ICM Analysis, Modeling, and Simulation

Workshop Goal

Motivate, inspire, and equip you to take specific, successful action towards accomplishment/ advancement of your Integrated Corridor Management (ICM) Analysis, Modeling and Simulation (AMS).

Introductions

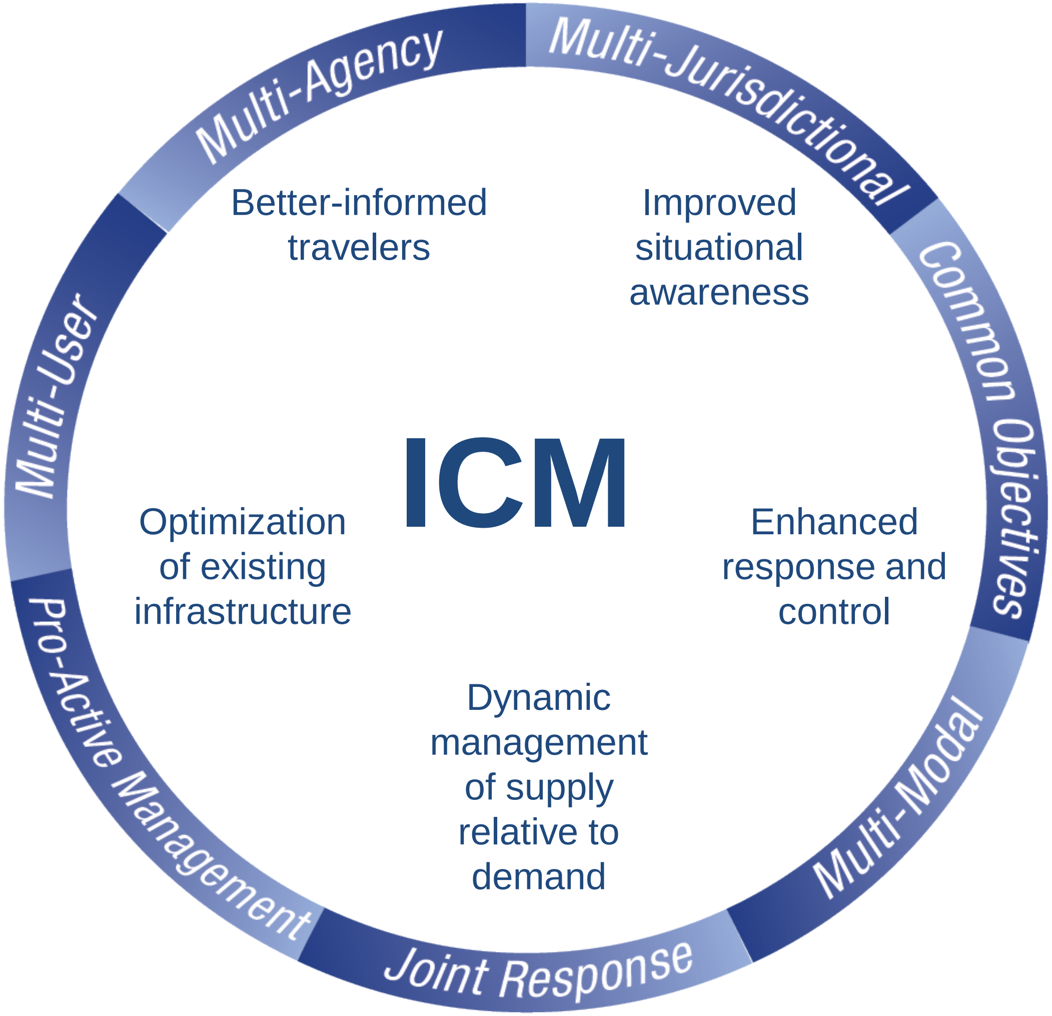
- Name
- Employer
- City and State
- **Why are you here?**
- **Expectations?**

Workshop Components

Introduction to ICM and ICM AMS
Workstep 1: Develop Analysis Plan
Workstep 2: Develop Data Collection Plan and Collect Data
Workstep 3: Model Setup and Calibration
Workstep 4: Alternatives Analysis and Documentation
Workstep 5: Continuous Improvement

Overview of ICM and ICM AMS Methodology

What is Integrated Corridor Management?



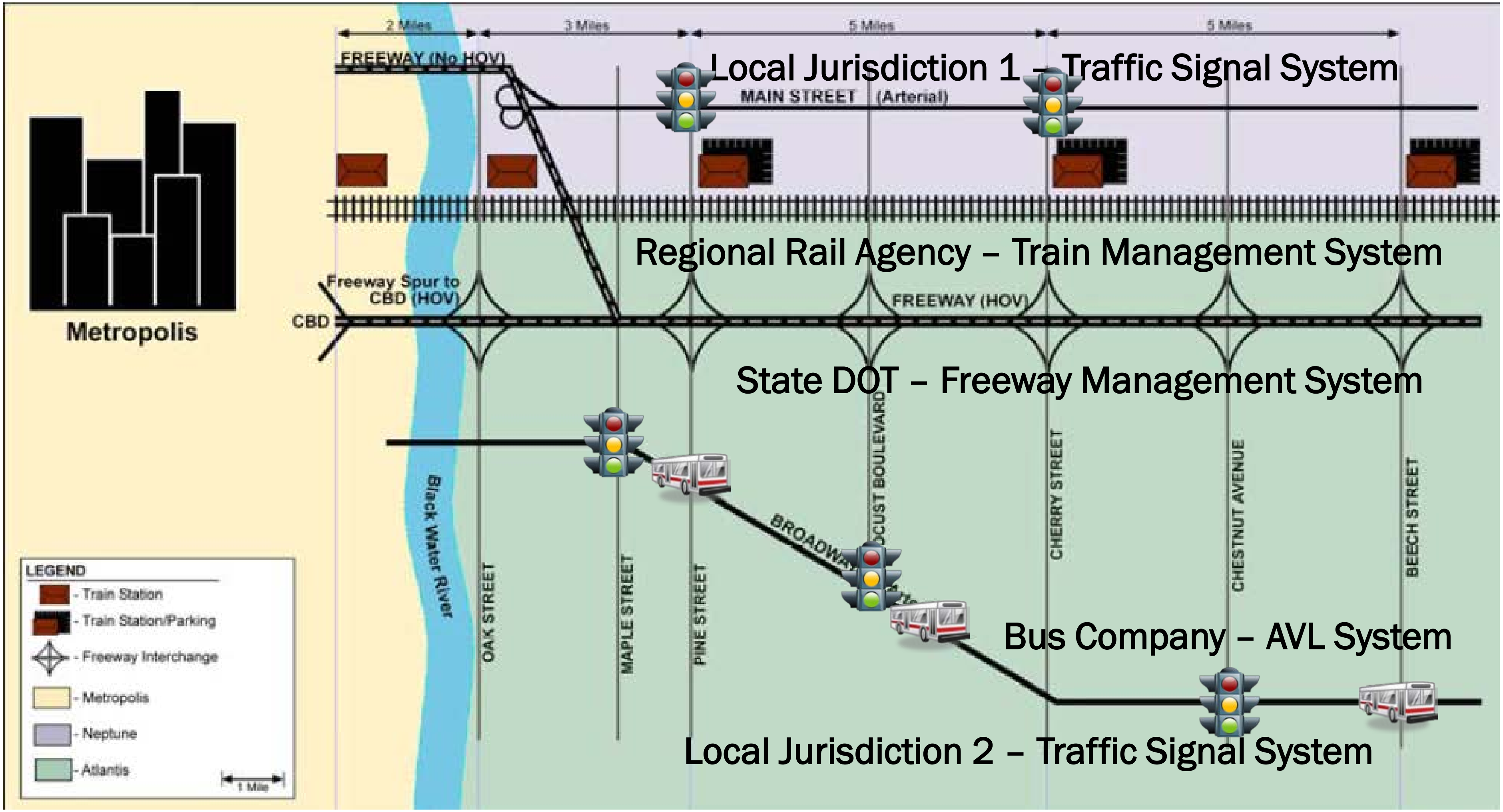
"Integrated"

Institutional **Integration**	Coordination to collaboration between various agencies and jurisdictions that transcends institutional boundaries.
Operational **Integration**	Multi-agency and cross-network operational strategies to manage the total capacity and demand of the corridor.
Technical **Integration**	Sharing and distribution of information, and system operations and control functions to support the immediate analysis and response.

"Corridor"

- Linear geographic band
- Movement of people, goods, and services
- Similar transportation needs and mobility issues
- Travel patterns in and through geographic band
- Various networks that provide similar or complementary transportation functions
- Cross-network connections

Generic Corridor

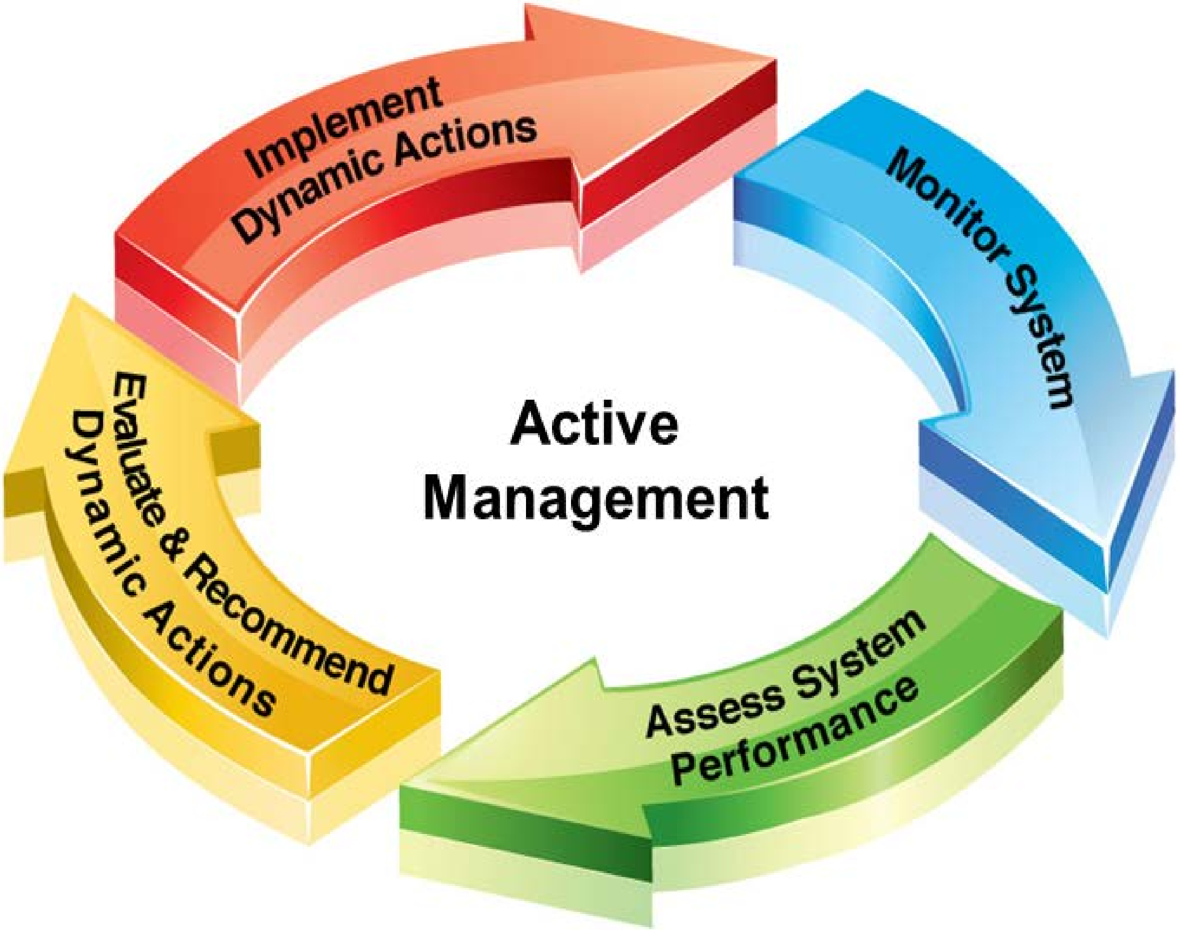


“Management”

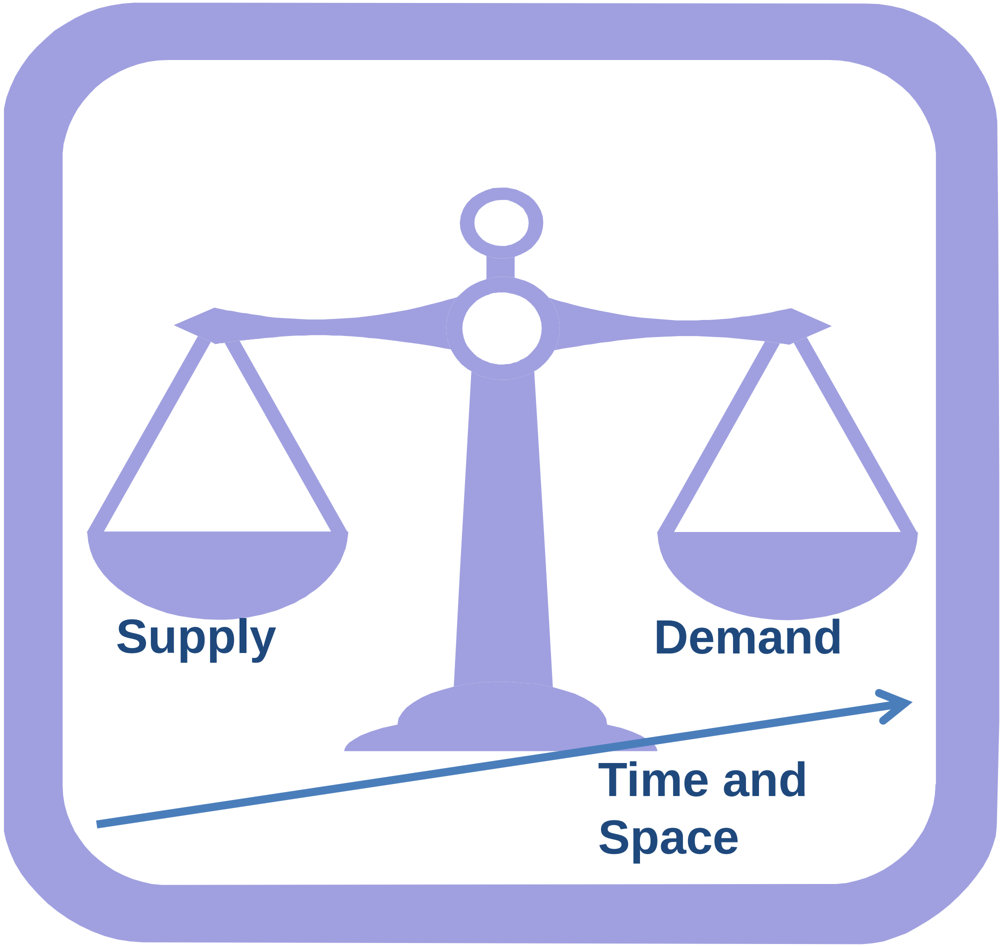
ICM requires that the notion of *managed* corridors, and the *active management* of ***ALL*** individual facilities within the corridor, be considered.

