Mainstreaming ITS Into a Regional Transportation Program

The Maricopa County Department of Transportation
ITS Mainstreaming Process

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ABSTRACT

In an effort to mainstream ITS infrastructure elements into their Transportation Improvement Program (TIP), the Maricopa County Department of Transportation (MCDOT) and Kimley-Horn and Associates have developed an ITS mainstreaming procedure. Maricopa County reviews TIP projects at three phases: Candidate Assessment Reports, Design Concept Reports, and TIP Design Projects. At each level the project is developed in greater detail and must be approved by MCDOT and their Board of Supervisors to move to the next level. To successfully mainstream ITS infrastructure into the County TIP, ITS infrastructure elements must be included in a project's Candidate Assessment Report along with other infrastructure elements, such as drainage improvements, sidewalk construction, and pavement overlay. Projects in the Candidate Assessment Report phase compete against each other for funding and a limited number move to the Design Concept Report phase. At the Design Concept Report phase, projects are refined and preliminary designs are developed. Under the ITS Mainstreaming Procedure, ITS infrastructure is also refined and specific technologies are determined. If a project is approved to move to the TIP design phase, the ITS infrastructure will be designed and constructed as part of the TIP project.

In order to mainstream ITS into the TIP process, a detailed assessment criteria has been developed that allows MCDOT to review an individual project, such as a segment of a roadway under construction, and determine the feasibility of implementing ITS infrastructure into that project. Detailed sets of questions are available to ensure that proper consideration is given to determining which ITS infrastructure elements are appropriate. In addition, cost estimates and benefits have been developed for each level of the TIP process. At the Candidate Assessment Report phase, basic functionality and feasibility is defined for the project. At the Design Concept Report phase, the technology is selected and a preliminary design concept is developed. Finally, in the TIP Design phase, technical design requirements are determined. This level of detail for the ITS infrastructure coincides with the same level of detail that is used for the design of pavements, drainage, and other facilities in the project.

As new projects are developed, MCDOT personnel and consultants performing Candidate Assessment Reports, Design Concept Reports, and TIP designs will be expected to be familiar with the ITS Mainstreaming Procedure. Just as the need is determined for drainage and pavement overlay, the need for ITS infrastructure will be determined as a project's Candidate Assessment Report is developed. The costs and benefits of the ITS infrastructure will be incorporated into the overall benefits of the project, and it will be ranked with other TIP projects regardless of which projects include ITS. As this procedure is implemented, ITS will no longer be considered a separate program in the Maricopa County TIP, but rather will be designed and funded as a normal part of the TIP process.

INTRODUCTION

Local ITS Background

Maricopa County is located in central Arizona and includes the incorporated cities of Phoenix, Scottsdale, Tempe, Mesa, and a number of other cities. The County has one of the fastest growing populations in the country, and therefore faces the challenge of providing a transportation system that meets the continually growing demands. Agencies throughout Maricopa County, including the Arizona Department of Transportation, MCDOT, and several municipalities have championed implementation of ITS technologies to enhance traffic management, incident response, and communication with motorists. These agencies have made a substantial investment in the local ITS infrastructure, and additional technology deployments are planned for the freeway and arterial networks. A system architecture was developed for Maricopa County as part of its ITS Strategic Deployment Plan completed in 1996. Since then, a regional ITS architecture was developed for the AZTech Model Deployment Initiative in Maricopa County, and a new regional architecture will be developed as part of an updated ITS Strategic Plan to be completed in 2000. Maricopa County and other local agencies are strong supporters of ITS technologies and programs, and are committed to continued deployment and operations to achieve long-term regional transportation goals.

Purpose of the Study

MCDOT develops a five-year TIP to address the transportation needs of the County. The TIP includes such projects as new street construction, street widening, street and intersection reconstruction, pavement improvements, and various safety and geometric improvements. These projects present an ideal opportunity for MCDOT to implement various ITS infrastructure elements at optimum cost; by coordinating the ITS infrastructure elements with existing roadway construction and other improvements, MCDOT will be able to accelerate the installation of various ITS components to accomplish regional goals.

In order to successfully implement ITS infrastructure into the TIP process, MCDOT needed a procedure to mainstream ITS into their TIP. Mainstreaming of ITS typically refers to the use of traditional roadway funds for ITS projects, but MCDOT sought to take the mainstreaming concept further. They wanted to include ITS elements in their TIP projects in the same manner that other infrastructure, such as drainage improvements and sidewalk construction, are considered when developing a TIP project. By evaluating the need for ITS infrastructure in every TIP project, from the initial project conception through final design, ITS infrastructure can be mainstreamed into the Maricopa County TIP process.

The ITS mainstreaming process objectively assesses ITS improvements with respect to the long range goals, objectives, and policies of the County. The procedure will also serve as a guide to County staff and appointed and elected officials when recommending or selecting ITS projects and elements for inclusion in MCDOT's TIP.

