January 28, 2015

TO: Members of the MAG Intelligent Transportation Systems Committee

FROM: Catherine Hollow, City of Tempe, Chair

SUBJECT: MEETING NOTIFICATION AND TRANSMITTAL OF TENTATIVE AGENDA

Wednesday, February 4, 2015- **10:00 a.m.**
MAG Office Building, 2nd Floor, Ironwood Room
302 North First Avenue, Phoenix

The ITS Committee has been scheduled at the time and place noted above. Committee members or their proxies may attend **in person or by video conference or by telephone conference call**. Those attending by telephone conference call please contact MAG offices for conference call instructions.

Please park in the garage under the MAG building, bring your ticket, parking will be validated. For those using transit, Valley Metro/RPTA will provide transit tickets for your trip. For those using bicycles, please lock your bicycle in the bike rack in the garage.

In 1996, the Regional Council approved a simple majority quorum for all MAG advisory committees. If the ITS Committee does not meet the quorum requirement, members who have arrived at the meeting will be instructed a legal meeting cannot occur and subsequently be dismissed. Your attendance at the meeting is strongly encouraged.

Pursuant to Title II of the Americans with Disabilities Act (ADA), MAG does not discriminate on the basis of disability in admissions to or participation in its public meetings. Persons with a disability may request a reasonable accommodation, such as a sign language interpreter, by contacting Jason Stephens at the MAG office. Requests should be made as early as possible to allow time to arrange the accommodation.

If you have any questions regarding the meeting, please contact Sarath Joshua at (602) 254-6300.

TENTATIVE AGENDA

	COMMITTEE ACTION REQUESTED
1. Call to Order For the February 4, 2015 meeting, the quorum requirement is 10 committee members.	
2. Approval of the January 7, 2015 ITS and TAG Joint Meeting Minutes	2. Review and approve minutes of the ITS and TAG joint meeting held on January 7, 2015.
3. Approval of the January 7, 2015 Meeting Minutes	3. Review and approve minutes of the meeting held on January 7, 2015.
4. Call to Audience An opportunity will be provided to members of the public to address the ITS Committee on items not scheduled on the agenda that fall under the jurisdiction of MAG, or on items on the agenda for discussion but not for action. Members of the public will be requested not to exceed a three minute time period for their comments. A total of 15 minutes will be provided for the Call to the Audience agenda item, unless the ITS Committee requests an exception to this limit. Please note that those wishing to comment on action agenda items will be given an opportunity when the item is heard.	4. For information and discussion.
5. Program Managers Report The following items will be discussed: • Status of TSOP Projects • Status Report on the RCN	5. For information and discussion.
6. Emergency Vehicle Pre-emption Study The Emergency Vehicle Preemption (EVP) Best Practices Study is conducting a comprehensive review of the EVP practices to identify best practices and develop recommended practices for the MAG region to follow. Findings from the first two study tasks are documented in Draft Technical	6. For information and discussion.

Memorandum No.1 (See Attachment One) . This addresses the compilation of a regional EVP inventory and the identification of challenges and limitations. A brief presentation will be provided on these findings.

The discussion will also include regional deployment inventory and implementation, EVP operations and maintenance, and regional challenges with existing systems.

7. Developing Traffic Management Response Plans for Freeway Closures: I-10 West and US 60 Projects

Two of the FY2014 TSOP projects involved the development of corridor arterial traffic management plans that would be utilized whenever the arterial is impacted by a major diversion of traffic from a parallel freeway.

One of these projects, extended similar previous work for the I-10 West segment between I-17 and Loop 101 Agua Fria. The second project developed diversion plans for the US 60 corridor between I-10 and Loop 101 Price.

Each of these projects involved close coordination with the local agencies, ADOT and DPS. A process similar to that being followed in the national Integrated Corridor Management (ICM) demonstration projects was followed, including Analysis and Simulation Modeling (AMS) using the MAG Dynus-T model.

A brief overview of the project for the US-60 corridor, final results, and lessons learned will be provided.

7. For information and discussion.

8. Reports by Committee Members

Members will be provided an opportunity to share information related to ongoing ITS activities in their jurisdictions.

8. For information and discussion.

9. Request for Future Agenda Items Topics or issues of interest that members of the committee would like to have considered for discussion at a future meeting will be requested.	9. For information and discussion.
10. Next Meeting Date and Place The next meeting is scheduled to be held at 10:00 a.m. on Wednesday, March 4, 2015. It will be held in the Ironwood Room on the 2nd Floor of the MAG office building.	10. For information.
Adjournment	

MINUTES OF THE
MARICOPA ASSOCIATION OF GOVERNMENTS
TECHNOLOGY ADVISORY GROUP AND INTELLIGENT TRANSPORTATION SYSTEMS COMMITTEE
JOINT MEETING
January 7, 2015
MAG Ironwood Room, 2nd Floor
302 North First Avenue
Phoenix, Arizona

TECHNOLOGY ADVISORY GROUP MEMBERS ATTENDING

**Michael Echols for David L. Stevens, Maricopa County, Chair
Rob Lloyd, Avondale, Vice Chair
**Greg Platacz, Buckeye
**Jim Keen, Carefree
*Brian Poore, Cave Creek
**Patrick Hait, Chandler
**Pat Timlin, El Mirage, Chair
**Mike Ciccarone, Fountain Hills
*Mark Kramer, Gilbert
**David Atchison, Glendale
**Dan Cotterman, Goodyear
*Pat O'Keefe, Mesa
**Joseph Curtis Paradise Valley
**Dan Lorti for John Imig, Peoria
*Debbie Cotton, Phoenix
*Kim Clark, Queen Creek
** Brad Hartig, Scottsdale
**Tracy Mills, Surprise
**Dave Heck, Tempe
*Scott Debi, Valley Metro

INTELLIGENT TRANSPORTATION SYSTEMS COMMITTEE MEMBERS ATTENDING

Reza Karimvand, ADOT
*Chris Hamilton, City of Avondale
*Chris Lemka, City of Buckeye
Mike Mah, City of Chandler
Captain Burley Copeland, DPS
Bryce Christo, City of El Mirage
Toni Whitfield, FHWA
Leslie Bubke, Town of Gilbert
*Debbie Albert, City of Glendale
Luke Albert, City of Goodyear
Nicolaas Swart, Maricopa County
**Avery Rhodes, City of Mesa
**Ron Amaya, City of Peoria
Marshall Riegel, City of Phoenix
**Steve Ramsey, City of Scottsdale
Albert Garcia, City of Surprise
Catherine Hollow, City of Tempe
Amanda Luecker, Valley Metro

OTHERS PRESENT

Audrey Skidmore, MAG
Sarath Joshua, MAG
Jason Tyre, Phoenix PD
Micah Henry, MAG
Eric Nava, MAG
Scott Kelley, AMEC
Jeff Jenq, OZ Engineering
**Mark Ashley, Fort McDowell
Ryan Gish, MAG
Fisal Saleem, Maricopa County
Margaret Boone, MAG
Dave Chambers, Transcore
Don Wiltshire, YSMA
Ron Pace, Valley Metro

Matt Yentz, Strand Assoc.
Cory Steele, Strand Assoc.
Lisa Burgess, Kimley-Horn
Dan Hartig, Ayres Assoc.
Arnab Gupta, PB
LeShawn Charlton, MCDOT
Suzy Chambers, Dibble
Anita Joham, ASJ Engineering

**Participated via telephone conference call.

JOINT MEETING OF THE MAG INTELLIGENT TRANSPORTATION SYSTEMS AND THE TECHNOLOGY ADVISORY GROUP

1. Call to Order

The Technology Advisory Group (TAG) meeting was called to order at 10:05 a.m. by Vice Chair Rob Lloyd of Avondale. The Intelligent Transportation Systems Committee (ITS) meeting was called to order at 10:05 a.m. by Chair Catherine Hollow of Tempe. All members introduced themselves and Vice Chair Lloyd covered the procedures for teleconferencing and public comment.

2. Call to the Audience

No comments were made by the audience.

3. City of Phoenix PD RCN No Cost Addition

Vice Chair Lloyd asked Audrey Skidmore of MAG to give an overview of the item. Ms. Skidmore reminded the committees that the RCN is overseen by the TAG and ITS committees jointly. Under the authority delegated by the Regional Council, these two committees can jointly approve no-cost service additions to the RCN. Ms. Skidmore reminded the group that the committees have done so on two previous occasions. She then presented an application received via Phoenix Police Department to allow public safety departments to share CCTV images via the RCN and noted the concept had been discussed at the last meeting of each committee. Ms. Skidmore noted that the law enforcement community would like to have this in place prior to the SuperBowl. The RCN currently has the capacity to allow this use and the applicant has agreed to the stipulations on primary transportation use and best effort repair. Jason Tyre, from Phoenix PD and Ryan Gish, the RCN Program Manager, were both available to answer any questions. Ms. Skidmore identified the requested action as approval of the application for no-cost service addition.

Vice Chair Lloyd indicated that no comment cards had been received and opened the floor to questions and a possible motion.

Brad Hartig of Scottsdale motioned for approval of the application for no-cost service addition for the TAG Committee and Dave Heck provided a second. Vice Chair Lloyd opened discussion on the

motion. Dan Cotterman of Goodyear raised the possibility of limiting the term of the approval to cover only the Super Bowl. Ms. Skidmore clarified that the application was for ongoing use. Mr. Cotterman requested additional clarification due to the short timeframe for application review.

Detective Jason Tyre of Phoenix PD and Ryan Gish, the RCN Program Manager, clarified that the public safety use would be ongoing for addressing large events and incidents as necessary, but no in constant use.

David Atchinson of Glendale asked for clarification on the scope of camera images being shared, specifically with the concern of duplication service. Detective Tyre clarified that there would not be duplication.

Ron Amaya of Peoria asked if the addition would be limited to the agencies on the current application. Ms. Skidmore clarified that the application indicated that this would be available to all participating RCN agencies, as has been the case previously.

The motion was restated to include the clarification that this was an ongoing need to manage specific incidents and special events. Mr. Hartig and Mr. Heck agreed this was the intent of their motion. Vice Chair Lloyd called for a vote and the application with clarification was approved unanimously by the TAG committee.

