Regional Traffic Signal Pre-emption/Priority Standard Evaluation

Final Report and Recommendations

REVISED MAY 2006

Chittenden County Metropolitan Planning Organization

Communities working together to meet Chittenden County's transportation needs

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1. OVERVIEW

1.1. Introduction

Traffic signal pre-emption technology has been used in Chittenden County, Vermont for a number of years. The principal application of this technology is to expedite the movement of fire, emergency medical services, and police vehicles through signalized intersections along congested corridors, reducing emergency response times. By providing a green signal to approaching emergency vehicles, the technology also reduces the need for emergency vehicles to traverse intersections against red signals, lessening the chance of collisions with opposing traffic.

The Chittenden County Metropolitan Planning Organization (CCMPO) has hosted two workshops on the topic of regional signal pre-emption/priority coordination in recent years. The first workshop was held on September 23, 2004 during the development of the *Regional ITS Architecture and Strategic Plan for Chittenden County.* A second workshop was held on January 10, 2006, with the objective of developing a regional consensus approach to the future use of traffic signal pre-emption/priority technology in the County.

This document provides an overview of this process, including a summary of background issues and the outcomes of the January 10, 2006 workshop. It includes a detailed action plan for implementation of the consensus approach envisioned by stakeholders for Chittenden County.

1.2. Document Organization

The document is organized into four sections:

Section 1 – Overview;

Section 2 – Background;

Section 3 – Workshop Summary;

Section 4 – Recommendations for Action.

In addition the document contains two appendices:

Appendix A is a primer on traffic signal pre-emption/priority technology;

Appendix B provides draft language for a CCMPO Board of Directors policy statement reflecting the consensus decision of the working group.

1.3. Motivations for Revisiting Existing Pre-emption Practices

The use of traffic signal pre-emption technology in Chittenden County is widely regarded as a successful application of Intelligent Transportation Systems (ITS) to meet a specific need of the community. However, the County is at a crossroads in deciding how traffic signal pre-emption/priority technologies are best utilized to meet regional needs, based upon a number of emerging conditions:

- **Concern about possible misuse of "unencoded" signal pre-emption infrastructure.** Existing systems in the county utilize an open industry standard that can potentially be misused by unauthorized persons who purchase a vehicle emitter from a third-party vendor (such devices are available over the Internet). While the extent of misuse in Chittenden County is currently unknown due to a lack of data, this security concern does represent an ongoing liability of the current, "unencoded" system.

- **Advances in available signal pre-emption/priority features.** Most signal pre-emption/priority devices on the market today provide the ability to "encode" the systems and assign unique attributes to specific emergency vehicle and transit vehicles. This feature allows for improved security, greater customization of the system configuration, better usage monitoring, and simplified troubleshooting. However, it requires the adoption of a common regional standard in the County to take advantage of these advanced features.

- **Pending investment by the Chittenden County Transportation Authority (CCTA) in transit signal priority in the County.** CCTA has received federal earmark funds to implement transit signal priority (TSP) along key service corridors in the urbanized portion of the county. Because this represents a significant investment, and because of the multi-jurisdictional nature of the region's key arterial roadways, CCTA is seeking clarity in the overall regional direction in the use of this technology, which can also be used for transit vehicle detection.

- **Deployment of traffic signal pre-emption technologies elsewhere in Vermont.** The Vermont Agency of Transportation (VTrans) has deployed emergency vehicle pre-emption technology in the Route 7 corridor of Rutland, VT. Additional deployment of traffic signal pre-emption equipment outside of Chittenden County is possible in the future, and could lead to varying technological and institutional approaches in different parts of the VTrans jurisdiction. This consideration, combined with VTrans' significant signal permitting and operations responsibility within Chittenden County, is another reason to develop a coherent, consensus vision for the future use of these technologies.

- **Long-Term Impact of Short-Term Equipment Procurement Decisions.** Finally, it is worth noting that traffic signal pre-emption equipment is being expanded and upgraded across the region on an ongoing basis, usually in conjunction with a larger signalized intersection upgrade or roadway reconstruction project. The lifespan of this equipment is upwards of twenty years, so the individual actions of deploying municipalities or contractors can have longstanding regional repercussions on any

effort to standardize signal pre-emption/priority technology used in Chittenden County.

1.4. Options Available to the County

At the January 10, 2006 workshop, consultants from IBI Group facilitated a discussion on the future of traffic signal pre-emption/priority in Chittenden County, with the objective of developing a consensus among affected stakeholders.

Through initial outreach to stakeholders in the region, a set of three options for the future use of traffic signal pre-emption/priority technology in the county were identified:

OPTION #1: Continue the current approach of using an "unencoded" system;

OPTION #2: Migrate gradually to an "encoded" pre-emption standard as existing equipment reached the end of its useful life; or

OPTION #3: Perform a one-time switch to an "encoded" pre-emption standard.

These options, as well as other key issues raised at the January workshop, are discussed in greater detail later in the remainder of this document.

1.5. Preferred Approach

Based on a discussion of the key issues surrounding this decision, participants at the workshop favored adopting **OPTION #2, gradual migration toward an "encoded" traffic signal pre-emption standard.** This consensus option is the basis for the Recommendations for Action presented in Section 4.

2. BACKGROUND CONCEPTS

2.1. Signal Pre-emption versus Signal Priority

Signal pre-emption and signal priority are related but distinct terms. While they can sometimes be used interchangeably, it is important to be aware of the distinction between the two concepts:

- **Signal Pre-emption** is a method by which the emergency vehicles are given right-of-way at a signalized intersection, usually by providing the emergency vehicle with an exclusive green phase in its direction of travel. This is accomplished using emitters mounted on the vehicle, detectors mounted at the intersections, and discriminators at the intersection.

- **Signal Priority** causes the regular operation of traffic signals to be altered temporarily in response to the presence, or imminent presence, of a transit or maintenance vehicle as determined by some form of vehicle detection. Signal priority requests are a lower priority than emergency vehicle requests. A variety of rules can be implemented to grant *conditional* signal priority—for example, prevailing traffic conditions or whether a particular bus is on schedule.

An introductory primer on traffic signal pre-emption and priority technologies is included in Appendix A.

2.2. Benefits of Signal Pre-emption and Priority

Both signal pre-emption and signal priority effectively reduce the impacts of traffic congestion and intersection delay on those vehicles that are most adversely impacted by those delays: **emergency vehicles, public transit vehicles**, and **maintenance vehicles** (e.g., snowplows).

Congestion delays to ***emergency vehicles***, involved in protecting life and property, jeopardize public safety. A recent study[1] by the Federal Highway Administration documents many of the benefits of Emergency Vehicle Signal Priority, including:

- Reduced incident response time;

- Reduced accidents at signalized intersections involving emergency vehicles; and

- Improved public safety (saved lives, reduced property damage, lower insurance rates) due to quicker incident response.

Delays to ***public transit vehicles***, lower the quality of service by reducing schedule reliability and increasing overall trip times. Transit vehicles also experience higher *person-delay* than

[1] Federal Highway Administration (FHWA).*Traffic Signal Preemption for Emergency Vehicles: A Cross-Cutting Study* (FHWA-JPO-05-010), January 2006.

low-occupancy vehicles. Transit vehicle priority counteracts the impacts of congestion, increasing the relative attractiveness of the transit mode and saving time for passengers.

