

## COLORADO

Downtow

40

Department of Transportation

### Club 20 RoadX Overview February 23, 2018



# FY 2016-2017 \$1.44 Billion Budget







#### **OUR CHALLENGE : CONTINUED GROWTH**



1991 3.3 million 2015 5.4 million

27.7 billion vehicles miles traveled

\$125.70 spent per person

50.5 billion vehicle miles traveled

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72.3 billion vehicle miles traveled

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\$68.94 spent per person \$41.16 spent per person

All dollar figures adjusted for inflation



RoadX VISION: Crash-free, Injury-free, Delay-free and Technologicallytransformed travel in Colorado.

RoadX **MISSION**: Team with public and industry partners to make Colorado one of the most technologically advanced transportation systems in the nation, and a leader in safety and reliability.

Colorado Is Open For Business - Colorado invites partners to join us in accelerating the adoption and deployment of technological solutions.





## WHY ARE WE LOOKING TO TECHNOLOGY?

# SAFETY 80% reduction in crashes per NHTSA estimates

# 40 to 400% increase in capacity





## 5 LEVELS OF DRIVING AUTOMATION

Image: Human driverImage: Automated system

Automated driving system monitors the road

Human driver monitors the road



Highly Automated Vehicles (HAVs)



## NHTSA'S AV GUIDANCE AND ODD

The document identifies **Operational Design Domain (ODD)** as the critical definition of where (such as what roadway types, roadway speeds, etc.) and when (under what conditions, such as day/night, normal or work zone, etc.) an HAV is designed to operate. The importance of communicating the ODD of an HAV to the consumer as part of broader product education is highlighted.





## CONNECTED ROAD CLASSIFICATION SYSTEM

Level

Unpaved and/or non-striped roads designed to a minimum level of standard of safety and mobility



Paved roads designed to AASHTO's standards with MUTCD signage. There is not Intelligent Transportation System (ITS) equipment or infrastructure to collect connected vehicle data (Dedicated Short Range Radio). Access to cellular date service may be available



There is Intelligent Transportation System (ITS) equipment operated by a Traffic Operation Center (TOC) and/or, one way electronic data share between DOT/Vehicle/User and/or, mixed use lanes







#### CONNECTED ROAD CLASSIFICATION SYSTEM

Level

Roadway or specific lane(s) has adaptive ITS equipment (i.e. smart signals hold for vehicles, highway lighting that turn on for vehicles, etc.) with Traffic Operations Center override only, and/or two way data share between DOT/Vehicle/User, and/or lanes designated for vehicle levels 3 & 4 only





(Advance Guide-way System) roadway or specific lane(s) designed for vehicle level 4 only with additional features that may include inductive charging, advance/enhanced data sharing, etc. Additionally, no roadside signs are needed as all roadway information is direct to vehicles' on-board systems



Could solar roadways power our future?





All roadway elements designed for only vehicle level 5 systems - no signs, signals, striping... needed









# ROADX PROJECT CLASS (RPC)

Identifying Projects Based on Technology Readiness and Risk



#### **TECHNOLOGY READINESS LEVELS (TRL)**



TIMING : STARTING WINTER 2017



#### VEHICLE-TO-VEHICLE (V2V)

The three biggest problems facing our nation's roadways...

5.6 million crashes 32,719 deaths

MOBILITY

SAFET

CONNECTION



6.9 billion hours in traffic

ENVIRONMENT



3.1 billion gallons wasted

"The safety benefit of V2V is undeniable. It will save lives, and everybody knows that. A delay in rolling out V2V will cost lives, and that's a tragedy."

- Harry Lightsey, General Motors

#### TIMING : STARTING WINTER 2017

V2V



#### WHAT DOES V2V UNLOCK?

Potential...

CONNECTION



Prevent up to 592,000 crashes Save 1,000S of lives Avoid up to 270,000 injury crashes

Using This Data 📃		
	Basic Safety Message Core Data	Example Contextual Vehicle CAN Data
	Latitude	Steering Wheel Angle Rate
	Longitude	Brake Applied Pressure
	Elevation	Throttle Position
	Positional Accuracy	Wiper Set
	Transmission State	Road Friction
	Speed	Rain Sensor
	Heading	Vehicle Mass
	Steering Wheel Angle	Vehicle Type
	AccelerationSet4Way	Vehicle Height
	Brake System Status	AirBag Status
	Vehicle Size	

#### To Address The Most Dangerous Crashes....

V2V technology can see where we cannot:

- Queue Warning & Crash Ahead
- Freeway Merge Assist
- Intersection Movement Assist
- Left Turn Assist
- Emergency Electronic Brake Lights
- Wrong Way Driving

V2V technology provides every vehicle with:

- Real-time situational awareness for:
  - Surrounding vehicles
  - Weather
  - Roadway conditions
- Enhanced, safer driving conditions

<u>http://www.nhtsa.gov/staticfiles/rulemaking/pdf/V2V/Readiness-of-V2V-</u> Technology-for-Application-812014.pdf









#### SMART 285 PAVEMENT

Turning existing roadways into a smart, digitally connected network that and can provide weather, pavement conditions and relay possible safety concerns to the responding agencies.