Chair Hollow asked for a corresponding motion from the ITS Committee. Reza Karimvand of ADOT made the motion which was seconded by Albert Garcia of Surprise. There was not further discussion, so Chair Hollow called a vote. The ITS Committee approved the application with the clarification unanimously.

4. Adjournment

Vice Chair Lloyd asked for a motion to adjourn the TAG. Brad Hartig of Scottsdale made the motion and Pat Timlin of El Mirage seconded. The motion was approved unanimously at 10:24 AM. Chair Hollow indicated that the ITS Committee would reconvene at 10:30 AM.

DRAFT MINUTES OF THE
MARICOPA ASSOCIATION OF GOVERNMENTS
INTELLIGENT TRANSPORTATION SYSTEMS COMMITTEE
January 7, 2015
MAG Ironwood Room, 2nd Floor
302 North First Avenue
Phoenix, Arizona

MEMBERS ATTENDING

Reza Karimvand, ADOT
Chris Hamilton, City of Avondale
Chris Lemka, City of Buckeye
Mike Mah, City of Chandler
Captain Burley Copeland, DPS
Bryce Christo, City of El Mirage
Toni Whitfield, FHWA
Leslie Bubke, Town of Gilbert
Allan Galicia, for Debbie Albert, City of Glendale
Luke Albert, City of Goodyear
Nicolaas Swart, Maricopa County
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Marshall Riegel, City of Phoenix
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Albert Garcia, City of Surprise
Catherine Hollow, City of Tempe
Amanda Luecker, Valley Metro

OTHERS PRESENT

Faisal Saleem, MCDOT
Jason Tyre, Phoenix PD
LeShawn Charlton, MCDOT
Ron Pace, Valley Metro
Jeff Jenq, OZ Engineering
Dave Chambers, TransCore
Lisa Burgess, Kimley-Horn
Anita Johari, ASJ Engineering
Don Wiltshire, YSMA
Suzy Chambers, Dibble
Dan Hartig, Ayres
Scott Kelly, AMEC
Arnab Gupta, PB
Corey Steele, Strand
Matt Yentz, Strand
Margaret Boone, MAG
Ryan Gish, MAG
Micah Henry, MAG
Sarath Joshua, MAG
Eric Nava, MAG

* Not present or represented by proxy
\# Participated by teleconference
\+ Participated by videoconference

1. Call to Order

Chair Catherine Hollow called the meeting to order at 10:30 a.m.

2. Approval of the December 3, 2014 Meeting Minutes

Chair Hollow requested approval of the meeting minutes from the December 3rd ITS Committee meeting. Nicolaas Swart from MCDOT requested a correction to Item 7 for the job position title. **Reza Karimvand from ADOT moved, Bryce Christo from El Mirage seconded and it was unanimously carried to approve the minutes of the meeting held on December 3, 2014.**

3. Call to Audience

Chair Hollow made a call to the audience providing an opportunity for any members of the public to address the ITS Committee. No comments were received.

4. Program Manager's Report

Chair Hollow invited Sarath Joshua from MAG to present the Program Manager's Report. Mr. Joshua addressed the following items in his report:

- Current Status of TSOP Projects:

  A total of 11 TSOP projects, seven have been completed, four projects are underway. The two ICM projects on I-10 in Phoenix are scheduled to be completed by March 2015. The two ICM projects on US-60 in Tempe are scheduled to be completed by January 2015. The FY2015 TSOP project list was recommended for approval by TRC and Management Committee, and approved by the Regional Council on December 3rd. There are 11 projects for a total cost of $303,000. Task orders will be developed in January and February 2015. Projects will be initiated in February and completed by June 2015. The Synchro training workshop is scheduled for April with the dates to be finalized.

- Status Report on the Regional Community Network (RCN)

  Sarath Joshua requested that Ryan Gish from MAG provide an update on the latest RCN developments. Mr. Gish detailed the joint MAG TAG meeting with the ITS Committee to approve the RCN no-cost Addition for law enforcement video. MAG and the City of Glendale established a fiber link to the Glendale Regional Public Safety Training Center (GRPSTC), providing an extra path for the 911 dispatch center and support future sharing of the law enforcement video. MAG staff is working with local agencies to establish video sharing via the Luxriot software.

- National Center for Excellence

  The committee was briefed on the new National Operations Center of Excellence and the appointment of Dennis Motiani, formerly with New Jersey DOT, to the position of Executive Director. He indicated that the establishment of this center is a clear reflection of the shift in focus to operations at the national level. The ribbon-cutting ceremony for the Center will be held during the upcoming TRB. The Center will also be hosting various training modules. Reza Karimvand with ADOT highlighted the Center's focus to provide agencies with a centralized and comprehensive set of resources for TSM&O specialists, making this information available to state and local jurisdictions.

5. Systems Management & Operations Plan

Chair Hollow invited Sarath Joshua with MAG to present on the development of the Systems Management and Operations (SM&O) Plan. This was first identified by the ITS Committee during approval of funds for FMS expansion. The study has been endorsed by both Transportation Review Committee and Management Committee. The draft scope of work was distributed with the meeting items. A MAG study for approximately $300,000 to develop this plan is proposed in the Draft FY2016 Work Program.

The draft scope of work is currently being developed. MAG is seeking input on the development of the scope from member agencies. The plan will address the entire roadway system, including both freeways and arterials. The plan will address funding, planning and operating of key transportation facilities. It will also guide future regional investments in SM&O, a departure from the past focus on ITS infrastructure. The plan

will be performance-based and linked to regional priorities, including input and review by Transportation Review Committee, Management Committee and Regional Council.

The draft scope of work introduces the concept of a two-tiered hierarchy of road facilities for SM&O focus. The first tier includes all freeways plus adjacent arterials that serve as feeder routes and detour routes during emergencies and periods of heavy traffic congestion. The second tier includes the Strategic Arterial Road (StAR) Network, principal arterials that provide connectivity and critical access to key destinations beyond the reach of freeways. This study will develop criteria to define and identify components of the tiers. Following regional endorsement the results will help determine how resources are allocated.

The SM&O Plan objectives are included in the draft scope. The plan will identify best urban SM&O practices (both nationally and internationally), identify supporting institutional framework, review current FMS operations, compare current operations with best practices, define 2038 Regional Concept of SM&O (aligning the effort with the RTP update), recommend a path forward for the next 20 years (with incremental 5-year phases), identify the process for data collection, identify the process for performance measurement and reporting, and develop a framework for inter-agency oversight and annual performance review.

The schedule for the development of the SM&O Plan includes ITS Committee review (January 2015), finalize scope of work (February 2015), presentation to TRC (March 2015), approval of MAG Work Program (June 2015), issue RFP (July 2015), consultant selection process (August to September 2015), MAG approval of consultant (October to December 2015), project kick-off (January 2016), project completion (June 2017), and adoption of plan by MAG (September 2018).

Chair Hollow inquired about the funding requirements for local agencies. The SM&O Plan will establish regional priorities, identifying primary facilities. The plan will identify the necessary resources and then prioritize the regional funding. He highlighted the fact that the current arterial ITS funding will be exhausted following the programming of FY2018 in the next TIP call for projects. This plan will help the region to identify the needs and the systematic way to invest in both infrastructure and operations.

Co-chair Riegel with Phoenix inquired on the correlation with future propositions for transportation taxes. With the plan's horizon year of 2038, it is anticipated that the plan will feature significantly for future revenues. Reza Karimvand with ADOT stated that ADOT is currently developing an internal Transportation Systems Management and Operations (TSM&O) Plan. It may be necessary for local agencies to adopt the MAG plan to establish this link to the individual TSM&O plans. These facilities will receive support from the regional level due to the significance and impact beyond local agencies' borders.

Mike Mah with Chandler stated that the focus is on operations, specifically staffing to perform the tasks associated with operations. The funding for additional staff might be regional funding. Currently regional funding cannot be used for staffing, but future funding could remove those restrictions so that investments can be made not only in infrastructure and equipment, but human resources as well. There is the potential for

unifying transportation operations into a single authority or a centrally-located operations centers; this study will explore that and other best practices. Faisal Saleem with MCDOT identified the potential role in future operations due to Connected and Autonomous Vehicles. Sarath pointed out that the scope includes addressing V2V and V2I technologies in the future.

The scope is currently in draft form. MAG staff is soliciting comments on the distributed draft due by January 30th. A small working group will be formed to finalize the scope by the end of February.

6. Developing Traffic Management Response Plans for Freeway Closures

Chair Hollow invited Eric Nava with MAG to present on the project involving the development of traffic management response plans for freeway closures. The Tempe ICM projects are anticipated to be concluded at the end of January and the Phoenix ICM projects at the end of March. At the next ITS Committee meeting the results will be presented.

The Phoenix project involves 4 separate scenarios for freeway closures due to unplanned incidents. These scenarios will be simulated and analyzed for both the AM and PM peak periods. The project identifies 3 strategies diverting traffic along the adjacent roadway network, as far north as Indian School Road and as far south as Buckeye Road. Mr. Nava has completed one of the scenarios. For the Tempe project the study team has completed the AM signal strategies. The experience has identified Southern Avenue and Baseline Road as alternative corridors for diverted traffic off of US-60. The modeling effort indicated that Broadway Road would also be used by the traveling public as an alternative corridor, due to the unique geometry of the Broadway Curve at I-10. The Tempe signal strategies now include Broadway as well. Mr. Nava will update the ITS Committee next month of the results of the modeling effort.

7. Reports by Committee Members

Chair Hollow called on members to report items of interest to the committee. Toni Whitfield with FHWA identified two white papers being developed by the agency regarding the Capability Maturity Model. Both papers are currently in the review process. She indicated that the final papers can be a reference in the future the MAG SM&O Plan. Reza Karimvand with ADOT announced a paper approved by TRB for presentation during a poster session, on wrong-way detection, at the TRB conference. He also mentioned that ADOT is also currently removing and replacing all Passive Acoustic Detectors (PADs) with loop detection. The agency is exploring alternatives for this effort with a selected consultant.

8. Request for Future Agenda Items

Chair Hollow called on members to request future agenda items. Marshall Riegel identified Eric Nava's presentation on signal strategies for freeway closures. Reza Karimvand with ADOT mentioned the potential to present on the upgrade of the agencies communications system. Mr. Karimvand will update the Chair.

