2019

AZTech TRAFFIC MANAGEMENT AND OPERATIONS PERFORMANCE INDICATORS BOOK

FREEWAYS • ARTERIALS • INTEGRATED CORRIDORS • INCIDENTS
TRAVELER INFORMATION • SPECIAL EVENTS • TRANSIT

Developed by the
AZTech Strategic Steering Committee
and Operations Committee

AZTech

REGIONAL INTELLIGENT TRANSPORTATION SYSTEMS PARTNERSHIP

PARTNERS / CONTRIBUTORS

The AZTech Regional Intelligent Transportation System Partnership wishes to thank and acknowledge the contributors of the AZTech Traffic Management and Operations Performance Indicators Book. The following member agencies of the AZTech Strategic Steering Committee and AZTech Operations Committee collaboratively contributed data, graphics, text and other information towards the development of this publication. All data reported in this book was provided by the respective agencies:

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FOREWORD

EXECUTIVE COMMITTEE

"What gets measured gets done, what gets measured and fed back gets done well…" — John E. Jones

The Phoenix metropolitan region and the AZTech Partnership have made significant traffic operations investments and impressive strides in advancing traffic management and operational strategies. For nearly two and a half decades, local, county and state agencies in the region have been very focused on improving the way we manage and operate the transportation network. We all strive to improve these functions within our jurisdiction and are also focused on how decisions influence our neighboring agencies…and most importantly, the travelers.

Continuous evolution of connected and automated vehicle technologies is a major topic in the transportation world. A 2015 Executive Order from the Governor opened Arizona up for vehicle manufactures and technology developers to test automated vehicles on Arizona roadways. Since then, a wave of automated vehicle innovation continues to pour into Arizona and created a spark within the region's transportation agencies to understand how this new technology will impact the operations environment and the roles that local agencies have in it. The AZTech Partners have banded together to look for ways to take on this challenge and consider ways that the region will need to adapt to the next generation of transportation and mobility.

In 2017, freeway, arterial and transit agencies within the region partnered to apply for and were selected to receive a federal Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Grant for the implementation of a model deployment for Integrated Corridor Management (ICM) and connected vehicle (CV) initiatives along the Loop 101. The successful pursuit of this grant not only highlights the Phoenix Metro area as a leader in deploying advanced technologies and strategies for operations, but it is a testament to the strong partnerships and collaboration among the region's transportation partners and the commitment to improving transportation operations at a regional level.

Driven by the AZTech Committees, the 2019 Performance Indicators Book is a reflection of the transportation environment. In this 2019 Book, you will see a focus on areas such as data, the integration of multi-modal and multi-agency transportation networks and systems, new mobility options, public-private partnerships, and traveler information. Measurable benefits have been realized with applications such as signal timing optimization, freeway ramp metering, and adaptive signal control such as along Bell Road through the region. ITS and operations continue to be a solid investment of agency resources.

Many thanks to those agencies and partners that provided the data and analysis for this fifth publication of this regional traffic management and operations focused performance report. There is a concerted effort at the AZTech Executive Committee to continue to refine those measures that are meaningful and create a framework for ongoing measurement, reporting, and improvement in how we operate our transportation network.

Executive Committee Chairs

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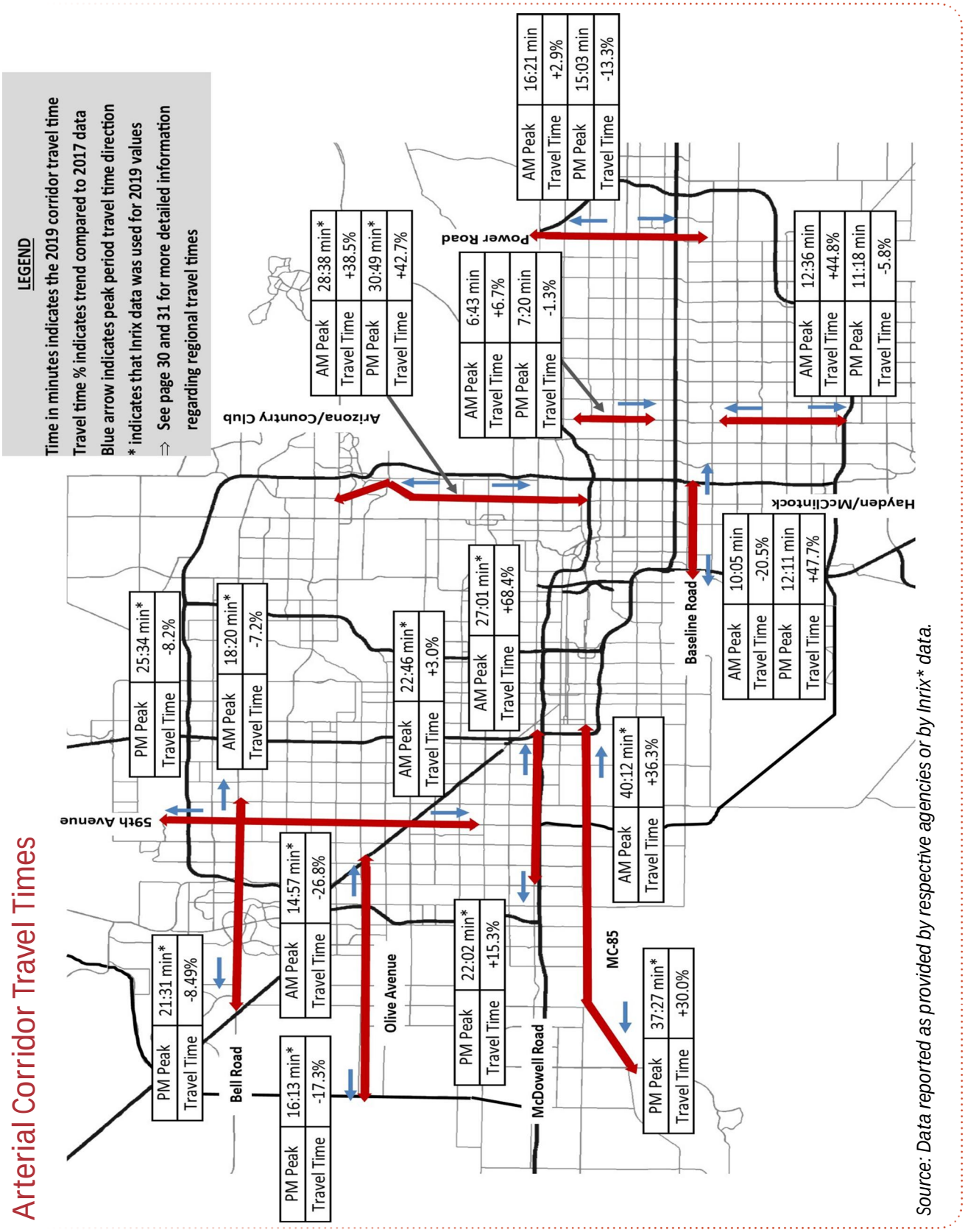
AZTECH PERFORMANCE DASHBOARD

Performance trending in favorable direction *Performance is trending in an unfavorable direction.*

Goal/ Performance Indicator	CY 2013-2014	CY 2015-2016	CY 2017-2018	CY 2018-2019	
Freeways					
Percent of Miles Congested (Out of Total of 422 Miles Measured as of 2019)	31.6%	36.7%	37.2%	33.6%	Overall freeways are experiencing less congested miles where average vehicle speeds drop below 50 mph
Percent of Time Congested Per Mile (Out of Total of 422 Miles Measured as of 2019)	25.2%	32.1%	39.6%	33.4%	Overall freeways are experiencing less congested time where average vehicle speeds drop below 50 mph
Arterials (*new and historical data provided by third party)					
Bell Road Westbound PM Peak Travel Time—35th Avenue to US-60	22:31 min	22:06 min	22:58 min	22:46 min	On average took less time to travel along this corridor in 2019
McDowell Road Eastbound AM Peak Travel Time—83rd Avenue to I-17	10:58 min	24:43 min	24:35 min	27:01 min	On average took over 2.5 minutes longer to travel along this corridor in 2019
Hayden Road/McClintock Drive Northbound PM Peak Travel Time—Loop 202 to Shea Boulevard	29:18 min	29:56 min	29:08 min	29:57 min	On average took longer time to travel along this corridor in 2019
Arizona Avenue/Country Club Drive Northbound AM Peak Travel Time—Guadalupe Road to Loop 202	6:34 min	6:17 min	6:29 min	6:31 min	On average took slightly more time to travel along this corridor in 2019
Average Arterial TMC Hours with Ability to Respond Per Week	44 hours	44 hours	44 hours	50.5 hours	77% of agencies also have on-call after hours support
Incident Management—Freeways and Arterials					
Percentage of Secondary Vehicular Crashes Out of Total Crashes (ADOT Motor Vehicle Division Crash Facts	6% (2011)	6.3% (2015)	2.6% (2016)	2.2% (2018)	Reduction of secondary crashes well below national average
Total Crashes (ADOT Motor Vehicle Division Crash Facts reported only as state values)	103,637 (2012)	109,554 (2014)	126,987 (2016)	127,056 (2018)	Slight increase although statistically similar value as compared to 2016
Number of Secondary Crashes when REACT is Present	0	0	0	0	Continues to meet goal
Traveler Information					
% of Urban area Freeway DMS and % of Arterial DMS Posting Travel Times in the Metro Area	30% fwy 5% arterial	58% fwy 8% arterial	53% fwy 10% arterial	100% fwy 0% arterial	DMS use for travel time purposes was increased on the freeway and decreased along arterials
Social Media Followers	68,037	232,512	500,818	530,353	Increase of approximately 6% in last two years of Social Media followers of agencies
Phoenix Fire CAD and Mesa 911 to RADS to AZ511	32,199	31,199	41,131	50,304	Mesa 911 for Police and Fire began sending data to RADS in August of 2017
Transit					
Transit Schedule Adherence (Percent of Time Transit Meets Schedule)	95.0%	92.7%	90.6%	88.9%	Less schedule adherence for Bus, 98.4% Light Rail on-time performance (up from 93.2% in 2017)
Number of Light Rail Transit Boardings Per Year	14.29 million	14.28 million	16.51 million	15.08 million	Light Rail continues to be a well-received service for the traveling public—while boardings may be down, improvements to service and signal coordination has improved on-time performance

Arterial Corridor Travel Times



Source: Data reported as provided by respective agencies or by Inrix data.*

AZTech and the Performance Indicators Book

AZTech is a regional traffic management and operations partnership in the Phoenix metropolitan area that includes transportation agencies and public safety agencies in the metropolitan area. The coalition, led by the Maricopa County Department of Transportation (MCDOT) and Arizona Department of Transportation (ADOT), supports the application of intelligent transportation systems (ITS) technologies across jurisdictional boundaries for managing regional traffic. The goal is to achieve more efficient mobility, less congestion, and a higher level of safety for travelers throughout the metropolitan area.

The 2019 AZTech Performance Indicator (PI) Book is a compilation of key regional transportation management and operations performance indicators that provide a snapshot of the transportation network in Maricopa County during the calendar years of 2018 and 2019. The successes that have accompanied AZTech efforts and partner agency investments have elevated the need to actively measure the operational performance of the regional transportation network. In order to share these findings, AZTech partners have collaborated to provide data and stories to develop the book on a biannual basis. This book, along with previous publications, is also available electronically for download at: http://aztech.org/about/performance-indicators-book.htm

The 2019 PI Book is organized into the following sections, which represent the key performance areas in the region:

- Emerging Technologies—AZTech involvement in activities that are nationally recognized
- Integrated Corridor Management—Integrated corridor management (ICM) activities related to planning or projects that connect freeway operations to arterial operations
- Using Data as an Operational Decision Making Tool —Activities that have been accomplished and things that have happened that give examples for how the AZTech partners are using their abilities to improve situational awareness of the network or of the travelers on the network
- Smarter Transportation and Mobility—Agencies are pursuing smarter technology and expanding their operational capabilities
- Traveler Information—Better traveler information being provided that starts with the right data being collected and results in multiple methods for dissemination
- Public Safety Coordination—Improved coordination with police using ITS tools
- Special Events—Agencies' activities surrounding and supporting special events in the region
- Transportation Systems Management and Operations Planning—Agencies that are undertaking a look at their agency through a TSMO lens
- Multimodal Coordination—Transit, bike, pedestrian , and rail activities in the region related to ITS

Themes in the 2019 Book

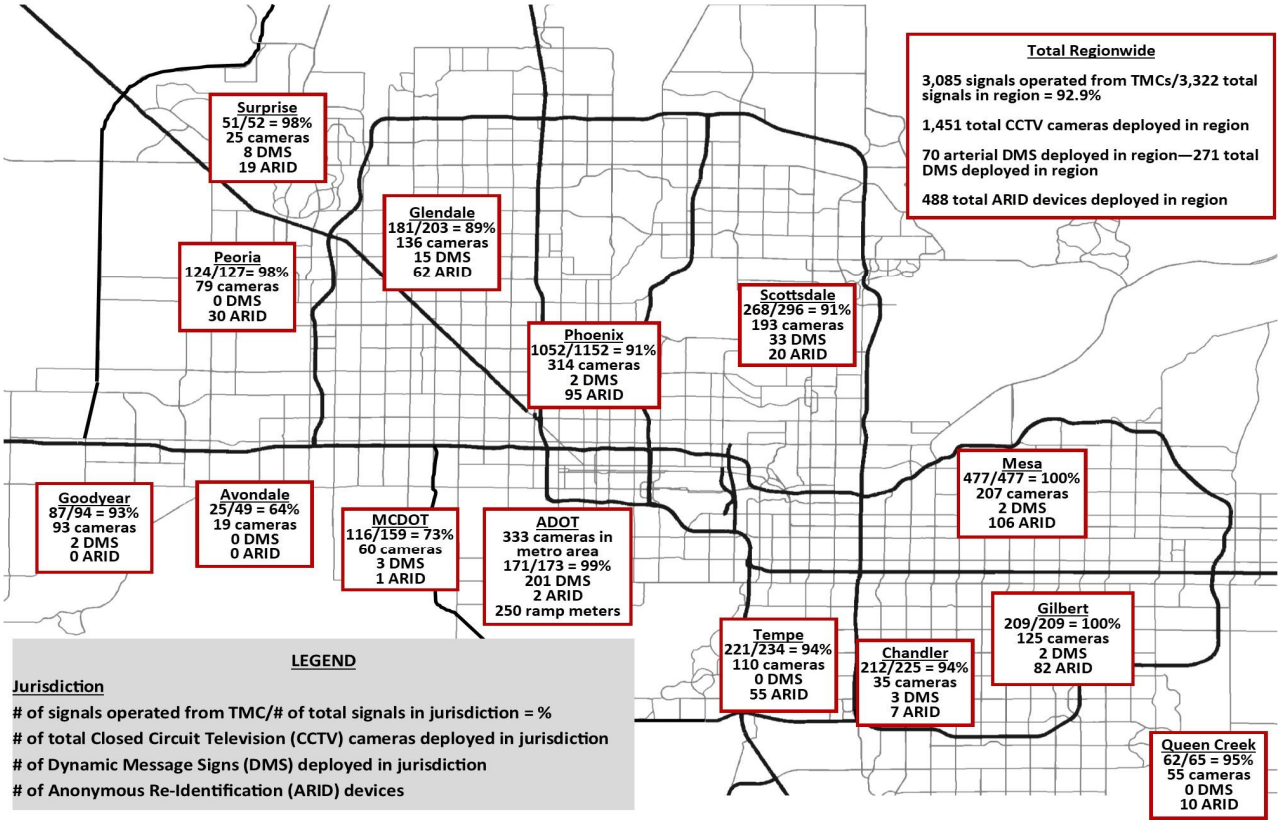
In addition to the measures reported in all Books, three themes arose during the development of the 2019 Book. These represent major regional initiatives for the 2018—2019 calendar year time period:

Leading Edge Technologies—This region has continued to be in the spotlight nationally on numerous initiatives and is the receipt of major federal grants, recognition from national centers, and invitations to participate in national initiatives and developments. Work zones, traveler information, connected vehicles, autonomous vehicles, integrated corridor management, and many other areas are leading edge initiatives being piloted in this region.

Transit—There are many strides that will greatly enhance the transit rider options for service, traveler information, and schedule adherence due to technology enhancements in the roadways.

Leadership—Training, self-assessing, and evaluating capabilities has been a hallmark for this region to continue to improve and find new opportunities to collaborate and share information.

Agency Intelligent Transportation Systems Infrastructure



Source: Data reported by respective agencies (as of December 2019)

AZTech Action Plan

In 2015, the AZTech Implementation Plan was developed through the collaboration and partnership of the member agencies to identify priority implementation strategies for the region to pursue. In 2016, the AZTech Action Plan was developed to translate the strategies in the Implementation Plan into tangible projects and activities to advance the implementation priorities for the region. The purpose of the Action Plan is to specifically define actionable activities along with scope, champions, and timeframe for implementation for the following AZTech Committees and Working Groups that are applicable to the purpose of the groups:

- Executive Committee
- Strategic Steering Committee
- Operations Committee
- TIM Coalition
- TMC Operators Working Group
- Media & Communications Task Force

Projects and initiatives that are included in the Action Plan were not being assigned or dictated, but instead were those that were selected by an AZTech Committee or Working Group as a priority warranting action. The individual Action Plan project sheets have been owned and driven by the AZTech members and much has been accomplished to date. AZTech members keep an accurate recording of Action Plan activity progress and discuss progress and needs to support implementation during regular Committee and Working Group meetings.

The AZTech Operations Implementation Plan has begun the update process in 2019 to define a new status of current priorities and identify future priorities of each of the AZTech Committees and Working Groups. The Action Plan will be updated in 2020 to reflect new activities and initiatives to support priorities for implementation.

TABLE OF CONTENTS

SECTION 1 INTRODUCTION

What is AZTech

AZTech is a regional traffic management and operations partnership in the Phoenix metropolitan area. All of the major governmental transportation agencies in the region are members, along with public safety agencies and several private technology and media companies. The coalition, led by Maricopa County Department of Transportation (MCDOT) and Arizona Department of Transportation (ADOT) and working through several collaborating committees, supports the application of intelligent transportation systems (ITS) technologies for managing regional traffic. The goal is to achieve more efficient mobility, less congestion, and a higher level of safety for travelers throughout the metropolitan area.

