

**Transit Signal Priority in a Connected Vehicle World:
Leveraging Technology to Improve Performance Seminar**

SEMINAR SUMMARY

TUESDAY, AUGUST 14, 2012 – 9:00 AM to 3:30 PM

Sponsored by the Federal Transit Administration/
Institute of Transportation Engineers/ American Public Transportation Association
Atlanta, GA

Room Location: America's Mart Building 2, 4th Floor, 204 F

Audience: Approximately 30 attendees including a mix of transit professionals and traffic engineering professionals. Attendees were primarily from the private sector but there were a few public sector employees. Attachment 1 contains a roster of the attendees.

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

Seminar Evaluation: Presenters received high ratings from seminar participants. A summary of the evaluations received is included in Attachment 3.

Summary and Conclusions: See the last page of these notes to review summary and conclusions.

Signal Priority and Preferential Treatments for Transit

Introduction/Welcome – Lisa Fontana Tierney (ITE), Ron Boenau (FTA), Lou Sanders (APTA)

Goals and Objectives

- *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.*
- *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 of 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.*
- *This seminar 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 (TSP) 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.*

Purpose of the Meeting and Meeting Outcome – Peter Koonce, City of Portland, OR

The purpose of the seminar 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 USDOT and how it may apply.*

Meeting Outcomes:

- *Learn about the CV program and how transit agencies are planning to 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.*

Learning Objectives:

- *Describe an overview of TSP techniques and the technology used during implementation and maintenance.*
- *Discuss new approaches to improve transit and traffic systems through priority treatment applications using emerging technology.*
- *Learn how the FHWA Connected Vehicle Technology program will impact future projects resulting in increased safety, efficiency, and improved transportation systems.*

Brief Overview of TCIP, Lou Sanders

- *TCIP is the transit application of the “sausage diagram.” It lets you define the interfaces among all the various elements.*
- *An important component of TCIP is that it was developed in an environment that is consistent with the national architecture and NTCIP.*

- *TCIP tools, called TIRCE, have been prepared to make TCIP more user friendly – TCIP is a “foot and a half of paper” but tools have been developed to help simplify the application. TIRCE is available for agencies to use in creating standards-based project and procurement requirements.*

Overview of the Federal Transit Administration’s Role in the Connected Vehicle Initiative – Ron Boenau, FTA

- *Public Transportation in the U.S. provides access to jobs for millions of Americans with >55 billion trips/year.*
- *Transit ridership increased 38% in a recent 13 year period while U.S. population grew 14%.*
- *Gas prices and use of technology make transit more desirable and increases riders’ choice. The importance of transit in urban areas is significant when considering access to downtown or other high density areas.*
- *There are currently several federal ITS Public Transit research projects including Mobility Services for All Americans (MSAA); Vehicle Assist and Automation (VAA); Integrated Corridor Management (ICM); and Connected Vehicle (CV) Program.*
- *The Vehicle Assist and Automation (VAA) program includes technologies that partially or fully control bus movement including, for example, precision docking, vehicle guidance, and collision warning/avoidance.*
- *The Integrated Corridor Management (ICM) program goals include demonstration and evaluation of strategies and ITS technologies that help transportation operators efficiently and proactively manage corridors.*
- *The transit connected vehicle program concept of operations includes safety, mobility, and environmental applications.*
- *Agencies in the transit community tend to look to their peers for leadership in adopting new technologies, which can lead to stagnation. One example of this is while AVL systems for internal use were adopted quickly, AVL information to the public has been slow in developing.*

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

- *An audience poll indicated that about ½ of the audience has planned TSP systems; a few have designed them; and for a couple people in attendance TSP is a new concept.*
- *The presentation focused on the basics of TSP operation and how it fits in the context of connected vehicles.*
- *One problem in trying to move transit faster is co-mingling with mixed traffic flow. Overall objective of successful transit priority treatments is to determine how to best “share the space” to make the overall street network more effective.*
- *Exclusive bus lanes may be the best option for moving transit but TSP is thought of as more of a system-wide improvement.*

- *Traditional signal timing has the primary objective of minimizing delay for vehicles. TSP modifies this objective slightly by recognizing that buses operate differently and provides an opportunity to reduce delay for buses.*
- *Techniques such as red truncation and green extension can be used the latter is especially beneficial if the bus comes late in the cycle and time can be taken away or borrowed from the next phase.*
- *In TSP applications, the key is not how much green time is available but having the green at the right time. Shorter cycle lengths can also help as passive strategies, but may reduce the flexibility of the typical TSP strategies.*
- *Outcomes of the meeting are defined as (1) Identify key elements of TSP that are barriers for implementation and (2) How can we do better with the new technologies that are now available to us?*

