Traffic Management Systems (TMSs) Supporting Part-Time Shoulder Use (PTSU)

Transportation Management Center (TMC)

Pooled-Fund Study(1)

Federal Highway Administration (FHWA)

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Presentation Outline

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How TMSs Manage and Operate Part-Time Use of Shoulders

- Agencies have implemented PTSU, or the part-time use of shoulders, on freeways and other roadways to support actively managing traffic.
- Agencies can use PTSU to actively manage traffic to address the following:
  - Increase peak roadway capacity (e.g., use of shoulder) when needed (e.g., crash restricting flow in another lane, increased demand).
  - Allow transit vehicles to use shoulders to bypass congested traffic.
  - Improve safety and reliability.
  - Provide access for emergency responders.
- Agencies implement PTSU based on time of day and day of week or traffic conditions.
- Some agencies implement PTSU along with variable speed limits and other TMS strategies.
- TMS assets may include:
  - Closed-circuit television cameras (CCTVs).
  - Changeable message signs (CMSs).
  - Overhead lane control signs.

PTSU Benefits

- Adds roadway capacity only when necessary, allowing the shoulder to remain a refuge for most hours of the day.
- Reduces severity and number of crashes and improves reliability of travel during the times PTSU is in operation.
- Helps agencies address political, physical, and financial constraints.
- Enables a flexible and cost-effective solution to managing traffic and improving overall transportation efficiency.
- Reduces travel time from 22 min to 10 min on average, according to the Michigan Department of Transportation (DOT).[1]

Issues Faced by TMSs Supporting PTSU

- TMSs face challenges with operating and managing part-time shoulders for the following reasons:
  - Traffic conditions may change often or sporadically (e.g., incidents, planned special events).
  - Traffic demand may exceed vehicle-carrying capacity of travel lanes during these events.
  - Traffic demand does not support adding a traffic lane, which can be expensive.
  - Procedures may differ from other traffic management operations, such as variable speed and lane control.
- Agency challenges may include:
  - Operational strategies, agency policies, and operating procedures may need to be altered.
  - Legislation and policies may need to be developed to implement and manage the use of PTSU.
  - Additional TMS resources, capabilities (e.g., surveillance, monitoring), staff with special skills, or training may be needed.
- Careful planning is required to integrate PTSU into TMSs.

Desired Outcomes of Using PTSU

- Manage TMSs actively based on changing conditions and circumstances.
- Improve safety by reducing the number and severity of crashes.
- Alleviate congestion and increase system reliability by adding capacity at the times when capacity is most needed.
- Provide emergency responders with access to crashes and incidents.
- Understand the information operators need to actively manage and operate PTSU.

Key Considerations

- What policies, procedures, and staff resources are needed to support the active management and operations of PTSU?
- What operations staffing and scheduling are needed to enable and operate PTSU?
- What operator position is needed, in terms of knowledge, skills, and abilities, to manage PTSU operations?
- Are changes needed to operator position job descriptions?
- What methods are best for enforcing PTSU?
- What legislation, policies, and procedures are needed to actively manage and operate PTSU?

Challenges With Implementing PTSU

- PTSU benefits may vary from site to site because of the following:
  - Driver awareness of reasons to use shoulder.
  - Driver behavior.
  - Road geometry.
- PTSU compliance may be low if restricted use is not enforceable.
- PTSU requires significant investment in intelligent transportation system (ITS) field devices, TMS capabilities, staff, and support resources.
- PTSU implementation may involve the following:
  - Agency policy changes.
  - Agency operating procedural changes.
  - Additional staffing.
  - Additional training for operators.

TMS Support for Using and Managing PTSU

- TMSs need the capabilities and resources to support actively managing and operating the use of PTSU.
- TMSs need to perform the following functions:
  - Collect and process data.
  - Disseminate information to travelers, emergency responders, and service providers.
  - Ensure the shoulder is clear of obstructions prior to opening.
  - Monitor the shoulder in realtime.

