The Future of Mobility

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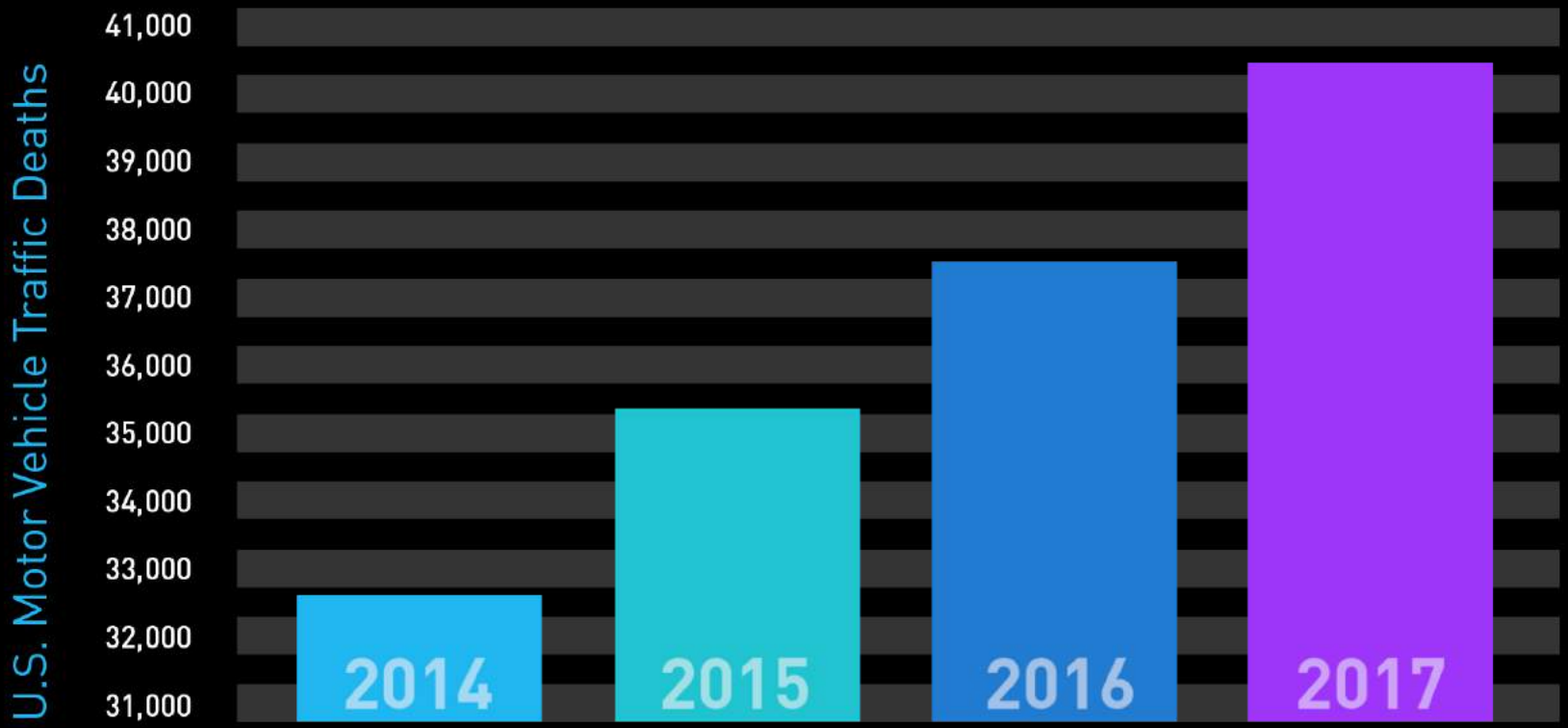
You know us for our consumer products ...

But we've evolved ...