Finally, delays to ***maintenance vehicles***, principally snowplows, decreases the efficiency of road maintenance operations and raises costs due to labor, fuel, and wear and tear. The principal benefit of signal priority for snowplows is reduced intersection delays, allowing greater productivity per hour of winter road maintenance. (Note that this benefit tends to be lessened, but not necessarily eliminated, during overnight plowing in corridors with actuated signals that operate in a 'hibernate' mode in these hours).

2.3. Current Utilization and Practices in Chittenden County

Signal pre-emption systems are used extensively throughout the more urbanized cities and towns of west-central Chittenden County, to facilitate movement of emergency vehicles with minimal traffic delay. Equipment from two major industry vendors, 3M (manufacturer of *Opticom*™ systems) and Tomar (manufacturer of *Strobecom*™ systems), are utilized in mixed proportions in various municipalities in the region, with the majority of installations using Tomar technology.

The signal pre-emption inventory in the county is in a state of constant evolution, as is evidenced by recent signal upgrades along U.S. Route 7 (Shelburne Road) and pending upgrades along the Route 15 corridor. Technology determination for signal pre-emption (3M or Tomar) is often left to the discretion of the project contractor; if competed on a price basis, Tomar has historically proven to be the lower cost option, and is therefore the technology most often deployed.

Transit signal priority (TSP) is currently not used in Chittenden County, although the Chittenden County Transportation Authority (CCTA) has imminent plans to deploy such systems along major corridors as part of its Intelligent Transportation Systems program. CCTA is working with the Vermont Agency of Transportation and local municipalities on the design and pilot deployment of this technology.

At present signal pre-emption equipment in Chittenden County is operated in an *unencoded* fashion, whereby the emitters and detectors utilize the *de facto* industry standard of a 14MHz for emergency signal pre-emption (and 10 MHz for transit signal priority if it was in use). This "open" standard, used jointly by both 3M and Tomar, provides interoperability between equipment provided by the two vendors. Interoperability is an important consideration because of the tendency of emergency responders to cross municipal boundaries, as during mutual aid responses and hospital trips.

The Fletcher-Allen Health Care Medical Center Campus in Burlington is a major medical and trauma center serving a large portion of northern Vermont beyond the boundaries of Chittenden County. Because of this, a number of EMS responders from rural communities inside and beyond Chittenden County currently take advantage of the unencoded signal pre-emption system.

2.4. "Encoded" versus "Unencoded" Systems

The fundamental choice faced by Chittenden County is between "unencoded" and "encoded" signal pre-emption/priority systems. Both of these approaches are described below.

- **Unencoded Systems:** Unencoded systems provide signal pre-emption to any vehicle emitting an optical signal at the correct frequency. There is a *de facto* standard within the industry that allows interoperability of unencoded equipment from multiple manufacturers. At present, all signals pre-emption systems in Chittenden County operate in an unencoded mode with a mixture of interoperable equipment manufactured by two manufacturers, 3M and Tomar.

  However, because unencoded systems use a relatively simple technology, such systems are subject to unauthorized use. Also, because they cannot identify specific vehicles based on a unique ID, they cannot accommodate more advance signal prioritization and logging functions that may be desirable.

- **Encoded Systems:** An encoded system is capable of logging the vehicle class code (transit vehicle, snowplow, ambulance, etc.) and unique vehicle identification. This provides the ability to implement a wide array of signal priority permissions based upon user type and prevailing traffic conditions. Encoding also prevents unauthorized use of the system by requiring confirmation of a special encrypted code in order to activate pre-empt or priority functions.

  In order to encode, the system equipment *from only one manufacturer must be used throughout the region*, and emitters on the emergency vehicle must also be capable of generating an encoded signal. In the case of Chittenden County, either the 3M or Tomar equipment would have to be replaced by equipment from the other, chosen manufacturer to activate encoding features.

The following table summarizes the principal advantages and disadvantages of each of these two approaches.

Table 2-1: Comparison of Encoded and Unencoded System Attributes

Approach	Benefits	Drawbacks
Unencoded **(OPTION 1)**	• Equipment from multiple manufacturers is interoperable – no need to swap out or upgrade existing hardware • Easy to administer, since codes are not required to activate system	• Susceptible to unauthorized use through illicit or "bootleg" emitters • Does not log individual vehicles, which may be beneficial for emitter fault detection • Does not make full use of system functionality

Approach	Benefits	Drawbacks
Encoded **(OPTION 2 & OPTION 3)**	• Can provide more robust prioritization functions to transit vehicles • Enables tracking of system usage by individual vehicles • Resistant to misuse by unauthorized users	• Lack of a national 'open' standard – region must choose ONE equipment manufacturer's proprietary standard • Requires central administration of vehicle code • Needs of emergency responders en route to County medical facilities must be considered

2.5. Comparison of Available Options

In broad terms, there are three options available to the County. The choice of the preferred alternative requires an understanding of the benefits of encoded and unencoded systems, as well as the technological, institutional, and cost implications for a broad set of stakeholders, including: municipal DPWs, transit operators, emergency responders, winter maintenance personnel, VTrans, and others. Selection from among these alternatives (or a hybrid approach), was the principal objective of the January 10th Workshop.

- **OPTION 1: Stay "Unencoded":** The County maintains its "unencoded" approach to signal pre-emption using multiple manufacturers' equipment (i.e., 3M *Opticom*™ and Tomar *Strobecom*™). The principal benefits of this approach are that all equipment remains interoperable, and there is no immediate investment aside from routine hardware replacement or system expansion. The primary drawbacks are the inability to leverage the advanced capabilities of "encoded" systems, and the susceptibility of the system to unauthorized users. The encoding issue can be revisited in the future in light of changing needs, new technologies, emergence of non-proprietary standards, etc.

- **OPTION 2: Gradual migration toward an "encoded" pre-emption standard:** Upon adopting a preferred standard, the County will gradually move towards an "encoded" system by upgrading non-compliant or obsolete field and onboard equipment as it reaches the end of its useful service life. There is no additional cost to this approach, since all new equipment purchased can operate in an encoded mode. The benefit of this approach is the ability to implement an encoded system after a 5 to 10-year period, maximizing the service life of existing equipment, amortizing implementation costs, and eventually realizing a standardized encoded network. The principal drawbacks of this approach are the inability of unencoded vehicles to use the pre-emption system, as well as the longer lead-time to realize a fully-encoded system.

- **OPTION 3: One-time implementation of an "encoded" pre-emption standard:** Upon adopting a preferred standard, the County will implement an "encoded" system through a one-time replacement of non-compliant or obsolete field and onboard equipment. Stakeholders can immediately realize the benefits of an encoded network; on the other hand, this option has the largest up-front cost to accomplish the switchover, and some onboard and cabinet equipment will need to be replaced before the end of its useful service life.

3. WORKSHOP SUMMARY

3.1. Overview

On January 10, 2006, representatives from a variety of agencies and municipalities met at the CCMPO offices in South Burlington for a half-day signal pre-emption/priority workshop. The purpose of the workshop was to build upon earlier discussions (Fall 2004) during the development of the *Regional ITS Architecture for Chittenden County* and to determine a consensus approach for the region on the topic of signal pre-emption/priority standardization.

Prior to the workshop, a briefing document was presented to invitees, providing an overview of the technology and issues surrounding this topic and presenting the three implementation outcomes (OPTIONS 1, 2, and 3) introduced earlier in this document.

