Southwest Washington
Regional Transportation Council

Vancouver Area Smart Trek (VAST)
Tranportation System Management and Operations (TSMO) Plan:

2016 TSMO Plan Update and Implementation Plan

IBI

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1. Introduction

TSMO at Work in the Region: Key Initiatives since the 2011 TSMO Plan

- Washington State Department of Transportation (WSDOT): Developed bi-state traveler information in partnership with ODOT for major freeway corridors and bridges in region.
- C-TRAN: Completed Mill Plain Transit Signal Priority (TSP) Pilot Project; additional TSP implementation in other corridors (including BRT) is currently underway. Implementing new bi-state multiagency fare collection system.
- Clark County: Significantly expanded and improved traffic signal management and detection capabilities, and is a leading agency in performance measurement and optimization of arterial corridors.
- City of Vancouver: Developing asset management plan including ITS infrastructure.
- Regional Transportation Council (RTC): Continues to lead regional TSMO coordination and funding, and is applying operations data for planning and performance measurement using PORTAL and other tools.
- Regional: Incorporated SW Washington agency archived transportation/ITS data into the PORTAL bi-state regional data archive hosted by Portland State University. Implemented functional enhancements to support multimodal analysis and performance measurement.

This document provides a five-year update to the Vancouver Area Smart Trek (VAST) Regional Transportation Systems Management and Operations (TSMO) Plan.

In 2011, the VAST partner agencies developed the TSMO Plan to guide the implementation of operational strategies and supporting Intelligent Transportation Systems (ITS) technologies for Clark County in Southwest Washington. The TSMO plan builds upon the region's reputation of success and innovation for interagency, multimodal transportation operations coordination and investment. The most visible example of this is VAST (Vancouver Area Smart Trek), a coalition of multimodal state, regional and local agencies which have been actively working together for over 10 years, implementing Intelligent Transportation Systems (ITS) and operations solutions to address the region's transportation needs.

The TSMO Plan presented a strategic framework to guide transportation system management objectives; at the same time, it supported future ITS technology investments and capital improvements necessary to realize those objectives over the next 10 year period. The Plan was intended to be incorporated into the mainstream of RTC's transportation planning efforts, including the regional Congestion Management Process (CMP). The CMP identifies regional transportation needs that can be addressed through the implementation of TSMO strategies, while the Regional Transportation Data Resources developed under this project provide a means for tracking CMP and TSMO performance metrics for recurring and non-recurring sources of congestion.

The original TSMO Plan was developed with a horizon of ten years; while this is shorter than the planning horizon of most regional plans, it is indicative of both the nature of TSMO strategies as viable near-term solutions to operational deficiencies, as well as the rapid evolution of ITS technologies and operations practices.

In the five years since the adoption of the plan, agencies in the region have made significant efforts to improve the regional transportation system according to the recommendations of the TSMO plan. This appendix is an

interim update to the TSMO plan that attempts to capture how far the region has come, and adjust the TSMO goals and objectives of the region for the next five years.

1.1. Intelligent Transportation Systems – The Enabling Tools of TSMO

The 2011 Plan identified potential future ITS infrastructure investments based on the TSMO strategies recognized by regional agencies in the context of other elements of a successful regional operations program, such as institutional coordination, policies and performance measures.

Examples of TSMO Include:

- Traffic Signal Enhancements
- Ramp Metering
- Access Management
- Traveler Information
- Smart Transit Management
- Coordinated Incident Response

As opposed to conventional strategic planning efforts, the Plan enlisted a more comprehensive view of ITS as the "enabling tools" that allow agencies to collaborate in active management of the transportation system. This active management, in turn, reflects the operational objectives that address the transportation needs and priorities acknowledged by transportation professionals and decision-makers at the regional level.

1.2. Participating Agencies

Developing the TSMO Plan concerned a diverse array of stakeholders that play a functional role in transportation operations, planning and incident management in Clark County. A Steering Committee comprised of the applicable public agencies was established to guide the planning process; the TSMO Steering Committee Agencies include the following:

- Washington State Department of Transportation
- Clark County
- City of Vancouver
- Clark County
- Southwest Washington Regional Transportation Council
- C-TRAN
- City of Camas
- Metro

Figure 1: Since the 2011 TSMO Plan, WSDOT and ODOT have collaboratively developed and deployed a Bi-state Travel Time providing motorists with real-time information to inform decision making on key freeway corridors.

1.3. Regional TSMO Vision

The TSMO Plan was developed around a regional vision for coordinated and integrated operation of the regional transportation system, as articulated in the TSMO Vision Statement below. TSMO programs and investments in Clark County use innovative and proactive operational strategies to maximize the transportation system efficiency. It focuses on lower cost operational and multimodal strategies that are regionally coordinated in an effort to better utilize existing transportation facilities.

TSMO Vision for Clark County

Transportation System Management and Operation (TSMO) strategies promote more efficient and cost-effective use of the existing transportation system, providing increased accessibility, reliability, and safety for people and freight.

TSMO provides options to address transportation needs where conventional transportation investments may be cost prohibitive, infeasible, or undesirable. In this way, TSMO is highly complementary to other regional transportation strategies and should be considered an integral part of the region's toolkit to address existing and future needs.

1.4. An Agile Response to Rapid Changes in Transportation

Many transportation improvements are years in the making. Due to the timeframe required for planning, permitting, community consultation, funding, and construction, it is often challenging to address immediate transportation needs through conventional infrastructure projects.

While Transportation System Management and Operations cannot fully replace conventional infrastructure projects to maintain the performance of the transportation system and meet the needs of a growing region, it does offer the advantage of providing benefits that can often be realized in the near term (0-5 years) at a fraction of the cost of conventional projects. Therefore, TSMO is an important tool in the regional transportation toolkit that complements other forms of transportation investment, and can provide a more immediate response to transportation needs.

Figure 2: C-TRAN's new Bus Rapid Transit (BRT) system uses numerous ITS technologies and expands the region's Transit Signal Priority (TSP) system, providing increased transit reliability and speed in a congested mixed-traffic corridor.

A challenge—and an opportunity—is also the rapid pace of innovation in transportation technology today. Conventional Intelligent Transportation Systems continue to evolve into more powerful and integrated multimodal systems. Agencies are continually building both capability and expertise in harnessing these tools and the data they generate to improve transportation system operations.

Furthermore, there are profound innovations that are dramatically reformulating long-held assumptions about mobility, traveler behavior, business models, and infrastructure priorities. As with many other facets of contemporary life, new technologies and market forces are shaping how transportation, and particularly transportation system management and operations, will be delivered and experienced. From technology companies to auto manufacturers, new market entrants are rapidly becoming significant active partners in shaping the transportation system of the future.

Figure 3: The VAST program funds implementation of ITS and communications infrastructure projects across the region.

To fully harness these changes to the maximum benefit of the region, it is necessary for agencies in Southwest Washington maintain an agile footing, and to be prepared to re-evaluate plans, policies, and investment priorities to capitalize on evolving technology trends. This TSMO plan update is no exception, and has been created by the partner agencies in full recognition of the need to retain flexibility and innovation in the region's TSMO program and infrastructure.

It is not possible for this document to anticipate the full impact of the fundamental changes underway. The needs, strategies, and implementation priorities documented in this plan should continually refined in the coming years. The evaluation of candidate strategies and technologies should be guided by the goals set out in the regional transportation plan, and the enduring principles of maximizing transportation system safety, reliability, capacity, convenience, and choice across modes and jurisdictions.

1.5. The VAST Consortium - Harnessing Technology Innovation to Benefit Southwest Washington

For over 15 years, VAST has helped the region harness the benefits of technological innovation and regional approaches to Transportation System Management and Operations. This unique partnership promotes interagency collaboration to improve the management and operations of the multi-modal transportation system. VAST has helped agencies, identify, evaluate, fund, implement, and operate emerging transportation technologies for the benefit of Clark County residents.

This role as a facilitator of transportation innovation is more important as ever, as Southwest Washington faces emerging trends that will have profound impacts on transportation. With continued population growth and transportation system pressures, coupled with sweeping impacts of Smart Cities and Connected/Autonomous Vehicles, technology innovation and partnerships will play an increasing role in the future mobility in of the region.

Figure 4: VAST provides a forum for agencies to discuss emerging transportation technologies, opportunities, and challenges. In 2016, VAST hosted a Connected and Autonomous Vehicles (CAVs) workshop to discuss their profound future impacts on transportation in Clark County.

