



Regional Transportation Operations and Technology Strategic Plan

February 2023



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Executive summary

The purpose of the Regional Transportation Operations and Technology Strategic Plan is to guide the Denver Regional Council of Governments' efforts to deploy technology, tools and coordinated system procedures to manage the multimodal transportation system. Regional Transportation Operations and Technology is a set of tools and processes used by public and private operating agencies' staff to meet the day-to-day demands of the traveling public.

Thousands of transportation operations staff work to provide the best mobility services and facilities to people and businesses across the region every day. Snowplow drivers, rail and bus operators, maintenance crews, emergency responders, traffic management center staff, law enforcement personnel, Regional Transportation District dispatchers, shared mobility providers and **many** others all work tirelessly to keep the transportation system operating safely and efficiently. Maintaining reliable operations also requires monitoring performance over time to improve service and to account for changes in transportation demand.

This plan examines existing challenges to transportation operations in the region and identifies a vision, goals and objectives for regional transportation operations and technology. Performance measures will be used to track progress. Several strategic initiatives are defined that will subsequently guide investments for the deployment of system operation projects. One of the first set of investments will be defined through DRCOG's Regional Transportation Operations and Technology Transportation Improvement Program Set-Aside funding program in 2023.

The vision for the Regional Transportation Operations and Technology Strategic Plan is:

Transportation systems serving all travel modes across the DRCOG area are interconnected, collaboratively operated, managed and maintained to optimize safe, reliable and efficient travel for all system users, contributing to the region's economic prosperity and high quality of life.

Exhibit 1: Goals for Regional Transportation Operations and Technology Strategic Plan

Safe operations	Efficient, seamless travel	Travel time reliability	Equitable access	Environmental sustainability
<p>Physical and technological improvements and intentional operations management deployed to both reduce crashes and achieve zero fatalities.</p>	<p>Interconnected systems across jurisdictions and modes are actively and cooperatively managed to optimize operator situational awareness, provide accurate and timely traveler information and allow collaborative transportation systems operation.</p>	<p>Multimodal travel times are monitored in real-time and operations are managed to limit disruptions affecting travel time reliability.</p>	<p>People of all ages, abilities, languages, backgrounds and incomes have access to safe and reliable mobility options.</p>	<p>Apply technology, services and operations that reduce energy consumption, improve air quality and reduce greenhouse gas emissions.</p>



Existing challenges to the optimal effectiveness of regional transportation operations and technology include:

- Real-time operational strategies are not effectively and comprehensively coordinated among jurisdictions and agencies and between modes.
- Common standards and procedures to share data and integrate systems have not been adopted.
- Resources to actively manage transportation systems in real-time are lacking in some jurisdictions.
- Multimodal traveler information sources in the region are not well integrated, hindering travelers' decision-making capabilities.
- Operational performance measures are not universally and systematically used to improve travel reliability.
- The condition of the region's multimodal transportation system facilities and equipment is not monitored comprehensively.

To achieve significant progress towards the goals, 20 strategic initiatives listed below are described in the action plan. They are grouped into three priority levels. The primary initiatives include large-scale regional systems and operational procedure efforts to serve as the foundation for more topically specific secondary initiatives. Further tertiary initiatives will address precise products and functions.

Primary initiatives:

- Develop a Regional Situational Awareness platform.
- Develop processes to share traffic camera view and control between jurisdictions and public safety.
- Develop a Regional Performance Monitoring Data Archive platform.
- Develop strategies and processes to coordinate performance-based management.
- Deploy additional supporting transportation surveillance and control systems and infrastructure.
- Develop Traffic Incident Management standard operating procedures.
- Standardize and implement transit signal priority performance management and system optimization procedures.

Secondary initiatives:

- Develop evacuation and recovery plans and exercises.
- Develop processes to coordinate traveler information messaging across the region.
- Develop active work zone monitoring and management in the field.
- Deploy additional safety-focused technology applications.

- Expand the Regional Performance Monitoring Data Archive platform.
- Expand the Regional Situational Awareness platform.
- Expand transit signal priority deployment.

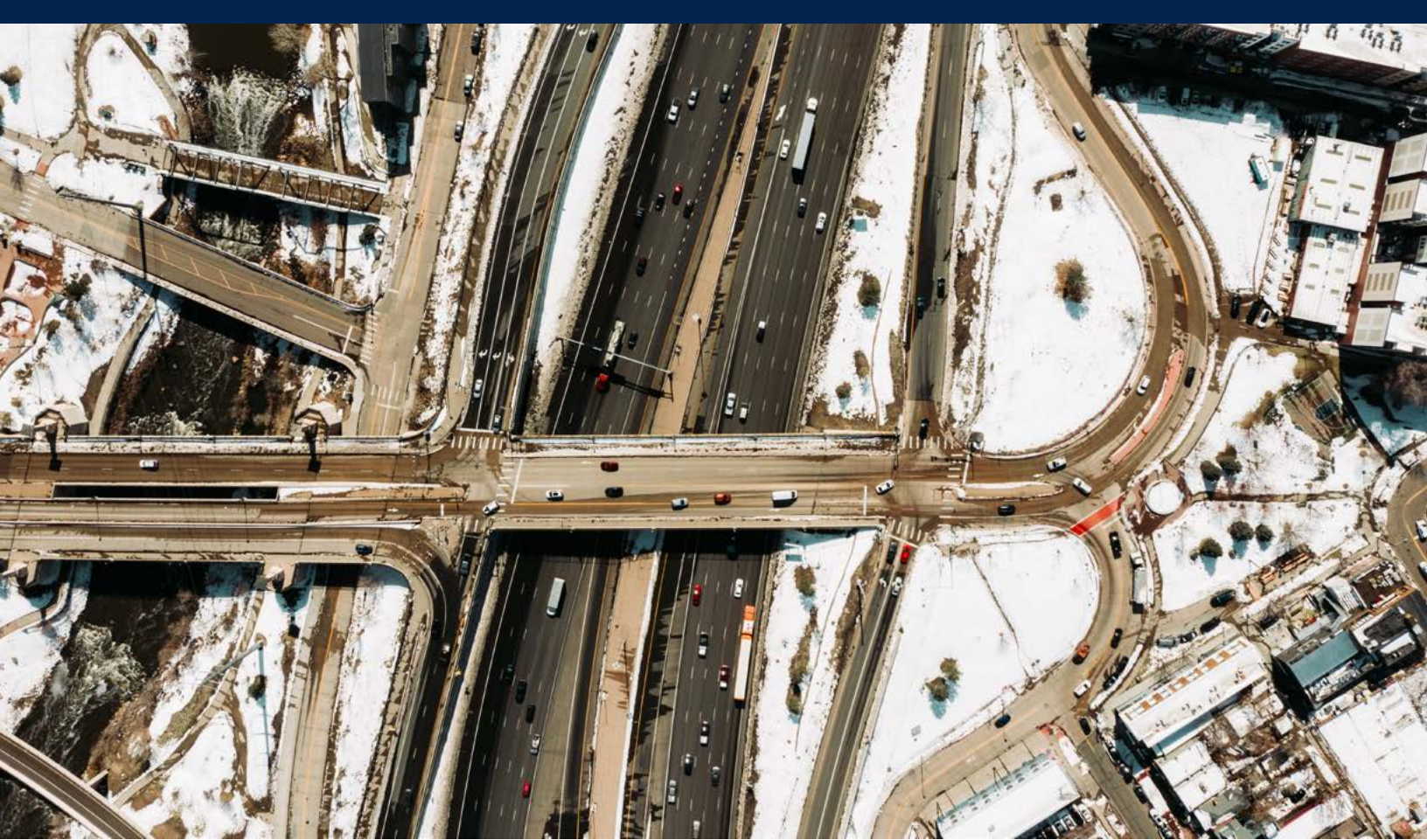
Tertiary initiatives:

- Develop a Regional Multimodal Traveler Information platform.
- Develop a process to monitor regional parking availability, capacity and pricing.
- Develop a multimodal trip planner and reservation/payment system.
- Develop and deploy dynamic ride-sharing.
- Develop and implement curbside management standards.
- Develop continuity of operations plans.

Technology alone does not address problems directly but can facilitate coordinated systems and improved operational procedures. A regional approach to data management and information sharing is emphasized in this plan. Improved data and information sharing procedures affords operators greater situational awareness of real-time conditions. The Denver region will benefit from greater access to real-time traveler information and greater knowledge of the available mobility options. A regional data governance structure that ensures data interoperability, cybersecurity and user privacy is essential for achieving maximum benefits.

It is also recognized that each jurisdiction and agency in the region has varying needs and resource capacities to address the initiatives. The evaluation and selection process for the upcoming Regional Transportation Operations and Technology Transportation Improvement Program Set-Aside Call for Projects will consider the interdependence of the initiatives and the relative importance of the functions resulting from proposed projects.

Several initiatives identified will require regional-level approaches to how they are administered. Presently there are a wide variety of unique systems used across the region. Thus, there is a limited level of direct system integration and coordination. Real-time awareness of regional conditions is sometimes lacking or segmented between jurisdictions and agencies. Having an overarching understanding of real-time transportation situations supports jurisdictions of all sizes and capabilities while improving mobility for all travelers. DRCOG staff will lead the stakeholders in refining the requirements for specific initiatives and evaluating implementation options, including the possibility for DRCOG to be the operational lead or the owner.



Introduction

Purpose

The purpose of the Regional Transportation Operations and Technology Strategic Plan is to guide the Denver region's efforts to deploy technology tools and coordinated system procedures to manage the multimodal transportation system. These efforts will assist transportation operations staff in serving daily travel demands across the region.

On an average day in the Denver region, people make more than 15 million trips across all travel modes. This Regional Transportation Operations and Technology Strategic Plan will help improve the economic vitality and quality of life for people traveling to jobs, health care facilities, schools, shopping, recreation and many other purposes. Businesses use the same transportation system for shipping, deliveries and other services.

Travel on the street and highway system results in thousands of hours of disruptive and often unexpected congestion delays every day. Contributing to the daily disruptions are an average of 200 crashes per day. Crashes represent a critical public safety issue for not only travelers but also the teams of first responders attending to the crashes.

This plan details goals, objectives, performance measures, concepts and initiatives that will subsequently guide investments for the deployment of system operation projects. One of the first sets of investments will be defined through DRCOG's Regional Transportation Operations and Technology Transportation Improvement Program Set-Aside funding program in 2023.

What is regional transportation operations and technology?

Regional transportation operations and technology is the set of tools and processes used by public and private operating agencies to meet the day-to-day demands of the traveling public. Multiple independent transportation systems and processes must be managed and coordinated to provide safe and efficient mobility for all travelers. Additionally, operators must be prepared to address both planned and unplanned disruptions in the network to optimize performance. Admittedly, much of the traveling public may not even be aware of the extent of these transportation operations activities except on days when things go poorly and are not meeting travelers' expectations.

Day-to-day operations

Thousands of transportation operations staff work to provide the best mobility services and facilities to people and businesses across the region every day. Snowplow drivers, rail and bus operators, maintenance crews, emergency responders, traffic management center staff, law enforcement personnel, Regional Transportation District dispatchers, shared mobility providers and many others all work tirelessly to keep the transportation system operating safely and efficiently. Enhancing traveler safety, improving reliability and reducing severe traffic congestion for the transport of persons, goods and services are the overarching goals of this plan. Leveraging technology and systems, transportation operations staff continually monitor operations to quickly identify and address disruptions, such as:

- Issues with control systems (such as equipment or communication failures) may arise that disrupt the ability of operators to monitor and manage operations.
- Scheduled construction/work zones or other scheduled events.
- Bus and rail services disrupted by staffing shortages or mechanical issues.
- Crashes or unplanned events that represent both emergency safety conditions as well as travel disruptions.

Once detected, operations staff follow maintenance and management procedures to address system issues, deploy supporting operations strategies, distribute traveler information and directly support first responders at traffic incidents.

Data analytics and planning

Maintaining reliable operations also requires monitoring performance over time to improve service and to account for changes in transportation demand. Transportation systems collect extensive data and provide many tools that provide quicker and more robust analyses. The performance measurement information is used to adjust operations to enhance safety and efficiency.

Additionally, data collected while providing transportation services is becoming a powerful resource in transportation planning activities such as corridor studies, safety analyses and transit service planning.

Regional guidance

The Regional Transportation Operations and Technology Strategic Plan is built on the foundation of other regional plans.

Metro Vision

Metro Vision is the Denver region's plan for continued success. The most basic purpose of the regional plan is to safeguard for coming generations the region's many desirable qualities. One of the five overarching themes states:

“The Denver region aspires to have a connected multimodal region that provides everyone with viable travel choices.”

The two regional outcomes defined in Metro Vision that relate closely to regional transportation operations and technology are:

- The regional transportation system is well-connected and serves all modes of travel.
- The transportation system is safe, reliable and well-maintained.

To achieve these outcomes, several Metro Vision objectives related to transportation operations are defined as:

- Improve and expand the region's multimodal transportation system, services and connections.
- Improve the capacity of the multimodal regional roadway system.

- Improve the region's comprehensive transit system.
- Improve bicycle and pedestrian accessibility.
- Improve interconnections of the multimodal transportation system within and beyond the region for people and freight.
- Expand travel demand management services and strategies.
- Operate, manage and maintain a safe and reliable transportation system.
- Maintain existing transportation facilities in good condition.
- Improve transportation system performance and reliability.
- Improve transportation safety and security.

Mobility Choice Blueprint

The Mobility Choice Blueprint (published in 2019) was a collaborative effort of DRCOG, the Regional Transportation District, the Colorado Department of Transportation and the Denver Metro Chamber of Commerce. It focused on technology strategies to help maximize safety and mobility choices for people in the region. The document was developed through an integrated approach that identified 34 tactical actions to leverage technology and improve coordination between the region's transportation partners.

The Advanced Mobility Partnership was established to assist with implementation of the Mobility Choice Blueprint. The Advanced Mobility Partnership is facilitated by DRCOG staff and has emphasized the following operational tactical actions:

- Establish a regional mobility data-sharing platform.
- Establish data-sharing requirements for private-sector roadways users.
- Develop a universal mobility app for trip planning and payment.
- Implement curbside management standards.
- Pilot neighborhood scale mobility hubs.
- Implement transit priority on all major bus corridors.
- Implement smart traffic signal control technology on all major regional arterial corridors.
- Pilot integrated corridor management on ten arterial corridors.
- Coordinate traffic management center systems and operations.

The Advanced Mobility Partnership serves as a forum for information sharing and coordination between the partner agencies and other stakeholders that are responsible for implementing and operating transportation systems.

Regional Transportation Operations and Technology planning framework

The goals and objectives for the Regional Transportation Operations and Technology Strategic Plan flow from the following vision statement:

Transportation systems serving all travel modes across the Denver region are interconnected and collaboratively operated, managed and maintained to optimize safe, reliable and efficient travel for all system users, contributing to the region’s economic prosperity and high quality of life.

Regional transportation operations and technology goals

Based on the Regional Transportation Operations and Technology Strategic Plan vision statement, the specific topical goals described below in Table 1 were defined.

Table 1: Operations goals for the multimodal regional transportation system

Safe operations	Efficient and seamless travel	Travel time reliability	Equitable access	Environmental sustainability
Physical and technological improvements and intentional operations management deployed to both reduce crashes and achieve zero fatalities.	Interconnected systems across jurisdictions and modes are actively and cooperatively managed to optimize operator situational awareness, provide accurate and timely traveler information and allow collaborative transportation systems operation.	Multimodal travel times are monitored in real-time and operations are managed to limit disruptions affecting travel time reliability.	People of all ages, abilities, languages, backgrounds and incomes have access to safe and reliable mobility options.	Apply technology, services and operations that reduce energy consumption, improve air quality and reduce greenhouse gas emissions.

Regional transportation operations and technology objectives

Ten objectives were defined and will be measured over time to track progress toward achieving associated goals. The objectives, corresponding goals and performance measures are defined in Table 2.

Table 2: Regional transportation operations and technology objectives and performance measures

Objectives	Performance measures
Improve safety and reduce crashes, fatalities and injuries.	Fatalities and serious injuries – by all modes of travel and by demographic traits.
Reduce annual average emergency responder struck-by incidents.	Number of responders or equipment struck by motor vehicles.
Reduce average incident duration and disruption.	Roadway travel lane clearance time Full incident clearance time.
Reduce occurrence of secondary incidents.	Number of secondary incidents.
Improve air quality by reducing transportation-related emissions.	Air quality monitors and modeled emissions of pollutants.
Improve operator and traveler decision-making capabilities.	Analytics to be defined.
Maximize transportation operations infrastructure reliability and availability.	Frequency of failures Time to repair.
Improve transit operations performance.	On-time standards (fixed and dynamic). Trip availability.
Increase trip time reliability for all travelers.	Percentage of person-miles traveled that are reliable. Truck travel time reliability index.
Minimize traveler delay due to system operations and disruptions.	Annual hours of peak-hour excessive delay per capita.