9. Next Meeting Date and Place

Next meeting date was announced at 10:00 a.m. on Wednesday, February 4, 2015, in the Ironwood Room (2nd floor) at MAG.

10. Adjournment

Chair Catherine Hollow adjourned the meeting at 11:25 a.m.

Maricopa Association of Governments (MAG)
Task Order No. 536-K.OP14-01

Maricopa Association of Governments (MAG)
Emergency Vehicle Preemption Best Practices Study

Technical Memorandum No. 1

Regional Inventory, Challenges and Limitations

Draft Report

Prepared by:

OZ Engineering
Systems Integrators
Software Consultants

January 21, 2015

Maricopa Association of Governments (MAG)
Emergency Vehicle Preemption Best Practices Study

Technical Memorandum 1:
Regional Inventory, Challenges and Limitations

The Maricopa Association of Governments (MAG) is conducting a regional study of the Emergency Vehicle Preemption (EVP) best practices. This technical memorandum is the first of a series of technical documents produced by this project. This report summarizes the regional inventory and state of implementation of EVP as well as the regional challenges and limitations regarding the maintenance and operations of the EVP system in the MAG region. The remaining technical documents expected from this project include:

- Technical Memorandum 2 – Research and Review of Current EVP Technologies
- Technical Memorandum 3 – Best Practices
- Project Report - Emergency Vehicle Preemption Best Practices Study

Emergency Vehicle Preemption (EVP) is a device installed on a traffic signal to facilitate clearing the intersection thereby enabling an emergency vehicle to proceed with minimal delay. Emergency vehicles equipped with an emitter can request traffic signal preemption treatment as they approach an instrumented intersection. Several jurisdictions in the MAG region began installing EVP systems shortly after the introduction of EVP technology in early 1980. Nowadays, EVP capability is widely considered by the first responder and transportation communities as an essential function of traffic signal operations.

While the Manual on Uniform Traffic Control Devices (MUTCD) specifies the standards for how to transition into and out of preemption, there is a lack of guidance in the critical aspects regarding EVP operations, including preemption signal phase, confirmation light, data encryption, and the needed inter-agency coordination in support of emergency response mutual-aid agreements. This MAG EVP Best Practices study intends to address these knowledge gaps by identifying priority issues and recommending feasible approaches toward improved regional coordination.

1. OVERVIEW OF EVP TECHNOLOGY

The EVP currently deployed within the MAG region are optical-based systems using technology originally introduced in the late 1970's by 3M. By 1990, EVP was widely endorsed by the emergency response community as an effective tool for reducing response time, improving safety of emergency vehicle operations, reducing agency liability, savings in fire/rescue and EMS planning, and savings on fire insurance premiums[1]. Several jurisdictions[2] in the MAG region began implementing EVP systems in early 1980 funded primarily by public safety funds.

The optical-based EVP system consists of onboard vehicle emitters and traffic signal components: optical detectors, preemption detector cards and optionally confirmation lights. Figure 1 illustrates the basic components of an optical-based EVP system.

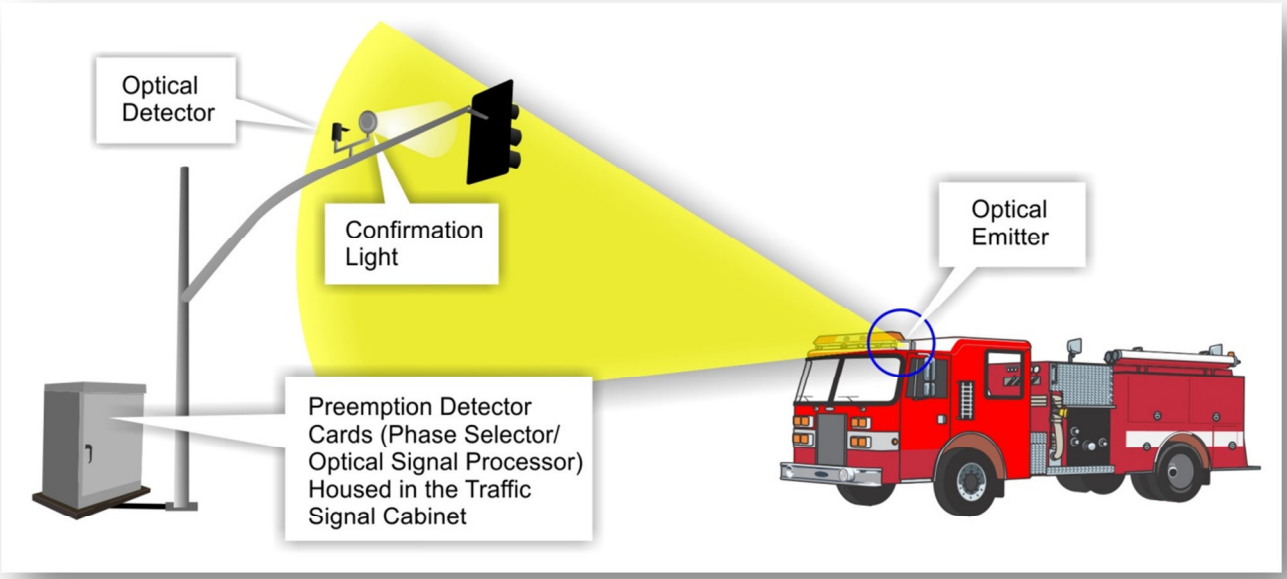

Figure 1. Basic Components of the Optical-Based EVP System

A general description of each EVP system component is provided here as part of the overview. Details on the configurations of EVP systems among MAG jurisdictions are provided in Sections 2 and 3 of this document.

[1] Traffic Signal Preemption for Emergency Vehicles Traffic Signal Preemption for Emergency Vehicles, A CROSS-CUTTING STUDY, FHWA, Page 3-1, January, 2006
[2] The early adopters of EVP in the MAG region included the Cities of Tempe, Mesa, Scottsdale and Chandler.

Optical Emitter

The optical emitter is typically mounted on top of the emergency vehicle. When activated, the emitter produces an infrared strobe signal at a pre-programed frequency that can be received by the optical detectors on the traffic signal mast arm. The vehicle emitter typically operates at a constant maximum intensity level that can be detected up to approximately 2,500 feet[3]. The actual detection range can be set by adjusting the intensity thresholds on the preemption detector card housed in the traffic signal cabinet. In general, the detection range is predicated on the amount of time needed for an emergency vehicle to arrive at the intersection as well as the minimum time required to transition from the current traffic signal timing plan to the special preemption mode. Figure 2 shows the optical emitter installed on a City of Tempe fire engine.

Figure 2. EVP Emitter Installed on a City of Tempe Fire Engine

The emitter is typically wired to the gearshift of the vehicle and/or the vehicle door switch that will turn off the emitter when the vehicle is parked or door opened. This configuration prevents continuous actuation from a parked vehicle within the range of a detector.

The latest EVP emitters can be encoded with an assigned ID. The embedded ID code is transmitted in the optical signal that can be read and recorded by the roadside equipment for monitoring usage.

[3] The maximum range of an EVP emitter may vary by mounting height, vertical and horizontal alignments with the optical detector, atmospheric condition, deterioration of the detector and emitter, obstructions to the line of sight (e.g., vegetation), etc.

Optical Detector

The traffic signal component of the EVP system includes the optical detectors and the (optional) confirmation lights on the traffic signal mast arm, and the preemption detector cards housed in the traffic signal cabinet. The optical detector is made up of a light-gathering sight tube that contains a lens, and a photodiode (light sensor) housed within the cylinder-shaped unit. Figure 3 shows common configurations of optical detectors in the MAG region.

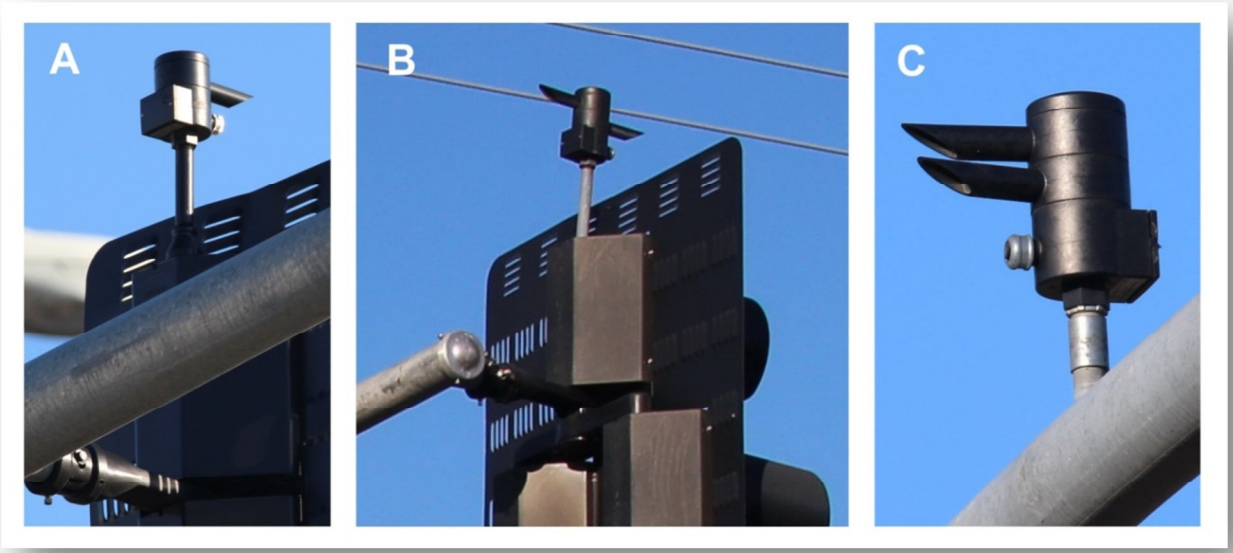

Figure 3. Examples of EVP Optical Detectors in the MAG Region

Picture A of Figure 3 shows a detector unit mounted on the back of a traffic signal head (City of Mesa). Picture B shows the detector unit with two sight tubes aiming at the opposite approaches (City of Mesa). The rationale for combining two detectors in a single unit is to reduce the amount of wiring within the mast arm and the underground conduits which are often crowded with traffic signal-related electrical cables. Picture C shows two sight tubes pointing in the same direction at slightly different angles to provide wider coverage of an approach (City of Chandler). This configuration is also used on curved roads to cover both the near and far fields of the approach to compensate for the line of sight limitations of the optical-based detection.