2. Emerging Operations Issues and Trends Impacting TSMO in Clark County

Regional TSMO Benefits: Clark County Public Works Example

TSMO is a cost-effective way to help the region get the most out of its existing infrastructure. Over the past ten years, Clark County's $15 million investment in traffic signal systems, vehicle detection, and fiber optic communications provides County-wide benefits of reduced congestion, increased safety, and improved travel time reliability. TSMO complements the County's conventional infrastructure projects that provide important but localized benefits. For example, the County's recent widening and improvement project on NE 88th St. upgraded 1.7 miles of arterial at a total cost $17.2 million.

2.1. Overview

One of the advantages, and the challenges, of TSMO is the rapid pace of technological innovation and the development of new operational strategies both locally and nationally.

As part of the TSMO Plan interim update, the VAST member agencies discussed both current and emerging operations issues and trends that are impacting the direction of transportation systems management and operations in the region. These issues have been taken into consideration in the update of the TSMO strategies toolkit as well as the updated Implementation Plan.

Key issues identified in this interagency discussion are summarized in the tables below by topic. This list represents a snapshot of key issues at the time of writing. As was emphasized earlier, due to the rapidly evolving nature of transportation technology, it is important to re-evaluate issues and opportunities on an ongoing basis in the coming years.

VAST agencies recognize the need for flexibility and openness to changing technology, market, policy, and funding conditions in the realization of the TSMO program.

2.2. Emerging Technologies

EMERGING ISSUES AND TRENDS	OPPORTUNITIES AND IMPACTS FOR TSMO IN CLARK COUNTY
Connected and Autonomous Vehicles (CAV)	Connected and autonomous vehicle are anticipated to have a profound impact on the surface transportation system. A substantial amount of activity is currently underway to develop technologies, industry partnerships, technical standards, and policy frameworks to support the implementation of CAVs. VAST agencies recognize the need for a proactive approach to CAV implementation. There is a need and a desire among the agencies to "future proof" infrastructure to accommodate CAVs as devices and standards become available. An example of this is the installation of high powered signal controllers that can process large amounts of data and can communicate with vehicles and other roadside devices. There is also the opportunity to position the region to take advantage of new funding sources for infrastructure upgrades, pilot projects, and new agency-industry partnerships as they emerge over the next 5-10 years. Dedicated federal funding sources were an important catalyst for ITS infrastructure investment in its early evolutionary period, and a similar program could possibly be implemented to support CAV deployment. New private sector participants in the CAV field also raise the prospect of increased public-private partnerships.

Figure 5: The rapid advance of Connected and Autonomous Vehicle (CAV) technology has created a host of new technology, policy, and infrastructure issues to be coordinated between public agencies, auto manufactures, and third-party service providers. (Source: Nissan)

EMERGING ISSUES AND TRENDS	OPPORTUNITIES AND IMPACTS FOR TSMO IN CLARK COUNTY
Smart Cities	Another major industry trend is the application of information technology to increase the connectivity and intelligence of urban infrastructure. This concept—referred to as "Smart Cities"—envisions increasingly integrated urban infrastructure to provide real-time monitoring, information, user feedback, and performance measurement. The result is a safer, more efficient, and more user-responsive urban infrastructure. In many ways, Intelligent Transportation Systems represent the early application of Smart Cities concepts to the transportation sector. While ITS has been a Smart Cities strategy for many years, and CAVs will substantially increase this automation, the widespread adoption of Smart Cities approaches in areas such as energy, education, commercial development, public safety, and related areas of civic infrastructure are likely to create new partnership opportunities between VAST and like-minded Smart Cities advocates in other fields and government departments. Examples include sharing of physical communications infrastructure or integrating transportation data into broader government open data initiatives. Coordinated efforts towards Smart Cities deployments by multiple governmental agencies and departments is likely to reap benefits in terms of functionality, infrastructure cost sharing, and increased public/policy awareness.
Quality, Integration, and Open Sharing of Transportation Data	Transportation data is an increasingly important asset to be managed and leveraged to achieve public benefits. Development in ITS systems and the braided technology community have illustrated the power of open data standards, and the ability to share ITS and traveler information with third parties to provide value-added services. An example is the use of highway and transit agency data by third-party mapping applications to provide multi-modal trip planning and real-time traffic and service conditions. The VAST agencies have identified the opportunity to continue increase the accessibility and exchange of data from formerly "closed" systems such as traffic signal systems and transit management. In particular, increasing sharing of agency data with third parties (including CAVs) through open data standards and a regional data portal is a key strategic initiative, and builds upon the region's successes in adopting the PORTAL regional transportation data archive.
Supporting Emerging Operational Strategies	Innovation is at the heart of the VAST community, and new TSMO strategies have been identified that can address the transportation needs of the region. One example is exploring the the use of Bus on Shoulder (BOS) for C-TRAN buses on SR 14 and along the bi-state I-205 corridor. Other examples include the potential for expanded use of ramp metering or freeway active traffic management (ATM) in the region topics that will be studied in the near future led by WSDOT. For these initiatives and others, the partner agencies recognize the role VAST can play in "making the case" for investment, building partnerships, securing funding, creating regional operations strategies and agreements, and communicating project benefits.

EMERGING ISSUES AND TRENDS	OPPORTUNITIES AND IMPACTS FOR TSMO IN CLARK COUNTY
Cost Sharing and Sustainable Funding	An ongoing commitment of sustainable, predictable funding is required to maintain the existing TSMO capabilities and ITS infrastructure that exists today, let alone to expand capabilities or coverage in response to emerging needs and opportunities. Without this sustainable funding, TSMO capabilities that exist today, such as incident response, traffic signal coordination, or traveler information, risk becoming non-functional or obsolete. Given their technological nature, many ITS devices and systems have expected useful lives of 5-10 years. This makes continued re-investment imperative to the ongoing success of the program. Similarly, TSMO programs require a sufficient level of staffing to support engineering, maintenance, and operations of systems. The personnel and expertise needs range from field device installation and repair, to IT network and communications expertise, to staffing of operations control centers, to planning/policy coordination with other agencies. A perennial challenge for transportation agencies involved in TSMO planning and deployment is the identification of sustained funding sources for capital and operating expenses. This need was re-emphasized in the 2016 TSMO plan update. A foundation for stable funding is ensuring that policy makers and potential project partners are aware of the opportunities, benefits, and past successes of the VAST program and agency TSMO initiatives.
ITS Infrastructure Renewal and Asset Management	Due to the successes of past efforts, VAST agencies have deployed a substantial infrastructure of ITS and communication equipment across the region. Like any transportation infrastructure, these systems and devices require a systematic approach and sustained funding to ensure asset replacement and continued operation of the system. With this plan update, VAST agencies noted the need to ensure that funding and renewal of existing ITS infrastructure was considered in addition to deployment of expanded ITS infrastructure. Development of regional ITS Asset Management tools to assist with conditions assessment, need identification, and capital budgeting, was recognizes as a particular opportunity. As ITS infrastructure is renewed, it is important to consider opportunities to "future proof" infrastructure to incorporate emerging technologies such as Connected and Autonomous Vehicles or Smart Cities applications.

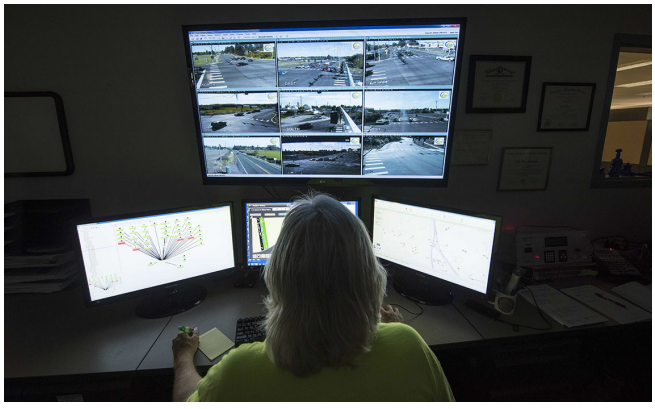

Figure 7: A successful TSMO program requires sustainable funding for operations and maintenance, including the personnel who staff operations centers and provide technical support and maintenance of ITS infrastructure.