AZTech began as one of four regions selected for a Federally-sponsored Intelligent Transportation Systems Metropolitan Model Deployment Initiative in 1996. Throughout the initial demonstration project and continuing into a permanent partnership, AZTech quickly evolved into a successful regional traffic management and operations entity. The partnership has carefully integrated individual traffic management strategies and technologies for the region's benefit, yet has retained most operational control protocols important to individual units of government. In 1997, AZTech adopted several Values, Goals, and Strategies to guide its growth from a demonstration project to what has become a full-fledged regional partnership focusing on:

Values

- Collaboration
- Leadership
- Integration
- Results

Goals

- Integrate existing ITS infrastructure into a regional system
- Establish a regional integrated traveler information system
- Expand the transportation management system for the Phoenix metropolitan area

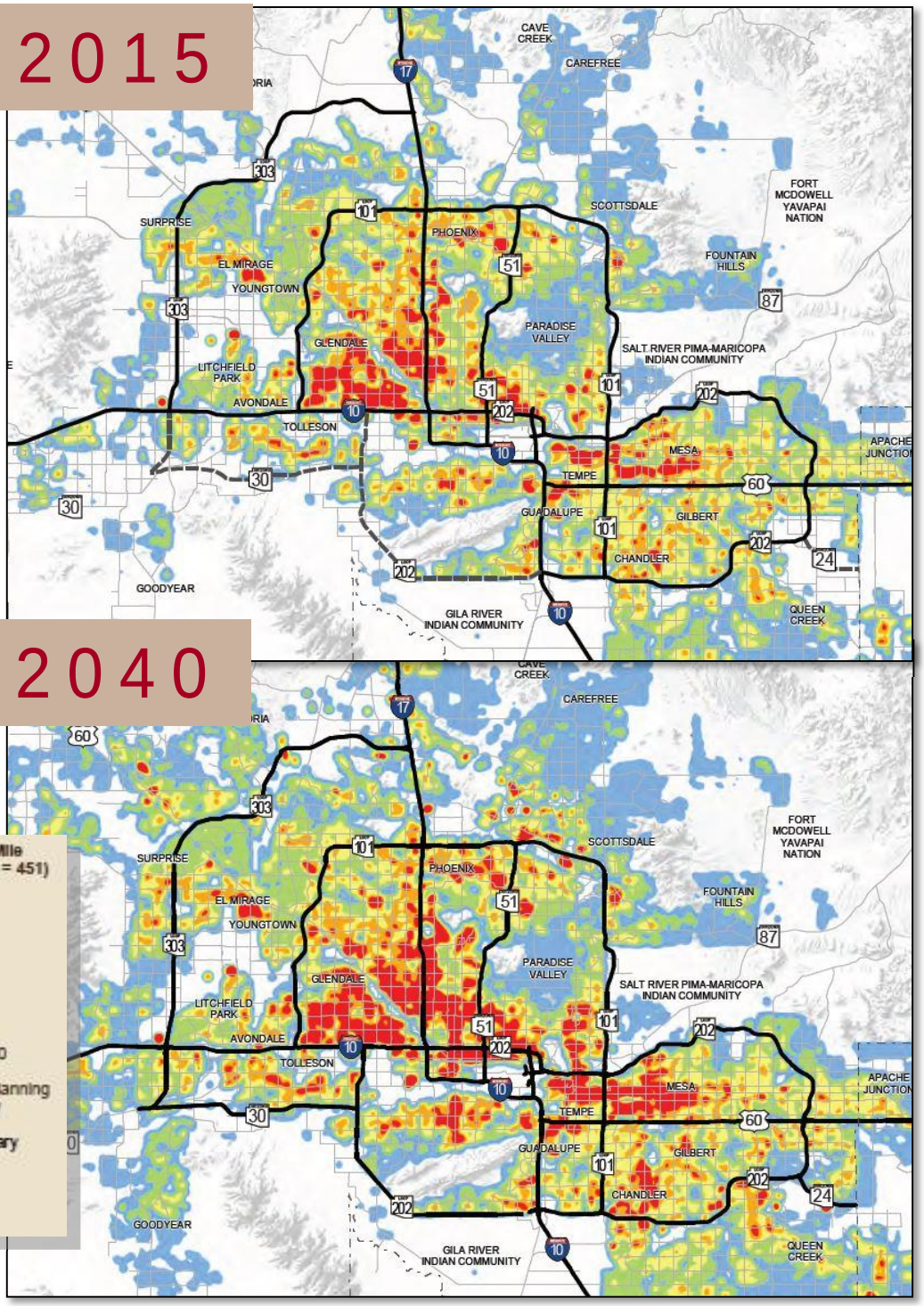
Strategies

- Establish Education and Outreach Programs
- Expand and Strengthen Partnerships
- Optimize Regional Operations and Management
- Plan, Develop, and Deploy Integrated Regional Systems
- Research and Test New Technological Opportunities

PHOENIX METROPOLITAN REGION

The population for Maricopa County grew more than 15% between 2010 and 2018 (United States Census Bureau). Peak travelers, those who begin a trip by any mode during the peak period, are growing faster than the general population growth and the growth of arterial lane miles. With funding not readily available for infrastructure expansion, the emphasis is shifting towards more efficient management and operation of the existing transportation system.

For the past several decades, the region has been one of the fastest growing metro areas in the U.S. As calculated by the 2017 MAG Socioeconomic Projections, by 2040, the MAG metropolitan area is projected to increase its population by more than 51 percent over 2015, with an anticipated total of 6.5 million people. Population concentration maps are shown here for 2015 and 2040.



Source: MAG 2040 Regional Transportation Plan

Characteristics of Performance Indicators

In support of operational policy and decision making, strategic performance measures monitor the implementation and effectiveness of an organization's strategies, determine the gap between actual and targeted performance, and determine organization effectiveness and operational efficiency. Performance indicator characteristics include:

- Focusing attention on measures that will inform the outcome toward the goal
- Identifying accomplishments, not just work that is performed
- Providing a common language for communication and measurement
- Being clearly defined in terms of owner, unit of measure, collection frequency, data quality, expected value (targets), and thresholds
- Being valid - to ensure measurement of relevant metrics relating to goals
- Being verifiable - to ensure data collection accuracy

Key Regional Indicators

There is no building our way out of congestion; instead, transportation agencies are using better technology and data analytics to relieve congestion.

The 2019 Global Traffic Scorecard by Inrix revealed that urban drivers in America lost an average of 97 hours a year due to congestion, costing them nearly $87 billion in 2018, an average of $1,348 per driver. Phoenix metropolitan region is designated as a Major City in the report. Statistics from 2019 listed below highlight the importance of measuring performance to determine the effectiveness of transportation management strategies.

- 33rd—rank of Most Congested City in the Country
- 35—hours of driving time spent in congestion (was 34 hours in 2017 and 51 hours in 2015)
- $518—cost of congestion to each driver each year

The Urban Congestion Report (UCR) published in February 2019 using the Federal Highway Administration's Highway Performance Monitoring System provides traffic volume data by road section. The following snapshot of performance metrics cited in the report related to the Phoenix metropolitan area:

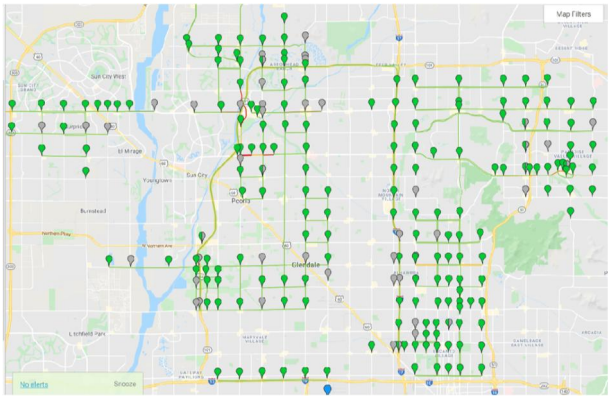
- 2 hours and 59 minutes of average daily congestion—reduction of 16 minutes from 2017.
- 1.23 Travel Time Index (measure of peak period versus off-peak period travel times)— reduced from 1.31 since 2014.
- 1.72 Planning Time Index (measures added planning time to take the same trip because of unreliable conditions) - reduced from 2.49 in 2017.

EMERGING TECHNOLOGIES

SECTION 2

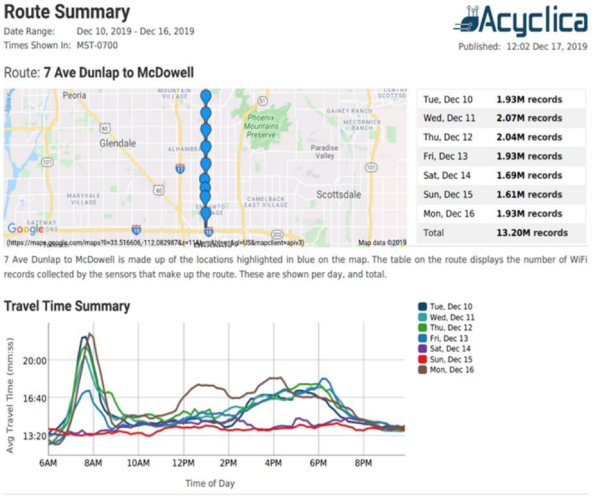
This section describes AZTech involvement in nationally recognized activities related to emerging technology applications.

Evaluation of ARID Technologies



Anonymous Re-Identification Detection (ARID) sensors have been deployed in several jurisdictions in MAG region. The lack of standard in anonymizing the MAC address resulted in incompatible data between vendor products that limit the applications across jurisdictions.

The local jurisdictions that currently operate ARID-based travel time monitoring system include Chandler, Gilbert, Glendale, MCDOT, Mesa, Peoria, Phoenix, Queen Creek, Scottsdale, Surprise, and Tempe. The City of Tempe's ARID system is used to actively manage the City's arterials, monitor the state of their transportation network in real-time and compare the current state to historical congestion levels. The City of Phoenix uses the regional map provided by their ARID vendor, Acyclica, to view automated travel time reports, delay reports, turning movement counts, and speed data. The City of Phoenix also uses the ARID infrastructure to increase real-time visual capabilities by 11%. Images from the City of Phoenix system is provided to the right.



ARID sensors are a valuable tool that enables the City to provide safe and efficient operations of arterials. Gilbert, Mesa, and Tempe partnered on a regional project to gather and share ARID data across much of the east valley through the East Valley Travel Time Map project. The EVTTM received the 2018 American Public Works Association Technical Innovation Award in recognition of this forward-thinking project that has pioneered the addition of arterial travel time data on the AZ511 statewide map.

MAG Emerging Technologies On-Call Field Pilot Projects

In mid-2019, MAG released a Statement of Qualifications for Emerging Technologies Field Pilot Projects. This mechanism was a new and innovative way to demonstrate latest and greatest technologies within the MAG region. The On-Call program will use $400,000 in a variety of contracts in partnership with MAG member agencies. By the end of 2019, there were 19 on-call contracts executed and four under negotiation. Pilot projects have been initiated for the jurisdictions of Glendale, MCDOT, Phoenix, Scottsdale, Mesa, ASU, and Chandler.

Piloting Micro Transit in Glendale

Microtransit is an emerging transit mode that offers flexible and dynamic demand-driven transportation solutions to areas with limited transit access or where traditional fixed-route service is simply not feasible. In 2019, Valley Metro, a MAG member city and Transloc research and plan the deployment of the first true Microtransit service in the Phoenix metropolitan area. The pilot is scheduled to kick off in March 2020.

The goal of the pilot is to answer questions about serving both transit and paratransit riders' mobility needs, to expand the reach of existing transit service to areas that may not have a propensity for transit, and to understand changes in technology and service. The plan is to have two zones, served by two vehicles each, and study the level of service offered, riders' feelings about the service, and understand how a microtransit service can integrate into existing transit and paratransit operations. The pilot is scheduled to run from March through August 2020, with all project stakeholders carefully monitoring the service throughout and making decisions whether the service should continue after the pilot is ended.

ATC Cabinet in Mesa for Light Rail

The City of Mesa, which has nearly 500,000 residents, is Arizona's third largest city. Supporting the growing traffic management system, the city contains 466 traffic signals, 4 miles of Light Rail Line, and 2 miles are under construction containing 9 signals and 10 Advanced Traffic Control (ATC) cabinets. ATC is used as an energy conservation technology as well as a tool to increase public safety. Public safety is affected by the cabinets, for the service assembly contains the flasher enabling the signal to remain in flash while rebuilding the signal cabinet. Not only is public safety effected but so is the safety of the city staff and technicians. One benefit discovered by the technicians was that the ATC cabinet has reduction of exposure to arch flash hazards. This allows for the technicians to repair the system without having to wear arc flash personal protective equipment in the Arizona heat.

In 2015/2016, City of Mesa began requiring ATC to be included in all new builds. Since then the following projects have been completed:

- Deployed McCain controller 2/ D4 at Broadway/ Alma School for new fire station
- Stadium Connector Project which included plans for 3 ATC cabinets and controllers

Today, the City of Mesa has 5 ATC Cabinets with McCain/D4 controllers running and 4 additional signals are to be activated for Gilbert Road Extension to begin revenue service as well as containment of D4 deployment to the LRT line.

Future plans include the 2017 standard detail of a combo foundation to accommodate 352i ATC, TS2, or 350iATC as well as the continual testing of other ATC controllers in the McCain cabinet.

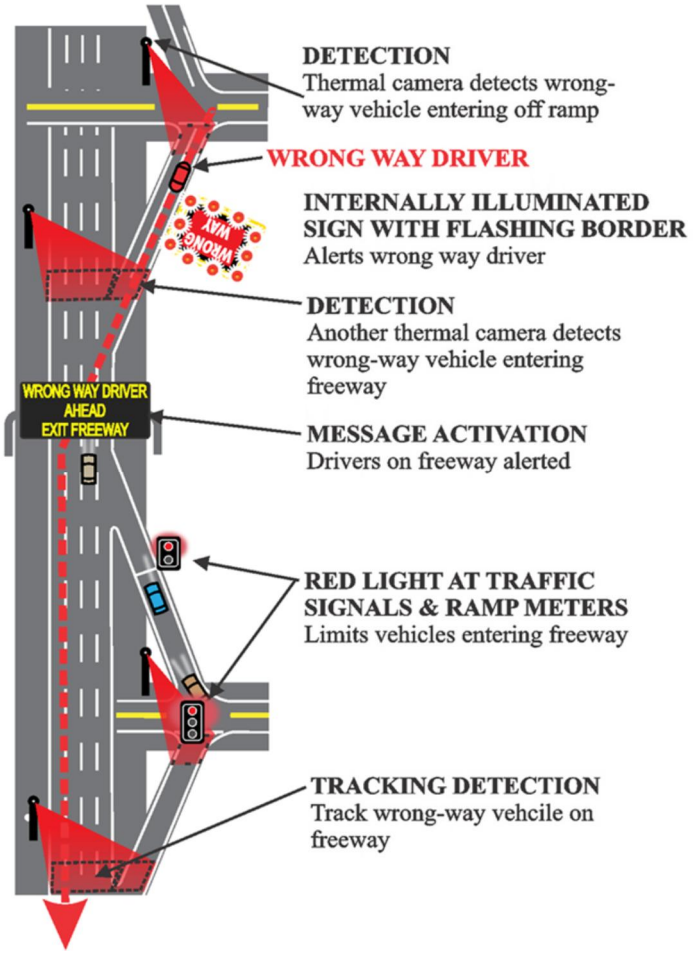
ADOT Wrong-Way Driver Pilot System

In January 2018, the Arizona Department of Transportation's first-in-the-nation wrong-way driver pilot system along Interstate 17 in Phoenix became operational. The 15-mile system is located on I-17 between the I-10 "Stack" interchange and Loop 101. The design, construction and integration of the $4.2 million system were funded by the Maricopa Association of Governments (MAG).

Thermal cameras were used for the primary detection at the ramp and mainline/freeway points of entry. The video clips from the intersection cameras provide initial notification and subsequent tracking that allow Traffic Operations Center (TOC) operators and State Troopers in the TOC to visually verify and track the wrong-way (WW) incursion.

Combined with the thermal detection is enhanced warning signage. Along with the lower and oversized static Wrong-Way and Do Not Enter signs, this pilot project added internally illuminated wrong-way signs (IIWWS) with a flashing LED border which was installed approximately 600 ft upstream from the freeway exit ramp stop bar. The pilot project has documented a significant number of vehicles that have self-corrected on the freeway exit ramp that may have been influenced by the placement of either the IIWWS with a flashing LED border or the oversized and lowered WW signs.

The backbone of the detection pilot system is a Decision Support System (DSS). The DSS allows the initial detection to trigger the system automatically to deploy all countermeasures including the automatic positioning of Closed Circuit Television (CCTV) cameras, the automatic population of warning messages to upstream Dynamic Message Signs (DMS), turns the signal face on the upstream ramp meters to a steady red indication and notifies DPS Dispatch.



During the data collection period 109 incursions occurred within the pilot limits. Of those 109 incursions 88% of the vehicles self-corrected on the exit ramp. Of the 12% that did not self-correct on the ramp two resulted in an injury crash before law enforcement could intercept the errant vehicle.

Based on the results of the deployed Wrong Way Detection (WWD) pilot system on I-17, ADOT has developed solutions that can be applied throughout Arizona. These solutions will not include all of the automated countermeasures that were a part of the pilot system, but will include the integral components that will be used as a viable early detection system to provide an advanced WWD incursion notification to law enforcement. The future WWD detection plan will consist of two different deployments that either fit an urban or rural environment. The deployment locations will be prioritized by evaluating both historical crash data and DPS's WWD contact data.

Arizona Pursues Connected Vehicle Technology to Improve Safety

In 2007, the Arizona Connected Vehicle Consortium (ACVC) was created to form a partnership between the Maricopa County Department of Transportation (MCDOT), the Arizona Department of Transportation (ADOT), the University of Arizona (UA), and the U.S. DOT with the joint purpose of improving traffic safety and incident management across the state. Under this organization, the MCDOT SMART*Drive* Program was created with a primary effort on improving emergency responder safety within intersections.

Since then, the program has expanded to include the Anthem Connected Vehicle (CV) Test Bed, which includes an application developed by the research team at University of Arizona, Multi-Modal Intelligent Traffic Signal Systems (MMITSS), which features an algorithm that improves traffic signal operations through innovative detection capability, prioritization, and adaptability. The Anthem Test Bed has been demonstrated to interested parties from around the world. The table shows the number of attendees for each demonstration and the number of attendees that participated. Photos from some of the events are shown as well. The program is further supported by the AZTech Regional Partnership that brings private and public agencies together. These agencies also contribute data to the Regional Archived Data System (RADS) to assist with coordinating ITS processes, including CV improvements.

AUDIENCE	#	DATE(S)
Greater Phoenix Economic Council (GPEC)	13	3/19/18
National Association of County Officials	20	9/27/18
NRITS (National Rural ITS) & ITS Arizona Annual Conference & Arizona Transportation Association; AzTA Board	25	10/22/18
Japanese Delegation	6	12/12/18
City of Montreal	20	4/30/19
NCHRP - National Cooperative Highway Research Program - State of the Art Review of Cooperative Automated Transportation (CAT Systems); State Farm	25	12/5/19

CV is included as part of the development of the new Regional Transportation Plan (RTP) by the Maricopa Association of Governments (MAG), as well as the Transportation Safety Plan. CV is considered part of smart city development. As such, MAG has initiated a Smart Region Framework, including several smart domains to aid in linking smart city applications across the Phoenix Metropolitan Area. The domain, *Smart Transportation*, will use ATMS and CV to improve safety by lessening crash rates and better traffic flow.

INTEGRATED CORRIDOR MANAGEMENT SECTION 3

This section includes activities related to planning or projects that connect freeway operations to arterial operations.

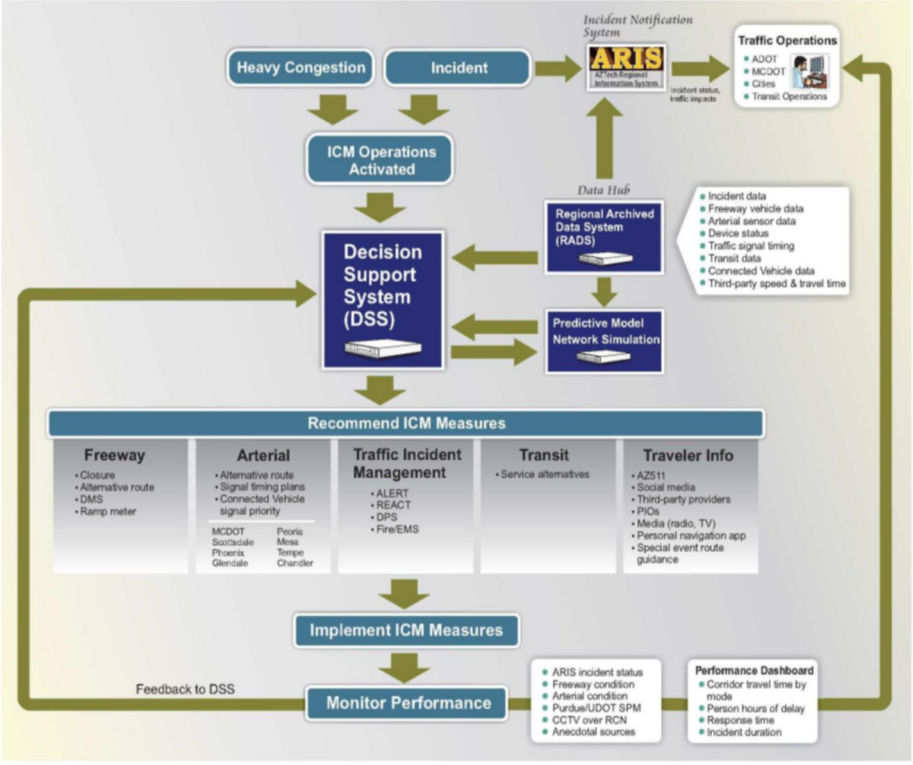
Loop 101 Mobility Project

Integrated Corridor Management has been a key focus for agencies in the region for over a decade. Planning for ICM resulted in a pilot ICM program on Loop 101 in Scottsdale that was able to develop and test improved notification processes, expanded arterial incident response strategies, and traffic re-routing strategies on parallel arterials. These experiences provided a pivotal foundation for the region to successfully secure a $6M federal grant through the Advanced Transportation and Congestion Management Technologies Deployment Program (ATCMTD). The Loop 101 Mobility Partnership was formed and expands the pilot ICM program to include the entire 61-mile freeway corridor. Tasks for the initial phase got underway in 2019, including building the stakeholder coalition, mapping out operations planning tasks and initiating systems engineering activities.

