



COLORADO

Department of
Transportation

Identifying and Addressing Non-Technical
Key Research Questions: Infrastructure
Shailen P. Bhatt, Executive Director
July 12, 2017

FY 2017-2018
\$1.42 Billion Budget

CDOT RESPONSIBILITIES

ADMINISTERS
\$208
MILLION
EACH YEAR IN FEDERAL
GRANTS

3,454

BRIDGES

CDOT
MAINTAINS & OPERATES
23,000
 **TOTAL**
LANE MILES
OF HIGHWAY



**DIVISION OF
TRANSIT
AND RAIL**
ADMINISTERS FED/STATE
GRANTS AND OPERATES
BUSTANG

6.1 MILLION
MILES
PLOWED
OF SNOW PER YEAR 

 **35** MOUNTAIN
PASSES
OPEN YEAR-ROUND

AIRPORT
PLANNING
INTERFACE WITH FAA



Source: Colorado Department of Transportation, 2014

Purpose To save lives and make lives better by providing freedom, connection and experience through travel.



Values Safety, people, integrity, customer service, excellence and respect are at the heart of all that we do.

Summit The best DOT in the country for all customers by focusing on our people, leading-edge technology and a healthy multi-modal system.

Peaks

Base Camps

Technology

Help Our People with Technology

Improve Travel Experience with Technology

Big Data

People

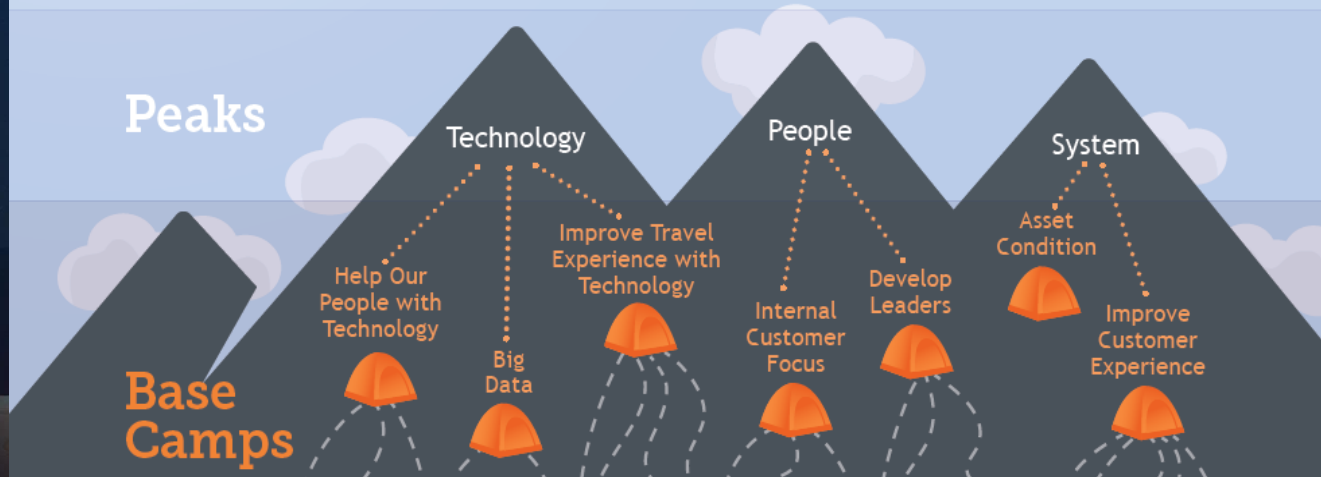
Internal Customer Focus

Develop Leaders

System

Asset Condition

Improve Customer Experience



OUR CHALLENGE

Continued Growth

1991



3.3 million



27.7 billion
vehicles miles traveled

\$
\$
\$
\$\$\$

\$125.70

spent per person

2015



5.4 million



50.5 billion
vehicle miles traveled

\$
\$\$\$\$\$\$\$\$\$\$\$\$\$\$\$\$

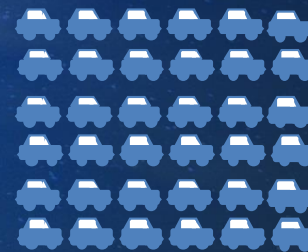
\$68.94

spent per person

2040



7.8 million



72.3 billion
vehicle miles traveled

\$

\$41.16

spent per person

*All dollar
figures
adjusted
for inflation*



RoadX **VISION**: Crash-free, Injury-free, Delay-free and Technologically-transformed 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 do we need to act?

SAFETY

80% reduction in crashes per NHTSA estimates



MOBILITY

40 to 400% increase in capacity



5 levels of driving automation

		Steering and acceleration/ deceleration	Monitoring of driving environment	Fallback when automation fails	Automated system is in control
Human driver monitors the road	0 NO AUTOMATION				N/A
	1 DRIVER ASSISTANCE				SOME DRIVING MODES
	2 PARTIAL AUTOMATION				SOME DRIVING MODES
Automated driving system monitors the road	3 CONDITIONAL AUTOMATION				SOME DRIVING MODES
	4 HIGH AUTOMATION				SOME DRIVING MODES
	5 FULL AUTOMATION				

Highly Automated Vehicles (HAVs)









Human driver

Automated system

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.

		Steering and acceleration/ deceleration	Monitoring of driving environment	Fallback when automation fails	Automated system is in control
3	CONDITIONAL AUTOMATION				SOME DRIVING MODES
4	HIGH AUTOMATION				SOME DRIVING MODES

Connected road classification system

Level
1

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

Level
2

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 data service may be available

Level
3

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
4

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

Level
5

(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

Level
6

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





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ROADX
ACCELERATING TECHNOLOGY

Smart Highways

Smart 25 Ridegate to University

Software and sensor
upgrades to better manage
flow resulting in:



Fall 2017



Smart 70 Golden to Vail

Partnership with Here will
provide real time data
about hazards such as:



Winter 2016

Panasonic Smart 70 Panasonic

Self-driving vehicles and
infrastructure share data to
eventually:



Ongoing



COLORADO
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ROADX
ACCELERATING TECHNOLOGY
Innovation

OTTO

Transport

Self driving vehicles,
platooning, smart parking



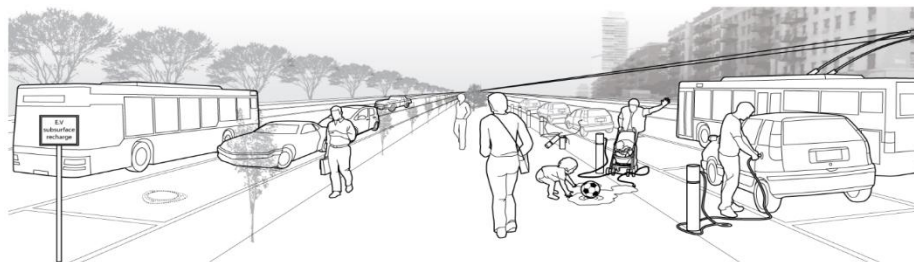
Hyperloop

New way to move people
and freight



Smart Powered Lane

Pilot to embed charging in
roads to power electric
vehicles





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Questions?