EMERGING ISSUES AND TRENDS	OPPORTUNITIES AND IMPACTS FOR TSMO IN CLARK COUNTY
TSMO as a Part of "Practical Solutions" (Least Cost Planning and Practical Design)	"Practical Solutions" is WSDOT's two-part strategy including Least Cost Planning and Practical Design to enable more flexible and sustainable transportation investment decisions. TSMO is an inherent part of a Practical Solutions approach to transportation issues in Southwest Washington, because it may defer or eliminate the need for more expensive conventional infrastructure projects. TSMO offers a suite of lower-cost operations and technology solutions that can be implemented in the near term to make more flexible use of existing infrastructure (e.g., reversible lanes or bus on shoulder). Furthermore, TSMO complements other practical design and least cost planning solutions such as Access Management and Transportation Demand Management. Maximizing this Practical Solutions opportunity requires collaboration among planners, project design teams, and personnel responsible for system management and operations.

Figure 8: A successful TSMO program requires sustainable funding for operations and maintenance, including the personnel who staff operations centers and provide technical support and maintenance of ITS infrastructure.

EMERGING ISSUES AND TRENDS	OPPORTUNITIES AND IMPACTS FOR TSMO IN CLARK COUNTY
Bi-State Coordination	In the past few years, the region has implemented significant bi-state TSMO initiatives with partner agencies in Oregon – most notably the bi-state traveler information system (WSDOT/ODOT), the new regional electronic transit fare collection system (C-TRAN with TriMet), the bi-state interagency ITS Network, and the PORTAL regional transportation data archive. Given the transportation and economic integration of the bi-state region, continued emphasis on bi-state cooperation is recognized, particularly with respect to maintaining up-to-date regional concepts of operation and agreements.
Opportunities for Collaborative Initiatives and Shared Infrastructure	Build upon current collaboration in shared fiber/communications infrastructure, video sharing, and bi-state travel time. Explore new areas between agencies for improved functionality, seamless systems, better operations and cost savings.
Funding and Implementation Support for Individual Agency Initiatives	Each community and agency in Clark County has unique transportation issues and priorities. While there are fertile opportunities for regional collaboration on TSMO initiatives of common interest, the VAST partners also recognize the need to support priorities of the individual participating agencies. Examples include: WSDOT's feasibility assessment for expanded ramp metering in the region; Clark County's efforts to enhance traffic signal system performance and provision for CAVs; and C-TRAN's ongoing Smart Bus technologies initiatives. VAST provides opportunities to build mutually beneficial partnerships and general policy awareness that can support the success of specific agency initiatives.

Figure 9: Bi-state coordination between Washington and Oregon is required to keep the transportation system operating seamlessly across the entire metropolitan region. In particular, the region's two Columbia River bridges require proactive management to mitigate the impacts of incidents, and congestion.

EMERGING ISSUES AND TRENDS	OPPORTUNITIES AND IMPACTS FOR TSMO IN CLARK COUNTY
Leveraging TSMO to Address Regional Transportation Needs	A major theme of the 2011 Plan was demonstrating the relevance of TSMO to regional transportation needs, policies, and projects. The VAST agencies recognize that there is more to be done to ensure that potential project partners are aware of the benefits of TSMO as a potential solution to regional safety and mobility needs. A key opportunity is the use of the PORTAL regional data archive to provide analytics and insight that can support regional transportation planning and policy. The most notable example is the ability of ITS data to support Congestion Management Process (CMP) required by Federal law. This in turn can identify locations to implement TSMO strategies to address congestion hotspots. Continued awareness building among policy makers and capital project proponents is critical to ensure that the relevance of TSMO and the efforts of the VAST agencies are leveraged to maximum benefit for the region.
Regional Performance Measurement	The role of Performance Measurement in transportation planning and investment is increasing at the agency, state, and federal levels. VAST agencies recognize the need for more robust metrics than traditional volume/capacity (v/c) ratios. In May 2016, the Federal Highway Administration (FHWA) published final rulemaking for performance measurement of the National Highway System, Freight Movement on the Interstate System, and the Congestion Mitigation and Air Quality Improvement Program as required by MAP-21 and the FAST Act. Performance measurement can leverage data generated by ITS field systems and aggregated through the PORTAL regional data archive. Automation of data collection and performance measurement through improved data analytics will reduce the burden of generating performance measures, and also allows for standardization across the region (as well as Washington State and the bi-state region). Regional performance measures can also be used to quantify the benefits of TSMO initiatives, such as improved transportation reliability and congestion relief. Finally, increased quantification and transparency concerning transportation system performance may identify new opportunities to apply TSMO strategies to address deficiencies as part of the region's Practical Solutions approach.
Regional Performance Measurement Multi-Modal Approach to TSMO	VAST agencies are involved in a variety of initiatives to improve the performance, safety, and connectivity of the region's multi-modal transportation network. Beyond cars, this includes transit, pedestrians, bicycles, and freight mobility. Meeting the needs of each of these system users opens opportunities to TSMO strategies and ITS infrastructure tailors to specific user needs. Example initiatives include improved vehicle count station to differentiate vehicle types, transit signal priority to maximize corridor person (as opposed to vehicle) throughput, and bicycle detection and pedestrian accommodations at signalized intersections. VAST should work with its planning and project development partners to continue to identify and promote multi-modal TSMO opportunities at all levels, from system-wide planning to specific corridors to individual projects.

3. Regional TSMO Strategies and Goals

3.1. TSMO Strategy Current and Future State of Practice

Candidate TSMO strategies were evaluated by the stakeholders by revisiting the current state of practice in the region for each strategy, and the degree to which they would like to see the strategy implemented in the future. This rating was originally completed as part of the 2011 Regional TSMO Plan. As part of the 2016 TSMO update, stakeholders were asked to re-evaluate the TSMO strategies. Figure ? illustrates the state of practice and goals as of 2011 and 2016 for each strategy.

3.2. TSMO Strategy Rating Scale

The current and future state of TSMO implementation for individual TSMO strategies was rated by the stakeholders according to the following five-point scale (Table 1). Note that the ratings assigned to a particular TSMO strategy reflect the overall state of practice in Southwest Washington, recognizing that there is often variability among agencies and facilities.

IMPLEMENTATION LEVEL	DESCRIPTION
Level 1: Not Implemented	The TSMO strategy is not implemented in Southwest Washington today, however it has been identified for future implementation.
Level 2: Limited Implementation	The TSMO strategy is implemented on a very limited or trial basis, e.g. through a pilot project.
Level 3: Partial Implementation	The TSMO strategy is partially implemented based on limited geography, functionality, or agency participation.
Level 4: Widespread Implementation	The TSMO strategy is widely implemented. These strategies are a mainstay of the regional TSMO program.
Level 5: Complete Implementation	The TSMO strategy has been implemented to its fullest extent across agencies and geography, Functionality and processes reflect fullest capabilities of current technologies and national best practices.

Table 1: Regional TSMO Strategies: Implementation Rating Scale, 2011 and 2016

The TSMO strategies discussed and rated below are organized into five groupings:

- **Regional Management and Operations**
- **Roadway Management and Operations**
- **Transit Management and Operations**
- **Freight Management and Operations**
- **Traveler Information**

3.3. TSMO Toolkit Strategies – Current Status and Future Goals

The re-evaluation of the 2011 strategies identified both successful work completed in the previous five years and new goals for the region to accomplish in the future. In discussion, the accomplishments and new goals are described for each of the adjusted strategies, along with a comparison of 2011 and 2016 states of practice and goals

3.3.1. Regional Management and Operations

Regional Management and Operations encompasses strategies that promote integrated management of the multi-modal transportation network across agencies and facility types. In the case of Southwest Washington, this also includes bi-state coordination with agencies in Oregon to manage the significant daily volumes of passenger, freight, and transit across the Columbia River.

The 2011/2016 state of practice and goals for Regional Management and Operations are summarized in Figure 10.

Table 2 summarizes Regional Management and Operations accomplishments since the 2011 plan, as well as objectives for the next five years that were considered in the establishment of the updated 2016 goals.

