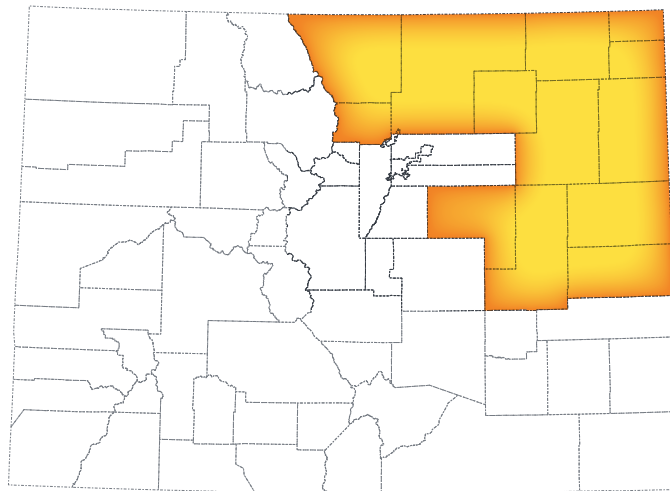


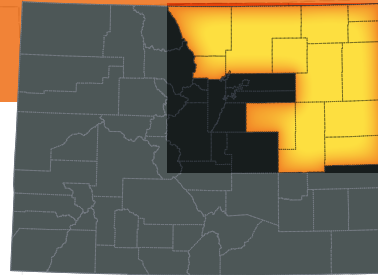
CDOT REGION 4

Smart Mobility Regional Plan



APRIL 2019

CDOT REGION 4 SMART MOBILITY REGIONAL PLAN



The purpose of this regional plan is to identify potential areas where Smart Mobility implementation could apply in Region 4. These applications could be location specific solutions that could translate into their own projects or be added onto existing projects. These applications could also be general strategies for future investments across the region. These recommendations provide a starting point of solutions that address needs and are not prioritized at this time. This regional plan, along with the other four regions, will be rolled into a Statewide Smart Mobility Plan, which will then feed into the overall CDOT Statewide Transportation Plan. The Smart Mobility applicable technologies and the statewide priorities are intended to be updated on an annual basis through coordination with the Smart Mobility Committee in each region. Outreach for this plan was focused on stakeholders representing CDOT staff and local planning and transportation agencies. Broader public outreach will be incorporated into the Statewide Transportation Plan effort.

PROCESS AND PARTICIPANTS

Stakeholder engagement incorporated statewide and region-specific outreach. The Smart Mobility Plan is intended to assess the readiness of the state's facilities, prepare a toolbox for future strategies, and develop regional and statewide plans for how to deploy Smart Mobility strategies. Kickoff webinars were held on Tuesday, May 29, 2018 and Monday, June 11, 2018. These webinars introduced the definition of Smart Mobility; explained how the plan will be coordinated with other concurrent planning efforts; reviewed the plan elements, scope, and schedule; and presented the draft plan vision and goals for feedback. Following these webinars the Colorado Department of Transportation (CDOT) held a stakeholder workshop with regional Traffic Engineers on Wednesday, June 13, 2018 at the CDOT Headquarters in Denver, Colorado. This presentation included a discussion of the Smart Mobility Plan overview and process, tools and readiness assessment, and implementation case studies. Following the presentation participants broke into small groups and provided input on the Smart Mobility definition, vision, and goals, needs and potential tools, and challenges and opportunities. An online questionnaire was also distributed concurrent with the webinars and Traffic Engineers workshop to solicit input on challenges, potential technology tools, desired Smart Mobility Plan benefits, challenges, and opportunities.



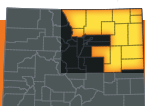
CDOT held a Region 4 specific workshop on Thursday, November 1, 2018, at the CDOT Region 4 Headquarters in Greeley, Colorado. The purpose of the workshop was to seek feedback from stakeholders on region specific priorities, needs, and implementation strategies as part of the Smart Mobility Plan.

Invitations were sent to stakeholders representing key municipalities within the Region; representatives of local transit agencies; County departments; and the State of Colorado Department of Transportation. Approximately 16 participants including key Smart Mobility staff attended the workshop.

- Johnny Olson/ CDOT
- Rodney Arnold/ CDOT
- Rich Christy/ CDOT
- Gary Dewitt/ CDOT
- Larry Haas/ CDOT
- Peter Heumann/ CDOT
- Katrina Klobberdanz/ CDOT
- Daniel Mattson/ CDOT
- Long Nguyen/ CDOT
- Rhianna Poss/ CDOT
- Karen Schneiders/ CDOT
- James Usher/ CDOT
- Jonathan Woodworth/ CDOT
- Tricia Sergeson/ FHWA
- Becky Karasko/ NFRMPO
- Suzette Mallette/ NFRMPO
- Elizabeth Reldford/ Weld County
- Bob Fifer/ CDOT
- Lily Lizarraga/ CDOT



Figure 1. Region 4 Workshop Participation



REGION 4 CONTEXT

Region 4 is located in northeast Colorado. I-25 is a north-south interstate facility providing critical connections within Region 4, extending south into the Denver metropolitan area, and North into Wyoming. I-70 is an east-west interstate facility providing critical connections between Denver to Kansas and beyond. I-76 is an interstate connecting central Denver to Nebraska at the northeast corner of the state. There are several population centers in the vicinity of I-25 throughout Region 4, including Fort Collins, Loveland, Greeley, Longmont, and Boulder.