AGENDA

The workshop was facilitated by IBI Group and addressed the following topics in an open dialogue format:

- Welcome and Introductions;
- Primer on Emergency Vehicle Pre-Emption/Priority Technology;
- Description of the Three Alternatives Available to the County;
- Discussion of Regional Needs and Deployment Considerations; and
- Selection of a Preferred Alternative.

WORKSHOP ATTENDEES

The following representatives were in attendance at the January 10, 2006 workshop:

Scott Johnstone	CCMPO
Susan Smichenko	CCMPO
Aaron Frank	CCTA
Bruce Nyquist	Vermont Agency of Transportation
Roger Thompson	Vermont Agency of Transportation
Norm Baldwin	City of Burlington
Dave Garen	City of Burlington
Floyd Sheesley	Town of Colchester

Bruce Hoar	City of South Burlington
Neil Boyden	Town of Williston
John Collura	University of Massachusetts
Alex Mermelstein	University of Massachusetts
Randy Knapick	IBI Group
Mike Corby	IBI Group

3.2. Discussion Issues

For purposes of workshop discussion, strategies 2 and 3 from above were combined, emphasizing the fundamental distinction between *unencoded* and *encoded* systems. (The only difference between strategy 2 and 3 is the timing of the roll-out of an encoded system; whereas in strategy 3 the code capable system is implemented immediately, strategy 2 involves implementation over some period of time.)

Table 2-1 is a summary of the issues raised in the open discussion portion of the workshop as well as pre-workshop fact-finding telephone interviews with CCMPO, VTrans, and CCTA personnel.

Table 2-1 – Summary of Regional Discussion Issues

TOPIC	DISCUSSION ISSUES
Traffic Management and Operations	• Municipal traffic personnel have concerns over maintenance of the codes due to additional system complexity, which might favor an unencoded approach. • A uniform system would simplify system maintenance, and allow entities within Chittenden County to share resources or outsource maintenance. Also the level of vendor technical support may increase due to the volume of common devices in the County.

TOPIC	DISCUSSION ISSUES
Emergency Vehicle Pre-emption	• Various emergency medical services including approximately 30 emergency trips per day to Fletcher Allen Health Care Medical Campus, from both inside and outside Chittenden County • For fire departments, reporting capabilities of an encoded system are perceived as beneficial. • Driver training on how to use the system should be provided. • Currently there may exist a wiring issue with respect to turning off the emitter when the fire vehicle is parked and responding to an emergency (e.g. light bar remains on).
Transit Signal Priority	• In the short-term CCTA is implementing a TSP demonstration project. The objective to increase ridership through reduced travel time and travel time reliability. • Transit is just starting the functional requirements definition for TSP, and identifying potential deployment sites. At this time, options 1, 2 and 3 could work for transit depending on their functional requirements. • CCTA's core routes serve 7 communities, and a regional standards decision is important to their pending investment in technology. • CCTA would prefer to leverage off of existing equipment to simplify cabinet wiring, system maintenance, capital costs, etc.
Road and Winter Maintenance	• There may be value to leveraging off of the pre-emption/priority technology. There may be a partnering opportunity, but a coded system is required for vehicle logging, etc.
Security Considerations	• Traffic indicated that they have not identified unauthorized system use.
System Maintenance	• The fire departments contact traffic personnel when they have an operational concern (approximately once per year). Traffic maintenance personnel investigate and repair the system as necessary. No formal maintenance agreement exists between traffic and fire.
Cost Allocation and Sharing	• There is a potential for cost sharing between traffic and transit through implementation of a combined EVP/TSP system. • Switchover funding may be necessary to encourage some municipalities to adopt a standards-based system.

3.3. Preferred Regional Approach

Based on a discussion of the key issues surrounding this decision, participants at the workshop favored adopting **OPTION #2, gradual migration toward an "encoded" traffic signal pre-emption standard.**

This option is the basis for the Recommendations for Action presented in the following chapter.

4. RECOMMENDATIONS FOR ACTION

Based on the preferred scenario identified by stakeholders in the January 10, 2006 workshop, Chittenden County will adopt a common technology standard to support long-term implementation of an encoded traffic signal priority/pre-emption system. Equipment in support of the standard shall be rolled out over a period of time as equipment is replenished or as is necessary to support the new transit signal priority function along select transit corridors.

Now that an approach has been agreed to by the relevant parties, the region can move forward towards detailed articulation of the technological approach as well as formalization of the institutional framework required to implement the encoded system. Certain actors in the region will need to assume new or modified roles in order to support this transformation.

This section presents a detailed discussion of next steps, specific stakeholder roles and responsibilities going forward, and other special deployment issues that should be considered in implementation of this approach.

4.1. Selection of an Encoded Technological Standard

Now that a decision has been reached to implement an encoded traffic signal pre-emption/priority standard, the region must select a specific technology platform to implement.

As discussed previously in this document, the proprietary nature of commercially-available signal encoding standards requires a wholesale switch to one specific vendor across the region. For all practical purposes, this means a selection between one of the two leading suppliers of optical signal pre-emption technology (Chittenden County currently uses optical systems), 3M *Opticom*™ and Tomar *Strobecom*™.

FACTORS IN SELECTING A PREFERRED TECHNOLOGY

While the majority of existing infrastructure in Chittenden County was manufactured by Tomar, there are a number of factors that must be considered as part of selecting the preferred technology for the future.

- **Suitability of Technology to Future Needs** – Is the existing field hardware capable of addressing the future needs of the region for all users (emergency, transit, and/or maintenance)? Can the equipment accommodate encoding, remote communications, and/or signal coordination? Is the system scalable as it grows in coverage or functional complexity?

- **Transit Requirements** – Can the existing technology support CCTA's functional requirements for transit signal priority, and is it supported by the preferred vendor(s) of transit CAD/AVL systems?

- **Equipment Condition and Life Cycle Cost** – What is the age and condition of existing equipment, its remaining useful service life, equipment features, manufacturer support, backwards compatibility of newer technology, and past performance reliability? Is there a replacement cost/functionality tradeoff that needs to be examined?

- **Local Technical Support** – What technical support is available locally from each vendor for an encoded system, particularly one involving a transit signal priority function?

INFORMATION TO SUPPORT DECISION-MAKING

It is in the region's best interest to have the following information in hand prior to making a final decision regarding a specific preferred technology/vendor:

- A detailed articulation of the requirements of all potential system users – emergency providers, transit, and/or state, municipal, or contract road maintenance providers.

- Identification of the quantity and location of existing and planned traffic signal pre-emption locations throughout the County;

- Detailed transit functional requirements, deployment locations, and deployment phasing (by corridors or routes) for the transit signal priority function;

- A detailed equipment inventory for existing signal pre-emption and traffic controller hardware in the field, including the technical details specified above.

PROCUREMENT AND COST COMPETITIVENESS CONSIDERATIONS

At some point in the process of selecting from between the available proprietary encoding standards of the two leading manufacturers, there is a concern that the region will compromise its purchasing leverage. This is because, once a given manufacturer's standard is selected, most of the key components of the signal pre-emption/priority standard can only be obtained from that manufacturer.

To protect the interests of the region, it is recommended that the region consider a competitive qualifications and cost-based technology evaluation. In this approach, competing vendors would be asked to demonstrate their ability to meet the functional and technical requirements of the encoded system in a cost competitive environment, resulting in a selection based upon best total "value for money."

