Prioritizing Transit in a Connected Vehicle World—
A Transit Signal Priority (TSP) Workshop

WORKSHOP SUMMARY
MONDAY, MARCH 19, 2012

Sponsored by the Federal Transit Administration (FTA) / Institute of Transportation Engineers (ITE) / American Public Transportation Association (APTA)

Worthington Renaissance Hotel
Fort Worth, Texas

Audience: Approximately 45 attendees including a balanced mix of transit professionals and traffic engineering professionals. *Attachment 1* contains the roster of attendees.

Instructors: Nine expert instructors from across the country. *Attachment 2* includes a roster of the instructors.

Workshop Evaluation: Presenters received high ratings from workshop participants. A summary of the evaluations received are included in *Attachment 3*.

Signal Priority and Preferential Treatments for Transit
Introduction/Welcome, Jeff Spencer (FTA), Lisa Fontana Tierney (ITE), Lou Sanders (APTA)
Purpose of the Meeting and Meeting Outcome, Peter Koonce, City of Portland

> *Transit signal priority is an application that offers transportation agencies a cost-effective means to reduce transit delay, improve service reliability and potentially provide significant benefits to non-transit traffic and other road users. The capital costs of a signal priority project are modest compared with the lifetime savings associated with their implementation. There are several unquantifiable savings associated with their deployment including reduced pavement wear, fewer emissions, and lower vehicle maintenance costs associated with the elimination of stops at signalized intersections.*
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> *To date, widespread implementation of transit signal priority has been limited by the reluctance of some agencies to invest in technology that works cooperatively between transit and traffic systems. This proposed partnership between transit and traffic engineering professionals is intended to help identify and overcome technical and policy-related limitations to implementation and foster an improved understanding the benefits of transit signal priority. It is also intended to facilitate integration of transit with the Connected Vehicle Technology platform, allowing for growth, expandability, and incorporation of newly evolving technologies to make transit signal priority more effective and easier to maintain.*
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> *This workshop will highlight some of the barriers associated with the implementation and maintenance of transit signal priority systems. Industry leaders will describe how they have embraced new approaches to improve coordination and synchronization between transit and traffic systems. Attendees will leave the meeting with an understanding of transit signal priority applications and how the Federal Highway Administration (FHWA) Connected Vehicle Technology program will impact future projects resulting in*

increased safety, efficiency, and information exchange that can be used to improve the overall transportation system.

The purpose of the workshop is to:

- *Inform about technology, costs, impacts and decision making frameworks of different treatments*
- *Identify, discuss, and document barriers to implementation*
- *Increase the proficiency of agencies to more effectively implement transit priority treatments*
- *Discuss the emerging concepts of connected vehicle (CV) program at FHWA and how it may apply*

Meeting outcomes:

- *Learn about the CV program and how transit may be involved*
- *Discuss best practices in TSP applications and other preferential treatments*
- *Dialogue about barriers that local agencies have experienced and what strategies are being used*
- *Identify activities to promote improved application of TSP*
- *Define transit's role in the CV program*

Overview of Transit Signal Priority, Peter Koonce, City of Portland

- *Key to successful TSP is a strong partnership between traffic engineering and transit agencies. Animosity (or lack of understanding of either other's objectives) can be a significant barrier to the implementation of TSP and other transit priority treatments.*
- *Overall objective of successful transit priority treatments is to determine how to best "share the space" to make the overall street network more effective.*
- *In order for transit priority treatments to be successful the measures of effectiveness need to get beyond measures that rely exclusively on single occupant vehicle throughput and delay. There needs to be a shift to measures such as person delay.*
- *The City of Portland TSP program is now about 15 years old and is in the process of being updated. It is comprised of 3 main elements including (1) smart buses (GPS and AVL) (2) Opticom – Bus controller communications shared with emergency services (fire) and (3) updated traffic controllers and software*
- *How it works in Portland: Bus will only ask for priority when they are running late – smart system. A challenge for this system is that portions of the system are still operating on 30 year old controller technology– has been updated in 250 locations – but still has old technology operating beyond that*
- *Traditional signal timing has the primary objective of minimizing delay for vehicles. TSP modifies this objective slightly by recognizing that busses operate differently and provides an opportunity to reduce delay for busses*
- *Portland uses two types of treatments (1) red truncation (to reduce amount of red time for all system users) and (2) green extension. The objective of these treatments is not necessarily just to increase green time but rather to ensure effective use of the green time*