MCDOT Transportation Improvement Program

In an effort to integrate ITS infrastructure elements into the County's TIP, MCDOT and Kimley-Horn and Associates, Inc. have developed a cost effective ITS mainstreaming process for MCDOT to use when developing its 5-year TIP. Maricopa County reviews TIP projects at three stages: Candidate Assessment Reports, Design Concept Reports, and TIP Design Projects. At each level the project is developed in greater detail, and must be approved by MCDOT and the Maricopa County Board of Supervisors before the project can move to the next level.

To successfully mainstream ITS infrastructure in the County TIP, ITS infrastructure elements need to be given the same consideration in a project's Candidate Assessment Report as other infrastructure elements, such as drainage improvements, sidewalk construction, and pavement overlay. Projects in the Candidate Assessment Report stage compete against each other for funding, and a limited number move on to the Design Concept Report stage. At the Design Concept Report stage, projects are refined and preliminary designs are developed. Under the ITS mainstreaming process, ITS infrastructure needs are also refined and specific technologies are determined during this phase. When a road construction project is approved to move to the TIP design phase, the ITS infrastructure will be designed and constructed as part of the TIP project.

Role of ITS Infrastructure Assessment Process

MCDOT develops Candidate Assessment Reports, Design Concept Reports, and TIP design projects primarily through the use of consultants. TIP design projects include the paving and widening of existing roads, bridge construction, intersection redesign, and new road construction. During any of these projects, associated infrastructure elements are included such as drainage improvements, sidewalk construction, signing, lighting, striping and signal installation, depending on the type of project. MCDOT wanted to include ITS infrastructure elements as another area that must be considered, and a uniform approach to assess the feasibility and applicability of including ITS infrastructure in all MCDOT TIP projects needed to be developed.

The ITS mainstreaming study sought to develop this uniform process. At each level of project development, a series of questions and guidelines were developed for consultants and MCDOT staff to use when evaluating applicable ITS technologies for various projects. Detailed implementation cost estimates, operations and maintenance cost estimates, and benefits have also been developed to assist in the ITS infrastructure assessment process.

Applications to Other Local Jurisdiction

The process that was developed for MCDOT's ITS mainstreaming can be applied in a variety of jurisdictions. While the specific needs may differ, many jurisdictions use a project development process that includes an initial report defining a project and alternatives, a detailed Design Concept Report, and finally if selected and approved, project design and construction.

The ITS infrastructure elements and the criteria used for evaluating the infrastructure will likely differ for each government agency. For example, the MCDOT ITS mainstreaming process does not consider electronic toll collection technology because toll roads do not exist in Maricopa County. Also, the evaluation questions developed include considering if a proposed project is located on a MCDOT Primary Route or an AZTech (Model Deployment Initiative) SMART Corridor. Public works agencies that are considering an ITS mainstreaming process can use the MCDOT process as a starting point, and then tailor the infrastructure elements and evaluation questions to suit their specific needs.

EXISTING MAINSTREAMING ACTIVITIES

As a first step in developing MCDOT's ITS mainstreaming process, a search was conducted to determine if other counties throughout the country were implementing similar mainstreaming processes. There was little information found that documented any existing processes for mainstreaming ITS infrastructure into a jurisdiction's TIP that was consistent with the process that MCDOT desired. As part of the literature review for existing ITS mainstreaming processes, eight counties were identified with similar demographics and growth characteristics to Maricopa County. These counties included:

- Hennepin County, Minnesota (Minneapolis)
- Montgomery County, Maryland (Northwest of Washington, D.C.)
- Oakland County, Michigan (North of Detroit)
- King County, Washington (Seattle)
- Clark County, Nevada (Las Vegas)
- San Diego County, California (San Diego)
- Harris County, Texas (Houston)
- Dallas County, Texas (Dallas)

Interviews were conducted with representatives of each county's Department of Transportation to determine if they were attempting to mainstream ITS into their transportation or capital improvement program. It was found that none of the counties that were interviewed had formal ITS mainstreaming processes in place. Most relied on internal coordination among planners, traffic engineers, and traffic operations personnel to ensure that ITS infrastructure elements were implemented into the transportation improvement program, but formal processes had not been developed.

In discussions with the counties, nearly every representative expressed a need to eventually implement a formal ITS mainstreaming process for several reasons:

- County TIPs are growing and the number of projects that must be coordinated requires more staff efforts;
- ITS infrastructure is becoming more sophisticated and the amount of infrastructure being deployed is increasing;
- turnover within the county agencies makes coordination among the different sections (such as traffic engineering and planning) more difficult;
- and many counties felt they had missed opportunities to include ITS infrastructure in some projects because a more formal process did not exist.

Many mentioned that the earlier they can identify the need for an ITS infrastructure element during the project development phase, the more likely it is that a project will receive funding for that ITS element.

Several counties expressed that they would rather risk installing unneeded infrastructure in a TIP project than miss an opportunity to install infrastructure during construction and then later need to tear up pavement or sidewalks.

For the reasons expressed above, most counties said they would be looking at a more formal process for including ITS into their TIP. Many also recognized that for ITS to be truly mainstreamed, it must be considered in a project from the initial conceptualization through the final design.