The Loop 101 Mobility Project will address the collective goals of reducing congestion, increasing travel time reliability, and improving incident and event management on the Loop 101 freeway and adjacent arterials. The Project supports regional mobility, accessibility of essential health and educational services, and economic development for the Loop 101 corridor.

The proposed technologies to be deployed, tested, and evaluated as part of the Project include: (develop up an abbreviated summary of the key technologies)

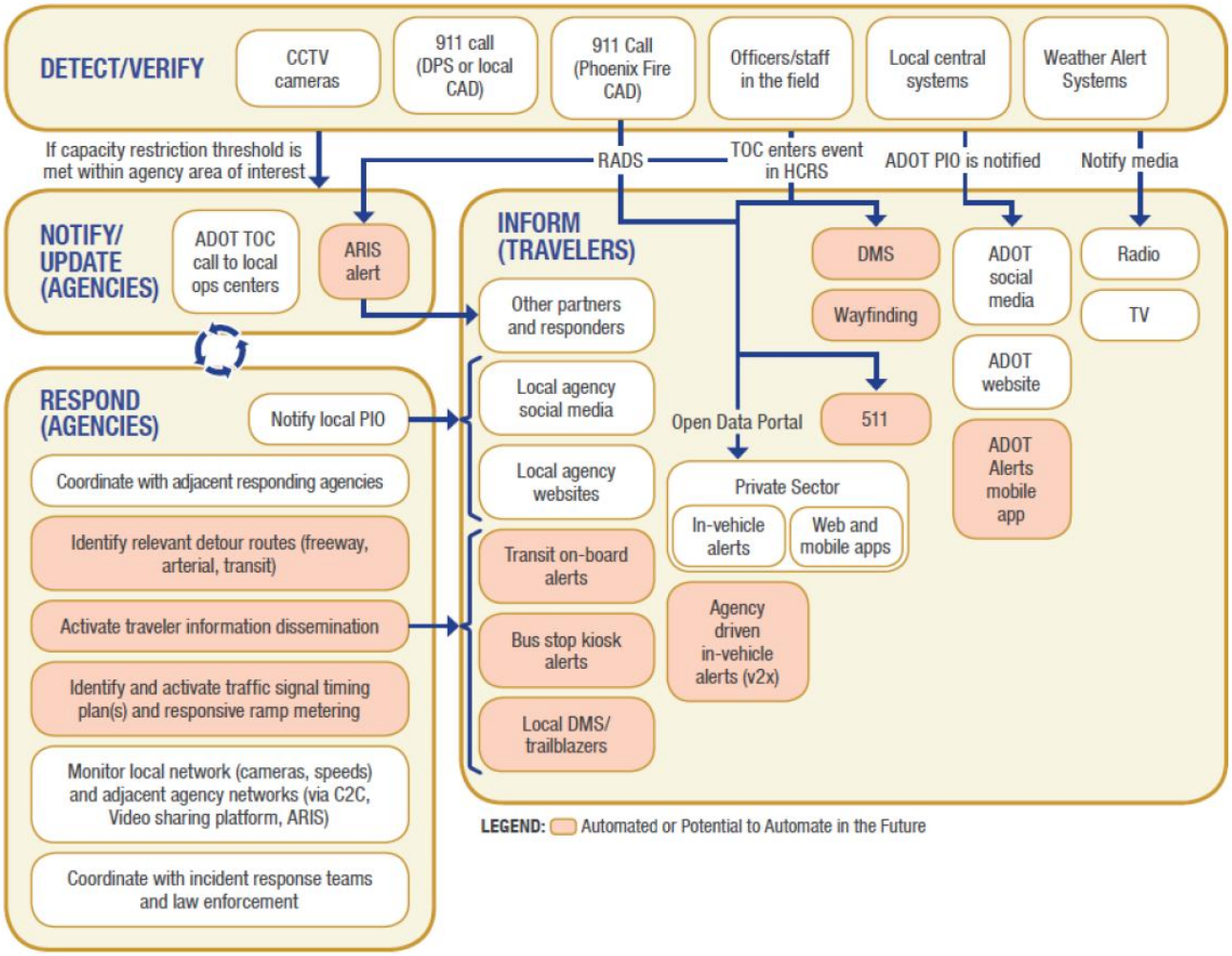
Loop 101 Mobility stakeholders include the Arizona Department of Transportation (ADOT); Maricopa County Department of Transportation (MCDOT); Valley Metro; Arizona Department of Public Safety (AZDPS); Maricopa Association of Governments (MAG); the cities of Glendale, Mesa, Peoria, Phoenix, Scottsdale, Chandler and Tempe; Salt River Pima Maricopa Indian Community; the University of Arizona and Arizona State University.



I-10 Integrated Corridor Management Plan Completion

Maricopa Association of Governments (MAG) was awarded a federal grant to conduct an ICM Development Planning Study along the I-10. ICM has been shown to reduce average delay up to 26 percent, reduce number of vehicle stops up to 42 percent, and increase average speeds up to 9 percent on arterials with traffic signal control. The ICM study area includes the I-10, the adjacent arterials and associated transit facilities between Loop 101 in the West Valley and Loop 202 Red Mountain Freeway in the East Valley. The Plan looks at how non-recurring events, such as crashes, work zones and special events impact transportation operations on I-10 corridor facilities and what types of operational strategies and multi-agency coordination procedures can be put into place to help agencies best respond to and manage traffic during those times.

Phase 2 of the I-10 ICM Project began in 2017 and includes the development of an ICM Concept of Operations, an Analysis, Modeling and Simulation (AMS) Plan, and Systems Requirements Specifications. The completion of Phase 2, which occurred in Fall of 2018, sets the region up to pursue implementation of the identified ICM concept along the corridor. The following is an excerpt from the Concept of Operations that describes communication paths and tools to be used between agencies during ICM implementation.



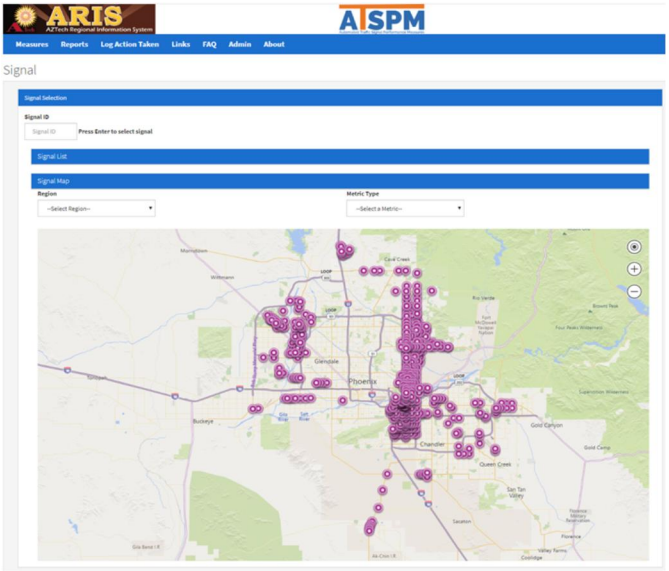
USING DATA AS AN OPERATIONAL DECISION MAKING TOOL

SECTION 4

This section includes activities that show how the AZTech partners are using their abilities to improve situational awareness of the network

AZTech Regional Automated Traffic Signal Performance Measures (ATSPM) System Growth

Maricopa County is one of the fastest growing counties in the United States. With the growth in population comes increased travel times and delay on the roadways. Traffic Engineers continue to search for tools that aid in efficient real-time traffic operations while reducing the time it typically takes to troubleshoot traffic signal issues and improve travel time reliability. Automated Traffic Signal Performance Measures (ATSPM) is a proven innovation for improving efficiencies in real-time traffic signal operations. ATSPMs is a suite of performance measures, High Resolution Data (HRD) collection and data analysis tools used to support objectives and is a performance-based approach to manage traffic signal programs in real time that the AZTech Regional Partnership has deployed.



2015 Phase 1
- Pilot project initiated
- 7 Agencies -10 signalized intersections each integrated
- Server upgrades with one server approach
- Integrated UDOT ATSPM4.0
- Held FHWA ATSPM Workshop

2017 Phase 2
- Troubleshooting controller and data retrieval
- Increased MCDOT & Mesa to 100+ signalized intersections in system

2018 Exploration
- Explored vendor offered solutions
- MCDOT completed 2 corridor retiming projects using ATSPM instead of traditional approach
- Push for use in daily operations

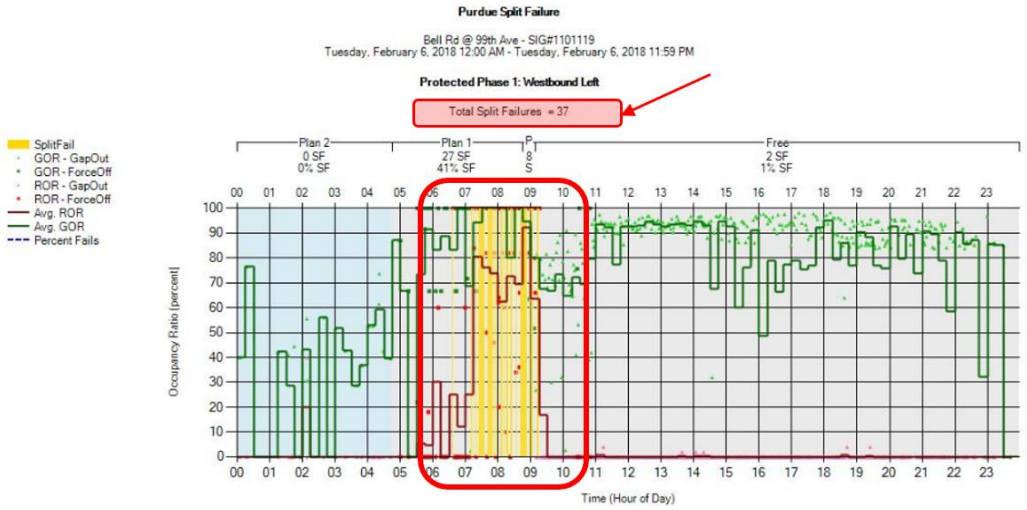
2019 Education
- Hold User's Workshops
- Increased the number of signals
- Increased agency participation

The exploration in this space began in 2015 and the ATSPM system continues to grow and evolve. There have been many phases to the deployment leading us to were our system is today.

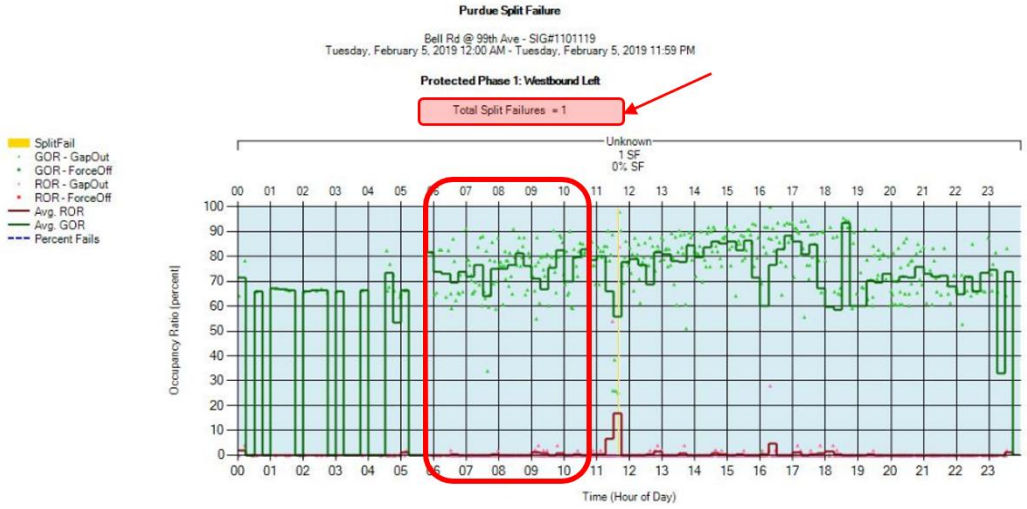
In 2018, vendor offered ATSPM solutions were explored. Ultimately, the partners found the solutions to be costly and offered limited expansion capabilities for the region. During this phase, MCDOT moved forward with completing two corridor retiming projects using ATSPM in-place of the traditional approach with developing Synchro models. It was found that retiming projects using ATSPMs were quicker to implement, fine-tune and complete. It was also found that the ATSPM retiming approach was budget friendly allowing for two projects to be completed for the same budget as traditional retiming approaches using Synchro models. The real-time information provided consultants with multiple days of information instead of a one day's snapshot. When the timings were field tweaked, the results were seen in real-time using the performance metrics.

Today, ATSPMs are not only used for troubleshooting citizen concerns and equipment malfunctions but also evaluating the impacts of deploying new and emerging technologies. As part of the Bell Rd Adaptive Signal Control Technology (ASCT) Deployment Project completed in 2019, at locations where ATSPMs were available, the before and after data was reviewed showing agencies the operational impacts of the ASCT systems. For movements that we typically see phase failures, drivers are experiencing less delay and few numbers of stops along the route.

Before Conditions



After Conditions



In Anthem, home of the Arizona Connected Vehicle Testbed, MCDOT is using ATSPMs to evaluate the effectiveness of connected vehicle applications related to vehicle prioritization. ATSPMs is able to show how the Multi-Modal Intelligent Traffic Signal Systems (MMITSS) applications effect signal operations. During many demonstrations of MMITSS, no noticeable difference is seen in the ATSPM performance metrics, which shows that MMITSS can operate seamlessly with existing traffic signal systems while achieving the applications' goals.

Currently, there are 3,300+ traffic signals in the Phoenix metropolitan area. 570 traffic signals are integrated into the AZTech Regional ATSPM system with a total of 9 agencies participating. Future ATSPM expansion projects are in-place and proposed for the upcoming years. AZTech Partner Agencies are encourage to join in the ATSPM regional efforts.

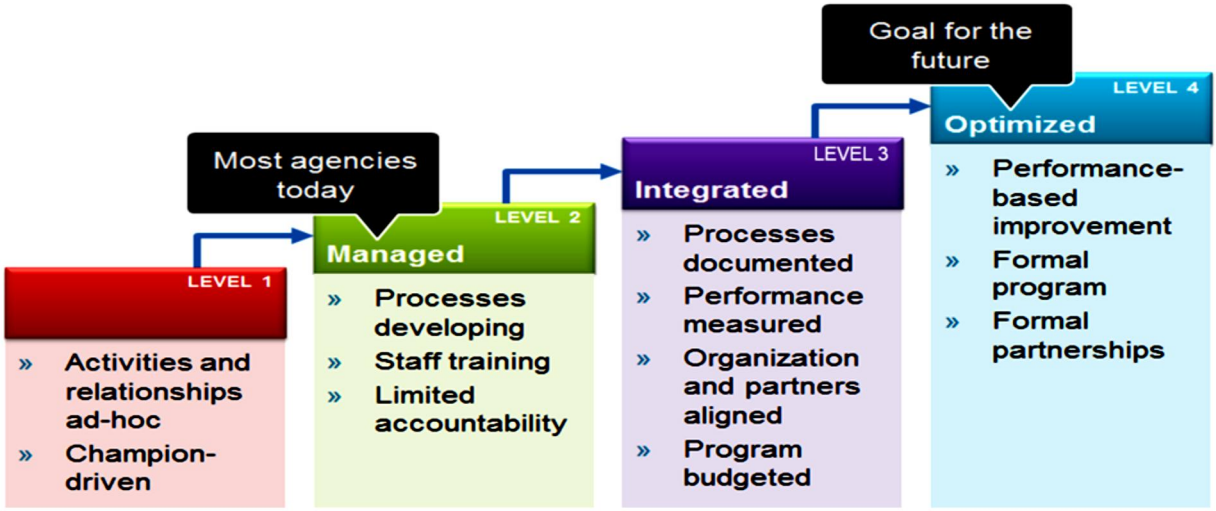
CMM Scores and Progression Over the Years

In May of 2019, AZTech partners participated in an Arizona Capability Maturity Model (CMM) Self-Assessment Workshop to discuss and evaluate capabilities, challenges, and constraints regarding system deficiencies, existing opportunities, and consider what future transportation needs are required to best move people and goods throughout the state. Prior to the 2019 CMM, the region had participated in two previous CMM assessments, held in 2010 and 2014. The 2019 update allowed partners in the region to revisit previous action items and reevaluate previous CMM assessment results to see progress over time.

The CMM framework includes six dimensions and four levels of capability or maturity.

- Business Processes: Planning, programming, budgeting, and project development.
- Systems and Technology: Application of systems engineering, ITS architectures, and level of technology integration.
- Performance: Performance monitoring, measuring, and reporting; integrating performance outcomes into operations strategies; collecting and managing data to support performance measures.
- Culture: Leadership buy-in and support for TSMO and the organization's overall level of formal TSMO understanding.
- Organization and Workforce: Organizational structure, staff accountability, training availability, and staff resource allocation to support TSMO.
- Collaboration: Level of collaboration within the agency and among partners, as well as established public/private partnerships.

Each of these dimensions are assessed against four levels of capability or maturity.



This CMM self-assessment process relies on candid feedback about where the region currently stands, and what level the region wants to achieve. Within each level there are specific steps to get to the next level, understanding that the goal is not always to achieve a level 4 in all dimensions, but to acknowledge the specific steps that can be taken to reach the next level.

The 2019 CMM Workshop, hosted by MAG and facilitated by FHWA, included 27 participants from 15 agencies: ADOT, Avondale, Buckeye, Casa Grande, Chandler, FHWA, Glendale, MAG, MCDOT, Mesa, Peoria, Phoenix, Pima County DOT, Scottsdale, and Surprise.

Results of the 2019 self-assessment shows that partners felt that capabilities at the agency, regional, and state level have improved from 2010 to 2019. Some key highlights from the workshop include:

- AZTech has improved to level 3 across all dimensions. The group is fully integrated and meeting its mission. It has a clear vision forward, but the challenge is getting all agencies together.
- The biggest improvements since 2014 were perceived to be in business processes and organization and staffing, which went from a Leve 1 in 2014 to a Level 3 in 2019.
- Outside of the AZTech Partnership, local agencies are challenged by being asked to do more with fewer resources and fell constrained in relation to organization/staffing and business processes.
- Some agencies continue to struggle to gain buy-in from leadership to invest in TSMO initiatives, infrastructure, and staff.
- The Phoenix region is fortunate to have a core partnership through AZTech and MAG; however, some key players are still missing from regional discussions and efforts.

The complete CMM results over time for the AZTech partnership are shown in the table.

DIMENSIONS	ENTITY	LEVEL 1 PERFORMED	LEVEL 2 MANAGED	LEVEL 3 INTEGRATED	LEVEL 4 OPTIMIZING
BUSINESS PROCESSES	AZTECH	2014 (+)		2019	
SYSTEMS & TECHNOLOGY	AZTECH		2010 | 2014	2019	
PERFORMANCE MEASUREMENT	AZTECH	2010	2014	2019	
CULTURE	AZTECH	2010 (+)	2014	2019	
ORGANIZATION/ STAFFING	AZTECH	2010 (+) | 2014 (+)		2019	
COLLABORATION	AZTECH		2010 (+) | 2014	2019	

Legend	
Gray	2010 CMM Results
Blue	2014 CMM Results
Green	2019 CMM Results
(+)	Plus or + 0.5

Freeway Travel Time Index

Travel Time Index (TTI) is computed by dividing the actual (measured) travel time by the free flow travel time along a corridor of interest. This measure considers the peak-hour periods (6am to 9am and 3pm to 7pm) during Tuesdays, Wednesdays, and Thursdays and measures separately for the general purpose lanes in the inbound (morning) and outbound (evening) directions for freeways where vehicle detectors are available. The table below shows the comparison of Travel Time Indices of named freeways between the years 2015, 2017 and 2019. This measure is "normalized" by the free flow travel time and therefore allows comparison of freeway corridors of different lengths.

The results show that the 2019 travel times have varied corridor to corridor. Travel times decreased as much as 39.7% (Papago EB) and increased as much as 8.59% (Red Mountain EB).