- *The bus detection system in Portland is a simple concept of getting the message from the bus to the signal controller through the use of an optical detection system. The technology is about 15 years old currently and only provides a signal when the bus is running late. The technology is the same technology used for fire preemption – a proven technology and the existing equipment is already out there in some cases.*
- *Infrared optical technologies have several advantages (existing equipment on many intersections, proven technology, lower cost (i.e., already installed for emergency pre-emption) and disadvantages (requires a line of site, maintenance of the devices, and limited information transmitted and proprietary)*
- *Currently a standard approach is used to the TSP message. The technology is limited in what messages can be transmitted from the bus. The future approach will consider additional data such as assessing bus stop location, determining traffic signal capabilities and setting detection range in the field based on estimated speeds. If CV technologies are available, further enhancements could be made such as measuring traffic conditions and adjusting for congestion.*
- *The existing automatic vehicle location (AVL) criteria include a series of questions that are examined in real-time. Additional possible criteria include evaluation as to whether a rider is present at a stop (maybe no stop is necessary), what is the current ridership, what time of day is it (in terms of congestion).*
- *Priority request server information is available that allows a measurement of traffic conditions to "update" green times, accept priority requests when bus is in range and provide feedback between agencies.*
- *Summary – (1) partnerships are needed between traffic and transit agencies to build systems of the future (2) many of the first generation systems are now over 10 years old and it is time to update the equipment and (3) applications of new technologies can vastly improve the effectiveness of similar systems.*

Question & Answer Session
Q: Of the 250 locations that have TSP – do many of them still have near side stops.
A: Yes, over half of them do. This limits the effectiveness of TSP.

Q: What qualifies as "late" for busses?
A: 30 seconds, but the starting point was 90 seconds and it was modified to make the equipment more effective.

Q: Of the 250 locations are any of them networked to the transportation management center
A: 75% yes

Q: Do they share data with the DOT
A: No. Both systems are distributed systems and they are not linked to the DOT's system.

Q: How aggressive should we be? Maybe TSP should be implemented times other than when the busses are late.
A: In Portland, they have worked with TriMet to try and shorten their schedule and take a bus out of the system. A challenge faced by some agencies is that there is an animosity between traffic engineers (TE) and transit agencies (TA). (i.e., you are screwing up my signals by asking

for priority). In King County, priority is integrated into the system and it is not applied just when things are running late. In King County, they work with the TEs to determine the threshold for how much priority can be allocated for transit priority. For example, in some cases the traffic agencies may be willing to give priority every other cycle, etc. The transit agency is responsible for asking for priority only when it is needed most.

Q: What is the frequency? How often can you implement TSP?
A: Initially, it was implemented every other cycle. More recently they have now found with the new equipment that it can be determined based on real time conditions to determine the need and it may or may not be necessary to skip a cycle.

Transit Preferential Treatments—State of the Practice Report: TCRP Synthesis 83, Alan Danaher, Parsons Brinckerhoff

- *Overall project focused on broad range of bus and rail preferential treatments with emphasis on at-grade transit and arterial streets on roadway segments (median treatments, exclusive lanes) and spot locations (including TSP, special signal phasing, queue jump and bypass lanes). Intended to be a consolidated source of information on the subject. Today's presentation focus will be on TSP.*
- *A broad-based national survey conducted in 2009-2010 indicated that TSP is the most common type of transit preferential treatment that is being used with 67% of the agencies that implement transit preferential treatments indicating that they are using TSP.*
  - *The survey also indicated that of those agencies that were implementing TSP, over half of them were using "unconditional" priority type, though conditional applications are increasing.*
  - *Approximately half of those surveyed had distributed systems as opposed to centralized systems. As time passes, there has been a trend toward more centralized systems.*
  - *According to the survey, the transit agencies are primary involved in the front end of indentifying and locating treatments and are less involved in the construction, maintenance and monitoring of the treatments. The traffic agencies on the other hand were typically less involved in identifying and locating treatments and more involved in the operation and maintenance.*
  - *For traffic agencies that monitored the priority treatments, they all reported involvement in the detection of transit vehicles and oversight of the equipment functionality.*
  - *The survey also indicated that intergovernmental agreements can be a successful means of facilitating TSP. Several examples include agreements for design and construction of facilities and equipment; monitoring; maintenance; equipment replacement; and coordination meetings to review project implementation operations and strategize on future improvements.*
  - *Other survey conclusions from within transit agencies include: (1) a lack of existing warrants for treatment identification (there are some criteria that are being used…but no warrants), (2) the use of green extension/red truncation as the most common form of TSP timing, (3) a lack of formal comprehensive transit preferential treatment program within most transit agencies and (4) only a slight majority transit agencies have intergovernmental agreements.*
  - *Other survey conclusions within traffic agencies include: (1) median transitways and exclusive lanes were perceived as having the greatest impact on general traffic*