Note: A “responder struck-by” incident is a collision between a motor vehicle in transit and a responder working a roadway incident. The responder may be a nonmotorist, an occupant of a stopped response vehicle or an unoccupied response vehicle.

Current state of regional transportation operations

Regional transportation operations involve a complex combination of several systems and services working simultaneously. To simplify their description, this section is arranged into 10 transportation service areas – natural focus areas relevant to daily real-time transportation management. The transportation service areas are:

- Freeway management.
- Arterial management.
- Traffic Incident Management
- Regional traveler information.
- Transit operations.
- Emergency management.
- Maintenance and construction.
- Travel demand management.
- Parking management.
- Data management.

The descriptions below are a summary of existing deployment efforts, responsible agencies and key infrastructure components. More details description of roles and responsibilities of the envisioned operations is presented in the appendix.

Freeway management service area

The freeway management service area covers the freeways under the Colorado Department of Transportation's responsibility as well as tollways under the responsibility of the public highway authorities.

- The public highway authorities (E-470 and the Northwest Parkway) independently operate and maintain the infrastructure and systems on their respective tollways. All toll collection systems technology in the state are compatible with state legislation. (Colorado Revised Statutes § 42-4-1012 (1) (d).)

In CDOT, several units share responsibilities for deployment, operation and maintenance of the infrastructure and systems used to monitor and control freeway operations, including the following:

- Figure 1 illustrates an extensive network of freeway travel data collection devices deployed and maintained by the CDOT Intelligent Transportation Systems and Network Services branch.
- Figure 2 illustrates the deployment of nearly 500 traffic cameras on freeways and tollways in the region. CDOT Intelligent Transportation Systems and Network Services is responsible for deploying and maintaining the freeway traffic cameras while the public highway authorities are responsible for their own cameras.
- Nearly 600 dynamic message signs (see Figure 3) are deployed across the region. The bulk are owned by CDOT, and most are deployed as part of Express Lane toll operations and active traffic management on select corridors.

Figure 1: CDOT travel data detectors

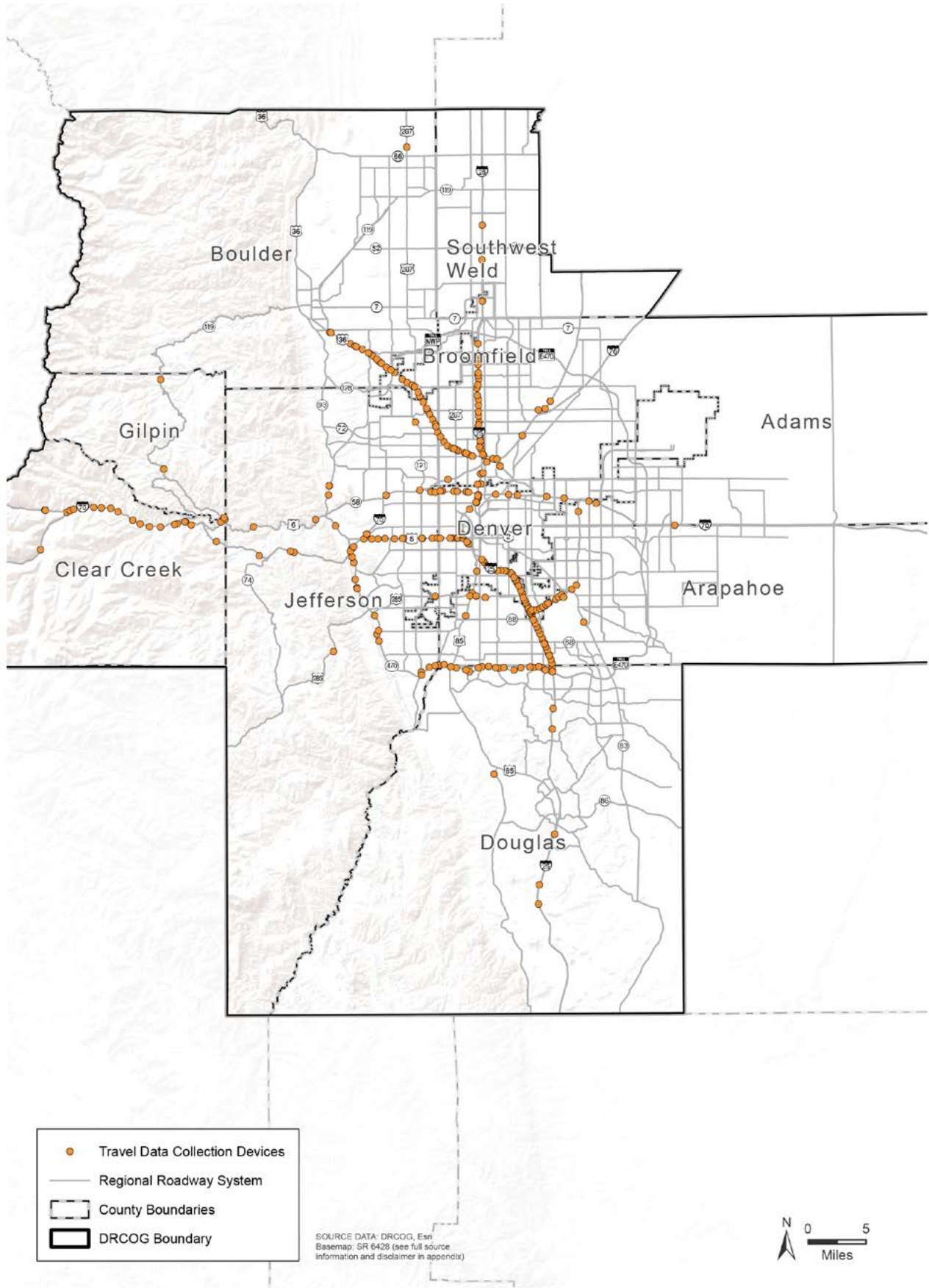


Figure 2: CDOT and Public Highway Authority traffic cameras

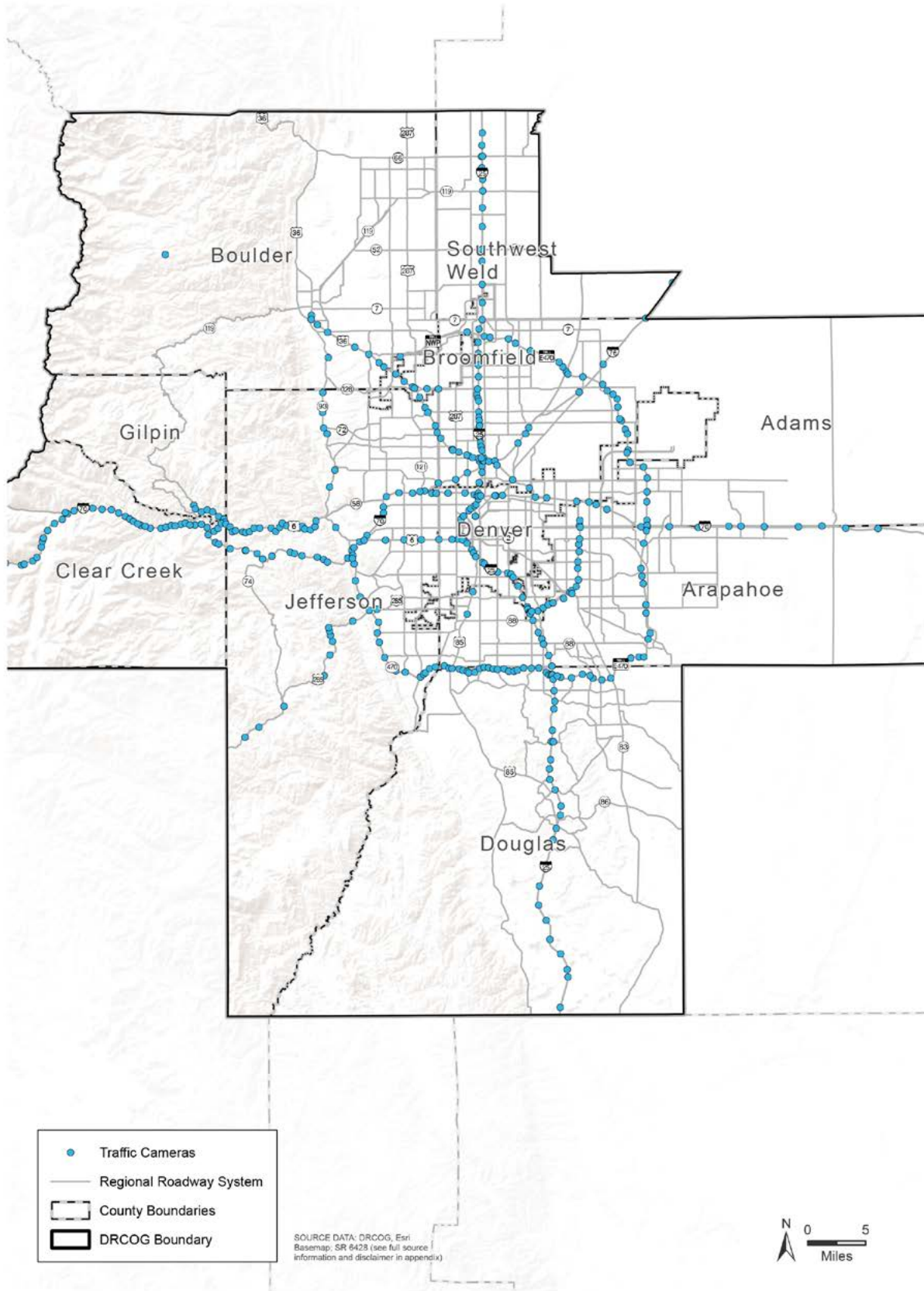
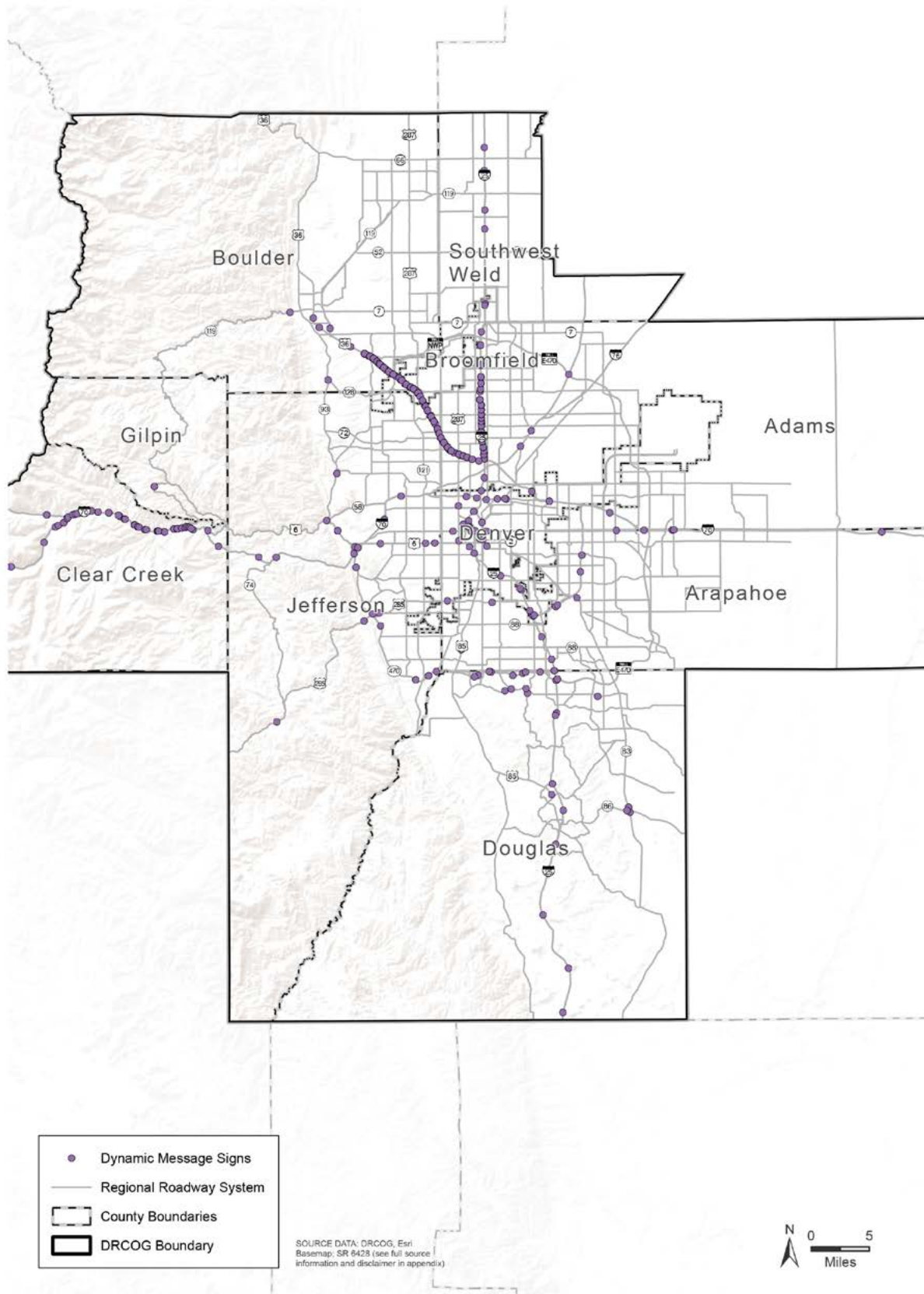
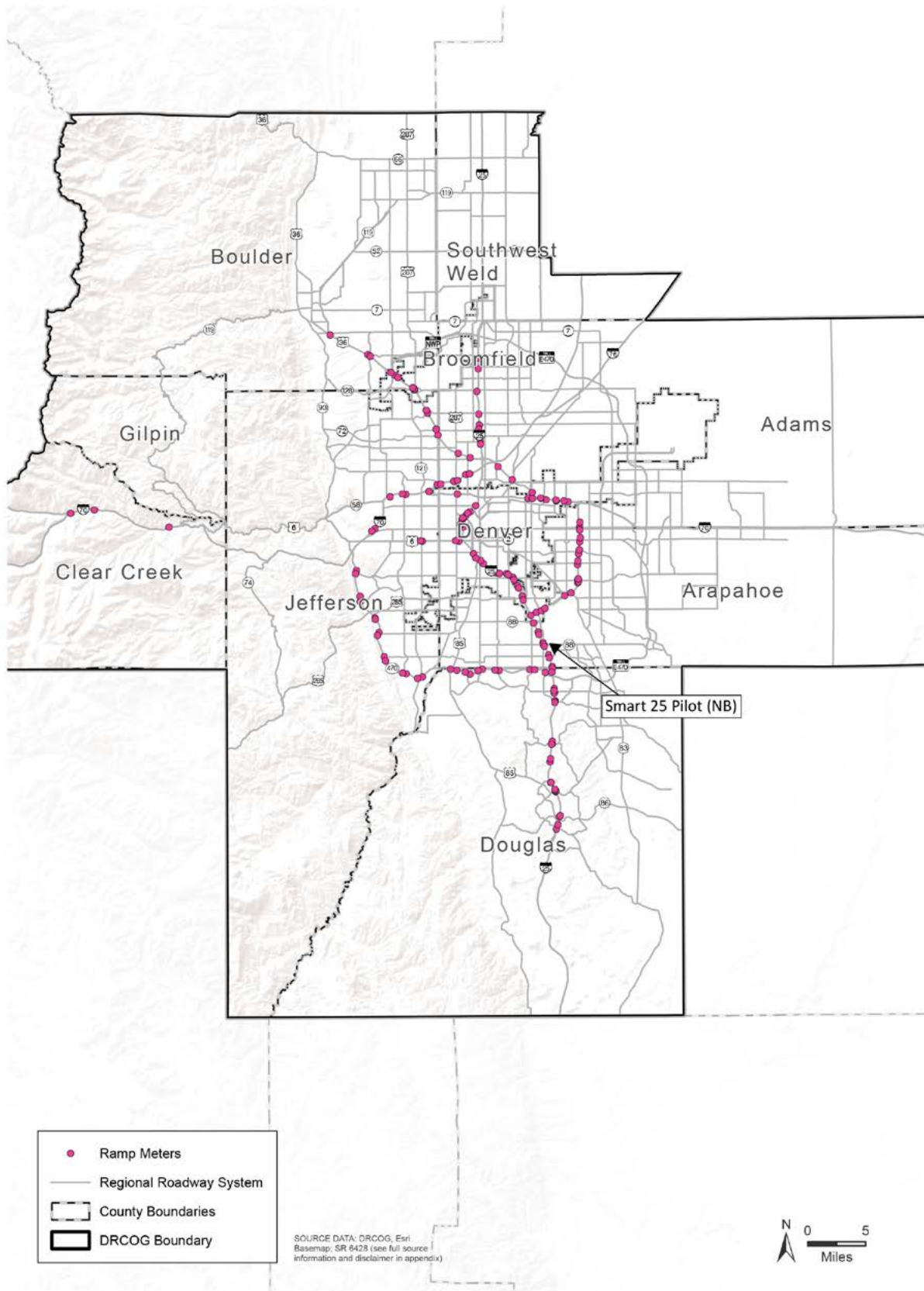


Figure 3: Dynamic message signs



- The Colorado Transportation Investment Office is responsible for deployment, operation and maintenance of toll system infrastructure on the freeways in the region.
- The CDOT Real-Time Operations Services branch operates the freeway infrastructure and systems:
 - CDOT operates several traffic management centers across the state, which are all connected to roadside and field infrastructure via hundreds of miles of fiber optic communications networks deployed and maintained by CDOT Intelligent Transportation Systems and Network Services branch.
 - The Colorado Traffic Management Center in Golden houses the statewide Advanced Transportation Management System and the statewide Video Management System used to manage the freeways in the DRCOG region. CDOT's traveler information system is also controlled by the Colorado Traffic Management Center.
 - Colorado Traffic Management Center operators monitor and control freeway operations, including managed lanes, peak-period shoulder use and active traffic management corridors. Additionally, Colorado Traffic Management Center operators have access to data, analytics and decision support tools to augment performance monitoring and decision-making capabilities.
- CDOT Region 1 operates and maintains the ramp metering system. Figure 4 illustrates nearly 170 ramp meters in the Denver region. A pilot for a new ramp meter control strategy (Smart 25) is complete and its benefits are being evaluated.
- The CDOT Office of Innovative Mobility has deployed freeway-connected vehicle infrastructure. Over 100 roadside units have been installed along portions of the U.S. Interstate 70 mountain corridor and the C-470 Express Lanes with several hundred more planned for other freeway corridors. On-board units have been installed on snowplows and other CDOT fleet vehicles. CDOT staff are collecting connected vehicle basic safety messages and storing the data in CDOT's data ecosystem. Applications using and analyzing the connected vehicle data are in development.