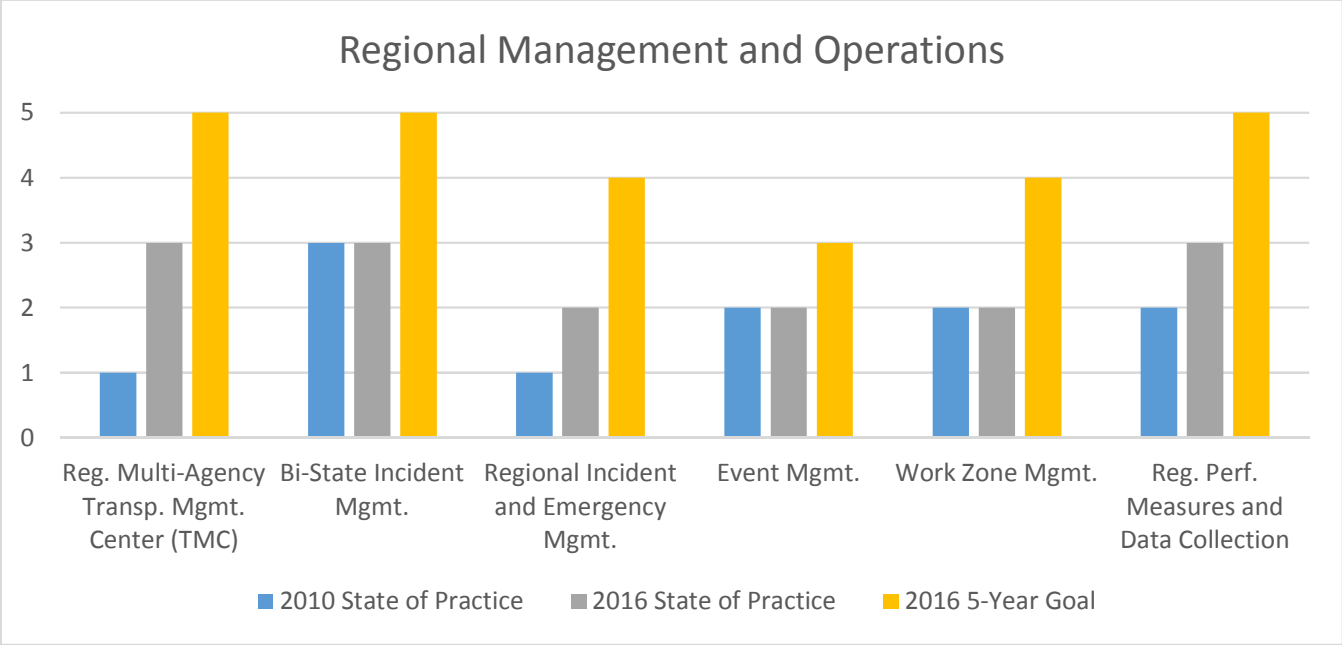

Figure 10: Regional Management and Operations 2011/2016 State of Practice and Goals

TSMO TOOLKIT STRATEGY	CURRENT LEVEL AND KEY ACCOMPLISHMENTS SINCE 2011	FUTURE LEVEL AND 5-YEAR STRATEGIC GOALS
Regional Incident and Emergency Management	CCTV and Traffic Monitoring ITS equipment expansion	Increased data sharing with third parties Increased interagency integration through interoperable systems (CCTV video sharing as pilot project)
Regional Performance Measures and Supportive Data Collection	WSDOT data has been reported to PORTAL since prior to the 2011 plan. Clark County and C-TRAN have been working to feed performance data including vehicle counts and travel times to the PORTAL data archive	Refinement of regional performance standards based on USDOT guidelines Increased PORTAL/ITS system capabilities by expanding the range of multimodal data available, improve ease of use, and provide improved metrics and automate performance measurement

Table 2: Regional Management and Operations: Recent Accomplishments and 2016 5-Year Goals

3.3.2. Roadway Management and Operations

Roadway Management and Operations includes TSMO strategies for both arterial and freeway corridors in the region. This therefore encompasses facilities operated by WSDOT, Clark County, and individual cities. An integrated approach to management across facility types and jurisdictional boundaries is, therefore, and important underpinning to this family of strategies.

The 2011/2016 state of practice and goals for Roadway Management and Operations are summarized in Figure 11.

Table 3 summarizes Roadway Management and Operations accomplishments since the 2011 plan, as well as objectives for the next five years that were considered in the establishment of the updated 2016 goals.

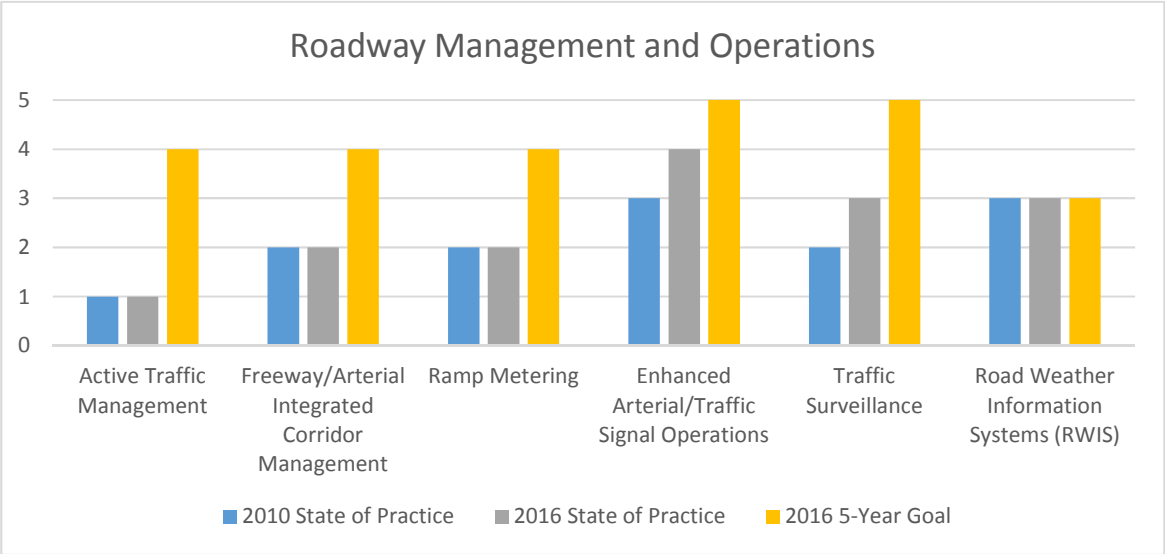

Figure 11: Roadway Management and Operations 2011/2016 State of Practice and Goals

TSMO TOOLKIT STRATEGY	CURRENT LEVEL AND KEY ACCOMPLISHMENTS SINCE 2011	FUTURE LEVEL AND 5-YEAR STRATEGIC GOALS
Active Traffic Management	No implementations in the region to date; examples in Puget Sound Region and Oregon to draw upon	Study feasibility of Active Traffic Management in the region Plan/implement pilot if warranted by study
Freeway/Arterial Integrated Corridor Management	Increased instrumentation of key arterial corridors such as Mill Plain/Fourth Plain Rds.	Clark County plans to integrate traffic operations for common management of I-5 and Highway 99 operations
Ramp Metering	Maintenance of existing, limited ramp metering infrastructure in the region.	WSDOT is undertaking a study of ramp and its application to all Clark County urban freeways
Enhanced Traffic Signal Operations	Clark County has expanded and improved traffic signal management and detection capabilities. Traffic signal controller CPU's are being upgraded on some corridors in the region and new functionality, e.g. Arrival on Green, is being tested	Implementation of increasingly sophisticated controller and central signal systems. Strategies may include preparation to "future proof" the system for Connected and Autonomous Vehicles, adaptive or traffic responsive signal control, performance measurement, and other related strategies to improve arterial operations
Traffic Surveillance	Agencies have deployed additional traffic cameras across the region and video sharing has been tested	Agencies plan to implement a video sharing pilot

Table 3: Roadway Management and Operations: Recent Accomplishments and 2016 5-Year Goals

3.3.3. Transit Management & Operations

Transit Management and Operations primarily impacts C-TRAN vehicles and assets, as well as roadway facilities where transit operates. This area has seen significant investment in the five years since the 2011 plan. Transit Management and Operations also encompasses joint strategies involving TriMet, most notably the new regional integrated fare system that will be implemented across the bi-state region in 2017.

The 2011/2016 state of practice and goals for Transit Management and Operations are summarized in Figure 12.

Table 4 summarizes Transit Management and Operations accomplishments since the 2011 plan, as well as objectives for the next five years that were considered in the establishment of the updated 2016 goals.

