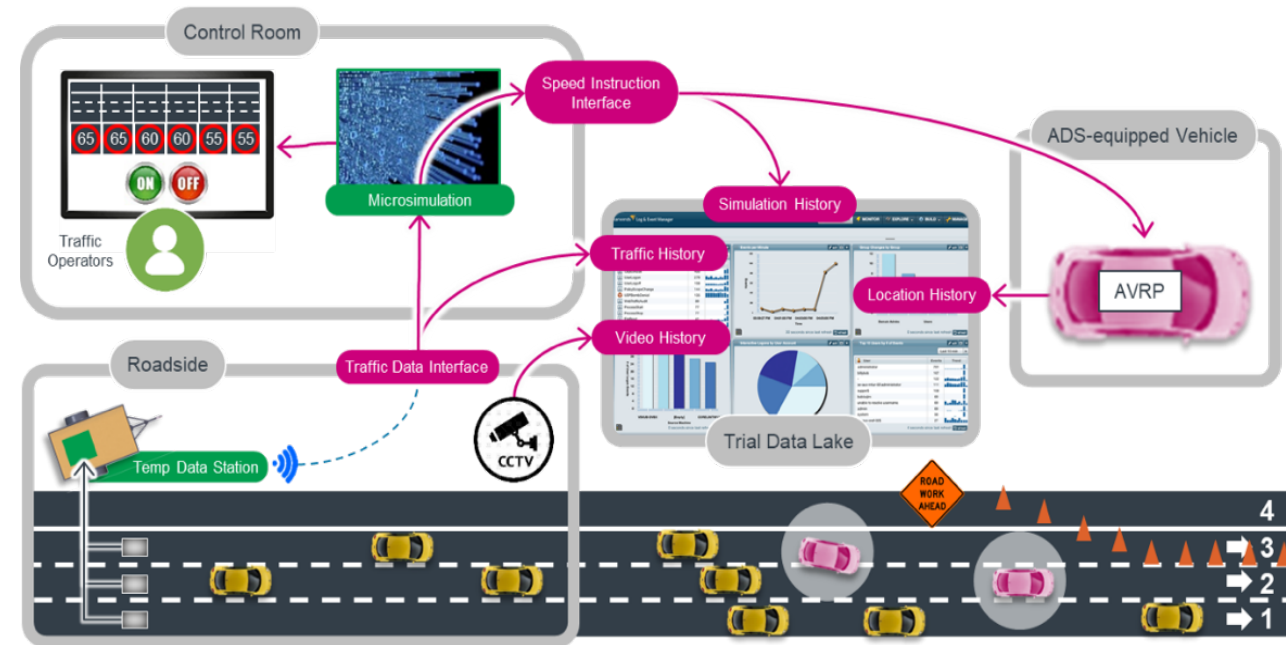
Task 5: Design and Conduct Demonstrations

- Three high profile demonstration events
  - Northern VA and possibly Smart Road in Blacksburg, VA
  - Primary stakeholder groups include IOO's, OEM's, Public Safety Providers
  - On-road, parking lot, and test track options
