The Future of Connected Autonomous Vehicles

Transportation Interim Committee

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Vision and Mission

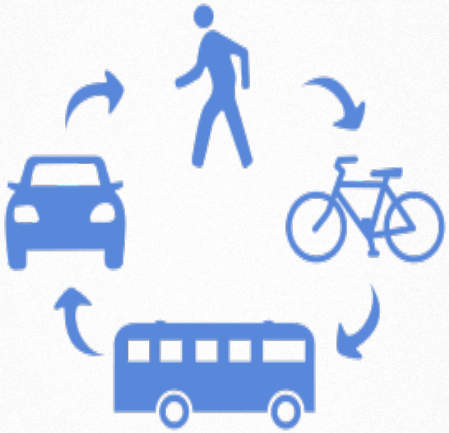
MISSION

Innovating transportation solutions that strengthen Utah's economy and enhance quality of life.

Strategic Goals

zero Crashes Injuries Fatalities

Zero Crashes, Injuries, Fatalities



Optimize Mobility

Preserve Infrastructure

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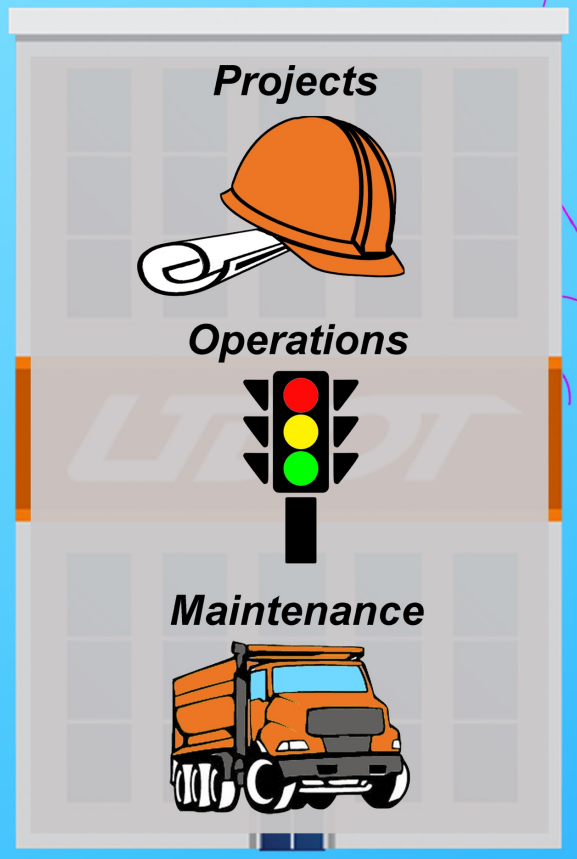
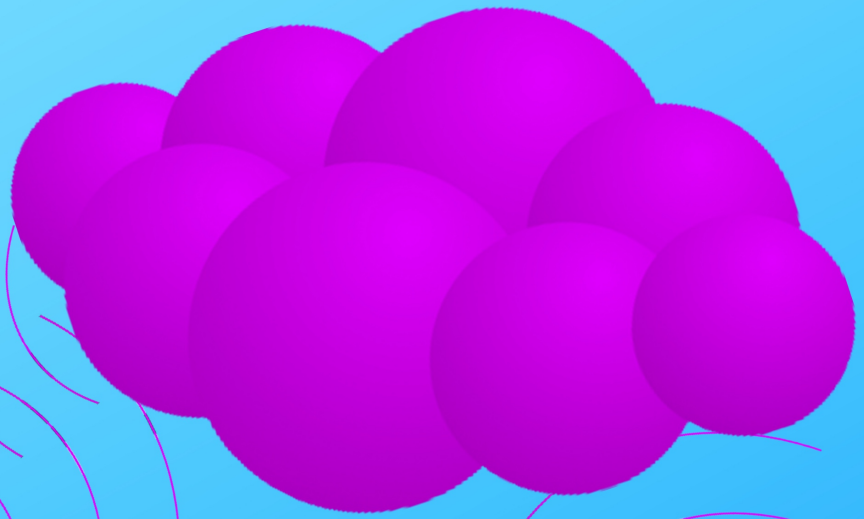
DOT of the Future





Three Categories of Change

Automation

Electrification

Mobility as a Service

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Automated Vehicles

Automated Vehicle Technology

- Vehicle takes over some (or all) driving functions
- On-board devices provide input:
  - LiDar (64 rotating laser beams)
  - Digital Cameras
  - GPS
  - Radar sensors

- Technology motivated by:
  - Safety
  - Reduced energy use
  - Democratization of access