Panasonic is a leading global supplier of automotive systems & technologies

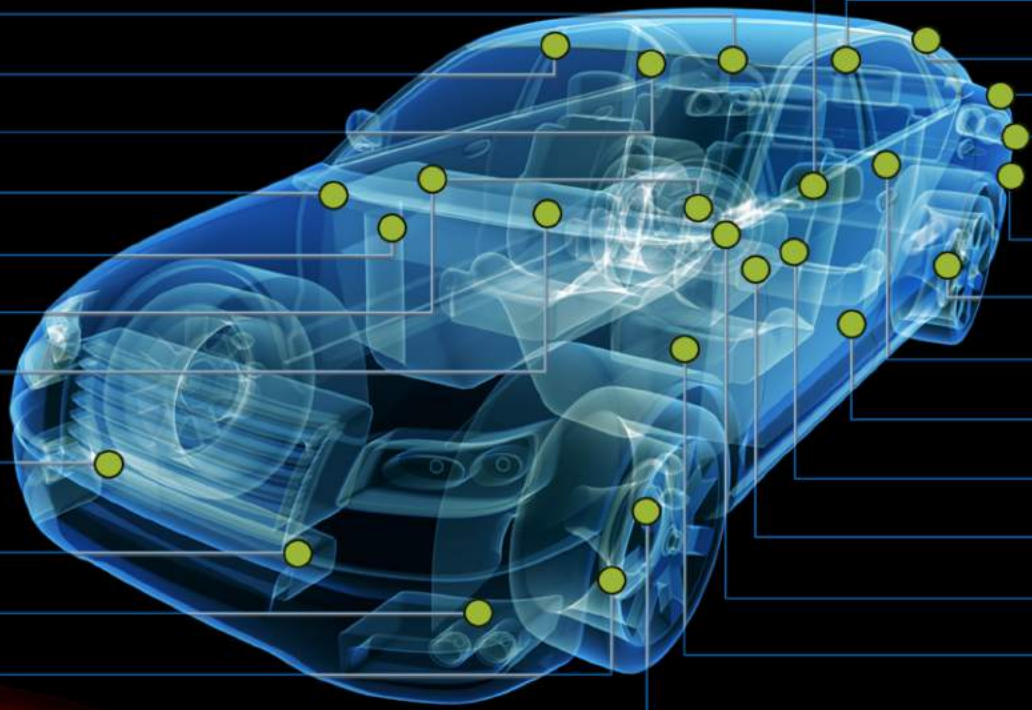

Audi
BMW
FIAT
FCA
Ford
GMC
ISUZU
JAGUAR
Jeep
NISSAN
PEUGEOT
PORSCHE
SEAT
SUBARU

Why does all of this matter?



SOURCES: NHSTA and National Safety Council

Today's cars have a lot to say ...