MCDOT ITS INFRASTRUCTURE NEEDS

Technology Compatibility and Applicability

To determine the appropriate ITS infrastructure elements to consider for the mainstreaming process, a review of the existing technologies, programs, and studies for the Maricopa County area was conducted. In addition to examining existing infrastructure, several other studies were reviewed. These included the Maricopa County ITS Strategic Plan, the Statewide ITS Deployment Plan, and the AZTech Model Deployment Initiative program.

The review of recommended technology and long-range transportation goals for an area is critical to any ITS mainstreaming effort. A primary concern with the mainstreaming effort is that the technology recommended be consistent with existing technology, as well as any local or regional ITS architecture that has been established.

Some of the ITS elements recommended in these reports and programs were eliminated from consideration in Maricopa County's TIP because they were not applicable to TIP projects. Kiosks, for example, are usually installed inside of or adjacent to a building or fixed structure; TIP projects would not provide an opportunity for kiosks placements because they typically only include street and bridge improvements. Similarly, in-vehicle devices also would not be included as part of a TIP project.

Candidate ITS Technologies

The result of the review of existing reports and programs was a detailed table of infrastructure elements that should be included as part of MCDOT's ITS mainstreaming process. These infrastructure elements and a recommendation for deployment are included in **Table 1**. These infrastructure elements were deemed to be applicable to the region's long term ITS goals, consistent with existing architecture, and cost-efficective to implement in conjunction with TIP projects.

Table 1 – Recommended Candidate ITS Infrastructure

ITS Infrastructure Element	Recommendation for Deployment
Controller Upgrade	Installation of 2070 controller.
Fiber Optic Installation (Signal to Signal)	Installation of fiber optic for signal coordination.
Fiber Optic Installation (Signal to TOC)	Installation of fiber optic for signal-to-TOC communication.
Conduit Installation (Signal to Signal)	Installation of conduit for future signal coordination.
Conduit Installation (Signal to TOC)	Installation of conduit for future signal-to-TOC coordination.
CCTV Camera (Full Motion Video)	Installation on/near corridors, selected intersections, special event generators, severe weather locations, rest stops or other locations for surveillance.
CCTV Camera (Compressed Video)	Installation on/near corridors, selected intersections, special event generators, severe weather locations, rest stops or other locations for surveillance. Used in place of full motion video where telecommunications are unavailable or too costly.
VMS Installation	Installation on/near corridors, special event generators, severe weather locations or other locations for information dissemination.
Machine Vision Sensor	Installation on corridors or other locations where traffic volume and speed data are required.
Sonic Sensors	Installation to supplement or replace machine vision sensors.
Loop Surveillance	Installation on corridors or other locations where traffic volume and speed data are required but cost prohibits other technologies.
Road Weather Information Systems	Installation in locations where severe weather conditions may exist.
Blowing Dust/Visibility Sensors	Installation in locations where severe wind and dust may exist.
Flash Flood Sensors	Installation in locations where there is a low bridge crossing or dry river bed crossing.
Vehicle Detection Systems	Installation in areas where it is necessary to know if a vehicle has entered an area such as in a work zone or other restricted area.
Weigh-in-Motion (WIM)	Installation in locations where enforcement or data collection of truck weights is required.
Non-POE Enforcement Locations	Installation on truck routes where mobile enforcement of commercial vehicles is desired. Includes WIM and pull out area for vehicle inspection.

ITS INFRASTRUCTURE ASSESSMENT PROCEDURE

ITS Infrastructure Assessment Goals

The first stage in developing the evaluation criteria was to define the assessment goals for the Candidate Assessment Reports, Design Concept Reports, and TIP design projects. It was envisioned that the level of detail for the evaluation would increase with each stage in the TIP process.

The goal of the Candidate Assessment Report assessments is to evaluate ITS functions and determine their feasibility for deployment in a project. At the Design Concept Report level, specific ITS technology is identified and a preliminary design concept is recommended. Finally, for TIP design projects, the assessment goals are to specify technical design requirements. These goals are indicated in **Figure 1**.