  operations, (2) traffic agencies are generally most supportive of TSP, queue/jump lanes, exclusive lanes and limited stop applications, (3) traffic agencies are most involved in operating/maintaining treatments and least involved in identifying/locating treatments.
  - *Four excellent case studies include San Francisco (most comprehensive program in the US with 460 transit priority treatments including Bus/Streetcar/LRT); Seattle (speed and reliability program – bus); Portland (integration of bus/streetcar/LRT) and Denver (skip stop/bus lane applications)*
- *The synthesis work began the process of gathering information on warrants, costs and impacts of treatments including information on TSP delay savings, queue jump delay savings and the establishment of a sample "decision-making framework" to determine when and where TSP should be applied.*
- *Future needs from this research study include: impacts of limited stop/stop consolidation; warrants for transit preferential treatments, benefits of multiple transit preferential treatments, and tradeoffs on intersection-based transit preferential treatments.*

Overview of the Federal Highway Administration Connected Vehicle Initiative, Yehuda Gross, RITA/JPO

- *Presentation focus is on TSP in the USDOT connected vehicle (CV) research program*
- *CV is a system of systems—a suite of technologies and applications that use wireless communications to provide connectivity (among vehicles of all types, between vehicles and roadway infrastructure and among vehicles, infrastructure and wireless consumer devices)*
- *What does CV provide us? Provides for improved safety, mobility and helps the environment.*
- *The mobility program area allows for real-time data capture and management and dynamic mobility applications based on the data collected. An example would be based on data collected, allow timing plans to be adjusted based on how many people are actually on the bus or make adjustments for example for bad ozone days.*
- *TSP is part of the FHWA Multi-Modal ITS System. This is a comprehensive traffic signal system for complex arterial networks that addresses multiple modes (passenger vehicles, transit, pedestrians, freight and emergency vehicles)*
- *TSP as part of the CV program allows earlier, more accurate and continuous monitoring of transit vehicles as they approach and progress through an intersection; it allows the selection of the most appropriate priority strategy based on real time information such as schedule adherence, passenger loads, service type, time of day and peak direction; and it allows TSP on a network of arterials.*
- *PED-SIG (mobile accessible pedestrian signal system) is another related program. It allows an "automated pedestrian call" to be sent to the traffic controller from a visually impaired persons' smart phone. It can determine the level of disability by calculating how fast the person is actually moving across the street and can accommodate a change in signal timing. It can also inform the visually impaired person as to when to cross and how to remain in aligned in the crosswalk.*
- *I-SIG (intelligent traffic signal system) is an additional element of this program. It allows data integration through wireless communications to improve traffic signal operation with capabilities of transit and freight priority, preemption, and pedestrian movements to maximize overall network performance.*

- *A final element discussed was IDTO (integrated dynamic transit operations). It provides for dynamic transit operations with dynamic scheduling, dispatching, and routing for transit vehicles and facilitates passenger connections.*

Local Perspectives on Transit Priority Applications
Transit Signal Priority in Texas, Susan Langdon, Savant Group

This presentation will provide an overview of a local project, discuss challenges to implementation from the transit and traffic perspectives and provides an overview of lessons learned.

The DART light rail system runs on city streets through downtown Dallas with conflicts between rail and vehicular traffic. The system was undergoing an expansion with the opening of a third line (green line) with a goal of increased throughput required by proposed service headways. There are four stations and 14 signalized intersections that the trains run through. The street is mainly dedicated for light rail operation, but the crossing traffic impacts were of concern. There is some limited vehicle access but is mainly transit traffic. There was also a significant need to address pedestrians throughout the project area.