In addition to the interstates, there are several state highways serving urban and rural communities and freight movement in the eastern portion of the state. For example, US 36 is a managed lane to Boulder. US 34 connects all the way from the eastern border with Nebraska through Greeley and Loveland into Estes Park. US 85 and US 287 are the primary north-south alternatives to I-25, east and west of the interstate respectively. I-25, I-70 and I-76 are the top three focus corridors as noted by the TPR chairs in Region 4. However, since Region 4 has both urban centers and rural areas, there are different concerns along all state highway corridors. In the urban areas, congestion (due to volume and crashes/incidents), incident management, bike/pedestrian interactions, and inter-agency communication are of primary focus. In the rural areas, weather related delays, closures, wildlife-vehicle collisions, and communication gaps are focus points. In addition, truck bunching on I-70 and US 385 and US 287 for both directions is a primary issue and accident avoidance would be useful.

There are also several rail lines throughout Region 4 which cross the state highways.

CURRENT REGION 4 SMART MOBILITY INITIATIVES

Ramp metering is in place along the I-25 corridor at two locations (SH392/I-25, prospect I-25 and Harmony/I-25). Managed lanes are currently being built and scheduled for completion in 2021.

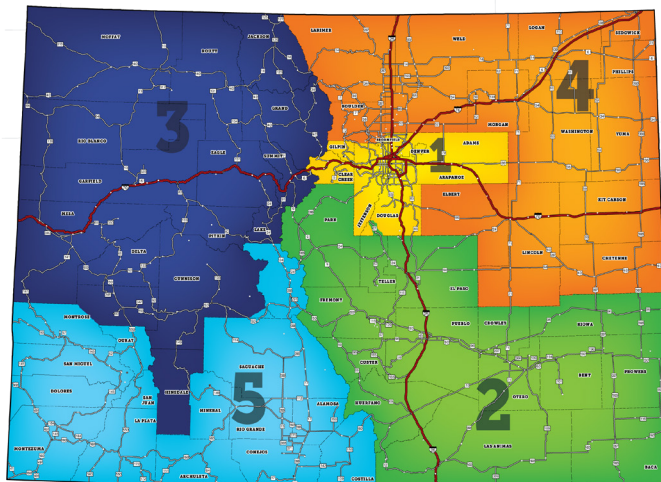


Figure 2. CDOT Regional Map

Adaptive signal control has been implemented on several highways within the cities of Greeley and Longmont to improve the efficiency of moving traffic through intersections.

A Transportation Operations Center (TOC) is currently planned and in the design phase with some funding allocated.

Fiber has also been installed on I-25, I-70, a portion of I-76 and US 85 to accommodate communication needs and future intelligent transportation systems (ITS), with plans to extend fiber further east. Additionally, a Better Utilizing Investments to Leverage Development (BUILD) grant was secured to expand the connected vehicle environment along I-25 and extend the fiber installation along I-76.

Ongoing Smart Mobility related work in the region includes freight mobility testing (freight priority at signals) on US-85 and improving Road Weather Information Systems that are already in place.

National Highway Freight Program Funds have been applied for to build I-70 and I-76 Truck Parking and to install US 85 Commercial Vehicle Safety Plan (CVSP) for trucks. In addition, Port-of-Entry (POE) is planning a virtual port on US 85 at Platteville.



REGION 4 PRIORITIES

The team used “priority corridors” identified in previous planning efforts to start the conversation for potential technology applications. Regional and specific technology solutions were overlaid on these corridors, as well as others identified during the workshops, to address the previously identified needs.

An overall region wide priority is development of the TOC. Additionally, several rural and urban priorities were identified to apply Smart Mobility Solutions across the region. The following regional priorities were identified for Region 4.

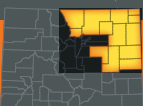
Rural:

- Fiber infrastructure for communication purposes
- Road Weather Information System (RWIS) improvements
- Smart Work Zones - and working with Waze and other third-party mapping providers to share information
- Lane Departure Warning
- Curve Warning
- Stop Sign Gap Assist
- General Congestion Management tools along I-25

Urban:

- Ramp Metering
- Dynamic Route Assignment (Alternatives to I-25)
- Adaptive/Coordinated Signal Control
- Pedestrian Detection/Protection
- Road Weather Information System (RWIS) improvements
- Response, Emergency Staging and Communications, Uniform Management and Evacuation (RESCUME)
- Positive Train Control
- Transit Signal Priority and Automatic Vehicle Location
- Smart Work Zones

A recommendation for a tool to add was a virtual weigh station that would expedite freight movement and enforcement. Another recommended addition was Positive Train Control improvements. The team is looking into additional technologies that could apply to virtual weigh stations.