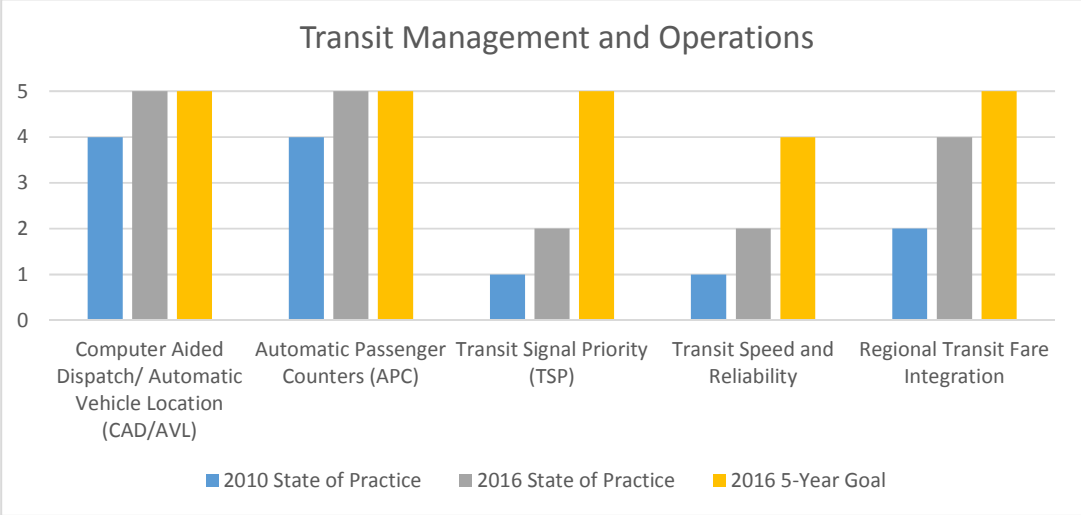

Figure 12: Transit Management and Operations 2011/2016 State of Practice and Goals

TSMO TOOLKIT STRATEGY	CURRENT LEVEL AND KEY ACCOMPLISHMENTS SINCE 2011	FUTURE LEVEL AND 5-YEAR STRATEGIC GOALS
Automated Vehicle Location (AVL) and Computer Aided Dispatch (CAD)	C-TRAN equipped entire fleet with AVL and updated the CAD system to provide more frequent vehicle location information	Complete upgrade of CAD/AVL systems, and use technology as a basis for enhanced operations and traveler information
Automated Passenger Counting (APC)	C-TRAN equipped entire fleet with APC	Continue to operate APCs and use APC data for advanced planning analysis and archive into Portal
Transit Signal Priority (TSP)	TSP pilot project was implemented on Mill Plain	TSP to be implemented on HWY 99, extended on Mill Plain and 164th and implemented on Fourth Plain with BRT project
Transit Speed and Reliability	In addition to TSP and BRT projects, C-TRAN has made route and schedule changes to improve speed and reliability	C-TRAN is finalizing the capability to archive performance data in the PORTAL data archive
Regional Transit Fare Integration	C-TRAN is working with TriMet in Portland to design and implement a Region-wide integrated smart fare system	Begin operations of regional smart card fare system (Hop Fastpass™) – estimated 2017

Table 4: Transit Management and Operations: Recent Accomplishments and 2016 5-Year Goals

3.3.4. Freight Management & Operations

Freight Management and Operations strategies promote movement of freight across Clark County in a safe and efficient manner. Most notably, access to and from the Ports of Vancouver and Portland require coordination across the freeway network as well as local arterial streets.

The 2011/2016 state of practice and goals for Freight Management and Operations are summarized in Figure 13.

Table 5 summarizes Freight Management and Operations accomplishments since the 2011 plan, as well as objectives for the next five years that were considered in the establishment of the updated 2016 goals.

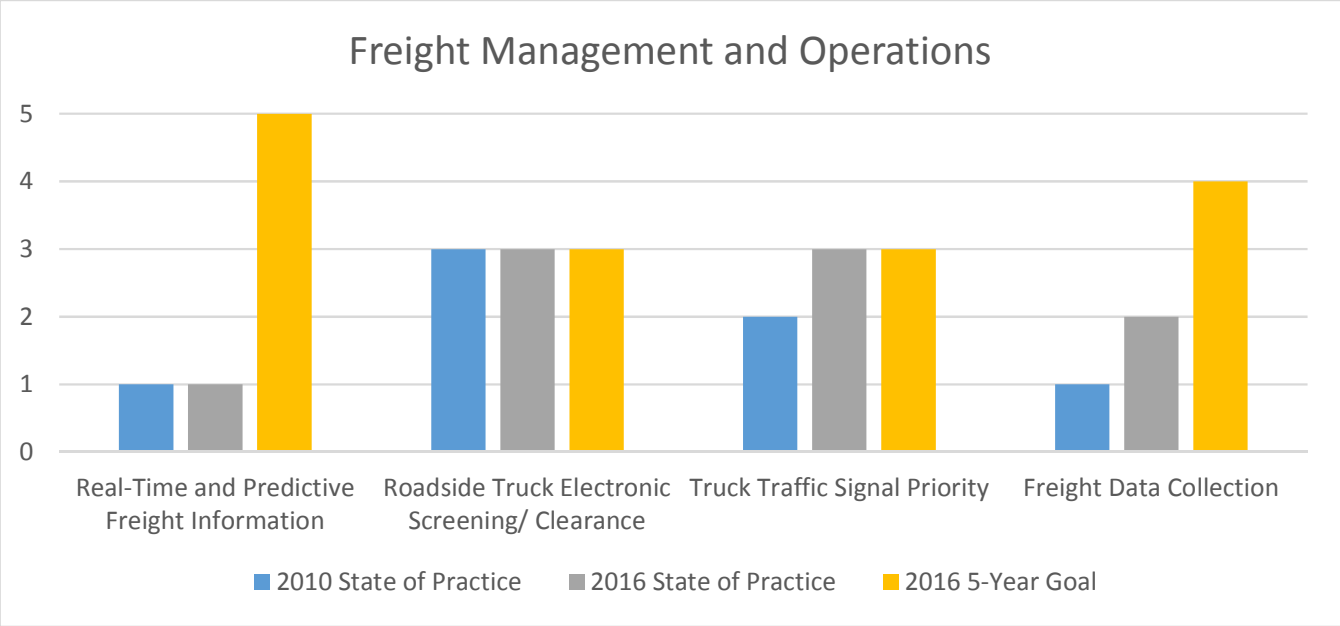

Figure 13: Freight Management and Operations 2011/2016 State of Practice and Goals

TSMO TOOLKIT STRATEGY	CURRENT LEVEL AND KEY ACCOMPLISHMENTS SINCE 2011	FUTURE LEVEL AND 5-YEAR STRATEGIC GOALS
Truck Traffic Signal Priority	Implemented truck-responsive detection at two signal locations (NW 36thAve/NW McCann Rd and NW 79th/NW 9th Ave) to assist with safety on downhill signal approaches	Expand truck signal priority to other priority truck travel/ safety locations (e.g. Padden/94th). This application is anticipated to leverage transit signal priority technology Improve signal integration with railroad grade crossings for safety
Freight Data Collection	City of Vancouver performed a freight study that collected classification data in central Vancouver west of I-5. Limited detection station capabilities to classify vehicles by length	Improve detection station capability around the region to classify vehicles by length and incorporate resulting freight data into Portal Expand number and coverage of count stations with freight data collection capabilities Incorporate fright data and query capabilities into the PORTAL regional data archive

Table 5: Regional Management and Operations: Recent Accomplishments and 2016 5-Year Goals

3.3.5. Traveler Information

The 2011/2016 state of practice and goals for Traveler Information are summarized in Figure 14.

Table 6 summarizes Traveler Information accomplishments since the 2011 plan, as well as objectives for the next five years that were considered in the establishment of the updated 2016 goals.