- 0.8 km segment to be constructed at US 285 Red Mountain Pass
- Immediate alerts to first responders if a vehicle leaves the roadway
- Future capabilities include inductive charging



Expansion ports for new features

2

Fiber Optic Sensing cable makes the road "touch sensitive"



Data and power connections at the edge

Contained within a prefab concrete slab compliant with standard pavement design specifications



TRANSPORT 🕺





#### PHASE - SMART TRUCK PARKING (PRE-PASS, CELLULAR AND DSRC)

Using detection and cloud-based software that understands and can report available parking spots to truckers, improving:

- Truckers wasted time and fuel
- Excess wear and tear on Colorado's roadways

2016

Excess pollution

The first phase of this project will integrate six existing parking facilities into the Smart Truck Parking System.

2017

2018

SAFETY





#### RURAL SAFETY CHALLENGE

Using a challenge format, solicit ideas for industry and others to help identify new approaches to rural safety problems like:

Animal Vehicle Collisions (AVCs)

2016

- Soft Shoulder Rollovers
- Steep Grades & Sharp Curves
- ...??

Other state DOT have expressed interest in partnering with CDOT to deploy proposed idesa.

2017

2018







## **ITS' SMART MOBILITY PLAN**

Plan Objectives:

- Promote using technology to provide a crash free and on time trips to the traveling public.
- Create a transportation plan that not only looks at today's • transportation but also looks at future technology impacting transportation.

#### **Benefits:**

- Soft Provide more consistent and expected travel experience. •
- Improve roadway safety, incident response and maintenance. .

2016

2017

Estimated completion, December 2018









#### SMART 70 - GOLDEN TO VAIL

CDOT has partnered with HERE, a leader in mapping and location technology, to create a connected vehicle environment to provide the most real-time data possible to drivers traveling through the I-70 Mountain Corridor. By using the new "RoadX" app, drivers will receive accurate travel alerts and safety warnings about potential hazards, such as traffic delays, icy conditions and crashes.

CDOT currently has a 50-person pilot testing how accurately and quickly information can be transferred using cellular networks. The ultimate goal is to eventually use the connected vehicle system to inform self-driving cars.







2017



#### SMART 25 - RIDGEGATE TO UNIVERSITY

Colorado will be doing a significant software and traffic sensor upgrade to the aging traffic management and ramp metering systems on the highway. This hyper-smart system will help to better manage the flow with vehicles, which could have the result of effectively adding a new lane on I-25 at a fraction of the cost.

The anticipated results are:

- More reliable trips and travel times
- Fewer crashes
- Reduction in stop-and-go traffic
- More efficient flow of traffic without expanding the roadway



2019

2018

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## SMART POWERED LANES

2016

CDOT is looking partner with interested parties to embed power sources into Colorado's roadways that can wirelessly charge electric batteries in freight trucks while they are driving. The Smart Powered Lanes project desires to deploy this technology in live traffic for the first time in the United States. An open forum for business owners and fleet operators will be held on June 7 - join us to learn more!



Power source embedded into the roadway wirelessly transfers energy to vehicles while in motion.

Roadside equipment efficiently connects to the utility grid and distributes power to the roadway.

Minimal power storage needed within the vehicle because the batteries receive power from the roadway on the go, allowing longer trips and less battery storage.

2017

2018









2017



#### HYPERLOOP

Hyperloop is a new way to move people and freight using a custom electric motor to accelerate and decelerate levitated sleds through a low-pressure tube at speeds up to 700 mph.

- The Rocky Mountain Hyperloop team (CDOT, AECOM, Denver, Greeley and the Denver International Airport (DEN)) was selected as one of 10 worldwide winners.
- P3 between CDOT & HL1 underway to refine Initial application and define next steps
- Rocky Mountain Hyperloop Feasibility Study / Next Steps done July 1, 2018.





2019

2018



one

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TIMING : SUMMER 2017

2016

2017



hyperl∞p

one



#### UNITED STATES CHEYENNE - DENVER - PUEBLO TEAM: Rocky Mountain Hyperloop

Colorado's population growth and emerging industry sectors would benefit immensely from a Hyperloop connection along the Front Range. A high-speed link would be beneficial for the state's tourism industry, link high value-added sectors such as biotechnology, technology and aerospace, and help alleviate intercity congestion.

Denver - Greeley: 64km, 6 min Denver - Fort Collins: 129km, 9 min Denver - Vail: 121 km, 9 min Denver - Colorado Springs: 118 km, 9 min Colorado Springs - Pueblo: 65 km, 6 min Total Route Length: 580 km

2019



#### COMMUTING





#### ARRIVO

Arrivo is a new take on a regional transportation system that aims to be safe, fast and clean. The Arrivo system propels four models of vehicles through an enclosed, electromagnetic superhighway, using magnetic levitation to float the vehicles and an all-electric linear motor to push them forward at speeds up to 200 mph with zero emissions.

#### ARRIVO'S INVOLVEMENT IN COLORADO INCLUDES:

- Development of a full system test track adjacent to E-470
- The creation of 200+ jobs in the Denver metro area by 2020 along with a Arrivo Engineering and Technology Center
- Arrival at DEN in under 20 minutes from anywhere in the Denver metro area









#### OTTO SELF-DRIVING TRUCK

Colorado (Colorado Department of Transportation, Colorado State Patrol and Department of Revenue) partnered with Otto of Uber to complete the world's first commercial delivery by a self-driving truck. This approximately 120-mile demonstration of self-driving technology in the real-world environment of Colorado is a monumental next step in advancing safety solutions that will help Colorado move towards zero deaths on our roadways. Colorado is enthusiastic about working with Otto and others on:









# **NEXT STEPS**

**Privacy** Address security issues



People Educate public



**Technology & Planning** Plan and model for rapid change



**ROI** Invest now in technology platforms

#### Regulation

Establish consistent policy direction that supports autonomous future



# **QUESTIONS?**