Named	Inbound 6am-9am						Outbound 3pm-7pm					
	Dir	Lgth	2017 TTI	2018 TTI	2019 TTI	% Change	Dir	Lgth	2017 TTI	2018 TTI	2019 TTI	% Change
Agua Fria	SB	15.0	1.03	0.96	0.96	0.00%	NB	14.0	1	0.96	0.97	1.04%
Agua Fria	EB	5.6	1.51	1.35	1.39	2.96%	WB	5.4	1.4	1.44	1.47	2.08%
Black Canyon	SB	11.6	1.38	1.46	1.52	4.11%	NB	10.7	1.3	1.67	1.59	-4.79%
Maricopa	WB	16.1	1.75	1.88	1.8	-4.26%	EB	15.1	1.8	2.00	1.99	-0.50%
Papago	EB	14.9	1.83	3.90	2.35	-39.7%	WB	13.5	1.8	2.77	2.59	-6.50%
Piestewa	SB	12.1	1.35	1.37	1.38	0.73%	NB	13.1	1.3	1.30	1.27	-2.31%
Pima	EB	13.6	1.35	1.62	1.64	1.23%	WB	11.8	1.7	1.83	1.75	-4.37%
Pima	NB	15.7	1.2	1.13	1.16	2.66%	SB	14.5	1.3	1.29	1.36	5.42%
Price	NB	9	1.75	1.51	1.54	1.99%	SB	9.3	1.7	1.71	1.73	1.17%
Red Mountain	WB	9.1	1.8	1.44	1.42	-1.39%	EB	9.6	1.4	1.28	1.39	8.59%
Superstition	WB	20.5	1.24	1.34	1.34	0.00%	EB	19.5	1.2	1.13	1.16	2.65%

**Data reported as provided by ADOT. Construction and change of data source (INRIX) for some of the performance metrics may have had an impact on the values.*

Freeway Percentage of Corridor Miles Congested

The percentage of Corridor Miles Congested (PMC) assesses the extent of recurring congestion by identifying the number of miles on a freeway corridor that was congested during the peak periods. A segment of a corridor (corresponding to a detector station) is considered congested when the average vehicle speed drops to 50 miles per hour or less. This measure is useful for monitoring the spatial extent of congestion along a commute corridor.

The table on the top of the next page shows the comparison of corridor miles congested by named freeway per commute direction between the years 2017, 2018 and 2019. Most freeways have remained relatively steady in terms of PMC, with the exception in 2019 of the Papago, Pima, and Price portions of the freeway which were all undertaking significant construction projects for the South Mountain freeway and Loop 101 reconstruction.

Named	Inbound 6am-9am						Outbound 3pm-7pm					
	Dir	Lgth	2017 PMC	2018 PMC	2019 PMC	% Change	Dir	Lgth	2017 PMC	2018 PMC	2019 PMC	% Change
Agua Fria	SB	-	0.39	1.0	1.8	80.%	NB	-	1.34	0.9	1.5	66.67%
Agua Fria	EB	-	38.9	39.2	42.4	7.65%	WB	-	37.11	28.8	43.0	49.3%
Black Canyon	SB	11.6	41.64	47.1	49.5	5.19%	NB	10.7	53.3	63.5	68.9	8.41%
Maricopa	WB	16.1	48.61	50.0	50.9	1.68%	EB	15.1	65.14	66.0	67.8	2.83%
Papago	EB	14.9	53.7	55.8	39.1	-29.91%	WB	13.5	49.64	56.7	43.1	-24.10%
Piestewa	SB	12.1	29.17	28.7	27.5	-4.10%	NB	13.1	23.7	25.8	26.9	4.47%
Pima	EB	13.6	39.89	41.2	22.6	-45.23%	WB	11.8	46.99	0	0	0%
Pima	NB	15.7	13.57	16.3	19.2	17.79%	SB	14.5	27.4	32.7	36.4	11.31%
Price	NB	9	43.88	46.7	40.2	-13.91%	SB	9.3	39.67	36.5	41.4	13.41%
Red Mountain	WB	9.1	39.32	40.6	39.0	-3.85%	EB	9.6	20.61	13.6	25.5	87.04%
Superstition	WB	20.5	18.16	23.8	27.3	14.56%	EB	19.5	14.59	16.9	20.1	18.90%

**Data reported as provided by ADOT. Construction and change of data source (INRIX) for some of the performance metrics may have had an impact on the values.*

Freeway Percentage of Time Congested

Percentage of Time Congested (PTC) represents the percentage of time a corridor is considered congested during the peak periods. Congestion is defined as when the average speed drops to 50 miles per hour or less. Along with the "percentage of corridor miles congested", it depicts the extent of congestion both in space and time. The table below shows the comparison of percentage of time congested by named freeway per commute direction.

Named	Inbound 6am-9am						Outbound 3pm-7pm					
	Dir	Lgth	2017 PTC	2018 PTC	2019 PTC	% Change	Dir	Lgth	2017 PTC	2018 PTC	2019 PTC	% Change
Agua Fria	SB	15.0	0.5	1.2	2.4	100%	NB	14.0	1.33	0.8	1.5	87.50%
Agua Fria	EB	5.6	37.1	37.7	37.2	-1.3%	WB	5.4	39.27	31.7	45.7	44.16%
Black Canyon	SB	11.6	41.83	48.3	51.7	7.0%	NB	10.7	52.36	34.0	35.8	5.05%
Maricopa	WB	16.1	48.4	50.7	49.2	-3.0%	EB	15.1	65.61	66.2	49.2	-25.59%
Papago	EB	14.9	54.9	52.2	38.6	-26.1%	WB	13.5	47.24	54.6	39.2	-28.19%
Piestewa	SB	12.1	28.35	28.8	28.1	-2.4%	NB	13.1	21.79	23.8	24.7	3.97%
Pima	EB	13.6	39.87	41.4	21.4	-48.3%	WB	11.8	48.12	0	0	0%
Pima	NB	15.7	13.53	16.6	19.5	17.5%	SB	14.5	26.22	31.6	35.6	12.65%
Price	NB	9	42.25	44.5	38.9	-12.6%	SB	9.3	46.82	43.2	46.3	7.27%
Red Mountain	WB	9.1	36.91	39.0	37.8	-3.1%	EB	9.6	25.65	19.0	27.1	42.77%
Superstition	WB	20.5	20.83	26.4	29.3	11.0%	EB	19.5	13.87	16.2	19.2	18.62%

**Data reported as provided by ADOT. Construction and change of data source (INRIX) for some of the performance metrics may have had an impact on the values.*

This section describes how agencies are pursuing smarter technology and expanding their operational capabilities.

State Route 51 Smart Ramp Metering

ADOT has piloted an important improvement to traffic mobility in the region through the use of smart ramp metering along SR-51. State Route 51 is an urban access-controlled freeway in the City of Phoenix. It runs from I-10 and the Loop 202 at the Mini Stack in the south to Loop 101 in the north. In May 2019, ADOT introduced an adaptive ramp metering program to the southbound ramp meters in the corridor. Includes a 15 mile corridor that contains 14 ramp meters.

This program received runner up for the 2018 *NOCoE TSMO Award for Best TSMO Project (Creative Solution)*. The program weighs local and downstream conditions to feed a virtual detector loop. The statistics from this loop are used to determine metering rates.

Expected Benefits:

- Reduced travel times and increased flows through the corridor
- Metering can shut off when traffic conditions do not require it
- Responds to traffic on a corridor level
- Potential for all day operation

The SR51 SB pilot project has generally seen faster speeds and higher flow rates than with ADOT's standard fixed rate metering. This has resulted in thousands (at least 2k) of dollars a day in reduced user costs. In addition, drivers have also seen reduced times of metering during lighter rush hours, particularly during summer and holiday seasons, and downstream of lane blocks. Conversely, one of the potential next steps is allow expanded or all day metering times to allow the system to better capture peaks and to respond to off-hour incidents.

Bell Adaptive is Up and Running

Bell Road is a significant corridor spanning roughly 36 miles east to west through several jurisdictions across Maricopa County. Several agencies are responsible for managing the traffic control signals along Bell Road and have coordinated their efforts, and in Spring 2018, many signals within portions of Bell Road were converted to Adaptive Signal Control Technology (ASCT) as part of a pilot program organized by MCDOT and AZTech.

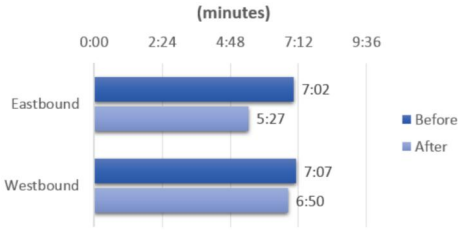
This pilot project was funded through the Maricopa Association of Governments (MAG) Congestions Mitigation and Air Quality (CMAQ) grant, with a local agency match. The project is also considered a Federal Highway Administration (FHWA) Project of Division Interest (PoDI) due to the level of complexity, the multi-jurisdiction coordination, and the associated risk. The overall budget for this project came to $2.7 Million. $1.8 Million of that budget (68%) went

toward the ASCT Systems themselves, with the inclusion of a 6-year maintenance and support services contract. The remainder was spent on vehicle detection, wi-fi readers, and measuring performance.

The project was divided into four project areas.

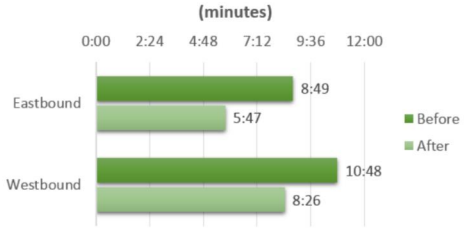
- Project Area 1 – Located entirely within Surprise and contains 21 signals operated by the City of Surprise. The primary objective was to mitigate traffic issues caused by special events, such as spring training at the Surprise Ballpark. The ASCT software chosen for this area was Kadence by Kimley-Horn.
- Project Area 2 – Overlaps State Route 101 Loop with 3 signals operated by MCDOT, 4 operated by the City of Peoria, 1 operated by ADOT, and 5 operated by the City of Glendale. Traffic related to special events and Arrowhead Mall holiday shopping were of interest. The software system for this project area was InSync by Rhythm Engineering.
- Project Area 3 – Scottsdale Road to Thompson Peak Parkway contains 10 signals all operated by the City of Scottsdale. Managing high peak time traffic volumes and high vehicular and pedestrian traffic during special events was a the priority for this area. The ASCT software chosen for this area was TransCore ACDSS in collaboration with KDL Engineering.
- Project Area 4 – At 35th Avenue to 19th Avenue, this area contains 6 signals operated by the City of Phoenix and 2 signals operated by ADOT. The priority for this area was to improve traffic flow across the I-17 freeway interchange, without negatively impacting the freeway ramps, and without over extending city staff efforts. The ASCT software chosen for this area was TransCore ACDSS in collaboration with KDL Engineering.

AM Peak Period Travel Time



	Before	After	Improved By	% Change
Eastbound	7:02	5:27	1:35	23%
Westbound	7:07	6:50	0:17	4%

PM Peak Period Travel Time



	Before	After	Improved By	% Change
Eastbound	8:49	5:47	3:02	34%
Westbound	10:48	8:26	2:22	22%

Results of the adaptive system implementation show that there is an overall average of about 16% reduction in travel time along the corridor.

Lessons Learned

Preliminary Engineering is Key
Agency partners all agreed that an extensive amount of pre-work on the preliminary systems engineering aspect of this project helped in the smooth deployment of the system.

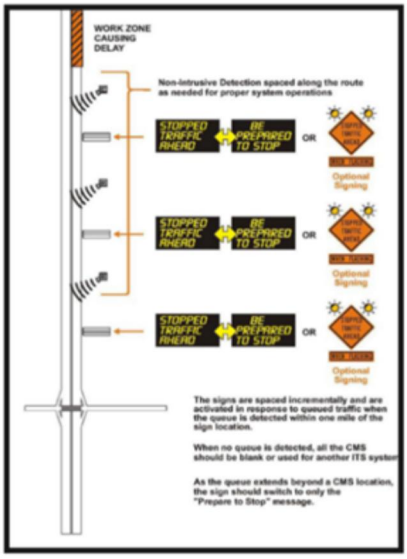
Keep Non-Motorized Traffic in Mind
Systems that rely on historical data may not be able to adapt to the needs of non-motorized highway users.

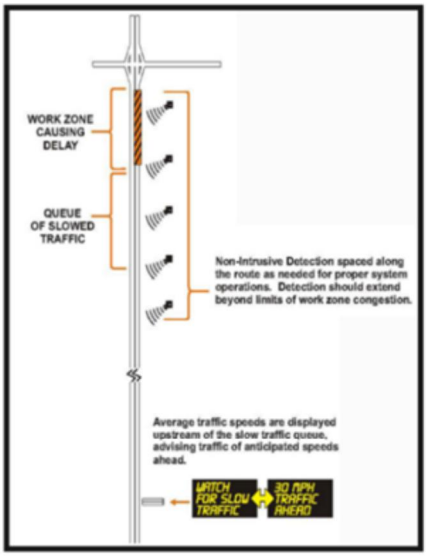
Software and Detection Should Go Together
Agency partners would suggest a contract similar to a Construction-Manager At Risk (CMAR), or one in which the vendor and the contractor work as a team from the start.

Budget for Communication Upgrades
The Maricopa Association of Governments (MAG) provided communication infrastructure for agency partners to tie into, which made the adaptive system possible.

ADOT Smart Work Zone

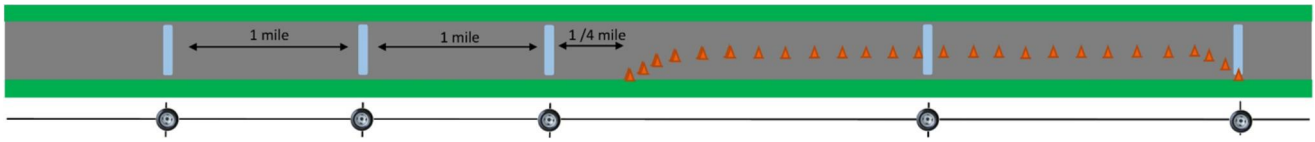
The Arizona Department of Transportation (ADOT) and Maricopa County Department of Transportation (MCDOT), both individually and in partnership within the AZTech Coalition, are advancing work zone management state of practice in Arizona through Smart Work Zone (SWZ) technologies by deploying innovative work zone technologies. The goal of SWZs is to improve safety while enhancing and optimize traffic operations within work zones. Successful SWZ and connected vehicle (CV) work zone deployments in the area have provided a foundation of experiences and lessons learned to generate buy-in and expand practices to other work zones. SWZ systems are also critical to the Department's compliance with Executive Order 2018-04 *Advancing Autonomous Vehicle Testing And Operating; Prioritizing Public Safety* by providing support for the operation of autonomous vehicles.





The first and most important step in design considerations of SWZ systems is whether it should be included on a project or not. Therefore ADOT is developing a capacity analysis tool to determine queueing and delay for existing conditions within a proposed work zone. This would allow for a non-subjective approach, thus reducing ADOT's overall liability in using these systems. ADOT and the FHWA recently approved a new standard specification section 710 for Smart Work Zones. This section includes language for Traffic Data Collection, Queue Warning, Dynamic Lane Merge, Travel Time, Traffic Monitoring Camera, and Variable Speed Limit subsystems. This will allow these subsystems to be added on any future ADOT projects, as any current traffic control device currently is.

Although standardization of a specification has been done only recently, ADOT has not waited to include their benefits on projects. ADOT's first SWZ project was a Queue Warning System on I-15 is nearing completion. ADOT recently awarded a $13.5 million bridge replacement project at I-17 and Central Ave with two Smart Work Zone Systems. The project will use a travel delay system to notify drivers along this route of delays associated with construction and incorporate a truck enter/exit warning system for median work. Another travel delay system was recently awarded on



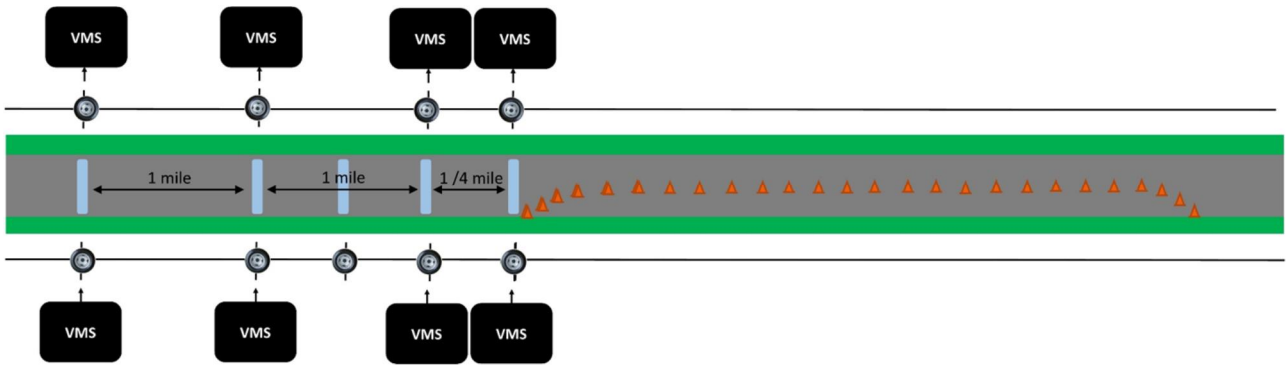
SR64, which is a critical travel route to the Grand Canyon during the busy summer tourist season. Recently bid results were read for the first dynamic merge system on I-40 near Meteor Crater. Several more projects in development are in the works. ADOT's Major Projects group is also working on how to include SWZs into alternative delivery, namely within Public Private Partnership initiatives.

A CV SWZ component was supported through a Federal Motor Carrier Safety Administration (FMCSA) grant to ADOT and MCDOT, formerly called the Commercial Vehicle Information Systems and Networks (CVISN) grant and now known as the Innovative Technology Deployment (ITD) Program. Additionally, Executive Orders from Arizona's governor were a basis for justifying the need for SWZs that support CAVs on the roadways. Specifically, the MC-85 project and a nearby work zone on I-10 served as two testbeds for deploying and testing CV technologies. ADOT and MCDOT worked with the University of Arizona (UofA) and Swift Trucking to assist in the development and testing of the connected work zone application.

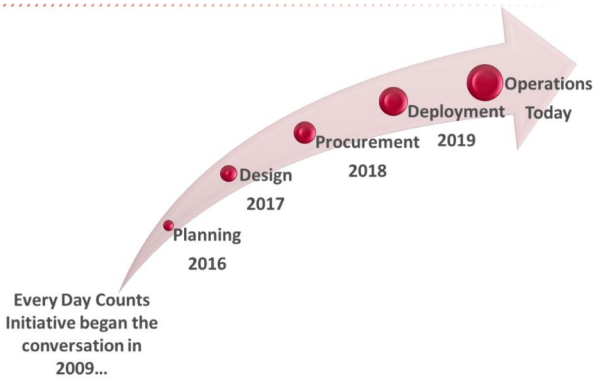
Work Zone Life Cycle Stages (Source: *FHWA*)

The Federal Highway Administration (FHWA) also began the Work Zone Data Initiative (WZDI) to better organize the next generation of work zone event data and data systems to facilitate ingest and dissemination by third-parties, interoperability of vendor systems, and enable local, regional, and national data sharing. A starting point in the WZDI for many agencies is the related Work Zone Data Exchange (WZDx). The WZDx effort is supported by United States Department of Transportation (USDOT) and includes a broad public- and private-sector work zone data stakeholder community for input and consensus. In support of these efforts ADOT and MCDOT also hosted the first ever peer exchange for the WZDx back in April 2019.

With all the recent efforts in SWZs, ADOT is also looking at its' own processes as well. The ADOT Work Zone Safety and Mobility Policy ENG 07-3 and Implementation Guidelines for Work Zone Safety & Mobility are being reviewed for updating and clarification of how SWZs should be implemented state-wide. The Work Zone Safety and Mobility committee is including data collection within SWZs as part of the 2020 Process Review. ADOT's Transportation Systems and Management (TSMO) Operational Traffic and Safety Group, who spearheaded the initial SWZ efforts and development standard specifications, are initiating a round 2 of additional standard specifications to add additional technologies that have emerged since the commencement of the efforts.