Passive ⟷ Active

Dynamic Management



Load Balancing



Stakeholders

Who's here today?

Who's missing?

- Roadway Agencies
- Planning Organizations
- Private Sector
- Transit Agencies
- Activity Centers
- Fleet Operations
- Public Safety
- Other agency departments
- Traveler

Operational Approaches

- Information sharing and distribution
- Improve operational efficiency at network junctions
- Accommodate (passive) / Promote (active) cross network route and modal shifts
- Modify capacity-demand relationship within corridor (short-term)
- Modify capacity-demand relationship within corridor (long-term)

Examples of ICM Strategies

- Active Traffic Management
- Managed lanes
- Congestion pricing
- En-route information
- Incident response policies
- Integrated electronic payment
- Real-time traffic signal management
- Ride-sharing
- Advanced parking systems
- Advanced ramp metering
- Inter-agency information sharing
- Regional data integration
- 3rd party integration
- Transit supply increase
- Transit signal priority
- Connection protection
- Real-time decision support

Demonstration Site Strategies

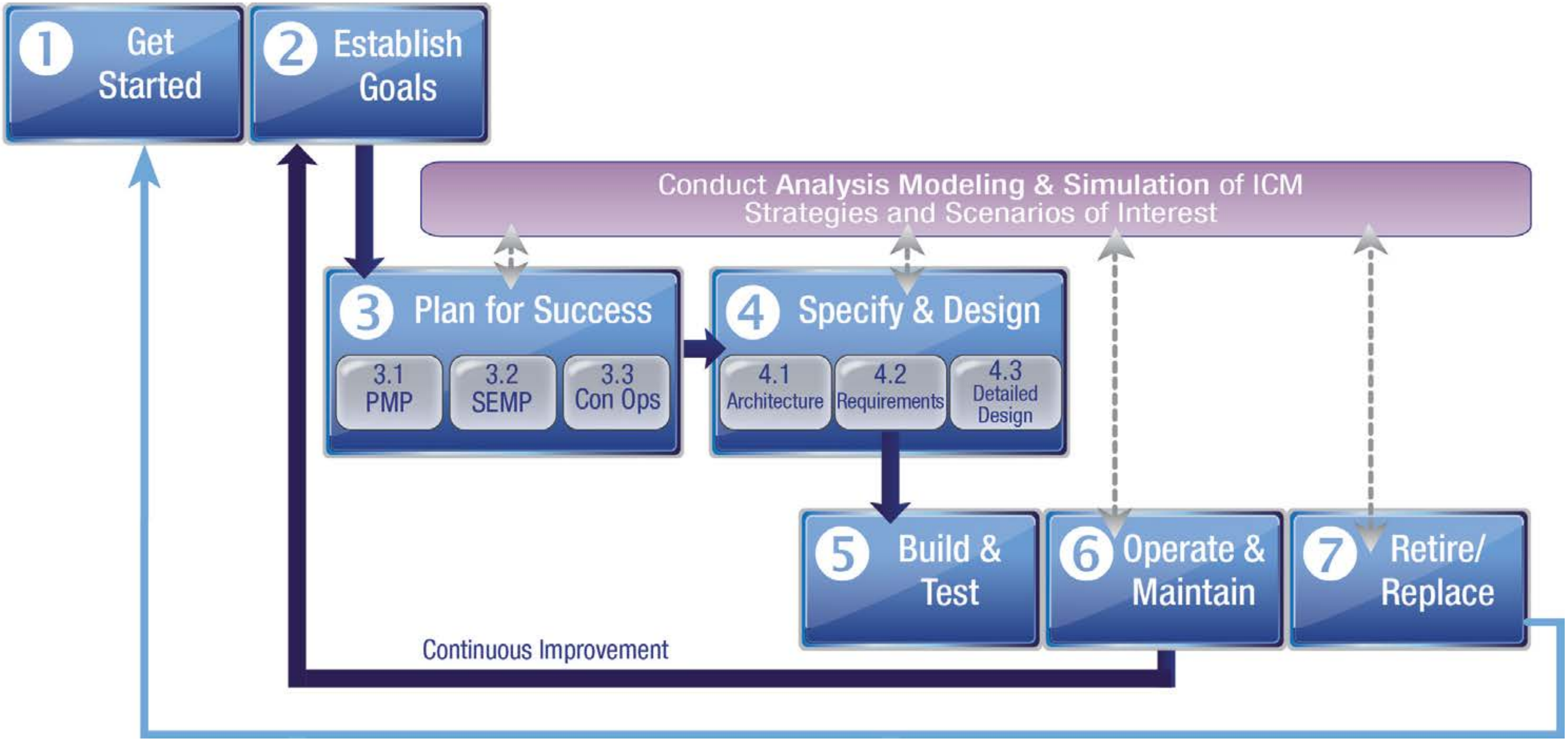
Dallas, TX

- Integrated operational systems
- Increased park and ride capacity and parking management system
- Decision support system
- Responsive traffic signal system
- Arterial street monitoring
- Traveler information
- Coordinated incident management
- HOV/HOT lane strategy
- Route and mode diversion

San Diego, CA

- Coordinated incident management
- Freeway coordinated ramp metering
- Congestion pricing on managed lanes
- Decision support system
- Congestion avoidance rewards
- Traveler information
- Transit signal priority
- Signal coordination on arterials with freeway ramp metering
- Physical bus priority on arterials
- Increased HOV occupancy requirements

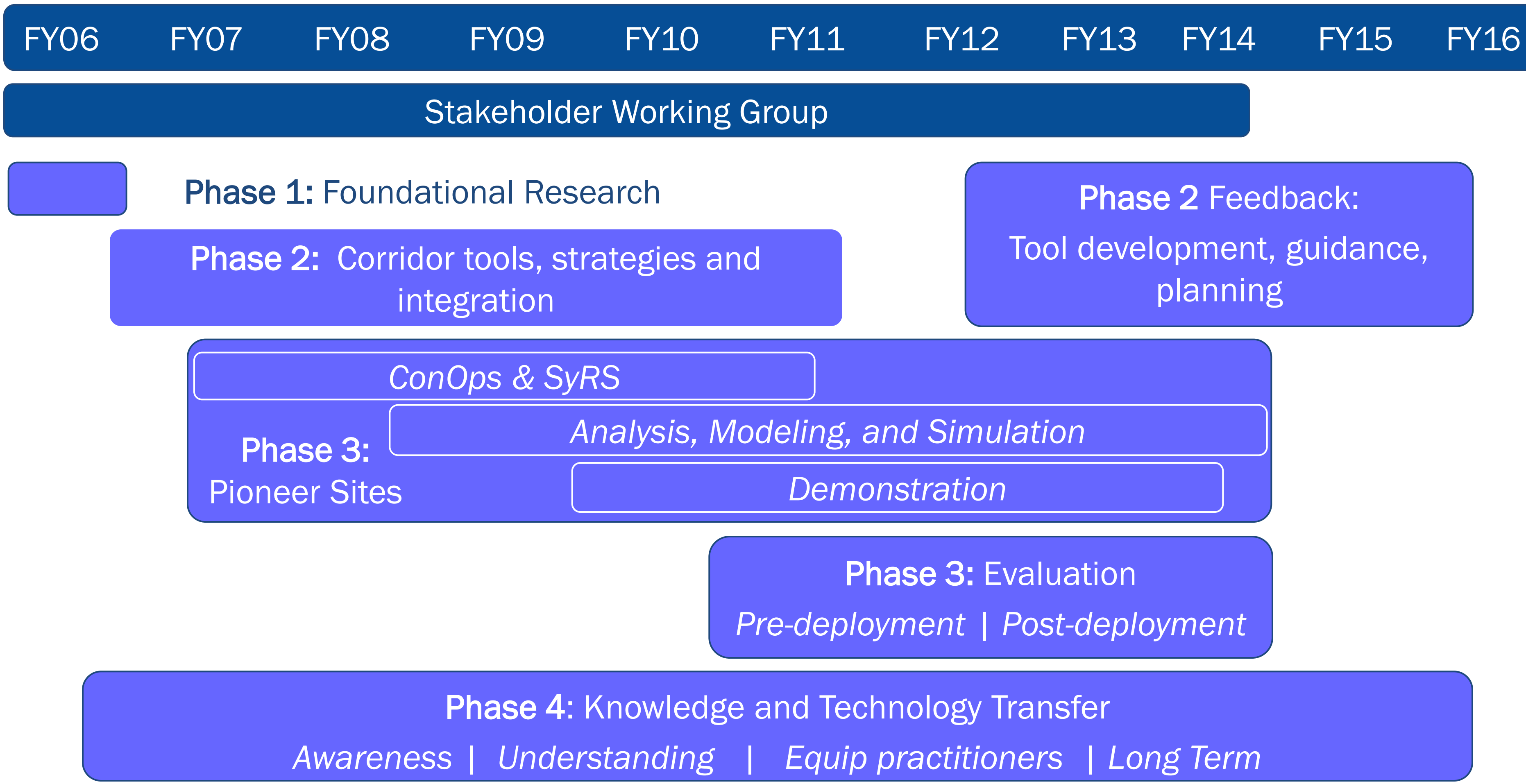
7-Phase ICM Implementation Process



ICM Program Objectives

1. Demonstrate and evaluate pro-active integrated approaches, strategies, and technologies for efficient, productive, and reliable operations.
2. Provide the institutional guidance, operational capabilities, and ITS technical methods needed for effective Integrated Corridor Management.

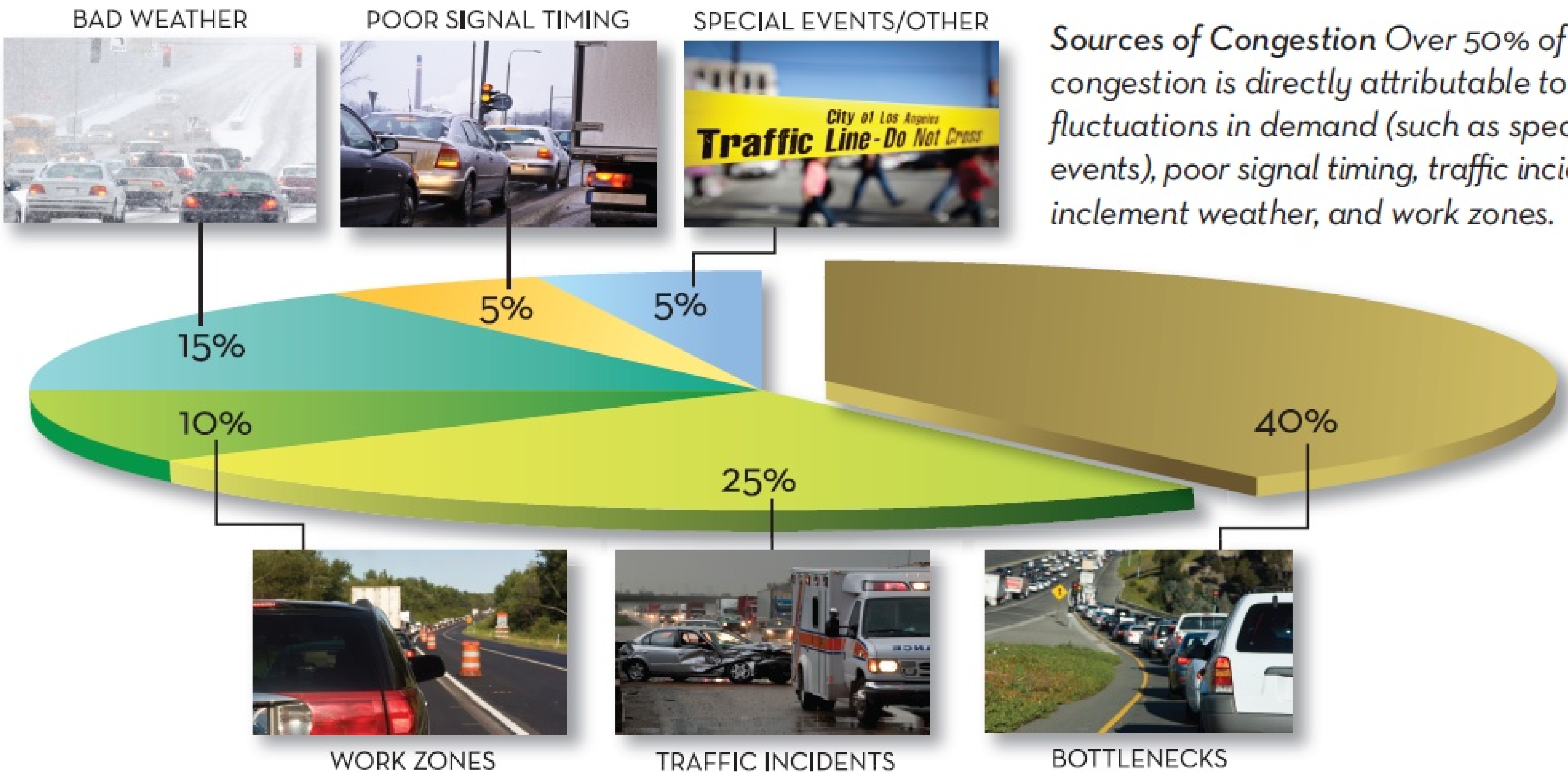
ICM Program Roadmap



ICM Program - Expansion

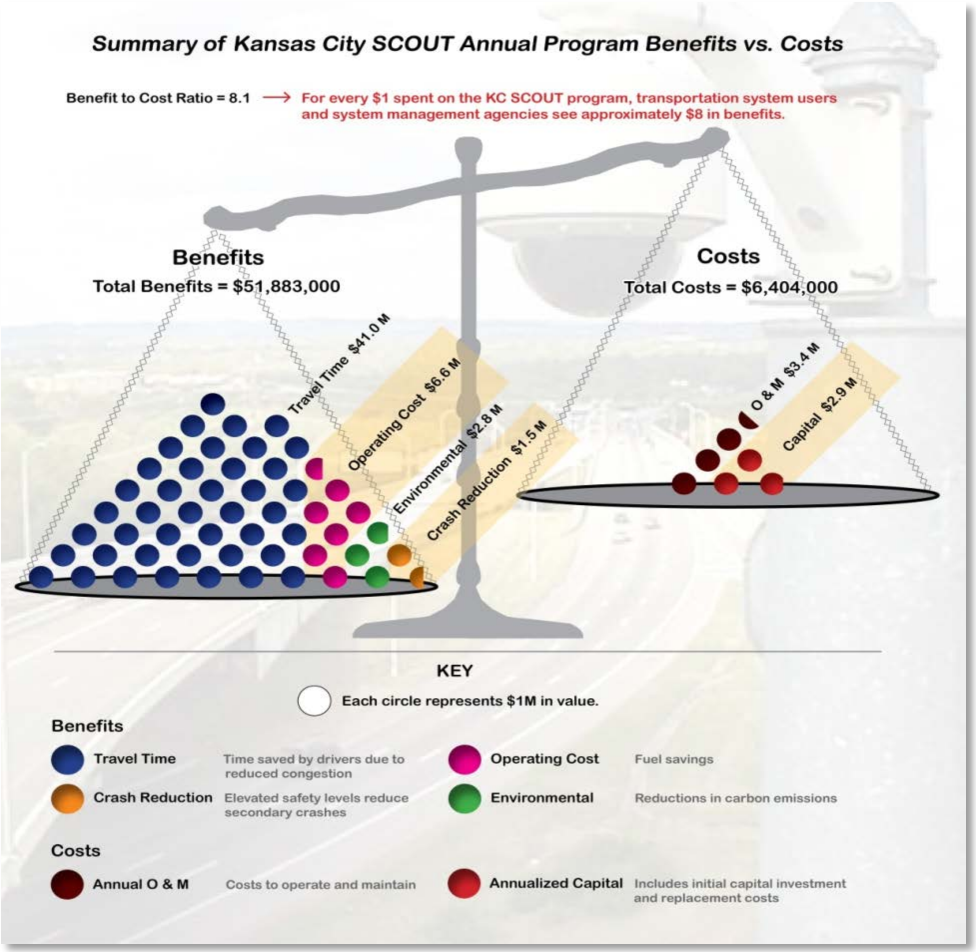
Why Planning for Operations?