This procurement approach should take into account the following items:

- Cost of all roadside and in-vehicle components of the system;

- Cost of replacement parts/spares, including price guarantees over a multi-year period;

- Multi-year maintenance agreements and warranty information, including turn-around time for repairs and or replacement parts;

- Any manufacturer incentives, e.g., trade-in credits for used equipment or for future upgrades;

- Any opportunities for joint procurement or negotiated price agreements through a statewide (e.g. VTrans) or a lead regional entity (e.g., CCTA, CCMPO, City of Burlington).

4.2 Near-Term Technology Recommendation

It is recommended that in the near term, while the region develops a standard, the region should deploy Tomar equipment. This recommendation is based on the fact that the majority of the equipment in the Region is Tomar, Tomar equipment generally is less expensive than 3M as demonstrated in past competitive procurements, the Tomar representative provides good service and technical expertise, and the system will meet the requirements of the region today, and can be upgraded, or expanded to meet future requirements.

The equipment used for emergency vehicle pre-emption and TSP requires an emitter, roadside detector and discriminator. The discriminator is the heart, and logic of the system. Tomar offers three discriminators, which provide a range of functionality, briefly described below (from the most sophisticated to the least sophisticated):

- 2140 – The model 2140 discriminator receives and decodes signals from the detectors, logs pre-emption and priority activity, communicates with other traffic control devices, and optically isolates the pre-emption channels.
- 2080 – The model 2080 discriminator receives and decodes signals from the detectors, and optically isolates the pre-emption channels. The 2080 can be upgraded to a 2140 discriminator.
- 2070 – The model 2070 discriminator receives and decodes signals form the detectors, and optically isolates the pre-emption channels.

It is recommended that in the near term that either the model 2080, or 2140 discriminator is purchased. The model 2140 discriminator will be used in jurisdictions that require pre-emption event logging.

The model 2090 and 2091 Tomar detectors operate with all three of the above discriminators. The selection of either the model 2090 or 2091 detector is based on the physical attributes of the intersection approach (e.g. intersection width), and do not require standardization.

The model 3060 Tomar emitter is capable of operating in either an unencoded, or encoded mode. Furthermore, this emitter can be used for either emergency vehicle, or transit vehicle applications (with the addition of a visible light filter). Since this is the only emitter available from Tomar, it is by default the standard.

4.3. Requirements for Implementation of Encoded Operation

At some point in the future (e.g., when transit signal priority is implemented) the region will collectively need to decide when to switch to encoded system operation. The principal prerequisites for this transition are the following:

- Conversion of all **roadside equipment** at pre-emption/priority intersections to a common technology platform that supports the desired regional standards and functional requirements of emergency vehicle, transit, and/or maintenance operations.

- Similarly, all **onboard vehicle transmitters** must be capable of transmitting an encoded emitter signal to communicate with the encrypted roadside equipment.

- All necessary **institutional agreements** must be in place to support system configuration and maintenance (see discussion of agency roles and responsibilities). Many of these responsibilities are extension of existing roles and responsibilities for the existing unencoded system:

    - Procurement of any new equipment required at the time of switchover;
    - Initial system configuration and testing;
    - Development of the regional coding scheme and assignment of central responsibility for assigning codes and disabling bad tags;
    - System maintenance/troubleshooting; and
    - Collection and archiving of system use data log files.

Implementation of an encoded standard will require a more in-depth functional requirements and technological compatibility than has been conducted to date to determine the short-term recommendation. Additional planning, institutional coordination, and technological evaluation requirements are detailed later in this section.

4.4. Phasing in an Encoded Regional Standard

The defining characteristic of the preferred OPTION 2 is the migration over time toward encoded operation. There are four specific phases to this migratory approach.

PHASE 1: IMPLEMENTATION OF NEAR-TERM STANDARD

With the decision to implement a near-term standard, the region should move immediately to coordinate ongoing deployment of traffic signal pre-emption/priority equipment in the region. As noted earlier in this report, because of the lifespan of this equipment (upwards of 15 or 20 years), decisions made today will have cost ramifications for a long time, even if this equipment is not immediately deployed in the encoded mode.

The region should establish a lead entity for coordinating signal pre-emption/priority deployment in the short term so that all parties, including contractors and construction project managers, are aware of the standard.

The standard regional specification should be promoted and cited in future infrastructure deployments through a CCMPO Policy Statement, interagency MOUs, and/or Vermont Agency of Transportation signal permit review processes, to promote compliance with the standard.

While the near-term standard does not require immediate replacement of non-compliant systems, every effort should be made to ensure that new equipment installations are standard-compliant, thereby facilitating gradual migration towards a common technology platform.

PHASE 2: DEVELOP TECHNICAL SPECIFICATION AND STANDARDIZE FUTURE DEPLOYMENT OF ENCODED EQUIPMENT

If in the future the region decides to implement an encoded signal pre-emption/priority system, it is recommended that the region assess the existing technology capabilities and functional requirements as a first step in the process. These steps are discussed later in this section.

Depending on the age, condition, and functionality of existing equipment in the field, the near-term standard should provide a strong basis for switching to an encoded system pending a review of how

well existing systems meet desired emergency vehicle, transit, and maintenance functionality (discuss later in this chapter).

Provided all participants agree to a switchover timeframe to activate encoding (see Phase 3), there is nothing that necessarily precludes implementation of non-compliant equipment (if, for example, a municipality is using salvage or spare equipment) during this stage. This is because an encoded emitter can activate an unencoded discriminator. However, given lifecycle cost-effectiveness considerations, it is unlikely that any entity would deploy *new* non-compliant infrastructure knowing that it has to be replaced within five years, and the practice should be actively discouraged.

PHASE 3: DEPLOY ENCODED TRANSIT SIGNAL PRIORITY

For optimum performance, reliability, and system evaluation (particularly during a pilot deployment), transit signal priority should be implemented as an encoded system from its first day of operation. Both technology options support implementation of a split encoding scheme whereby transit priority operates in an ENCODED mode while emergency vehicle pre-emption continues to operate in an UNENCODED mode.

The advantage of this approach is that it allows transit service to utilize the benefits of encoded operation (e.g., identifying specific vehicle IDs, implementing conditional priority requests based upon schedule adherence, etc.) on a limited set of transit corridors where suitable equipment is in place. Meanwhile, it provides greater latitude for emergency vehicles which operate through ALL signalized intersections in the region until the roadside/onboard equipment switchover is complete.

PHASE 4: SWITCHOVER HORIZON FOR EMERGENCY VEHICLE PRE-EMPTION

As part of an interagency agreement on encoded traffic signal pre-emption/priority, it is advisable to define a 'horizon' date for switchover to an encoded system (e.g., 5 years), by which time all parties agree to bring their systems (roadside and onboard devices) into compliance with the regional encoding standard. By doing so, all affected parties in the region are given a milestone target against which progress can be measured and expectations aligned.

4.5. Role and Responsibilities

Implementation of the regional standard involved specific responsibilities for a number of affected parties both inside and outside of Chittenden County.

DESIGNATION OF A LEAD IMPLEMENTATION/OPERATIONS AGENCY

To date the Chittenden County Metropolitan Planning Organization (CCMPO) has, in its role as a regional facilitator, led the effort to explore the feasibility of the regional signal pre-emption/priority standard.

To maximize the probability of success as this initiative moves from planning toward engineering design, implementation, and day-to-day operations and maintenance, it is strongly desirable to involve one or more traffic signal *operating agencies* as a lead agency for this initiative. CCMPO can continue to be involved as a lead agency on planning and inter-agency coordination issues.