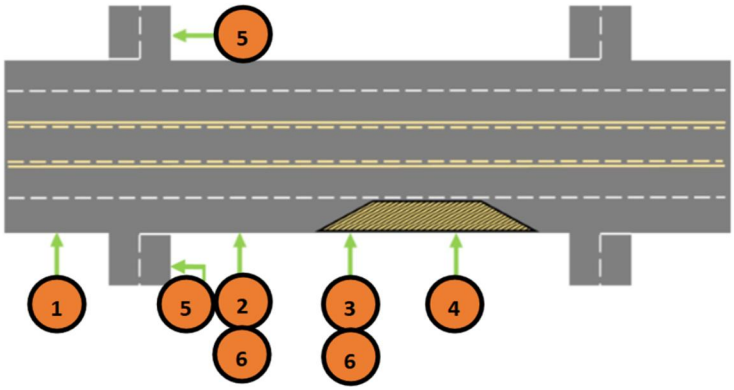


MCDOT Smarter Work Zone



Beginning in 2019, MCDOT began testing out a pilot program for Smarter Work Zone (SWZ) technology for the construction site at MCDOT's MC-85 project between 107th Avenue to 75th Avenue, which was the first SWZ application in the U.S. deployed on an arterial roadway. The technology uses sensors which gather traffic data, which is then used to calculate travel time expected for motorists to travel through a work zone. This time, along with other pertinent information, is then displayed on Variable Message Signs (VMS). This information informs commuters of how their commute will be altered from the construction activities, and they are able to decide to take an alternate route. When motorists decide to take an alternate route, this alleviates congestion with less cars traveling through the work zone. Less cars present also improves safety conditions for construction crews.

1. **INFORM**—VMS, Side-Fire Radar, ARID Traffic Detector
2. **ADVISE**—CCTV, VMS, Side-Fire Radar, ARID Traffic Detector
3. **WARN**—Speed Feedback
4. **CHECK**—Speed Feedback
5. **STAND-ALONE DETECTION**—Side-Fire Radar, ARID Traffic Detector on Alternate Routes supplemented by third party data
6. **CVISN**—DSRC at ADVISE and WARN locations



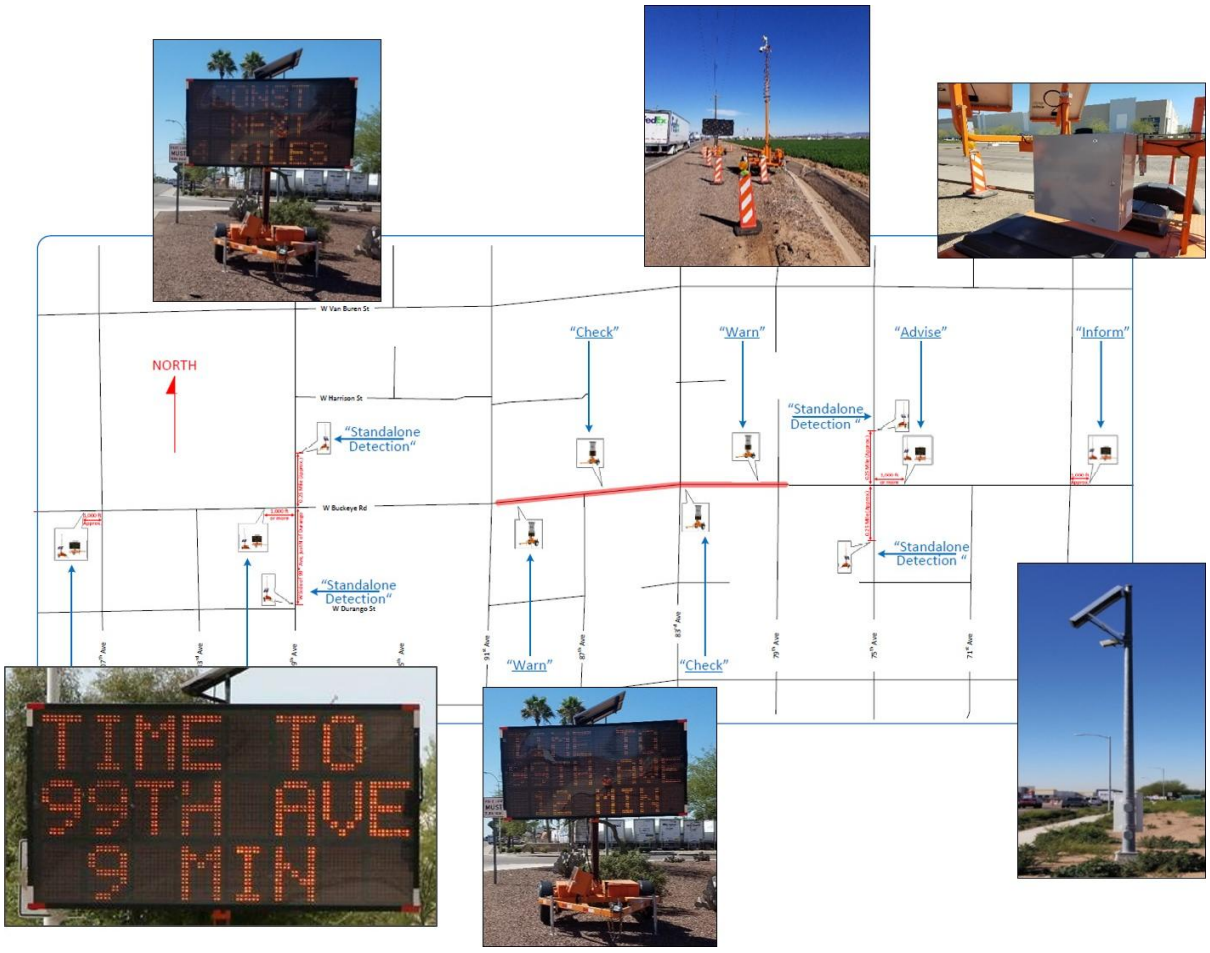
This pioneering project presented a unique testing opportunity, since it had never been deployed on arterial roadways before. While freeways have limited access opportunities, arterial roadways are much more complex, with many intersections and intersecting streets. Roughly 60% of work zone related crashes occurred on arterial roadways and other minor collector and local streets.

When SWZ applications were properly deployed, results show that commuter behavior adapts to be compliant with the implementations. The following results were experienced during the implementation of the MCDOT SWZ applications:

- Displaying alternate messages slowed down commuter speeds when approaching the work zone and prompted speeds to increase when exiting the work zone.
- Travel times were also reduced during peak periods with the use of SWZ equipment, which also allowed for cost savings without the need for assistance from law enforcement.
- Over the weeks that were evaluated, there were no crashes or fatalities during deployment of SWZ implementations, and work crews observed that the equipment did not cause distractions to drivers.
- Furthermore, the information displayed for travelers influenced many of them to choose an alternate route.

During morning peak times, commuters preferred to take the detour south of the MC-85 work zone.

- Prompting motorist to bypass the work zone lessened the number of vehicles traveling through the work zone, which improved safety for construction crews and reduces congestion.



As part of the MC-85 and I-10 connected, SWZ projects, MCDOT used information within RADS to generate an open API feed for these two work zones that was compliant with the USDOT Work Zone Data Exchange (WZDx) version 1.1 specification. In doing so, MCDOT utilized standard work zone event data within a long-term, connected SWZ on both an arterial roadway and freeway to successfully support innovative in-vehicle messaging capabilities. Local agencies in the region have also integrated lane closure information to a single data system for dissemination to the traveling public, which is now a basis for converting all work zone information to conform to the WZDx version 2.0 specifications, with version 3.0 coming in the summer 2020.

As part of the MC-85 SWZ project, a CV freight application that was demonstrated on the construction site during three separate occasions: to the USDOT (Brian Cronin) in April of 2019, to the NOCoE Local Agency Peer Exchange Participants and USDOT in May of 2019 (24 participants), and to the FHWA Work Zone Data Peer Exchange and ACTI and FMSCA in July of 2019 (55 participants).

Experiences on both MC-85 and I-10 can be leveraged to facilitate future connected SWZ deployments in area work zones, while expanding capabilities to meet the anticipated needs of CAVs to navigate work zones.

This section includes agency activities that support better traveler information which starts with the right data being collected and results in multiple methods for dissemination.

AZTech Media and Transportation Forum

The AZTech Media and Transportation Forum was held on October 23, 2019, which hosted many transportation agencies and recognized media representatives. Topics that were discussed included AZ511 updates, ADOT Incident Response Unit, Traffic Incident Management (TIM) training opportunities, latest progress from the Bell Road Adaptive Traffic Signal Pilot Program.

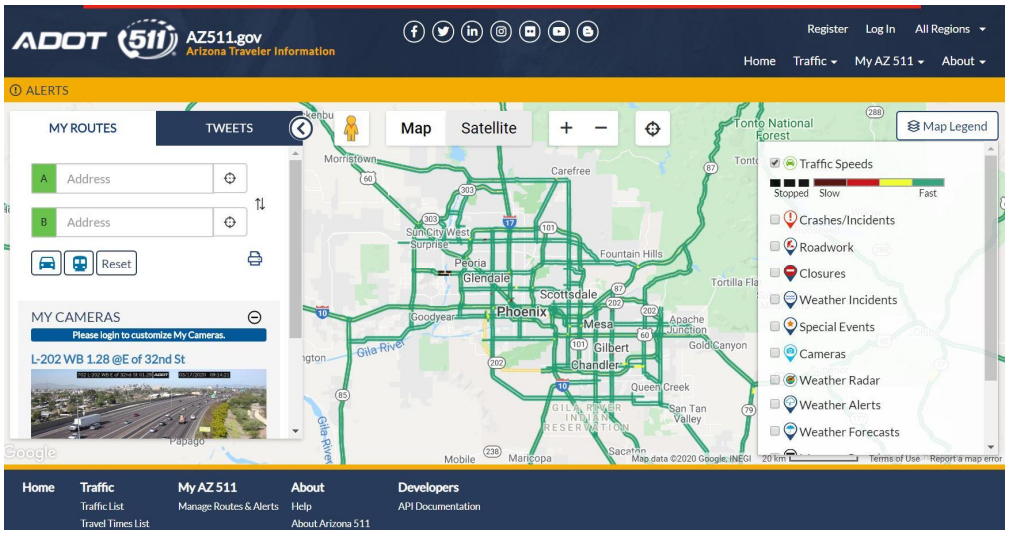
Significant topics discussed by the panel include reporters' use of social media, particularly Twitter, to scan feeds for crashes, updates for incidents, etc. Third-party sources, such as INRIX, Total Traffic and WSI are also used as a source for information both when live and for reports. Media representatives shared that they appreciate the Thursday summary of construction closures, however, they would like to receive that earlier. They would also like access to video feeds, so that they can show traffic videos, which tell a better story and grab people's attention better than photos. The outcomes of the forum were shared with those in attendance and will be continued in upcoming years to leverage the partnership between transportation and media.

Update to 511

In February 2019, a new version of the AZ511 website was released to the public. The following are features of this site:

- Speed map for the entire state
- Routing options along with travel times
- My 511: Users who sign up for a personal account can save their favorite traffic cameras and routes so they can be easily pulled up when they log in—this personalized option also allows users to customize email or text notifications about crashes or delays along their routes
- Users with a phone number linked to their personalized account can also call 511 and receive traffic updates on their saved routes before they leave home

- AZ511.gov is mobile friendly
- New complementary AZ 511 app has been added
- ADOT Twitter feed appears on the webpage
- Weather radar, NWS watches and warnings
- Border wait times
- Local Pinal County incidents integrated into AZ 511

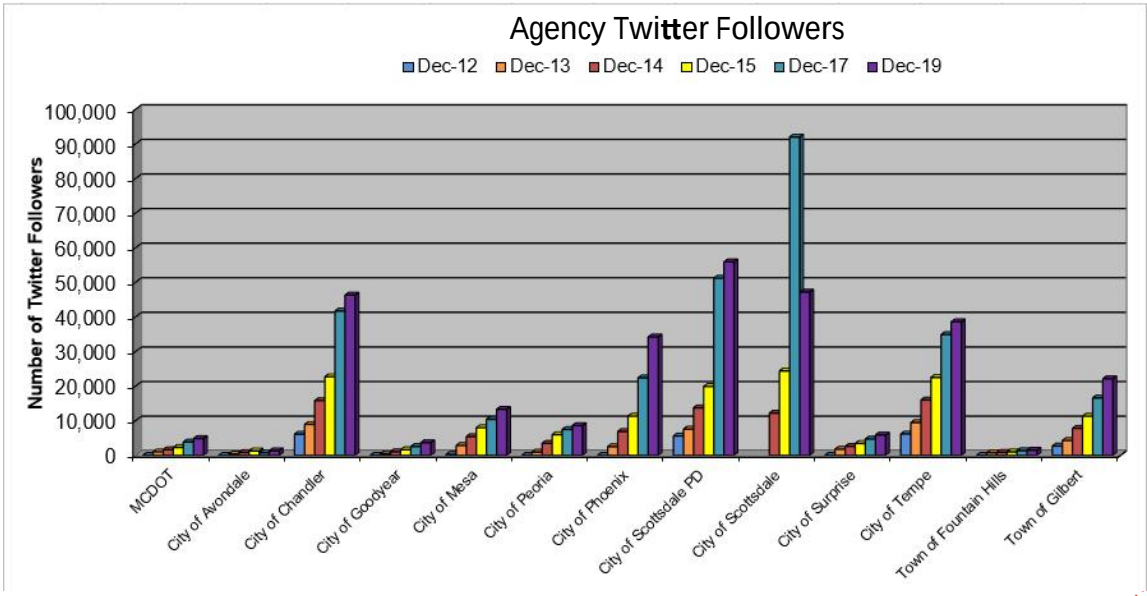


Additionally, incident data is captured within AZ511 through the Spillman Computer Aided Dispatch (CAD) system. This permits ADOT to collect highly granular incident response and clearance times that can be used to analyze incident responses and help ADOT improve incident management clearance. Faster clearance on the roadway minimizes secondary crashes and keeps traffic moving.

Social Media Notifications

Transportation Departments and Public Safety Departments are using more email alerts and various social media outlets to provide traveler information to the public. The number of Twitter postings are rising on a week-to-week basis and the number of Twitter followers are concurrently rising.

Since 2012, ADOT public information officers located at the TOC have communicated daily with the media and the public via Twitter (@ArizonaDOT). The Twitter account allows ADOT to have immediate communications to the media and the public about such issues as road closures, crashes and

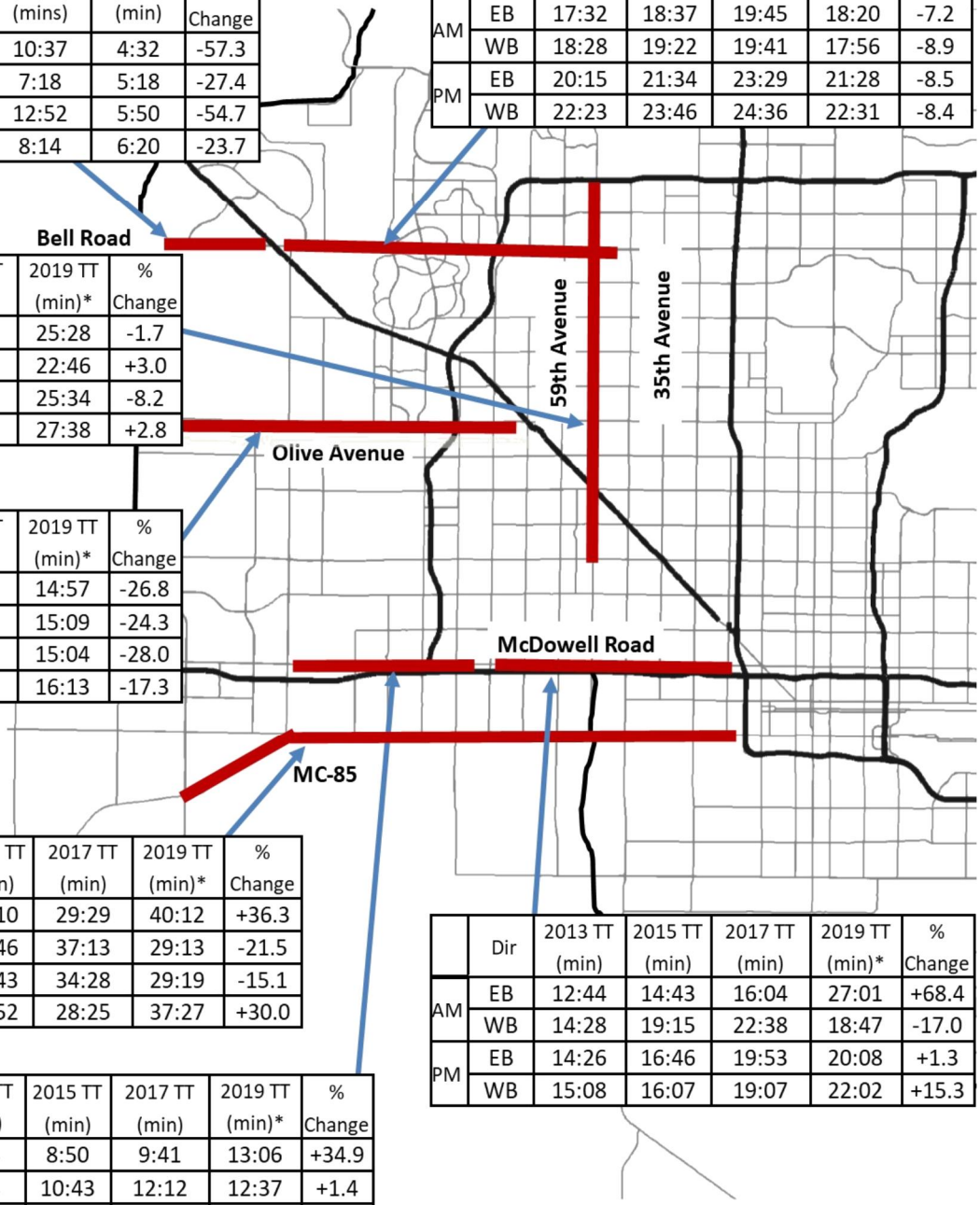


Regional Corridor Travel Times

Arterial data collection corridors have been identified by AZTech Committees to facilitate consistency in measuring and reporting the operational performance each year in collaboration with AZTech partner agencies. Travel time data for AM and PM peak hours is collected and percentage change in travel time is reported, as shown in the graphic.