Lane departure system

Temperature/light sensor

Front object CCD camera

Windshield wiper set

Pedestrian warning

Airbag sensors

Infotainment System

Front object laser radar

Nightime pedestrian warning IR sensor

Road friction sensor

Tire pressure sensor

GPS/Telematics

Side curtain sensor

Rear camera

Blind spot detection

Cross traffic alert

Rear object laser radar

Wheel speed sensor

Central computer

Collision sensor

Side airbag SRS

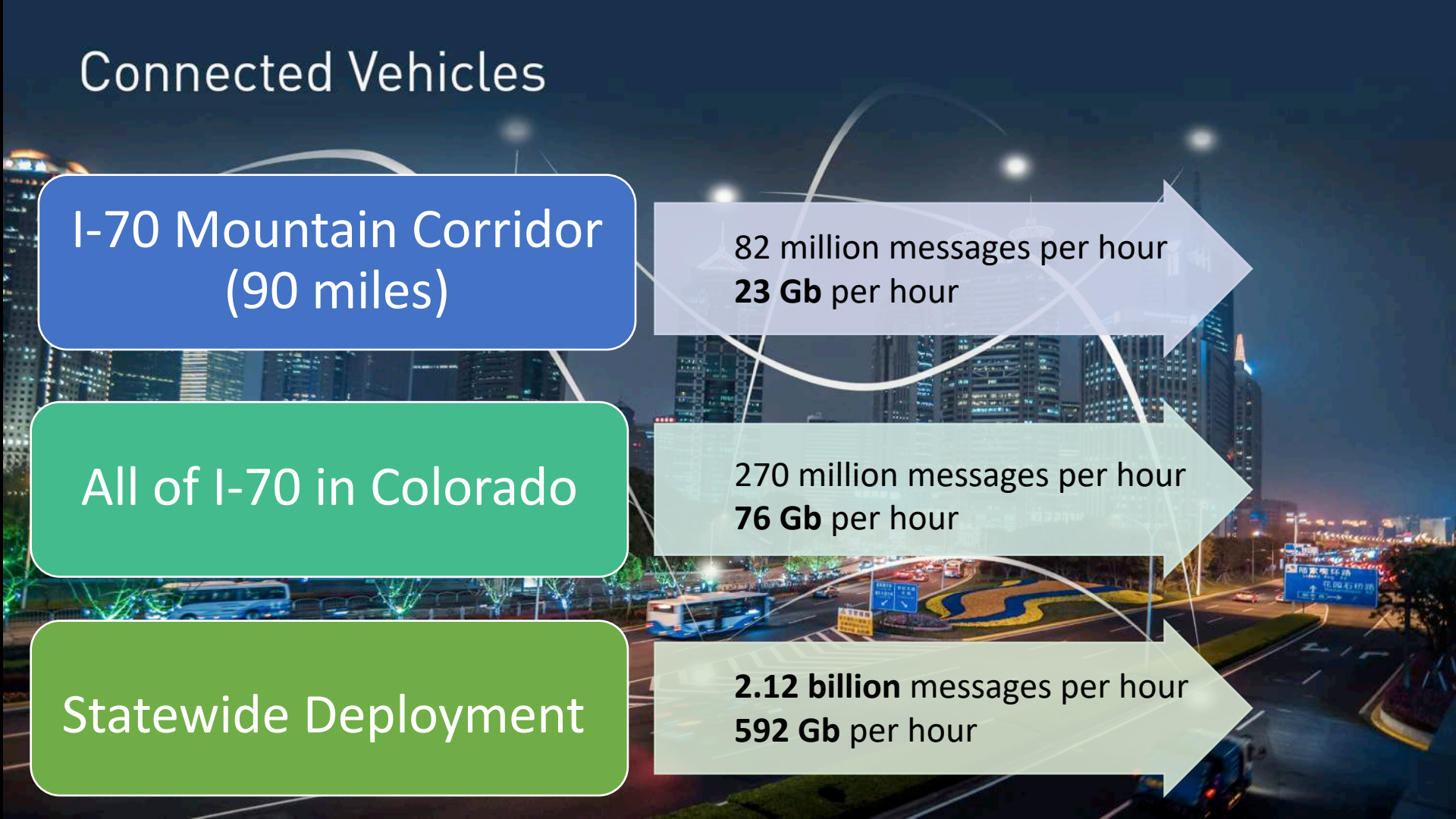
Steering angle sensor

Adaptive cruise control