Sources of Congestion Over 50% of congestion is directly attributable to large fluctuations in demand (such as special events), poor signal timing, traffic incidents, inclement weather, and work zones.

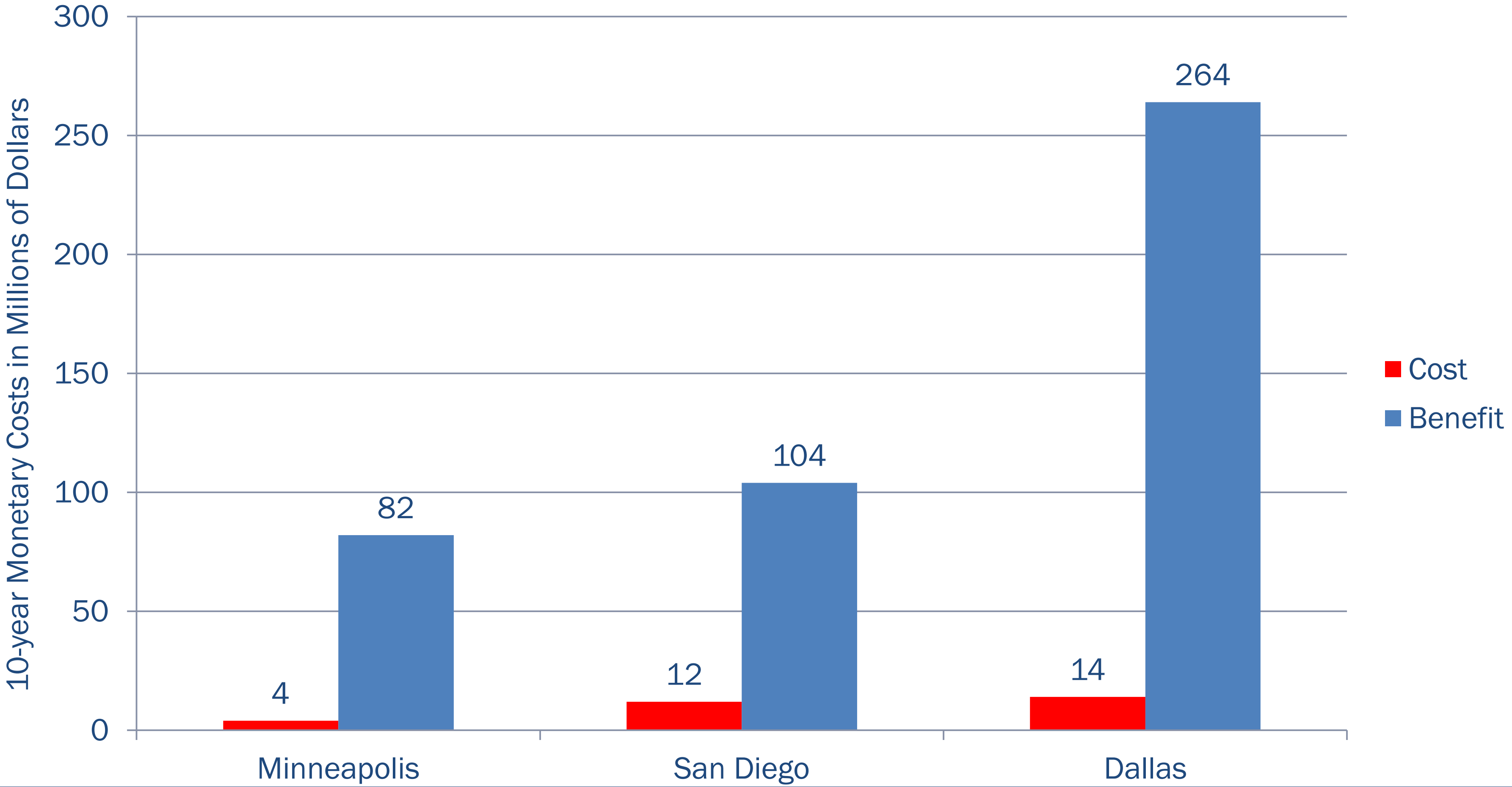


Role of Analysis Tools

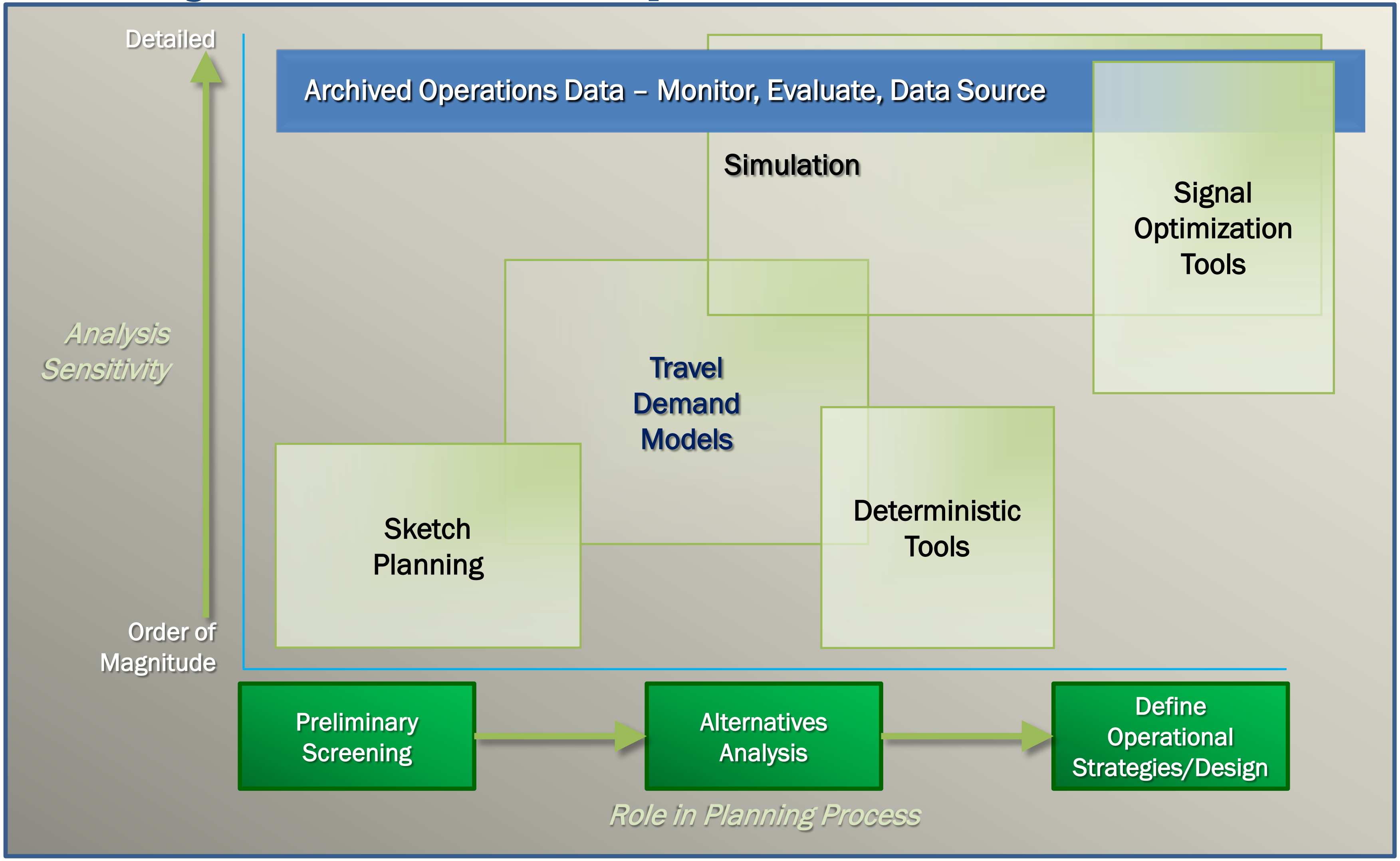
- Analyze alternatives to optimize transportation system
- Intuitive presentation to stakeholders
- Improved decision-making



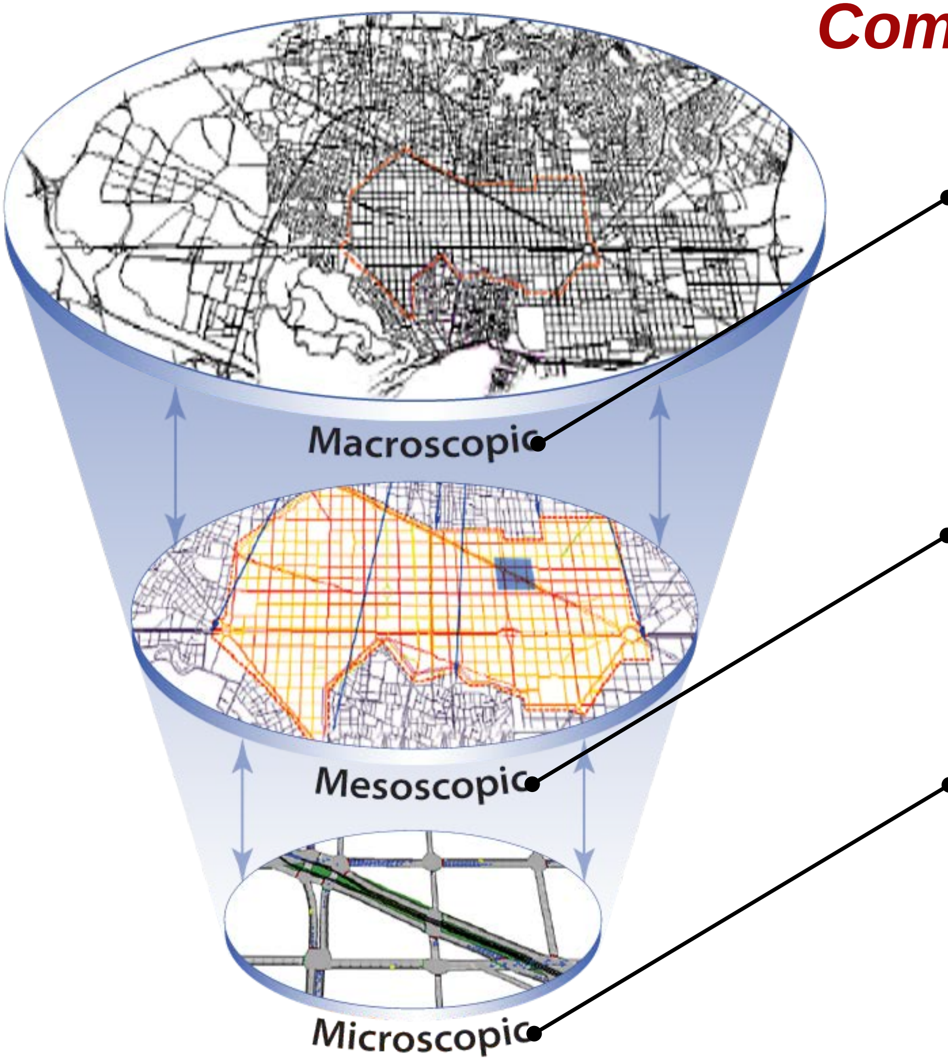
Application of AMS Tools at Pioneer Sites



Analysis Tool Capabilities



Multi-level Analysis Tools Provide Comprehensive Insight



- Regional patterns and mode shift; Transit analysis capability
- Traveler information, HOT lanes, congestion pricing and regional diversion patterns
- Traffic control strategies such as ramp metering and arterial traffic signal control

What is ICM AMS Methodology?

- Assists in forecasting and assessing the potential benefits and implications of ICM
- Analyzes different operational conditions (recurrent and non-recurrent congestion) across time and modes and across a large enough geographic area to absorb all impacts
- Enables agencies to understand system dynamics at the corridor level

ICM AMS Challenges

- Significant data are needed
- Staff skill levels must be suitable to the challenge
- Costs are significant

The ICM AMS approach is neither inexpensive nor easy to accomplish. However, the value gained outweighs the expense and pays dividends throughout an ICM Initiative.

Performance Measures

- Mobility
- Reliability
- Emissions and Fuel Consumption
- Benefits and Cost Comparison

Value of ICM AMS

- Invest in the right strategies
- Invest with confidence
- Lower risk associated with implementation
- Continually improve implementation

Traffic Analysis Toolbox Volume XIII:

Integrated Corridor Management Analysis, Modeling, and Simulation Guide

www.its.dot.gov/index.htm
May 5, 2012
FHWA-JPO-12-074

U.S. Department of Transportation
Research and Innovative Technology Administration

ICM AMS Guide

What?	Step-by-step approach to implementation of ICM AMS methodology, with lessons learned from its application to three ICM Pioneer sites and a test corridor.
Who?	Technical and/or program managers who may oversee implementation of ICM and/or an ICM/AMS initiative. Helpful reference for *all* stakeholders involved in AMS.
Why?	Help corridor stakeholders implement the ICM AMS methodology successfully and effectively.