Issues To Consider When Incorporating PTSU Into TMSs

- Agencies may implement PTSU based on times of day and days of week or traffic conditions.
- Agencies may implement PTSU with other TMS strategies (e.g., variable speed limits, dynamic lane management, display of queue warning messages).
- Agencies may need to integrate ITS devices to support TMSs in managing and operating PTSU.
- Agencies may need to change legislation, policies, or operating procedures for PTSU.
- Agencies may need to automate TMS operation of PTSU to achieve desired safety and operational results.
- Agencies may need to increase TMC operator staffing and training.
- Agencies may need to communicate PTSU status to vehicles upstream of the shoulder.
- Agencies have indicated the need for TMSs to have the capability to communicate with emergency responders and other agencies.

Considerations When Planning for TMS Support of PTSU

- Evaluate staffing resources and capabilities to manage and operate PTSU.
- Identify training needs to effectively operate PTSU.
- Integrate PTSU operational strategy into TMSs.
- Assess TMSs' capabilities to allow operators to monitor, evaluate, and report on travel conditions.
- Consider PTSU to mitigate adverse impacts of changing traffic and roadway conditions.
- Explore operational considerations when implementing or extending the use of PTSU along a roadway section or corridor or an entire region.
- Review policies and processes to actively manage and operate PTSU.
- Review legislation, policies, and procedures to operate PTSU.

PTSU—Scenario for TMSs Opening and Managing PTSU During Changing Traffic Condition

- TMS senses reduced speed and increased traffic along a section of freeway.
- TMS analyzes current and projected conditions to recommend opening the shoulder to accommodate traffic and improve travel reliability.
- TMS operator accepts the recommendation to implement PTSU.
- TMS operator uses CCTV cameras to verify no obstructions are on the shoulder where PTSU will be implemented.
- TMS operator dispatches service patrol or maintenance vehicle to confirm opening the shoulder to traffic is safe.
- TMS operator issues command to open the shoulder to traffic after receiving safety confirmation.
- TMS places a message on a CMS to inform approaching motorists of the opening.
- TMS changes the overhead lane control signs over the shoulder from red x's to green arrows.
- TMS operator monitors traffic flow on the shoulder using CCTV cameras.
- TMS operator initiates procedure to restrict traffic from using the shoulder by changing the green arrow to a red x when traffic conditions return to acceptable levels.

Examples of Agencies Using PTSU

State DOTs that currently use PTSU include the following:

- New Jersey.(2)
- Michigan.(1)
- Virginia.(3)
- Georgia.(4)
- Washington State.(5)

New Jersey DOT Example[2]

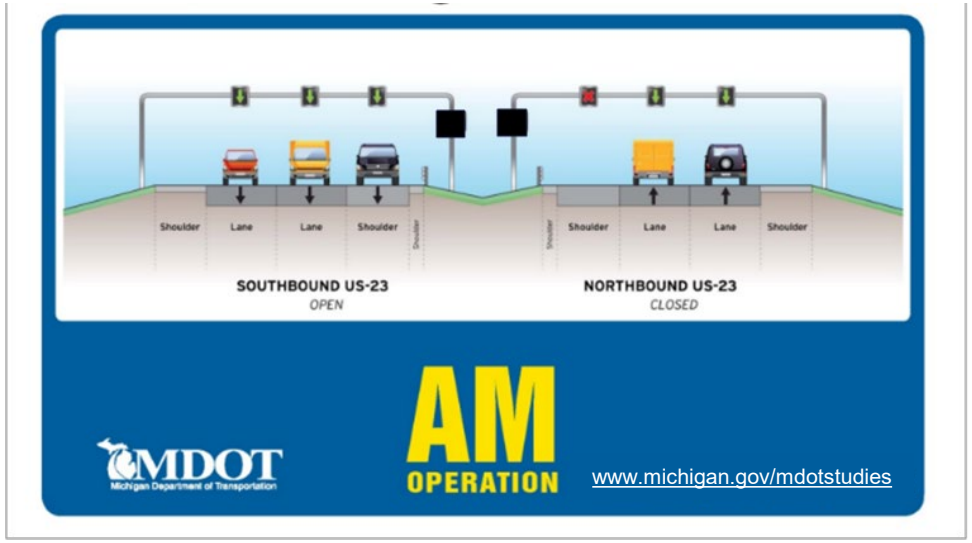
PTSU:

- Implemented on a 4-mi arterial section of U.S. 1.
- Stemmed from congestion at a lane-reduction bottleneck.
- Operates based on time of day and day of week.
- Uses lane use control signals, CMSs, and CCTV cameras to allow for application of PTSU when conditions warrant, offering more flexibility during changing conditions.
- Extended hours of operation implemented by New Jersey DOT.
- Managed initially by dedicated TMC operators, but all operators now support.
- Leveraged extensive stakeholder and public outreach for initial implementation.

Michigan DOT Example[1]

PTSU:

- Implemented on U.S. 23 in the Ann Arbor area when needed to provide additional capacity during peak hours and special events.
- Required no policy or staffing changes within the TMS to actively manage and operate.
- Uses reallocation of on-road maintenance personnel to sweep and verify that obstacles are not present to restrict the use of shoulders for traffic lanes.
- Presents a possible challenge in terms of timing deicer application in PTSU lanes during snow events.
- Improved travel time substantially.



Virginia DOT Example[3]

- Virginia DOT has operated PTSU for several years:
  - On I–66 in Northern Virginia: No longer in operation after implementation of managed lanes.
  - On I–264 in Hampton Roads: Shoulder is open for 2 h in each direction on weekdays and may be opened based on predicted or current conditions. Commercial vehicles are restricted from using the shoulder when opened to traffic.
- TMS operators can manage PTSU as part of routine duties.
- TMS operators must develop the needed capabilities before assignment to manage and operate PTSU.
- TMSs did not need additional staff to support PTSU management and operation.

Georgia DOT Example[4]

PTSU:

- Located along State Route (SR)-400 and I–85 northbound.
- Operates on a peak period schedule; however, the TMS may also activate, manage, or remain open as needed.
- Restricts buses from using the SR-400 shoulder; trucks are restricted from using the part-time shoulders on both SR-400 and I–85.
- Managed by senior TMS operators (TMC specialists).
- Activated after other TMS operators perform sweeps of shoulders for obstacles and then recommend activation to TMC specialists.
- Reviewed annually for standard operating procedures for activation and management.

Washington State DOT (WSDOT) Example[5]

- WSDOT has successfully implemented PTSU on various corridors:
  - I–405.
  - Highway 2.
  - Highway 14.
- WSDOT TMSs manage and operate PTSU.
- WSDOT designated transportation engineer positions to operate PTSU because of the capabilities required.

Lessons Learned in Incorporating PTSU in TMS

- Agencies that implemented PTSU based on changing conditions instead of by time of day required more TMS operator staff.
- Agencies that initially used TMS operators to manage and operate PTSU exclusively transitioned to training all operators to manage and operate PTSU.
- Agencies benefited from training TMS operators responsible for operating PTSU in traffic operations and traffic flow theory.
- Agencies found that PTSU operating procedures and plans should be reviewed and updated regularly.
- Agencies benefited from investigating the need for policy and legislative changes early in the planning process.

Additional Resources

- FHWA. 2024. “Part-Time Shoulder Use” (web page). http://ops.fhwa.dot.gov/atdm/approaches/ptshoulderuse.htm, last accessed August 26, 2024.
- Conference of European Directors of Roads, Traffic, and Network Management Working Group. 2022. “Hard Shoulder Running Fact Sheet v2.0.” https://www.cedr.eu/docs/view/629f3cd6e8920-en, last accessed September 19, 2024.
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- FHWA. 2023. "TMC Pooled-Fund Study" (web page). https://tmcpfs.ops.fhwa.dot.gov, last accessed August 26, 2024.