  - Staged scenarios and events
- Participation from public safety partners
- Focus group sessions
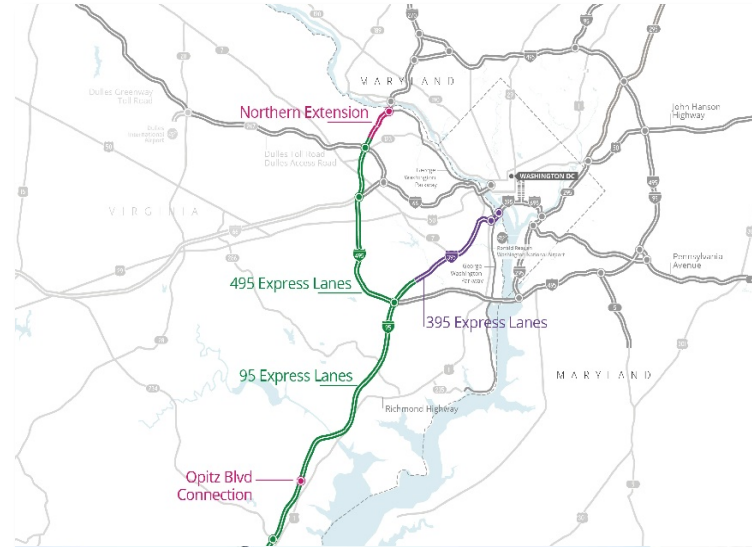
Task 6: Data Collection, Processing, and Dissemination

- Data collected during testing and demonstrations will be processed into several datasets
  - On-board DAS
  - Scenario demonstration