Figure 4: Ramp meters



Arterial management service area

For decades, regional partners have coordinated arterial (arterial streets are roadways that are neither freeways nor tollways and may include local streets and highways) operations by deploying, operating and maintaining traffic signal control systems, signal controllers and communications systems to provide base-level signal control, the foundation for inter-jurisdictional signal coordination. Traffic signal system infrastructure deployment includes the following:

- CDOT Regions One and Four, plus 36 local jurisdictions have deployed traffic signals along major arterials, streets and highways at over 4,000 intersections and mid-block pedestrian crossings. As illustrated in Figure 5, each entity has a traffic signal control system and an associated communications system to monitor and control their signals except for the City of Edgewater, the City of Federal Heights, the Town of Frederick, the City of Golden and the City of Sheridan.
- The City of Wheat Ridge and Boulder County have legacy traffic signal control systems with no communications to their signals.
- About 86% of all traffic signals are interconnected with a traffic signal control system while 94% of the Regional Roadway System are interconnected.
- As a service to the regional partners, DRCOG staff develop inter-jurisdictional signal timing coordination plans. Staff from local jurisdictions and CDOT regions deploy and maintain these time-of-day plans as part of daily operations.

Base-level traffic signal control requirements

- Provide automatic synchronization to Coordinated Universal Time to minimize clock drift.
- Provide reliable upload/download of timing/coordination parameters.
- Provide for backup time-based coordination operation.
- Provide remote access to system databases.
- Provide real-time and reliable monitoring of signal system and intersection operations.
- Provide error detection and automatic reporting.
- Provide uninterruptible power at critical intersections where power reliability is poor.

Several jurisdictions are building from this foundation towards more advanced arterial operations by deploying travel data collection systems (such as inductive loop detectors, microwave detectors, video detectors, Bluetooth/WiFi detectors, road/weather detection stations, connected vehicle roadside units, etc.) and traffic camera systems to improve operator situational awareness and decision-making capabilities.

Expanded travel data collection systems and traffic camera systems facilitate advanced arterial management strategies, including:

- **Signal preemption:** Signal system immediately turns signals red for all approaches other than that for approaching emergency vehicle or train.
- **Priority signal control:** Signal systems automatically adjust phase timing based on detection of an authorized vehicle (especially transit) to minimize signal delay to that vehicle.
- **Pedestrian and bicycle phasing:** Pedestrian and bicycle detection prompts specific phases in traffic signal controllers.
- **Traffic responsive signal control:** Traffic signal controllers react to approaching traffic by selecting the most suitable signal timing plan stored in the controller.

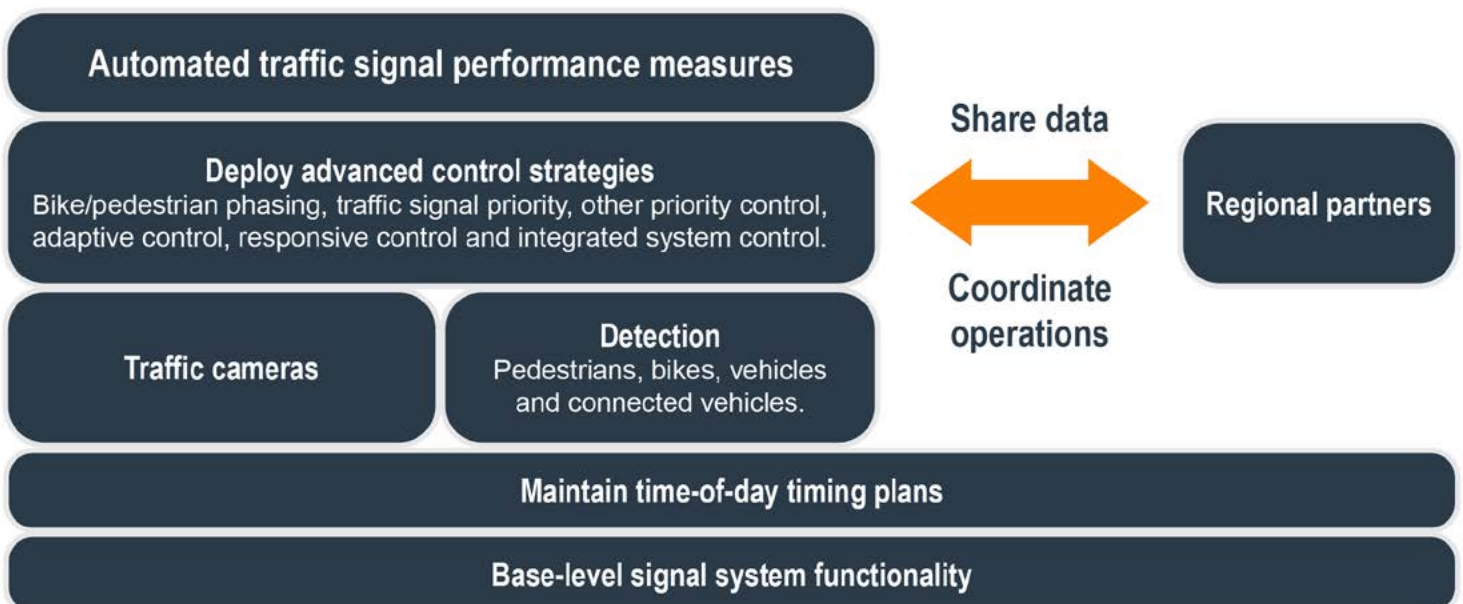
- **Traffic adaptive signal control:** Traffic signal controllers react to approaching traffic by continually adjusting signal phasing to accommodate demand in real time.

- **Direct system integration:** Neighboring traffic signal systems are integrated to allow shared monitoring and, potentially, control.

The existing deployment of advanced transportation system elements includes the following:

- Nearly 200 intersections are equipped with bicycle detection. When bicycles are detected, special signal phases are activated to serve the bicycle movement through the intersection. Similarly, staff from the City and County of Denver is piloting deployment of passive pedestrian detection at select intersections to improve safety by activating and extending pedestrian signal phases, as required.

Exhibit 2: Deployment strategy building from existing foundation



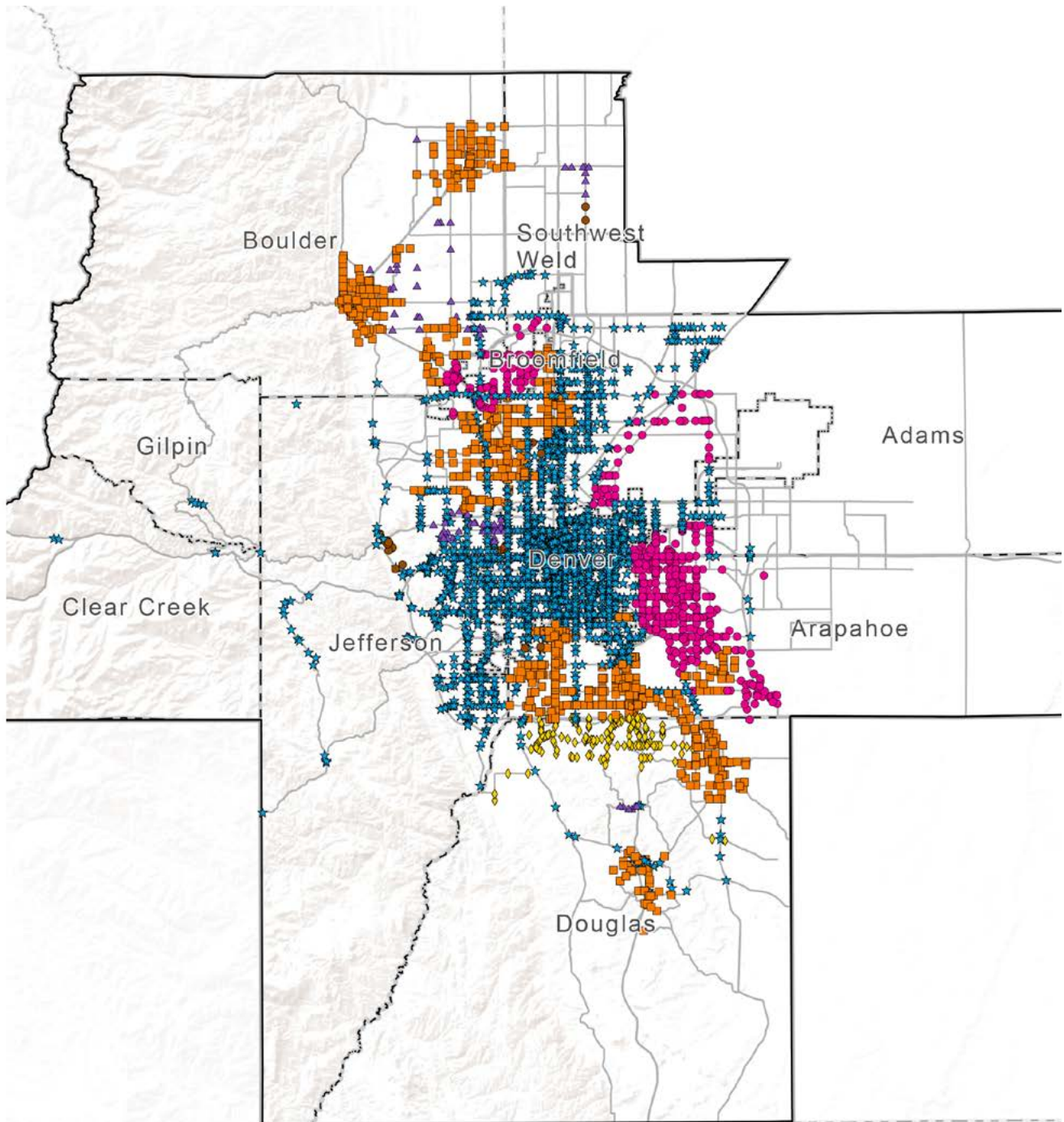
- Figure 6 illustrates the deployment of travel data collection systems on arterial roadways by 16 jurisdictions, including CDOT Region 1. Three different (and incompatible) types of arterial travel data collection systems have been deployed. CDOT staff have deployed a server that replicates data from several jurisdictions, allowing multijurisdictional monitoring for authorized users.
- Twenty-one jurisdictions have deployed more than 1,300 traffic cameras (Figure 7) on arterial roadways. Nine different video management systems have been deployed. There is no traffic camera control sharing between entities, while there is limited sharing of video snapshots and fixed video streams.
- About two-thirds of the controllers in the region can provide the high-resolution data necessary for automated traffic signal performance measure operations, but only CDOT Region 1 and the City of Lakewood employ automated traffic signal performance measure in a limited fashion. Several automated traffic signal performance measure system deployments (Figure 8) are in progress. The Town of Castle Rock's automated traffic signal performance measure project, in partnership with the CDOT Office of Data Management and the CDOT Intelligent Transportation Systems and Network Services branch, is developing a model

for sharing automated traffic signal performance measure data between entities at a regional scale within CDOT's data ecosystem.

- Staff from the City and County of Denver have deployed connected vehicle roadside unit infrastructure at several intersections and installed on-board units on several fleet vehicles including snowplows and some Regional Transportation District buses. Staff from the City and County of Denver is collecting connected vehicle basic safety messages and storing the data in Denver's data ecosystem. Applications using and analyzing the connected vehicle data are in development.

Finally, CDOT Region 1, the City and County of Denver and the City of Lakewood have directly integrated traffic signal control systems allowing select real-time operational data to be shared. Several jurisdictions, led by the City of Centennial, are in the process of integrating their traffic signal control systems.

Figure 5: Traffic signal control systems

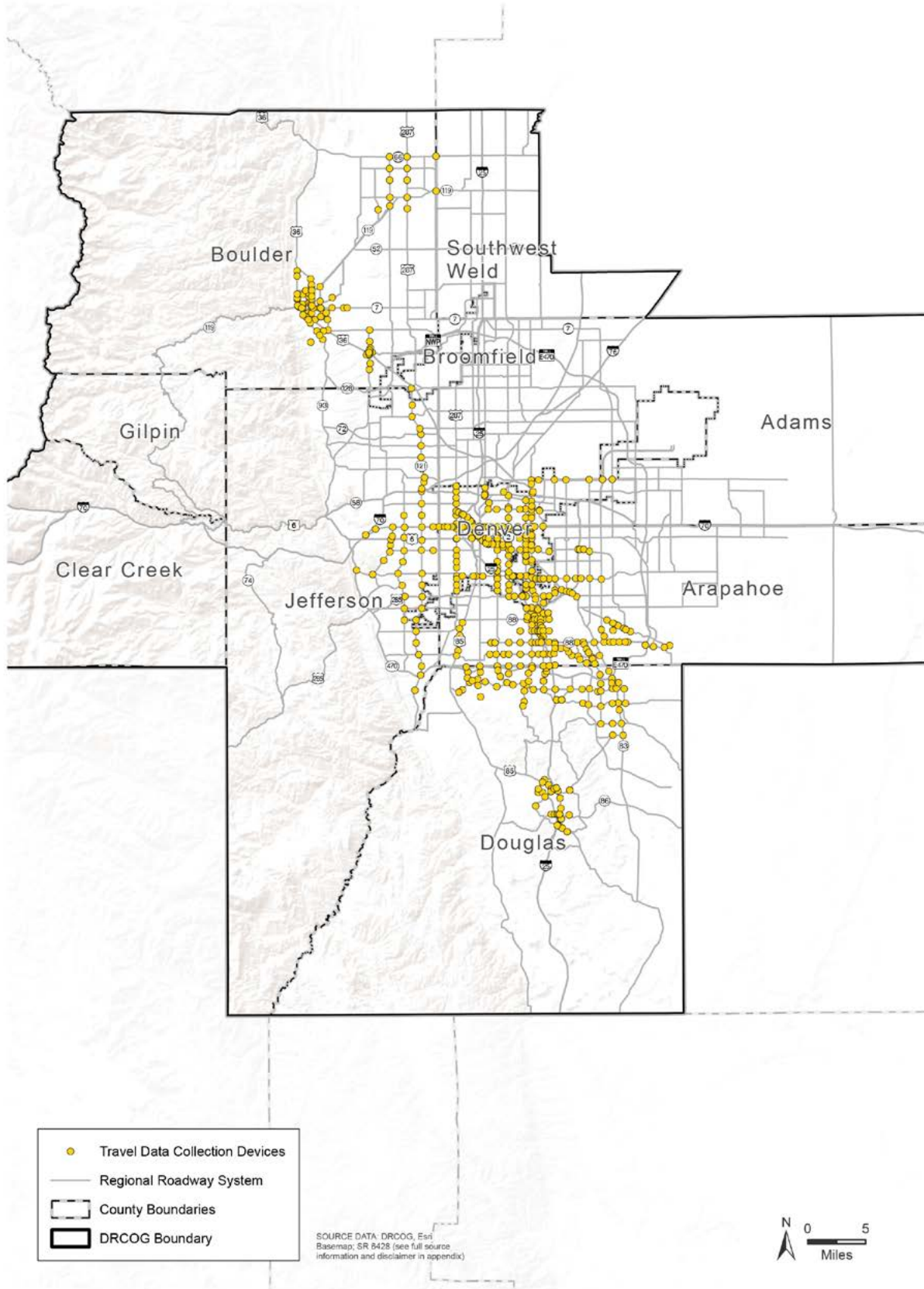


- | | |
|------------------------|---------------------------|
| ★ Transcore TransSuite | — Regional Roadway System |
| ■ Econolite Centracs | ▭ County Boundaries |
| ▲ Other System | ▭ DRCOG Boundary |
| ◆ Trafficware ATMS | |
| ● Siemens Tactics | |
| ● No System | |

SOURCE DATA: DRCOG, Eeri
 Basemap: SR 6428 (see full source
 information and disclaimer in appendix)



Figure 6: Arterial travel data detectors



Regional Traffic Incident Management service area

Traffic Incident Management is a collaboration between the public safety agencies (fire, enforcement, emergency medical services), the transportation operations agencies, tow/recovery services and other partners to respond to and clear traffic incidents safely and efficiently. The safety of the first responders and the traveling public is the primary focus of Traffic Incident Management. The following describes the current state of Traffic Incident Management.