Traction control system

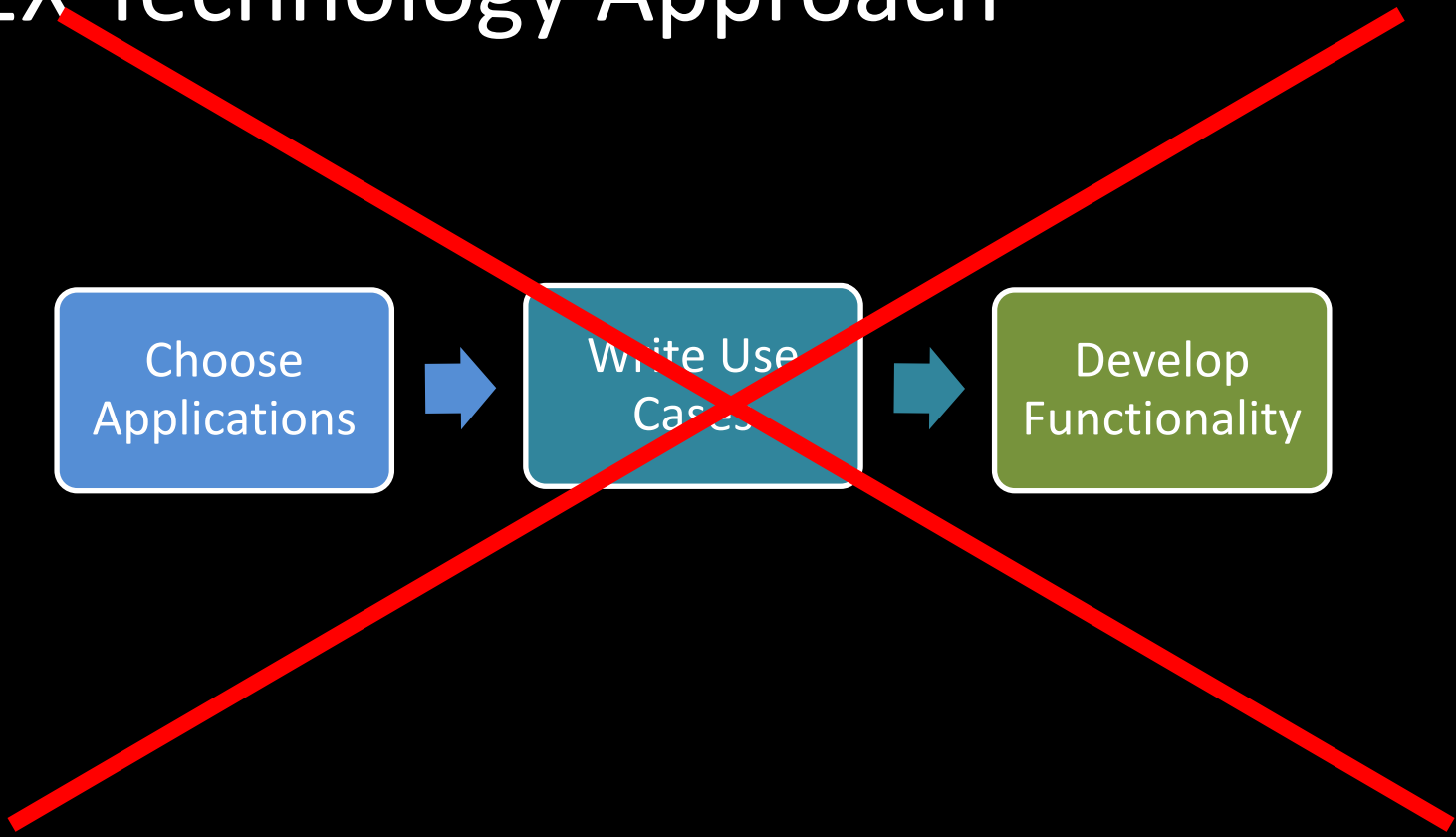
Wheel speed sensor

Connected Vehicles



I-70 Mountain Corridor (90 miles)	82 million messages per hour **23 Gb** per hour
All of I-70 in Colorado	270 million messages per hour **76 Gb** per hour
Statewide Deployment	**2.12 billion** messages per hour **592 Gb** per hour

V2X Technology Approach



V2X Technology 4-Level

Identify Needs → Target Functionality to Meet the Needs → Develop Use Cases Implementing the Functionality → Develop Applications Implementing the Use Cases