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

- *This presentation focused on the research results of TCRP Synthesis 83: Bus and Rail Preferential Treatments in Mixed Traffic.*
- *Overall project focused on a broad range of bus and rail preferential treatments with emphasis on at-grade transit on arterial streets (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. The focus of the seminar presentation was on TSP.*
- *A summary of a broad-based national survey conducted in 2009-2010 of 100 transit agencies and their partnering traffic agencies provided information on warrants, costs, and impacts of treatments as well as sample interagency agreements.*
- *Survey results 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 other survey results are as follows:*
 - *Intersection-based treatments are the most common.*
 - *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.*
 - *According to the survey, the transit agencies are primarily 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.*
 - *Traffic agency perception of transit preferential treatments is that they perceive higher impact on treatments that take up ROW as opposed to spot*

treatments and therefore are more likely to support spot treatments over roadway segment treatments.

- *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 a formal comprehensive transit preferential treatment program within most transit agencies, and (4) only a slight majority of 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 U.S. with 460 transit priority treatments including Bus/Streetcar/LRT and limited application of TSP); Seattle (speed and reliability program – bus which was focused on TSP and other improvements); Portland (integration of bus/streetcar/LRT with a large emphasis on TSP), and Denver (skip stop/bus lane applications, limited TSP).*
- *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.*
- *A new TCRP A-39 research project which will be initiated in 2013 will address some of these issues and may include recommendations to amend the MUTCD.*

Question & Answer Session

Q: Are there criteria for when you should consider a queue jump treatment?

A: There is a list of criteria in the report

(http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_83.pdf) for when you should consider queue jumps including what the tradeoffs are.

Q. Is violation of queue jump lanes a common issue?

A. There is always potential for this but it is not a huge issue. There are special signals that can be seen only by the bus and enforcement is always key. However, through

movement queues that block the right-turn-only/queue jump entrance are a significant issue. There is a need for design analysis to determine the length of the queue jump lane. A good method of enforcement is the use of clear signage.

Q. Are there examples of successful Integrated Corridor Management (ICM) programs?

A. Yes, in Dallas and San Diego.

Q. Is there anything in the research that quantifies the time saving benefits of TSP?

A. There are some tables in the back of the TCRP report that documents the travel time savings, but they are largely generalized by several assumptions.

Q. (Observation by Toronto) Traffic is supportive of queue jumps, but unpopular with planners because of the long pedestrian crossing distance.

A. Curb extensions are a tool that helps transit and reduces the pedestrian crossing distance.

(Aside some of the best traffic/transit coordination is at MUNI in San Francisco that has over 500 priority treatments and has traffic engineers on the transit staff. Vancouver is another example of a city with good transit/traffic cooperation.)

Q. It is important to have good coordination between TE and transit agencies... where is this being done?

A. The best example of coordination is in San Francisco. The two agencies have moved them into the same department to work together. In Canada, the best example is in Vancouver. The transit planning for the 2010 winter Olympics – managed lanes, exclusive bus lanes is a good example. The coordination between the city and the transit agency was excellent. They were drawing in buses from all across the country (and from the U.S.), so they couldn't use TSP – the buses had different technologies... managed lanes were used instead.

Q. Is preemption or priority used for LRT?

A. Preemption is integrated into LRT systems. Buses do not use preemption.

Q. What is the status of Connected Vehicles? Is V2V development still a priority over V2I?

A. There is no formal change in prioritization of effort, but there seems to be a trend toward a balance between the two.

Q. (Observation) TSP is an incremental improvement over several signals, not a big benefit at a single intersection.

A. TSP is a subtle tool with benefits beyond just travel time reduction including increased schedule reliability, reduced pavement wear (less buckling from heavy vehicles stopping), and reduced point emissions (less idling in queue). A significant question is how you measure and quantify these benefits.

Q. Peter Koonce asked rhetorically if transit is really reticent to adopt new technologies.

A. Not in his experience. A survey response showed many feel there are too many layers

of coordination required for ITS. Successful technology innovations at agencies usually have an internal champion. ITS/ITE members can be those champions. Yes, public transit can be risk averse, but they are also financially constrained. ITS is desired, but not always affordable.