Among other general coordinating functions, the lead entity will be responsible for developing the regional encoding scheme and manage the distribution and use of encoded equipment by all

operating agencies. This entity must coordinate with emitter users, traffic signal maintenance personnel, and others to perform system maintenance and troubleshooting, and to de-activate any emitters on a 'bad tag' list. The lead agency may also perform a procurement function on behalf of other users, depending on the specific purchasing vehicle employed in the region.

There are several possible lead agencies that have been identified through the course of this initiative to date. The Vermont Agency of Transportation (VTrans) is a logical candidate given its statewide oversight of traffic signal operations and ITS, its status as an operating agency, and its role in defining transportation policy in the state. The City of Burlington, which operates the majority of traffic signals in the region, is another potential lead agency. Finally, the Chittenden County Transportation Authority (CCTA) will be leading the deployment of traffic signal priority in the region and could potentially leverage its available ITS funding for this purpose.

The ultimate selection of a lead agency, or coalition of lead agencies, ultimately requires self-nomination based on an internal assessment of available resources and an institutional willingness to undertake the role.

SPECIFIC ROLES AND ACTIONS BY ENTITY

Specific actions related to the development and implementation of the regional traffic signal pre-emption/priority standard are detailed by entity in the table on the following pages.

Table 4-1 Specific Roles and Actions by Entity

ENTITY	ROLES AND ACTIONS
ALL PARTICIPATING ENTITIES	• Participate in ongoing dialogue regarding the planning, design, implementation, and evaluation of the regional signal pre-emption/priority standard • Participate in interagency agreements and/or informal partnerships and support each party's specific roles with respect to standard development and/or system operations
Chittenden County Metropolitan Planning Organization (CCMPO)	• Lead *planning agency* for the development of the regional traffic signal pre-emption/priority standard • Facilitate regional dialogue on standard development among affected parties • Facilitate development and execution of interagency agreements • Demonstrate support for the consensus standard through a policy statement of the CCMPO Board • Assist in the development of a detailed hardware inventory (onboard and roadside) including manufacturer, model, ownership, and condition • Work with stakeholders to develop a timeline for switchover

ENTITY	ROLES AND ACTIONS
	to encoded operations • Post-implementation evaluation and measurement
Vermont Agency of Transportation (VTrans)	• Possible lead *operating agency* for the development of a regional signal priority technical standard • Define functional requirements for a standardized traffic signal preemption system based upon needs in Chittenden County and statewide. • Reinforce implementation of the regional signal priority through state review of signal permits and/or state highway design standards. • Evaluate the use of state procurement leverage (e.g., statewide negotiated price contract) to support competitive pricing of signal pre-emption equipment and maintenance. • Possible coordinating agency for a regional system maintenance agreement • If *conditional* transit signal priority is planned, work with CCTA and local municipalities on the development of prioritization rules • Maintain state-owned signal pre-emption equipment
Chittenden County Transportation Authority (CCTA)	• Develop functional requirements for the transit signal priority system as part of the standard development project, including identification of prioritized deployment corridors • If *conditional* transit signal priority is planned, work with VTrans and local municipalities on the development of prioritization rules • Possible source of equipment switchover funds along transit priority corridors • Design, implement, and evaluate one or more transit signal priority “pilot corridors” as a proof of concept • Coordinate process with deployment of other related transit Intelligent Transportation Systems, e.g. computer-aided dispatch (CAD) and automatic vehicle location (AVL) • Provide system usage/safety training to operators

ENTITY	ROLES AND ACTIONS
Municipalities	• The City of Burlington is a possible lead *operating agency* for the development of the regional traffic signal pre-emption/priority standard • Work with lead agency to evaluate maintenance vehicle (snowplow) signal priority as a component of the regional standard. • If *conditional* transit signal priority is planned, work with CCTA and VTrans on the development of prioritization rules. • Maintain municipal-owned signal pre-emption equipment
Emergency Service Providers	• Work with lead agency to develop functional requirements for emergency vehicle operations, including access to Fletcher Allen Health Care Medical Campus for non-encoded or non-emitter equipped vehicles • Inventory and encode in-vehicle emitter devices • Report equipment malfunctions or missing/defective devices • Provide system usage/safety training to operators
Other Entities	• Third-Party Maintenance Providers: Provide system maintenance functions under contract • Public Safety Associations: Coordinate standard development and system operations among members

4.6. Institutional Framework

Because of the complexity of the technology and operating issues, the number of affected stakeholder, and the impact on capital cost and operations funding decisions, it is recommended that key elements of the regional traffic signal pre-emption/priority standards be memorialized through Interagency Agreements (IAGs) a/k/a Memoranda of Understanding (MOUs).

In addition, the regional consensus should be endorsed by regional decision-makers to garner support, and in regional framework ITS planning documentation. Each of these items is discussed below.

CCMPO POLICY STATEMENT

In recognition of the work and decisions made to date on this subject, and to demonstrate regional support for the concept. The CCMPO Board of Directors should vote to endorse a policy statement favoring the phased implementation of a regional standard. This agreement could be used as a basis for moving forward into detailed development of the technical specification and procurement.

Draft language for a policy statement is included as Appendix B.

REGIONAL ITS ARCHITECTURE AND STRATEGIC PLAN FOR CHITTENDEN COUNTY

In 2005, CCMPO completed a *Regional Intelligent Transportation Systems Architecture for Chittenden County* and a project-based *ITS Strategic Deployment Plan for Chittenden County* as a framework for coordinated deployment of ITS in the region. During the course of the development of the *Regional ITS Architecture*, emergency vehicle pre-emption and transit signal priority were cited by study participants as technologies of interest to the region. The September 23, 2004 signal pre-emption workshop sponsored by CCMPO was conducted as part of this study.

Reference to these technologies is made in several parts of the *Regional ITS Architecture*, including the needs assessment, ITS inventory. Two market packages (specific ITS services) relevant to this topic are EM-03 – Emergency Routing (for emergency signal pre-emption) and APTS-07 Multi-Modal Coordination (for transit signal priority). Traffic signal pre-emption/priority is also mentioned specifically as an example in the Standards Plan chapter of the *Architecture*.

The *Strategic Deployment Plan*, furthermore, includes a Transit Signal Priority project (PT-4) composed of a design activity and a three-tier deployment plan prioritized by need: short-term (the Route 15 corridor), medium-term, and long-term. Several other arterial management (AM) category projects include the statement that "a regional Emergency Signal Preemption/Transit Signal Priority strategy and standard is recommended" as a condition for moving forward with project implementation.

The selection of the preferred approach (OPTION 2) does not alter the fundamental recommendation of these documents to achieve coordination and standardization among projects involving signal pre-emption or priority.

Reference to the technical standard and interagency agreements resulting from this signal pre-emption/priority standard development process can be incorporated as addenda to the *Regional ITS Architecture* retroactively or in future versions. Because the documents acknowledge and allude to this process as a follow-up action, however, both the *Regional ITS Architecture* and the *Strategic Deployment Plan* are factually correct as currently written.

INTERAGENCY AGREEMENTS

All entities responsible for design, operation, maintenance, and/or funding of the regional traffic signal priority/pre-emption system, including related emergency apparatus and traffic control devices, should be party to an interagency agreement (IAA) reflecting detailed arrangements for the proposed system.