<u>Project overview</u>
The project was broken generally into two segments. The first phase (phase one) is now complete. The goal of this phase was to provide improved (reduced) headway for the LRT. It included early green and green extensions, installation of train detection, countdown timers to prepare transit drivers for timely departures and it supported some peer-to-peer communication. Phase two is being worked on now. It will allow monitoring of trains through the CBD; new controllers (central system upgrade); support more peer to peer communication and allow the opportunity for the vehicle operator opportunity to cancel requests.

Project Goals Phase 1-
The City of Dallas (traffic engineering) and DART (transit) both had their own project goals. The City was concerned with the traditional need to maintain vehicular level of service, as well as pedestrian service, vehicular progression and minimizing intersection blockage. DART's primary goals were to support 2.5 minute headways and improved station-to-station train movement.

The primary challenges the project faced were the (1) need to know where the trains are (detection system); (2) communication network necessary in order to send messages back and forth—this was not in place before this project started; (3) legacy traffic signal equipment (1980s); and the biggest challenge was (4) communication /organization/ coordination between agencies/staff/consultant/contractor. The project included several departments within DART and several different people in the city and each had their own consultants. Trying to get all these people on the same page was a real challenge.

Transit Agency's Perspectives on Barriers to Implementation, Abed Abukar, DART

The primary challenges faced in this project from the perspective of DART included:

(1) the need for an organizational change in philosophy (leadership and operational). There was a true need for a mindset change for both the City and DART. They needed to think regionally, understand each other's perspectives, and work together to solve problems with solutions that work for both agencies. One example was the implementation of low level boarding. This eliminated a significant amount of dwell time at each station which was really important to improve a more reliable departure for synchronization with the signals;

(2) the need to manage multiple on-going parallel projects (such as the low level boarding project);

(3) difficulties with detection systems—they found that the magnetometers had some issues so they came up with a new type of detector; and

(4) issues at the junctions located at the project limits. The project was initially limited to the downtown area, but problems were also identified at the junctions outside the downtown area. The project limits were therefore adjusted in order to incorporate these problem areas.

Traffic Engineering Barriers, Curtis Jarecki, City of Dallas

Similar to the transit perspective, the City also realized several challenges including (1) the need to develop solutions from a multimodal perspective with direct input and close coordination with the DART staff. The City's perspective was traditionally focused primarily on moving automobiles within the city and there was a true need to change from this auto-centric approach; (2) legacy signal controllers and (3) peer-to-peer communication—there is a need for the controllers to talk to each other not just the central system.

Operational changes that were necessary were also a challenge. The city was "a world apart" from DART and they needed to work together as a team. There was a need to understand DART's organizational structure. The city also learned the need to be flexible in signal timing designs to accommodate and balance the needs from pedestrians, vehicle and trains. This also involved understanding the needs of the train operators.

The city staff involved in this project needed to understand the huge commitment that it was. The City found documentation very important because there was a significant amount of customization that was necessary for the project. Ultimately, the documentation saved time in the end. It was also very important for the City to take ownership of the system—consultants are helping now but they will not be there forever; there is therefore a need to understand the whole system in its entirety and how to operate it into the future.

There were several unique traffic signal controller requirements in this project including (1) train signals (2) countdown timer to allow operators to know how much time they have left to make a better decision as to whether allow additional patrons and (3) early green/extended green to allow transit to get from one station to the next.

Another challenge faced was with the age of the signal equipment and limited logic capacity with no TSP capability. The solution to this issue was found by looking outside the industry. A Modbus (an external logic computer) used in the process control industry was used to determine if downstream track was clear and length of train. This technology transmitted detector inputs between intersections.

Lessons Learned (Susan Langdon)

The following were the key lessons learned:

- *Plan ahead. Transit priority needs (including detailed technology review) should be planned while planning rail expansion projects. The ideal situation would have been the city would have gotten new equipment prior to the start of this project and before the green line was extended. They learned the need to work together from the start (city and DART).*
- *Budget conservatively using examples from elsewhere to guide you. Several cities have gone through this before. In some cases, you don't need to recreate a solution that has been developed elsewhere.*
- *Specify roles, responsibilities and funding early in the process. Once the system is in, who is going to maintain it? How do we determine when things are broken and who is going to fix it?*
- *Make sure everyone on the team in the agencies is kept informed on the decisions that are made at meetings. Not everyone will be at the meetings. When the decisions are implemented you need to make sure that everyone is aware of it.*
- *Don't be afraid to look outside of your agency. Expertise from the computer industry was used to supplement traffic engineering technologies to meet the needs of this project.*
- *Team continuity is critical. Projects of this scale are long projects – there is a need to make sure team is maintained throughout duration. If you have a key person leave it will take a long time to get someone else new in and up to speed.*
- *Allow for flexibility. We all start with an initial idea of goals and plans for a project. Along the way we need to be able adjust.*
- *Third party consultant (mediator) can bring a lot of benefit to the team. Texas Transportation Institute did a lot of outside research to add to the team. They gave an encompassing view looking at both city and transit perspectives.*
- *Keep things simple. Sometimes building in too much can cause problems. When someone steps away from the project someone else needs no to be able to pick it up and understand it. Programming knowledge needs to be readily transferred. Maintenance people also need to understand it.*

Question & Answer Session

Q: Communications network and controller – needed a robust operation. How did you do it with the old equipment?
A: The programmable logic devices were carrying the heavy load (the modbus). It should be noted that the city is now in the process of selecting and installing new ATC controller that will include this functionality within it (and won't need modbus for future communications).

Q: What about implementation of new CV technologies from the bus side
A: DART is building a smart vehicle with GPS, AVL, 4g, they are migrating and testing to prepare for the future CVs. They can track devices to know how they are functioning and let city know if there are problems. It is vitally important to get new controllers in order to advance this.

Q: Not all GPSs are equal. If the accuracy is only within 30 meters they can't always tell where the bus is.

A: That is true – but they are getting better. The system knows generally where the bus is but GPS should be able to tell you more closely where it is. Looking outside the box is necessary. They almost did too good of a job in phase 1. Things are working well so they have had to go back and justify the need for advanced traffic controllers.

Q: The system is very complex. How do you maintain it?
A: It pretty well runs itself. All the procedures are well documented. Fail safe mode is also built in. It defaults to a pre-timed system if needed. The communication system that is running is 3 layers, if one fails, it goes to the next and then to the next.

Q: Is there anything that monitors the Modbus to determine failures?
A: It is monitored through a control center 24-7. DART and city get an alarm if something malfunctions. System has two areas of responsibilities – part is the city's responsibility and part is the responsibility of DART.

Q: Did you look within the industry instead of just outside? LA has done something to solve these issues.
A: They needed a solution really quickly. They didn't have the time to write the specs for a whole new system.

Q: What performance measures do you use?
A: TTI helped with a before and after study. There was an increase from 18 to 24 trains. Also slight improvement in traffic travel times.

Q: Do they have on-going performance measurement? Or just the before and after results?
A: They do not currently have on-going performance measurement plan but would like to have real time monitoring to see if travel times start creeping up.

Changing Paradigms Using Technology
2nd Generation TSP in Seattle, John Toone, King County
The King County (KC) Transit ITS Architecture includes a complete CV environment for transit using 4.9GHz public safety band. CV describes short-range, high bandwidth wires communications between vehicles and the transportation infrastructure. Ultimately, CV will standardize on the 5.9 GHz DSRC Band. The architecture unifies 1,400 buses and five systems on a single network.

The benefits of the ITS architecture include: multipurpose, extensible (new installations require little new engineering) and expandable (new systems can be easily integrated).

KC is currently running multiple systems including TSP, off-board fare payment, real time information signs, signal interconnect, vehicle location and transit security video (not in operation yet).

The key components for TSP in a CV architecture are the smart bus (knows its location and the location of priority intersection approaches); unified network (equipment can communicate and interact in a secure environment); and mobile wireless communications. In this CV architecture, *the TSP strategies get loaded into priority request server in the controller; then signal timing plans are loaded into the signal controller; and the bus fleet is loaded with the location of every TSP request on every route pattern.*

An example of TSP messages associated with a TSP request applications include: (1) The signal controller implements a TSP request based on the initial detection point—the CV architecture makes this a virtual location where there is no hardware. The priority request message includes a time stamp and the number of passengers on board at that time. (2) Once the bus is through the intersection there is a Checkout detection, which allows the signal to drop the call. (3) Signal priority scenarios. Using a CV environment allows multiple TSP scenarios within the same system. (i.e., data transfer between the transit management center, traffic control center, transit vehicle and signal control are all interconnected.)