Figure 1 – ITS Assessment Goals

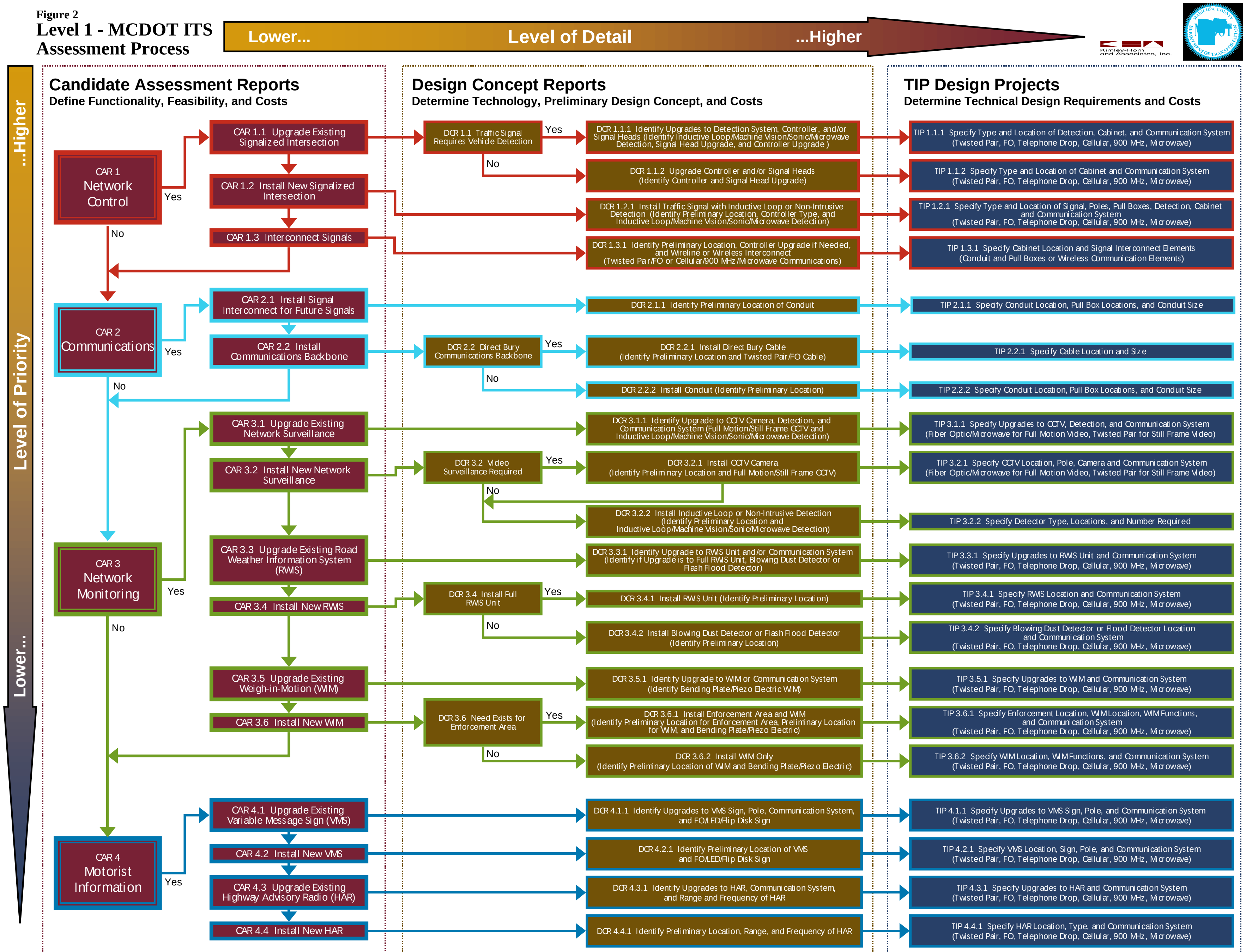
ITS Infrastructure Assessment Diagram

The second stage in the evaluation criteria was to determine the ITS functions and technologies that could be included for the Candidate Assessment Reports, Design Concept Reports, and TIP design projects. **Figure 2** shows the Level 1 ITS Assessment Diagram, which indicates the ITS functions and technologies which will be recommended in each of the projects under consideration.

The Level 1 ITS Assessment Diagram identifies four primary ITS functions that will be evaluated: Network Control, Communications, Network Monitoring, and Motorist Information. Each project will be evaluated to determine which of these ITS functions are applicable and/or recommended for deployment. A set of screening questions was developed for each ITS function to assist the evaluator in making this decision. Once an initial ITS function is identified, the evaluator then follows the flows identified in the Level 1 ITS Assessment Diagram to determine which technologies will be recommended. The level of the project being assessed (Candidate Assessment Report, Design Concept Report, or TIP design) will dictate which area of the flow diagram the evaluator should use.

An example of how the diagram is used to evaluate a project is presented in later in this paper.

Figure 2
Level 1 - MCDOT ITS Assessment Process



Evaluation Questions

A set of evaluation questions was developed for each decision block in the Level 1 ITS Assessment Diagram to assist the evaluator in determining which technologies to recommend. At the Candidate Assessment Report level, these questions can be answered with "yes" or "no." If the requirements in each block are met then that TIS technology is recommended. An example of the Candidate Assessment Report evaluation questions is provided in **Table 2.**

Table 2 – Example Candidate Assessment Report Evaluation Questions

CAR3 NETWORK MONITORING MCDOT ITS Master Plan identified need for network monitoring infrastructure in project area or Project is part of a Maricopa County Primary Route or Project is part of a MAG Road of Regional Significance or Project is installing network control or Project has high accident rate or Project is affected by unusual traffic demands or Project is affected by severe weather and flooding or Truck traffic exceeds 5% of total traffic	**CAR3.1 Upgrade Existing Network Surveillance** Network surveillance (CCTV, vehicle detection systems) exists within project limits AND Existing network surveillance is no longer compatible with MCDOT system or Existing network surveillance does not support the desired functions or Significant performance or maintenance problems exist with system or Replacement of existing network surveillance scheduled near date of future project construction **CAR3.2 Install New Network Surveillance** MCDOT ITS Master Plan identified network surveillance installation in project area or Critical need for data collection exists at location or High accident rate exists or Unusual traffic demands exist that require continuous monitoring