In Chittenden County, this group is likely to include emergency services personnel (fire, EMS, and/or police, emergency medical facilities involved in ambulance dispatch or receiving, and/or blanket organizations/associations); municipalities responsible for operating or maintaining traffic signals; the Vermont Agency of Transportation (VTrans), the Chittenden County Transportation Authority (CCTA), and the Chittenden County Metropolitan Planning Organization (CCMPO).

Like many other types of ITS deployment agreements, the interagency agreement(s) put in place for this initiative must address a variety of issues, including:

- A specific description of agency roles and responsibilities in all phases of design, deployment, operations, training, and maintenance;

- A definitive timeline for 1.) adopting a regional technological standard and 2.) completing the switchover to encoded operation;

- Detailed technical information and functional requirements pertaining to the selected regional standard, including specific equipment models and settings if relevant;

- A discussion of funding contributions by each agency (cash and/or in-kind) during both the deployment and operating phases;

- Formal legal declarations such as limitations on liability, confidentiality of the regional coding scheme, etc.

4.7. Emergency Vehicle Access to Fletcher Allen Health Care Medical Campus

Special consideration must be given to given to emergency vehicle access to the Fletcher Allen Health Care Medical Center Campus in Burlington. This medical facility is a major trauma center serving rural portions of northern Vermont far beyond Chittenden County.

Specifically, the situation of emergency responders from rural communities with non-emitter equipped or non-encoded vehicles must be considered in light of the implementation of an encoded signal pre-emption system.

There are several possible approaches to this issue:

- **Ensure that all emergency responders accessing Fletcher Allen Health Care have onboard emitters that are compatible with the encoded system.** This option would provide complete interoperability throughout Chittenden County's encoded network, but it could significantly increase the quantity of emergency vehicles involved in the encoding scheme, and may require some responders to purchase an expensive new emitter for vehicles which seldom travel into the pre-emption area.

- **Allow signals on the hospital approach from Interstate 89 to continue to operate in an unencoded fashion.** In this option, signals between Exit 14 and the Medical Center Campus would remain unencoded even after the switchover to encoded operation elsewhere in the County. A drawback to this approach is that it could create potential confusion among emergency responders about where signal pre-emption will work for unencoded vehicles. It also precludes the use of emergency vehicle pre-emption along detour or seldom-used approaches to the hospital, as well as for certain mutual aid calls.

- **Implement a manual override option along the hospital approach route.** This solution involves implementation of an operator-actuated device to provide green phase pre-emption to an approaching emergency vehicle, effectively flushing traffic in advance of the ambulance. Disadvantages of this approach are the need for close coordination between the signal operator and the emergency vehicle driver, the cost of implementation (communications, software, vide surveillance), and potential impacts on surrounding traffic if the signals do not have adaptive control capabilities to recover from the resultant traffic disruption.

- **Do not provide special treatment to emergency vehicles without encoded emitters.** In any emergency pre-emption scenario (encoded or unencoded), it is likely that at least a few emergency vehicles entering the County will lack appropriate emitter equipment. While

not the preferred option, vehicles that to not have encoded emitters (or emitters of any kind) do not have to be given signal pre-emption treatment in Chittenden County. Under this scenario, it is important to ensure that other measures are in place to facilitate the movement of emergency vehicles through congestion bottlenecks on the hospital approach (e.g., wide paved shoulders, mountable median strips).

An analysis of ambulance call data at Fletcher Allen Health Care would help to identify the extent of this issue. Whichever approach is chosen, it is important that the entire emergency response community is aware of any changes to the regional signal pre-emption system and understands the capabilities and limitations of the system.

4.8. Additional Activities to Implement a Regional Encoded Standard in the Long Term

In spite of the adoption of a near-term regional standard, it is in the region's interest to conduct a more in-depth assessment of longer-term regional interoperability needs before implementing an encoded standard.

Encoding will require an additional level of evaluation and to ensure that the proposed technology standard is adequate to meet all transit, emergency vehicle, and maintenance needs. The region must also administer the encoding standard, ensuring that the institutional infrastructure is in place to support adoption and ongoing operational coordination of an encoded system.

Should the region pursue this option in the future, Table 4-2 presents a summary of next step actions to advance an encoded regional signal pre-emption/priority standard towards implementation. This approach provides for once again re-visiting the near-term standard to allow for reflection on its ability to meet regional needs and the performance of technology. The region may choose to exercise the option of competitive procurement (Step 6) both to promote cost competitiveness as well as to ensure that all commercially-available option have been considered before investing in the long-term solution.

Table 4-2 Activities to Implement a Regional Encoded Standard

Action	Involved Stakeholder(s)
1. Identify a **lead agency** or a coalition of lead agencies to oversee the development of the technological aspects of the regional standard development, as well as system implementation, operation, and maintenance	*CCMPO* *VTrans* *CCTA* *City of Burlington*
2. Complete fact-finding and **evaluation of existing pre-emption hardware** (field and onboard equipment)	*Lead Implementation Agency* *CCMPO*
3. Propose **CCMO Board of Directors** policy statement in favor of the development of a regional signal priority/preemption standard	*CCMPO*
4. Develop a **'concept of operations'** identifying the functional requirements for the systems in terms of traffic operations, transit, and maintenance vehicles	*Lead Implementation Agency* *CCMPO* *Other participating agencies*
5. Identify **transit functional requirements** for the transit signal priority system, including a prioritized deployment plan, interfaces with other transit/roadway ITS and signal infrastructure, and identification of operating protocol (including conditional priority scheme if relevant)	*CCTA* *Lead Implementation Agency* *CCMPO* *Other traffic signal operating agencies*
6. **Select a preferred technology/vendor** for the regional	*Lead Implementation Agency*

Action	Involved Stakeholder(s)
signal pre-emption/priority standard based upon an assessment of existing conditions and a competitive value-based request for quotations procurement process.	*CCMPO* *CCTA* *VTrans*
7. Execute **Inter-Agency Agreements (IAAs)** detailing the roles and commitments of entities participating in the regional signal pre-emption/priority scheme.	*CCMPO* *Other entities involved in IAAs*
8. Implement a **pilot transit signal priority project** (e.g., Route 15) as a proof-of-concept and to evaluate the proposed technology and operating protocol before region-wide deployment	*CCTA* *Lead Implementation Agency* *CCMPO* *Other traffic signal operating agencies*