Q. Do agencies prefer to use passive treatments instead of conditional priority?

A. Making decisions on what conditions to use is very difficult with many factors: is TSP for travel time (prioritize late buses) or schedule reliability (prioritize all buses)? Are you favoring transit for the number of riders on the bus or waiting to board the bus?

Q: Does MAP 21 give us an additional ability to improve V-I?

A: There is no significant change.

Perspectives on Transit Priority Applications

History of Transit Priority – Tom Urbanik, Kittelson & Associates

- *Tom is against the use of warrants for TSP: “warrants are reasons NOT to do something. Well-designed TSP should be able to work anywhere.”*
- *This presentation provided a brief history of transit and traffic. Passive priority began in the 1930s.*
- *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. Preemption allows the controller to take over complete control of the signal without regards to any other factors. The negative impacts of these early implementations set back TSP '20 years.'*
- *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. Priority allows preference but not complete preemption. This is much more palatable. 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.*
- *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 third generation is where we need to go in the future.*

- *Some of today's systems today include smart buses. They know if they are on schedule or off schedule. Timelines really should be the key and is even more important than knowing how many people are on a bus. In his opinion, if used, conditional priority should consider on-time status, but not passenger load. It should be noted that the TCRP Synthesis indicated that many agencies don't currently have an effective way to get this information integrated to the traffic signal system.*
- *In order to achieve better transit operations in the future, there needs to be a better understanding of signal operations and bus operations. For example, information on which bus routes to prioritize 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, there is a need to understand the whole system; where benefits can be accrued along a route; where the problems are likely to occur (what are the limitations); and gain a global perspective of what is going on along the entire corridor.*
- *What do we need to achieve better transit? If more than one bus comes to an intersection, there is a need to know which one is more important. Conditional priority is very important from the bus side. We cannot do a good job with TSP with near side bus stops. The problem with near side stops is that information is limited because the system doesn't know if the bus is going to stop and if it does, for how long. Smarter decisions are needed – what is ITS (its technology stupid). It is information at the right place and the right time.*
- *TSP has arrived, 40 years late. There is a need for a better understanding and for both sides to realize the benefits. In many cases, the overall system (total intersection delay) can be reduced.*

Q: Should TSP systems provide feedback to vehicles and drivers?

A: Too much information to bus drivers might be counter-productive. Feedback to vehicles is something that is addressed in the Signal Phase and Timing (SPAT) area of CV.

Q: Are pedestrian calls factored into red truncation strategies?

A: Yes, MUTCD pedestrian crossing minimums are required.

The Case for Improving a Status Quo TSP System – Peter Koonce, City of Portland, OR

- *Portland's first generation signal priority system was designed in 1997 after initial testing of different traffic detection technologies. The transit system included GPS-based Automatic Vehicle Location which made the system able to grant conditional priority. The bus to traffic controller communication method was shared with fire services (Opticom). Engineers set the priority distance to "approximately" where the buses were with this system.*

- *How it works: A “smart” bus knows its general location and if it was late, it activates the Opticom emitter. The intersection receives the call and as the bus passes through the signal, the controller returns to normal operation.*
- *The bus detection system consists of an optical detector, which gets a message from a bus and sends it through wires in signal controller. It is a one-way system – no information is going back.*
- *Given that the Portland TSP system is over 15 years old, a wider variety of detection systems including radio-based, wayside detector, and WiFi should be considered.*
- *Infrared optical detection has several advantages and disadvantages. It was a simple detection system that used existing equipment on many intersections, a proven technology, and relatively low-cost. The disadvantages include limitations on line of sight; a limited amount of information transmitted; and is proprietary.*
- *Signal priority overview: If the bus arrives on green (or if the bus is getting close to an intersection), it sends a message to get extra time. If the bus arrives on red, it shortens other phases. A determination is made as to whether the bus will be stopping or not. The Portland signal priority implementation includes over 360 intersections (240 are bus-only) and 100 are rail. This system was the most expansive system of its time. (Los Angeles has now taken over with the most.) The system resulted in travel time reductions and a key benefit was reliable service delivery to passengers.*
- *The standard approach to a TSP message is to assess the bus stop location and determine how often the bus is stopping at that stop. Traffic signal capabilities are then determined and the detection range is set in the field based on estimate of the speed.*
- *The future approach in a CV realm is to measure the traffic conditions and possibly alter plans based on real-time conditions. This would allow different treatments in the morning and afternoon.*
- *Existing AVL criteria include determinations as to the bus location, doors closed, and whether the message has already been sent. A determination of “late” was originally defined as 90 seconds; they have now gone to a 30-second late threshold.*
- *Additional possible criteria that can be considered for prioritization include if the bus is going to stop at a nearside location, ridership numbers, and what time of day it is. Need to consider: Are you competing with other buses? What are the headways on competing routes?*
- *In summary, partnerships are needed to build successful transportation systems. Partnerships require an exchange of system information in order to design effective TSP. The systems also need to be updated to better use new information. For example, Labor Day Monday is treated the same way as any other Monday. New systems will be able to accommodate this information.*