	Dir	2013 TT (min)	2015 TT (mins)	2017 TT (mins)	2019 TT (min)	% Change
AM	EB	10:08	10:22	10:37	4:32	-57.3
	WB	6:56	6:53	7:18	5:18	-27.4
PM	EB	11:16	11:56	12:52	5:50	-54.7
	WB	7:34	8:19	8:14	6:20	-23.7

	Dir	2013 TT (min)	2015 TT (min)	2017 TT (min)	2019 TT (min)*	% Change
AM	EB	17:32	18:37	19:45	18:20	-7.2
	WB	18:28	19:22	19:41	17:56	-8.9
PM	EB	20:15	21:34	23:29	21:28	-8.5
	WB	22:23	23:46	24:36	22:31	-8.4



	Dir	2013 TT (min)	2015 TT (min)	2017 TT (min)	2019 TT (min)*	% Change
AM	NB	26:10	25:00	25:54	25:28	-1.7
	SB	25:00	25:00	22:06	22:46	+3.0
PM	NB	23:00	24:00	27:51	25:34	-8.2
	SB	26:30	26:00	26:38	27:38	+2.8

	Dir	2013 TT (min)	2015 TT (min)	2017 TT (min)	2019 TT (min)*	% Change
AM	EB	19:21	20:39	20:25	14:57	-26.8
	WB	19:30	19:24	20:00	15:09	-24.3
PM	EB	19:38	21:14	20:55	15:04	-28.0
	WB	19:25	19:18	19:36	16:13	-17.3

	Dir	2013 TT (min)	2015 TT (min)	2017 TT (min)	2019 TT (min)*	% Change
AM	EB	24:17	27:10	29:29	40:12	+36.3
	WB	26:07	30:46	37:13	29:13	-21.5
PM	EB	26:56	30:43	34:28	29:19	-15.1
	WB	24:56	26:52	28:25	37:27	+30.0

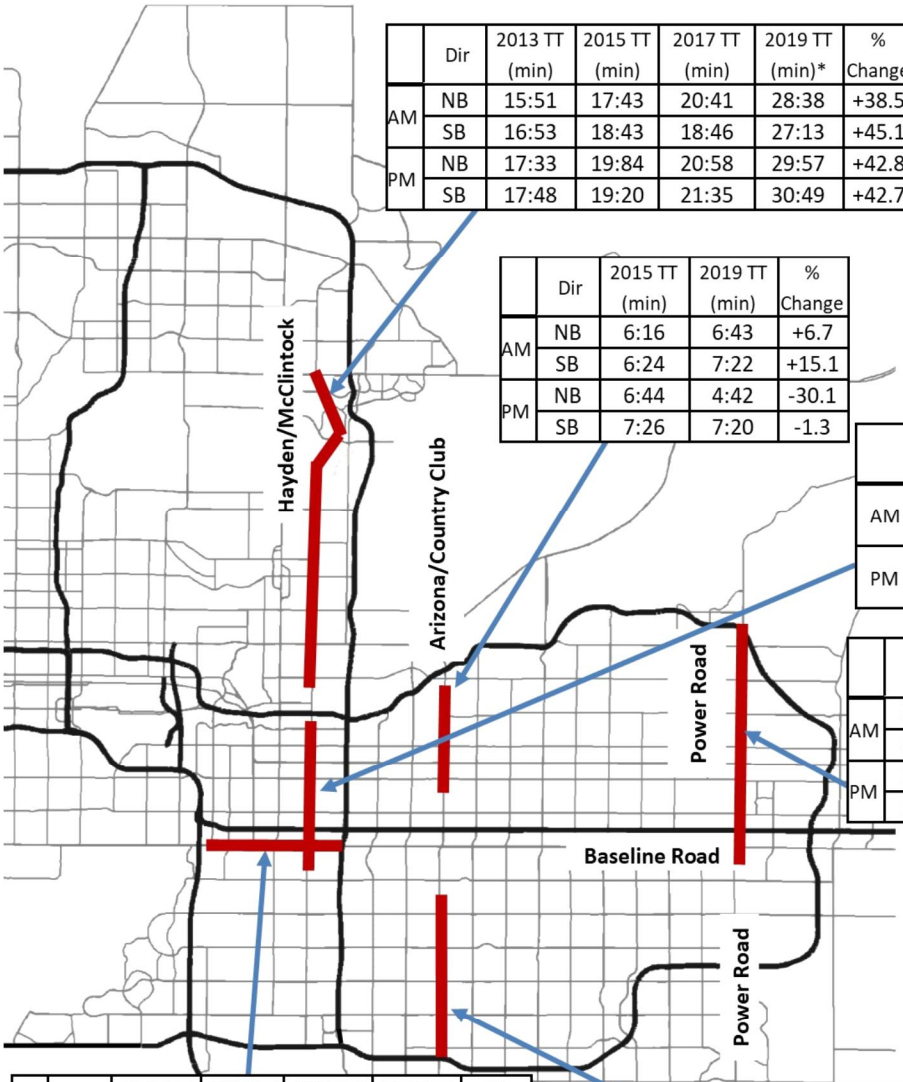
	Dir	2013 TT (min)	2015 TT (min)	2017 TT (min)	2019 TT (min)*	% Change
AM	EB	12:44	14:43	16:04	27:01	+68.4
	WB	14:28	19:15	22:38	18:47	-17.0
PM	EB	14:26	16:46	19:53	20:08	+1.3
	WB	15:08	16:07	19:07	22:02	+15.3

	Dir	2013 TT (min)	2015 TT (min)	2017 TT (min)	2019 TT (min)*	% Change
AM	EB	8:08	8:50	9:41	13:06	+34.9
	WB	9:38	10:43	12:12	12:37	+1.4
PM	EB	8:45	9:53	12:16	13:49	+10.0
	WB	10:32	11:56	12:58	14:29	-10.2

Regional Corridor Travel Times

Data from previous year's Books have been reflective of individual agency data collection activities and reporting. In recent years, ADOT has acquired a third party private data source for statewide data which included historical data on arterials. This third party data was used in areas with an * to develop this travel time map which accounts for historical corridor trends.

**Data reported as provided by MCDOT using third party data and verified by respective agencies data.*



	Dir	2013 TT (min)	2015 TT (min)	2017 TT (min)	2019 TT (min)*	% Change
AM	NB	15:51	17:43	20:41	28:38	+38.5
	SB	16:53	18:43	18:46	27:13	+45.1
PM	NB	17:33	19:84	20:58	29:57	+42.8
	SB	17:48	19:20	21:35	30:49	+42.7

	Dir	2015 TT (min)	2019 TT (min)	% Change
AM	NB	6:16	6:43	+6.7
	SB	6:24	7:22	+15.1
PM	NB	6:44	4:42	-30.1
	SB	7:26	7:20	-1.3

	Dir	2013 TT (min)	2015 TT (min)	2017 TT (min)	2019 TT (min)	% Change
AM	NB	10:52	10:16	9:50	11:05	+12.7
	SB	8:39	7:40	8:39	9:22	+8.3
PM	NB	10:39	9:23	11:16	13:14	+17.4
	SB	12:01	12:57	14:22	15:00	+4.4

	Dir	2015 TT (min)	2019 TT (min)	% Change
AM	NB	15:45	15:10	-3.7
	SB	15:53	16:21	+2.9
PM	NB	17:21	15:03	-13.3
	SB	16:37	15:36	-6.1

	Dir	2013 TT (min)	2015 TT (min)	2017 TT (min)	2019 TT (min)	% Change
AM	EB	9:20	10:10	8:26	9:04	+7.6
	WB	7:28	9:02	12:41	10:05	-20.5
PM	EB	9:42	10:27	8:15	12:11	+47.7
	WB	8:31	9:51	10:19	10:24	+0.8

	Dir	2013 TT (min)	2015 TT (min)	2017 TT (min)	2019 TT (min)	% Change
AM	NB	11:12	9:00	8:42	12:36	+44.8
	SB	10:48	9:48	10:06	11:23	+12.7
PM	NB	10:54	12:00	10:42	12:35	+17.6
	SB	11:48	14:12	12:00	11:18	-5.8

PUBLIC SAFETY COORDINATION

SECTION 7

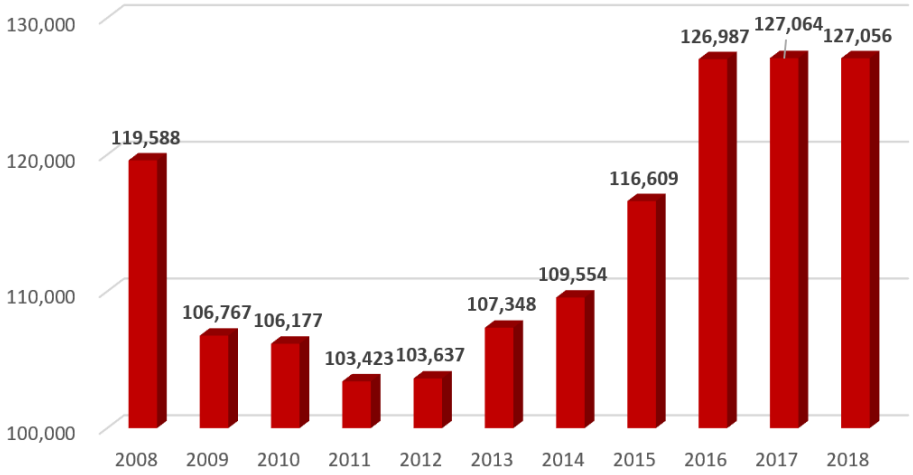
This section describes improved coordination with police using ITS tools.

Crash Activity Reported

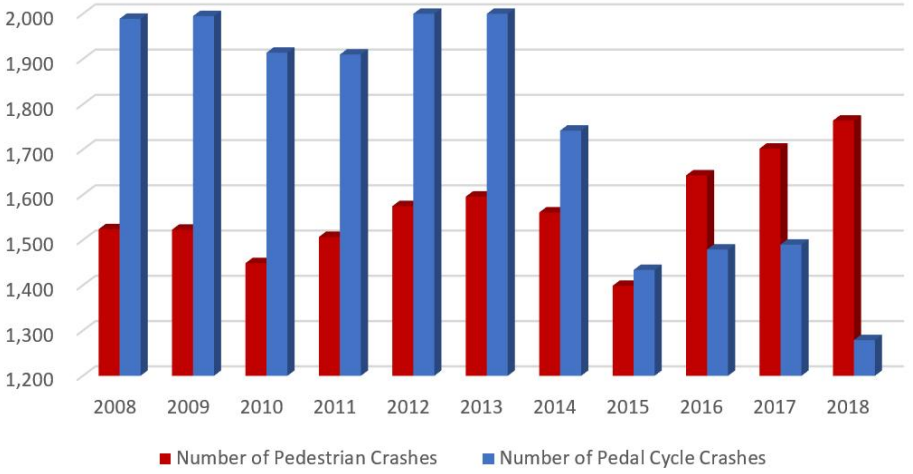
The ADOT Motor Vehicle Division (MVD) tracks statewide crash rates on a yearly basis and publishes this information within the annual Arizona Crash Facts report. Since 2014 the annual crash rates have increased statewide by almost 15%. In 2018, there were a reported 127,056 total crashes in the state of Arizona, 93,813 of which were in Maricopa County. Total economic loss in Maricopa County exclusively in 2018 is estimated to have been $11,374,012,434 including Fatalities, Injuries, and Property Damage Only. The following statistics are reported for 2018 in the Arizona Crash Facts report:

- Approximately 2.77 persons were killed each day.
- One person was killed every 8 hours and 39 minutes.
- There were 146 persons injured every day.
- One person was injured every 9 minutes and 51 seconds.
- Alcohol Related crashes accounted for 3.66% of all crashes and 26.30% of all fatal crashes.
- Single vehicle crashes accounted for 14.74% of all crashes and 32.53% of all fatal crashes.
- Of all Pedestrian crashes, 13.72% were fatal while 1.88% of Pedal Cycle crashes were fatal.
- Crashes which occurred during daylight hours (6:00 a.m. to 6:00 p.m.) accounted for 72.9% of all crashes.
- Motor vehicle crashes resulted in $19.349 billion in economic losses to Arizona.

Total Vehicular Crashes in Arizona



Total Pedestrian and Pedal Cycle Crashes in Arizona

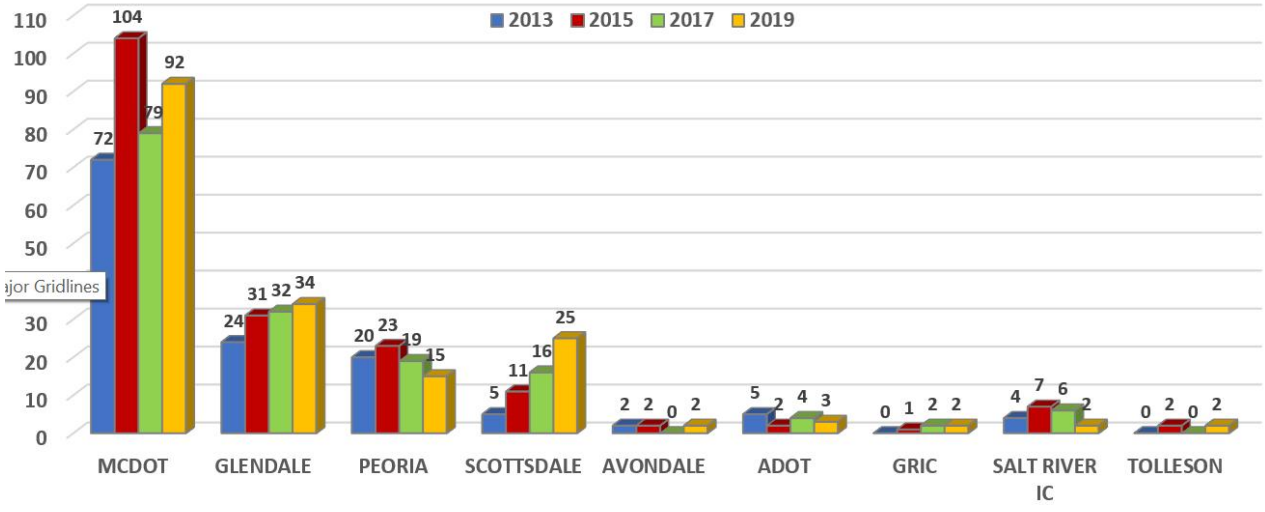


Maricopa County Regional Emergency Action Coordination Team (REACT) Called for Assistance

The various agencies in the region that utilize MCDOT's Regional Emergency Action Coordination Team (REACT) have shown consistency in their request for assistance during traffic incidents that require traffic control support. There are many factors that may close roadways and warrant the use of traffic control assistance, and local agencies are continuing to see the benefit of MCDOT REACT coordination to support their needs. The following are statistics reported for the MCDOT REACT Program for the 2019 calendar year:

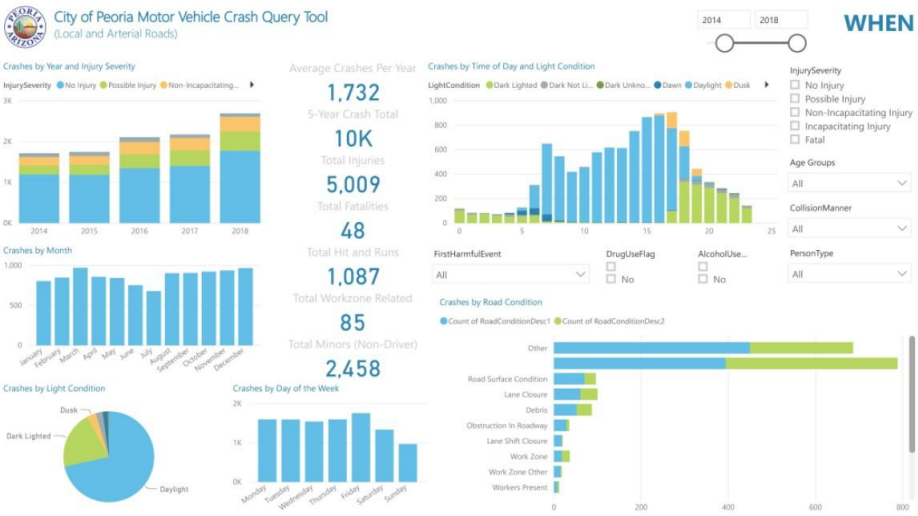
- 41% of all call outs are weekday responses. Weekday responses are defined as incidents that occur Monday-Friday (excluding holidays) from 5:30 AM to 5:30PM.
- The average incident duration for calendar year 2019 is 4.46 hours. Average incident duration is defined as the time of notification to the time traffic control is removed from road.
- 9% of all calls are concurrent calls. Concurrent is defined as two or more calls occurring at the same time.

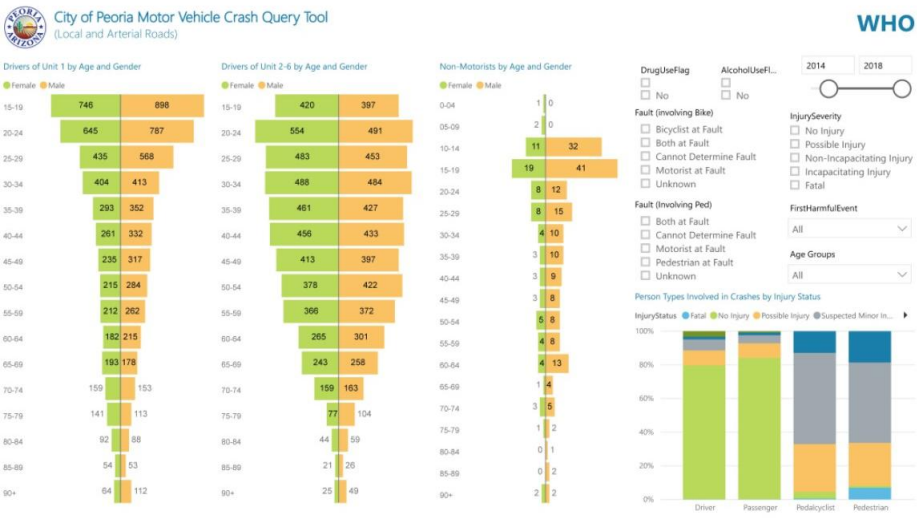
Arterial Traffic Incident Management Responses



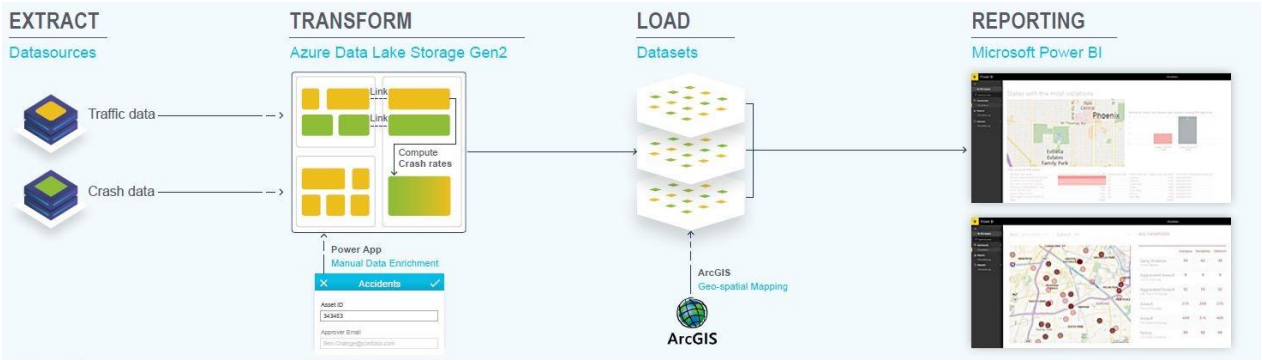
Peoria Creates Collision Data Power BI Tool

The City of Peoria partnered with Y2K Engineering to build a citywide crash analysis tool using Microsoft Power BI to develop interactive dashboards comprised of multiple visualizations. Five years of crash data were transformed into a clean "Incident" dataset with relationships connected between the "Person" dataset, "Unit" dataset, pedestrian crash types, and bicyclist crash types. Visualizations were created to depict correlations between the data as illustrated with the graphics on this page.





This visual tool is extremely helpful in identifying trends and dissecting the data. Visualizations on the page can be used to cross-filter and cross-highlight the other visualizations on the page. For example, selecting the bar for left-turn crashes filters all other charts, tables, and map on the page to display only data that applies to that one crash type. The City has also used the crash analysis dashboard tool for individual intersection crash summaries and network screening to identify unsignalized intersections that may warrant a traffic signal based on crash history.



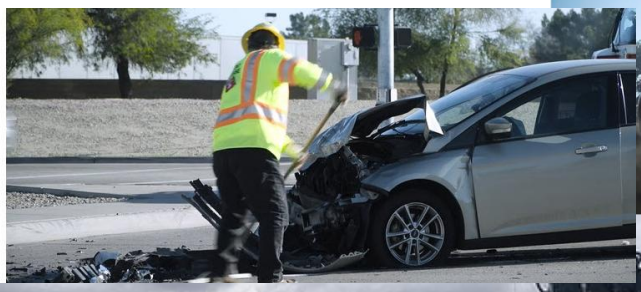
ADOT Incident Response Unit (IRU)

In October 2019, ADOT launched the Incident Response Unit (IRU) for the Metro Phoenix area, a 14-member team dedicated to reducing crashes and congestion on our freeways working with state troopers and first responders from 5:00 a.m. – 8:00 p.m. The IRU responds to an average of 1,400 incidents per month.

The IRU team provides traffic control and assistance at crash scenes, and also prevents crashes by removing debris in our roadways. They can push or pull stalled vehicles out of travel lanes; that keeps traffic moving and helps keep drivers safe. The IRU team has come to the aid of stranded motorists, much to their relief and appreciation based on the feedback we have received. When not responding to traffic incidents, the team will perform minor highway maintenance tasks.

The IRU replaces ADOT's Arizona Local Emergency Response Team (ALERT), which operated out of ADOT's Central Maintenance District and was staffed by employees who volunteered to be available for emergency calls. IRU is different from ALERT because the new teams are mobile and dedicated full-time to traffic incident management. Previously, ALERT members would have to stop their highway maintenance work and return to their yard to pick up vehicles and equipment before responding to a crash.