The Design Concept Report level includes "yes" or "no" questions, or a series of recommendations or statements that must be considered before deciding on an appropriate recommendation. Some decisions will rely on the evaluator's experience and knowledge of the ITS technologies as well as the specific needs of the projects. An example of the Design Concept Report evaluation questions is provided in **Table 3.**

At the TIP design level, most of the questions regarding which technology to deploy should have been answered at the Design Concept Report stage, with the exception of communication technologies. At this level, the evaluator must take into account a number of considerations and begin to make recommendations on specific design aspects of the technologies being deployed. Many of these decisions will require an evaluator with design experience to identify the specific locations for the technology being deployed and begin specifying detailed design items. Design considerations are given to assist the evaluator in recommending communication systems and specifying the location and number of ITS infrastructure items. An example of the TIP design considerations is provided in **Table 4.**

Table 3 – Example Design Concept Report Evaluation Questions

DCR3.2 Video Surveillance Required Imagery data is required or Need for real-time information verification or Will be used in conjunction with an incident management system or Severe weather requires visual monitoring AND Existing environment conducive to camera surveillance: minimal visual interference from trees, buildings, signs, bridges, and horizontal and vertical road geometry	**DCR3.2.1 Install CCTV Camera** ***(Identify Preliminary Location and Full Motion/Still Frame CCTV)*** Identify location of CCTV camera based on: ▪ Desired surveillance elements and range of view ▪ Percent of coverage and redundancy required ▪ Objects that may hinder the line of sight (i.e. buildings, bridges, trees) ▪ Opportunity to mount camera on existing objects (signal pole, lighting pole, buildings) ▪ Aesthetic issues Consider full motion video if: • High quality images required • Need for real time information • Communications system can support full motion Consider still frame video if: • Limited visual surveillance is adequate • Communication system can not support full motion video

Table 4 – Example TIP Design Considerations

Conduit Installation	▪ Identify location of existing interconnect to be tied into ▪ Identify type of existing interconnect: twisted pair or fiber optic ▪ Specify type of interconnect to be used ▪ Specify size/capacity of interconnect, by evaluating existing and future communication needs ▪ Identify underground utilities, number of driveway crossings, roadway crossings, railroad crossings, waterway crossings, number of junction boxes and number of cable termination/splice cabinets ▪ Specify if rigid conduit or polyethylene conduit ▪ Identify need for open cuts and jack/bore

Implementation and Operations & Maintenance Costs

A set of cost estimates was developed for each ITS infrastructure recommendation for the Candidate Assessment Reports, Design Concept Reports, and TIP design projects. Costs were estimated for the initial deployment of the technology, and for the operations and maintenance of the technology over a five-year period. A summary of the ITS infrastructure implementation and operations and maintenance costs are provided in **Table 5.**

Table 5 – ITS Infrastructure Estimated Deployment Costs

ITS Infrastructure Element	Units	Estimated Cost	Estimated 5 Year O&M Cost[1]
Network Control			
Install Controller (Peek 3000 and Cabinet)	1 unit	$11,000	$1,000 - $2,500
Install Controller (Econolite 2070 and Cabinet)	1 unit	$14,000	$1,000 - $2,500
Upgrade Controller (Peek 2000 to Peek 3000)	1 unit	$2,500 - $9,500	$1,000 - $2,500
Upgrade Controller (Econolite 2000 to Econolite 2070)	1 unit	$9,500	$1,000 - $2,500
Install Traffic Signal (Signal, conduit, inductive loops, cabinet)	1 signal (four leg intersection	$95,000	$12,000 - $15,000
Communications			
Direct Bury Armor Encased Fiber Cable (Installation and Cable)	1 km (1 mile)	$37,000 ($60,000)	$0 - $1,000[2]
Conduit Design and Installation – Corridor (1-75 mm (3 inch) Conduit)	1 km (1 mile)	$40,000 ($65,000)	$0 - $1,000[2]
Twisted Pair Installation	1 km (1 mile)	$7,500 ($12,000)	$0 - $1,000[2]
Fiber Optic Cable Installation	1 km (1 mile)	$12,000 ($20,000)	$0 - $1,000[2,3]
Telephone Drop	1 drop	$1,000 - $3,000	$1,000 - $1,500
Cellular Communication	1 unit	$500	$1,500 – $2,000
900 MHz Spread Spectrum Radio	1 link	$9,000	$750 - $2,000
Microwave Communication	1 link	$15,000	$1,500 - $3,500
Network Monitoring			
CCTV Camera (Full Motion Video, Includes Pole)	1 unit	$32,000	$6,500
CCTV Camera (Still Frame Video, Includes Pole)	1 unit	$32,000	$6,500
Inductive Loop Surveillance on Corridor	4 loops	$3,000	$2000 - $4,000
Inductive Loop Surveillance at Intersection	4 legs (2 lanes per approach)	$12,000	$2000 - $4,000
Machine Vision Sensor on Corridor	1 sensor (both directions of travel)	$29,000	$1,000 - $2,000
Machine Vision Sensor at Intersection	4 sensors (four leg intersection)	$34,000	$1,000 - $2,000
Passive Acoustic Sensor on Corridor	2 sensors (both directions of travel)	$10,000	$1,000 - $2,000
Passive Acoustic Sensor at Intersection	4 sensors (four leg intersection)	$15,000	$1,000 - $2,000
Remote Traffic Microwave Sensor on Corridor	1 sensor (both directions of travel)	$6,000	$1,000 - $2,000
Remote Traffic Microwave Sensor at Intersection	4 sensors (four leg intersection)	$18,000	$1,000 - $2,000
Road Weather Information Systems	1 unit	$75,000	$7,000 - $12,000
Blowing Dust/Visibility Sensors	1 unit	$20,000	$1,500 - $3,000
Flash Flood Sensors	1 unit	$30,000	$1,500 - $3,000
Weigh-in-Motion (Bending Plate)	1 unit	$55,000	$25,000
Weigh-in-Motion (Piezo Electric)	1 unit	$10,000	$25,000
Non-POE Enforcement Locations	1 unit	$60,000	$27,000
Traveler Information			
VMS (Arterial, Including Structure and Cabinet)	1 unit	$65,000	$14,000 - $16,000
Highway Advisory Radio (HAR)	1 unit	$32,000	$3,000 - $4,000