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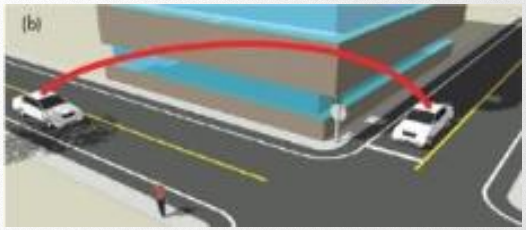
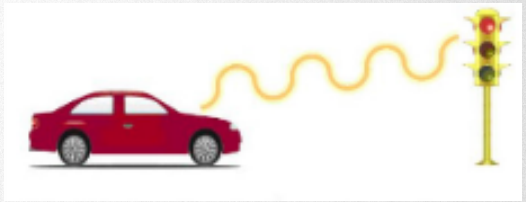
Levels of Automation

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	**No Automation**	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	**Driver Assistance**	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	**Partial Automation**	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	**Conditional Automation**	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	**High Automation**	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	**Full Automation**	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Connected Vehicles

- **Connected Vehicle Technology**
  - **Complements Automated Vehicle Technology**
  - Vehicles share information with other vehicles (V2V)
    - Basic Safety Message (location, speed, direction, braking, etc)
  - Vehicles and Infrastructure share information (V2I)
    - Signal Phase and Timing (SPaT)
    - Basic Infrastructure Message (BIM)
  - Benefits include:
    - crash avoidance
    - improved mobility
    - enhanced fuel efficiency





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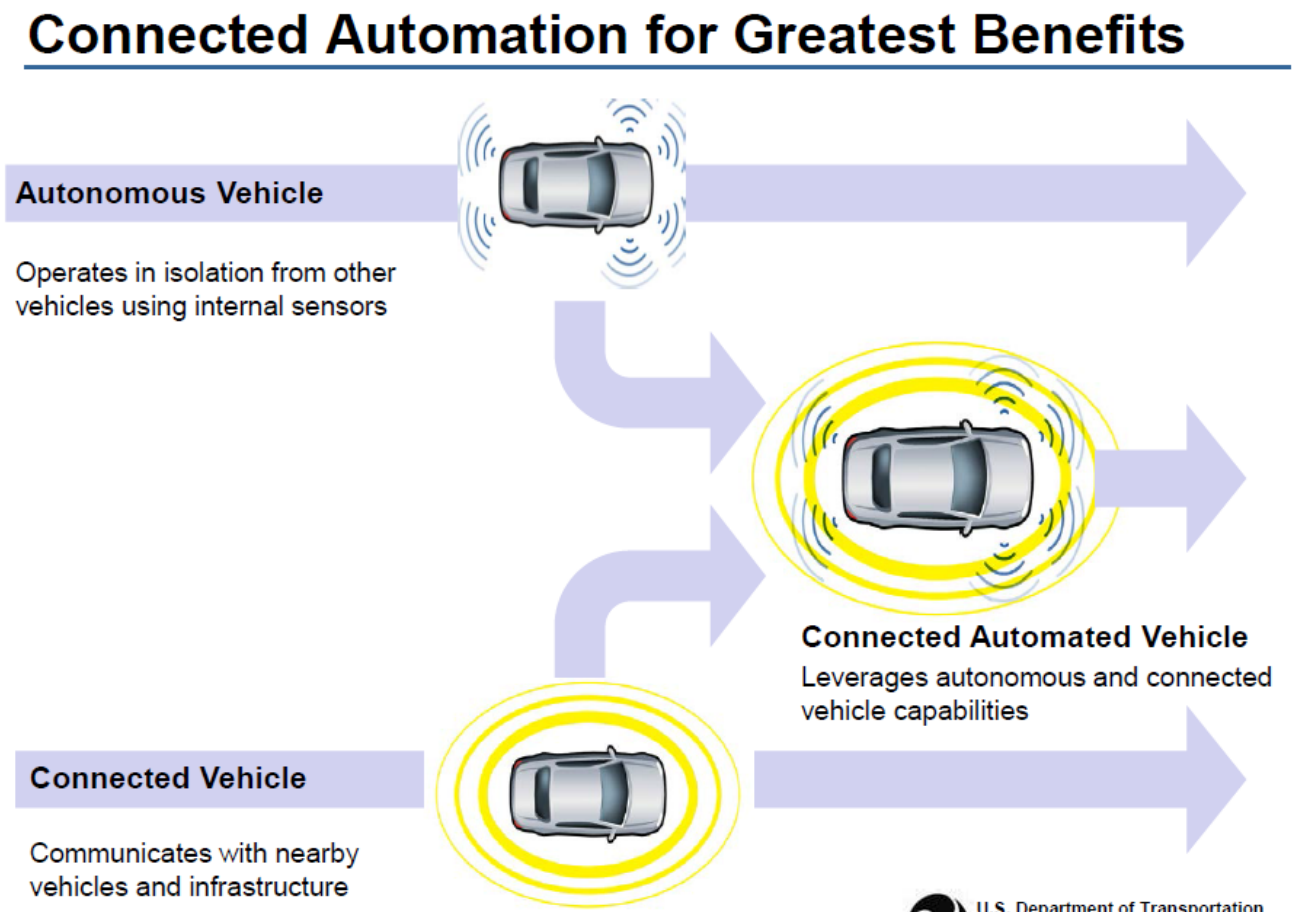
Connected Automation