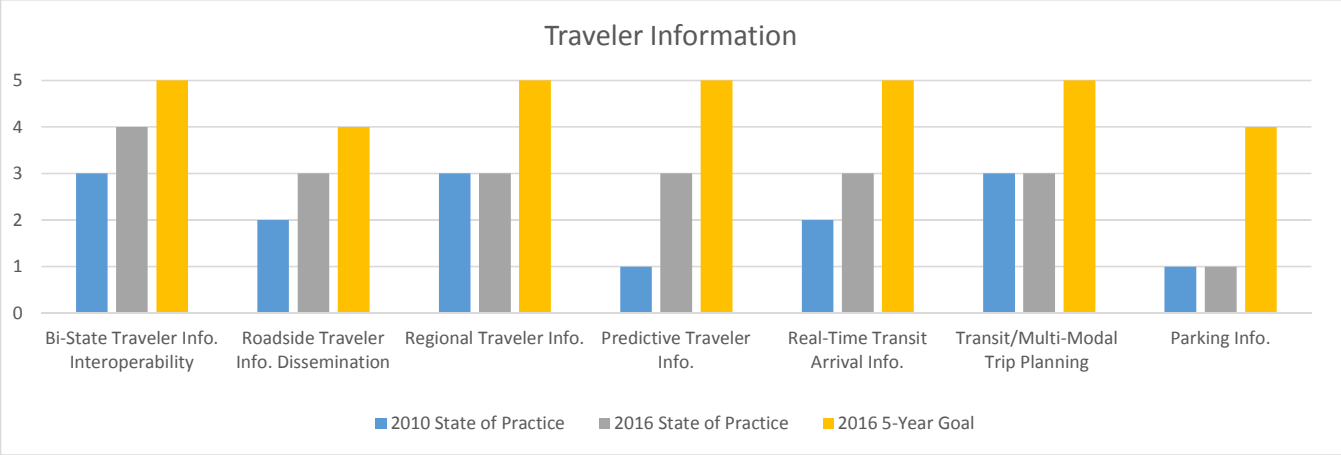

Figure 14: Traveler Information 2011/2016 State of Practice and Goals

TSMO TOOLKIT STRATEGY	CURRENT LEVEL AND KEY ACCOMPLISHMENTS SINCE 2011	FUTURE LEVEL AND 5-YEAR STRATEGIC GOALS
Bi-State Traveler Information Interoperability	WSDOT and ODOT implemented roadside bi-state travel time information for travelers	Increase web and mobile access to travel time information to provide more origin/destination locations and as an alternative to deployment of additional field hardware Share travel time information with third parties for increased reach and value-add services Improve travel time estimation capability and reliability on the interstate bridge crossings (I-5 and I-205) to support proactive travel decision making
Roadside Traveler Information Dissemination	WSDOT implemented roadside travel time signs for travelers on Clark County urban freeways and continues to operate and maintain the regional Dynamic Message Sign network	Maintain and replace regional Dynamic Message Signs with limited expansion locations Investigate the use of portable Highway Advisory Radio (HAR) stations for construction projects
Regional Traveler Information	Congestion and construction information is available on the SW Region WSDOT website and the WSDOT official app	Clark County is planning to provide traffic video and arterial congestion information over the web WSDOT is considering dissemination of near real time traffic CCTV video clips, a capability currently provided in WSDOT Northwest region
Predictive Traveler Information	WSDOT has implemented travel time information signs using a predictive travel time algorithm	Continue to refine predictive capabilities of travel time prediction algorithms Ensure that agency traffic data available to third parties providing predictive travel time services using real time and historical data sources
Real-Time Transit Arrival Information	C-TRAN has equipped entire fleet with AVL and is developing GTFS and GTFS-realtime feeds for arrival and departure information	Enhance reporting capabilities and accuracy with upgrade to CAV/AVL system Extend availability of bus arrival information to users through expanded web and phone application and ensure availability of real-time transit traveler information to third party information providers

Table 6: Regional Management and Operations: Recent Accomplishments and 2016 5-Year Goals

4. TSMO Corridors in Clark County

Figure 15 identifies a regional network of TSMO corridors comprised of limited-access roadways, principal and major arterials in urbanized Clark County where TSMO strategies are likely to be effective strategies given their operational characteristics and needs. For example, varying levels of congestion on these corridors, either by time of day or due to non-recurring events such as traffic accidents, weather, or special events, suggests that an active approach to managed operations is necessary to minimize impacts to the traveler and commercial freight.

The regional TSMO corridors network provides a guideline for future regional and operation planning; these strategies should be considered a viable approach to meeting at least some of the transportation needs of these corridors, based upon the analysis and feedback from transportation agencies participating in the development of this network.

In this 2016 Plan update, the Regional TSMO network was updated to reflect emerging corridors that are becoming operationally significant to the region based on growth in urban development, VMT, and congestion. The overall footprint of the TSMO network was reviewed with the TSMO Committee and within these corridors, Priority TSMO Corridors were re-assessed and updated. The resulting updated TSMO network is shown on the map on the following page.

4.1. Critical Operations Sub-Corridors

While all corridors within the Regional TSMO Network are operationally significant, there were specific critical segments within each of the corridors that would stand to benefit the most from TSMO strategies (due to existing conditions and potential benefit). This guidance reflects the notion that a corridor has many elements and that, although on the whole a corridor may be operating within acceptable limits, certain segments and/or intersection combinations may be in need of attention.

This subset of the Regional TSMO Network knowns as "Critical Operations Sub-Corridors" were identified both from the list of high-scoring corridors against the criteria described previously, as well as suggestions by members of the Steering Committee who are familiar with these facilities, their operational characteristics and their physical constraints.

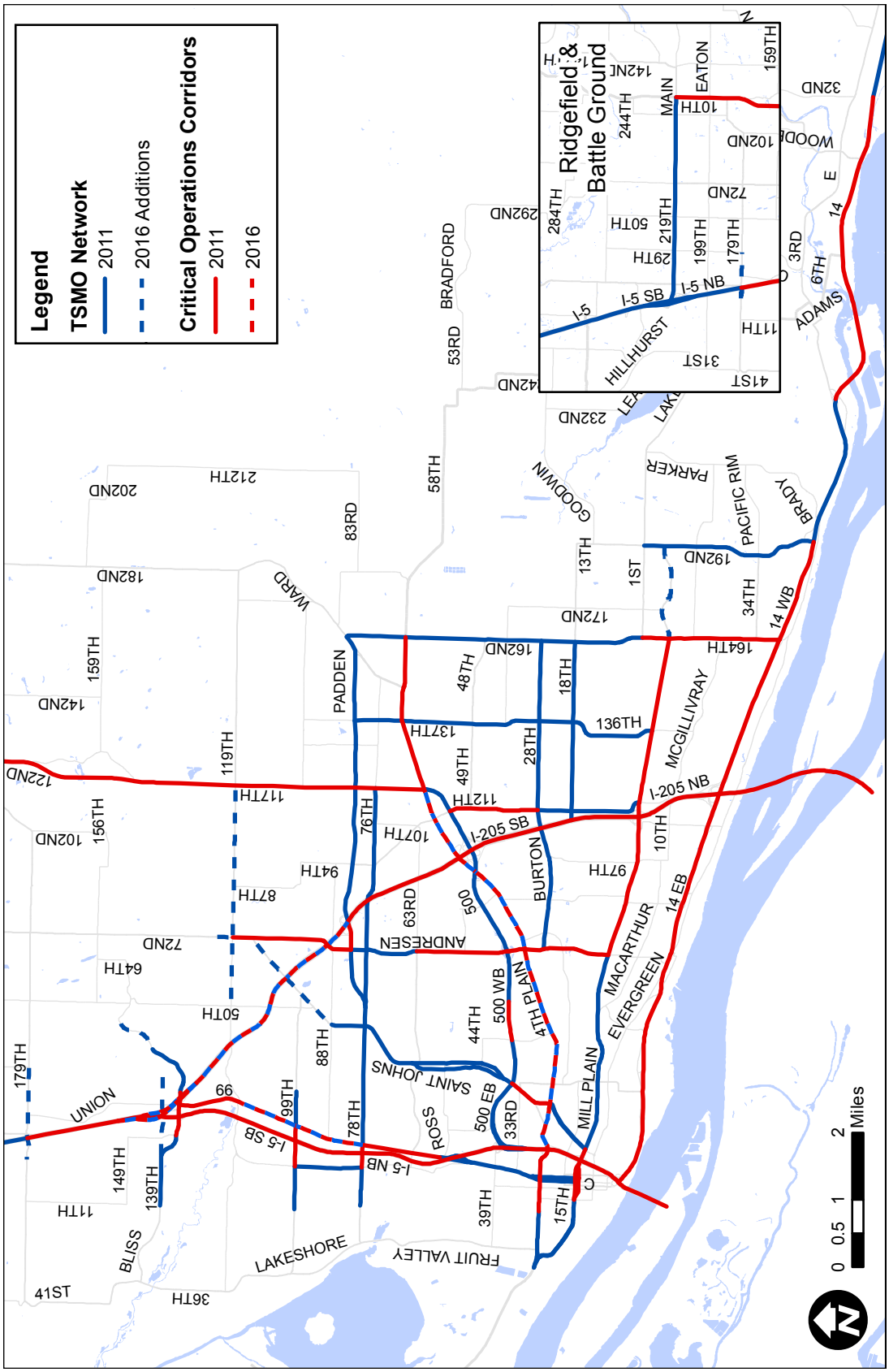

Figure 15: 2016 Updated TSMO Network and Priority Corridors

5. Regional TSMO Implementation Plan

5.1. Overview

The Regional TSMO Implementation Plan provides a roadmap for deployment of ITS field equipment, systems, policies, and practices to support successful system management and operations over the next ten years.