APPENDIX A: TECHNOLOGY AND STATE-OF-PRACTICE OVERVIEW

A.1. Terms and Definitions

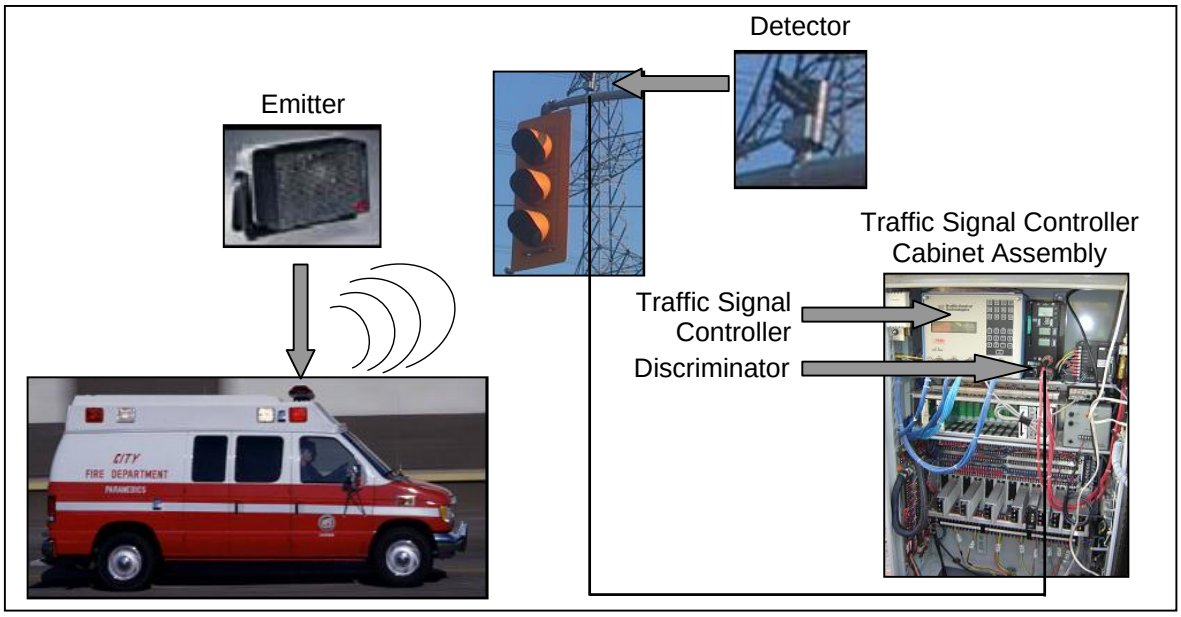
SIGNAL PRE-EMPTION VERSUS SIGNAL PRIORITY

Signal pre-emption and signal priority are related but distinct terms. The former is more commonly associated with emergency vehicles, while the latter is associated with other types of vehicle such as transit buses and snowplows. This section discusses the distinction between the two as well as other terms associated with these concepts.

EMERGENCY VEHICLE PRE-EMPTION

As presented in Exhibit 1, an Emergency Vehicle Pre-emption (EVP) system consists of an emitter, detector and discriminator. Other types of equipment, such as confirmation lights, are optional and may be added if needed.

Exhibit A-1: EVP System Components



The following traffic signal system terms and definitions are used throughout this briefing:

- **Emergency Vehicle Pre-emption (EVP):** Emergency vehicle pre-emption is a method by which the emergency vehicles are given right-of-way at an intersection, usually by providing the emergency vehicle with an exclusive green in its direction of travel. This is

accomplished using emitters mounted on the vehicle, detectors mounted at the intersections, and discriminators at the intersection. The actual process is:

1. The transmission of a signal from the emergency vehicle, requesting pre-emption;

2. Receipt of the signal by a detector at the signalized intersection;

3. Signal received by the detector is relayed to a discriminator that determines if the signal is valid;

4. Assuming the signal is valid, the discriminator issues the appropriate pre-empt to the controller;

5. The traffic controller implements the pre-empt request, which typically involves safely clearing the intersection by timing pedestrian flashing don't walk, vehicle amber and all red, and then displaying the appropriate green display (solid green and pedestrian don't walk, or left turn arrow with solid green and pedestrian don't walk);

6. Once the emergency vehicle clears the signalized intersection the request for pre-emption stops. As a result, the controller transitions back to normal operations. This process involves completing the pre-empt routine by returning to an all-red display and then returning to the normal signal display sequence. Offset transitioning occurs, to return to the pre-programmed offset for coordination purposes. Depending on the intersection phasing, offset and cycle length, this process may require 2 to 5 minutes.

- **Emitter:** The emitter is mounted on the priority vehicle, and sends a signal to the detector requesting priority. The emitter may transmit additional information, such as vehicle type (e.g. fire or ambulance), and a unique vehicle identification number for security encoding.

- **Detector:** A detector is mounted at or near the intersection. The detector requires an unobstructed view of the approaching emergency vehicle. The signal generated by the emitter is received by the detector and relayed to the discriminator.

- **Discriminator:** The unit receives the pre-emption request from the detector, decodes and prioritizes signals from the detectors, and issues the request for pre-emption to the traffic signal controller. The new discriminators can store pre-emption data (i.e. date, time, vehicle type, vehicle ID, direction of pre-emption) and communicate via dial-up modem to a remote location (i.e. EMS headquarters, traffic signal system maintenance department, etc.).

- **Confirmation Lights:** Confirmation lights are used to assure the emergency vehicle driver that the intersection is running signal pre-emption and the emergency vehicle has the right-of-way at an intersection. Confirmation lights are usually mounted on top of the traffic signal poles.

- **Encoding:** The EVP system can operate in an encoded mode. In an encoded mode, the system is capable of logging the vehicle class code and vehicle identification. Encoding is used to prevent the unauthorized use of the system. In order to encode the system, up-to-date EVP equipment **from one manufacturer** is required at the intersection, and emitters on the emergency vehicle must also be capable of generating an encoded signal.

A.2. Transit Signal Priority

Transit Signal Priority (TSP) is used to advance the transit vehicle through the signalized intersection, using either passive or active priority techniques, which are defined as follows:

- **Passive Transit Priority:** Passive transit priority is a low-tech alternative that involves setting signal timing plans to complement transit schedules along a given route. Passive priority does *not* adjust the signal timings in real-time because there is no means of detecting the presence of a transit vehicle. Passive signal timing plans are of limited value because buses may arrive at a signal during its red interval due to normal variations in travel time. Furthermore, ineffective timings can delay the cross-street vehicles even when a transit vehicle is not in the vicinity.

- **Active Transit Priority:** Active transit priority causes the regular operation of traffic signals to be altered temporarily in response to the presence, or imminent presence, of a transit vehicle as determined by some form of transit vehicle detection. Active transit priority is "unconditional" if it is granted every time a transit vehicle is detected. Active transit priority is "conditional" if only granted when certain conditions in addition to the mere presence of a transit vehicle are met. For example, priority may only be granted if the vehicle is substantially behind schedule, or if the priority request will not induce significant delays for other vehicles. This form of active transit priority requires the interaction of the transit management system and traffic signal control system as presented in Exhibit 2.