Timeline for CAVs

- Today – Automated features (Level 1 and 2) on many new cars
- 2017 – GM offers DSRC on Cadillac CTS (summer ‘17)
- 2017 - GM offers electric (Chevrolet Bolt EV) vehicle
- 2018 - Tesla to have fully autonomous vehicle
- 2019 - Volkswagen to offer fully autonomous vehicle
- 2020 - Fully autonomous vehicle available (Toyota)
- 2021 – Google driverless car available
- 2021 – DSRC on all new light vehicles (rule pending; 3-yr phase in)
- 2021 – Highly automated car available (Volvo, BMW, Ford)
- 2022 – Hyundai to introduce fully autonomous vehicle
- 2030 – 15% of new cars will be fully autonomous (per McKinsey)
- 2035 – Most cars will have DSRC on board

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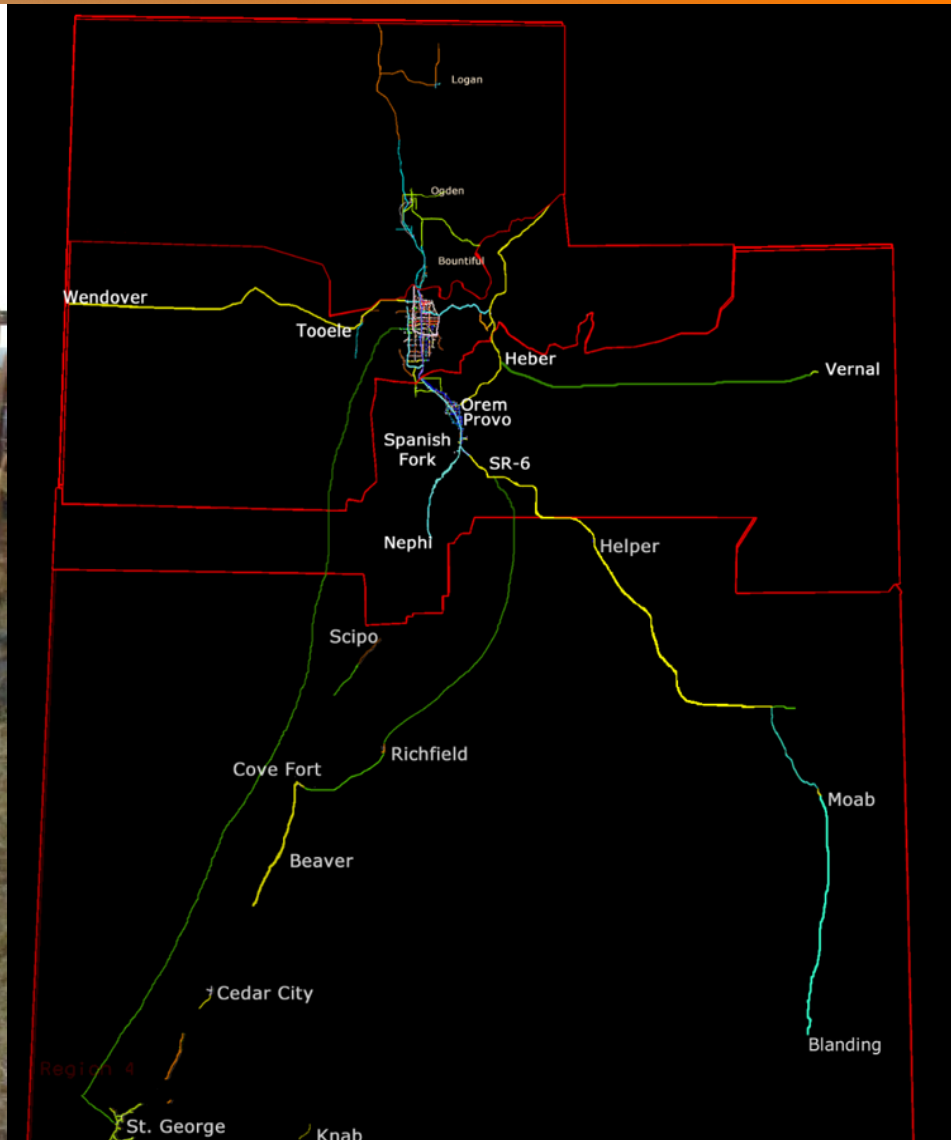
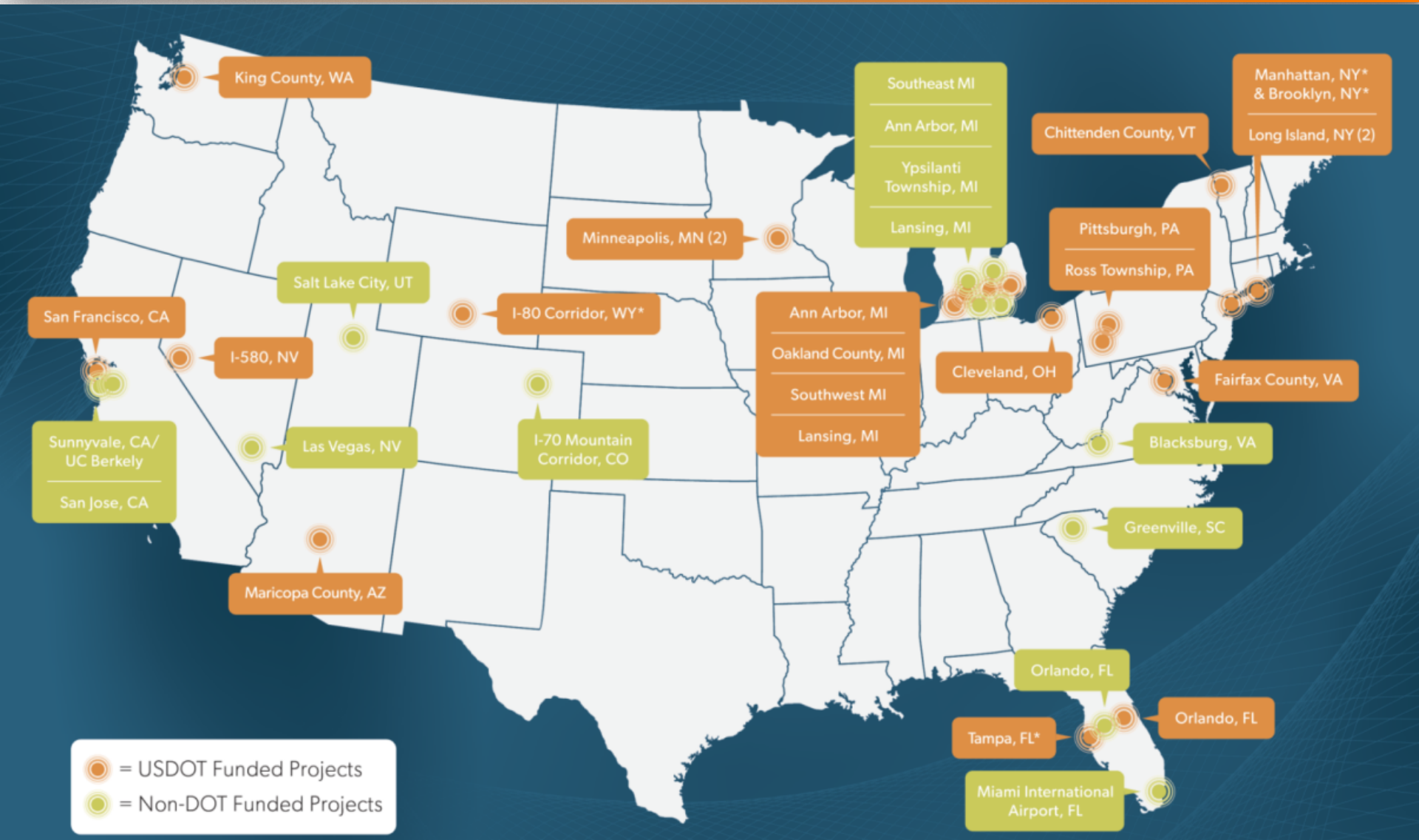
Collaboration