Confirmation Light

Less than half of the cities in the MAG region have deployed the confirmation light, typically installed adjacent to the optical detector on the signal mast arm. The primary purpose of the confirmation light is to inform the emergency vehicle operator whether the preemption request is provided. This feature is especially important when more than one emergency vehicle is requesting signal preemption from conflicting directions. As an ancillary benefit, the confirmation light advises the general public to act with caution as the intersection is being preempted for an approaching emergency vehicle.

Figure 4 shows two variations of the EVP confirmation light in the MAG region. The City of Phoenix (Picture A of Figure 4) has deployed one (white) confirmation light for each approach. A steady light indicates the direction that the emergency vehicle is approaching from. In the case of multiple preemption requests, a flashing light informs the emergency vehicle operator that their right-of-way has been denied due to an earlier competing preemption request from a conflicting approach. The City of Apache Junction (Picture B of Figure 4) uses two strobe lights of differing color to indicate the direction of the emergency vehicle (e.g., blue indicates east-west, white indicates north-south direction). These strobe lights can be seen from all approaches of the intersection.

Without proper training and a public information campaign, the meaning of color and flashing versus steady lights could be confusing to emergency vehicle operators and the general public alike. More discussion regarding the implementation of EVP confirmation lights in the MAG region is provided in Sections 2 and 3.

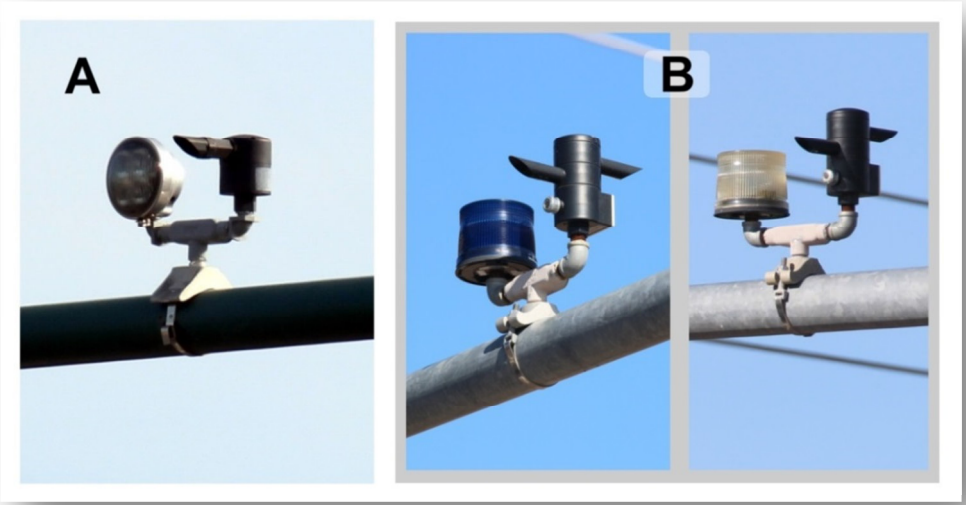

Figure 4. Different Confirmation Light Configurations in MAG Region

Preemption Detector Card

The preemption detector card, in the form of an electronic board, is housed in the traffic signal cabinet. When the optical detector on the mast arm receives the request from an approaching emergency vehicle, the infrared signal, converted to electric current, is processed by the preemption detector card. If encoding is used, the preemption detector card will verify the ID code embedded in the signal to determine if it is within the range of permitted IDs (programmed on the preemption detector card). To grant the preemption request, the preemption detector card examines the intensity level of the signal (correlated to the distance of the emergency vehicle). If the intensity level exceeds a pre-programmed threshold[4], the detector card would make a preemption call to the traffic signal controller to begin the transition from the current signal phase to the special preemption mode. Figure 5 shows an example of the preemption detector cards housed in the traffic signal cabinet at an intersection in the City of Tempe.

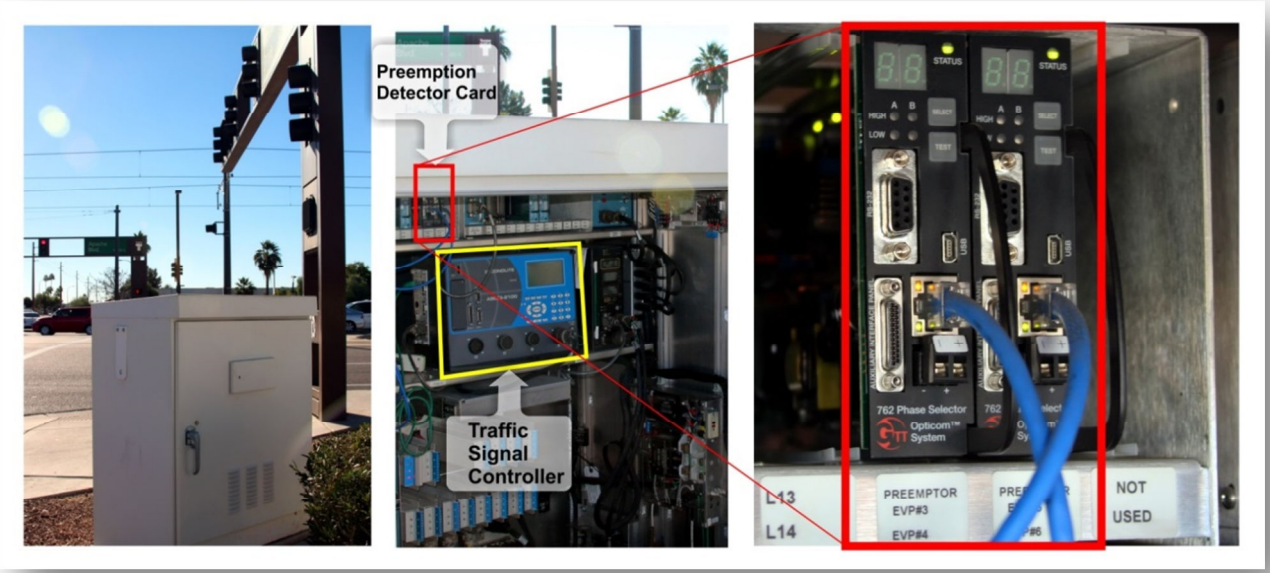

Figure 5. Example of Preemption Detector Cards in a City of Tempe Traffic Signal Cabinet

Figure 5 shows that two two-channel preemption detection cards (4 channels total) are used at the location. Each channel corresponds to an optical detector on the mast arm which allows

[4] The intensity level (range) is set by positioning an emitter (mounted on a truck) from a desired distance to the detector. The traffic signal technician at the traffic signal cabinet than records the intensity value on the corresponding preemption detector card. This process is referred to as setting detection range.

the system to differentiate the direction of the preemption request. First-come, first-serve[5] applies when there are multiple preemption requests coming from the conflicting approaches. If the confirmation light is used (not applicable in Tempe), it is activated by the preemption detector card rather than the traffic signal controller.

Though not part of the EVP equipment, the traffic signal controller takes input from the preemption detector cards and transitions the traffic signal from the current timing plan to a pre-defined preemption signal phase. The purpose of the preemption signal phase is to provide right-of-way to the approaching emergency vehicle and prevent traffic from the conflicting approaches. However, the implementation of the preemption signal phase is inconsistent across the MAG jurisdictions; this might be confusing to an emergency vehicle operating outside of its own jurisdiction.

[5] The preemption detector cards do not communicate with one-another. The arbitration between conflicting preemption calls is handled by the traffic signal controller which has an input for each direction of requested priority.

2. REGIONAL EVP INVENTORY

Information regarding EVP implementation was obtained from the following agencies using a combination of survey, personal and telephone interviews:

- Apache Junction
- Avondale
- Buckeye
- Chandler
- El Mirage
- Fountain Hills
- Gila River Indian Community
- Gilbert
- Glendale
- Goodyear
- Maricopa
- Mesa
- Paradise Valley
- Peoria
- Phoenix
- Scottsdale
- Surprise
- Tempe
- Tolleson
- Queen Creek
- Maricopa County Department of Transportation (MCDOT)
- Pinal County
- Arizona Department of Transportation (ADOT)
- Valley Metro

Unlike the cities, ADOT's EVP deployment has been limited to freeway interchanges that are managed by local jurisdictions through an Inter-Governmental Agreement (IGA). The EVP configuration is therefore determined by the managing jurisdiction. Valley Metro is included in this study as they are using the low priority request feature of the EVP system to provide Traffic Signal Priority[6] (TSP) to the LINX Bus Rapid Transit (BRT) services in Mesa, Chandler and Gilbert.

[6] The buses use an emitter configured in a low-priority mode that may be over-ridden by emergency vehicles. The bus only activates a request for service if it is on-time or behind schedule (i.e., schedule adherence). The intersection either provides an early or extended green indication to facilitate the passing of the approaching bus. Unlike preemption, TSP does not cause the traffic signal to transition to get back into coordination with adjacent signals.

The key information solicited in the regional survey included:

- Number of EVP equipped intersections (out of total signalized intersections)
- Brand of EVP system deployed
- Signal phase provided during preemption
- Confirmation light configuration
- Use of encoding
- Other jurisdictions coordinated for encoding
- Detection range settings (typical)
- Maintenance practices
- Funding (hardware, maintenance)
- Users (fire, ambulance, police)
- Management of EVP systems using the Central Software
- Review of usage data
- Shared use with transit Traffic Signal Priority (TSP) applications

Although this study does not advocate a specific vendor's product, the brands of EVP systems deployed by the individual jurisdictions are of interest from the perspective of system compatibility in support of mutual aid agreements. The two EVP products deployed in the MAG region are made by Global Traffic Technologies (GTT) and TOMAR Electronics. GTT (formerly 3M as of 2009) marketed its optical-based EVP system as Opticom©. TOMAR Electronics branded its optical-based EVP product as Strobecom©. Although the two products work in a similar way, the proprietary encoding scheme employed by each product is a source of incompatibility should the jurisdiction choose to encode EVP system.