Q: How is “late” defined?

A: It should be based on headway. If you only have one bus every 30 minutes making a change to the signal timing, it is not that big of a deal. More aggressive TSP strategies are appropriate for infrequent, ‘pulsed’ service.

Q: Does Portland's system use line-of-sight, not GPS?

A: Correct, it relies on proximity, which is dependent on external factors that lead to inconsistent detection points. Opticom now offers systems that utilize GPS location.

4.9 GHz Applications for Transit Applications in Atlanta – Bryan Nace, DKS Associates

- *The focus of this presentation was on the use of radio for TSP and other transit applications. There are various frequencies available for wireless transmission and the 4.9GHz band is very similar to 5.9GHz DSRC.*
- *As a summary into what MARTA is doing, the presentation began with an explanation of what is taking place on the West Coast – King County (KCM)/Seattle DOT Concept of Operation. The Seattle system is much more advanced, so this is a good model for others to consider.*
- *The KCM 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 systems engineering process for building the deployment scenarios that contributed to a life cycle cost assessment. The KCM 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 KCM technology for the Rainer Avenue 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.*
- *MARTA operates very differently than the King County systems described. There are three on-going transit ITS projects in Atlanta: TSP implemented with GPS, mobile CCTV, and train control upgrades.*
- *The MARTA SmartBus program includes a full fleet of 700 buses of fully equipped smart buses. Most importantly, they added an Opticom GPS system in 2009. 100 percent of buses have capacity counts, wireless routing, fare data, etc.*
- *The MARTA Mobile CCTV program consists of 2,000 fixed cameras, with up to 12 cameras per bus with a total of over 9,400 cameras. This project is being implemented now using some different frequencies including 5.0 GHz, 4G LTE, and 2.4 GHz wireless. A 10 GB backbone was installed to support video. MARTA is also starting to virtualize their data centers. If the primary site were to go down, a virtual site would go into action. This is a cloud-based application.*
- *The MARTA train control upgrade system project consists of 22 stations using 4.9 GHz public safety mesh wireless. Deployment is anticipated in 2013.*
- *The future of mobile wireless may be multiple-radio integrated services routers, providing IP based networks for flexible data exchange.*

Question & Answer Session

Q: How long does MARTA archive video?

A: 30 days storage on bus. Logs are then maintained for 2 years off site.

Q: How accurate is the MARTA precision accuracy?

A: Today, TSP is a standalone system. The system has plans to incorporate AVL... this will happen in the future. The accuracy is currently plus or minus 30 feet.

Q: Does BRT have dedicated lanes?

A: No, it is in mixed traffic.

Q: What is the device that is used?

A: Mobile Gateway technology – the device is called an integrated services router (in motion).