Organization of the Guide

Section 1.0 – Introduction and Background

Section 2.0 – Overview of Recommended Approach

Section 3.0 – AMS Worksteps (1-5)

Section 4.0 – Lessons-Learned

Appendix A – USDOT Guidance on Performance Measures

Appendix B – San Diego Data Collection Plan

Companion Documents

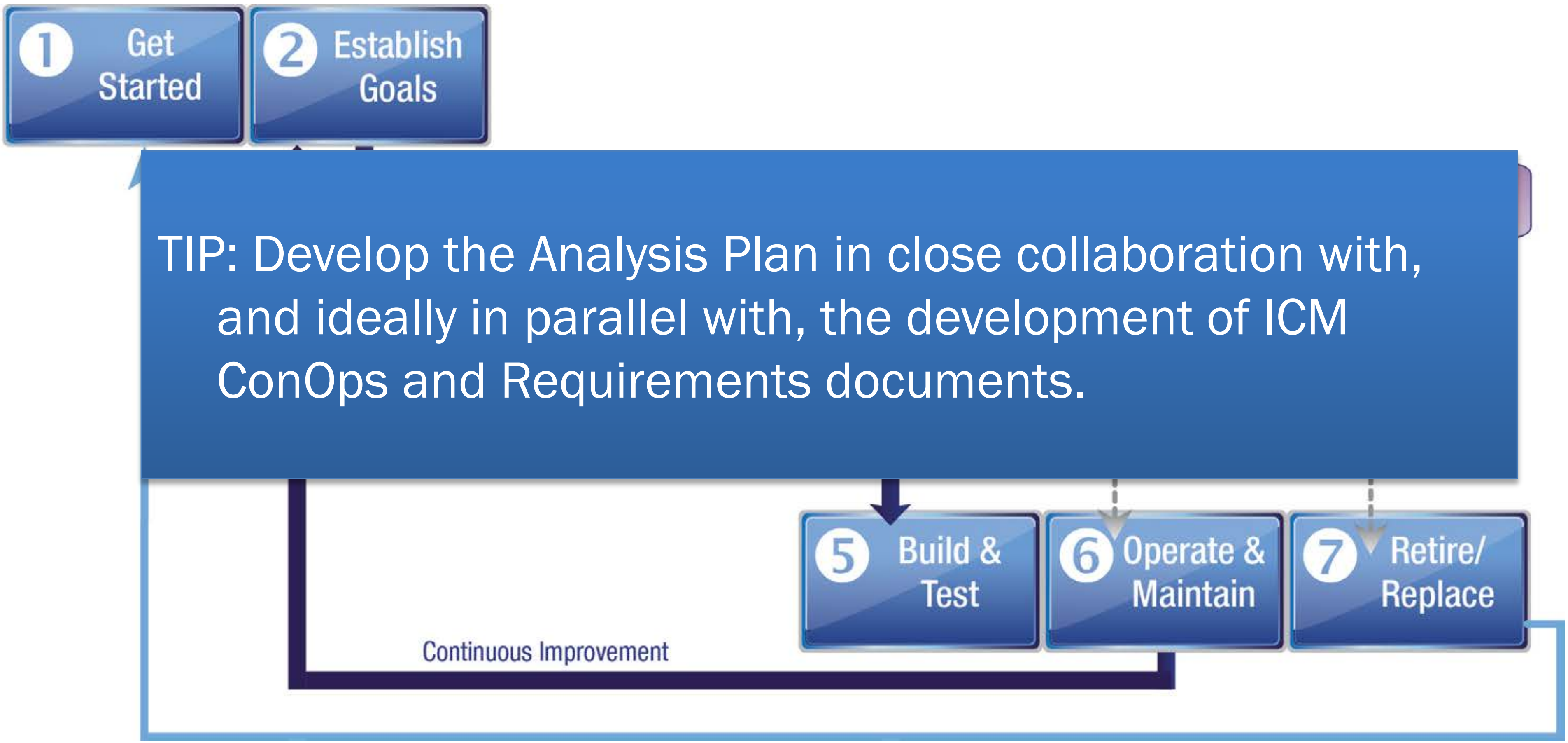
- ICM AMS Methodology
- ICM Implementation Guide
- Pioneer Site Analysis Plans (also called "Experimental Plans")
- Pioneer Sites AMS Reports
- FHWA Traffic Analysis Toolbox
- National Highway Institute (NHI) course "Planning and Managing Successful Applications of Traffic Analysis Tools" (Course Number: 133108)


1
Develop Analysis Plan
2
Develop Data Collection Plan and Collect Data
3
Model Setup and Calibration
4
Alternatives Analysis and Documentation
5
Continuous Improvement
ICM AMS Approach Worksteps

Workstep 1
Develop Analysis Plan

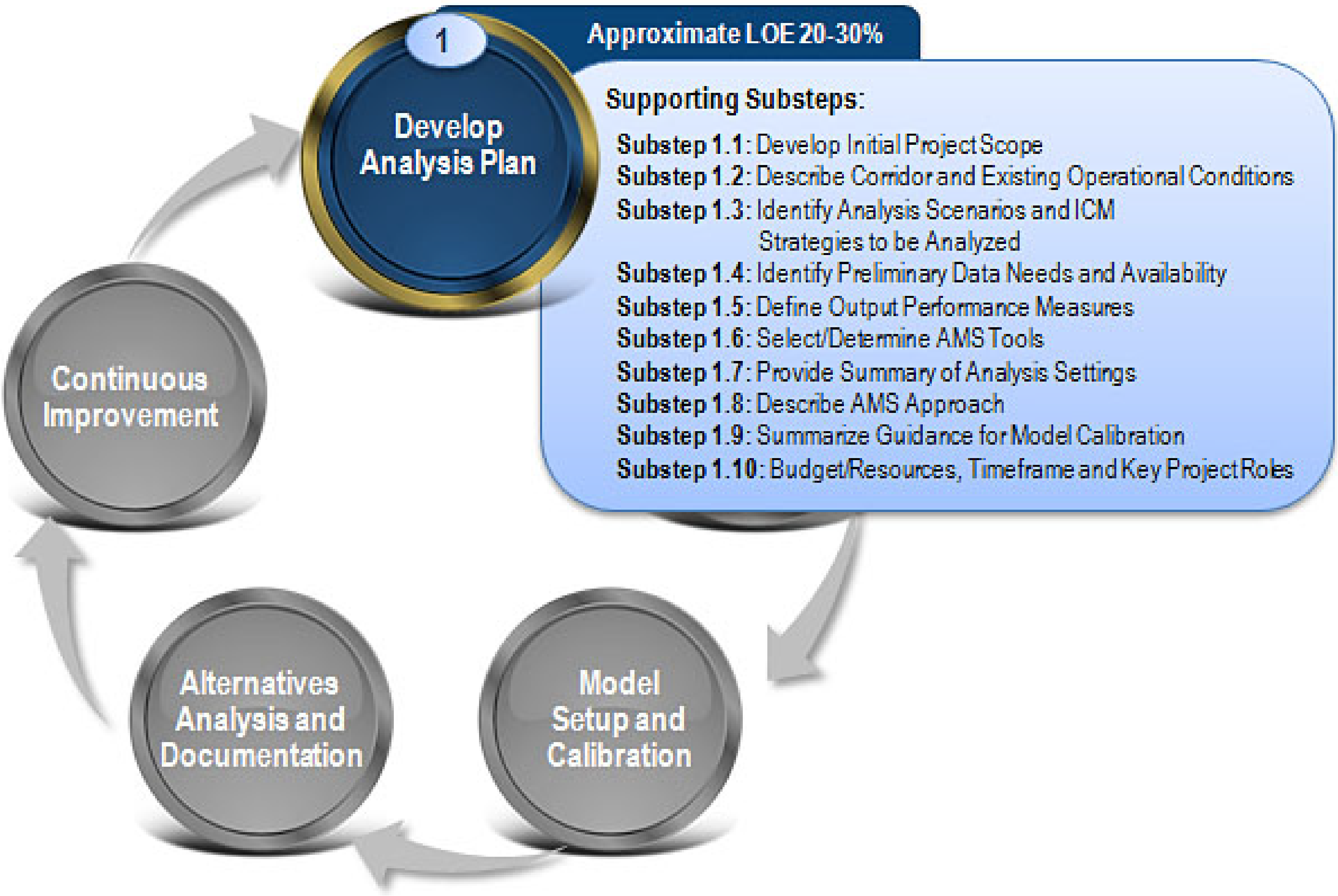
Value of Workstep

- Identify flaws or technical issues in the ConOps
- Communicate the scope of the project
- Identify project challenges and plan mitigation
- Identify and prioritize resources to project objectives
- Better understand existing corridor conditions and deficiencies
- Set expectations of project participants and define roles and responsibilities
- Utilize AMS in an iterative manner with the design process to refine alternatives
- Document the analysis planning process



TIP: Develop the Analysis Plan in close collaboration with, and ideally in parallel with, the development of ICM ConOps and Requirements documents.

Workstep 1: Analysis Plan



Example Outline for Analysis Plan

1. Introduction and Initial Project Scope:
    a. Corridor Overview
    b. Project Background and Guiding Principles
    c. Project Goals and Objectives
2. Corridor Description and Existing Operational Conditions
3. Analysis Scenarios and ICM Strategies
4. Data Needs and Availability
5. Output Performance Measures
6. AMS Tools and Methodology
7. Summary of Analysis Settings
8. Summary of AMS Approach
9. Guidance for Model Calibration
10. Budget, Schedule and Key Responsibilities

- Develop corridor overview
  - Geographic boundaries, modes, trip generators
- Project background and guiding principles
  - Transportation gaps
- Determine project objectives and needs
- Process for developing and applying the Analysis Plan
  - Stakeholders, working groups, meeting schedule, deliverables

- Stakeholder consensus on the general process, timeline, and roles and responsibilities associated with the envisioned ICM AMS effort (through Kickoff Meeting)

Substep 1.2: Define Corridor & Existing Operational Conditions

- Geographic scope
- Facilities and modes to include in the AMS
- Existing ITS
- Available analyses and tools
- Expected traveler responses
- Performance measures
- Budget and timeframe for AMS

Documentation of existing corridor and traffic conditions:

- Average daily and peak traffic levels
- Directionality of traffic flow
- Variability of traffic flow
- Status of construction activities
- Known bottlenecks
- Queuing conditions
- Free flow and average peak speeds
- Summary incident and accident statistics for the corridor

Problem Definition and Problem Diagnosis

- Problem Definition may already be documented as part of ConOps work
- Problem Diagnosis should include a more thorough analysis of corridor conditions to ensure that the needs are properly defined

- Develop analysis scenarios for range of operational conditions of greatest interest to site
  - Travel demand, incidents, weather, ...
- Compile data on the frequency and severity of conditions linked with elevated congestion
- Identify the ICM strategies and define under which analysis scenarios the strategies will be activated

Summary ICM High Priority Strategies for US 75 in Dallas

Scenario	Daily Operations – No Incident		Minor Incident		Major Incident		
Demand	**Med**	**High**	**Med**	**High**	**Low**	**Med**	**High**
Traveler Information							
Comparative, multimodal travel time information (pre-trip and en-route)	●	●	●	●	●	●	●
Traffic Management							
Incident signal retiming plans for frontage roads			●	●	●	●	●
Incident signal retiming plans for arterials			●	●	●	●	●
Managed Lanes							
HOT lane (congesting pricing)	●	●					
Express toll lane (congestion pricing)	●	●					
Light-rail Transit Management							
Smart parking system						●	●
Red line capacity increase						●	●
Station parking expansion (private parking)						●	●
Station parking expansion (valet parking)						●	●

- “Traditional” and “non-traditional” data sources
- Archived automated data sources more desirable than manually collected data
- For each data source:
  - Time periods when the data are available
  - Data format
  - Are the data sufficiently detailed and specific for analysis purposes?
  - Reliability of the data sources
  - Any time lags in data availability?
  - Any known data quality issues?

- Performance Measures should:
  - Provide an understanding of travel conditions in the study area
  - Demonstrate the ability of ICM strategies to improve corridor mobility, throughput, and reliability based on current and future conditions
  - Help prioritize individual investments or investment packages within the corridor

Performance Measures

- Mobility
- Reliability
- Emissions and Fuel Consumption
- Benefits and Cost Comparison

1. Research and identify available analysis tool type(s) for the study area
2. Identify factors for selecting tool type(s)
3. Select the appropriate tool type(s)

Analysis Context: Planning, Design, or Operations/Construction

1 Geographic Scope

What is your study area?

- Isolated Location
- Segment
- Corridor/ small network
- Region

2 Facility Type

Which facility types do you want to include?

- Isolated intersection
- Roundabout
- Arterial
- Highway
- Freeway
- HOV lane
- HOV bypass lane
- Ramp
- Auxiliary lane
- Reversible lane
- Truck lane
- Bus lane
- Toll plaza
- Light rail

3 Travel Mode

Which travel modes do you want to include?

- SOV
- HOV (2, 3, 3+)
- Bus
- Rail
- Truck
- Motorcycle
- Bicycle
- Pedestrian

4 Management Strategy

Which mgmt strategies should be analyzed?

- Freeway mgmt
- Arterial intersections
- Arterial mgmt
- Incident mgmt
- Emergency mgmt
- Work zone
- Special event
- APTS
- ATIS
- Electronic payment
- RRX
- CVO
- AVCSS
- Weather mgmt
- TDM

5 Traveler Response

Which traveler responses should be analyzed?

- Route diversion (pre-trip and en-route)
- Mode shift
- Departure time choice
- Destination change
- Included/ foregone demand

6 Performance Measures

What performance measures are needed?

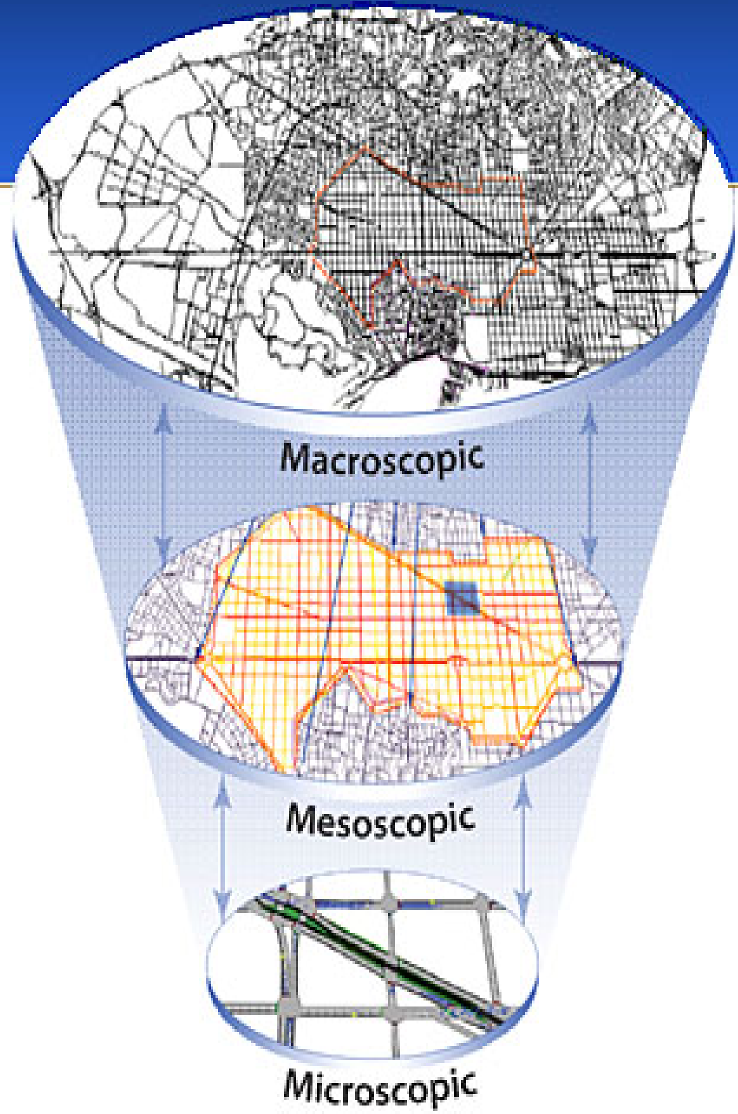
- LOS
- Speed
- Travel time
- Volume
- Travel distance
- Ridership
- AVO
- v/c ratio
- Density
- VMT/PMT
- VJJT/PHT
- Delay
- Queue length
- # stops
- Crashes/duration
- TT reliability
- Emissions/fuel
- Noise
- Mode shift
- Benefit/cost

7 Traveler Response

What operational characteristics are important?