Table 1 provides a summary of key EVP implementation characteristics in the MAG jurisdictions.

Table 1. Summary of EVP Implementation in the MAG Region

Jurisdictions (Traffic Signal Contracted to)	# of EVP Intersections (Total Signalized)	Brand (GTT, TOMAR)	Encoding (Y/N)	Signal Phase Provided (B, B+A)[7]	Confirmation Light (2, 4-way)[8]	Detection Range (Feet)	Maintenance Period	Users (Fire, Ambulance, Police)	Review Usage Data[9]	Transit Low Priority (Y/N)
Apache Junction	26 (32)	G	Y	B+A	2-way	2500	3 mo	F[10], A	Reactive	N
Avondale	40 (47)	T	N	B+A	4-way[11]	1000	3 mo	F, A	Reactive	N
Buckeye	11 (16)	G	N	B+A	N/A	2600	Annual	F, A, P	Reactive	N
Chandler	201 (201)	G	Y	B	N/A	2600	Annual	F, A	Reactive, TransSuite	N
El Mirage	7 (12)	G, T	N	B	2-way	200	Annual	F, A	Reactive	N
Fountain Hills	13 (13)	G	Y	B+A	N/A	Max	6 mo	F, A	Reactive	N
Gila River Indian Community (MCDOT)	5 (7)	G, T	N	B+A	N/A	250	6 mo	F	Reactive	N
Gilbert	175 (180)	T	N	B+A	N/A	1000	2 mo	F, A, P	Centracs	Y
Glendale	13 (192)	T	N	B+A[12]	N/A	200-2500	Annual	F	CMS[13], KITS	N
Goodyear	46 (46)	G	Y	B+A	N/A	790-1180	Annual, 2 mo	F, A, P	Reactive	N
Maricopa[14]	4 (15)	?	?	?	N/A	N/A	N/A	N/A	N/A	N
Mesa	349 (425)	G	Y	B, B+A[15]	N/A	1800	Annual	F, P[16]	CMS, Centracs	Y
Paradise Valley (City of Phoenix)	12 (12)	T	N	B	4-way	1500	Annual	F, P	N	N
Peoria	111 (114)	G	N	B	N/A	1500	3 mo	F	CMS[17], Intelight MaxView	N
Phoenix	243 (1100)	T	N	B	4-way	2500	Annual	F	Reactive	N

[7] B indicates a green ball for both opposing through movements for permissive and protected left-turn locations; B+A represents a green ball and green arrow for protected left-turn locations.
[8] Type of confirmation light: 4-way directional flood light, 2-way strobe light, N/A – not deployed.
[9] Indicates how EVP usage data is reviewed: Reactive – field data download in response to trouble calls, CMS – GTT Central Management Software, TransSuite, Centracs, KITS, Intelite Maxview are the central traffic signal management software capable of logging preemption events.
[10] Only some fire engines are equipped with an emitter.
[11] Confirmation lights are not deployed at all EVP equipped intersections.
[12] Raised median island – green ball and arrow; No island – green ball for both through movements.
[13] Glendale has the software but it is not actively used.
[14] Maricopa has installed hardware at four intersections but it is not configured for operations. No emitter was purchased.
[15] Half of Mesa's EVP intersections have green ball plus green arrow for the preempted direction at protected left turn locations, and the other half have been converted to green ball for both through movements at the protected left-turn locations.
[16] Mesa is conducting an experiment involving 12 police cruisers.
[17] Peoria initially used Central Management Software. After traffic signal management software upgrade, started relying on the logs of the Intelight MaxView ATMS system.

Jurisdictions (Traffic Signal Contracted to)	# of EVP Intersections (Total Signalized)	Brand (GTT, TOMAR)	Encoding (Y/N)	Signal Phase Provided (B, B+A)[7]	Confirmation Light (2, 4-way)[8]	Detection Range (Feet)	Maintenance Period	Users (Fire, Ambulance, Police)	Review Usage Data[9]	Transit Low Priority (Y/N)
Scottsdale	300 (300)	G	N	B	N/A	1500	Annual	F, A	TransSuite	N
Surprise	50 (50)	T	N	B+A	2-way[18]	500-1000	Reactive	F, A, P[19]	Reactive	N
Tempe	230 (230)	G	Y	B	N/A	1000	Biannual	F, A	CMS, TransSuite	N
Tolleson (Avondale)	4 (10)	T	N	B+A	4-way	500	3 mo	F, A	Reactive	N
Queen Creek	28 (32)	T	N	B	N/A	2500	Routine	F	Reactive	N
ADOT	-	-	-	-	-	-	-	-	-	
MCDOT	40 (170)	T	N	B+A	Vary	150	Annual	F	Reactive	N
Pinal County[20]	12 (26)	G	N	B	4-way	N/A	N/A	N/A	N/A	N
Valley Metro	40	G	Y	-	-	800	-	-	-	Y

Level of EVP Implementation

Among the 21 jurisdictions that responded to the survey, 1,920 out of 3,230 (59.4%) signalized intersections are equipped with EVP. Figure 6 shows the percentage of signalized intersections equipped with EVP, by jurisdiction.

[18] Surprise only installed the confirmation light at some of the intersections. The confirmation lights are not configured to work as of the time of survey.
[19] Surprise plans to include police as EVP users in 12 months.
[20] Pinal County has installed but not configured its hardware. No emitter was purchased.

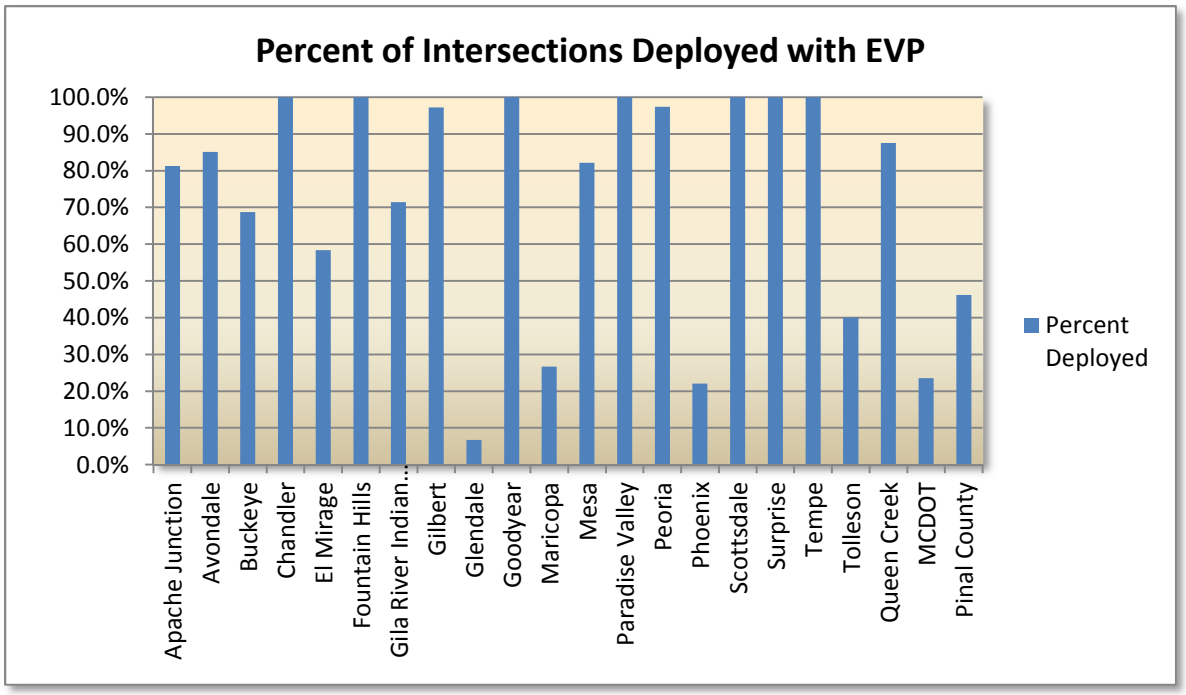

Figure 6. Percentage of Signalized Intersections Equipped with EVP

Encoding by Type of EVP System

Eleven agencies with a total of 1,299 (67.8%) intersections deployed the GTT system. Nine agencies with a total of 605 (31.6%) intersections are equipped with the TOMAR system. Two jurisdictions with a total of 13 (0.6%) intersections deployed both GTT and TOMAR systems. None of the TOMAR (11) systems deployed in the region are encoded. Figure 7 shows the percentage of intersections by system type and encoding. The un-encoded system is denoted as open.

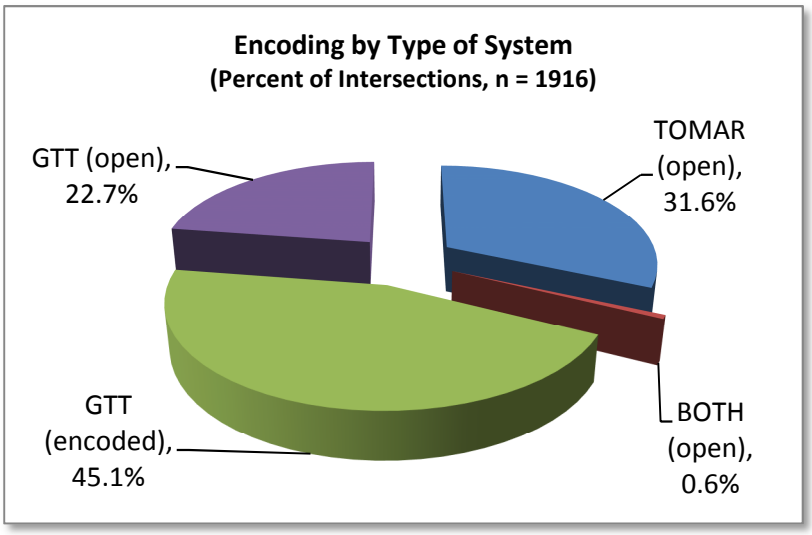

Figure 7. Encoding by Type of System

Among the encoded jurisdictions, Mesa, Chandler, Tempe, Apache Junction and Fountain Hills employed the coding scheme developed by the East Valley EVP consortium and thus support interoperability. These jurisdictions not only can activate preemption in each other's jurisdiction, the uniquely assigned vehicle emitter ID can be captured for system monitoring and usage data analysis. Goodyear (GTT) is the only jurisdiction in the West Valley that encodes its EVP system. The encoded system would lock out all TOMAR and un-encoded GTT emitters employed by neighboring cities. Although part of the East Valley EVP consortium, Scottsdale (GTT) and Gilbert (TOMAR) both chose not to encode their systems. Being an open system, both cities' EVP can be activated by TOMAR emitters (e.g., Phoenix, Gilbert) and encoded GTT emitters (e.g., Tempe, Mesa, Chandler) from the neighboring jurisdictions.