As far as locations, the areas with existing fiber (yellow in the figure below), or near term proposed fiber (orange in the figure below) as identified as part of CDOT's statewide Fiber Plan would be the recommended priority areas to focus on for near term implementation of Smart Mobility solutions:

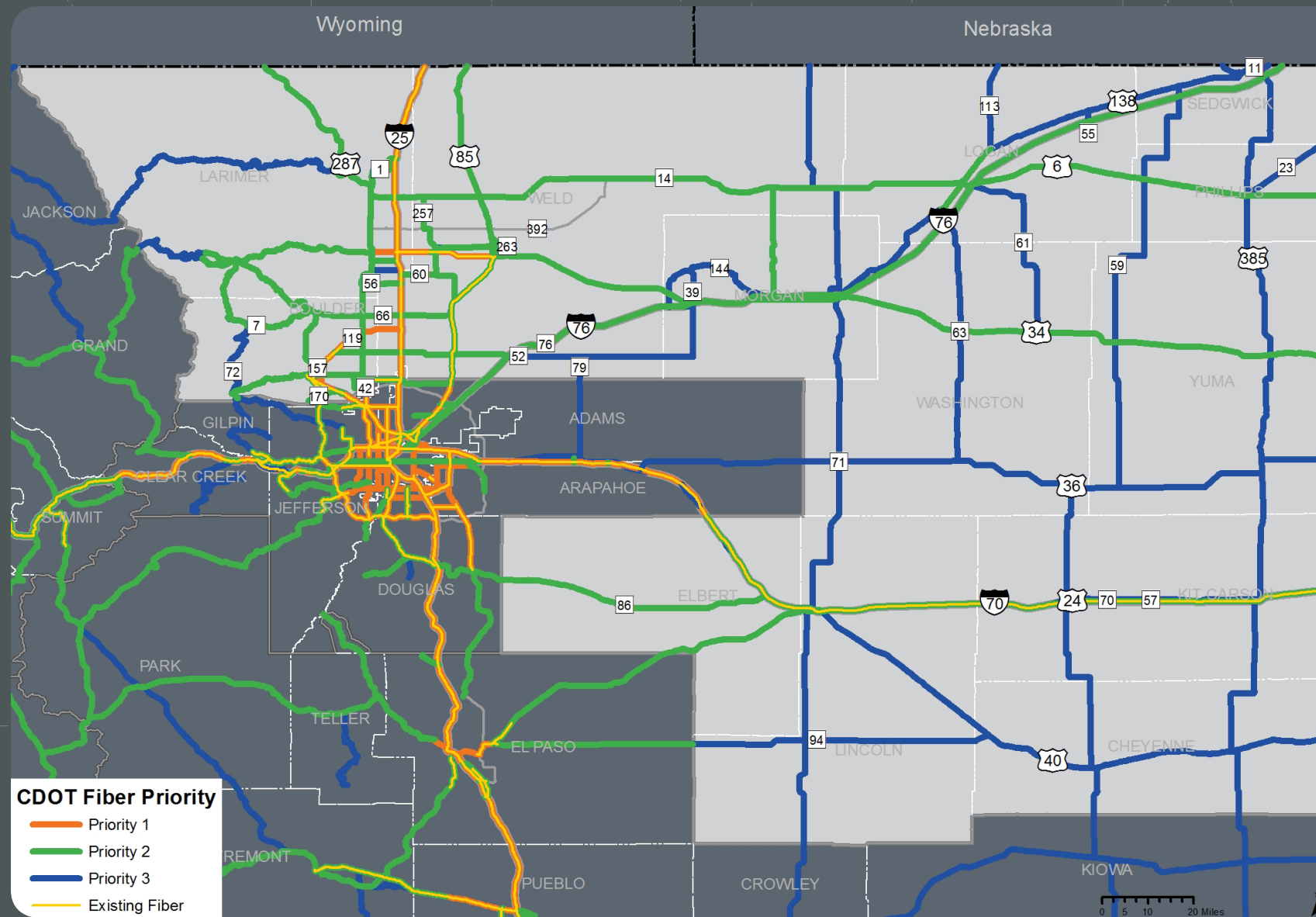


Figure 3. Region 4 Fiber Priorities

In addition to the regional priorities, several location specific applications were identified and incorporated into the GIS mapping tool. Access to the GIS data and the Smart Mobility Tool is available to CDOT employees through this link: <https://cdotapd03.dot.state.co.us/cdot/>. Locations of the solutions identified during the workshop were mapped, and a table ties the mapped location to a potential solution or note about the corridor. These recommendations are a starting point, the list will continue to evolve, and new solutions may be added to or removed from the map based on additional feedback and analysis. The solutions are not prioritized at this time, but performance-based prioritization is a future goal for the Smart Mobility Plan.