- Staff from the Colorado State Patrol, together with CDOT, lead a mature statewide Traffic Incident Management program (<https://sites.google.com/state.co.us/coloradotim/home>) comprising the Colorado Standing Committee on First Responder Safety (executive level leadership) and five subarea Traffic Incident Management teams (tactical application) covering the region. Several, but not all, local jurisdictions (both operations and public safety) participate in their respective Traffic Incident Management teams.
- Traffic incidents are generally reported to 911, which initiates response by first responders (police, fire and emergency medical service). Public safety personnel and equipment provide on-scene management and lead incident clearance including hazmat management and contract towing, as required.
- The on-scene incident commander coordinates with transportation operations to provide support control adjustments (such as signal timing, ramp metering, active traffic management systems) and traveler information to accommodate closures and diversions.
- The statewide Traffic Incident Management program is leading the development of standard operating procedures to improve the coordination for Traffic Incident Management planning and execution for all the metro transportation incident management teams in the region.
- Staff from CDOT and the public highway authorities contract and dispatch motorist safety patrols operating on several corridors in the region. The patrols assist stopped motorists who represent a hazard to freeway traffic. The patrols may also provide material support to first responders on-scene.
- Public safety dispatchers coordinate incident response on computer-aided dispatch systems, but generally lack access to traffic cameras near the incident and an overall situational awareness of roadway conditions. Conversely, traffic management centers generally lack information regarding traffic incidents being tracked on computer-aided dispatch systems.
- Although no automated incident detection systems are employed in the region, several jurisdictions partner with Waze, which provides crowd-sourced information on crashes.

Regional traveler information service area

Regional traveler information is a critical activity used to inform travelers of mobility options and influence their choices. There are several distribution methods employed in the region: dynamic message signs; websites; 511 telephone system; personalized e-mail or text messaging; specialized mobile apps and traveler information kiosks/displays. The deployment of connected vehicle communications will provide another method to deliver traveler information directly to travelers. The existing traveler information resources include the following:

- CDOT staff have deployed a robust advanced traveler information system for CDOT facilities, distributing traveler information by dynamic message signs, direct traveler notification, the COTrip website, 511 telephone system, smartphone app and kiosks. The advanced traveler information system includes a trip planning service that also allows travelers to establish accounts to customize their alert notifications.
- RTD staff have deployed a robust transit traveler information system for its own operations. The traveler information is distributed by website, smartphone app, telephone and kiosks. A traveler may also establish accounts to customize their alert notifications. RTD's traveler information system also includes a trip-planning service.
- E-470 Public Highway Authority staff share snapshots from their cameras on their website.

- Staff from DRCOG's Way to Go program, in partnership with transportation demand management organizations across the region, provides an integrated multimodal trip planner and ridesharing services (for example, carpool, vanpool and Schoolpool).
- Staff from local jurisdictions provide a mix of traveler information available on jurisdiction websites and cable television (such as Channel 8). A few local jurisdictions have also deployed dynamic message signs on arterial streets.
- Staff from CDOT and several local jurisdictions monitor the location of snowplows. CDOT staff have integrated that information into the COTrip traveler information system while the others provide separate services to share that information with the public.
- Generally, distribution of traveler information in the region is neither consistent nor coordinated between jurisdictions.



Transit management and operations service area

Transit management and operations is the activity required to provide transit service, including both fixed route and dynamic transit operations. Direct coordination between transit and traffic operations is generally limited to transit signal priority, traveler information and, potentially, parking operations. The transit operations deployments include the following:

- RTD staff manage operations of over 1,300 vehicles which provide 136,000 bus and rail service miles daily.
- RTD vehicles are equipped with automatic vehicle location devices and passenger counting devices. The automatic vehicle location devices provide real-time location information to the dispatch center, which is also used for publicly available data feeds (such as transit apps providing arrival times and delays). The automatic vehicle location system is also used to initiate transit signal priority calls.
- Staff from RTD, in partnership with local jurisdictions, have deployed transit signal priority at 18 traffic signals with an additional 72 traffic signals under design or in deployment.
- Staff from RTD and several transit partners operate dynamic transit services. Several transit partners combined to form Ride Alliance to assist older adults, veterans and people with mobility challenges. Ride Alliance established the Trip Data Exchange to better match requests to service as a group.

- RTD staff have coordinated with private ride-hailing (for example, Uber and Lyft) and taxi companies to provide trips to and from transit stations.

Regional emergency management service area

Regional emergency management covers both transportation infrastructure security and transportation support for mass evacuation/re-entry during emergency operations. Resources include the following:

- RTD staff have deployed traveler security monitoring infrastructure such as surveillance cameras to protect both their infrastructure and their patrons.
- Staff from CDOT and some jurisdictions have deployed security monitoring infrastructure such as surveillance cameras (such as communications node buildings and other critical infrastructure) and surveillance devices (such as fire detection in Eisenhower Johnson Memorial Tunnel) for critical infrastructure.
- Emergency planning (evacuation and re-entry) generally occurs at the county level and focuses on public safety roles and responsibilities. At a regional level, there is limited coordination of evacuation and reentry planning.
- Staff from the North Central All-Hazards Region has developed a map-based situational awareness tool that has yet to be released for use. North Central All-Hazards Region staff are developing inter-agency agreements for use of the tool.

Maintenance and construction service area

All jurisdictions conduct regular maintenance and construction on their roadways to ensure continued safe and efficient operations. These activities also disrupt regular operations, requiring specific management and coordination to minimize impacts. Some activities in the region attempt to coordinate these operations:

- CDOT staff have integrated work zone scheduling into its advanced transportation management system, which shares this information with the public through its advanced traveler information system, the COTrip traveler information system.
- CDOT staff have deployed environmental sensor stations and road weather information systems to coordinate with the snow clearance Maintenance Decision Support System that combines this data with other real-time/projected road weather data to provide roadway treatment recommendations. Few other jurisdictions have deployed similar infrastructure and systems.
- There is no consistent or coordinated method to inform the public of work zones across the region.

Travel demand management service area

Transportation demand management assists travelers to use the transportation system more efficiently by encouraging options such as eliminating or shortening trips, changing the mode of travel or changing the time of day a trip is made. Staff from DRCOG, regional transportation demand management organizations and other transportation demand management service providers utilize transportation operations infrastructure, particularly traveler information infrastructure to support the services provided.

- DRCOG's Way to Go program, in partnership with transportation demand management organizations, provides an integrated multimodal trip planner and rideshare matching system.
- Various shared mobility providers (such as shared cars, bikes and scooters) allow customers to pay for their services across the region through smartphone apps. Reservations for these services are not coordinated with other transportation services.



Parking and curbside management service area

Parking management is the process of monitoring and managing the utilization of parking asset inventory through traveler information and payment services. Curbside management is an emerging opportunity that can efficiently and dynamically manage the use of curbside assets for passenger drop-offs/pick-ups, commercial deliveries, metered parking and other curbside activities.

The parking and curbside management resources include:

- Public and private parking operators manage their own parking monitoring and payment operations.
- Coordinated parking management strategies, requiring data sharing, does not exist in the region, save for some commercial services that allow for parking reservation and payment for commercial parking assets.
- Although curbside management is of significant interest, no deployments have been initiated.

Regional data management service area

Regional data management is the collection, storage, sharing and subsequent use (such as analytics) of transportation-related data both collected by regional transportation systems and procured from commercial sources. Generally, each jurisdiction individually manages its own data while data sharing or comparative analytics between data sets is extremely limited. Current data management in the region includes the following:

- CDOT staff have deployed, and continues to improve, a comprehensive data ecosystem that stores and analyzes CDOT data that supports CDOT operations and planning. This data is also used for CDOT's traveler information, which is augmented by Google and Waze data. CDOT staff also share select external data feeds to the public through application programming interfaces.
- CDOT staff have deployed a work zone scheduling tool that is integrated with the COTrip traveler information system, enabling the public to see CDOT work zones. Staff from CDOT have also developed a utility that translates CDOT planned events into the Work Zone Data Exchange specification, an open-source standard format used nationally. This data feed is also available to the public through application programming interfaces.
- RTD subscribes to mobility data interoperability data principles, committing to open standards that support the efficient exchange and portability of mobility data. RTD staff provide several external data feeds to the public through application programming interfaces.

- DRCOG is a member of the Open Mobility Foundation and uses an open-source standard, the Mobility Data Specification, to manage shared mobility data, in communities throughout the region.
- Several jurisdictions have established travel time data feeds that conform to CDOT’s data sharing specification to augment traveler information. These feeds are no longer being used for traveler information.
- The Advanced Mobility Partnership has published the Regional Mobility Platform Concept (2022) report (<https://advancedmobilitypartnership.org/wp-content/uploads/2022/05/AMP-Data-Platform-Concept-Paper.pdf>), which defines a framework for regional data sharing.

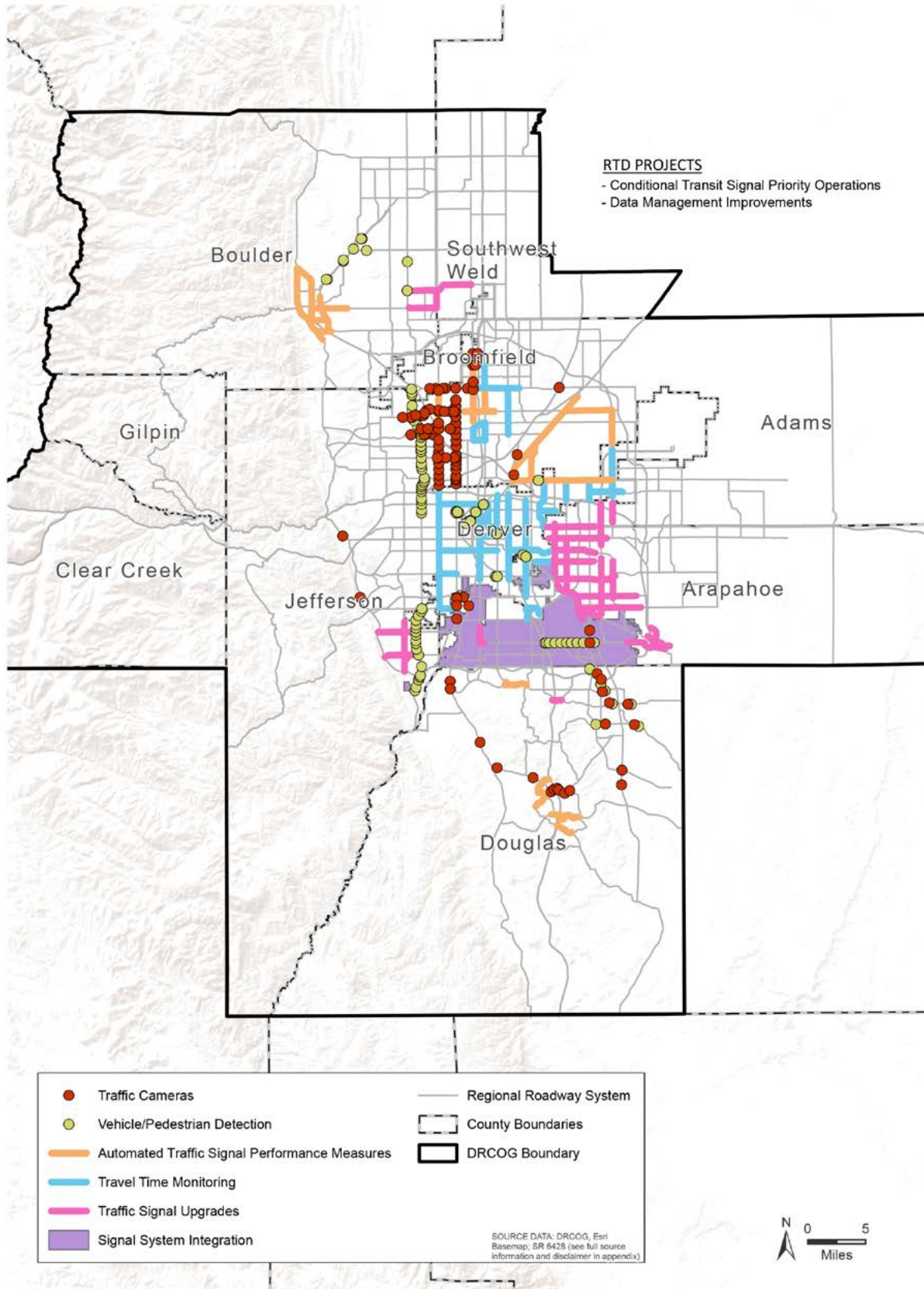
On-going regional transportation operations and technology deployment

Regional transportation operations and technology infrastructure continues to expand. For example, through the DRCOG Regional Transportation Operations and Technology TIP Set-Aside Call for Projects, 18 project sponsors were awarded fiscal year 2021-2023 federal funds to expand and upgrade several systems across the region. There are 25 on-going projects, illustrated in Figure 8, that provide a range of improvements, including:

- Traditional signal system and communications upgrades in the City of Aurora, the Town of Erie and Jefferson County.
- Traffic signal system integration between the Cities of Centennial, Littleton, Englewood and Greenwood Village, and Arapahoe County.
- Expansion of traffic detection and traffic camera deployments by CDOT, the City and County of Denver, the City of Westminster and the Town of Parker.
- Expansion of travel data collection systems by staff from RTD, the City and County Denver and the City of Thornton.
- Deployment of automated traffic signal performance measure systems in Boulder County, the Town of Castle Rock, the City and County of Denver, the Cities of Northglenn and Westminster, Douglas County and Commerce City.
- Transit signal priority improvements by RTD staff.



Figure 8: Regional transportation operations and technology fiscal year 2021-2023 projects



Transportation operations and technology challenges

Several overarching challenges to providing the most effective technological systems for optimizing multimodal transportation performance for the traveling public currently face the region:

- 1) Real-time operational strategies are not effectively and comprehensively coordinated among jurisdictions and agencies and between modes.
- 2) Common standards and procedures to share data and integrate systems have not been adopted.
- 3) Resources to actively manage transportation systems in real-time are lacking in some jurisdictions.
- 4) Multimodal traveler information sources in the region are not well integrated, hindering travelers' decision-making capabilities.
- 5) Operational performance measures are not universally and systematically used to improve travel reliability.
- 6) The condition of the region's multimodal transportation system facilities and equipment is not monitored comprehensively.

These challenges are not insurmountable. It may not be easy to fully address each one, as there are dozens of public and private entities operating transportation services and facilities across the region. However, this plan defines several strategic initiatives, which if implemented, will respond significantly to the challenges and help the region achieve the Regional Transportation Operations and Technology Strategic Plan goals and objectives defined in the Regional Transportation Operations and Technology Planning Framework.

Regional transportation operations needs

The regional transportation operation systems are not well-connected between jurisdictions, agencies and travel modes. Generally, systems are improved independently by jurisdictions and agencies, which improves the availability of operations data and the capability to manage systems locally, but without a mind for how the systems and jurisdictions can work together, it will be extremely challenging to achieve the above vision, goals and objectives.

Instead, the region must improve the understanding of conditions at a regional level for both operators and travelers to improve their decision-making capabilities. Additionally, this facilitates improved coordination and collaboration between jurisdictions and between modes.

Below is an assessment of the needs in each transportation service area necessary to achieve the above vision, goals and objectives.

Freeway management service area needs

Staff from the Colorado Department of Transportation and the public highway authorities must improve operations coordination with other jurisdictions by:

- Expanding situational awareness of freeway/tollway operators, which includes an understanding of conditions in on the arterial system.
- Expanding open data sharing with the public and partner jurisdictions/agencies to increase the decision-making capability of both operators and travelers.