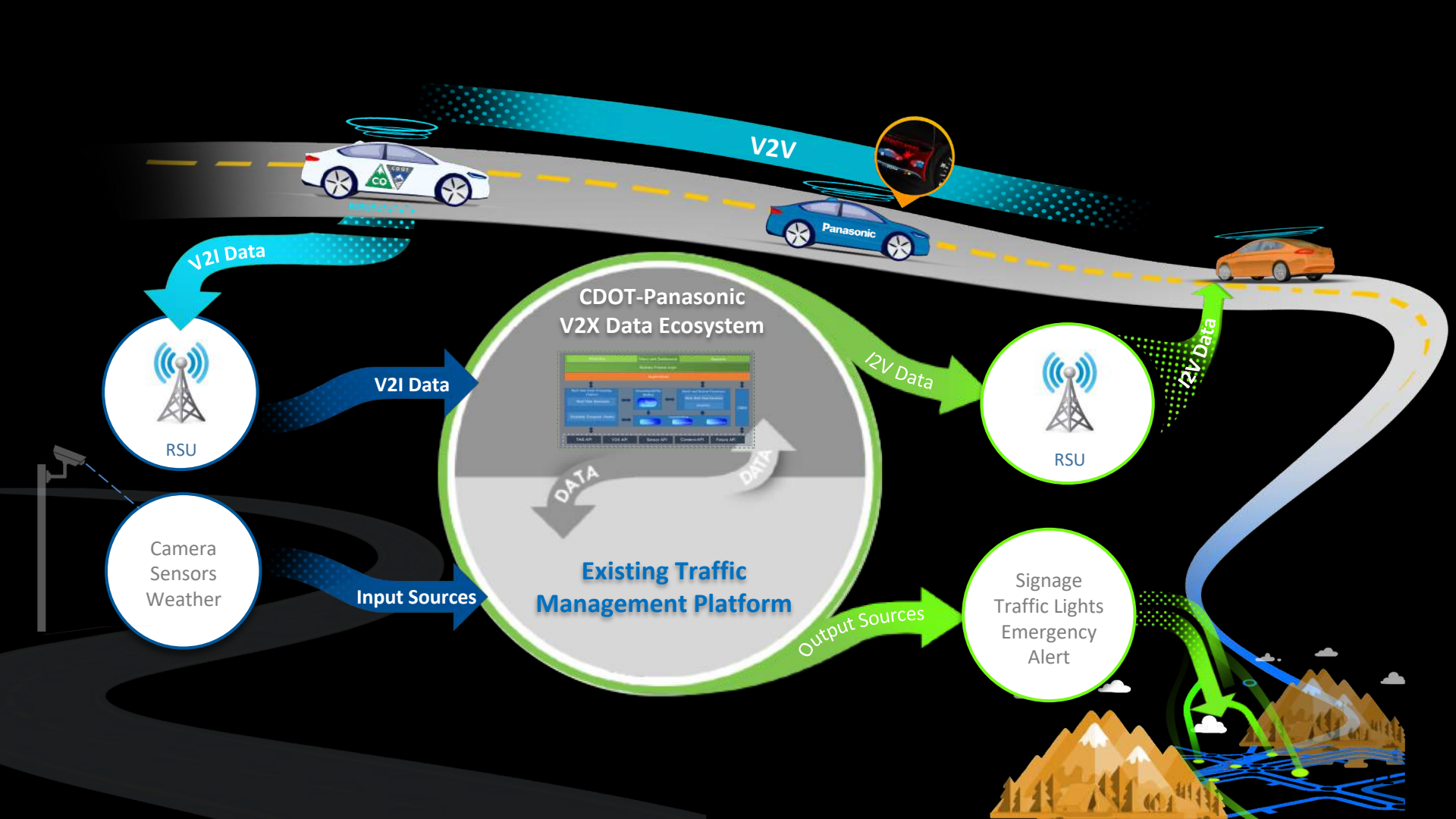
SAE INTERNATIONAL

ISO

IEEE 802.11-2012
IEEE 1609 Family
SAE J2945 Family
ISO 19091 Family
SAE J2735

IEEE

DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA


V2V
V2I Data
CDOT-Panasonic
V2X Data Ecosystem
V2I Data
I2V Data
I2V Data
RSU
RSU
DATA
DATA
Camera
Sensors
Weather
Input Sources
Existing Traffic
Management Platform
Output Sources
Signage
Traffic Lights
Emergency
Alert

Connected Cars Deployment Outcomes

Prevent **80%** of non-impaired crashes

Save **21,500*** lives

Save **thousands** of additional lives through faster emergency response

Improve freeway travel times by **42%**

Improve arterial travel times by **27%**

Reduce poor weather incidents by **25%**

Improve fuel savings by **22%**

Reduce VMT by **20%**

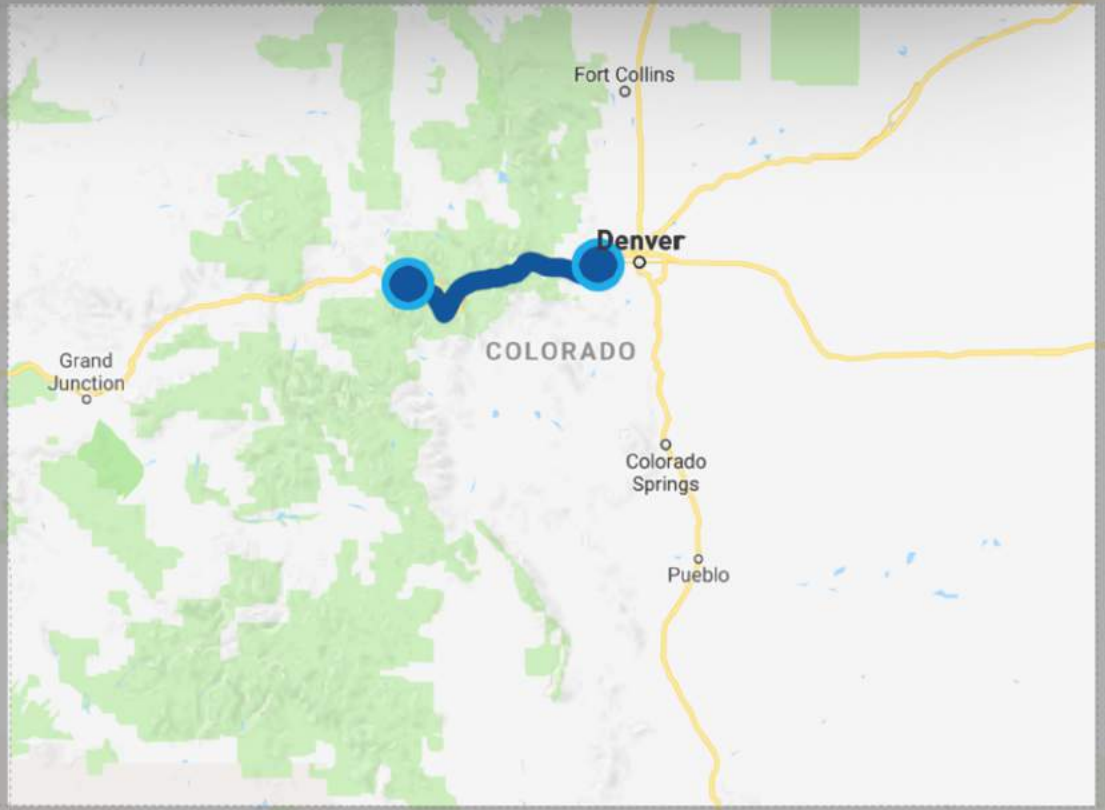
Improve freeway travel times by **42%**

*based on 2017 traffic fatalities statistics

Current deployment in Colorado

90 mile stretch of I-70

From Golden, CO to Vail, Co



CDOT & Panasonic

Panasonic = Connected Vehicle Foundation

How do we build a meaningful network at a scale that begins solving problems?