- Tool capital cost
- Effort (cost/training)
- Ease of use
- Popular/well-trusted
- Hardware requirements
- Data requirements
- Run time
- Post-processing
- Documentation
- User support
- Key parameters user definable
- Default values
- Integration
- Animation

Substep 1.6: Select/Determine AMS Tools



Minneapolis Minnesota	Dallas Texas	San Diego California
Metro Model in TP+	North Central Texas Council of Governments Model (TransCAD)	TransCAD
Dynus T – supported by University of Arizona	DIRECT – supported by Southern Methodist University (SMU)	
		TransModeler Micro

Example Summary Analysis Settings (I-15, San Diego)

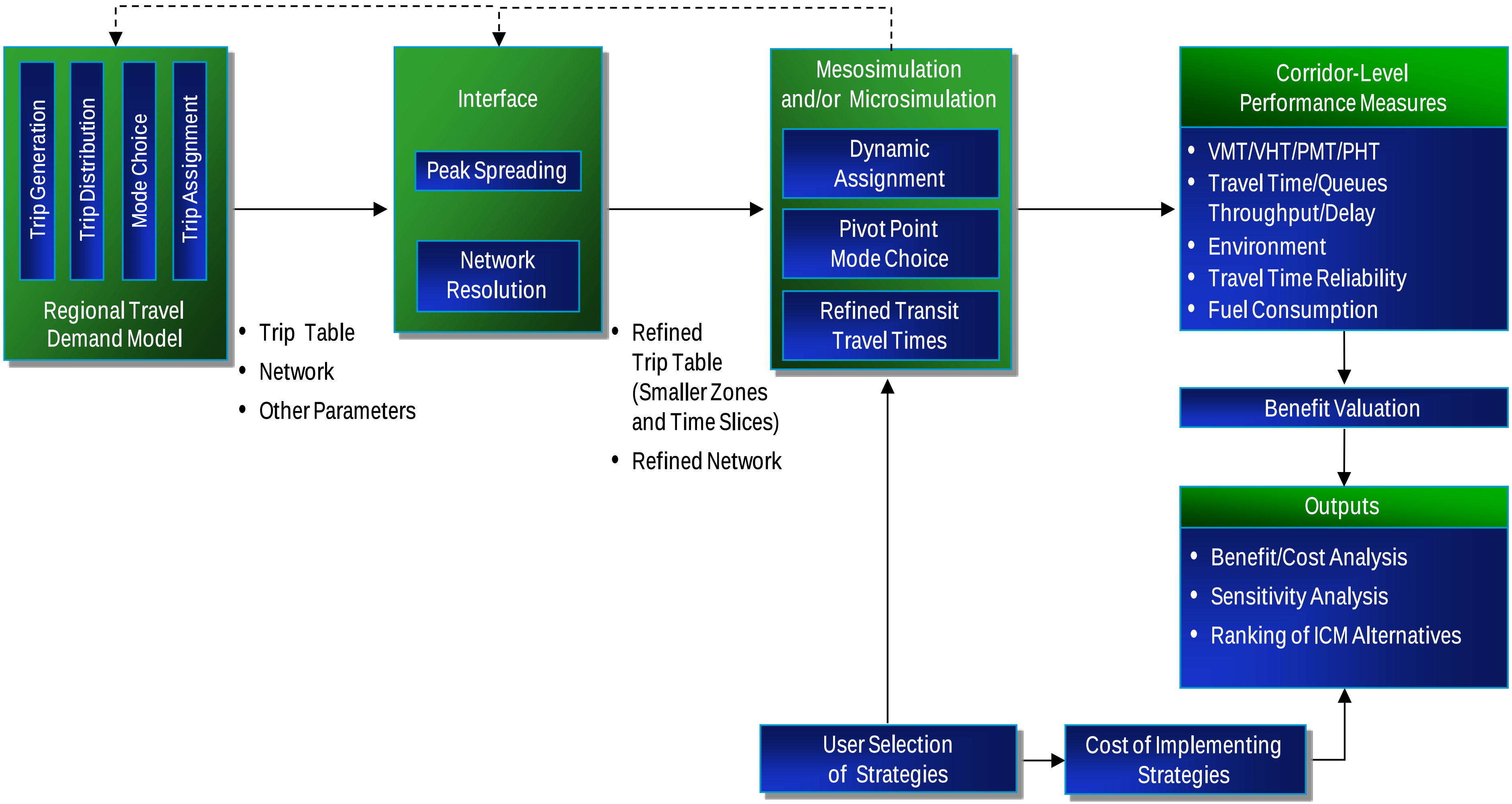
Parameter	Value	Guidance
Base year	2003	The SANDAG regional travel demand model was last validated for year 2003, and during 2003 there was no major construction activity within the corridor.
Analysis year	2012	The analysis year is derived from the anticipated completion of construction of the I-15 system, and the implementation of ICM strategies.
Time period of analysis	AM	The AM peak period has the most concentrated traffic congestion.
Simulation period	3-5 hrs	6 AM – 9 AM is the primary analysis period. Future baseline scenarios run through 6 AM – 11 AM to allow for congestion to build and dissipate.
Freeway incident location	South of Ted Williams Pkwy	This location experiences a high number of incidents, offers the potential for route diversion, and has a high impact on corridor travel.
Freeway incident duration	45 minutes	This duration is chosen to represent a major blockage in the peak period based on analysis of actual incident records. Incident occurs at 7 AM and is cleared by 7:45 AM.
Freeway incident severity	Lane closures	3 lanes closed and reduced speeds on lanes 4 and 5 from 7 AM to 7:30 AM. Only 2 lanes closed for the remaining duration of the incident and reduced speeds on lanes 3, 4, and 5.
Arterial incident location	On Carmel Mountain Rd east of I-15	Based on 2012 demand projections to calculate incident rates for different arterials under study.

Substep 1.8: Describe the AMS Approach

- Modeling package(s) and tools to be used
- Baseline networks and years
- Analysis periods (i.e., time-of-day)
- Future forecast networks and years

	Outcome of Strategies	Summary/Notes to Modeling Team	Without ICM	With ICM in Place
1.	En-Route Information			
1.1	Earlier dissemination of en-route incident and travel time information	Because of quicker notification, en-route traveler information systems will disseminate incident information earlier to travelers. The effect will be that more travelers will be able to alter routes, modes, and departure times. Incident duration stays the same with and without ICM.	10 minutes to dissemination	• 2 minutes to dissemination; and • 30% of travelers (smart phones, 511, radio combined) with traveler information. In the baseline year of 2003, 5% of travelers were assumed to have traveler information.
1.2	Comparative travel times (mode and route)	Information dissemination (pre-trip and en-route) will include travel time comparisons for freeway, general purpose lanes, arterial, and transit. The effect will be that more travelers will choose the best options to maintain consistent trip times.	General purpose lane and mainline travel time	Travelers will make diversion choices at equal intervals of time (for the next time period). The decision choice is based on a generalized cost that feeds into a decision model. The effect will be that as conditions worsen, more travelers will take more alternative options including transit.
2.	Improved Traffic Management			
2.1	Incident signal retiming plans	'Flush' signal timing plans that are coordinated and allow progression through different jurisdictions. The effect will be reduced arterial travel times during incidents or special event situations.	30 minutes to implement	• Based on Location in Primer on Signal Coordination provided; • 10 minutes to implement (variable based on severity); • Higher throughput; and • Off-ramp and diversion planning.
2.2	Freeway ramp metering and signal coordination	Incident location-based strategy to coordinate arterial traffic signals with ramp meters.	None	Coordination under RAMS framework.
2.3	HOT lanes	Existing today, HOT lanes are included in the modeling. Can be opened to all traffic during major incidents. Option of adding additional lane in incident direction using movable barrier.	Maintain HOT lanes during major incidents	Open HOT lanes to all traffic during major incidents to maximize throughput (I-15 managed lanes operations and traffic incident management plans).

Substep 1.8: Describe the AMS Approach



- Clear and mutual understanding between AMS managers, stakeholders and the technical modeling team of the process and criteria that will be used to calibrate the models
- USDOT Traffic Analysis Tools initiative: http://ops.fhwa.dot.gov/Travel/Traffic_Analysis_Tools/traffic_analysis_tools.htm

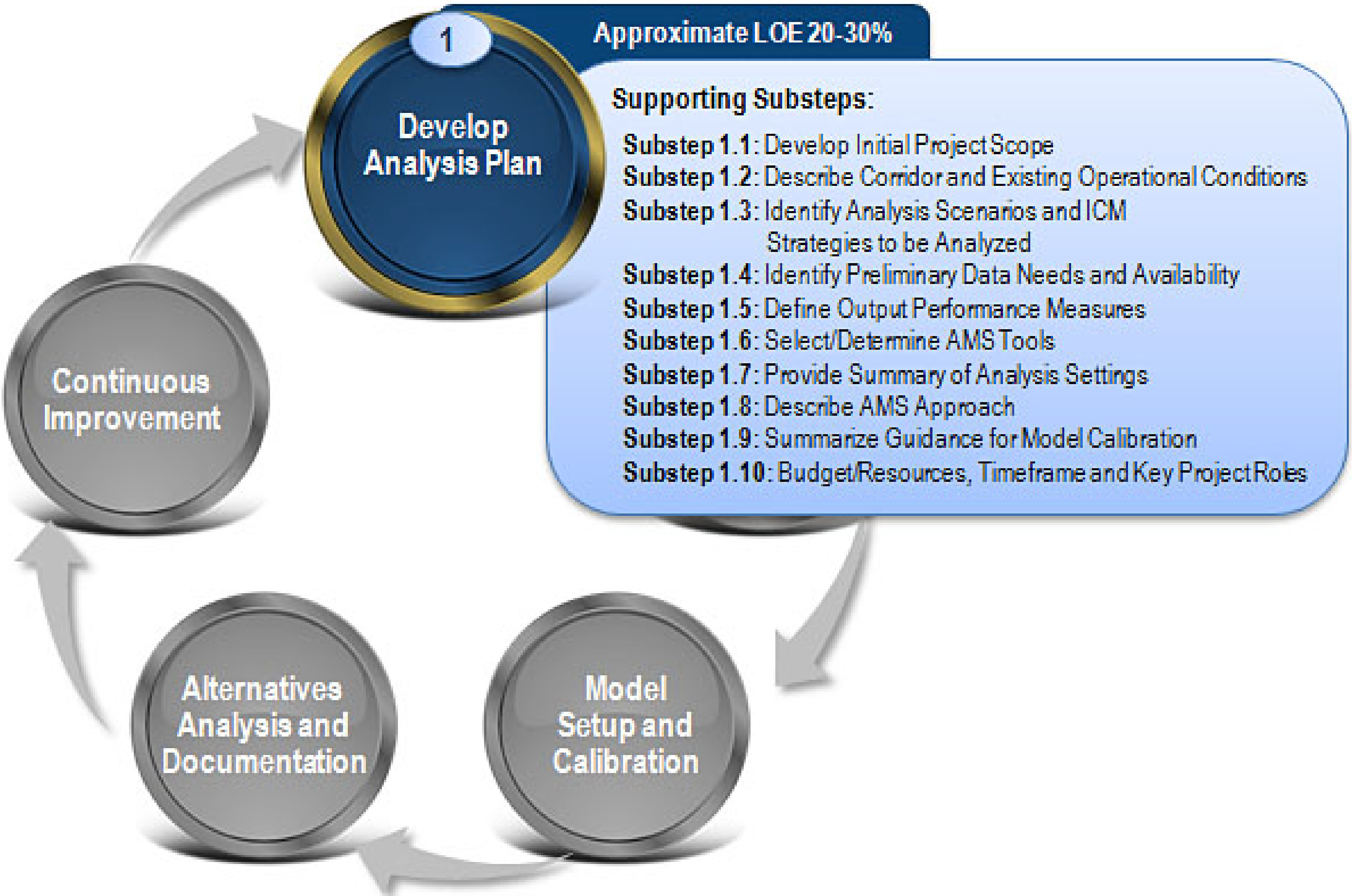
Substep 1.10: Develop Budget, Timeframe, and Roles

Workstep	AMS Project Manager	Operations Manager	Planning Manager	Modelers	Systems Manager	Stakeholders
Develop Analysis Plan	●	0	0	0	0	0
Develop Data Collection Plan and Collect Data	●	0	0	0	0	0
Model Setup and Calibration	●	0	–	●	–	–
Alternatives Analysis and Documentation	●	0	0	●	0	–
Continuous Improvement	●	●	●	●	●	0

● Primary Responsibility.