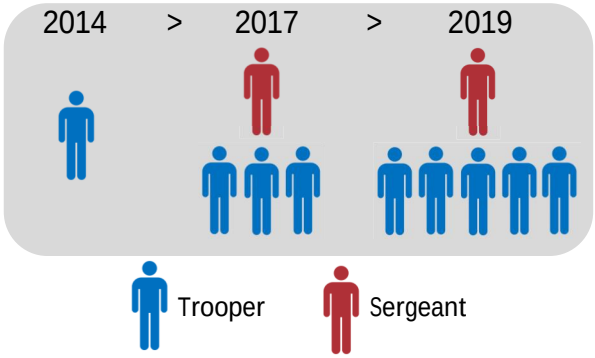
Through the sponsorship from State Farm®, ADOT IRU crews are now more visible and recognizable to drivers on the road. ADOT has new vehicle markings and new highway signs due to the sponsorship. The team is part of ADOT's Transportation Systems Management and Operations (TSMO) Division.



Arizona Department of Public Safety (DPS) Troopers Embedded into the Arizona Department of Transportations (ADOT) Traffic Operations Center (TOC)

Beginning in October 2014, a DPS trooper has been embedded into the TOC to specifically augment Traffic Incident Management (TIM) strategies. It began as a collective effort between ADOT, DPS, and the Maricopa Association of Governments (MAG). ADOT and MAG jointly funded the three-year pilot project to co-locate a trooper within the TOC. Starting with one assigned trooper in the fall of 2014, the pilot project has expanded and is operating nearly 24 hours, 7 days a week.

At the end of the pilot program, utilizing the Regional Traffic Simulation Model, the project showed an annual reduction of over *8 million vehicle hours for travelers* which is the equivalent of *$165 million in savings for the motoring public*. Based on the data and feedback from first responders, the Traffic Management Group Program Administrator from the Transportation Systems Management and Operations (TSMO) group recommended permanent funding for the project.



To distinguish a sworn trooper from an ADOT TOC operator, the assigned trooper utilizes the "HPTOC" call sign. The HPTOC trooper draws on their years of training and road experience to facilitate the principles of TIMs while utilizing the 335 cameras within the greater Phoenix and Tucson metro areas and an additional 192 traffic signal cameras throughout the state. When a traffic incident occurs, the HPTOC trooper can immediately vet the incident location, identify resources are needed, and suggest quickest access to the scene.

Providing timely and accurate information to responders improves response times which directly reduces roadway clearance times and incident clearance times (two performance measures used by the Federal Highway Administration). Additionally, HPTOC troopers are in constant communication with field responders throughout the state to provide accurate updates on traffic incidents and conditions. This offers real-time incident status to the TOC operators, as well as the ADOT Public Information Officer (PIO), for immediate updates to convey to the public.

In the first year, 2015, HPTOC assisted on 14,068 calls for service. Calls for service includes, collisions, disabled motorists, debris, and wrong way drivers to name a few examples. Now, in the last two calendar years of 2018 and 2019, HPTOC assisted with 24,992 and 28,750 calls for service, respectively. In contrast to the first year of the pilot program, this represents over 100% increase in effectively assisting first responders, thus improving performance measures on twice as many traffic incidents. As the program continues to evolve and more cameras are added throughout the state, the collaborative effort between ADOT and DPS will continue to be an invaluable resource for first responders and the public.

This section describes agency activities supporting large special events.

Glendale Reversible Lanes

For many years, the City of Glendale had been putting up temporary barricades to create reversible lanes to support heavy traffic for events at the University of Phoenix Stadium. In 2017, the City completed the installation of lane control signals along Maryland Avenue to allow reversible lanes. This project is located on Maryland Avenue west between 95th Avenue and 91st Avenue.

The City considers the area encompassed by 99th Avenue on the west, Northern Avenue on the north, 83rd Avenue on the east, and Indian School Road on the south to be the footprint of the traffic control boundaries related to the stadium and Westgate area. All freeways in the metropolitan area are included in the traffic control planning area as freeway message signs display event traffic information on all freeways for travelers on their way to the area.

In 2019, the City of Glendale expanded their electronic wayfinding signs around the City's Sports and Entertainment District to help manage event traffic at State Farm Stadium and Gila River Arena. Five sites were selected as part of the expansion.

- Site 1: SB 91st north of Coyotes
- Site 2: EB Cardinals west of 95th
- Site 3: EB Glendale west of 93rd
- Site 4: SB 91st south of Maryland
- Site 5: EB Glendale west of 95th

Scottsdale Golf Tournament

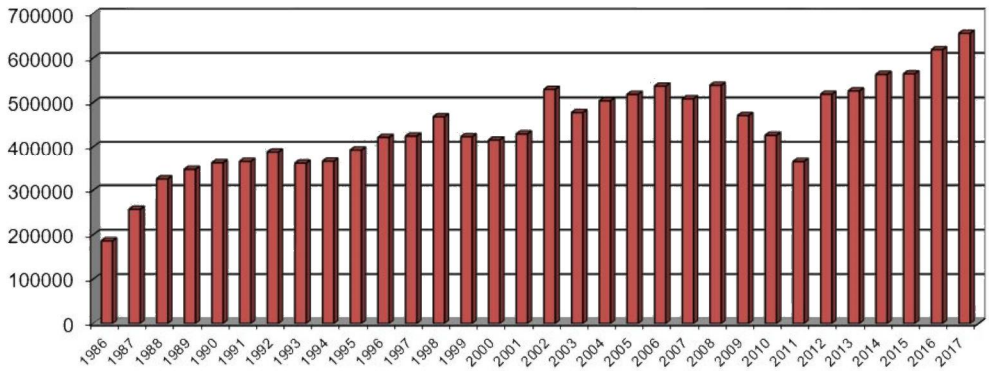
The Phoenix Open has been held in Scottsdale at the TPC Scottsdale course since 1986. More people attend each day of the tournament than attends a Super Bowl. Records continue to be broken each year for attendance, with 2019 topping out at more than 655,000 attendees during the week-long event.

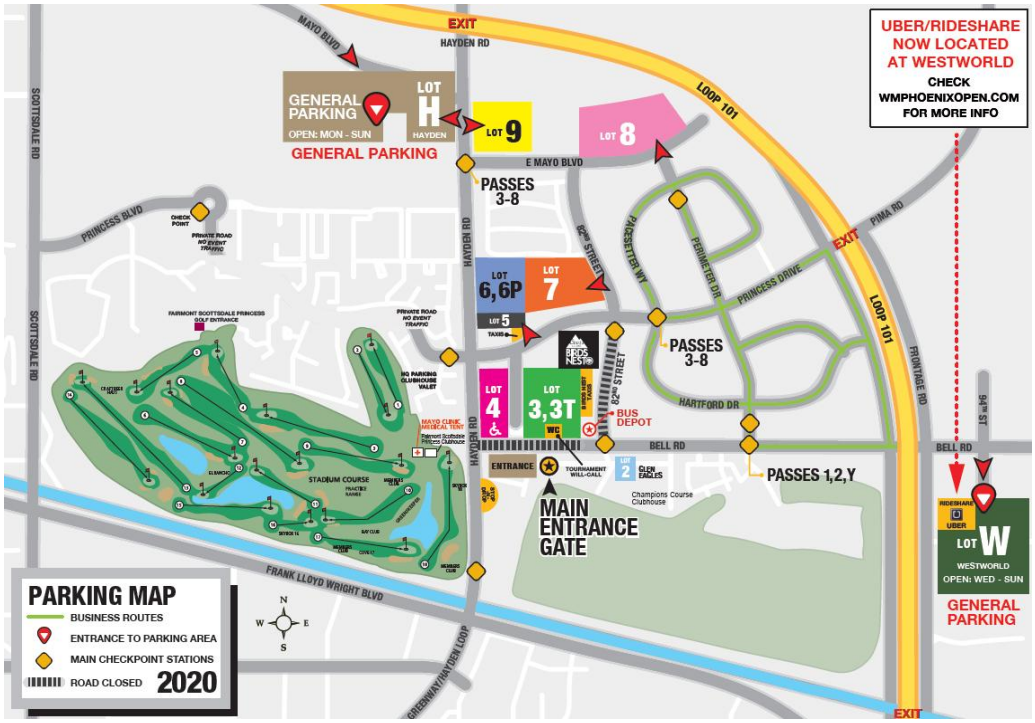
Scottsdale launched its ITS in 1993 to help alleviate congestion during the Phoenix Open. The cameras implemented in 1993 reduced the manpower and time required to control traffic at special events and set the foundation for today's system. In 2014, the TMC was expanded, upgraded and relocated to the North Corporate Yard. Viewing access to the pan-tilt-zoom cameras is provided to the Scottsdale Police Department and Arizona DOT's and neighboring communities' traffic operations centers.

The City TMC has been instrumental in helping move traffic and event goers to and from the event location at the TPC Scottsdale Golf Course. The City of Scottsdale has robust traffic signal timing plans for ingress and egress traffic to support mobility around and to the event. The City has trained some of their Police force to be able to operate out of the TMC, even if normal business hour Operators are not present.

Because the City does so well in managing the event year to year, regional coordination for this annual event is not necessary. The other agencies do, however, leverage the City of Scottsdale's tactics and lessons learned to support other larger events in the region.

Attendance at Phoenix Open (1986-2019)





This section includes agencies that are undertaking a look at their transportation management using a new perspective.

Summits Held to Train on Benefits and Needs of TSMO

Between June 18 and June 20, 2019, ADOT, MAG and MCDOT partner with the FHWA to host a series of events to advance multimodal TSMO in Arizona. The events were facilitated by FHWA Resource Center and Office of Operations included a TSMO Executive Briefing and a TSMO Technical Summit.

The events were focused on helping transportation agencies throughout the region evaluate and understand existing capabilities and needs to collectively plan, design, develop, implement, operate, manage, measure, and evaluate TSMO strategies such as integrated corridor management (ICM), traveler information, incident management, connected and automated vehicles, and other advanced operations and management strategies in the region.

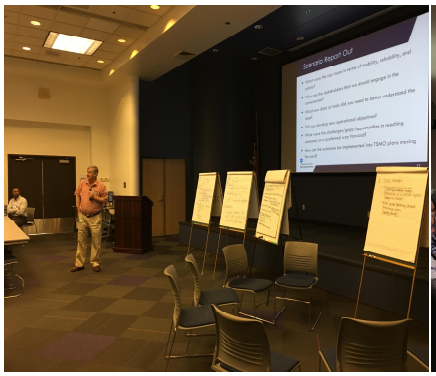
TSMO Executive Briefing (June 18, 2019)

The Executive Briefing brought together leaders and decision makers in Arizona to provide the opportunity for leadership to learn about TSMO, local operations stories, and discuss the future of TSMO in Arizona, including capabilities, challenges, and constraints. The summit also provided technical staff the opportunity to gain leadership buy-in and support for existing or upcoming efforts.

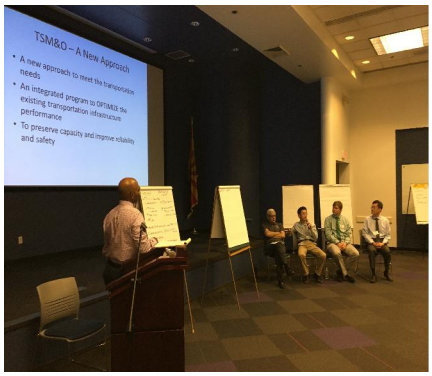
The Executive Briefing, hosted by ADOT and facilitated by FHWA, included 36 participants from 19 agencies: Arizona Department of Public Safety, ADOT, Chandler, FHWA, Gilbert, Glendale, MAG, MCDOT, Mesa, Northern Arizona University (NAU), Phoenix, Pima Association of Governments (PAG), Pima County DOT, Scottsdale, Surprise, Tempe, University of Arizona (UA), Valley Metro, and Yuma.

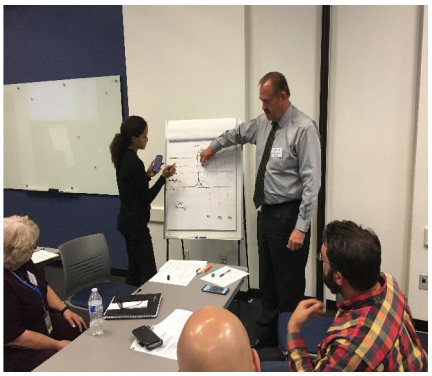
TSMO Technical Summit (June 19-20, 2019)

The Technical Summit facilitated collaborative discussions among local ITS and operations staff about the current state of TSMO in the region, where the partners want to be in terms of advanced operations, and a plan for reaching that desired state. A major topic of discussion was related to both technical and institutional approaches to successfully planning for and implementing ICM and other multi-agency and multi-modal operational strategies in the region.



The Technical Summit, hosted by ADOT and facilitated by FHWA, included 40 participants from 22 agencies: ADOT, Chandler, FHWA, Flagstaff, Gilbert, Glendale, MAG, MCDOT, Mesa, NAU, Peoria, Phoenix, PAG, Pima County DOT, Scottsdale, Sedona, Surprise, Tempe, Tucson, UA, Valley Metro, and Yuma.





ADOT ITS Architecture

The Arizona Statewide Architecture includes all ITS elements existing and planned in the sate of Arizona. There are two existing regional architectures; one in Tucson region and the other in the Phoenix region. Statewide Architecture will interact with these architectures but will remain separate and focused on statewide ITS elements, rural and ITS elements outside of these two regions. The exception to this is the ITS elements of Arizona Departments of Transportation (ADOT). ADOT is the state agency responsible for the safe, efficient and cost-effective movement of people and products throughout the State of Arizona. The Statewide Architecture will document all ADOT's ITS elements, including the Maricopa Association of Governments (MAG) Regional ITS Architecture and the Tucson Metropolitan Region ITS Strategic Deployment Plan developed by the Pima Association of Governments in 2004. The architecture plan has a timeframe of 20 years and pertains to the items in the surrounding figures within the service scope. To continually improve upon the Statewide ITS Architecture, National ITS Standards are referred to as well as coordinating with the appropriate agencies. The following agencies are involved in the development of the Regional ITS Architecture.

- Highway agencies
- Public safety agencies (police, fire, EM/medical)
- Transit Operators
- Federal Lands Agencies
- State Motor Carrier Agencies
- Other operational agencies to fully address regional ITS integration
- Coordinating with these agencies along with a well defined development process permits for an optimized transit network within the State of Arizona.

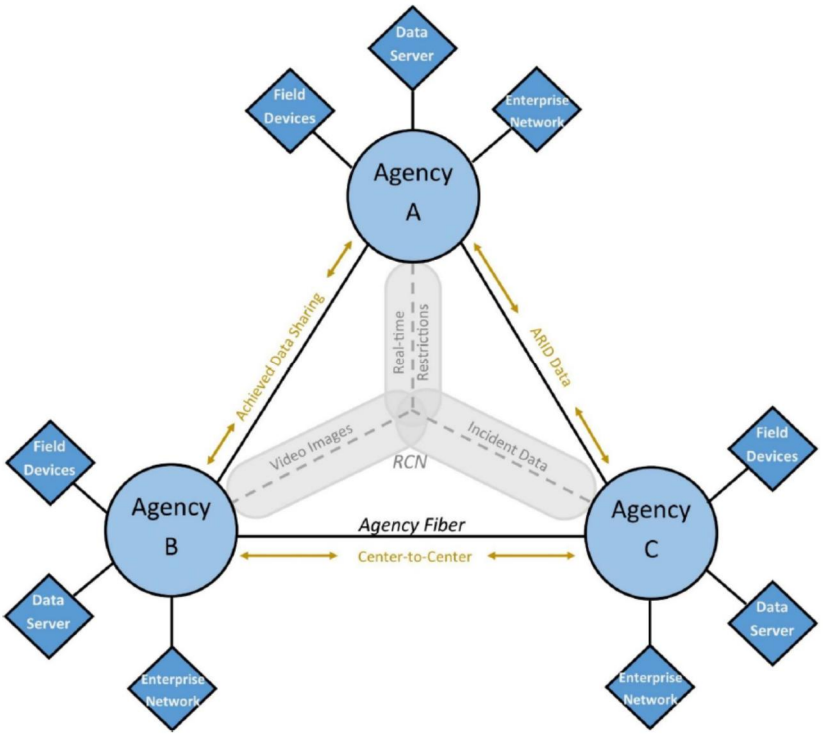
Maricopa Association of Governments (MAG) Regional ITS Architecture

The Maricopa Association of Governments (MAG) originally developed the Regional ITS Architecture (RIA) in 2001 in conformance with FHWA Rule 940 and FTA Policy on Architecture Conformity and Standards requirements for ITS projects to be eligible for federal funds. Over time, MAG has updated the RIA to capture evolving ITS infrastructure and capabilities throughout the region and keep the RIA current with the most recent versions of the National ITS Architecture and ITS architecture building tools.

The update to the MAG RIA project was completed in 2019 to update the current MAG Regional ITS Architecture to the current web-based implementation to be consistent with the latest version of the ARC-IT Version 8.1 (Architecture Reference for Cooperative and Intelligent Transportation). The project included updating the architecture framework reflecting the influence of connected vehicles and integrated transportation services as well as preparing the architecture for upcoming ITS programming in FY2020-2022, and development of a Communications White Paper. The Architecture is a plan to support regional consistency with ITS projects, programs and strategies. The MAG RIA is utilized as a guide by member agencies during the planning stages of new ITS infrastructure.

Electronic communications networks are essential for intelligent transportation systems (ITS) data sharing within agencies and across the MAG region. A Communications White Paper was developed as part of this project to provide a strategic direction for MAG member agencies as they develop their own agency communications networks and participate in a regional communications system to support ITS activities and a collaborative data sharing environment. Communications technologies provide the link necessary for traffic signals, ITS devices, and other field technologies to share information with the larger network, which includes transportation management centers (TMCs) and regional data storage centers. ITS data transmission is a key component of maintaining and improving Transportation Systems Management and Operations (TSMO) within the region. MAG member agencies are able to use the Communications White Paper to determine appropriate infrastructure and data/security investments consistent with their future vision of connectivity and functionality as defined by the MAG Regional ITS Architecture.

The 2019 RIA update includes expanded capabilities for technologies, systems and operations strategies. These include Integrated Corridor Management, expanded data management functions, connected vehicles, additional local agency traffic management systems, and expanded multimodal and transit systems and connectivity. The RIA provides a set of visual tools and databases that that capture the functions, system connections, information exchanges and agency connectivity that enable a wide range of technology-based transportation operations capabilities in the MAG region. The MAG RIA corresponds to the MAG planning area covering Maricopa County and parts of Pinal County.



MCDOT ITS Communication Plan—Urban, Rural & In-Between

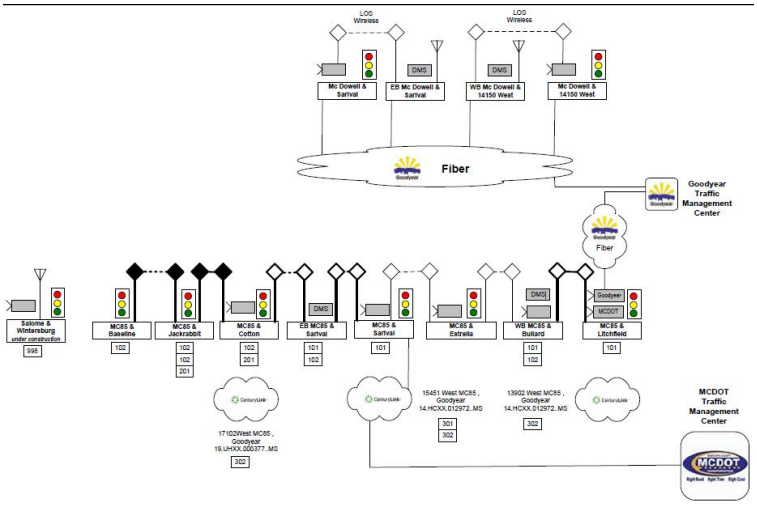
Maricopa County developed an Intelligent Transportation System Business Plan in 2006. The original plan made the recommendations to deploy ITS infrastructure on critical MCDOT corridors, enhance the MCDOT Traffic Management Center, continue to operate and develop the capabilities of the REACT teams, and lead regional ATIS and Arterial Traffic Management efforts through the AZTech Partnership. Substantially all of the recommendations of the plan have been implemented, except when superseded by differing priorities that have come to light in recent years.