[1]Electricity costs based on $0.0458/kwh.
[2]Cost of maintaining conduit and cable are for repairing line breaks. If no breaks occur then there will not be any O&M cost.
[3]Assumes County owns fiber optic conduit and therefore no leasing costs are required.

The broad scope of the Candidate Assessment Report analysis will not allow detailed costs to be developed. In some cases, such as the installation of network monitoring, a decision cannot be made at the Candidate Assessment Report level on which type of technology to deploy (i.e., loop detection or non-intrusive detection); however, for cost estimating purposes, the evaluator should determine which technology appears most feasible. If that is not possible at the Candidate Assessment Report level, then it is recommended that the evaluator choose the high cost alternative to ensure that enough capital funds are programmed for the project, regardless of the alternative chosen. An example of cost estimates developed at the Candidate Assessment Report level is included in **Table 6**.

Table 6 – Example Implementation and O&M Costs for Candidate Assessment Report Level

CAR Recommendation	Estimated Cost		Estimated 5 Year O&M Cost
CAR1.2 Install New Signalized Intersection	Signal (with video detection):	$115,000 per intersection	$15,000
CAR1.3 Interconnect Signals	Interconnect: (conduit and fiber optic)	$52,000 per km	$1,000
CAR2.1 Install Signal Interconnect for Future Signals	Interconnect (conduit only):	$40,000 per km	$1,000
CAR3.2 Install New Network Surveillance	CCTV: Loop Detection: Non-Intrusive:	$32,000 per camera $3,000 per location $29,000 per location	$6,500 $4,000 $2,000

At the Design Concept Report level, more detail on costs is provided. In the case of network surveillance, costs are listed for CCTV cameras, loop detection, machine vision detection, and sonic detection. At this level the evaluator should be able to accurately recommend the technology that is most appropriate for use in the project. An example of cost estimates developed at the Design Concept Report level is included in **Table 7**.

Details on costs of communications devices and other aspects of the project are listed in the TIP design level. It is expected that, at this level, the evaluator will also take into account other factors that could affect the cost of implementation, such as potential economies of scale (depending on the size of the project and quantity of ITS components selected) and the cost savings that could be realized through installation of the ITS infrastructure elements during an existing construction project. An example of cost estimates developed at the TIP design project level is included in **Table 8**.

Table 7 – Example Implementation and O&M Costs for Design Concept Report Level

DCR Recommendation	Estimated Cost		Estimated 5 Year O&M Cost
DCR2.2.1 Install Direct Bury Cable ***(Identify Preliminary Location and Twisted Pair/FO Cable)***	Direct Bury Cable: (fiber optic)	$37,000 per km	$1,000
DCR2.2.2 Install Conduit ***(Identify Preliminary Location)***	Empty Conduit: Fiber Optic:	$40,000 per km $12,000 per km	$1,000 $1,000
DCR3.2.1 Install CCTV Camera ***(Identify Preliminary Location and Full Motion/Still Frame CCTV)***	CCTV Camera:	$32,000 per camera	$6,500
DCR3.2.2 Install Inductive Loop or Non-Intrusive Detection ***(Identify Preliminary Location and Inductive Loop/Machine Vision/Sonic/ Microwave Detection)***	Loop Detection: Machine Vision: Sonic: RTMS:	$3,000 per location $29,000 per location $10,000 per location $6,000 per location	$4,000 $2,000 $2,000 $2,000