Preemption Signal Phase

In terms of preemption signal phase, nine (42.8%) jurisdictions employed only green indication for both through movements of the preempted approach at both permissive and protected left turn locations. Eleven (52.3%) jurisdictions employed green indication and green arrow for the preempted approach at the protected left turn locations, and green indication for both through movements at the permissive left turn locations. City of Maricopa has deployed the EVP hardware but has not configured it for operation.

Mesa originally deployed green ball and arrow at all protected left turn intersections. Efforts were made to convert those intersections into green indication for both through movements, in

compliance with the East Valley EVP consortium. The conversion effort was halted per request from the Mesa Fire Department because. This leaves half of the intersections with green indication only, and the other half with green indication and arrow. A resolution is being pursued with the Mesa Fire Department. Figure 8 shows the different preemption signal phase deployed by the MAG jurisdictions.

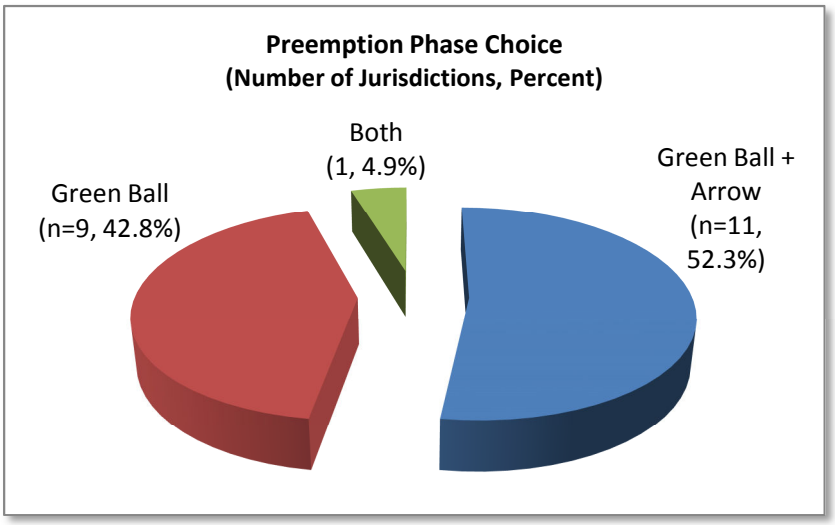

Figure 8. Preemption Phase Deployed

Confirmation Light

The majority (59%) of responding jurisdictions did not deploy a confirmation light. This includes municipalities with a high level of EVP implementation, including Chandler, Gilbert, Mesa, Peoria, Scottsdale and Tempe. Five jurisdictions (22.7%) deployed 4-way confirmation lights, including Avondale, Paradise Valley (contracted to Phoenix), Phoenix, Tolleson and Pinal County. It is worth noting that Phoenix is the only large jurisdiction that deployed a confirmation light. Three jurisdictions (13.6%) deployed 2-way strobe type confirmation lights, including Apache Junction, El Mirage and Surprise. Encompassing the entire Maricopa County, MCDOT implemented both types of confirmation lights based on the requirements of different fire districts. Figure 9 (next page) shows the distribution of confirmation light deployment in the MAG region.

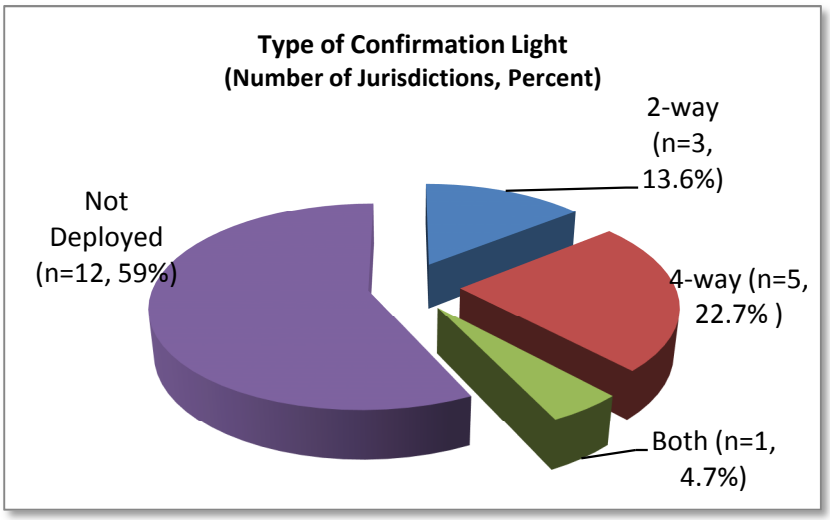

Figure 9. Type of Confirmation Light

Users of the EVP System

Fire departments are the most common users of the EVP systems. In most jurisdictions, ambulance service is also granted access to the EVP system. Police was initially excluded from using the EVP system citing the higher travel speed of the police cruiser than the fire engine (thus requiring a shorter response time to transition the traffic signal into preemption mode), and potentially more preemption calls due to higher police presence. Nonetheless, more jurisdictions are including police as EVP system users. Figure 10 shows the distribution of type of EVP system users in the MAG region.

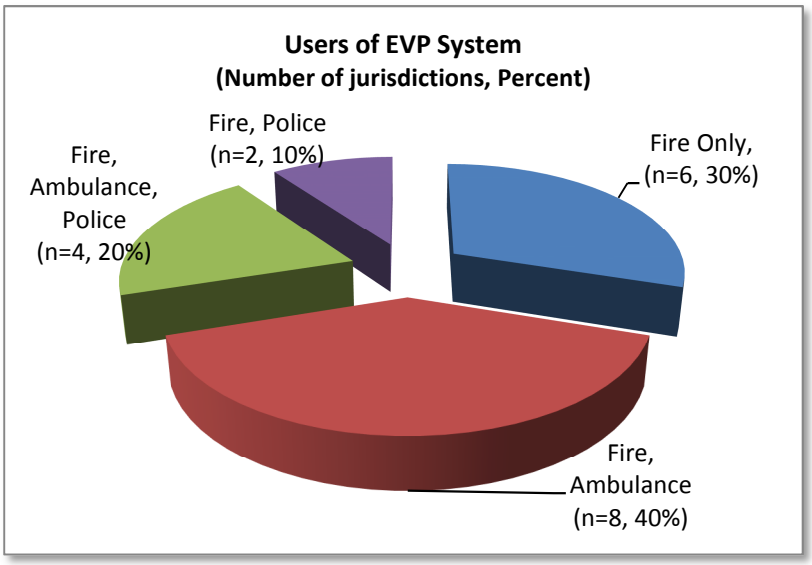

Figure 10. Users of EVP System

The City of Maricopa and Pinal County have only procured their roadside equipment and have not identified system users. Surprise plans to include police in 12 months. Mesa is conducting a test involving 12 police cruisers. The objective of the test is to understand the police usage patterns in support of future decisions. Tempe only provided EVP access to city- owned ambulances, in addition to the Fire Department.

Maintenance

All jurisdictions provide reactive repair in response to trouble calls. The scope of the reactive repair typically includes diagnosing any hardware and wiring issues. Most jurisdictions included EVP as part of the annual or biannual traffic signal preventive maintenance. The preventive maintenance includes cleaning of the detector lens, and testing preemption activation using the test button on the preemption detector card. Many jurisdictions include EVP inspection and testing as part of their regular traffic signal cabinet maintenance as frequently as every 2 to 6 months. Several jurisdictions also test the preemption system by driving with an emitter.

Review Usage Data

The preemption detector card keeps a log of preemption events which can be downloaded in the field using a laptop. The log provides useful information on time and day of the preemption event and, if properly encoded, the emitter ID that can be traced to an authorized vehicle or

used to identify unauthorized preemption requests. Most jurisdictions reported that usage data is only downloaded in the field as needed in response to trouble calls.

Both GTT and TOMAR offer management software[21] that allows remote download of the usage data, if communication is provided to the traffic signal cabinet. Mesa, Tempe and Peoria are active users of the GTT Central Management Software (CMS). The CMS can be used to update firmware, adjust preemption settings, download usage data (including emitter ID), and generate usage reports. Since upgrading their central traffic signal management system, Peoria has increasingly relied on the signal controller log in the traffic signal management software to analyze preemption events.

The central traffic signal management system captures detailed start and stop times of a preemption event, as well as the transition time for a traffic signal to get back in sync with the adjacent intersection. Chandler, Glendale, Mesa, Peoria, Scottsdale and Tempe routinely utilize the central traffic signal management software for trouble shooting as well as assessing traffic impacts associated with the preemption events.

Transit Low Priority Application

Valley Metro began using the optical EVP system to provide low priority Traffic Signal Priority (TSP) to the LINX Bus Rapid Transit (BRT) services in the East Valley in 2013. The TSP is provided for two BRT routes: the Main Street route serves between the Sycamore light rail station in Mesa to the Park-and-Ride lot at the northwest corner of the US-60 and Power Road. The Country Club Road/Arizona Ave route serves between the Sycamore light rail station and Germann Road in Gilbert that spans across Mesa, Chandler and Gilbert.

At 40 of the EVP equipped intersections in Mesa and two intersections in Gilbert, the same equipment is configured to recognize BRT (Bus Rapid Transit) vehicles. The buses use a low-priority emitter that can be over-ridden by the high priority emergency vehicles. The bus only activates a request for service if it is on-time or behind schedule. The intersection either advances or extends the green indication to facilitate the passing of the bus. Unlike preemption, the TSP does not require the traffic signal to transition to get back in sync with the adjacent signals. Using the encoded GTT system and the Central Management Software, Mesa is actively monitoring the usage of the TSP and provides feedback to Valley Metro regarding the performance of the TSP.