0 Secondary Responsibility.

Workstep 1: Analysis Plan



Workstep Outputs

- Project and initiative-level kickoff meeting presentations and materials
- Memoranda of Agreement/Understanding (MOA/MOU) among initiative stakeholder organizations documenting project scope, and anticipated roles and levels of effort
- Draft and Final Analysis Plan

Workstep Timeframe

- Approximately 4-6 months
- In parallel with development of ConOps and Requirements
- Not to be completed until the full definitions of the anticipated ICM strategies are finalized
- Continues as a “living document” throughout the analysis lifecycle

Workstep Challenges

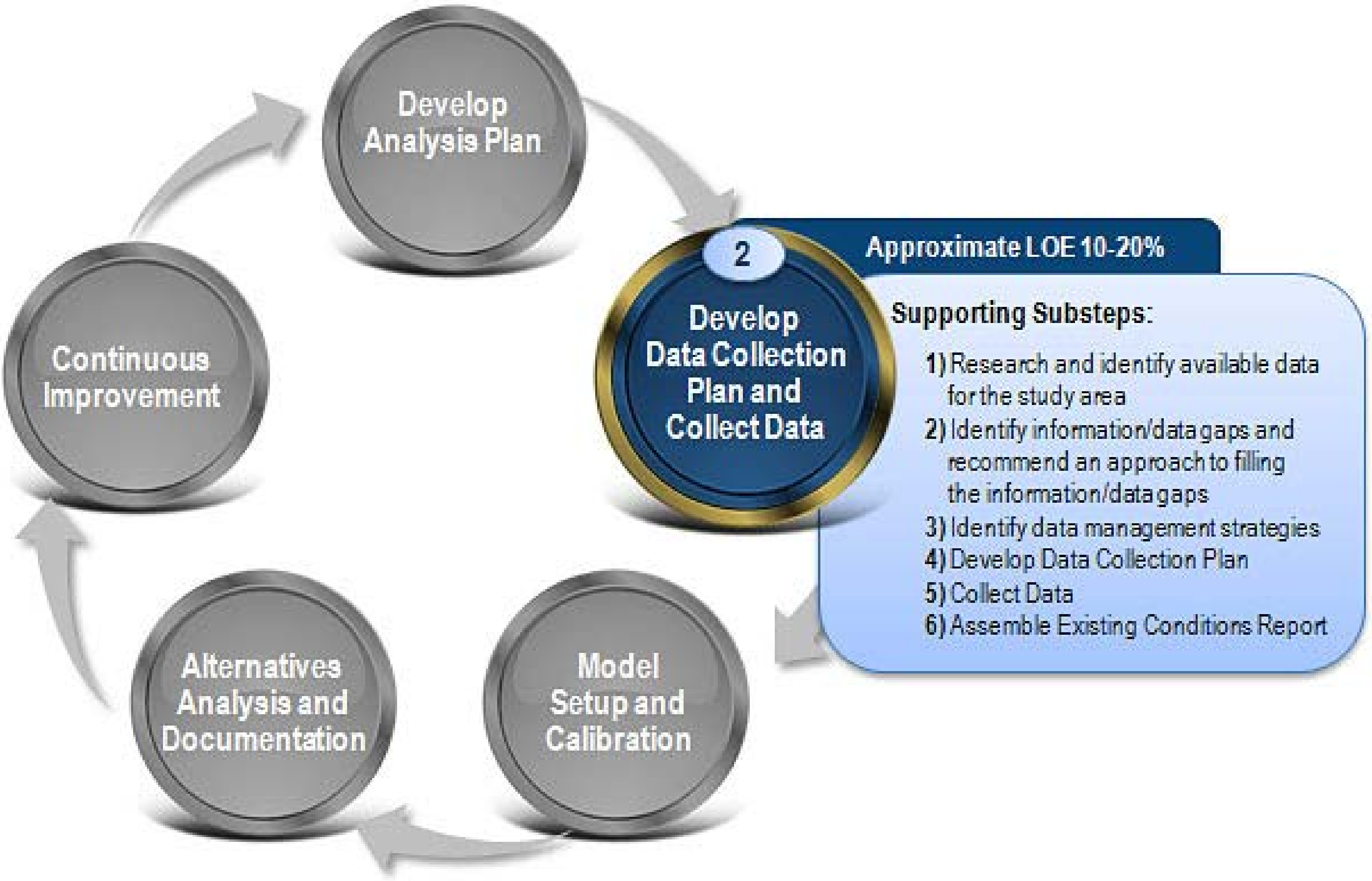
- Poor specification of ICM strategies
- Unfamiliar and/or non-specific performance measures
- Analysis expands beyond “average day” conditions
- Selecting analysis tools

Workstep 2
Develop Data Collection Plan and Collect Data

Objective of Workstep

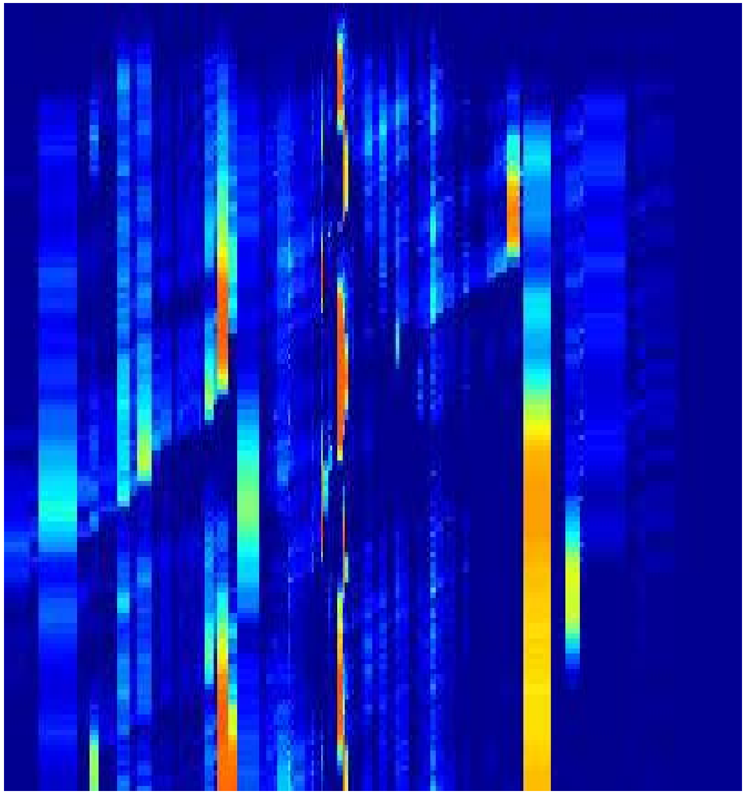
Build on the data requirements outlined in the Analysis Plan to develop a detailed Data Collection Plan, which will guide the compilation, analysis, and archiving of data that will be required to support the conduct of the AMS.

Workstep 2: Data Collection Plan/Collect Data



Data Challenges

- Transportation system coverage
- Data quality
- Data format/resolution
- Data integration
- Standards/consistency/metadata
- Backup, recovery, archiving
- Resources



Private Sector Data Helping to Address Some Challenges

- Combine information from multiple probe technologies such as cell phones, toll tags, crowd-sourcing, and fleet-based GPS probe vehicles, as well as data from existing fixed-sensor networks such as loop- or radar-based detection
- Data are then fused to provide real-time travel time estimates and incident information

INRIX TOMTOM ATRI American Transportation Research Institute

Total Traffic Network NAVTEQ™

Example Data Collection Plan Outline

1. Introduction and Background
2. Data Collection Methodology
3. Documentation Review
4. Summary of Input Data for AMS
5. Summary of Data Requirements for Approaches and Strategies
6. Current State of Required Data and Gap Identification
    - *6.1 Arterial-Related Data*
    - *6.2 Freeway-Related Data*
    - *6.3 Transit-Related Data*
7. Summary of Data Collection Methods

- *ICM AMS Guide* (p. 43)
- Start with data sources/requirements identified in Analysis Plan
- Data often required to be concurrent across all facilities and modes
- Obtain samples of the datasets prior to full data collection

Example Summary of Data

Network	Travel Demand	Traffic Control	Transit	ITS Elements
Link distances	Link Volume	Freeways	Transit Routes	Surveillance System
Free-flow speeds	Traffic Composition	Ramp Metering	Transit Stops	Detector Type
Geometrics – freeways	On- and Off-Ramp Volumes	Type (local, systemwide)	Location	Detector Spacing
# Travel Lanes	Turning Movement Counts	Detectors	Geometrics	CCTV
Presence of shoulders	Vehicle Trip Tables	Metering Rates	Dwell Times	Information Dissemination
# HOV lanes (if any)	Person Trip Tables	Algorithms (adaptive metering)	Transit Schedules	CMS
Operation of HOV lanes	Transit Ridership	Mainline Control	Schedule Adherence Data	HAR
Accel/Dec lanes		Metering	Transfer Locations	Other (e.g., 511)
Grade		Lane Use Signals	Transit Speeds	In-vehicle Systems
Curvature		Variable Speed Limits	Transit Fares	Incident Management
Ramps		Arterials	Payment Mechanisms	Incident Detection
Geometrics – arterials		Signal System Description	Paratransit	CAD System
Number of lanes		Controller Type	Demand-responsive	Response and Clearance
Lane usage		Phasing	Rideshare programs	Incident Data Logs
Length of turn pockets		Detector Type and Placement		Tolling System
Grade		Signal Settings		Type
Turning restrictions		Signal Timing Plans		Pricing Mechanisms
Parking		Transit Signal Priority System		TMC

Substep 2.2: Identify Information/Data Gaps

- Assess the appropriateness of the available data to analysis needs
- Identify any critical gaps in data availability
- Investigate potential approaches to filling data gaps, and document recommended approaches in the Data Collection Plan

- Procedures for conducting quality data control and archiving
- Thresholds for minimal data quality
- Process for addressing data shortcomings
- Responsibilities and procedures for data quality testing and archiving
- Planning for physical computational assets

- Document information gathered in substeps 2.1-2.3
- Detail data elements to be obtained and their respective data sources
- Recommend data collection methodologies
- Develop budget/timeframe estimates

Sample Data Collection Plan:

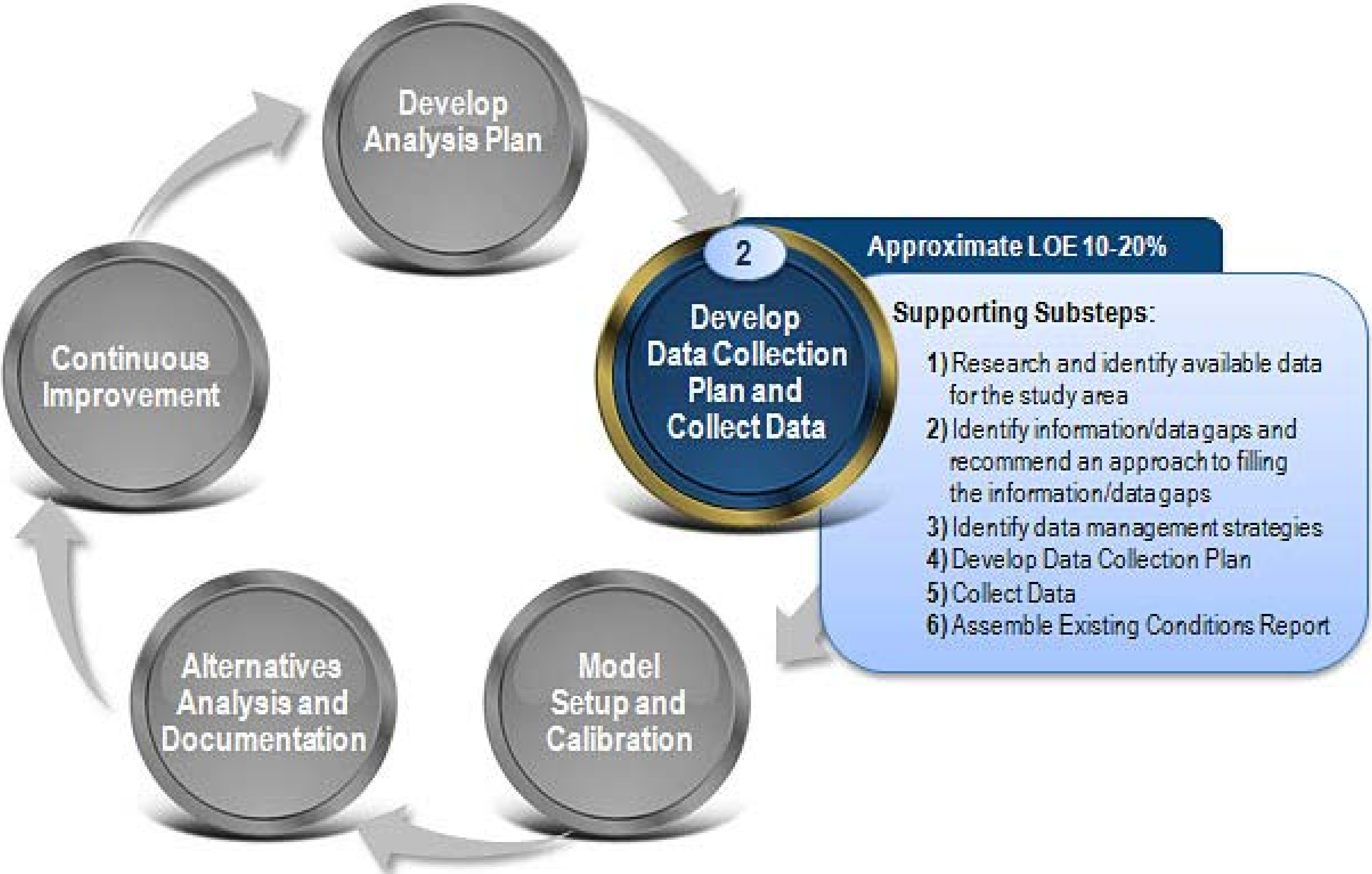
ICM AMS Guide Appendix B: Data Collection Plan for San Diego I-15 Pioneer Corridor

1. Assemble/collect data on physical infrastructure, geometrics, and transit service routes
2. Assemble/collect existing transportation performance data for all modes within the study corridor
3. Gather available information from corridor studies
4. Collect missing data
5. Conduct field reviews of all travel modes within study corridor

- Summaries of the data collected
- Outcomes of data quality reviews and any consistency/reasonableness checks as defined in the Data Collection Plan
- Statement of acceptance/rejection of the individual data sets
- Identification of any key problem areas along with an explanation of cause and identification of risk to the AMS

Tip

Take pictures and video of the corridor during site visits to support a visual understanding of the corridor by stakeholders.