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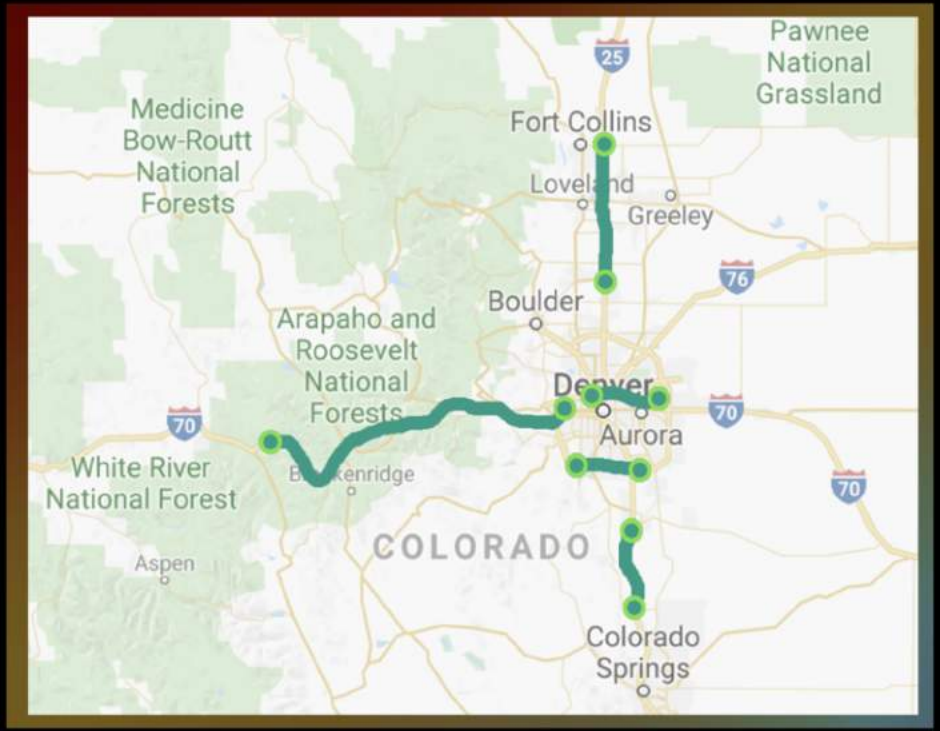
Stage 0

Funded

Managed Lanes, Panasonic

- I-70 W
- I-70 Central
- I-25 N (sect 7-8)
- I-25 S Gap
- C-470



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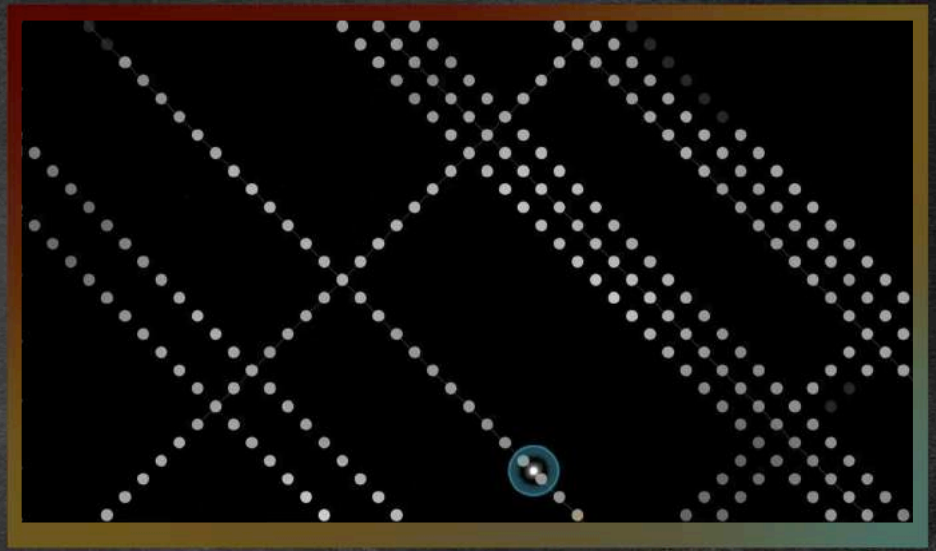
Blank Slate