Figure 4. Region 4 Location Specific Solutions

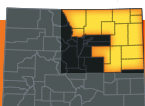
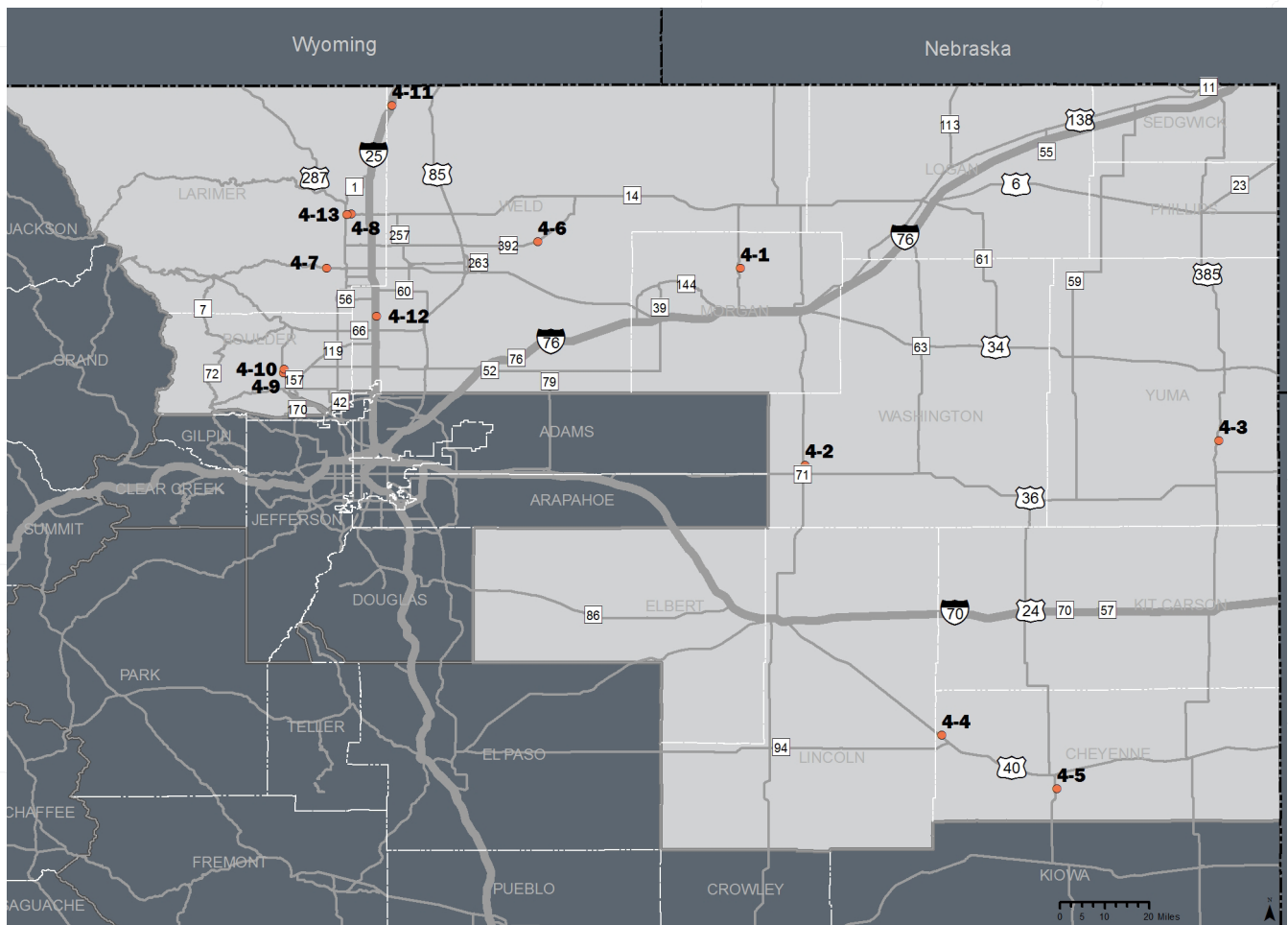