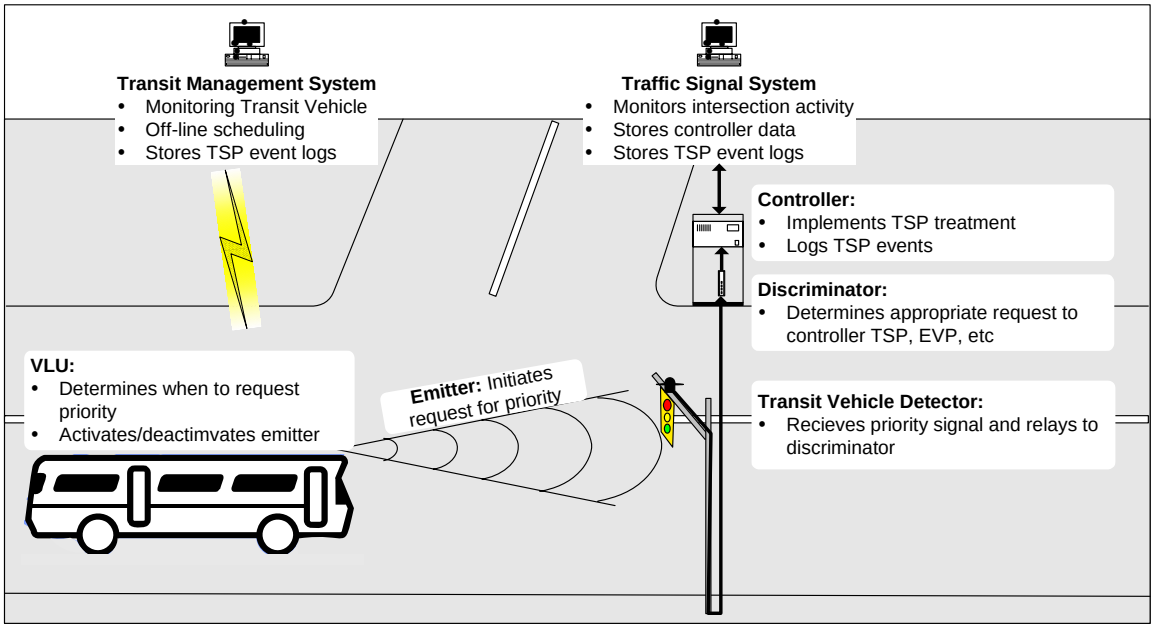


Exhibit A-2: Active Conditional Transit Signal Priority

A.3. Technology Standards and Issues

The use of pre-emption for emergency vehicles is common in the industry. Industry standards for the traffic signal controller are well defined in the NEMA TS2 Standards publication. NEMA TS2 defines pre-emption as "*The transfer of the normal control of signal control mode for the purpose of*

servicing railroad crossings, emergency vehicle passage, mass transit vehicle passage, and other special tasks, the control of which require terminating normal traffic control to provide the priority needs of the special task." In order for a controller to meet the NEMA TS2 Standard it must:

- Have 6 pre-empt inputs;
- Pre-empts 1 through 6 are prioritized, with 1 the highest;
- Pre-empt 1 and 2 are typically reserved for railroad and 3 through 6 for EVP;
- Have logic to transition into and out of pre-empt;
- Meet the pre-empt interface standard for NEMA TS2 Type 1 and 2 controller units; and
- The control unit must indicate the pre-empt call, control, interval, and counter.

The NEMA TS2 standard defines the logic for pre-empt as well as the physical interface. In comparison, there is no standard yet defined for TSP. Most traffic signal controller manufacturers offer a TSP logic, which is either implemented through upgrading existing controllers, or replacing older controller units. The logic itself varies significantly from manufacturer to manufacturer.

In terms of EVP systems, there are no standards in place. There are many technologies that are in use, such as optical/infrared, and spread spectrum, with others such as WiFi evolving. The systems based on optical/infrared technology are dominant in the industry, and have evolved into a quasi-industry standard, where the emitter interface for EVP is 14 Hz, TSP is 10Hz, and Probe mode 12Hz. The controller interface for pre-empt is defined under NEMA TS2, however, the TSP interface is not defined. For example, Opticom™ uses a 6.25 Hz input to indicate TSP. The Econolite and Eagle controllers recognize this input, whereas Peek does not.

The current state of the industry allows the interchangeability of competing EVP systems (e.g. Tomar and Opticom™). More recently, optical systems have introduced an encoded signal that is used to prevent unauthorized system use. The encoded signal is not standardized and, as a result, optical systems are not interchangeable when operating in an encoded mode. Included in the encoded signal is information on the vehicle ID and class code, which is used to implement more sophisticated EVP and TSP strategies, as well as for more comprehensive event logging.

A.4. State of the Practice Review

As mentioned previously, optical/infrared EVP technologies are dominant in the industry with Tomar and Opticom™ as the two major vendors. Other pre-emption technologies include spread spectrum radio, which historically was deployed by EMTRAC, and has been more recently introduced by 3M as an Opticom™ alternative. The 3M spread-spectrum system combines the use of AVL/GPS technology to track the vehicle location and provide this information to the intersection discriminator for implementing pre-emption. Acoustic systems have also been implemented, but have met with limited success.

For TSP, on-vehicle emitters are often used for bus detection, and optical/infrared system. These emitter systems have low on-vehicle costs, which is a benefit to transit operators that need to install the equipment on many or all of their buses even though they may only have TSP on selected routes since transit operators cannot dedicate buses to particular routes. Emitter technology offers accurate detection, low on-vehicle costs, and low operation and maintenance costs. Emitter technology has more expensive installation costs compared to optical technology because a reader

upstream from the intersection must be installed, for check-in purposes. This upstream reader requires a mounting location (such as an existing lighting pole), power and communications to the controller unit. These requirements often increase the installation costs beyond the cost of an optical system.

The main disadvantages of an optical TSP system is the increased on-vehicle costs compared to a emitter based system, and the inherent detection inaccuracy. More recently, the use of a Transit Management System and on-board Vehicle Logic Unit (VLU) has been used to implement active, conditional TSP. The VLU overcomes the detection inaccuracies of the optical based systems, and has the added advantage of reducing the in-cabinet complexity and maintenance of meshing the EVP and TSP systems with the controller. The detection inaccuracies are overcome by using the VLU to activate the emitter at the precise check-in and check-out point. The VLU tracks the progress of the transit vehicle using a combination of GPS and odometer readings (dead reckoning).

It is possible to implement multiple levels of TSP based upon varying criteria. For example, in a two-scheme transit signal priority installation, the first level of priority could be implemented when the transit vehicle is 3 minutes of schedule, and the second level of priority (which is more aggressive then the first) could be used when the transit vehicle is more than 5 minutes behind schedule.

APPENDIX B: SAMPLE CCMPO POLICY STATEMENT ON IMPLEMENTING A REGIONAL TRAFFIC SIGNAL PRE-EMPTION STANDARD

Regional coordination is necessary to ensure the effectiveness, security, and interoperability of traffic signal pre-emption systems in Chittenden County, in light of evolving needs and technologies.

Traffic signal pre-emption systems are currently used in several Chittenden County communities to expedite the movement of emergency vehicles through signalized intersections on the region's arterial roadways. These systems allow authorized emergency vehicles to override traffic signals using an optical emitter device mounted on the vehicle. Nationally, signal pre-emption equipment has been proven to reduce emergency response times, which in turn reduces fatalities and property destruction. In addition, these systems reduce the risk of collisions involving emergency vehicles at signalized intersections.

Existing traffic signal pre-emption systems in the County were installed by individual municipalities or the Vermont Agency of Transportation. This equipment uses an open industry standard that is increasingly obsolete and is subject to misuse by unauthorized individuals using illicit emitters to activate traffic signals.

Implementation of a more secure "encoded" standard, adopted and implemented by all affected parties will preserve the existing benefits of the existing, "unencoded" system while providing numerous additional benefits:

- Greatly reduce the potential for misuse of the signal pre-emption system by unauthorized users;
- Allow for better tracking of system usage and performance;
- Support implementation of transit signal priority by CCTA; and
- Improve usage monitoring, data logging, and system maintenance.

Implementation of a standardized "encoded" system can occur in a phased manner, as existing traffic signal equipment reaches the end of its useful life, to minimize the cost of transitioning to an encoded system, or until an agreed-upon switchover deadline is reached.

The CCMPO recommends implementation of a near-term regional traffic signal pre-emption standard in the urbanized areas of Chittenden County, in accordance with the attached specifications, to promote migration to a common technology platform. The regional standard should be endorsed by municipalities, emergency services, health care providers, the Chittenden County Transportation Authority, the Vermont Agency of Transportation, and other affected stakeholders in the region.