Changing Paradigms Using Technology

Traffic Controller Developer Perspective – Gary Duncan, Econolite

- *Early TSP was constrained by the sensor data that were available to it. Systems were limited to check in and check out based on a loop detector buried in the road. TSP and emergency vehicle preemption applications were examples of early CV efforts. At the time, it was called VII and was being demonstrated as early as 2005.*
- *There are a number of things that have driven expectations for TSP and CV. CV architecture supports the common elements of existing TSP or emergency vehicle preempt solutions. On-board equipment is needed that can generate a priority request. Roadside equipment is also an important part of the communications. DSRC is the primary technology being used. However, DSRC has distance limitations of approximately 300 meters.*
- *TSP is also being driven in the CV world because it can provide priority to multiple different types of modes – not just transit but also emergency vehicles, freight, etc.*
- *Some of the other things that have driven TSP in the CV world: (1) Both centralized and distributed priority concepts can be supported in the CV architecture. (2) The use of TSP is also looked at as an early success story for the CV program and will not require general (private sector) fleet deployment. (3) The CV approach (potentially) offers a non-proprietary solution to the hardware. It may also promote sharing between agencies if they are all using the same non-proprietary hardware.*
- *What will it take to get there? There is a need to move from research proof of concept and research to real implementation. We have seen some great examples in this seminar. The NTCIP 1211 standard will help us move forward. We need to develop standards in our industry if this is going to take off. The signal timing and phasing standard (SPAT which is in the process of being developed) will help. There are other standards still needed, such as standards for the RSE or OBE platform to allow for cross platform interchangeability at the hardware and software levels.*
- *Another significant consideration to determining what it will take to get there is a big question on what type of infrastructure will be needed for the CV program. There is both a cost to this and the physical aspect of getting it installed. Traffic signal controller-wise, there are decisions that have to be made. Many existing controllers can support current TSP solutions. However, a study done to determine how many controllers are ready for signal timing and phasing support indicated that only about 38 percent could be upgraded to support CV applications. As we replace signals, we need to think about what is needed to support the CV world.*

- *Finally, another consideration to get us there is related to applications development and this may come from the private sector. These solutions need to be developed. Right now, most TSP controller applications are based on a single level of priority (first come, first served). CV solutions must handle multiple levels of priority in order to provide optimum priority service. More work needs to be done in the area of freight priority. There is some research that is currently underway¹, but more work needs to be done. For example, what are the conditions when we should grant priority to trucks? Market factors will drive the private sector to improve on today's controller solutions.*
- *Some relevant projects to watch include (1) Signal Phase and Timing Message set standard and definition – SPaT. This project allows roadside infrastructure to inform approaching vehicles of intersection status and allows vehicles to send service requests to the intersection. There hasn't been a current standard to date. This was seen as an important need. About 1 and ½ years ago a team was put together to help define a message set that was implementable on today's controllers using the 1211 standard. This has been completed now. The project resulted in an NTCIP-based SPaT message set that was shown to be supportive on both current NEMA and 2070 controllers. The SPaT messages will be used in the upcoming safety pilot including a demo of improved transit/pedestrian safety at intersections using SPaT data. The next step is to get SPaT objects into NTCIP standards. The goal will be to roll them into the 1202 standard within the coming year. (2) The ATC standard update. The current generation of NEMA and 2070 controllers can be updated to support SPaT. However, of the 311,000 signals in the U.S. only 38% could be updated to support SPaT. This implies that a number of controllers may need to be upgraded in order to fully support CVs. The ATC standard just went through a major revision. It will be balloted soon to go out for user comment and should be able to support advanced concepts well into the future. (3) The multimodal intelligent traffic signal system (MMITSS) pooled fund study. This study has the purpose of defining a new traffic signal system approach that takes full advantage of the CV environment. The elements that are being looked at include ITS systems, TSP, emergency vehicle pre-emption or priority, freight signal priority, and mobile accessible pedestrian signal system. The study is being led by the University of Arizona with UC Berkeley. First phase is mainly a paper phase: gathering requirements, with a concept of operations, and study. The current status of the project is that the requirements data gathering phase has been completed. The first phase of the study is expected to be completed in early 2013.*

Traffic Signal Systems Implementation Concepts – Bob Rausch, Transcore

- *New York City (NYC) uses an alternative implementation approach to TSP and preemption. The NYC system that is moving forward that does not rely on DSRC. The system is centrally managed, priority/preemption over broad-based, wide-area*

¹ Multi-Modal Intelligent Traffic Signal System: Development of Concept of Operations, System Requirements, System Design, and Test Plan, http://cts.virginia.edu/PFS_MMITSS02_Task1_PMP.pdf, visited October 28, 2012.

wireless communications. This approach is being used in NYC for a system of 12,000 intersections with 6,000 buses, using a wide-area network.

- All CVs must include accurate location mechanisms and significant on-board processing capabilities and all vehicle fleets will include GPS tracking.
- Other trends include smarter, faster controllers; network connections to the street devices; and have available wide-area, broad-band ubiquitous communications. These capabilities enable you to do a lot more than what has been done in the past.
- The NYC early experiences with TSP included the classic TSP approach on projects such as Victoria Blvd and Fordham Road. They found that it worked... travel times decreased improvements were made but... the capital cost for installing these was not practical. They needed to look at an alternative approach.
- There must be a more cost-effective approach. All these things already exist: High speed TMC to intersection; transit vehicles already have GPS, and transit vehicles may already include high-speed wireless to transit management center.
- Summary – The NYC DOT, given its size, needed to support TSP but specialized infrastructure was considered too expensive. The approach they are using has no additional intersection infrastructure. The only infrastructure costs consist of in-vehicle systems. Not a significant cost. The centrally managed approach allows “big picture” conflict resolution and alternate routing. Wide-area communications is a viable solution.