[21] Central Management Software (CMS) from GTT, OSPtrack from TOMAR.

3. Regional Challenges and Limitations

It was evident from the regional survey that the lack of standards and coordination in EVP implementation has resulted in inconsistent operation across the MAG region. As emergency vehicles increasingly operate outside of their jurisdictional boundaries in support of the mutual aid agreements, these inconsistent operating environments pose a threat to the safety of the emergency responders and the general public alike. This section provides a discussion of the challenges and limitations associated with EVP operations across the MAG region.

3.1 Incompatibility Between Systems

The first and foremost challenge of the EVP operation in the region is the compatibility between the encoded and un-encoded EVP systems. When an EVP system is encoded, it will only accept preemption requests from an encoded emitter with a valid ID code.

In response to several highly publicized incidents of abuse in early 1990, 3M developed an improved version of Opticom that can be encoded to prevent un-encoded road emitters from activating preemption. Starting in 1994, the City of Mesa was the first jurisdiction in the MAG region to encode their Opticom EVP system. In 2010, a consortium involving several East Valley jurisdictions was formed to coordinate EVP operations, including:

- Coordinate EVP system encoding practices to ensure interoperability.
- Develop and maintain a code assignment scheme (based on the Opticom system) that can be used by all agencies in the region, including fire department, police, ambulance, transit, and other users. Each participating agency is assigned a unique block of ID codes.
- Coordinate the traffic signal phase provided during the preemption.

As of today, the East Valley EVP consortium has expanded to include Cities and Towns of Apache Junction, Chandler, Gilbert, Guadalupe, Mesa, Queen Creek, Scottsdale, Sun Lakes and Tempe. The code assignment developed by the consortium also includes placeholders for all emergency response agencies in the MAG region. Figure 11 (next page) shows the history of EVP implementation in the MAG region.

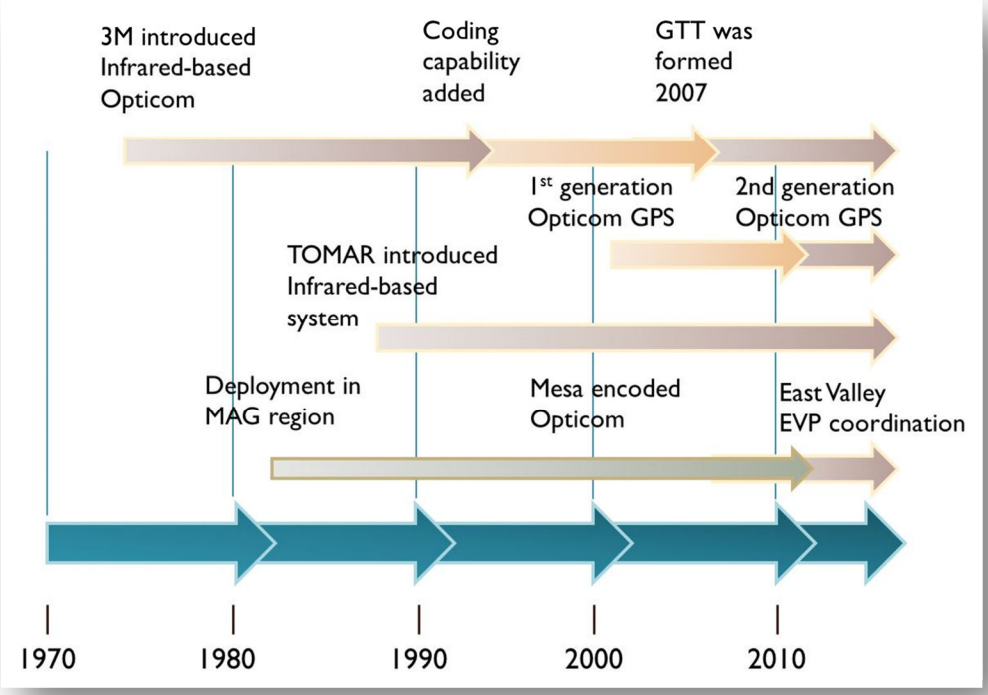

Figure 11. History of EVP Implementation in the MAG Region

As jurisdictions started encoding their EVP systems to improve security, it introduced incompatibility between the encoded and un-encoded systems. In general, an encoded vehicle emitter will be able to request preemption from an un-coded (open) roadside system. On the other hand, an un-encoded emitter will be locked out of the encoded system.

Currently, six jurisdictions that encode their EVP systems account for a total of 865 intersections (45%). The un-encoded EVP systems (16 jurisdictions) account for a total of 1,055 intersections (55%) in the region. Table 2 (next page) illustrates the compatibility between the EVP systems based on their encoding status. The Y designation indicates that an equipped emergency vehicle from a jurisdiction in the left column is able to preempt the traffic signal in a jurisdiction in the top row. The N designation indicates incompatibility between two systems. The brand of the EVP system and the encoding status are provided for reference, where G stands for GTT, T stands for TOMAR, and the encoding status is provided in parenthesis.

Table 2. Compatibility Between EVP Systems

	EVP Brand (Encoding Y/N)	Apache Junction	Avondale	Buckeye	Chandler	El Mirage	Fountain Hills	Gila River Indian C.	Gilbert	Glendale	Goodyear	Maricopa	Mesa	Paradise Valley	Peoria	Phoenix	Scottsdale	Surprise	Tempe	Tolleson	Queen Creek	MCDOT	Pinal County
		G (Y)	T (N)	G (N)	G (Y)	G, T (N)	G (Y)	G, T (N)	T (N)	T (N)	G (Y)	?	G (Y)	T (N)	G (N)	T (N)	G (N)	T (N)	G (Y)	T (N)	T (N)	T (N)	G (N)
		Operating in the above jurisdictions																					
Apache Junction	G (Y)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Avondale	T (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	N	Y	N	Y	Y	Y	Y
Buckeye	G (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Chandler	G (Y)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
El Mirage	G, T (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Fountain Hills	G (Y)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Gila River I C.	G, T (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Gilbert	T (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	N	Y	N	Y	Y	Y	Y
Glendale	T (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	N	Y	N	Y	Y	Y	Y
Goodyear	G (Y)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Maricopa	?	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	-	-	-	-	-	-	-
Mesa	G (Y)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Paradise Valley	T (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	N	Y	N	Y	Y	Y	Y
Peoria	G (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Phoenix	T (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	N	Y	N	Y	Y	Y	Y
Scottsdale	G (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Surprise	T (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	N	Y	N	Y	Y	Y	Y
Tempe	G (Y)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Tolleson	T (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	N	Y	N	Y	Y	Y	Y
Queen Creek	T (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	N	Y	N	Y	Y	Y	Y
MCDOT	T (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	N	Y	N	Y	Y	Y	Y
Pinal County	G (N)	N	Y	Y	N	Y	N	Y	Y	Y	N	-	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y

Emergency Vehicles from the jurisdictions on the left

Since reverting to un-encoded systems is not an option, the ultimate resolution to the compatibility issue is to encode all EVP systems in a compatible way. That is, all EVP systems will need to be able to transmit codes that are recognized by both competitive products in order to request preemption and track vehicle emitter ID. There are several hurdles that need to be overcome:

- Without sacrificing the commercial interest, the hardware manufactures need to agree upon a least common denominator to accept preemption requests from an encoded competitive emitter.

- The jurisdictions need to recognize the need to encode EVP systems. The expected benefits of an encoded system include:
    - Improved security (by locking out unauthorized road emitters).
    - Ability to monitor the users with unique IDs and identify unauthorized requests.
    - Improved troubleshooting capability by associating a vehicle unit with a particular preemption event.
    - Provide a means for managing current and future growth of the system users.
- There will be costs associated with encoding all the EVP systems, provided that manufactures come up with a solution to address the system compatibility. Based on the East Valley consortium experience, the following costs may be incurred:
    - Upgrade old EVP components. Especially for early adopters, there are likely multiple generations of products deployed in the field. To employ modern features such as encoding, a systematic review needs to take place to determine the needed upgrades.
    - Staffing in support of performance monitoring, maintenance coordination, upgrade and new implementation planning, and proactive management of the EVP system users.

As the product development and EVP technology continuously evolve, there lie opportunities to address the system compatibility issue which is not unique to the MAG region. The user community needs to develop a consensus on the needs for a more secure and manageable EVP system. These market demands will help steer manufactures decisions in producing compatible products in support of public safety interest.

3.2 Inconsistent Preemption Treatments

Inconsistent preemption treatments are evident throughout the MAG region in two aspects: (1) traffic signal phase provided during preemption and (2) the use of the confirmation light(s). These inconsistent treatments add uncertainties to the decision making of the emergency vehicle operators who may provide mutual aid in unfamiliar jurisdictions.

<u>Preemption Traffic Signal Phase</u>

As shown in Figure 12 (next page), there are at least two variants of the preemption traffic signal phase used in the MAG region. Scenario A (9 jurisdictions) provides green indication for both through movements at both protected left turn and permissive left turn locations. Scenario B (11 jurisdictions) provides green indication for both through and left turn

movements of the preempted direction at the protected left turn intersections. At the permissive left turn locations, green indication is provided for both through movements coinciding with the preemption direction.