Table 1. Region 4 Location Specific Solution Descriptions

LABEL	DESCRIPTION	CATEGORY	TOOL
4-1	Dynamic Curve Warning	Safety	Curve Speed Warning
4-2	Truck route with 2 lanes	Safety	Do Not Pass Warning (DNPW)
4-3	Truck route with 2 lanes	Safety	Do Not Pass Warning (DNPW)
4-4	Truck route with 2 lanes	Safety	Do Not Pass Warning (DNPW)
4-5	Bridge - LOSS 4	Data Collection, Analysis, and Communication	Road Weather Information Systems (RWIS)
4-6	SH 392, SH 14, US 34, SH 59- High risk rural road. HSIP \$	Safety	Stop Sign Gap Assist
4-7	Growing elk herd	Safety	Wildlife Detection
4-8	Switch Yards - Multiple tools applicable	Data Collection, Analysis, and Communication	Freight Advanced Traveler Information Systems (FRATIS)
4-9	Two-lane section	Safety	Stop Sign Gap Assist
4-10	Two-lane section	Safety	Do Not Pass Warning (DNPW)
4-11	North border on I25 - Need a tool for Virtual Weight Station	Data Collection, Analysis, and Communication	Freight Advanced Traveler Information Systems (FRATIS)
4-12	I25 Congestion	Congestion Management	Dynamic Route Assignment
4-13	Ft Collins Bike/Pedestrian Safety	Safety	Pedestrian Detectors (intersection)



REGION 4 ROADMAP

The following near-term, mid-term, and long-term actions are intended to move the Smart Mobility tools and strategies identified herein into implementation, to create an ongoing process for Smart Mobility evaluation, and to incorporate Smart Mobility solutions into CDOT's regular planning and project delivery processes.

One core concept to moving the Smart Mobility Plans forward is the concept of a Smart Mobility Champion in each region. For Region 4 Long Nguyen, the CDOT Traffic Engineer was identified.

Other general themes for the Region 4 roadmap include outreach, funding, and performance tracking.

OUTREACH

Data sharing is important between CDOT Region 4, CDOT Headquarters, and the local agencies/Transportation Planning Regions (TPRs). Data, Intelligent Transportation Systems (ITS), and permits are important pieces of information to collaborate on. Template inter-governmental agreements (IGAs) would be helpful to expedite local agency coordination and interoperability.

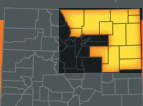
The outreach coordination will also help identify a place within the CDOT process where Smart Mobility can be incorporated. One approach is to include Smart Mobility as part of the Transportation Systems Management & Operations (TSMO) evaluation. These checks come at varying stages in the project development, so further coordination was suggested during the outreach.

FUNDING

While there is excitement about future technology, there is recognition that ongoing maintenance and project delivery are constrained within the current budget. Smaller scale technology, such as communication systems and signage, can potentially be incorporated into existing projects through the TSMO evaluation as long as the project funding or separate ITS funding allows for it.

PERFORMANCE TRACKING

Several of the tools presented are conceptual or emerging, so there is limited data tracking the performance of these tools. Often to apply for federal funding, the project application has to prove a safety benefit, which is hard to do for emerging technologies. As part of the Smart Mobility Plan, it is recommended to use the GIS tool, or the plan in general, to track applications and monitor the data for success or lack of success (potentially in the form of a benefit-cost ratio), and then share the information statewide. Once the performance of these tools is better quantifiable, then a performance-based prioritization process can be incorporated into future project selection.





NEXT STEPS

Building on the momentum of the current CDOT Smart Mobility Plan, the regional Smart Mobility Committees, led by the regional Smart Mobility Champions, and the headquarters support team, will continue to meet to discuss the evolving technology toolbox and future implementation strategies.

Additionally, the Intelligent Transportation Systems (ITS) Architecture update required by the Federal Highway Administration (FHWA) is being updated in conjunction with the Smart Mobility Plan.

CIVIL RIGHTS PLANNING REQUIREMENTS

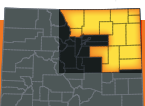
CDOT is dedicated to ensuring that no one is excluded from participation in, denied the benefits of, or in any other way discriminated against in the planning or implementation of its projects. This includes incorporating environmental justice principles that avoid, minimize, or mitigate disproportionate negative effects on low-income and minority populations, such as health, environmental, social, and economic impacts. All of the tools in the toolbox were evaluated for their contribution to social equity.

Interpretation & Translation Services

CDOT provides reasonable language assistance free of charge upon request. Contact the Civil Rights & Business Resource Center at (800) 925-3427 to make translation or interpretation requests related to this document or this planning process.



Appendix - Detailed Workshop Notes



COLORADO DEPARTMENT OF TRANSPORTATION SMART MOBILITY PLAN

REGION 4 STAKEHOLDER WORKSHOP SUMMARY

The Colorado Department of Transportation held a stakeholder workshop on Thursday, November 1, 2018, from 9:00AM to 4:00PM at the CDOT Region 4 Headquarters in Greeley, Colorado. The purpose of the workshop was to seek feedback from stakeholders as part of the Smart Mobility Plan, which will assess the readiness of the state's facilities, prepare a toolbox for future strategies, and develop regional and statewide plans for how to deploy Smart Mobility strategies.