The initiatives described in the implementation plan are organize into the following categories, reflecting key themes and recognized areas for regional collaboration and technological advancement as identified by the stakeholders:

- **ITS Network and Functional Expansion**
- **Integrated and Accessible Data**
- **Collaboration and Cost Sharing**
- **Asset Management**
- **Bi-State Collaboration**
- **Emerging Technologies**

Achieving these implementation objectives will require ongoing interagency coordination to plan, fund, implement, and operate these improvements. VAST can play a critical role in facilitating cooperation and promoting transportation innovation, much as it has for the past fifteen years.

5.1.1. Implementation Timeframe

Timeframes for TSMO initiatives are based on the following timeframe (Table 7). Timelines are given as approximations because many of the initiatives described are not yet programmed projects. The rapid pace of technological development suggests that any initiatives implemented more than 5 years in the future should be considered long-term initiatives.

TIMEFRAME	YEARS INTO FUTURE (2016 IS YEAR 0)
Near-Term	0-2 years
Medium-Term	2-5 years
Long-Term	5-10 years

Table 7: TSMO Implementation Plan Timeframe

5.1.2. Communications Infrastructure Requirements

A companion document prepared by the VAST Communications Infrastructure Committee, the Regional Communications Plan (2016), contains complementary recommendations and initiatives. It provides the underlying communications infrastructure coverage and capacity that connects ITS infrastructure and devices with the associated implementation TSMO strategies. Without corresponding investment in communications capabilities, it may not be possible to provide the necessary connectivity among field ITS devices, vehicles, and operations centers to support the TSMO strategies discussed in this document.

Figure 16: Active Traffic Management has been successfully deployed in the Puget Sound region and in Oregon, and may be a candidate strategy for Southwest Washington in the future.

5.2. ITS Implementation Areas

5.2.1. ITS Network and Functional Expansion

The continued expansion of the ITS Network continues to be a high priority goal of partner agencies. This goal includes the improving and maintaining of the communications network, and the expansion of ITS devices throughout the region. These activities provide agencies with greater ability to operate and monitor the transportation network.

ITS Network Expansion projects and initiatives include:

PROJECT OR INITIATIVE	DESCRIPTION	AGENCIES ** DENOTES LEAD*	TIMEFRAME
Increased Vehicle Detection Capabilities	Continue to increase vehicle detection capabilities throughout the region by deploying additional Bluetooth, Radar, and License Plate detection	•Clark County •City of Vancouver •WSDOT	•Near-Term
Communications Infrastructure Repair and Replacement	Repair or replace obsolete communications infrastructure across the region, including switches, fiber optic cables, and wireless networks. When possible, upgrades should address the anticipated needs of CAVs, Smart Cities, TSMO network resiliency, interagency partnership needs, and increases in data speed and bandwidth to accommodate future growth	•Clark County •City of Vancouver •WSDOT	•Medium-Term
Ramp Metering	Continue ramp metering deployment on I-5 and review opportunities for ramp metering on other Clark County urban freeways (WSDOT feasibility study anticipated late 2016)	•WSDOT*	•Near-Term •(Planning) •Medium-Term (Deployment)
Freeway Active Traffic Management	Conduct feasibility work to apply Active Traffic Management in the urbanized freeways of Clark County, leveraging technology and lessons learned from projects elsewhere in Washington and Oregon	•WSDOT* •ODOT	•Near-Term •(Planning) •Medium-Term (Deployment)
Advanced Arterial Traffic Management	Plan and deploy advanced arterial traffic management systems to improve the safety, reliability, and capacity of regional arterial corridors. Strategies may include but are not limited to: signal adaptive/traffic responsive capabilities, surveillance, data collection, truck/transit signal priority, performance measurement, traveler information, and supporting communications capabilities	•Clark County •WSDOT •Other Cities	•Near Term: •(Clark County pilot deployments) •Medium-Term •(Widespread regional deployment – Clark County, WSDOT and other agencies)
Rural ITS in Clark County	Implement safety projects, count stations, traveler information, and other ITS systems specific to needs in rural Clark County	•Clark County*	•Near-Term •(Planning) •Medium-Term (Deployment)

Table 8: ITS Network Expansion Projects and Initiatives

5.2.2. Integrated and Accessible Data

A key component to TSMO strategies is the accurate understanding of traffic network conditions both historically and in real-time. Historical traffic data provides agencies with information on traffic patterns that can be improved by other TSMO strategies and real-time information gives agencies the opportunity to make changes to traffic control systems immediately in the case of incidents or other delays. However, to gain the most utility from transportation data, it must be integrated across the system and accessible to operations staff and policy makers. Additionally, the emergence of third party tools and apps make it important for data to be made accessible. Agencies can take advantage of these tools and apps by ensuring high quality data is captured from traffic systems and made available to the public through common data feeds.

Integrated and Accessible Data projects and initiatives include:

PROJECT OR INITIATIVE	DESCRIPTION	AGENCIES ** DENOTES LEAD*	TIMEFRAME
Implement Signal Phasing and Timing (SPAT) data feeds	Work with traffic signal vendor to develop an open data feed for sharing SPAT data to automobile OEM's and CAV system suppliers	•Clark County*	•Near-Term
GTFS and GTFS-realtime Transit Data	Enhance C-TRAN's existing GTFS data by implementing a GTFS-realtime feed to share real-time transit info with the public through Google Transit and other third party apps	•C-TRAN*	•Near-Term
Leverage ITS Network for feeding transportation data to PORTAL data Archive	Determine type and range of potential data from existing and planned ITS infrastructure, identify data archiving projects and work to implement ITS network feeds to store data in the PORTAL data archive	•Clark County •City of Vancouver WSDOT •C-TRAN •PSU •VAST	•Near-Term
Data Visualization Tools	Work with PORTAL to develop data visualization and analysis tools	•PSU* •Clark County •C-TRAN	•Medium-Term
Performance Measures in PORTAL	Work with PORTAL to implement automated performance measurement tools and data analytics based on regional system management goals and emerging USDOT guidance	•PSU* •Other VAST Agencies	•Near-Term

Table 9: ITS Network Expansion Projects and Initiatives

5.2.3. Collaboration and Cost Sharing

Jointly operated systems offer partner agencies benefits in cost sharing, shared operation opportunities, and reduce additional communications requirements. While the region is currently exploring video sharing systems, opportunities for other shared systems should be identified and the advantages and disadvantages determined.

Collaboration and Cost Sharing projects and initiatives include:

PROJECT OR INITIATIVE	DESCRIPTION	AGENCIES ** DENOTES LEAD*	TIMEFRAME
Jointly-Operated Video Sharing System (VDG Sense)	Implement a jointly operated video surveillance capable of operating traffic cameras and sharing video between transportation agencies	•Clark County* •City of Vancouver •WSDOT •C-TRAN	•Near-Term
Consolidated EVP/TSP Central Management Systems	Jointly operate a single central management system for managing EVP/TSP (Emergency Vehicle Pre-emption and Transit Signal Priority) across the region, reducing multiple redundant systems, sharing costs and enabling new functionality	•Clark County •City of Vancouver •WSDOT •C-TRAN	•Medium-Term
Shared Regional ATMS with VAST Partners and Smaller Cities	Jointly operate a single ATMS system for the operation and maintenance of the traffic signal network of the region, reducing multiple ATMS systems, sharing costs and enabling new functionality across the region	•Clark County •City of Vancouver •WSDOT •C-TRAN	•Near-Term (Clark County and WSDOT) •Medium-Term •(Ridgefield, •Battle Ground, •Camas, •Washougal) •Long-Term (City of Vancouver)

Table 10: Collaboration and Cost Sharing Projects and Initiatives

5.2.4. Asset Management

VAST's continued success in regional collaboration has made progress in increasing the regional transportation system infrastructure. However, as some of these systems are nearing end of life and others need repairs, agencies are finding problems locating funding sources for management of transportation communications assets. Currently Clark County is the only agency that is required to set aside funds for Early Retirement and Replacement (ER&R) when purchasing new equipment.