The system allows for detection initiated by the bus based on location. This has several benefits including: detection points can be anywhere within the coverage area; detection points can be easily changed; it can accommodate complex strategies and multiple priority requests; and it has huge bandwidth support for the full TCIP dataset.

Finally, a unified ITS network supports more than just TSP. It includes a common platform for all communication paths and allows for integration between systems to improve capabilities. For example, remote weather monitoring can be done with the technology. This architecture is intended to be the foundation for multiple additional future efforts.

The next presentation will tell more about how the detail of the system works.

4.9 GHz Applications for Transit - Bryan Nace, DKS Associates
The focus of this presentation is to discuss how you take the concept of CV and make it work between agencies. The KC Transit ITS architecture provides a CV environment for transit using the 4.9GHz public safety band. The decision for 4.9GHz relates back to decisions from the ITS architecture and the presenter emphasized the importance of the systems engineering process for building the deployment scenarios that contributed to a life cycle cost assessment that made it clear to all stakeholders. The KC system unifies 1,400 buses and five systems on a single network infrastructure connected to the county wireless network. The system has provided opportunities to leverage the infrastructure for multiple uses, for example the City of Seattle is also using KC technology for the Rainer Ave corridor for its traffic signals. The goal was to come up with a common platform that allowed multiple agencies access with considerable room for growth. A concept of operations was envisioned with seamless operation from one agency to another.

The program began first with on-board equipment including bus tags/smart bus with a mobile router and evolved to roadside fiber optic ethernet, then center-to-center backhaul, then to TSP and finally to the future which is envisioned to make use of bus stations with integrated technology pylons. The capabilities of the system include: 54MB wireless, 2500 + range with 13MB wireless, 100MB over fiber; support for any IP based device; and support for emergency operations.

There was a brief discussion of the wireless medium (4.9 GHz vs. 5.9 GHz) and some speculation about the emergence of 5.9GHz applications. The presenter surmised that the future may be to use 5.9 because that has been allocated by FCC for this purpose. However, 4.9 was used in this project because that what was available in 2006 when they started this project.

Transit Signal Priority: Improving Its Benefits – Tom Urbanik, Kittelson

In order to improve on TSP, it is necessary to understand what existing standards can and cannot do. The first generation began with transit signal pre-emption in the 1970s. It consisted of passive signal control, was highly disruptive and was not very successful in meeting the expectations of implementers. One form of transit priority relied on height detectors to determine which vehicles were buses and often made errors including falsely identifying trucks as buses.

The second generation (which is where we are now) has come a long way. It includes priority concepts and the addition of conditional priority but is largely based on first come, first served basis. The third generation is system-based and incorporates an understanding of how traffic signals work and the establishment of transit priorities. It uses "smarter systems" to make "smarter decisions."

The second generation has benefited from several enhancements over first generation systems including: the emergence of standards; improved signal controllers; better communication; and better acceptance of TSP. We now have a national architecture for data and communication interfaces. Dedicated short range communications (DSRC) facilitates improved communications. NTCIP 1211 allows transit to talk to traffic signal and request priority. NTCIP 1211 has parameters for time of service desired (what time will the bus arrive at signal); estimated time of departure, priority level, priority class, and vehicle ID. For example, the future will allow a BRT bus to get priority over a local bus. Right now, the system works primarily on a first come, first served basis.

In order to achieve better transit operations in the future better understanding of signal operations and bus operations. For example, information on which bus routes are the biggest challenges, how to "tune" bus schedules to capture TSP value and where TSP can be most effective from a system perspective.

What's missing? There is still a need to be able to understand your overall system. Buses go in more than one direction. When implementing TSP on a network need to understand the whole system. There is a need to understand where benefits can be accrued along a route; understand where the problems are likely to occur; and gain a global perspective of what is going on along the entire corridor.

How do we move forward? It is important to see the CV program as an enabler. Once we see this as an accepted way to get there, we will be better off.

Wrap-Up Discussion

The presentations yielded several distinct aspects for moving forward between traffic and transit agencies as we seek to implement transit priority within the CV technology environment. There were general comments and questions related to the implementation of TSP and how it might be *taken forward with the CV program. There was a theme around the questions encouraging FTA to focus on getting information in the hands of practitioners about the CV test programs that are happening at a few of the sites around the country. There were follow-up questions related to the details about the technology used in the various cases and how traffic signal controller hardware/software was modified to meet the needs in Portland, Seattle, and elsewhere in the country.*