Invitations were sent to stakeholders representing municipalities within the Region; representatives of local transit agencies; County departments; and the State of Colorado Department of Transportation. Approximately 22 participants, including key Smart Mobility staff, attended the workshop. Because the meeting was held in Greeley, there was recognition that representatives from the Eastern TPR were not in attendance for the workshop.

Bob Fifer, Business Development and Planning Manager in the ITS branch welcomed participants and briefly introduced the meeting purpose. The workshop consisted of a series of presentations and interactive activities or facilitated discussion on the following topics: Smart Mobility Plan Overview, Regional Readiness Assessment, Regional Smart Mobility Tools, ITS Architecture Coordination, Smart Mobility Policies, and Regional Smart Mobility Roadmap (see attached presentation for content presented on each topic).

The workshop concluded with a discussion on next steps, including additional opportunities for stakeholder review and input. The facilitated discussion and interactive activity questions as well as stakeholder input received is summarized below by workshop topic.





MODULE 1 – SMART MOBILITY PLAN OVERVIEW

DISCUSSION QUESTIONS/INTERACTIVE ACTIVITY PROMPTS:

1. What are you already doing related to Smart Mobility?
2. How can this Plan build upon it?

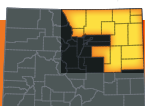
STAKEHOLDER INPUT/DISCUSSION:

- Region 4 has been on the cutting edge of technology since 2011, including adaptive signals fiber on I-76, I-25. Region 4 had the first ITS Architecture Plan in the state in 2011 and recognizes that technology will continue to evolve. The region can't build out of congestion, but can use Smart Mobility and technology/virtual solutions to improve mobility.
- Smart Mobility is being built from the regions up and will be chapter in statewide plan. Colorado is one of first states institutionalizing technology into the statewide plan.
- Farmers in Region 4 are already using autonomous vehicle technology in farming operations.
- Existing Smart Mobility related work in the region includes:
 - Freight mobility - testing now on US 85 and US 34.
 - Intelligent Transportation Systems (ITS) for signals.
 - Connectivity with TOCs - provide joint operations - emergency operations coordination.
 - Share cameras/data within region.
 - Need memorandums of understanding/inter-governmental agreements (MOUs/IGAs) to do these types of projects.
 - Road weather devices - communicates to headquarters and regions
 - Transparency on fiber build is needed.
 - State Transportation Innovation Council (STIC) grants - Road Weather Information System (RWIS) on CR 49.

MODULE 2 – REGIONAL READINESS ASSESSMENT

DISCUSSION QUESTIONS/INTERACTIVE ACTIVITY PROMPTS:

1. Review high-priority corridors using GIS tool.
2. Are there any corridors or hot-spots that are missing that should be added? Why?
3. Of identified corridors, which have highest need? Why?



STAKEHOLDER INPUT/DISCUSSION:

- State patrol would like to create weigh in motion stations- every truck carries a transponder that weighs them. Virtual weigh stations could be used to automatically fine vehicles. CDOT has a good list of where these are and in the team can add them to the tool.
- State Transportation Innovation Council (STIC) grant locations would be good to add to the tool (for example RWIS is being installed on County Road 49)
- Work zones - distracted drivers are an issue in the region.
- MPO has identified 27 corridors which should be referenced for regional Smart Mobility priority locations.
 - Coordinate fiber along Larimer County Road - I-70.
- Parallel arterials to state system are priority locations for smart mobility solutions- communication is needed on traffic detours/closures.
- Congestion, freight, capacity are issues on corridors across the region.
- SH 402 to SH 14 slated for ramp metering.
- Intersection prioritization study should also be referenced for priority intersections.
- SH 14 from I-76 to I-25/Fort Collins serves as a relief route for I-76 and is a priority location.
- All state facilities in the region shall be priority candidates for Smart Mobility solutions.

MODULE 3 - REGIONAL SMART MOBILITY TOOLS

DISCUSSION QUESTIONS/INTERACTIVE ACTIVITY PROMPTS:

1. Identify which tools to implement where.
2. Identify and apply any missing tools.

STAKEHOLDER INPUT/DISCUSSION:

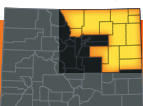
(Note- please see Figure 4 map and table above for Smart Mobility tools identified by corridor/location within this region.)

General Discussion:

- Wireless connection/fiber are needed for some tools but not all (prerequisites are identified in the solutions toolbox).
- CDOT is working with Google/Waze to route people based on construction/incidents. Local governments are hitting roadblocks with Google/Waze- CDOT can help.
- Lots of areas in region with rail crossings- some trains that stay for hours/days (would not want continuous notification in these cases).
- Regional Issues/Tools
 - Need to get infrastructure in place- fiber currently is not there- possibility to get fiber or radio communication- need communication.
 - Huge diversity in weather- need communication.