- Expanding the development and availability of data analytics to improve the decision-making capability of both operators and travelers.
- Jointly developing strategies and procedures to coordinate with other jurisdictions to improve inter-jurisdictional operations and improve travel time reliability.
- Developing procedures and processes to share access and control of select traffic cameras to provide neighboring jurisdiction operators greater situational awareness.
- Expanding deployment of travel data collection systems, including connected vehicle infrastructure (roadside units and on-board units), to fully cover freeways, non-signalized state highways and tollways.
- Replacing Dedicated Short-Range Communications roadside units and on-board units with units meeting the current standards.
- Improving integration of connected vehicle operations between jurisdictions/agencies to promote efficient and seamless travel. Currently, the City and County of Denver's and CDOT's connected vehicle deployments are not interoperable because they use different security credential management system providers.



Arterial management service area needs

Staff from local jurisdictions and CDOT regions must improve operations coordination with other jurisdictions by:

- Expanding situational awareness of local jurisdiction operators, which includes an understanding of conditions in neighboring jurisdictions.
- Expanding open data sharing with the public and partner jurisdictions/agencies to increase the decision-making capability of both operators and travelers.
- Expanding the development and availability of data analytics to improve the decision-making capability of both operators and travelers.
- Increasing staff and resources to actively manage transportation operations to promote efficient and seamless travel and travel time reliability.
- Jointly developing strategies and procedures to coordinate with neighboring jurisdictions to improve inter-jurisdictional operations and improve travel time reliability.

- Developing procedures and processes to share access and control of select traffic cameras to provide neighboring jurisdiction operators greater situational awareness.
- Expanding application of signal priority operations (especially transit) following regional standards.
- Expanding deployment of travel data collection systems, including connected vehicle infrastructure (roadside units and on-board units), to fully cover arterial roadways.
- Replacing Dedicated Short-Range Communications roadside units and on-board units with units meeting the current standards.
- Improving integration of connected vehicle operations between jurisdictions/agencies to promote efficient and seamless travel. Currently, the City and County of Denver's and CDOT's connected vehicle deployments are not interoperable because they use different security credential management system providers.

DRCOG staff must transform the transportation operations support services provided to effectively use the increasingly available data and analytics by:

- Developing strategies and procedures, in partnership with signal operators, to continually analyze transportation system performance and develop recommendations that promote seamless and efficient travel and improved travel time reliability.

Regional Traffic Incident Management service area needs

CDOT Real-Time Operations Services branch, CDOT regions and local jurisdictions must improve coordination with and support of on-scene first responders by:

- Developing procedures and processes to share access and control of select traffic cameras to first responder dispatchers to provide them greater situational awareness to dispatch resources safely and appropriately.
- Developing resources to share regional roadway conditions with first responder dispatchers to provide them greater situational awareness to dispatch resources safely and appropriately.
- Developing and deploying traffic incident detection to detect and verify incidents more quickly, improving safety and travel time reliability.

Public safety resources must improve coordination with transportation operations by:

- Developing procedures and processes to share traffic incident details, as a filtered data feed from computer-aided dispatch, with traffic operations resources to improve operator situational awareness, which promotes safe and reliable operations.
- Developing procedures and processes, in coordination with transportation operations, to notify the public of incident conditions including back-of-queue management to improve safety.

Regional traveler information service area needs

Travelers need consolidated access to all available traveler information sources to improve their mobility decision-making capability. The traveler information providers in the region should coordinate to prepare multijurisdictional and multimodal traveler information services including:

- Development and deployment of a single platform that provides access to all traveler information sources and that allows comparison of multimodal trip options.
- Development and deployment of a universal trip planning and payment system, coordinating transit, tolls, parking and other fee-based mobility options.

Transit operations and management service area needs

Staff from the Regional Transportation District, the CDOT Division of Transit and Rail (and other transit agencies as applicable) need to improve on-time reliability of transit service by:

- Maintaining vehicle location tracking system to monitor schedule adherence and trip travel time reliability.
- Deploying automated passenger counting system to monitor bus utilization rates.

- Coordinating with traffic signal operations to deploy conditional transit signal priority operations at select intersections based on schedule adherence and bus loading.
- Developing and deploying procedures and processes to monitor and optimize transit signal priority operations with traffic signal operations.

Regional emergency management service area needs

Emergency management departments within counties and local jurisdictions need to prepare coordinated evacuation plans within regional subareas that include specific transportation operations support. Emergency management departments should coordinate and develop multiagency evacuation and re-entry plans that include transportation modeling to ensure the transportation system and resources adequately support the process.

Maintenance and construction service area needs

Planned maintenance activity must be coordinated between jurisdictions/agencies by developing and deploying a common scheduling process. Doing so will improve both operators and travelers decision-making capability.

Active work zones must employ specific traffic monitoring and management systems to maintain the safety of roadway staff and improve decision-making capabilities of both operators and travelers.

Travel demand management service area needs

Deployment and operation of transportation technology systems must support the transportation demand management strategies as detailed in the ongoing update of the regional transportation demand management strategic plan. This is expected to include things like expansion of the use of traveler information system infrastructure including expansion of carpooling services to dynamically match trips to and from transit.

Parking and curbside management service area needs

Public parking operators must improve real-time parking inventory and utilization monitoring and share that information with both travelers and operators. Doing so will improve their decision-making capability.

Additionally, in the case of RTD parking facilities, awareness of available parking in and around RTD facilities is critical input for the application of integrated corridor management.

Jurisdictions deploying curbside management systems must adopt the Curb Data Specification (<https://www.openmobilityfoundation.org/about-cds/>), an open-source data specification and set of application programming interfaces developed to help jurisdictions identify curbside assets and deploy curbside management systems.

Note: Even as common standards will be used, jurisdiction deployments will be local and operate independently according to the needs of the jurisdiction.

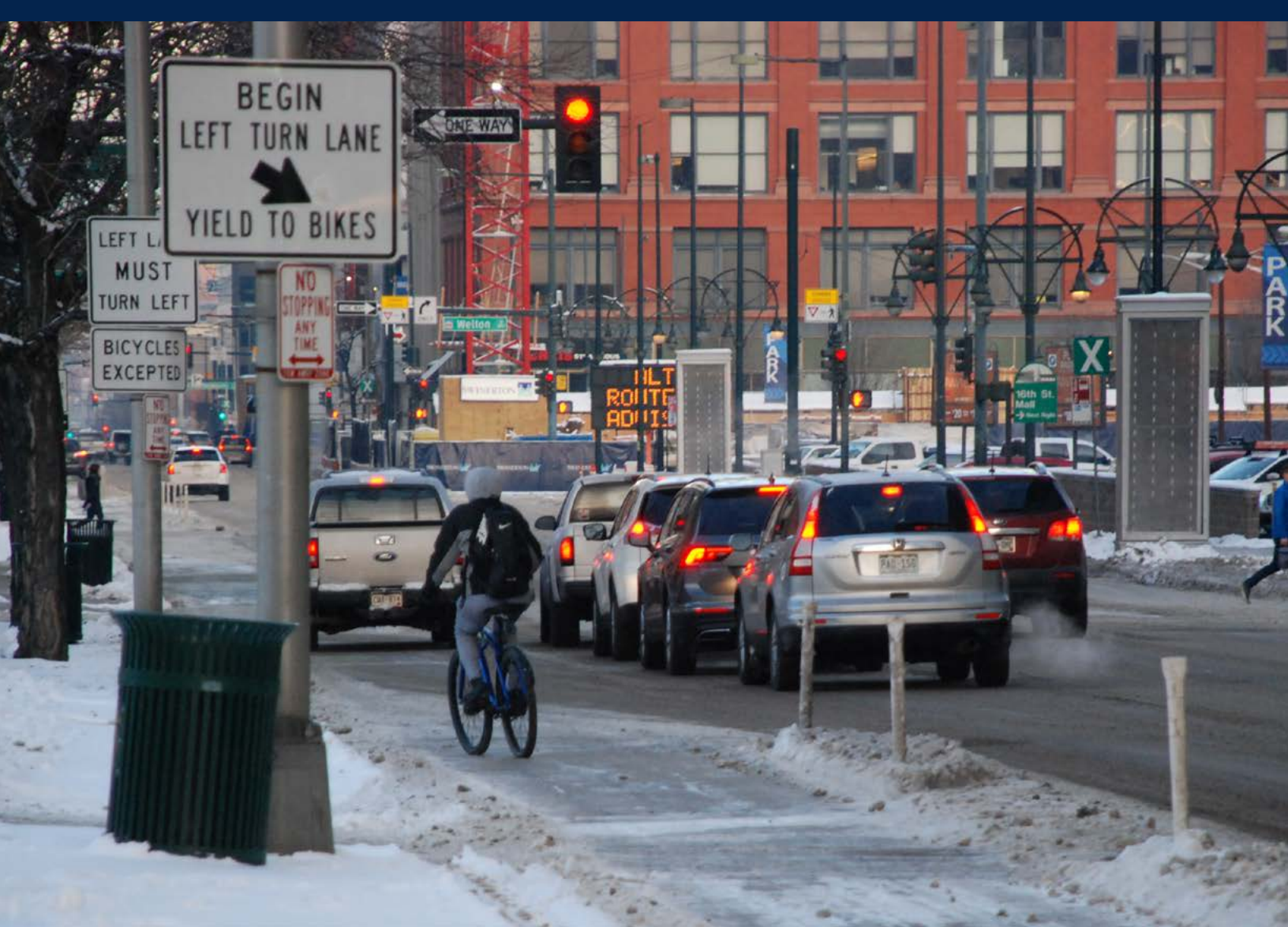
Regional data management service area needs

The region must develop and deploy a Regional Situational Awareness platform that combines select data feeds from multiple systems and jurisdictions and that may also be augmented with data procured from commercial sources. This platform will improve decision-making capabilities of operations staff.

The region must develop and deploy a Regional Performance Monitoring Archive platform that combines select data feeds from multiple systems and jurisdictions and that may also be augmented with data procured from commercial sources. Analytics and visualization developed from this data will allow operations staff to optimize operations.

The region must develop and deploy a Regional Multimodal Traveler Information platform that consolidates access to multimodal traveler information, which improves traveler decision-making capabilities.

Since multiple systems and multiple jurisdictions are involved in the development and use of each platform, the region must develop interagency agreement on standards and policies for public and private data sharing. This regional-scale data governance is critical to ensure interoperability, cybersecurity and privacy.

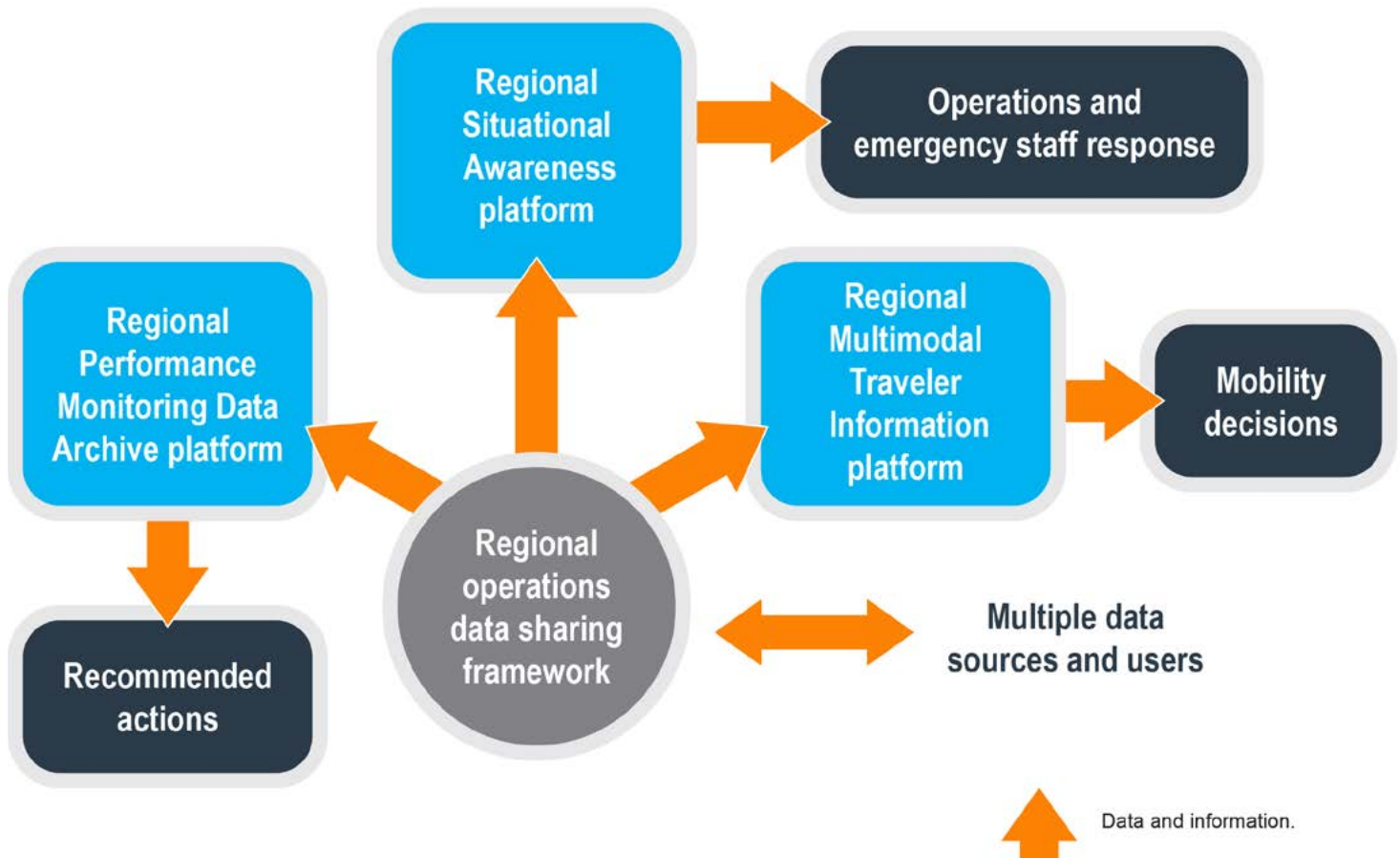


Action plan

To achieve the vision, goals and objectives described earlier, while addressing the operational challenges, the Denver region must focus on deploying project elements associated with the initiatives defined below. The initiatives will also aid in achieving the envisioned attributes of the regional operational concept (see appendix).

There is not a defined order for deployment of these initiatives, but it is recognized that there are interdependencies between the initiatives requiring foundational elements to be deployed before subsequent initiatives can be built upon them. As such, the initiatives are grouped into three categories: primary, secondary and tertiary. The primary initiatives are critical to establishing the desired regional framework for operations data sharing upon which the secondary and tertiary initiatives can build. Figure 9 displays the relationship of framework elements and example flows of data and information.

Figure 9: Data and information sharing framework



Many of the initiatives will involve deployment by multiple jurisdictions with specific attention to common standards and processes with the goal of allowing collaboration and coordination. To ensure multijurisdictional coordination DRCOG staff will lead stakeholders in refining the needs for specific initiatives and evaluating implementation options, including the possibility for DRCOG staff to be the operational lead or the owner.

Primary initiatives

Develop a Regional Situational Awareness platform

This will be a web-based platform providing a regional view of real-time, multimodal conditions focusing on key operations and disruptions:

- Roadway conditions (for example, speeds, congestion, travel time and queue information).
- Active crash information.
- Work zone scheduling information.
- Active work zone status information.
- Transit status data (for example, alerts, positions and vehicle occupancy).

Access to this secure platform will be limited to operations staff that have appropriate credentials.

DRCOG staff will coordinate regional discussions leading to the development, deployment and maintenance of a Regional Situational Awareness platform.

The definition and development of this platform will be preceded by the development and deployment of a regional data governance that ensures data interoperability, cybersecurity and user privacy.

Develop process to share traffic camera view and control between jurisdictions and public safety

Operators and public safety dispatchers will use shared traffic cameras to remotely assess roadway conditions, crashes and other disruptions to improve operations decision-making. Select video streams and snapshots will also be distributed as traveler information.

Sharing access and control to select traffic cameras will both expand the situational awareness of operators beyond their jurisdictional boundaries and allows public safety dispatchers greater awareness of crash details. In both cases, this improves staff decision-making capability.

Establishing and maintaining traffic camera sharing will require stakeholder agreements on institutional and technical processes required to share access and use the video. Elements of the agreements may include authority for camera use; hierarchy and user priority; and general rules governing recording, public privacy and video resharing. Technical revision to video management systems and the traffic cameras themselves may also be required to support the implementation of these processes.

Common camera standards and integrated video management systems allowed informal traffic camera control sharing between jurisdictions. Deployment of its new video management system has prompted Colorado Department of Transportation staff to reevaluate the process, emphasizing the use of interagency agreements that define camera-sharing requirements before re-establishing camera sharing. It is anticipated this will set the standard for traffic camera sharing between other jurisdictions.