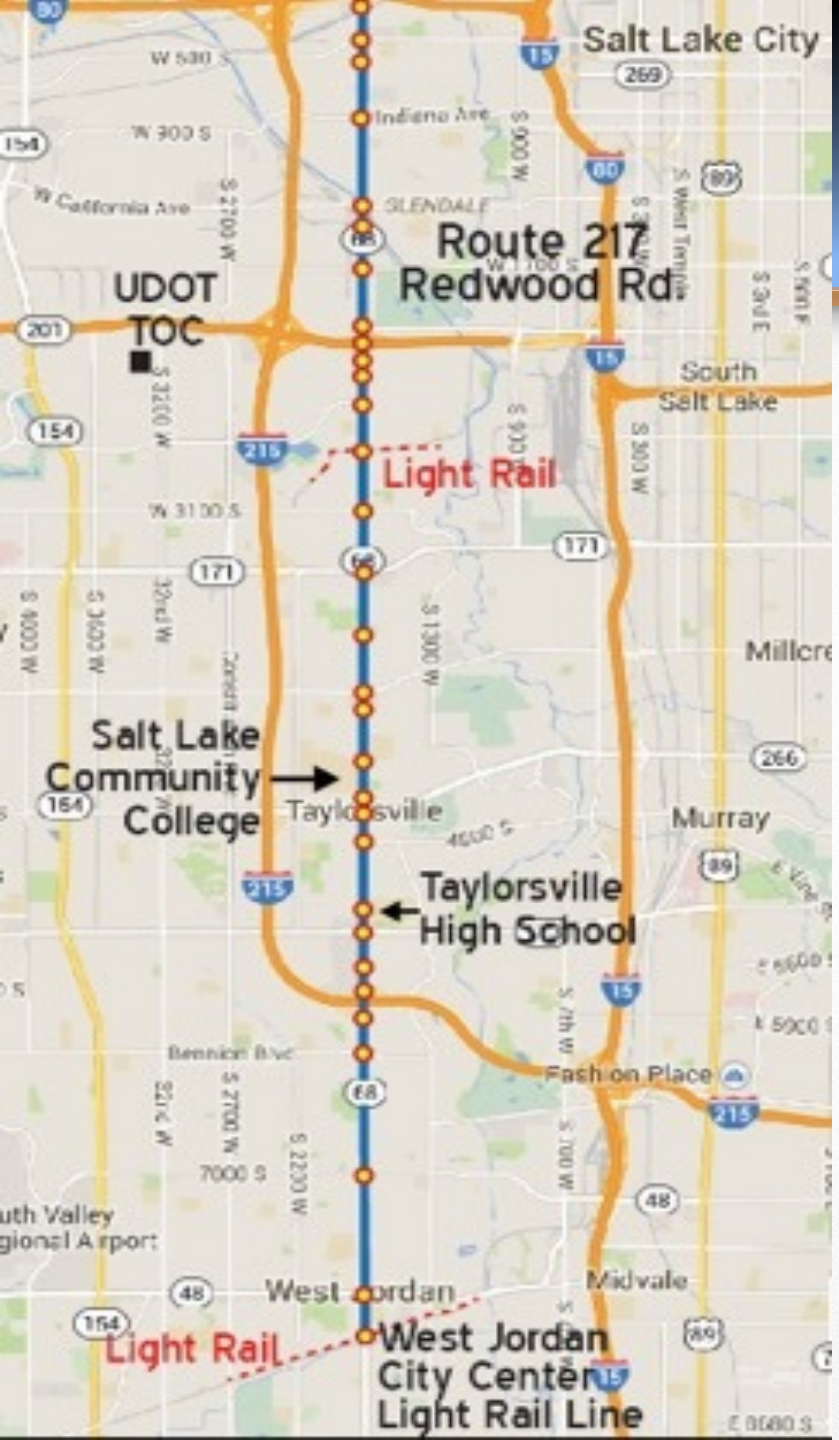
Fiber Connectivity



DSRC Radio

Locations Using 5.9GHz DSRC for Connected Vehicle Deployment





Goals of the UDOT CV Deployment

Transit Signal Priority for Improved Schedule Reliability

Full CV-DSRC Corridor

Meet the SPaT Challenge

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MMITSS Operation (Simplified)

- Bus comes into range of DSRC at intersection
  - Receives SPaT and MAP data
- GPS reports bus location
- MMITSS queries bus schedule system
  - If bus is late and occupied (per established thresholds): MMITSS generates request for priority
- MMITSS: Sends priority request to signal controller

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Redwood Road Installation

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System Evaluation

- Traffic analysis before and after:
  - Improve transit schedule reliability?
  - Impacts to other traffic?
- Tools:
  - Traffic Signal Performance Metrics
  - UTA Data on Bus Performance

The Future