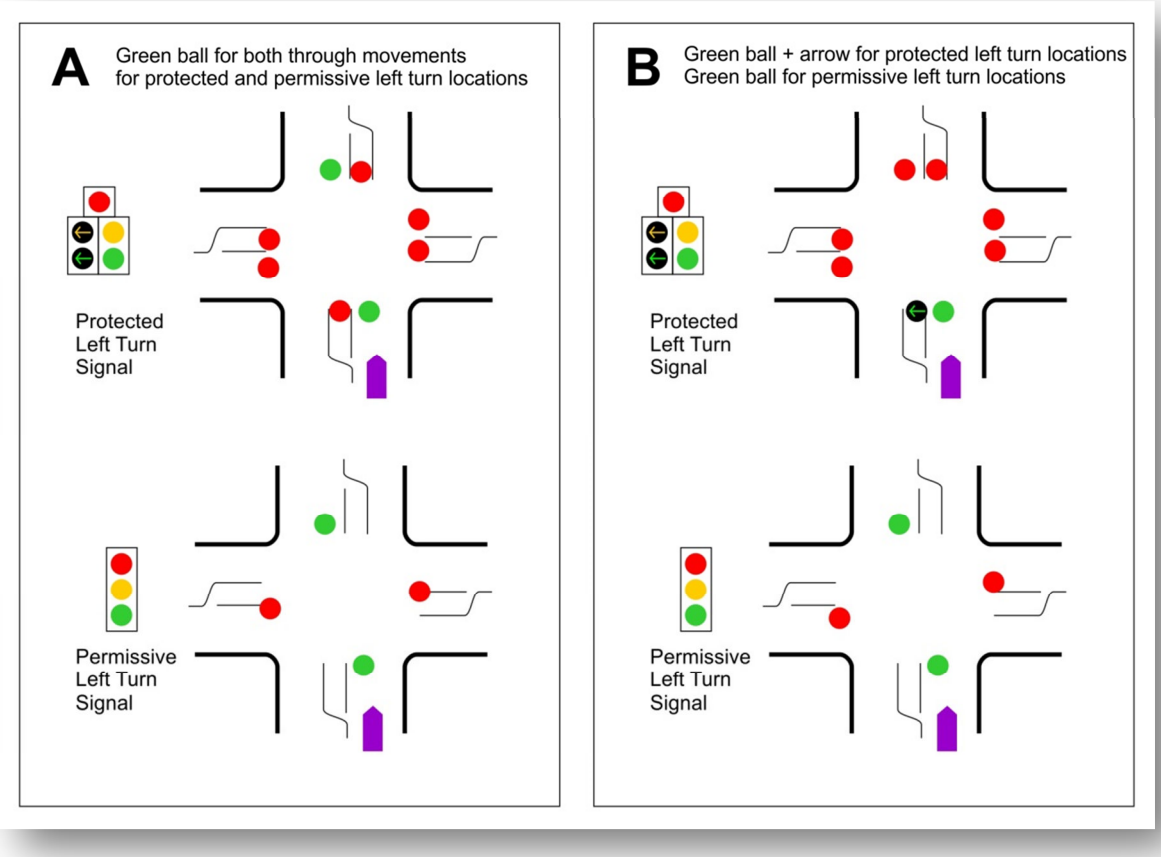

Figure 12. Alternative Preemption Signal Phases in MAG Region

Traffic engineers hold different opinions regarding the advantages and disadvantages of the two alternatives. The most stated safety concern of scenario B is based upon the fact that fire engines are allowed to cross into the opposing traffic lanes. As illustrated in Figure 13, the behavior of the fire engine increases the likelihood of colliding with the unsuspecting left turning vehicles during the preemption.

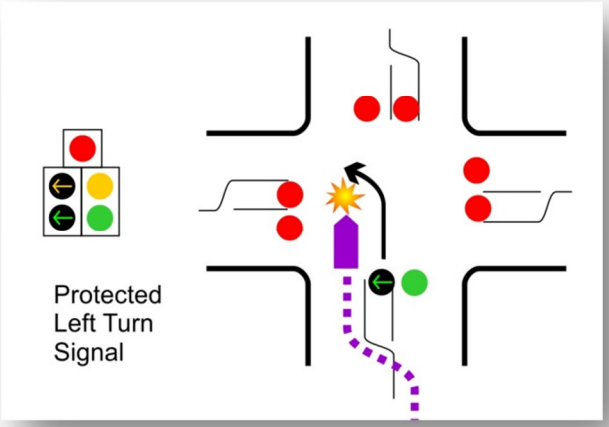

Figure 13. Plausible Collision Scenario Associated with Protected Left Turn Indication

There are, however, no accident statistics to support the claim. The primary advantage of scenario B (protected left turn) is the effective elimination of conflicting traffic from all non-preempted approaches and positive indication of the preemption direction.

The common denominator between the two scenarios is the green indication for both through movements. This configuration makes up the largest share of signalized intersections in the MAG region. The major disadvantage of providing green through indication is the inability to differentiate the direction of the emergency vehicle because both opposing approaches display the same green indication. The ability to indicate the preemption direction provides a positive feedback to the emergency vehicle operator and the general public. This shortcoming, however, can be remedied by deploying the proper type of confirmation light.

Confirmation Light

Despite their apparent safety benefits, the confirmation light is not deployed by most of the larger jurisdictions, with the exception of the City of Phoenix. The confirmation light has found greater acceptance within smaller and newer jurisdictions.

However, the two variants of confirmation light deployed in the region are not functionally equivalent. The 4-way flood light[22] provides the following functions:

- There are four lights each aiming at an approach. During preemption, only one light is turned on (steady) to indicate the direction of the emergency vehicle's approach.
- In the case of multiple preemption requests, a flashing light indicates that the right-of-way is denied due to a competing preemption request from another approach.

The 2-way, 2-color strobe light provides the following functions:

- The blue strobe light indicates the preemption coming from the east-west directions.
- The white strobe light indicates the north-south direction.

The advantages of the 4-way flood light are (1) the positive confirmation of preemption direction and (2) the ability to handle the concurrent preemption requests. The benefit of the 2-way strobe light is that the strobe can be seen from all approaches and thus benefit not only the emergency vehicle but also the general public. The shortcoming of the 2-way strobe light is its inability to indicate the actual approach of an emergency vehicle. The opponents of confirmation lights concern the legibility of the light during daytime and under challenging lighting conditions.

[22] Referring to the incandescent flood light as the technology was initially deployed. While the casing remains similar in shape, high performance LED is now commonly used as the light source.

It is no easy task to settle the preference of different preemption treatments. For example, despite years of coordination and cooperation, the East Valley EVP consortium is not in unanimous agreement regarding the preemption traffic signal phase. While the majority of the members agree upon the green indication for both through movements, the City of Gilbert has decided to retain the through and left indications for the protected left turn locations. The City of Mesa, which originally deployed the through and left indications for protected left turns, has started converting to the green indication for both through movements. Half way through the conversion, the effort was halted by a request from the Mesa Fire Department. Now the City is awaiting a decision from the Fire Department to resolve the inconsistent operations in the field.

These lessons confirm the importance of having a regional coordination mechanism that is fully endorsed by the policy and decision makers of all relevant agencies when it comes to improving the regional consistency in EVP operations.

3.3 Management of EVP System

Usage Data

From a traffic management standpoint, EVP preemption has a significant negative impact on traffic. Each time an intersection is preempted, it interrupts the normal cycling of the traffic signal. After the preemption, it takes minutes for a traffic signal to get back in sync with the rest of the network. Based on an analysis conducted by the City of Mesa[23] using the traffic signal controller logs, each preemption event lasted an average of 34-35 seconds but the traffic signal could take between 1 minute 45 seconds and 2 minutes 28 seconds to get back in coordination.

As the utilization of the EVP system continues to increase, additional usage of the system should be carefully justified based on needs and potential impacts on the traffic network. It was evident in the regional survey that most jurisdictions did not fully utilize the system functions to support the traffic management objectives.

One such function is to conduct regular review of the usage data. The preemption detector card stores the detailed data of preemption events in the data buffer. These data are stored for weeks before being overwritten in the buffer. The usage data can be downloaded in the field or using a direct laptop connection. If communication is available, central management software offered by the EVP manufacture can be used to remotely download the data. An ancillary benefit of the central management software is to sync the clock in the preemption

[23] Priority Treatment at Traffic Signal, A. Dock, August 27, 2013

detector cards, which otherwise would not maintain accurate time stamps. For an encoded system, the usage data would contain individual emitter IDs for monitoring authorized and unauthorized requests.

Another source of the usage data is the traffic signal controller logs maintained by the central traffic signal management system. The advantage of traffic signal controller data is that it provides signal transition time after the preemption which is not available from the preemption detector card. The limitation of the signal controller log is that it does not contain the vehicle emitter ID associated with the preemption event and thus cannot be used for managing the users.

Staffing

The level of staffing involved with the EVP operation varies significantly across the region. For those cities relying on other jurisdictions to maintain traffic signals, the EVP operation is limited to reactive repair. In some cities, the EVP operation is delegated to the traffic signal technicians and maintained like other stand-alone traffic signal equipment. Usage data is examined for the sole purpose of troubleshooting.

For more engaged cities, the EVP operation is better coordinated between the traffic operation staff, traffic signal technicians and the Fire Department. The traffic operation staff would typically serve as the point of contact with the Fire Department regarding operational issues. For trouble calls, they can examine the usage data and perform preliminary diagnosis to determine the root cause, before delegating the repair to the traffic signal technicians. In at least one city, the traffic operation staff also works closely with the vehicle maintenance of the Fire Department to maintain the list of active users (vehicle emitter ID). This keeps the traffic department aware of any updates and changes to the users of the EVP system.

As a region, the experience of EVP operation needs to be shared between the jurisdictions. This would reduce the learning curve and improve the regional coordination in EVP operation.

3.4 Maintenance of EVP in Large Jurisdictions

The maintenance of the EVP roadside system is carried out as part of the traffic signal maintenance. The activity typically involves inspecting wiring, testing the preemption detector cards, cleaning the optical detector, and driving the intersection with an emitter. For jurisdictions with relatively few signalized intersections, the maintenance is typically carried out every 2 to 6 months, according to the survey. For a large jurisdiction, conducting effective

maintenance on the EVP becomes very challenging due to the sheer number of the intersections.

While it is relative easy to aim an emitter at a detector to verify if the preemption is “working”, a thorough testing on the EVP would require a two-person team with more work than a typical cabinet maintenance entails. One technician needs to be at the traffic signal cabinet where the preemption detector cards are housed. The other would need to position a test emitter (in a vehicle) at the intended detection distance so that the person at the traffic signal cabinet can verify the range (signal intensity level). Compared to traffic signal cabinet maintenance, this process is extremely labor intensive and stretches the maintenance resources. Other needed maintenance such as cleaning the optical detector lens on the mast arm is also laborious and traffic impeding. Nonetheless, these requirements are uniquely associated with the optical-based detection system.