Develop Regional Performance Monitoring Data Archive platform

This will be a web-based platform that provides operators and planners access to operations data for purpose of visualizing and analyzing the regional performance measures used for system optimization, including such measures as:

- Automated traffic signal performance measures.
- Safety performance measures (fatalities and serious injuries).
- Incident duration, secondary incidents and responder struck-bys.
- Transit on-time performance.
- Transit signal priority efficiency metrics.
- Travel time reliability measures for all modes.
- Traveler delay by mode and between modes.
- Transportation infrastructure availability/reliability.
- Air quality/emissions information.
- Utilization rates for transit, parking and curbside assets.

Automated traffic signal performance measures

- Purdue phase termination.
- Split monitor.
- Pedestrian delay.
- Preemption details.
- Timing and actuation.
- Left turn gap analysis.
- Purdue split failure.
- Yellow and red actuations.
- Turning movement counts.
- Approach volume.
- Approach delay.
- Arrivals on red/green.
- Time-space diagrams.
- Purdue coordination diagram.
- Approach speed.
- Average platoon ratio.
- Corridor progression analysis.

Access to this secure platform will be limited to operations and planning staff that have appropriate credentials. This interactive platform will present users summaries of performance measures upon request and as custom dashboards/reports. Users will have the ability to also use historical information to compare current with past performance.

DRCOG staff will coordinate regional discussions leading to the development, deployment and maintenance of the Regional Performance Monitoring Data Archive platform.

The definition and development of this platform will be preceded by the development and deployment of a regional data governance that ensures data interoperability, cybersecurity and user privacy.

Develop strategies and processes to coordinate performance monitoring to collaboratively optimize system management regionwide.

DRCOG staff and regional stakeholders will develop the strategies and processes for utilizing the Regional Performance Monitoring Data Archive platform to identify issues and implement improved operations. For example, as part of its continued transportation operations support services, DRCOG staff will monitor corridor performance on behalf of the stakeholders. DRCOG staff will also identify performance issues and make recommendations to mitigate the performance issues.



Deploy supporting transportation surveillance systems and infrastructure to monitor and control operations and collaboratively optimize system management regionwide.

Deployment of the Regional Performance Monitoring Data Archive platform and associated strategies and processes to mitigate performance issues will inevitably highlight information gaps in the regional data collection sources. This initiative will address those gaps that prevent proper application of optimization strategies. Individual jurisdictions will identify and thoroughly evaluate all alternatives to address the gaps to ensure the operational strategies and processes can be effectively employed.

Develop Traffic Incident Management standard operating procedures

Traffic Incident Management plans traditionally require transportation operations support on a primary and a secondary diversion route, used to move traffic around the incident. This approach adequately addresses crashes in rural areas where there are few choices for diversion.

In an urban setting, there are more potential diversion opportunities than can be effectively managed. Plus, the volume of vehicles involved in diversions from freeways is much greater.

This requires a different approach, focusing on a set of standard operating procedures as the starting point for all urban area incident management, allowing flexibility to address the incident in its own context. The standard operating procedures for the Denver urban area will address:

- Scene management: First responder and traveler safety are the primary concerns while clearing the incident from the traveled way as quickly as conditions allow.
- Support management: First responders are supported by traffic management center and dispatch staff through distribution of traveler information, customized signal operations, end-of-queue management and integrated corridor management (also requires transit operations support).

CDOT's Traffic Incident Management Program has begun development of Traffic Incident Management planning for the Denver metro area, bringing together the resources of four Traffic Incident Management teams in the Denver region.

Standardize and deploy transit signal priority performance management and system optimization procedures.

Transit signal priority requires a partnership between transit and signal operations. Access to data generated by both the traffic signal system and the bus operations system must be analyzed together to determine the performance of transit signal priority operations. Additionally, the traffic operations and transit staff must agree how to mitigate any performance issues which may require traffic signal timing configuration changes and/or transit operation revisions.

Regional Transportation District staff are currently leading signal operation partners in the development and deployment of the back-office infrastructure and procedures for this initiative.

Secondary initiatives

Develop evacuation and recovery plans/ exercises

The Boulder County Marshall Wildfire in December 2021, highlighted challenges with evacuations from urban and suburban areas. From a transportation operations perspective, the ability to support the management of an evacuation with transportation technology and systems requires improved evacuation planning and exercising.

Also brought to light were issues with power for the field infrastructure. Although many traffic signals are equipped with backup battery power, it only provides normal function for a discrete period. After that, local power generation is required. However, this event seemingly exhausted the supply of available power generators, highlighting the need to develop and deploy an effective regional resource monitoring and ordering process.

City and county emergency management resources will consider the lessons learned from the Marshall Wildfire to guide improved emergency and evacuation planning updates.

Develop process to coordinate traveler information messaging across the region

Staff from CDOT, RTD and several local jurisdictions maintain traveler information systems. The traveler information systems maintained by CDOT and RTD are more robust, including more options for access to traveler information, including field infrastructure (such as dynamic message signs).

To avoid confusing the traveling public and to ensure a consistent message is projected by the regional transportation operations partners, a process to coordinate messaging is necessary.

A lead agency has not been identified for this initiative, but its scope requires regional administration.

Deploy active work zone monitoring and management in the field

Work zones are dangerous network disruptions both for the work zone personnel and the traffic negotiating a safe path through the work zone. This initiative will support the deployment of work zone monitoring and management technology.

All jurisdictions may take the opportunity to deploy work zone monitoring. Staff from CDOT have deployed work zone monitoring successfully and may expand work zone data sharing through the Work Zone Data Exchange standard to active work zones. This work will undoubtedly serve as a model for other jurisdictions.

Deploy safety-focused technology applications

Safe operations are an important goal of this plan. Each element developed and deployed considers operations safety as a primary issue. However, some projects and technologies are deployed to address specific safety issues. This initiative represents these types of projects collectively.

It is anticipated that individual jurisdictions will identify separate deployments under this initiative. DRCOG staff will monitor such deployment, sharing knowledge and best practices with regional stakeholders.

Expand Regional Performance Monitoring Data Archive platform

The initial deployment of the Regional Performance Monitoring Data Archive platform consolidated access to the archived operational data for visualization and analysis to identify performance issues.

This initiative augments the capabilities of that platform by adding real-time data elements and analytics to the process.

DRCOG staff will coordinate regional discussions leading to the development, deployment and maintenance of the Regional Performance Monitoring Data Archive platform.

Expand the Regional Situational Awareness platform

The Regional Situational Awareness platform will be initially deployed using key and immediately available data. From this initial viable product, the platform will be continually improved, adding more layers of information to increase situational awareness of the regional operators, including such information as:

- Traffic incident information from public safety computer-aided dispatch feeds.
- Traffic signal system status data (online/offline, control mode, timing plan, alarms/alerts, detector data, etc.) from the various signal systems.
- Improved active work zone status information based on data provided by work zone monitoring and management systems.
- Ramp meter status (or example, meter rates and ramp queue length).

DRCOG staff will continue to coordinate regional discussions leading to the development, deployment and maintenance of the Regional Situational Awareness platform.

Expand transit signal priority deployment

Mobility Choice Blueprint tactical action 2.4 recommends the implementation of traffic signal priority on all major bus corridors. This initiative represents the on-going work to complete that tactical action.

Staff from RTD, in partnership with local jurisdictions, will coordinate deployment of traffic signal priority as per local planning and as opportunities present themselves.



Tertiary initiatives

Develop Regional Multimodal Traveler Information platform

This is a web-based platform that provides consolidated access to traveler information for multiple modes from multiple sources. This allows travelers to make improved multimodal trip planning decisions. The platform will include travel information elements such as:

- Roadway conditions (for example, speed congestion and travel time).
- Traffic camera snapshots and feeds.
- Active crash information.
- Active work zone information.
- Transit traveler information.
- Weather-related information.
- Special event information.
- Availability and status of other mobility options.
- Parking availability and costs.
- Multimodal trip planning.
- Access to archived data for comparison (such as predictive information).

In addition to the web-based access, this platform will also provide additional access (such as phone, text, kiosks, etc.) when desired and practical.

The lead for development, deployment and maintenance of this platform has not yet been identified other than recognizing that its scope and purpose requires regional administration and management.

Develop process to monitor and share parking asset availability/capacity

To manage the utilization of their parking more effectively, public parking operators must inventory and monitor the real-time status of these assets and share this information with the various data management platforms.

Staff from CDOT, RTD and local jurisdictions may manage their respective parking assets. Deployment of monitoring systems should also prepare to share real-time status information.

Develop multimodal trip planner and reservation/payment system

Tactical action 3.1 of the Mobility Choice Blueprint recommended the development of a universal mobility app for trip planning and payment. The Regional Multimodal Traveler Information platform will be a key foundation for this initiative.

RTD staff will lead the development and deployment of this initiative, which will require coordination and partnership with multiple jurisdictions and, potentially, commercial entities.

Develop and deploy dynamic ridesharing

It is anticipated that this will be an expansion of the region's existing carpooling operations (such as the MyWayToGo.org platform) or coordination and procurement of commercial services.

DRCOG staff are responsible for maintenance and operation of the MyWayToGo platform. Any improvements or changes in this platform will be led by DRCOG staff in coordination with its transportation demand management partners.

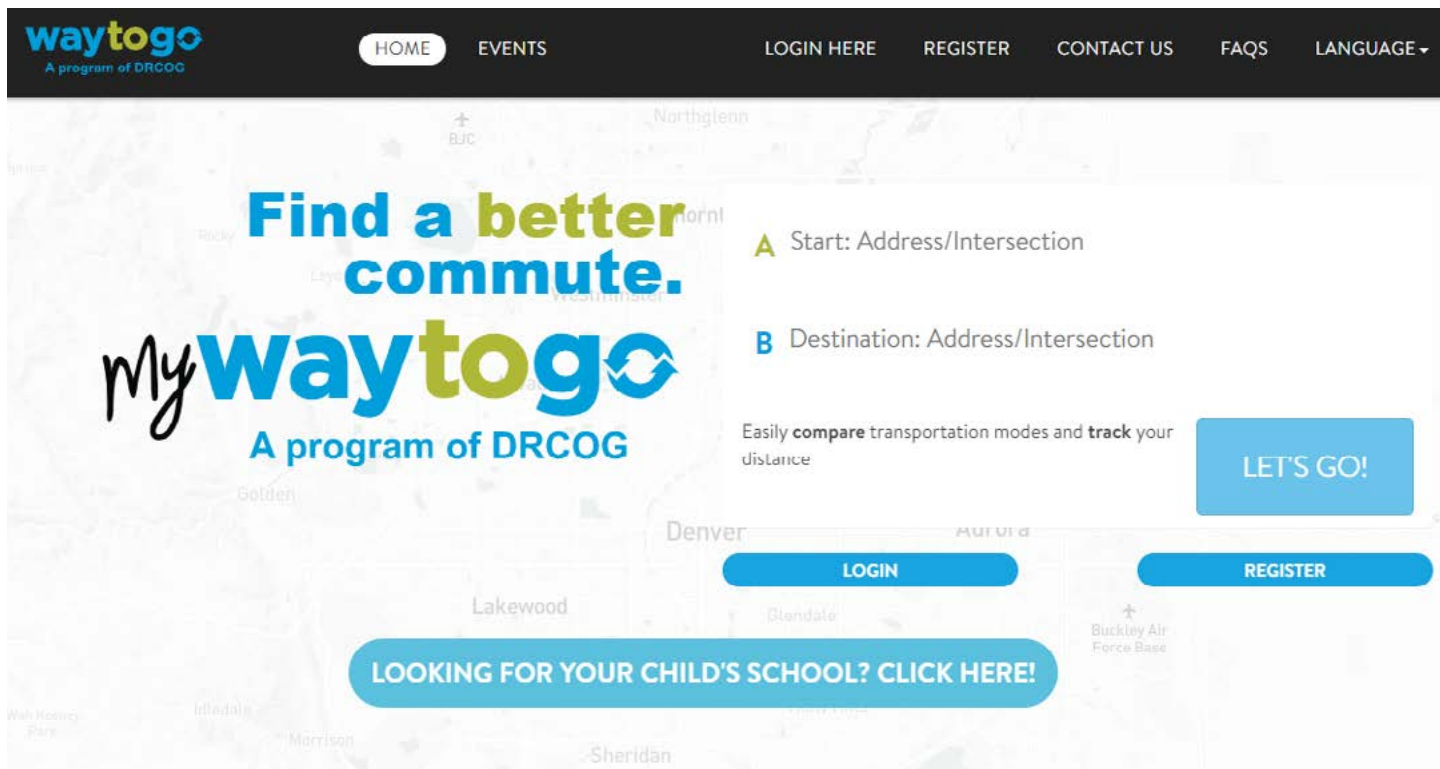
Develop and implement curbside management standards

Tactical action 3.4 of the Mobility Choice Blueprint recommended implementation of curbside management standards to facilitate the deployment of curbside management systems, as required, across the region. An open standard for the definition of curbside assets, including their status, has been identified. It is expected that pilots of model deployments by local jurisdictions will extend from this foundation.

Develop continuity of operations plans for transportation system operations

The Marshall Fire demonstrated that traffic management centers are at risk during such emergencies; therefore, regional transportation operations and emergency operations planning must both consider scenarios where such significant resources may be lost or unavailable.

Jurisdictions will individually assess their own environment and infrastructure, planning to address their own continuity of operations scenarios.



Conclusions

The purpose of the Regional Transportation Operations and Technology Strategic Plan is to guide near-term technology deployments to support safer, coordinated and more efficient multimodal travel in the region. Collaboration between operating agencies is imperative to achieve the greatest mobility benefits for the travelers and businesses of the Denver region.

Technology alone does not address problems directly but can facilitate coordinated systems and improved operational procedures. For example, a regional perspective on travel time reliability and performance monitoring will improve the decision-making capabilities for operators and travelers.

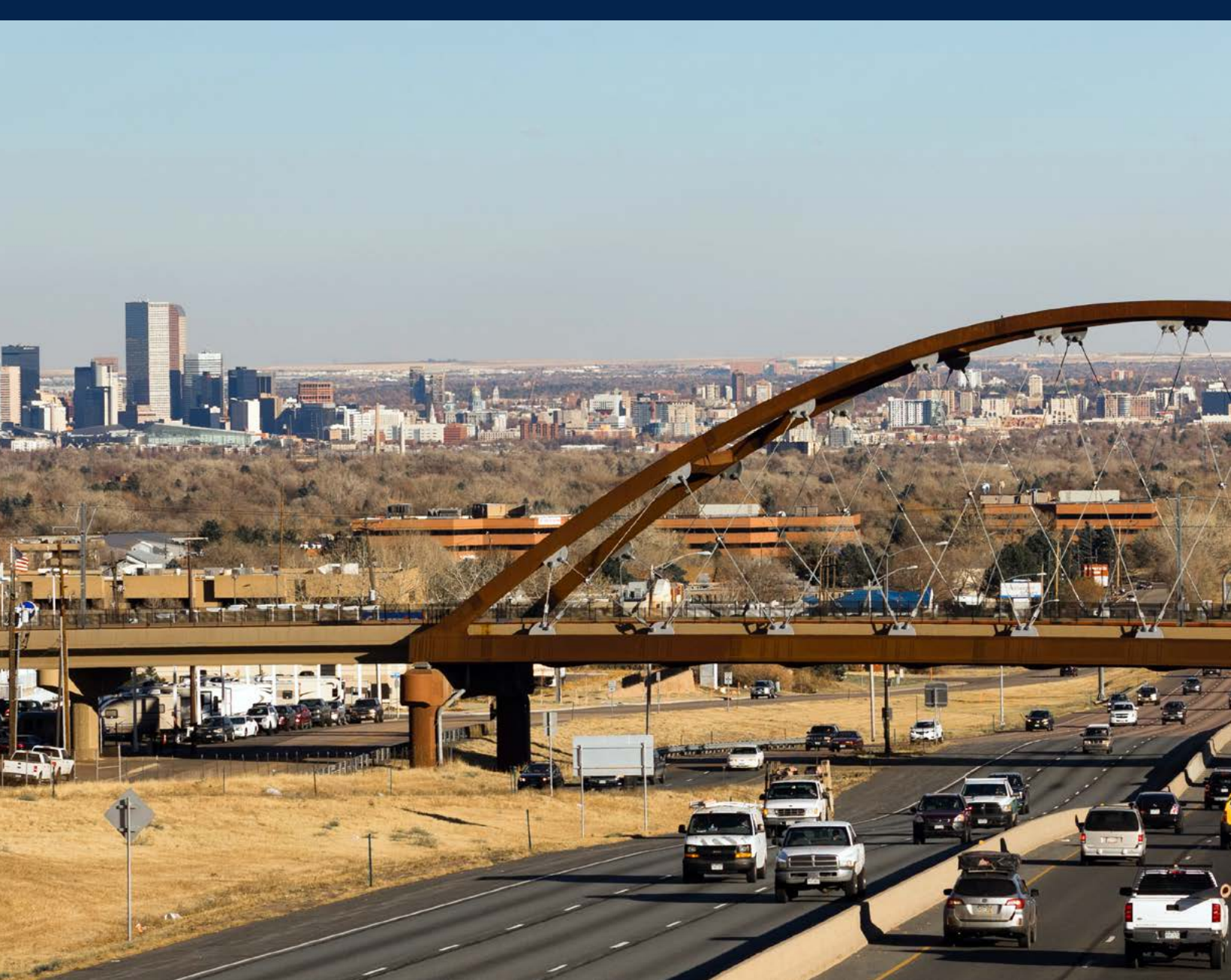
A regional approach to data management and information sharing is also an important component in achieving the Regional Transportation Operations and Technology Strategic Plan's vision, goals and objectives. Better data and access to information afford operators greater situational awareness of real-time conditions. Everyone will benefit from greater access to real-time traveler information and greater knowledge of the available mobility options. A regional data governance structure that ensures data interoperability, cybersecurity and user privacy is essential for achieving maximum benefits.