  - Scenario simulation
  - Infrastructure data
  - Subjective assessment
- Source data for ADS development and public safety training
- Hosted on portal for public access
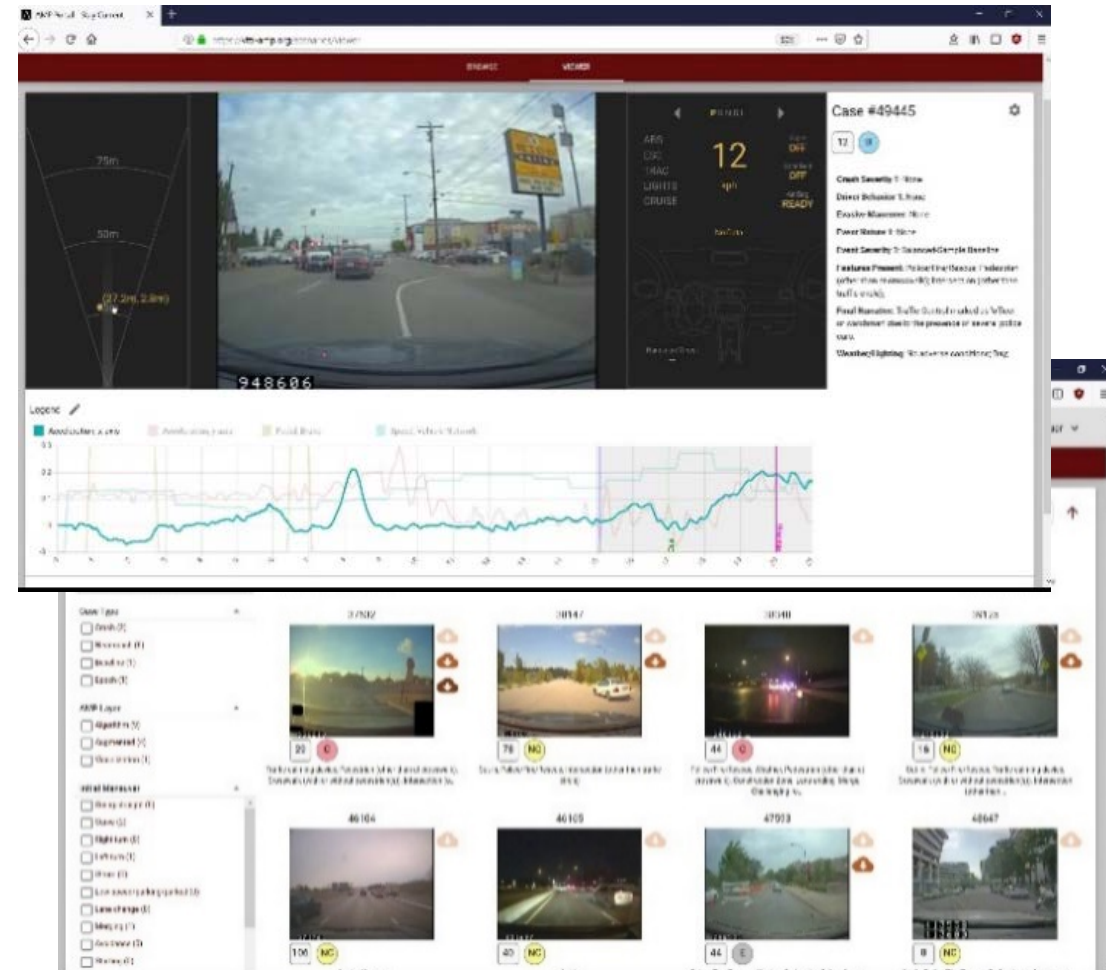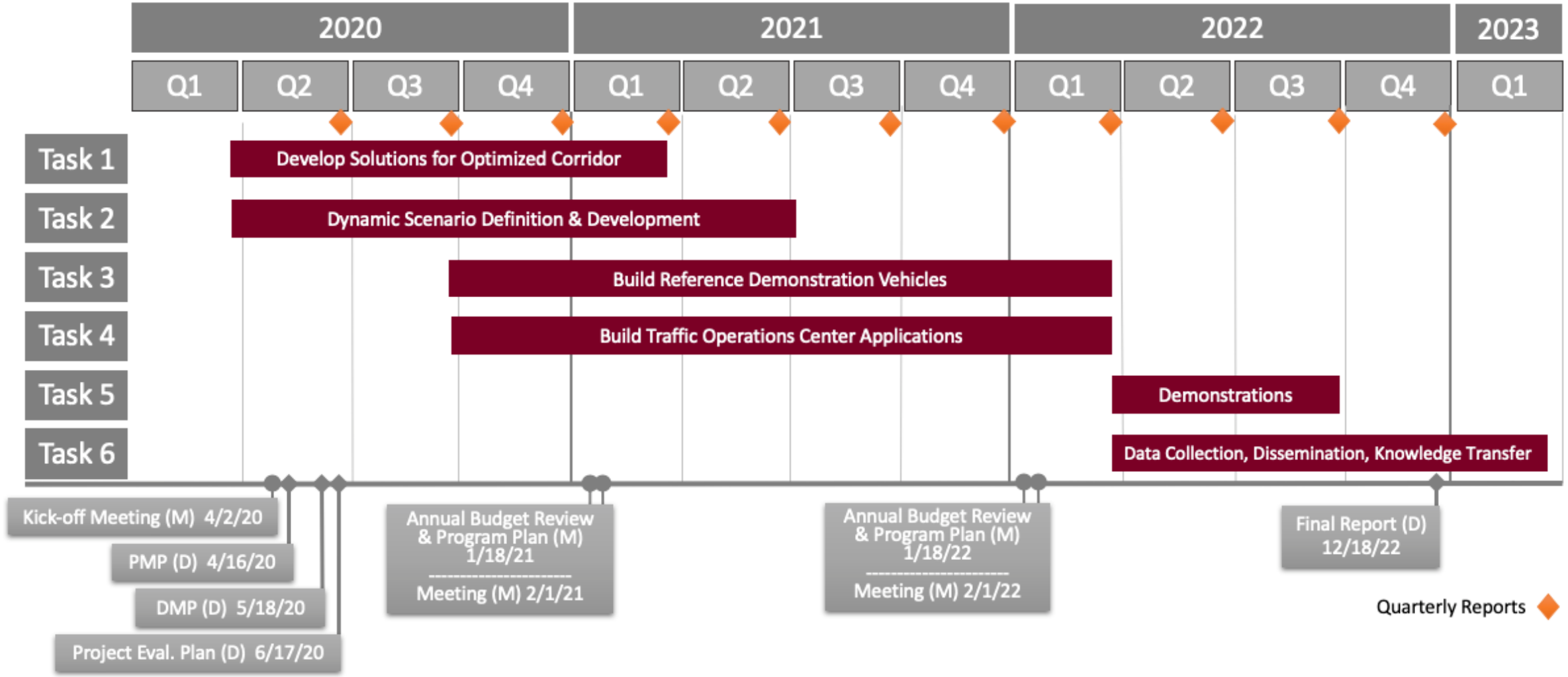
Questions?

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