Develop Analysis Plan
2
Develop Data Collection Plan and Collect Data
Approximate LOE 10-20%
Supporting Substeps:
1) Research and identify available data for the study area
2) Identify information/data gaps and recommend an approach to filling the information/data gaps
3) Identify data management strategies
4) Develop Data Collection Plan
5) Collect Data
6) Assemble Existing Conditions Report
Model Setup and Calibration
Alternatives Analysis and Documentation
Continuous Improvement

Workstep Timeframe

- Approximately 2-4 months
- Dependent on the types, quantity and quality of data required, data collection methods, and availability of archived data from automated sources
- Data collection/assembly often occurs in parallel with the development of the Data Collection Plan

Workstep Challenges

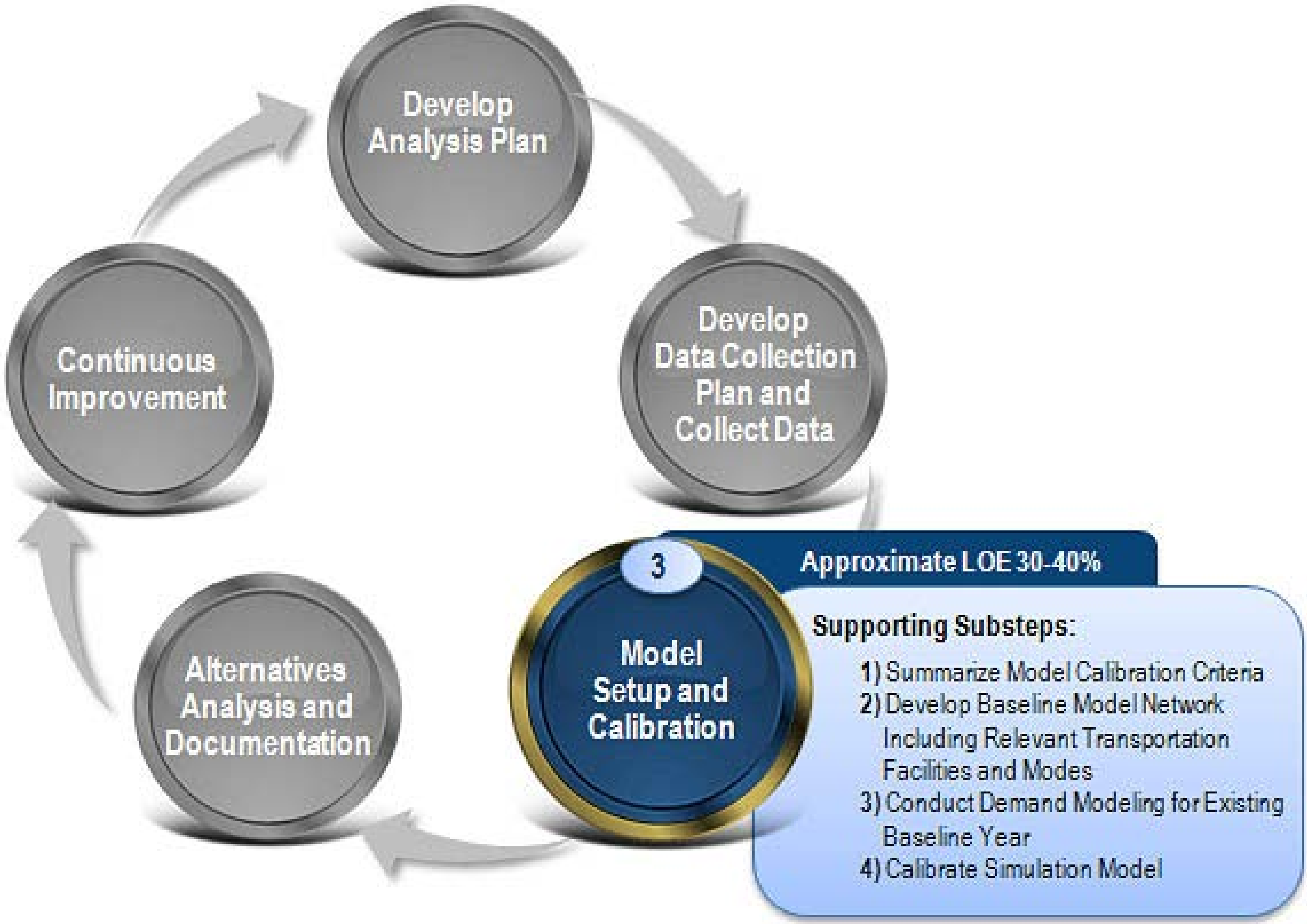
- Data related to nonrecurring congestion
- Concurrent data collection at different facilities and modes
- Insufficient data quality for modeling
- Limited data on traveler behavior
- Archiving/maintaining data

Workstep 3
Model Setup and Calibration

Learning Objectives

- Explain the objective and value of this workstep
- List example model calibration criteria
- List the steps to determine travel demand for a baseline year
- Describe key activities in model calibration
- Walk through the substeps to complete this workstep

Workstep 3: Model Setup and Calibration



Example Guideline Calibration Criteria for Recurrent Congestion

Calibration Criteria and Measures	Calibration Acceptance Targets
Traffic flows within 15% of observed volumes for links with peak-period volumes greater than 2,000 vph	For 85% of cases for links with peak-period volumes greater than 2,000 vph
Sum of all link flows	Within 5% of sum of all link counts
Travel times within 15%	>85% of cases
Visual Audits Individual Link Speeds: Visually Acceptable Speed-Flow Relationship	To analyst's satisfaction
Visual Audits Bottlenecks: Visually Acceptable Queuing	To analyst's satisfaction

Example Calibration Criteria for Nonrecurrent Congestion

- Freeway bottleneck locations. Should be on a modeled segment that is consistent in location, design, and attributes of the representative roadway section
- Duration of incident-related congestion. Duration where observable within 25 percent
- Extent of queue propagation. Should be within 20 percent
- Diversion flows. Increase in ramp volumes where diversion is expected to take place
- Arterial breakdown when incident. Cycle failures or lack of cycle failures

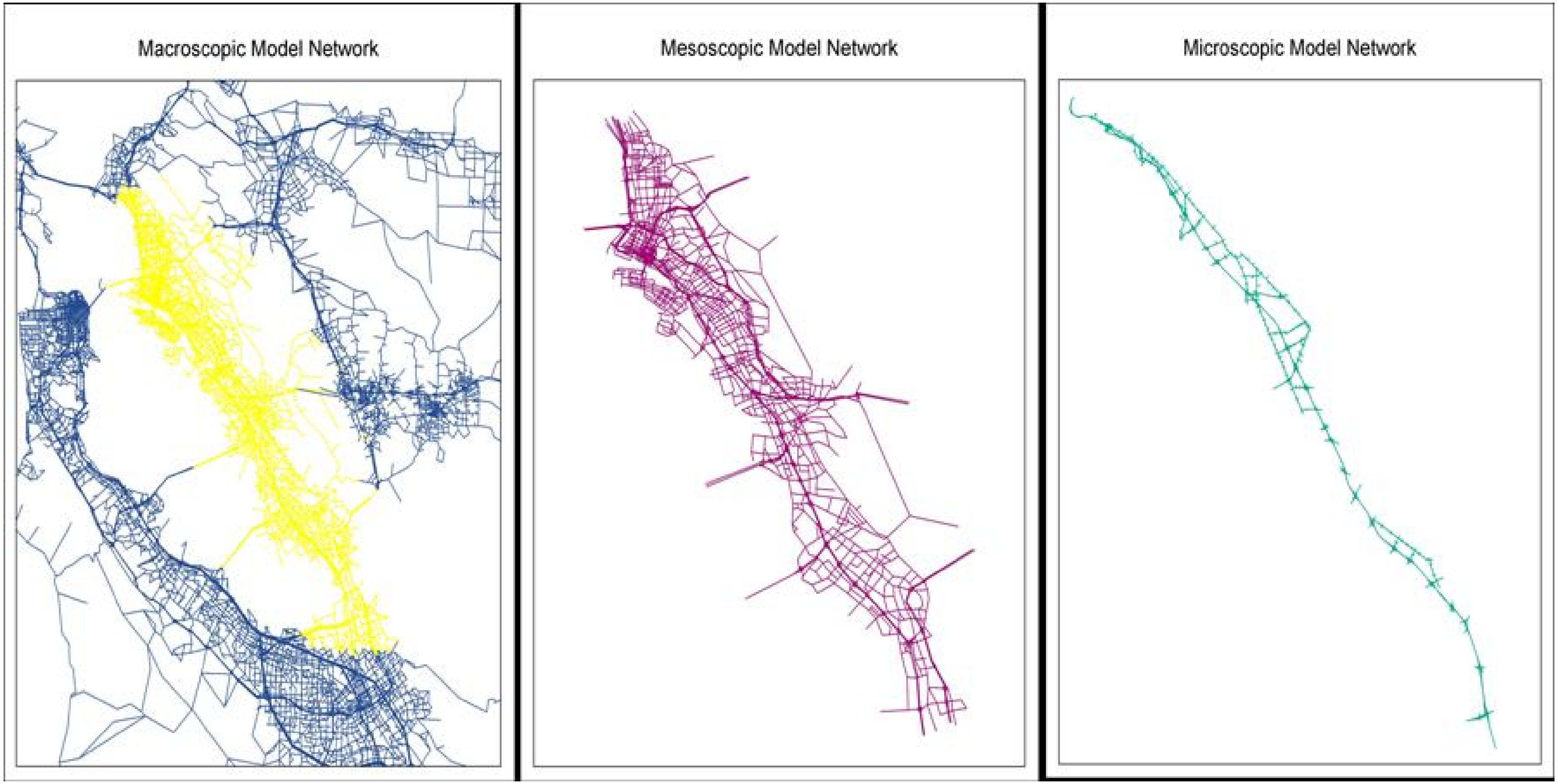
Example Model Calibration Criteria for Transit

Validation Criteria and Measures	Acceptance Targets
Light-rail station volumes within 20% of observed volumes	For 85% of cases
Light-rail park-and-ride lots	
Parked cars in each lot	Within 30%
Total parked cars for all lots combined	Within 20%

Subareas and networks may need to be extracted from the regional travel demand model. Factors to consider:

- Availability of network data in the regional travel demand model
- Network size capabilities of the simulation model and desired processing times
- Modes being considered in the analysis, any specialized transit links
- ICM strategies being considered and their likely impacts
- Diversion routes
- Location of major multimodal transfer locations
- Origin-destination patterns of corridor travelers
- Jurisdictional boundaries
- Availability and quality of coverage of supporting network data
- Special generators
- Any additional specialized analysis or reporting needs

Example Subarea Extraction



1. Develop trip table for corridor subarea from regional travel demand model
   – Disaggregate zones into simulation zone structure
2. Develop time-of-day distribution
   – Disaggregate peak period trip tables into more discrete time slices
3. Conduct Origin-Destination Matrix Estimation (ODME)
   – Develop balanced trip table for corridor study area

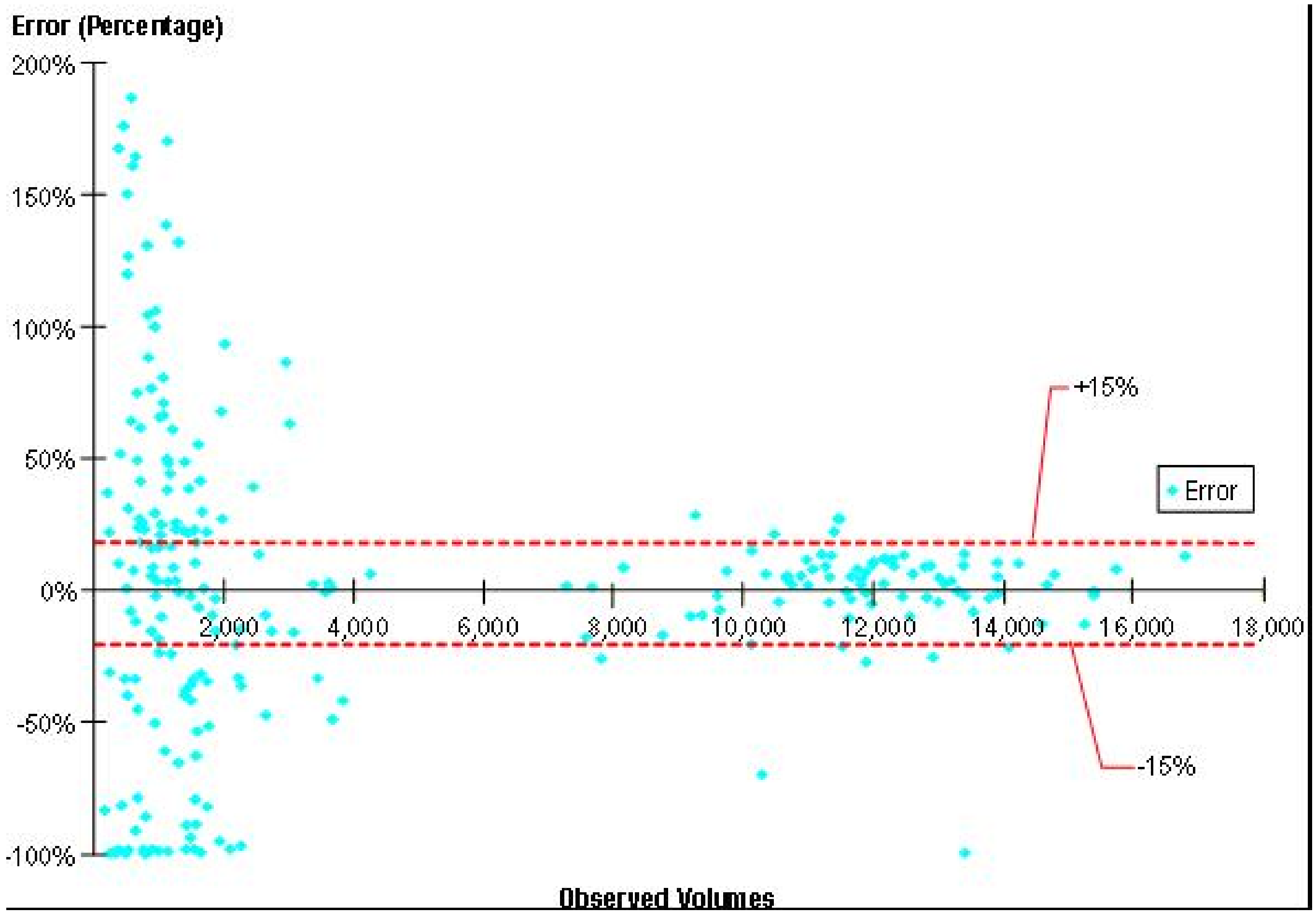
Calibration of Baseline Model

- Identify model calibration targets
- Select model parameter values to best match locally measured **corridor capacities**
- Select model parameter values that best reproduce current **route choice patterns**
- Calibrate overall model against overall **system performance** measures