This plan identifies several key initiatives which set the framework for subsequent DRCOG Regional Transportation Operations and Technology Transportation Improvement Program Set-Aside Call for Projects. It will take time to address all the initiatives. Their completion, however, will bring the region closer to achieving the overall operational concept described in the appendix.

It is also recognized that each jurisdiction and agency in the region has varying needs and resource capacities to address the initiatives. The project evaluation and selection process for the upcoming call-for-projects will consider the interdependence of the initiatives and the relative importance of the capabilities resulting from proposed projects.

Several initiatives identified will require regional-level approaches to how they are administered. Presently there are a wide variety of unique systems used across the region. Thus, there is a limited level of direct system integration and coordination. Real-time awareness of regional conditions is sometimes lacking or segmented between jurisdictions and agencies. Having an overarching understanding of real-time transportation situations supports jurisdictions of all sizes and capabilities while improving mobility for all travelers. DRCOG staff will lead the stakeholders in refining the needs for specific initiatives and evaluating implementation options, including the possibility for DRCOG to be the operational lead or the owner.





Appendix: Operational concept

This strategic plan describes improvements that interconnect the operations management of the separate partner jurisdictions and agencies so that they can collaborate to provide improved operations across the region. To reflect the strategic plan within the context of the Regional Intelligent Transportation Systems Architecture, as required by federal regulations, this appendix provides a description of the overall operational concept for regional transportation operations.

The operational concept is a high-level description of the roles and responsibilities of the region's stakeholders as they relate to transportation systems and operations management. The roles and responsibilities include both the existing operations and new roles and responsibilities required to achieve the vision, goals and objectives stated in this strategic plan. The operational concept describes regional transportation operations roles and responsibilities as they would exist with all the strategic plan improvements deployed.

Freeway management service area

Description

Several units within the Colorado Department of Transportation share responsibility for operations and technology.

CDOT Intelligent Transportation Systems and Network Services branch deploys and maintains the infrastructure and systems, including the communications network infrastructure.

CDOT Real-Time Operations Services branch operates the freeway infrastructure and systems to monitor and control freeway operations, including managed lanes, hard shoulder running and active traffic management corridors utilizing, primarily, the statewide Advanced Transportation Management System and the statewide Video Management System. The CDOT regions (Region 1 and Region 4) deploy, operate and maintain the ramp metering systems along the freeways.

The CDOT Office of Innovation Mobility leads deployment of connected vehicle infrastructure (roadside units and on-board units) and leads the development of connected vehicle data ecosystem that is integrated into CDOT's larger data environment. This requires coordination with CDOT Intelligent Transportation Systems and Network Services branch and the CDOT Office of Data Management.

CDOT operators have access to data, analytics, decision support tools and other features provided by CDOT's Advanced Data Analytics platform to augment performance monitoring and decision-making capabilities. CDOT operators also have access to

the Regional Situational Awareness platform and the Regional Performance Monitoring Data Archive platform. In addition, CDOT staff make select data feeds available for use for the Regional Situational Awareness platform and the Regional Performance Monitoring Data Archive platform.

Public highway authorities and the Colorado Transportation Investment Office deploy, operate and maintain their own tolling operations, which include the electronic collection of tolls and detection of violations.

Roles and responsibilities

- Staff from the CDOT Intelligent Transportation Systems and Network Services branch:
 - Deploys and maintains traffic monitoring and transportation data collection system infrastructure (such as vehicle detection systems, connected vehicle systems, travel time monitoring, road weather monitoring, etc.) on freeways and major state highways.
 - Deploys and maintains traffic camera system infrastructure on freeways and major state highways.
 - Deploys and maintains advanced transportation management system.
 - Deploys and maintains advanced traveler information system.
 - Deploys and maintains video management system.

- Coordinates traffic camera access with public safety agencies, neighboring jurisdictions and other regional stakeholders.
- Staff from the CDOT Real-Time Operations Services branch:
 - Monitors roadway conditions using advanced transportation management system and video management system, notifying CDOT Intelligent Transportation Systems and Network Services when infrastructure and systems are not working properly.
 - Monitors roadway conditions and actively manage systems to ensure optimal operations.
 - Deploys and dispatches motorist Safety Patrol.
 - Shares system and travel data with both the Regional Situational Awareness platform and Regional Performance Monitoring Data Archive platform.
 - Uses information from both the Regional Situational Awareness platform and Regional Performance Monitoring Data Archive platform to coordinate decision-making with other stakeholders.
- Staff from CDOT regions:
 - Deploys, operates and maintains ramp metering system infrastructure.
- Shares system and travel data with both the Regional Situational Awareness platform and Regional Performance Monitoring Data Archive platform.
- Staff from the Colorado Transportation Investment Office and the E-470 Public Highway Authority:
 - Deploys, operates and maintains toll collection and violation enforcement infrastructure and systems.
 - Deploys, operates and maintains transportation data system infrastructure (such as detection systems, connected vehicle systems, travel time monitoring, road weather monitoring, etc.) on tolled facility.
 - Deploys and maintains traffic camera system infrastructure on tolled facility.
 - Conducts toll collection and violation enforcement on tolled facility.
 - Monitors toll facility system health and operations and dispatch repair as required.
 - Shares select system and travel data with the Regional Situational Awareness platform and Regional Performance Monitoring Data Archive platform to coordinate decision-making with other stakeholders.

Arterial management service area

Description

Local jurisdictions and CDOT regions deploy, operate and maintain infrastructure and systems (traffic signal control systems, compatible signal controllers, communications system and travel data collection systems) to monitor and control arterial operations.

DRCOG staff provides transportation operations support services to signal operators. DRCOG staff develops inter-jurisdictional signal timing coordination plans. DRCOG staff also monitors regional performance measures on the Regional Performance Monitoring Data Archive platform, making operations recommendations to signal operators to optimize operations. Since there is a variety of systems deployed and several management strategies employed, operations decisions must be guided by performance measurement.

Roles and responsibilities

- Local jurisdictions and CDOT regions staff:

- Deploys, operates and maintains interconnected traffic signal system infrastructure on arterials.
- Deploys, operates and maintains travel data collection system infrastructure (traveler detection systems, connected vehicle roadside and on-board units, travel time monitoring, road weather monitoring, etc.) on arterials.
- Deploys, operates and maintains traffic camera system infrastructure on arterials.

- Deploys, operates and maintains field and system infrastructure necessary to support transit signal priority operations.
- Monitors health of transportation management systems and roadway conditions and dispatch repair as required.
- Monitors roadway conditions and actively manage system to ensure optimal operations.
- Shares system and travel data with both the Regional Situational Awareness platform and Regional Performance Monitoring Data Archive platform.
- Uses information from both the Regional Situational Awareness platform and Regional Performance Monitoring Data Archive platform to coordinate decision-making with other stakeholders.
- Coordinates traffic camera access with public safety agencies, neighboring jurisdictions and other regional stakeholders.
- Collaborates with DRCOG staff to develop and implement optimal signal timing plans and to address operation trouble spots.

- DRCOG staff:

- Collects corridor progression performance data on the regional roadway system.

- Develops inter-jurisdictional signal timing plans for signal system operators on the regional roadway system.
- Monitors and analyzes information on the Regional Performance Monitoring Data Archive platform to identify performance issues.
- Recommends revisions to traffic signal timing operations to regional stakeholders.
- Regional Transportation District, CDOT Division of Transit and Rail (and other transit agencies as applicable) staff:
 - Deploys, operates and maintains transit signal priority field infrastructure.
 - Deploys, operates and maintains on-board infrastructure (passenger counting systems, on-board communications, schedule data and logic processing units, etc.) to support transit signal priority operations.
 - Deploys, operates and maintains computer-aided dispatch systems and other fleet monitoring systems.
 - Leads planning and implementation of transit signal priority across the region.

Regional Traffic Incident Management service area

Description

Traffic Incident Management is a collaboration between the public safety agencies and the transportation operations agencies to respond to and clear traffic incidents safely and efficiently from the roadway. The safety of the first responders and the traveling public is the primary focus of Traffic Incident Management. Colorado State Patrol and CDOT staff lead the statewide effort to improve first responder safety, promoting consistent use of Traffic Incident Management best practices.

Generally, public safety personnel (police, fire and emergency medical service) respond to traffic incidents as directed by their dispatch. Once on scene, public safety personnel and equipment provide on-scene management and lead incident clearance (including hazmat management). The first responder incident commander also coordinates through dispatch for transportation operations support, as required.

Transportation operations provides resources to public safety to support the incident response, including:

- Access to real-time conditions information on both the Regional Situational Awareness platform and the Regional Multimodal Traveler Information platform.
- Access to traffic camera systems.
- Access to operations control adjustments (such as signal timing, ramp metering and active traffic management systems) to accommodate closures and diversions

- Distribution of incident management-related traveler information.
- Support for back-of-queue management.
- Access to system-based detection and verification of incidents.

Additionally, transportation operations agencies also deploy and dispatch motorist safety patrol(s), cruising their roadway network to assist stopped motorists, decreasing the chance of the incident becoming more serious. The patrols are also available to support first responders in the field both as material support and as a form of incident detection when they encounter unreported/undetected traffic incidents.

Roles and responsibilities

- Staff from CDOT Real-Time Operations Services branch:
 - Coordinates local Traffic Incident Management teams that lead development, implementation and management of Traffic Incident Management planning.
 - Deploys and dispatches CDOT Safety Patrol.
 - Integrates public safety agencies' computer-aided dispatch data feed into traffic management center operations.
 - Coordinates traffic camera access with public safety agencies, neighboring jurisdictions and other regional stakeholders.

- Monitors freeway and other state highway operations for disruptions, assisted with automated incident detection and other data sources.
- Maintains select data feeds for use by the Regional Situational Awareness platform, the Regional Performance Monitoring Data Archive platform, and the Regional Multimodal Traveler Information platform.
- Uses the Regional Situational Awareness platform to coordinate transportation operations response to support Traffic Incident Management plan execution with staff from local jurisdictions, CDOT regions, public safety and RTD.
- Provides equipment and resources as requested by public safety agencies during Traffic Incident Management response.

- Staff from local jurisdictions and CDOT regions:
 - Participates in Traffic Incident Management teams with the development, implementation and management of Traffic Incident Management planning.
 - Integrates public safety computer-aided dispatch data into traffic management center operations.
 - Coordinates traffic camera access with public safety agencies, neighboring jurisdictions and other regional stakeholders.

- Monitors arterials operations for disruptions, assisted with automated incident detection and other data sources.
- Maintains select data feeds for use by the Regional Situational Awareness platform, the Regional Performance Monitoring Data Archive platform and the Regional Multimodal Traveler Information platform.
- Uses the Regional Situational Awareness platform to coordinate transportation operations response to support Traffic Incident Management plan execution with staff from other local jurisdictions, CDOT Real-Time Operations Services branch, public safety and RTD.
- Provides equipment and resources as requested by public safety agencies during Traffic Incident Management response.
- Staff from public safety agencies:
 - Coordinate local Traffic Incident Management teams that lead development, implementation and management of Traffic Incident Management planning.
 - Deploys, operates and maintains an emergency call-taking and dispatch system.
 - Maintains select computer-aided dispatch data feeds for use by the Regional Situational Awareness platform, the Regional Performance Monitoring Data Archive platform and the Regional Multimodal Traveler Information platform.
- Uses the Regional Situational Awareness platform and North Central All-Hazards Region situational awareness tool to both dispatch/route emergency response and coordinate transportation operations response with staff from local jurisdictions, CDOT Real-Time Operations Services branch, CDOT regions and RTD.
- Staff from the North Central Region:
 - Maintains and operates the North Central All-Hazards Region situational awareness tool.
- Staff from public highway authorities:
 - Leads development, implementation and management of Traffic Incident Management planning for toll facility.
 - Integrates public safety computer-aided dispatch data with traffic management center operations.
 - Coordinates traffic camera access with staff from public safety agencies, neighboring jurisdictions and other regional stakeholders.
 - Deploys and dispatches contracted Safety Patrol.
 - Monitors toll facility operations for disruptions, assisted with automated incident detection and other data sources.

- Maintains select data feeds for use by the Regional Situational Awareness platform, the Regional Performance Monitoring Data Archive platform and the Regional Multimodal Traveler Information platform.
- Uses the Regional Situational Awareness platform to coordinate transportation operations response to support Traffic Incident Management plan execution with staff from other local jurisdictions, CDOT Real-Time Operations Services branch, public safety agencies and RTD.
- Provides equipment and resources as requested by staff from public safety agencies during Traffic Incident Management response.

Regional traveler information service area

Description

Regional traveler information is a critical activity shared by multiple jurisdictions and agencies used to inform users and influence their travel choices. Several delivery methods (for example, dynamic message signs, websites, 511 telephone system, personalized e-mail or text messaging, specialized mobile apps, traveler information kiosks and connected vehicle communications) are coordinated to ensure consistent messaging is distributed to users. Additionally, access to the various sources of traveler information is consolidated on the Regional Multimodal Traveler Information platform, providing access to comprehensive multimodal traveler information.

All regional transportation operations stakeholders that are collecting travel data during daily operations or have procured information from other sources provide select feeds of traveler information to the Regional Multimodal Traveler Information platform.



Building upon regional access to multimodal traveler information, RTD staff deploys and maintains a universal trip planning and payment tool.

Roles and responsibilities

- CDOT Intelligent Transportation Systems and Network Services branch and CDOT Real-Time Operations Services branch and CDOT Office of Data Management staff:
 - Maintains and operates CDOT's Advanced Transportation Management System and associated data ecosystem as traveler information data sources.
 - Deploys, operates and maintains Advanced Traveler Information System (COTrip website, COTrip app, 511 phone system, subscription e-mail/text alerts, Twitter integration, trip planner and other features).
 - Deploys, operates and maintains traveler information infrastructure (such as dynamic message signs).
 - Integrates and coordinates traveler information distribution with the Regional Multimodal Traveler Information platform.
- Local jurisdictions and CDOT regions staff:
 - Deploys, operates and maintains traveler information infrastructure (such as dynamic message signs) on arterials.
 - Deploys, operates and maintains television-based traveler information display.
 - Integrates and coordinates traveler information distribution with the Regional Multimodal Traveler Information platform.
- RTD, CDOT Division of Transit and Rail (and other transit agencies as applicable) staff:
 - Integrates and coordinates traveler information distribution with the Regional Multimodal Traveler Information platform.
 - Deploys, operates and maintains traveler information infrastructure (such as dynamic message signs, kiosks, etc.) at transit facilities.
 - Integrates and coordinates traveler information distribution with the Regional Multimodal Traveler Information platform.
 - Develops, operates and maintains the universal trip planning and reservation tool built upon the Regional Multimodal Traveler Information platform.
- Colorado Transportation Investment Office and the E-470 Public Highway Authority staff:
 - Deploys, operates and maintains traveler information infrastructure (such as dynamic message signs) on tolled facilities.
 - Integrates and coordinates traveler information distribution with the Regional Multimodal Traveler Information platform.

Transit management and operations service area

Description

Transit operations and management is all the activity required to provide transit service, including both fixed route and dynamic transit operations. Direct coordination between transit and transportation operations is generally limited to transit signal priority, traveler information and potentially parking operations.

Staff from RTD and other transit services coordinate with local jurisdictions and CDOT regions to deploy and maintain transit signal priority at select intersections. Priority requests are made based on the location, passenger load and transit schedule adherence.

Staff from RTD and other transit service properties deploy and maintain transit traveler information systems that are also integrated with the Regional Multimodal Traveler Information platform.

RTD's parking inventory and availability is a key resource for regional parking management.

Roles and responsibilities

- RTD, CDOT Division of Transit and Rail (and other transit agencies as applicable) staff are responsible for:
 - Deploying, operating and maintaining fleet monitoring systems and computer-aided dispatch for both fixed-route and dynamic transit services.