Table 8 – Example Implementation and O&M Costs for TIP Design Project

TIP Recommendation	Estimated Cost		Estimated 5 Year O&M Cost
TIP2.2.1 Specify Cable Location and Size	Direct Bury Cable (fiber optic): $37,000 per km Pull Boxes:	 $400 per box	$1,000 $0
TIP2.2.2 Specify Conduit Location, Pull Box Locations, and Conduit Size	Conduit: Fiber Optic: Pull Boxes:	$40,000 per km $12,000 per km $400 per box	$1,000 $1,000 $0
TIP3.2.1 Specify CCTV Location, Pole, Camera and Communication System ***(Fiber Optic/Microwave for Full Motion Video, Twisted Pair for Still Frame Video)***	CCTV Camera: Empty Conduit: Twisted Pair: Fiber Optic: Microwave:	$32,000 per camera $40,000 per km $7,500 per km $12,000 per km $15,000 per link	$6,500 $1,000 $1,000 $1,000 $3,500

Benefits

Quantitative and qualitative benefits have been developed for each of the four primary ITS functions that will be evaluated as well as the subsystem components. The benefits were derived from both federally sponsored studies and local studies performed in Maricopa County. When possible, evaluation methodologies are recommended for a detailed benefits analysis at the TIP design stage to determine the benefits of the recommended ITS infrastructure. An example of the benefits that were developed for the variable message signs is included in **Table 9**.

Table 9 – Example Benefits for Variable Message Signs

Motorist Information System Benefits
Summary of Traveler Information Systems Benefits: **Travel Time:** Decrease 10% – 45% in incident conditions **Fuel Consumption:** Decrease 6% – 12% **Emissions:** Decrease CO emissions 7% – 33% Decrease HC emissions 16% Decrease NO_x emissions 1.5% **Compliance:** 10% – 20% of drivers will divert when a message is displayed with alternate route or detour information
Qualitative Benefits: ▪ Increase overall efficiency of transportation system by informing motorist of alternatives ▪ Reduce travel time by allowing motorist to make informed decisions ▪ Benefits both local highway user and travelers unfamiliar with area
Benefits of Subsystem Components: Variable Message Signs (VMS): ▪ Provides real-time information to the motorists ▪ Capable of providing motorists with advance warnings ▪ Flexibility of message type: congestion, incident information, routing information, speed advisory, special events, parking information, weather information, etc. ▪ Can be used by multiple agencies by establishing hierarchy of needs ▪ Can use preprogrammed messages or messages developed for a particular situation ▪ Messages can be changed and modified quickly ▪ Can be used in conjunction with other systems: HAR, RWIS, Network Surveillance ▪ Excellent target value
Benefits Evaluation Methodologies: ▪ INTEGRATION simulation to analyze effect of VMS on corridors/networks ▪ Before and after studies of motorist compliance with VMS and HAR messages

Updating the ITS Infrastructure Assessment Procedure

The ITS Assessment Criteria was designed to be flexible enough to not require frequent updates; however, certain information will require updating. In particular, the cost estimates for the ITS infrastructure elements will change over time, and it will be necessary for agencies to review and update these costs. The ITS infrastructure elements are broad and represent the current technology in use. As new technologies emerge and others become obsolete, a review of recommended technologies should be conducted to determine applicability and feasibility.

ITS INFRASTRUCTURE ASSESSMENT EXAMPLE

Candidate Assessment Report Level

Figure 3 shows the results of a sample project that has been assessed for ITS infrastructure at the Candidate Assessment Report, Design Concept Report, and TIP design levels. Based on the initial screening it was determined that Communications, Network Monitoring, and Motorist Information were appropriate for this project. These three areas were then further evaluated for general technology recommendations, which included the installation of a communications backbone (CAR2.2), installation of network surveillance (CAR3.2), installation of a RWIS unit (CAR3.4), and the upgrade of an existing variable message sign (CAR4.1).