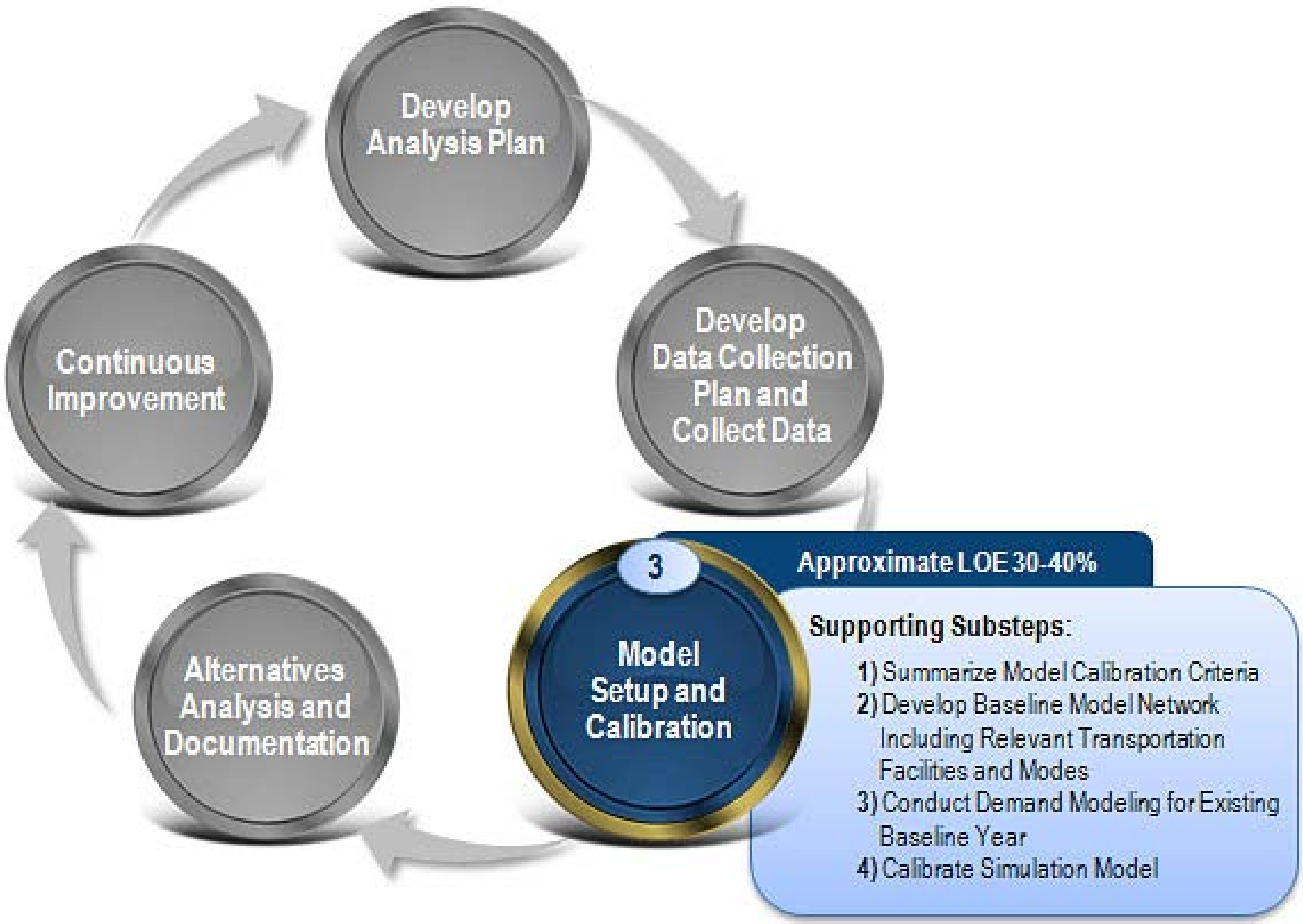
Additional Calibration Steps

1. Calibrate model for known incident conditions
2. Validate roadway model
3. Validate model for transit, HOV, and park and ride facilities
4. Summarize model calibration approach and findings in Calibration/Validation Report

Example Deviation between Observed and Modeled Volumes



Workstep 3: Model Setup and Calibration



Workstep Outputs

- Baseline model networks and trip tables
- Calibrated simulation model
- Calibration/Validation Report

Workstep Timeframe

- Approximately 2-10 months
- Model development, refinement, and calibration can vary in terms of level of effort and time required

Workstep Challenges

- Requires investment of time/resources
- Analysis may require expansion of the “typical” peak periods evaluated in travel demand models
- Stakeholders need to participate in development and review of model calibration settings
- Correct calibration will determine the success of the analysis and project itself

Workstep 4
Alternatives Analysis and Documentation

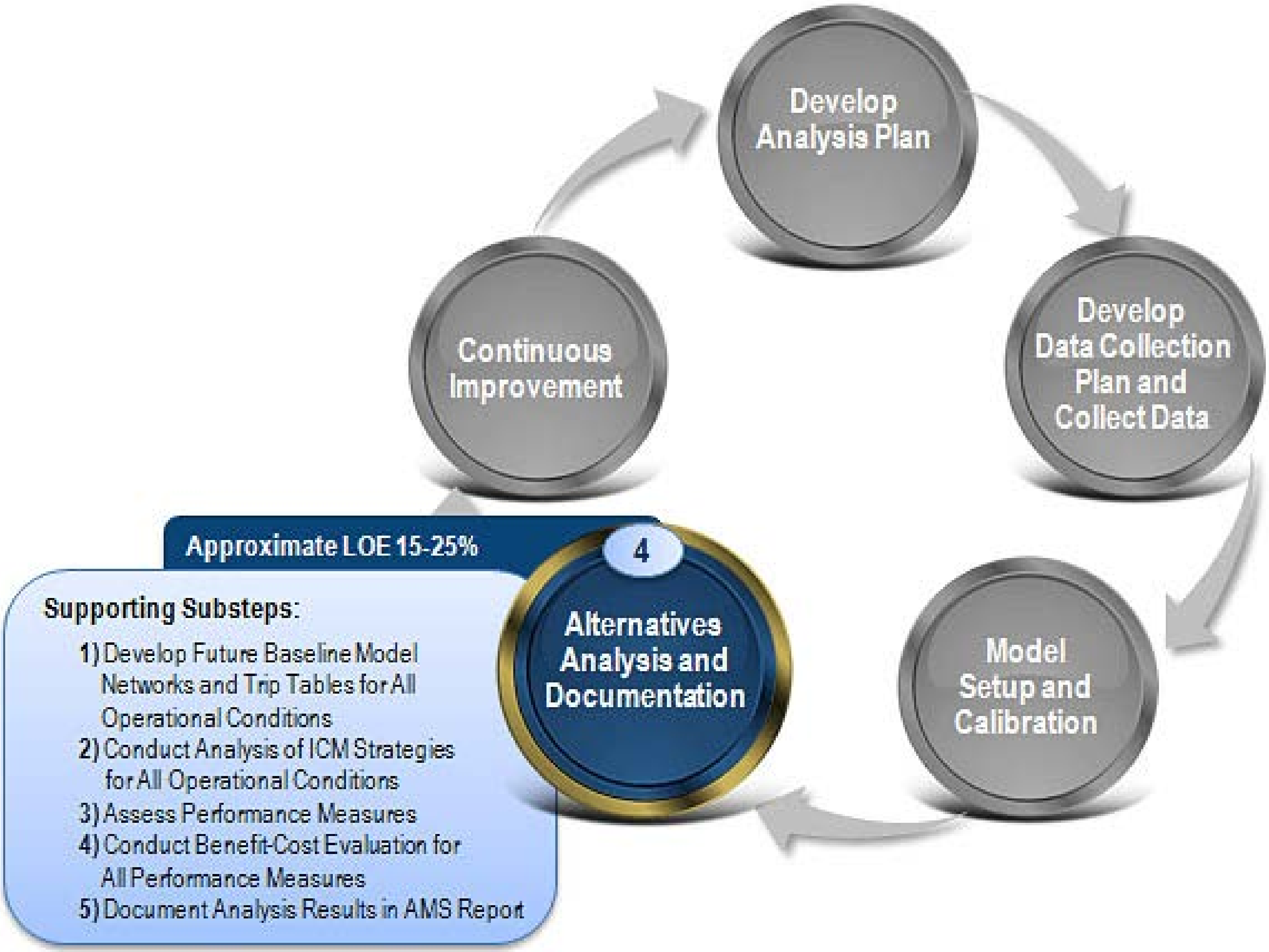
Objective of Workstep

Develop the alternative scenarios within the models developed and calibrated in Workstep 3. Includes the major investment decisions and the ability to assist planners and operators in devising appropriate operating parameters and concepts of operation to optimize the impacts of the selected strategies.

Value of Workstep

Prioritization of potential ICM investments and a clear communication of the potential project benefits.

Workstep 4: Alternatives Analysis and Documentation



Substep 4.1: Develop Future Baseline Model Networks and Trip Tables for all Operational Conditions

- Obtain future year model networks and trip tables from local agencies
- Develop future baseline model, consistent with calibrated model
- Model alternatives according to Analysis Plan guidelines

Substep 4.2: Conduct Analysis of ICM Strategies for all Operational Conditions

Evaluate the initial operational assumptions using AMS, scrutinizing the results for any underperforming or counterintuitive metrics.

→ **Brainstorm** causes for the underperformance and a potential set of “what if” adjustments.

→ **Assess** the impacts and benefits of adjustments to the operational assumptions.

→ **Analyze, compare, and refine** to identify the optimal operating parameters.

→ **Document** the tested scenarios and results

→ **Re-conduct** the refinement process in a continual feedback loop.

Mobility

Reliability

Cost Estimation

Emissions and Fuel Consumption

The sum of benefits should be weighted across the multiple operational conditions to reflect their likelihood of occurrence (i.e., the frequency in which the scenario would be expected to occur).

- Capital Costs
- Operations and Maintenance (O&M) Costs
- Annualized Costs
- Infrastructure Costs
- Incremental Costs

- Summary AMS Report
- Document deviations from Analysis Plan
- Document lessons-learned

Pioneer Sites ICM AMS Results

	San Diego	Dallas	Minneapolis
Annual Travel Time Savings (Person-Hours)	246,000	740,000	132,000
Improvement in Travel Time Reliability (Reduction in Travel Time Variance)	10.6%	3%	4.4%
Gallons of Fuel Saved Annually	323,000	981,000	17,600
Tons of Mobile Emissions Saved Annually	3,100	9,400	175
10-Year Net Benefit	$104M	$264M	$82M
10-Year Cost	$12M	$14M	$4M
Benefit-Cost Ratio	10:1	20:1	22:1

Workstep Outputs

- Performance measures for all alternatives
- Benefit/cost analysis for each alternative
- A prioritized list of response strategies for each scenario

Workstep Timeframe

- Alternatives Analysis: 1-4 months (varies based on number/complexity of test scenarios)
- Documentation: 1 month plus review time

Workstep Challenges

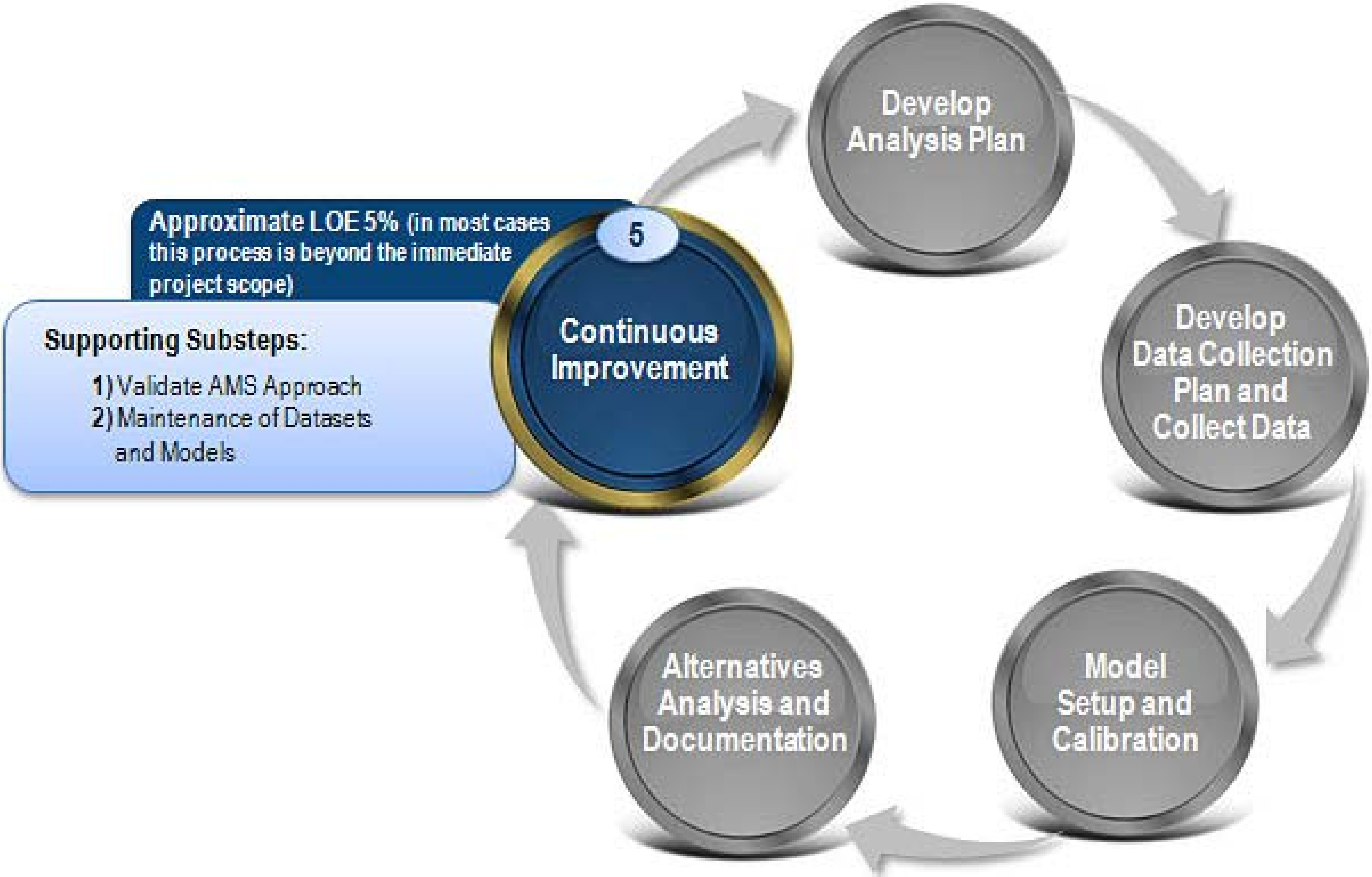
- Weighing model outputs against expected outcomes
- Fully understand capabilities and limitations of models and datasets
- Resources

Workstep 5
Continuous Improvement

Value of Workstep

Ensures the maintenance of the models and datasets, greatly reducing the costs, enhancing the ease with which future analyses may be performed on the corridor, and improving the effectiveness in which future investment decisions are made.

Workstep 5: Continuous Improvement



Workstep Outputs

- Technical memo summarizing findings
- Archive of models and datasets
- Documentation and data dictionaries

Workstep Challenges

- Tendency to forego this task
- May require a mindset change

Lessons Learned from the ICM Pioneer Sites

The Role of AMS

- Requires analytical complexity, but is invaluable
- Helps identify deficiencies in the design process
- Identifies key prospective benefits from proposed ICM improvements
- Enhances existing tools and capabilities
- Must be continually refined and improved

AMS Framework and Methodology

- Different tool types have different advantages and limitations
- An integrated approach can support corridor management planning, design, and operations by combining the capabilities of existing tools
- There are key modeling gaps in existing tools' capabilities
  - Traveler Information
  - Tolling and congestion pricing
  - Short-term mode shift

Data and Performance Measures

- Seek out peer information on unfamiliar datasets
- Thoroughly assess data quality from all sources
  - Specify data quality procedures and minimal data quality requirements
- Concurrent data collection can be demanding
- Archive and maintain datasets and dictionaries

Model Development

- Often the riskiest task
- Analysis of incidents and ICM strategies may require the expansion of the “typical” peak periods evaluated in the travel demand models
- In assessing the model results, weigh the model outputs against the expected outcomes identified in the Analysis Plan carefully