MCDOT partnered with RedHawk Solutions to develop an ITS Communication Plan Update that presents short-term (one to two year), mid-term (two to five year), and long-term (five to ten year) strategies for establishing reliable communication with MCDOT's traffic signals and Intelligent Transportation System (ITS) field devices. The objective of this plan is to recommend strategies to establish communications with all of the traffic signals owned and maintained by Maricopa County. Some specific goals include:

BACKHAUL PLAN BY AREA

Area	Sun City Area	Sun City West	Sun City North	Anthem Area	Carefree Hwy	Olive Ave	Dysart Rd.	Indian School Rd.	West MC-85	East MC-85	Salt River Area	Laveen Area	Wild Horse Pass	Sun Lakes Area	Gilbert Road	University	Broadway
Short Term Backhaul	PEO-RCN	PEO-RCN	PEO-RCN	ADOT Cell	Telco	PEO-RCN	PEO-RCN	ADOT	Telco	Wire less --> ADOT	ADOT	NLOS Wire less CHN-RCN	CHN-RCN	CHN-RCN	Telco / Cell	Telco	Telco
Long Term Backhaul	PEO-RCN	PEO-RCN	PEO-RCN	ADOT	Scottsdale --> ADOT	PEO-RCN	PEO-RCN	ADOT	Goodyear RCN / Cell	Fiber --> ADOT	ADOT	ADOT	ADOT	CHN-RCN	ADOT	Mesa RCN	ADOT

- Establish reliable communications to 100% of the Traffic Signals on Maricopa County Roadways.
- Take advantage of improved communications and connectivity to reduce reliance on maintenance vehicle dispatches to perform signal system troubleshooting.
- Develop a fault tolerant communications network where economically feasible.
- Participate and lead in regional partnerships to keep traffic moving efficiently and safely in a multi-jurisdictional environment.
- Maintain a skilled and highly trained staff to effectively maintain and operate the system
- Provide sufficient communication bandwidth to take advantage of recent technology innovations in the intelligent transportation systems field.



In 2019, MCDOT partnered with YMSA to complete an Arterial Mobility Strategic Plan which sets the strategic direction, identifies needs, and recommends actions for managing an optimized arterial network to deliver safe and reliable travel experience for all road users. The Strategic Plan identified ITS components of the arterial operation and management system, assessed existing ITS infrastructure, identified gaps, proposed short- and long-term initiatives, identified additional funding sources and suggested an organizational structure that supports the growing needs of arterial mobility. Strategic initiatives to achieve the vision and mission were identified through stakeholder meetings, discussion and research. These strategic initiatives in the areas of *Performance Reporting, System Management, System Upgrades, Innovation, Resources and Regional Initiatives* set the groundwork for defining projects and process improvements.

Consultants Supporting Real Time Operations

Many of the TMCs in the valley had a difficult time with obtaining and keeping staff was a strong background in arterial operations. With this growing need, MCDOT and City of Phoenix are exploring the use of consultants to fill that gap. Consultants are coming into the TMC on a daily basis to support arterial mobility and operations in real-time, improve existing processes and provide training to staff that do not have a strong background in ITS and operations.

Consultants bring a unique perspective and provide local agencies with a "deeper bench". By utilizing consultants as an extension of their own staff, agencies like MCDOT and the City of Phoenix are making strides in providing safe, efficient, predictable, and reliable networks throughout Maricopa County in preparation for the deployment of the L101 Mobility Project for integrated corridor management anticipated to be implemented in the upcoming years.

In 2019, the Maricopa County Department of Transportation (MCDOT) published a new Arterial Operations Strategic Plan (the "Strategic Plan"). This plan was crafted to establish the direction, needs, and actions necessary to help the County manage an optimized arterial network and deliver a safe and reliable travel experience for all road users.

To help support the vision and mission of the Strategic Plan, MCDOT has started to lean more heavily on consultants to provide support for daily traffic signal operations and other arterial mobility needs, including:

- General signal timing optimization in real time
- Active monitoring of daily traffic signal performance
- Identifying, tracking, following up on and developing resolutions for recurring issues
- Support for monitoring and evaluating new and emerging technologies
- Development of quick reference materials
- Staff training

Earlier this year, MCDOT started using On-Call consultant support providing in-person staff at the MCDOT Traffic Management Center (TMC) on weekdays during the PM peak travel period. This daily support consists of actively monitoring the County's traffic signals using KITS advanced traffic management system (ATMS) software and CCTV video footage to diagnose issues, evaluate and respond to calls from citizens, and identify opportunities to improve system efficiency in real-time.

In addition to actively monitoring the MCDOT traffic signals, Kimley-Horn's presence in the TMC gives MCDOT an extra set of hands to help support miscellaneous tasks like Synchro network updates, signal database cleanup, support for ITS projects, and basic signal timing training. Kimley-Horn has also been able to provide an outside perspective and give constructive feedback on existing TMC procedures, training materials, and tools and has even created new tools to help MCDOT track new or recurring complaints and other issues at signalized intersections.

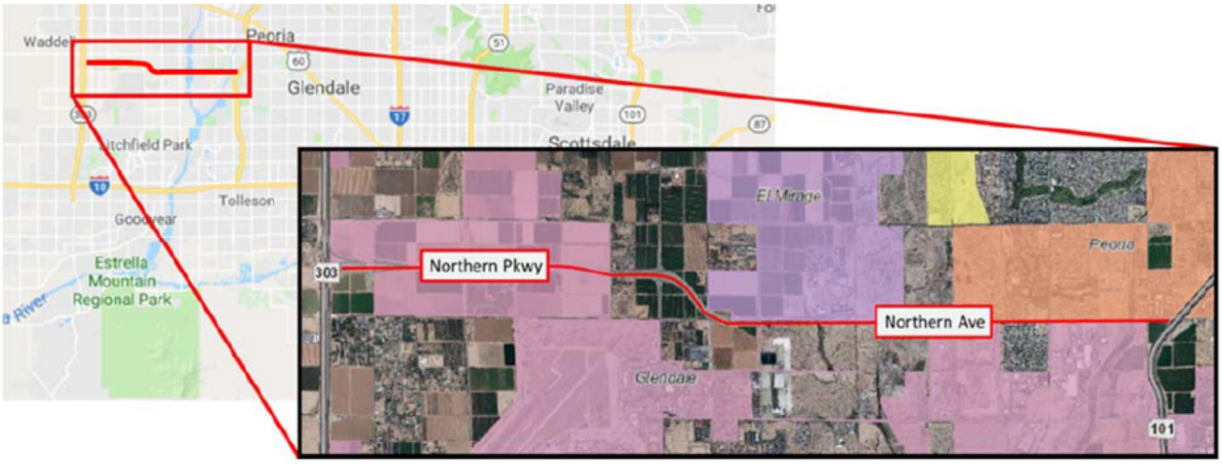
Across town, the City of Phoenix TMC Staff has also been relying on its consultants to help improve and manage operations at its 1,200+ signals. In addition to providing traditional signal timing services, the consultant is developing several standard operating procedures (SOPs) for TMC staff. All current TMC staff have completed a one-on-one Synchro basics course created and taught by consultant staff. This ensures the TMC staff is aware of the fundamental engineering concepts behind signal operations and is familiar with the tools available to them to make informed decisions. Some TMC staff members will also be starting advanced Synchro trainings. Kimley-Horn is currently in the process of helping the City perform some unique studies related to pedestrian clearance interval methodologies and

Northern Parkway ITS Architecture

The Northern Parkway ITS Assessment project evaluated a 9-mile portion of the corridor from the SR 303L to the SR 101 L to steer the design, operations, and maintenance needs to support ITS for this area. Project completion resulted in a high capacity east-west roadway, connecting the Cities of Glendale, Peoria, and El Mirage with Central Phoenix. The project was overseen by the Maricopa Association of Governments (MAG) along with the members of Northern Parkway Stakeholders Group (NPSG). The location and goals defined for the project are seen below.

Project Goals

- Support enhanced traffic management
- Promote consistent technology
- Accommodate for future ITS elements
- Address all stakeholder needs
- Enhance availability of traveler information



To ensure that ITS infrastructure systems were deployed to meet future corridor needs, a complete analysis of the existing infrastructure was completed to identify present gaps . Traffic Management Infrastructure gaps and needs were determined from data collection and performing the inventory assessment and the necessary regional systems and equipment required for traffic management to support NPSG agency needs were determined:

Regional Systems for Traffic Management

- Regional Archived Data System (RADS)
- ARIS AZTech Regional Information System
- Regional Community Network (RCN)
- Highway Conditions Reporting System (HCRS)

Equipment Required

- Traffic Signal Infrastructure
- ITS communications Infrastructure
- Traveler Information Systems
- CCTV Cameras
- Wrong-Way detection

The project was implemented by subdividing the corridor into four small phases with the end-goal to provide end-to-end fiber optic communications throughout the entire corridor and to deliver ITS needs for Northern Parkway.

MULTIMODAL COORDINATION SECTION 10

This section describes transit, bicycle, pedestrian, and rail activities in the region related to ITS and operations.

Waymo/Valley Metro Partnership Announced in Q4 of 2018

The U.S. Federal Transit Administration (FTA) oversees the MOD Sandbox Program which focuses on incorporating new transportation technologies to support existing public transit systems. In late 2016, Valley Metro was selected for this program, which also included an Autonomous Vehicle (AV) Pilot Demonstration Project. The goal of the project win was to consider attitudes and awareness of AV technology and to determine if incorporating self-driving mobility solutions would improve connection for travelers to Valley Metro's services.

The project concentrated on whether on-demand, self-driving cars could improve service in the following focus areas: improve safety, influence customer experience, and increase mobility and connectivity

The project was deployed in three phases:

Phase 1 – Employee Phase of the Experiment

Valley Metro employees who lived in the Phoenix Metro area were asked to participate in the AV MOD experiment as test subjects. Employees rated their experience using Waymo across different service areas after every trip, which resulted in an Average Trip Star Rating of 4.7, with 72% of trips having a 5-star rating. Five-star trips were attributed to smooth rides and good Pickups and Dropoffs. This indicated that the overall experience employees had using Waymo was very good and employees stated that their participation left a positing impression towards using self-driving cars. Employees also said they would use Waymo to get to public transit if it connected them to a light rail station, however, they were neutral or wanted more information about how the cost of Waymo compares to other ride-hailing services before agreeing to pay for the service.

Phase 2 – Incorporation of RideChoice Users

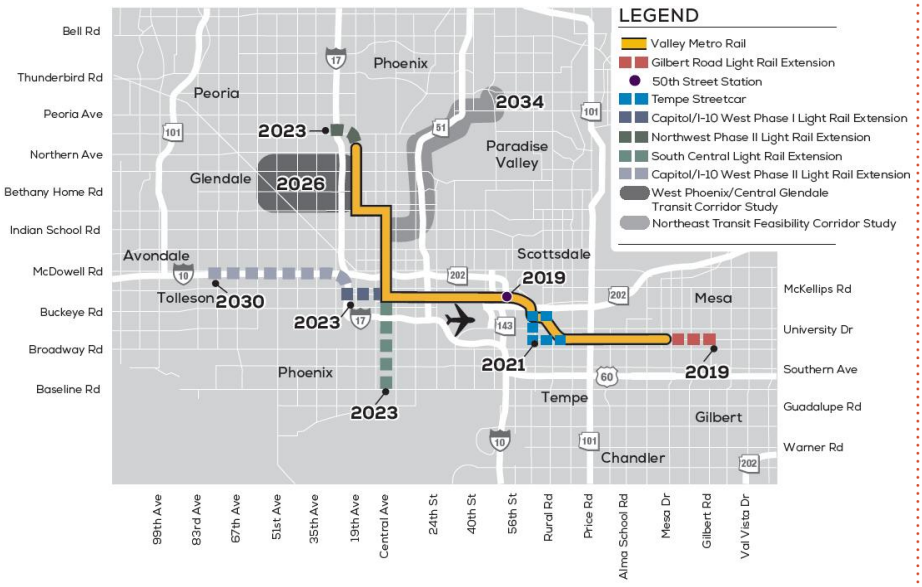
This phase of the project began in September 2019 in which Waymo started offering mobile RideChoice patrons the ability to order "on-demand" AV rides that begin and end within the AV service provider's operational boundaries through the service provider's app. Pre-survey data was collected during August and September 2019. As of January 30, 2020, over *885 RideChoice rides have been taken.

Recruitment was conducted by Valley Metro and Waymo. Pre-survey data showed that of the participants who met the criteria to participate, 29 were consistently riding. 60% of riders were male, and 40% are female. 51 riders submitted a pre-survey. Results from the pre-ride survey showed that 59% of riders were willing to wait up to 10 minutes after ordering the RideChoice service, and 49% would expect the ride to not cost more than a traditional RideChoice ride. Participants also stated that they would use self-driving cars 43% of the time. 19 of the 51 onboarded have not taken a RideChoice ride for a variety of reasons, including being close to the service boundary. These users either could not get picked up in front of their homes, or their destination was located outside of the service area.

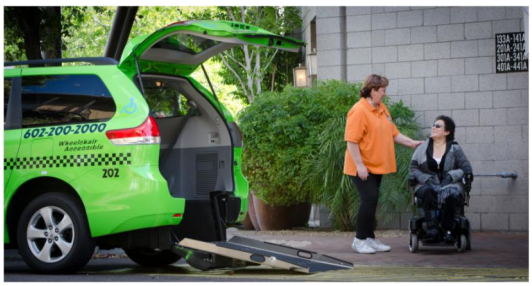
A during survey was administered in February 2020, and a post survey will also be administered with focus groups held in April 2020. A draft white paper is anticipated in late June 2020.

Light Rail Expansions

Valley Metro continues to extend the light rail lines throughout the valley, with multiple projects currently under design or construction. The Gilbert Road Extension will extend light rail on Main Street in Mesa from Mesa Drive to Gilbert Road. The first track is anticipated to be laid in spring 2018. The Northwest Phase II Extension is advancing to the next phase of design while the South Central Extension is in the initial design phase.



RideChoice Program



RideChoice is a subsidized transportation program for people with disabilities that are ADA certified and, in some cities, for seniors age 65 and over. In December of 2018 Valley Metro revamped the RideChoice program to simplify the program, make it more affordable, and make it better the ever as we moved into 2019. Some of these exciting changes included providing one phone number to call to make trip reservations 24 hours a day, expanding the transportation network, standardizing and simplifying the fare structure, and creating a card less and cashless system. RideChoice registered users call (602) 716-2111 anytime of day. Customer pay $3 for up to an eight-mile trip and $2 per mile additional after eight miles. Trips can be used to go anywhere in Maricopa County for any purpose. Customers have the choice of which of the authorized providers they wish to use, thereby using the power of the marketplace to maximize service quality.

With these changes, in 2019 Valley Metro saw the popularity of RideChoice grow in leaps and bounds. The number of trips being provided by RideChoice almost tripled by the end of the 2019. With this popularity several new communities joined the program. Currently RideChoice is available in Avondale, Chandler, Fountain Hills, Gilbert, Goodyear, Mesa, Scottsdale, Surprise, Tempe, Tolleson, and all unincorporated areas of Maricopa County. In 2019 the transportation provider network was even expanded further, the popular rideshare service Uber on board. Several other local companies were added to meet the increasing need for accessible vehicles. Finally, to help with customer who find themselves frequently taking trips longer than eight miles, a new mileage option was introduced.

Going into 2020 and future, RideChoice is always in the process of improvement and has some exciting plans on the horizon. The cost saving benefits for both riders and communities has sparked interest with other cities and towns that are now looking into joining the program. RideChoice will continue explore and expand its authorized transportation network. We will soon be introducing a RideChoice customer web portal and app where customer will be able to book trips, check on status of trips, monitor their accounts, and so much more.

Tempe Street Car Traffic Signal Priority (TSP) Project

Transit signal priority (TSP) with real-time tracking, which is currently under construction. The streetcar route will be a three miles through the City, with fourteen sheltered stops and two light rail connections. The streetcar will be powered by a hybrid battery, and will be off-wire through the downtown area on Mill Avenue. The streetcar fleet will have six vehicles with a capacity of approximately 125 passengers and will be ADA and bicycle accessible. The capital cost for the project is approximately $200 million. Funding sources include a federal grant, regional funding through Proposition 400, and the City of Tempe local public-private partnerships. The status of the project for the project is at 100% design. The rail has been delivered and welded. Construction of the rail began in November 2018. The streetcar is scheduled to open in 2021.

A few portions of the alignment will have dedicated guideway for the streetcar. However, much of the streetcar alignment will be shared lane with mixed traffic. ITS needs for the Tempe streetcar were outlined, including fiber communications, vehicle detection, CCTV monitoring, and TSP with real-time tracking. The ITS needs were funded via two City of Tempe capital improvement projects of $1 million for fiber communications and $1.2 million for the remaining ITS needs. A list, but not an exhaustive list, of TSP system requirements included virtual detection zones, priority requests based on multiple criteria, accurate real-time GPS-based tracking, wireless non-line of sight (NLOS) communication, monitor the battery's state of charge (SOC), support of existing EVP infrastructure and flexible hardware/software that would include support for silent alarm capabilities and export ETA data in standard formats.

CAD-AVL on Valley Metro

The 2018-2019 period will only include installation, testing and troubleshooting of the Clever CAD-AVL system. Valley Metro, Phoenix, and Scottsdale were all able to work together with our respective contractors to install Clever equipment on the 900 buses in the system. In addition, infrastructure enhancements to some of the yards was also undertaken in order to bring more effective tracking, efficiency, and information about the location and health of the bus fleet. Testing and troubleshooting have taken the rest of the time in the year 2019, continuing to 2020, where those systems are demonstrated in service and multiple sets of eyes have a chance to contribute to a better overall system.

SECTION 11 WHAT'S NEXT?

This Performance Indicator Book has been published every two years. It has served as a valuable summary of the data, pictures, and context that tells the transportation network story for the two-year period. The Book will continue to summarize the key performance indicators through dashboard and data reporting but it will be smaller in size, more reader-friendly, and will use the stories gathered throughout each year to put the data into context.

The AZTech Committees and their individual agency Public Information Office representatives held a forum in February 2020 to discuss the next steps of the Performance Indicator Book process. The outcome of that forum was a reevaluated mindset and action plan to engage additional representatives in the activities happening around the region. Intentional collaboration is key between transportation engineers or ITS representatives and agency Public Information Offices to have all parties stay up to speed on the latest types of projects that are being worked on to improve AZTech topic areas.

Highlights from AZTech partners that support the application of Intelligent Transportation Systems (ITS) technologies that provide efficient mobility for travelers throughout Maricopa County are great story ideas. A story could fall under the AZTech Partnership [Umbrella] if it includes any of these aspects within the realm of transportation:

- Intelligent Transportation Systems
- Traveler Information
- Technology & Operations (such as Traffic Management Centers)
- Transit
- Closed Circuit Television (CCTV) Cameras
- Managing traffic routes for events or critical incidents (Such as the Super Bowl)
- Training employees for the technology of the future
- Data and Data-driven Decision making
- Can be from a single jurisdiction or partnership
- Emerging Technologies
- Incident Management

The intent of this refreshed process is to gather and promote the achievements of AZTech partner agencies as they relate to Intelligent Transportation Systems in a more real-time and distributed manner that is able to be utilized for short Twitter posts or longer article postings. The variety of information acquired from AZTech partner agencies on a more real-time basis and compiled within an annual report will provide recent and relevant context to the benefits of the activities going on throughout the region.

The stories collected during calendar year 2020 will feed into the 2020 AZTech Traffic Management and Operations Performance Indicators Book which will be released early 2021.

AZTECH PARTNER AGENCIES

Arizona Department of Public Safety

Arizona Department of Transportation

Arizona Division of Emergency Management

Arizona State University

University of Arizona

City of Avondale

City of Chandler

City of Glendale

City of Goodyear

City of Mesa

City of Peoria

City of Phoenix

City of Scottsdale

City of Surprise

City of Tempe

Town of Fountain Hills

Town of Gilbert

Town of Paradise Valley

Town of Queen Creek

Federal Highway Administration

Maricopa Association of Governments

Maricopa County Department of Emergency Management

Maricopa County Department of Transportation

Maricopa County Sheriff's Office

Phoenix Sky Harbor International Airport

Valley Metro

Phoenix Fire Department