New digital infrastructure

Transportation systems becoming information systems

Roadways will be influenced by digital messages

Ability to influence and improve roadway conditions



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Internet of Roadways (IoR)
CDOT
CO
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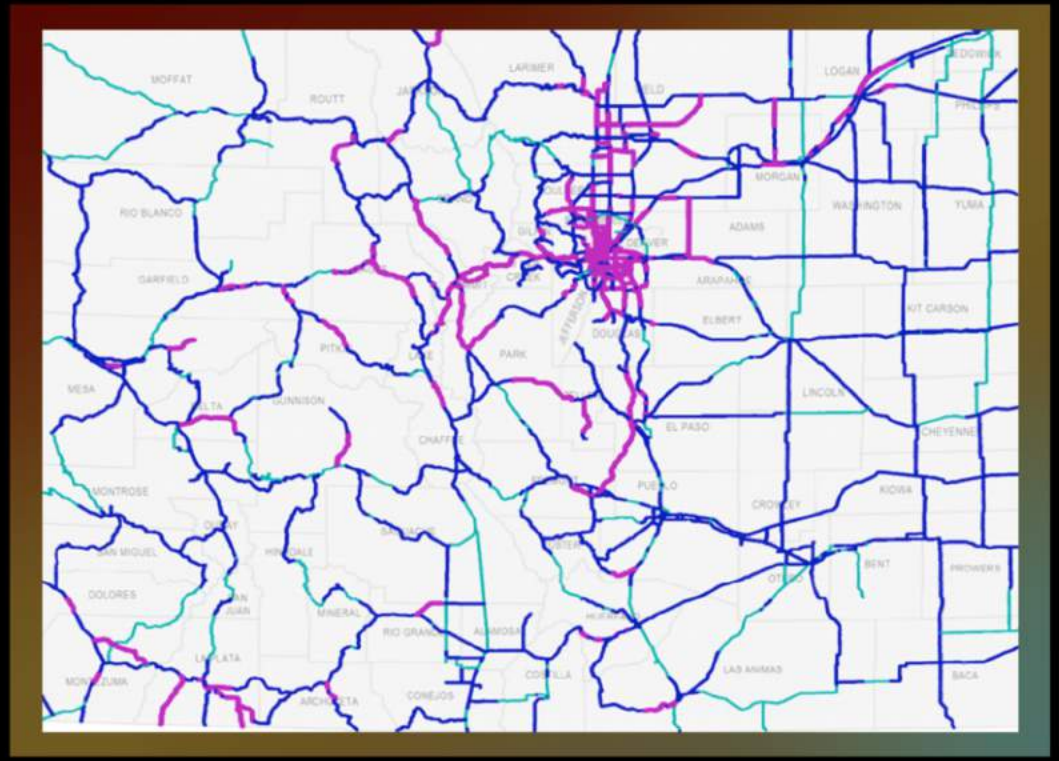
IoR Factors

Safety

Mobility

Freight



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IoR Factors – cont'd

- Fiber
- Air Quality
- Regional Coverage
- Interstate Corridors

Planned Fiber .....

Existing Fiber ———

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Safety Benefit Analysis

Quantifying the safety benefits of connected vehicles

Connected Vehicle Application	CMF Equivalent	% Reduction (PDO, Injury, Fatality)
Spot Weather Warning	Variable Message Signs	25%
Roadway Departure Warning	Rumble Strips	11% — 16%
Queue Warning	Queue Ahead Warning	16%
Dynamic Speed Harmonization	Variable Speed Limits (VSL)	19%

First-ever methodology created by CDOT Traffic Safety (David Swenka)