Asset Management projects and initiatives include:

PROJECT OR INITIATIVE	DESCRIPTION	AGENCIES ** DENOTES LEAD*	TIMEFRAME
Regional ITS Asset Management System Planning	Prepare an asset management plan for the repair and maintenance of existing traffic devices and ITS systems and addresses funding requirements specific to those types of procurements	•All partners •VAST*	•Medium-Term

Table 11: Asset Management Projects and Initiatives

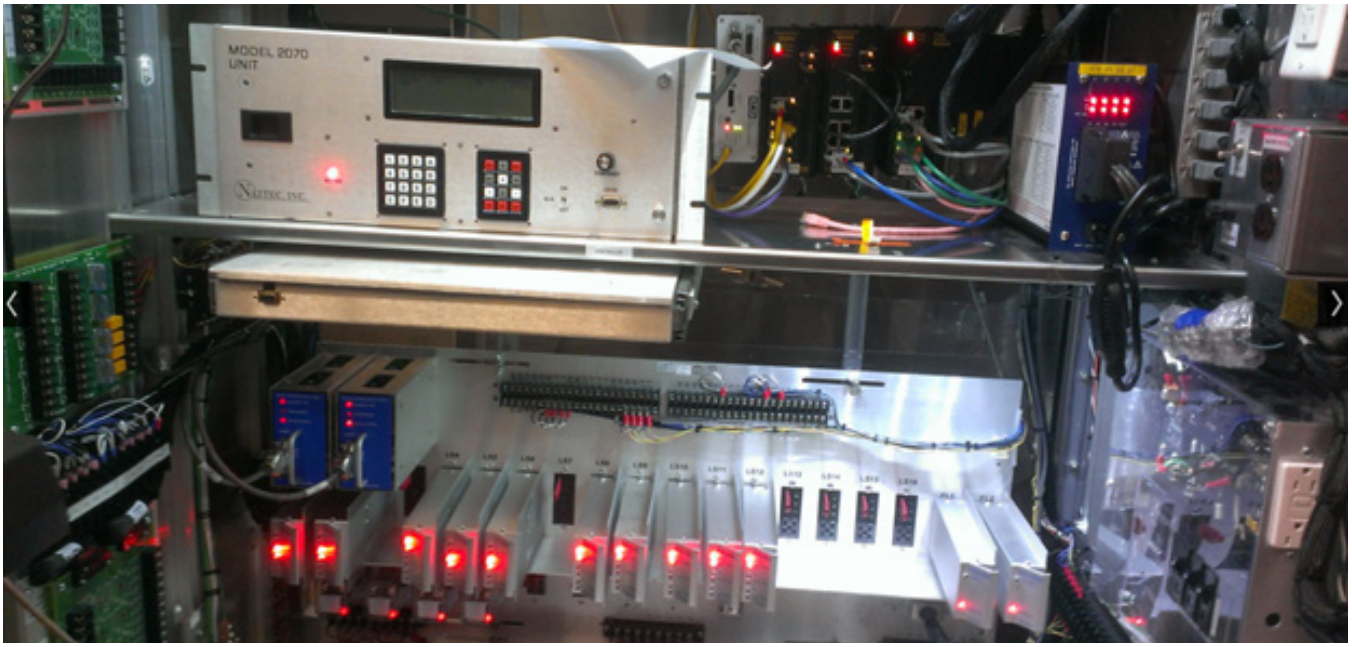

Figure 17: TSMO is supported by a network of ITS devices, communications, and data – key assets to be managed and replenished to ensure the effectiveness of the TSMO program.

5.2.5. Bi-State Collaboration

Clark County constitutes approximately one quarter of the Portland metropolitan Area. With strong commuting, social, and economic ties, ensuring mobility and coordinated system management and operations across the Washington-Oregon state line is vital. A substantial recent success in bi-state coordination was the development of the WSDOT-ODOT bi-state traveler information system. Future initiatives to strengthen institutional and real-time operations coordination (such as freeway bridge incident management) are anticipated to be at the forefront of bi-state efforts in the next five years. Coordination and cross-representation between VAST and its Portland area counterpart TransPort will be instrumental to the success of these efforts.

Bi-State Collaboration projects and initiatives include:

PROJECT OR INITIATIVE	DESCRIPTION	AGENCIES ** DENOTES LEAD*	TIMEFRAME
Bus on Shoulder (BOS) Operations	Develop operating plans, agreements, and technologies to support Bus on Shoulder operations in the SR14/I-205 corridor if warranted by ongoing feasibility assessment. If it is warranted, develop a set of regional policies that would guide how and when to consider BOS in other freeway corridors and regional bus operating protocols.	•C-TRAN*/ •RTC, WSDOT, ODOT, TriMet	•Near-Term
Bi-State Incident Management	Develop policies and procedures for clearing incidents with impacts across state lines	•WSDOT*/ •ODOT* and other bi-state partners	•Medium-Term
Updated Bi-State Operations and Incident Management Coordination Plans	Develop policies and procedures for bridge lifts, traffic incidents, and other related operations on I-5, affecting current agency roles, operating procedures, and ITS systems coverage/capabilities	•WSDOT*/ •ODOT* and other bi-state partners	•Medium-Term

Table 12: Bi-State Collaboration Projects and Initiatives

5.2.6. Emerging Technologies

Connected and Autonomous Vehicles (CAV's), Smart Cities, Electric Vehicles and Shared-Use Economies represent some of the emerging technologies that traffic agencies must prepare for. Currently standards for these emerging technologies are still being developed, however VAST partners should continue to follow these standards discussion and begin developing policies and projects that will future proof current systems (e.g. upgrading signal controller CPU's). Finally, any future discussions of emerging technologies should identify private partnerships with automobile manufacturers or software service providers where mutual benefits can be gained by the traffic agencies and third parties.

Emerging Technologies projects and initiatives include:

PROJECT OR INITIATIVE	DESCRIPTION	AGENCIES ** DENOTES LEAD*	TIMEFRAME
Connected and Autonomous Vehicle Roadmap	Develop an approach for considering Connected and Autonomous Vehicles in Clark County. Identify policy and technical issues, the role of public agencies, new partnerships, and early adoption opportunities to "future proof" and accelerate CAV implementation	•All partners •VAST*	•Medium-Term
Smart Cities Collaboration	Reach out to non-transportation partners and agencies to identify shared interests and early collaboration opportunities for Smart Cities deployment in Clark County as well as cooperation with entities in the Portland region. Jointly define a structure for implementation and consider new coordinating bodies akin to VAST	•All partners	•Medium-Term
Electric Vehicles	Develop policies for improving access to charging stations for electric vehicles in Clark County	•Clark County •City of Vancouver •WSDOT	•Medium-Term
Shared-Use Economies	Develop policies for interacting with shared-use services such as Transportation Network Providers, car-share, ride-share, and bike share. Identify and implement technology and data tools to facilitate integration of these services into the multi-modal transportation network	•All partners	•Medium-Term

Table 13: Emerging Technologies Projects and Initiatives

Appendix A: Regional ITS Architecture Update

The Regional ITS Architecture for Clark County describes the logical and functional relationships among ITS systems, devices, and agencies in the region. The Regional ITS Architecture is based on the National ITS Architecture developed and maintained by the U.S. Department of Transportation. In Clark County, the Regional ITS Architecture is multi-modal in scope and reflects ITS implementations at the state, regional, county, and local levels.

The Regional ITS Architecture ensures that Clark County derives the maximum value and functionality from its investment in ITS infrastructure and the associated operational projects. The Architecture requires participation from transportation stakeholders so that projects are coordinated and integrated. Consistency with the Regional ITS Architecture is also required to use federal funding for ITS infrastructure projects, in accordance with 23 CFR Part 940.

To ensure interoperability of ITS systems on the macroscopic scale, the Regional ITS Architecture is consistent with other ITS Architectures that provide the context for urbanized Clark County. These include: The WSDOT Statewide and Southwest Region ITS Architecture; the corresponding ODOT Statewide ITS Architecture; and the ITS Architecture for ODOT Region 1 (including the greater Portland region).

As part of this 2016 interim TSMO Plan update, the Regional ITS Architecture for Southwest Washington was updated to the current Version 7.1 of the National ITS Architecture (from Version 5.0 in the 2011 update). Version 7.0 includes numerous updates to User Services, Market Packages, and other architecture elements. One of the most significant changes is the inclusion of references to Connected and Autonomous Vehicles, as USDOT integrates the National ITS Architecture with the new Connected Vehicle Reference Implementation Architecture (CVRIA) to reflect the anticipated integration of CAVs with conventional ITS infrastructure and TSMO strategies.

The Regional ITS Architecture is maintained by the Regional Transportation Council of Southwest Washington, with the VAST TSMO committee serving as a standing multi-agency coordinating committee for ITS architecture use, updates, and maintenance. The Regional ITS Architecture is primarily an electronic resource made available to agencies and ITS project proponents through the RTC VAST website. The Regional ITS Architecture can also be accessed as a TurboArchitecture™ database file through RTC.