- Work Zones- use technology to reduce distractions, identify and communicate work zones.
- Better information is needed on tools that are out there such as existing RWIS, ITS, who's responsible, who owns it, who's responsible to repair it, fix it correctly.
- Lane departure- can use virtual guardrail- something besides physical rumble strip- to give people warnings before they leave roadway and cause a crash.
- Curve warning devices- highways go from straight to 90 degree turns and people are going too fast to safely navigate these (applies to SH 71, SH 385).
- Stop Sign Gap Assist- signs that are lower cost to detect if you have enough spacing to get across intersection- reduce the amount of crashes at county road/highways, county road/county roads.
- Funding available for High-Risk-Rural Roads- look at M&O component to implement solutions.
- Urban Issues/Solutions
 - Users include freight, vehicles, bike/ped.
 - Congestion is the number one issue - have ramp metering - all ramps along I-25
 - Tool #43 - reservation based intersection.
 - Tool #15 - automated traffic signal.
 - Dynamic route assignment but no freight along local roads - Alts to I-25 (#12).
 - Fast charging/dynamic charging should be considered as a new tool to add on I-25/US 85.
 - Congestion pricing could apply to I-25 in urban areas but may be unpopular.
 - Safety
 - Have 3 ramp meters- run them a dozen weekends a year- manually
 - Adaptive/coordinated signal control was recommended.
 - Many roads in region have no shoulder areas for safe emergency parking needed during crashes.
 - Queue detection recommended on- 392, I-25 - automated, dynamic signal timing.
 - Tool #2- pedestrian detection- was recommended to improve safety.
 - Distracted drivers/vehicles without connectivity may pose safety issues.
 - Need for operations and maintenance funding/training.
 - Should move from reactive to proactive deployment- obtain funding based on issues rather than after the fact based on collisions/fatalities.
 - US 287, I-25, US 85, US 34 - Spot weather warning (#19) and RWIS (#9) were recommended.
 - Transit
 - Transit ITS - (see last R4 ITS arch)
 - TSP in Fort Collins, Greeley, Loveland transit system recommended (Tool #1).
 - Positive train control recommended at rail crossings.
 - Recommendation to integrate the transit systems in the region.
 - Consider including on vehicle technology such as Automatic Vehicle Location (AVL).
 - Tool #14 - left-turn assist recommended to improve transit flow.



- Smart work zone management - people ignore it because they don't see people working. Should have better real-time information.
- Wildlife detection - Tool #34 recommended west of Loveland.
- Improved communication is needed between cities, CDOT R4, HQ - TOC, TMC, regarding permits, etc.
- Data sharing, integration - regular ITS quarterly meetings/coordination.
- Virtual weigh station at port of entry on I-25.
- Concentration of bikes/pedestrians near university - Fort Collins. Tool #2 pedestrian detector recommended at intersections in this location.

MODULE 4 - ITS ARCHITECTURE COORDINATION

DISCUSSION QUESTIONS/INTERACTIVE ACTIVITY PROMPTS:

1. Update regional stakeholders (note- a handout was distributed to obtain information on regional stakeholders and projects)
2. Review Regional Needs - Projects

Stakeholder Input/Discussion:

- Participants asked if the ITS interview/questionnaire results will be shared.
 - The ITS interview/questionnaire results will be summarized and will inform the ITS architecture and will be shared.

MODULE 5 - SMART MOBILITY POLICIES

DISCUSSION QUESTIONS/INTERACTIVE ACTIVITY PROMPTS:

1. Are there policies and procedures that support/ hinder this Plan?
2. How do you see the Smart Mobility Plan integrating into current CDOT processes?
3. How and when do you use the tool, and what does it do for you?
4. What opportunities are there to fund technology?
5. What support do you need to advance interoperability in your region?

STAKEHOLDER INPUT/DISCUSSION:

- Policies/procedures that could support Smart Mobility:
 - Struggle, need to address roads, pavement, and physical needs before technology can be considered.
 - Focus on physical needs, no funding for ITS/Smart Mobility.
 - Technology changes fast and may become obsolete. Need to determine when to revisit Smart Mobility Plan.



- Policies/procedures that can support/create opportunities for Smart Mobility
 - Smart Mobility can be incorporated in TSMO process - request it before scoping.
 - Can use tool to identify safety solutions.
 - Safety funding can be used if there's safety component.
 - Use tool to make data accessible, transparent.
 - Smart Mobility tool/Plan should have goals, reference but not specific. technology/vendor as specifics can change.
 - Refresh technology/plan every year - be nimble for future.
- Funding:
 - ITS budget may be available for Smart Mobility solutions.
 - Need additional information and knowledge base for available funding, for example rural funding opportunities.
 - Can shift funding that's already there - to have a better balance between technology and physical infrastructure funding.
 - Federal funds for ITS may be used for Smart Mobility.
- Interoperability
 - Templates for inter-governmental agreements and memorandum of understanding (IGAs, MOUs) would be useful to support interoperability and clarify who owns, operates and repairs Smart Mobility solutions.
 - A smart technology/ITS consortium could be set up with regular meetings to facilitate knowledge sharing and interoperability.