Design Concept Report Level

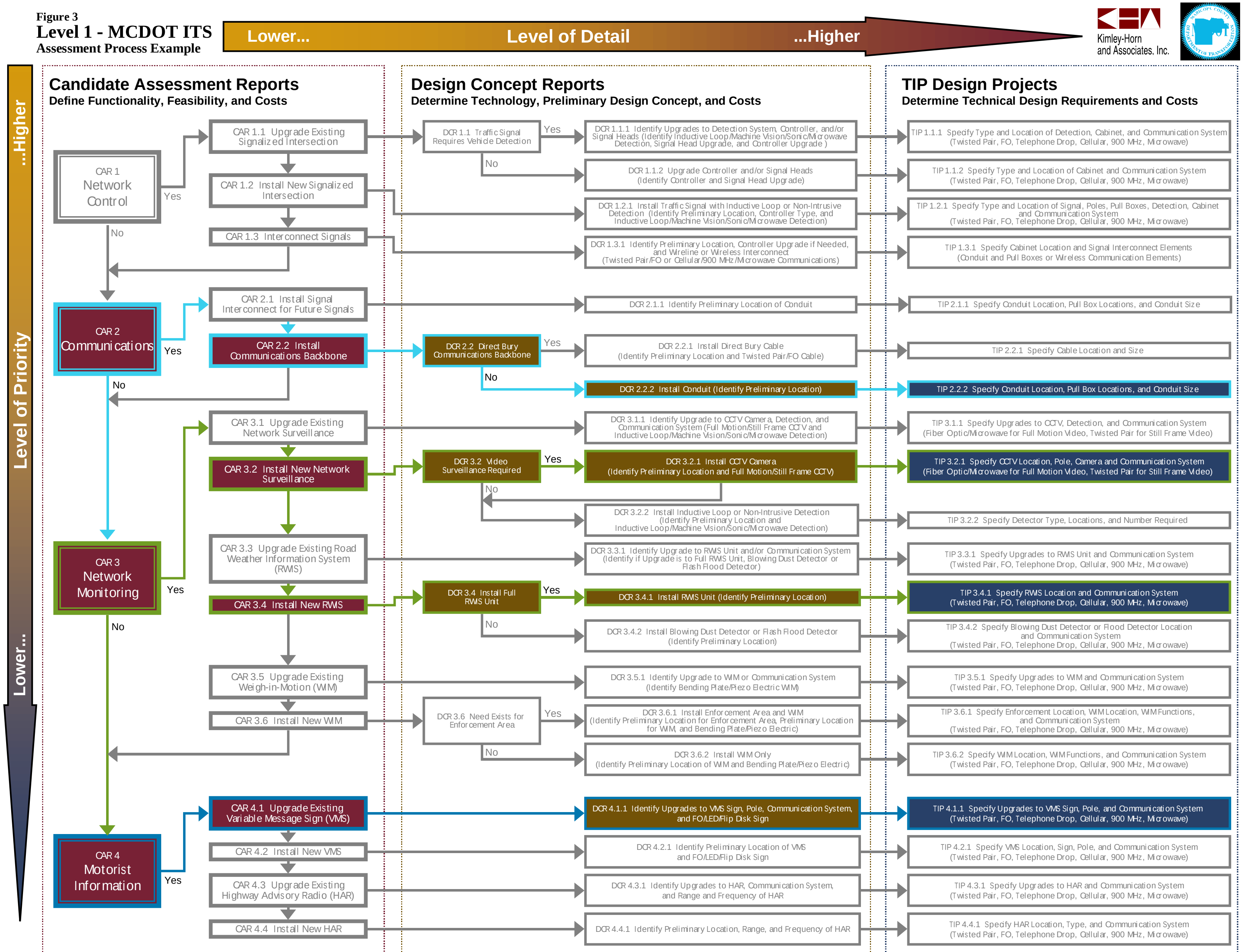
The Design Concept Report assessment evaluates only those ITS technologies recommended in the Candidate Assessment Report. For Communications, it is decided that a direct bury communications backbone (DCR2.2) is not feasible and therefore conduit installation (DCR2.2.2) is recommended. Preliminary location of the infrastructure (in this case, conduit) will be identified at this stage.

For Network Monitoring, it is decided that video surveillance (DCR3.4) is required and therefore a CCTV installation (DCR3.2.1) is recommended. The evaluator will recommend full motion or still frame video and identify a preliminary location. Following the flow diagram, installation of inductive loop detection or non-intrusive detection (DCR3.2.2) is also evaluated; however, it was decided that detection technology is not feasible for this project.

Also as part of Network Monitoring, a decision is made to install a full RWIS unit (DCR3.4). Following the flow diagram, the evaluator will recommend installation of the RWIS unit (DCR3.4.1) and identify a preliminary location.

For Motorist Information the evaluator will identify the upgrades to the existing variable message sign, pole, or communications (DCR4.1.1).

Figure 3
Level 1 - MCDOT ITS Assessment Process Example
Assessment Process Example



TIP Level

Based on the recommendations from the two previous levels, technical design requirements are identified in the TIP design assessment.

For Communications, the specific location of the conduit and pull boxes, and the size of the conduit (TIP2.2.2) will be specified.

As part of the Network Monitoring recommendations, a specific CCTV location and communication system will be identified (TIP3.2.1). The evaluator will also identify a specific RWIS location and communication system (TIP3.4.1).

Finally, as part of the Motorist Information recommendation the evaluator will specify upgrades to the communication system of the VMS sign (TIP4.1.1).

SUMMARY

The purpose of this paper is to provide a general overview of the MCDOT ITS mainstreaming process. The evaluation questions, detailed cost estimates and benefits developed for each level of project have not been included in their entirety. Rather, the focus has been to explain the process and how it can be used to ensure ITS infrastructure elements are included in all phases of the development of a capital or transportation improvement program project.

This MCDOT ITS mainstreaming process is unique in that it seeks to include ITS into the project development process that is normally used for traditional roadway projects. Rather then attempting to fund dedicated ITS projects with traditional roadway funds, as mainstreaming often refers to, MCDOT is seeking to always consider ITS in their TIP projects from initial project conception through design and construction. To embrace ITS and make it a part of the transportation system in Maricopa County, MCDOT believes that the mainstreaming process is necessary. As new projects are developed at the Candidate Assessment Level, MCDOT will continue to evaluate these projects for ITS infrastructure. As those projects move to the Design Concept Report and TIP design phase, ITS infrastructure will be funded through traditional capital improvement and roadway funds, and a truly mainstreamed ITS program will exist.

LIST OF FIGURES

LIST OF TABLES