Q: How does NYC leverage the current cost of 4G service?

A: From a transit perspective (the service was already provided) so they don't pay anything. No additional cost for TSP... very opportunistic.

Why is TSP Compelling to the Transit Agency & Traffic Agencies in Seattle – John Toone, King County

- King County Metro (KCM) has over 2,000 square miles of service area, 1.9 million people and 120 million trips per year on 1,300 buses.
- KCM 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 SmartBus (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.
- The KCM TSP is compelling to both the transit and traffic agencies in Seattle because they worked together and had similar goals, benefits, costs, and commitment.
- Having shared transportation goals was an important part of the success. They talked to everyone including the planners, engineers, elected officials, and the public. They all wanted to maximize mobility and minimize costs. The bottom line is mobility.

- *Done correctly, TSP implementations provide a new improvement in transportation speed and reliability. The shared benefit is the use of time and space that is most efficient.*
- *The costs of this project were shared. Capital partnerships benefit many modes of transportation. They got funding from the federal government and they also got a 1/10 of a percent of sales tax increase to help fund the project. In some cases, they gave small cities some funding just to bring up their signals up to date. This resulted in a two-way benefit for existing automobile traffic and other modes and the public transit of TSP.*
- *These projects demonstrate a shared commitment to getting the most efficiency out of the transportation system. Transit and traffic engineering professionals collaborated to develop and test new technologies and standards. The City of Seattle now funds and builds TSP installations on their own initiative with the support of KCM. After 10 years of working on this partnership, building up an understanding between planners, engineers, public, they have created a really good relationship with their cities. Seattle recently agreed to build two more corridors and gave them to King County.*

Question & Answer Session

Q: Have they talked about a long term funding strategy?

A: Yes, they put corridors into the regional planning documents and ultimately into their capital improvement program.

Q: Are you aware of significant research on this topic?

A: The researchers are finally focusing on the areas that we need. It has taken a while for everyone to realize what the capabilities of CV are. The emphasis seems to be in the right place although there is some duplicative research being done.

Wrap-Up Discussion with Panel moderated by Peter Koonce (Ron Boenau, Gary Duncan, and Tom Urbanik)

- What additional information do you need from ITE and FTA to inform you about this topic?
- What opportunities do you have forthcoming for working with local agency partners?
- What opportunities are there for a long-term strategy to integrate transit signal priority with the evolving connected vehicle initiative?

Q: What further research needs to be done? What are the issues?

A: One of the issues that was raised was that our traffic system analysis is not scaled up, engineers complete spot analysis, and are not prepared for multi-input prioritization.

A: There is a general lack of understanding about communication networks and network security among traffic and transit professionals. This is a hindrance to the expansion of CV and TSP.

A: The public agency IT staff needs to be a partner in ITS.

A: Relationships are keys to implementing TSP.

Q: What do we need to do to further implement TSP?

A: We are not yet looking at this from a systematic approach. For example, we look at one lane of travel and develop a model and then apply it to a 9-lane road and wonder why it doesn't work. How do you make a decision to prioritize competing requests?

A: Something that is needed and that a lot of cities lack is leadership. Cities would like to hear from FTA what the best path forward is, in particular for smaller agencies. In response, FTA offered that they can do things to help, such as bringing together a series of peers and providing technical support.

A: One problem with some of the local TSP programs is that the solutions being developed are often proprietary. We should be looking at standards and moving forward on a consistent platform. We are going back in history in the wrong way. We worked a long time ago to get away from all proprietary stuff in signals. Why would you install proprietary systems? A large part of the problems is that while there are standard messages. The problem is that there are concerns with security.

A: Another area of focus for improved implementation is to help train engineers in communications and relationship building. This has been shown to be a key to success.

A: Cooperation amongst the industry practitioners is also a key to success. The industry perspective has grown by cooperating to get the best solutions. The standards process has also helped. If we are going to continue to grow as an industry, we are going to have to share even more than we have in the past to improve interface standards. Security is a big part of this. Network security and networking is not really fully understood. More education is needed.