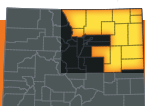
MODULE 6 - REGIONAL SMART MOBILITY ROADMAP

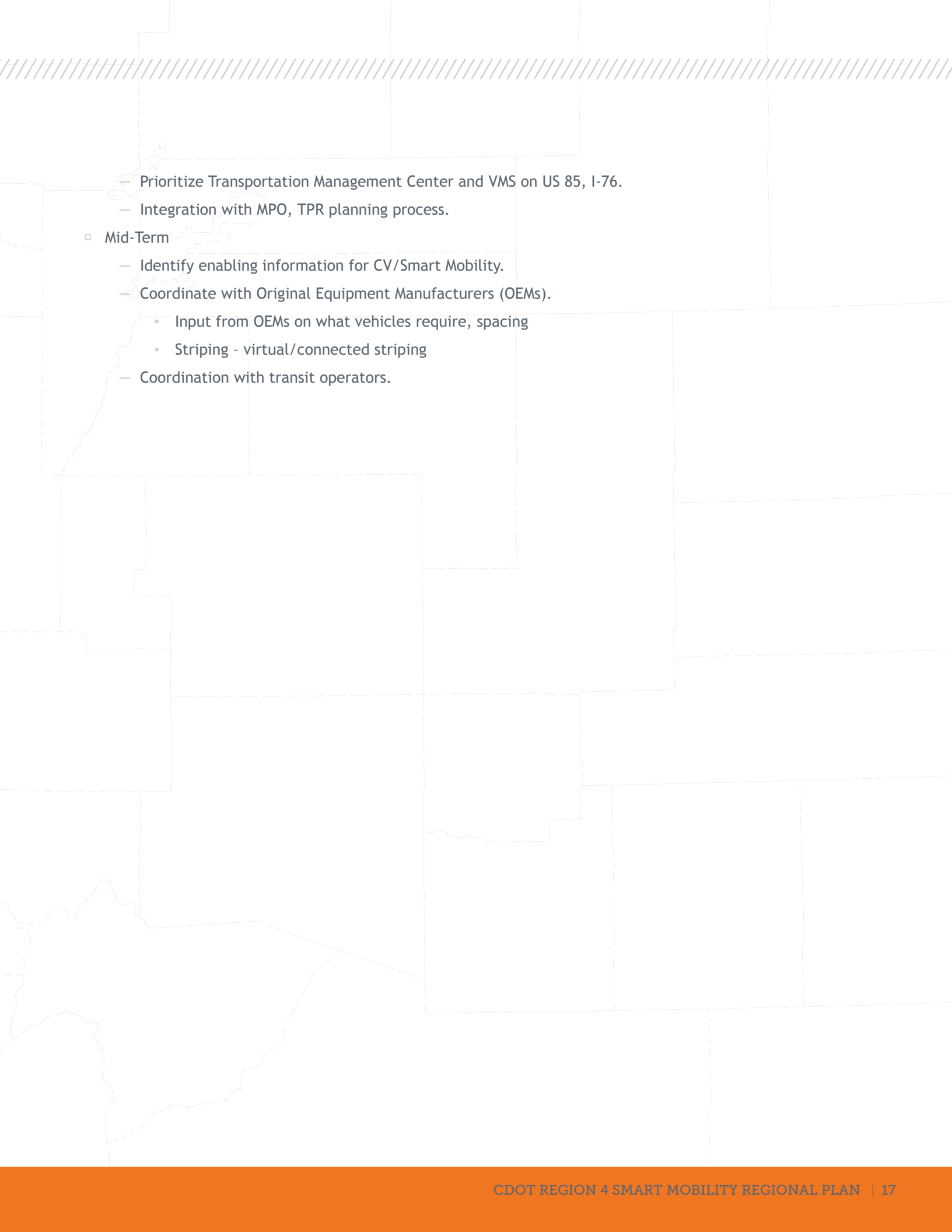
DISCUSSION QUESTIONS/INTERACTIVE ACTIVITY PROMPTS:

1. Develop an individual Roadmap for implementation
 - Near Term - 0-2 Years
 - Mid Term - 2 - 5 Years
 - Long Term - 5+ Years
2. Regroup to develop a collaborative Roadmap

STAKEHOLDER INPUT/DISCUSSION:

- Short-Term
 - Identify champion for ongoing Smart Mobility implementation - potentially region TE.
 - Refer to Smart Mobility Plan as part of project development process.



- 
- Prioritize Transportation Management Center and VMS on US 85, I-76.
 - Integration with MPO, TPR planning process.
 - Mid-Term
 - Identify enabling information for CV/Smart Mobility.
 - Coordinate with Original Equipment Manufacturers (OEMs).
 - Input from OEMs on what vehicles require, spacing
 - Striping - virtual/connected striping
 - Coordination with transit operators.