- Deploying, operating and maintaining on-board equipment and systems (such as transit security systems, fare collection equipment, passenger counting, connected vehicle, etc.).
- Deploying, operating and maintaining field system infrastructure necessary to support transit signal priority operations.
- Coordinating transit signal priority operations and performance monitoring with staff from local jurisdictions and CDOT regions.
- Sharing select transit operations and travel data feeds with the Regional Situational Awareness platform, the Regional Performance Monitoring Data Archive platform and the Regional Multimodal Traveler Information platform.
- Deploying, operating and maintaining dynamic transit system coordination for older adults, veterans and people with mobility challenges (Ride Alliance).

Regional emergency management service area

Description

Regional emergency management covers both transportation infrastructure security and transportation support for mass evacuation/re-entry during emergency operations.

Staff from the CDOT Real-Time Operations Services branch, local jurisdictions and RTD provide security monitoring of their infrastructure using detection and security cameras. Threats and observations are shared with the public safety community to enhance regional situation awareness.

Staff from the Colorado Department of Public Safety and the Division of Homeland Security and Emergency Management lead planning, implementation and training for emergency management (both natural and intentional emergencies) at the state level. County and local jurisdictions are responsible for evacuation planning at the local level. The roadway and traveler information infrastructure and systems and resources (state, local jurisdictions and RTD) support the execution of the evacuation/re-entry plans as they are activated by public safety agencies/departments.

Roles and responsibilities

- CDOT regions staff:
 - Assists public safety agencies with development of evacuation and recovery planning.
 - Uses the Regional Situational Awareness platform to coordinate implementation and management of evacuation and recovery response decision-making coordinating traffic monitoring, traffic management and traveler information with staff from public safety agencies, RTD and local jurisdictions.
- CDOT Real-Time Operations Services branch and CDOT Intelligent Transportation Systems and Network Services branch staff:
 - Assists staff from public safety agencies with development of evacuation and recovery planning.
 - Deploys, operates and maintains infrastructure security monitoring system(s).
 - Uses the Regional Situational Awareness platform to coordinate implementation and management of evacuation and recovery response decision-making coordinating traffic monitoring, traffic management and traveler information with staff from public safety agencies, RTD and local jurisdictions.

- Staff from local jurisdictions:
 - Assists staff from public safety agencies with development of evacuation and recovery planning.
 - Uses the the Regional Situational Awareness platform to coordinate implementation and management of evacuation and recovery response decision-making coordinating traffic monitoring, traffic management and traveler information with staff from public safety agencies, RTD and CDOT.
- Staff from public safety agencies and the North Central All-Hazards Region:
 - Deploys and operates infrastructure for distributing wide-area alerts.
 - Leads and coordinates the development of evacuation and recovery planning.
 - Leads and coordinates evacuation exercising and training.
 - Uses the Regional Situational Awareness platform to coordinate implementation and management of evacuation and recovery response decision-making coordinating traffic monitoring, traffic management and traveler information with staff from local jurisdictions, RTD and CDOT.
- RTD staff:
 - Assists staff from public safety agencies with development of evacuation and recovery planning.
 - Deploys, operates and maintains infrastructure and traveler security monitoring system(s).
 - Uses the Regional Situational Awareness platform to coordinate implementation and management of evacuation and recovery response decision-making coordinating traffic monitoring, traffic management and traveler information with public safety agencies, CDOT and local jurisdictions.

Maintenance and construction service area

Description

All jurisdictions conduct regular infrastructure maintenance and construction to ensure safe and efficient operations. These activities also disrupt regular operations, requiring specific management and coordination to minimize the safety and efficiency impacts. Planned maintenance and construction activity schedules by all jurisdictions are shared with the Regional Situational Awareness platform and the Regional Multimodal Traveler Information platform.

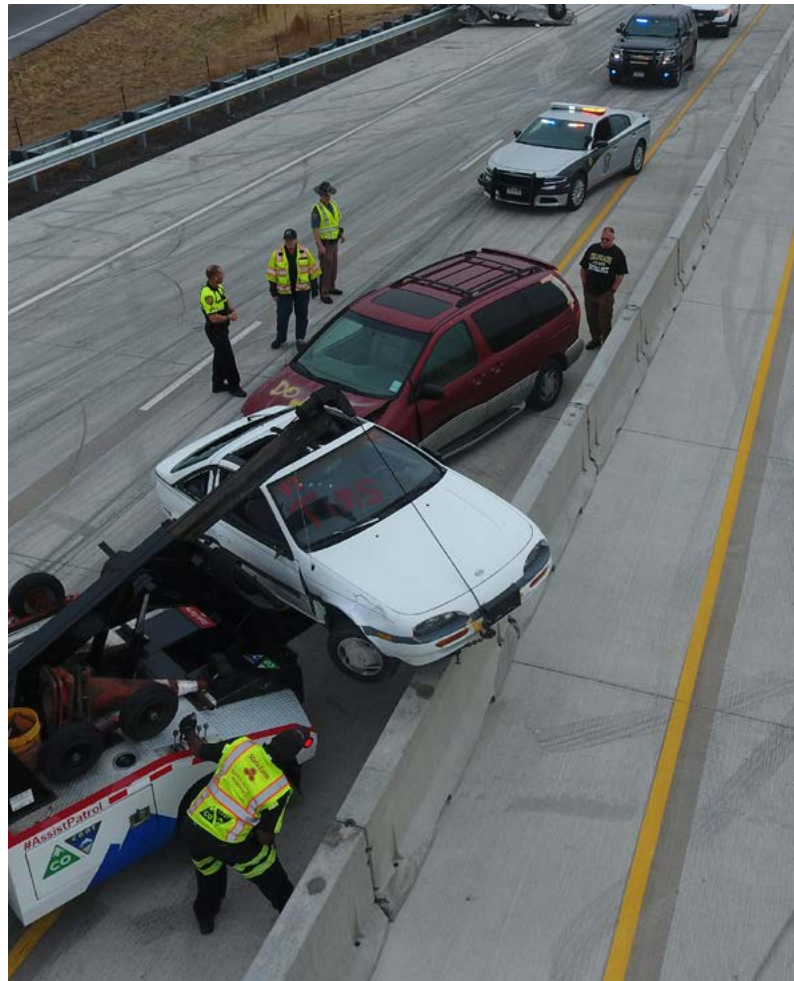
To manage operations around active construction/ work zones safely and efficiently, temporary traffic management is deployed (such as vehicle detection, traffic cameras and dynamic message signs) at significant work zones. Details of the roadway conditions around the work zone and status of the work zone are shared in real-time with the Regional Situational Awareness platform and the Regional Multimodal Traveler Information platform.

Snow clearance is a significant activity during several days per year in Colorado. As such, select jurisdictions' maintenance vehicles are equipped with onboard systems to continually communicate location and road weather conditions. Select jurisdictions employ the support of a maintenance decision support system that combines this data with other real-time/projected road weather data to provide roadway treatment recommendations.

Photo courtesy of the Colorado Department of Transportation.

Roles and responsibilities

- CDOT Intelligent Transportation Systems and Network Services branch staff:
 - Deploys, operates and maintains an asset management system.
 - Deploys, operates and maintains the Maintenance Decision Support System, an information processing system, for snow clearance and roadway treatment on freeways and state highways.



- CDOT regions staff:
 - Schedules construction/work zones on state highways with CDOT Real-Time Operations Services branch.
 - Monitors health of transportation management systems and infrastructure, coordinating dispatch for repair as necessary.
 - Deploys, operates and maintains an asset management system.
 - Deploys, operates and maintains Maintenance Decision Support System infrastructure on maintenance vehicle fleet.
 - Monitors status of active construction/work zones on state highways in real-time.
 - Shares maintenance and construction data (real-time work zone/lane closure information; real-time equipment/infrastructure failure status; real-time snow clearance vehicle locations; etc.) with the Regional Situational Awareness platform and the Regional Multimodal Traveler Information platform.
- CDOT Real-Time Operations Services branch staff:
 - Maintains detailed schedule of construction/work zones on freeways and major state highways.
 - Reports transportation management systems and infrastructure issues to CDOT Intelligent Transportation Systems and Network Services branch.
 - Manages Maintenance Decision Support System information processing system for snow clearance and roadway treatment on freeways and state highways.
 - Monitor status of active construction/work zones on state highways through an advanced transportation management system.
 - Shares maintenance and construction data (real-time work zone/lane closure information; real-time equipment/infrastructure failure status; real-time snow clearance vehicle locations; etc.) with the Regional Situational Awareness platform and the Regional Multimodal Traveler Information platform.



- Staff from local jurisdictions:

- Monitors health of transportation management systems and infrastructure, coordinating dispatch for repair as necessary.
- Deploys, operates and maintains asset management system.
- Deploys, operates and maintains a maintenance decision support system infrastructure on maintenance vehicle fleet.
- Deploys, operates and maintains maintenance decision support system information processing system for snow clearance and roadway treatment on local roadways.
- Schedules construction/work zones on state highways with CDOT Real-Time Operations Services branch.
- Monitors status of active construction/work zones on local roadways in real-time.
- Shares maintenance and construction data (real-time work zone/lane closure information; real-time equipment/infrastructure failure status; real-time snow clearance vehicle locations; etc.) with the Regional Situational Awareness platform and the Regional Multimodal Traveler Information platform.

- Public Highway Authority staff:

- Monitors health of transportation management systems and infrastructure, coordinating dispatch for repair as necessary.
- Deploys, operates and maintains an asset management system.
- Coordinates and dispatches infrastructure maintenance.
- Deploys, operates and maintains maintenance decision support system infrastructure on maintenance vehicle fleet.
- Deploys, operates and maintain maintenance decision support system information processing system for snow clearance and roadway treatment on tollway.
- Monitors status of active construction/work zones on tollway in real-time.
- Shares maintenance and construction data (real-time work zone/lane closure information; real-time equipment/infrastructure failure status; real-time snow clearance vehicle locations; etc.) with the Regional Situational Awareness platform and the Regional Multimodal Traveler Information platform.

Travel demand management service area

Description

Travel demand management offers a broad set of strategies to assist traveler to use the transportation system more efficiently. encourage modification of traveler behaviors. These strategies have a strong emphasis in encouraging mobility options that avoid or limit single-occupant vehicle travel (such as mode choice, departure time, route selection, etc.).

Several services areas are available as resources to support deployment of transportation demand management strategies.

Roles and responsibilities

- DRCOG's Way to Go program staff:
 - Deploys, operates and maintains the MyWayToGo.org platform (multimodal trip planning and ridesharing system).
 - Coordinates and deploys dynamic ridesharing services.
 - Coordinates with transportation operations personnel as part of transportation demand management project planning and development to leverage existing operations infrastructure and resources.
- Staff from transportation management associations:
 - Coordinates and deploys dynamic ridesharing services.

- CDOT Office of Innovative Mobility staff:
 - Coordinates with transportation operations personnel as part of transportation demand management project planning and development to leverage existing operations infrastructure and resources.
- Staff from local jurisdictions:
 - Ensures transportation demand management planners and transportation operations coordinate during project planning and development to leverage existing operations resources.
 - Coordinates with various share mobility providers deploying services within their jurisdictions.
- DRCOG staff:
 - Administers the Denver Region Shared Micromobility Portal.



Parking and curbside management service area

Description

Parking management across the region involves multiple entities (public and private) dynamically managing the available supply of parking in the region, which involves traveler information resources and fee payment resources.

Staff from public parking facilities (local jurisdictions, CDOT and RTD) monitor parking availability in real-time and share that data to support both parking coordination and to assist traveler decision-making. This involves the deployment and maintenance of systems that monitor parking availability, collect parking fees, accept reservations and provide traveler information.

Staff from local jurisdictions independently deploy, operate and maintain curbside access management systems that efficiently and dynamically manage the curbside for passenger drop-off/pick-up, commercial deliveries, metered parking and other curbside activity. These systems monitor curb space availability, collect fees, take reservations and share traveler information.

Roles and responsibilities

- Staff from local jurisdictions:
 - Deploys, operates and maintains parking management system(s) at public parking facilities and on-street parking.
 - Provides real-time parking supply and pricing information feeds for the Regional Situational Awareness platform, the Regional Multimodal Traveler Information platform and the universal trip planner and payment tool.
 - Deploys, operates and maintains curb access management systems that use the Open Mobility Foundation curb data specifications.
- CDOT and RTD staff:
 - Deploys, operates and maintains parking management systems at public parking facilities.
 - Provides real-time parking supply and pricing information feeds for the Regional Situational Awareness platform, the Regional Multimodal Traveler Information platform and the universal trip planner and payment tool.

Regional data management service area

Description

Regional data management is the collection, storage, sharing and subsequent use (such as analytics) of transportation-related data both collected by regional transportation systems and procured by other means.

Each transportation system individually gathers data, prepares analytics and manages the data while performing its necessary functions as monitored and controlled by the operators. Additionally, select transportation agencies augment their collected data/information with commercial sources. Operators rely on both real-time and archived data to make daily operational decisions while planners and researchers benefit mainly from archived data.

To enhance the decision-making capability of both operators and travelers the scope of their situational awareness and understanding of the regional transportation network is increased through access to three regional data platforms:

- Regional Situational Awareness platform – This platform provides operators a broad awareness of real-time travel conditions for all travel modes across the region. This platform is a map-based, interactive platform accessible through a website for authorized users. The source of data for this platform is select stakeholder data feeds that may be combined with data procured from other sources.
- Regional Performance Monitoring Archive platform – This platform provides operators and planners access to analytics and performance metrics for operations across the regional for all travel modes. This platform is a collection of interactive dashboards (illustrating performance at various scales as needed) accessible through a website for authorized users. The source of data for this platform is select stakeholder data feeds that may be combined with data procured from other sources.
- Regional Multimodal Traveler Information platform – Travelers are provided consolidated access to multimodal traveler information. This facilitates and improves traveler’s capabilities to compare and select various mobility options. This platform is a publicly available website that is map-based and interactive also providing for personalized customization, personalized trip planning, and trip reservations/payment.

Since multiple systems and multiple jurisdictions are involved, data governance is critical to ensure interoperability, cybersecurity and privacy.

Roles and responsibilities

- CDOT Intelligent Transportation System and Network Services branch and CDOT Office of Data Management staff:

- Collects and curates travel data and systems operations data under CDOT staff control.
- Deploys, operates and maintains data ecosystem, including key elements: real-time data hub and Advanced Data Analytics platform.
- Develops and maintains CDOT data governance for use of CDOT data, analytics and reports/deliverables.
- Complies with regional data governance for both provision and use of regional data, analytics and reports/deliverables.
- Maintains select data feeds to share data with the Regional Situational Awareness platform, the Regional Performance Monitoring Data Archive platform and the Regional Multimodal Traveler Information platform.

- CDOT regions staff:

- Collects and curates travel data and systems operations data under the region's control.
- Complies with regional data governance for both provision and use of regional data, analytics and reports/deliverables.
- Maintains select data feeds to share data with

the Regional Situational Awareness platform, the Regional Performance Monitoring Data Archive platform and the Regional Multimodal Traveler Information platform.

- Advanced Mobility Partnership staff:

- Leads and coordinates regional discussions regarding development and maintenance of supportive data governance policies and standards for public and private data sharing.
- Encourages regional partners to follow the key principles of data governance outlined in the Regional Mobility Data platform concept of 2022.

- DRCOG staff:

- Leads the definition and development of the Regional Situational Awareness platform.
- Leads the deployment and maintenance of the Regional Situational Awareness platform.
- Leads the definition and development of the Regional Performance Monitoring Data Archive platform.
- Leads the deployment and maintenance of the Regional Performance Monitoring Data Archive platform.

- Staff from local jurisdictions:

- Collects and curates travel data and systems operations data under jurisdiction's control.
 - Complies with regional data governance for both provision and use of regional data, analytics and reports/deliverables.
 - Maintains select data feeds to share data with the Regional Situational Awareness platform, the Regional Performance Monitoring Data Archive platform and the Regional Multimodal Traveler Information platform.
- Collects and curates travel data and systems operations data under jurisdiction's control.
 - Complies with regional data governance for both provision and use of regional data, analytics and reports/deliverables.
 - Maintains select data feeds to share data with the Regional Situational Awareness platform, the Regional Performance Monitoring Data Archive platform and the Regional Multimodal Traveler Information platform.
- Staff from RTD, the CDOT Division of Transit and Rail (and other transit agencies as applicable):
 - Collects and curates systems operations data.
 - Complies with regional data governance for both provision and use of regional data, analytics and reports/deliverables.
 - Develops, operates and maintains the universal trip planning and reservation tool that is built upon the information available from the Regional Multimodal Traveler Information platform.
 - Maintains select data feeds to share data with the Regional Situational Awareness platform, the Regional Performance Monitoring Data Archive platform and the Regional Multimodal Traveler Information platform.
- Staff from the Public Highway Authority and the Colorado Transportation Investment Office:



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