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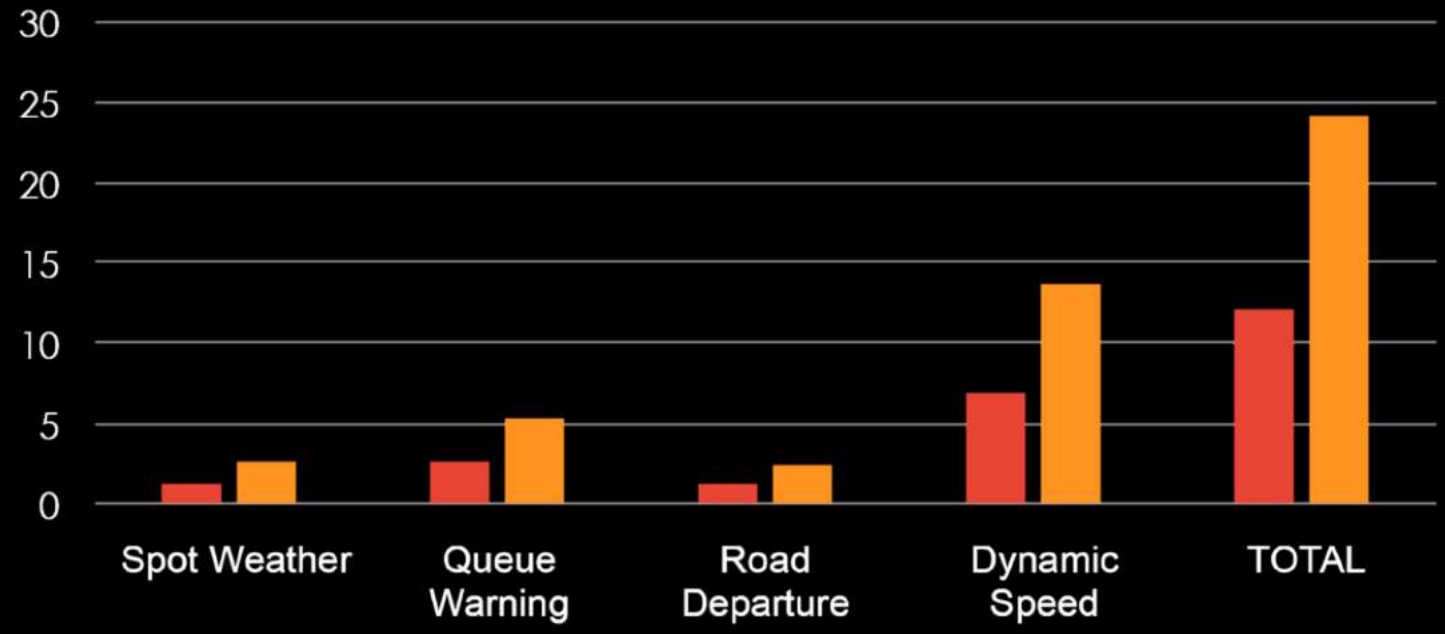
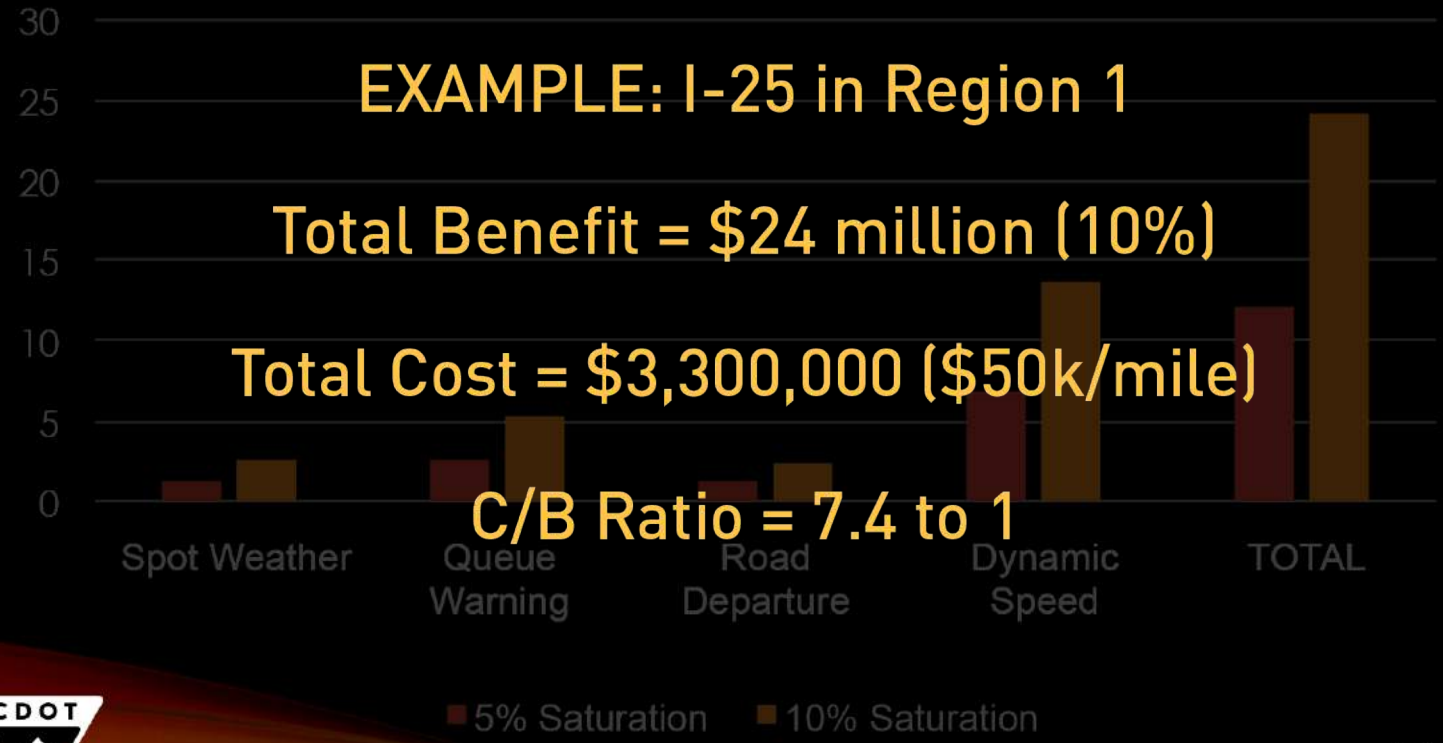
Safety Benefit Analysis – cont'd



Safety Benefit Analysis – cont'd



EXAMPLE: I-25 in Region 1

Total Benefit = $24 million (10%)

Total Cost = $3,300,000 ($50k/mile)

C/B Ratio = 7.4 to 1