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1. Michigan DOT and Michigan State University. 2021. *Evaluation of an Active Traffic Management System With Part-Time Use of the Inside Shoulder*. Report No. SPR-1706. Lansing, MI: Michigan Department of Transportation. https://www.michigan.gov/mdot/-/media/Project/Websites/MDOT/Projects-Studies/US-Route/US-23-Flex/US23-Flex-Final-Report.pdf?rev=ec5248017b0a46bb8afa33e6970381b0&hash=E729FFAA1B83E3BBCF47E7205F6167EF, last accessed July 21, 2024.

2. New Jersey DOT. 2017. "Route 1 Congestion Relief Project Will Use Shoulder as Travel Lane During Peak Commuting Times in South Brunswick." News Release on June 16, 2017. https://www.nj.gov/transportation/about/press/2017/061617.shtm, last accessed July 22, 2024.

3. Virginia Transportation Research Council. 2016. *Evaluation of the Impact of the I–66 Active Traffic Management System*. Report No. VTRC 17-R5. Richmond, VA: Virginia Department of Transportation. https://vtrc.virginia.gov/media/vtrc/vtrc-pdf/vtrc-pdf/17-R5.pdf, last accessed July 25, 2024.

4. Georgia DOT. 2014. *Welcome Packet for the Public Information Open House for the Proposed I–85 Express Lanes Extension Project*. Atlanta, GA: Georgia Department of Transportation. http://mydocs.dot.ga.gov/PublicOutreach/110600-/PDF/110600_PIOH_Welcome%20Packet.pdf, last accessed September 18, 2024.

5. Washington State DOT. N.d. "Part-Time Shoulders" (web page). https://wsdot.wa.gov/travel/roads-bridges/part-time-shoulders, last accessed July 21, 2024.

6. Jenior, P., R. Dowling, B. Nevers, and L. Neudorff. *Use of Freeway Shoulders for Travel—Guide for Planning, Evaluating, and Designing Part-Time Shoulder Use as a Traffic Management Strategy*. Report No. FHWA-HOP-15-023. Washington, DC: Federal Highway Administration. https://ops.fhwa.dot.gov/publications/fhwahop15023/fhwahop15023.pdf, last accessed September 20, 2024.

7. Michigan DOT. 2024. "Studies" (web page). https://www.michigan.gov/mdot/projects-studies/studies, last accessed September 20, 2024.

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Speaker's Notes

Speaker's Notes (1/22)

None.

Speaker's Notes (2/22)

This presentation is organized as follows:

1. TMSs Supporting the Part-Time Use of Shoulders – discuss the background for the implementation of PTSU, how they are being used, and the benefits of PTSU
2. Issues, Desired Outcomes, Considerations, and Challenges– discuss some issues, desired outcomes, considerations and challenges that an agency may face in the planning, implementation and operation of PTSU
3. Agency Practices and Examples – discuss a handful of agencies who have implemented PTSU along their roadways and what they are doing
4. Summary of Lessons Learned – summarize the lessons learned that agencies have shared
5. Resources

Speaker's Notes (3/22)

The strategy to use the shoulder as a part-time travel lane has been in existence for many years, originally as a TDM strategy to improve bus travel time and reliability.

- Part-time shoulder use may be used to fulfill any number of functions, such as:
- Increase capacity when needed to address congestion
- Allow transit vehicles to use the shoulder to improve travel time
- Improve safety and reliability by spreading the demand across more capacity
- Providing access to emergency responders during congested periods

Speaker's Notes (3/22) (continued)

PTSU can be implemented based on time of day and day of week – typically referred to as static operation. Where the use of the shoulder as a travel lane is based on a fixed, recurring schedule. If this case, the only treatment is static signing. Alternatively, the shoulder can be used – that is, opened and closed – based on demand, or as-needed. This is referred to commonly as a dynamic PTSU operation.

PTSU can be used as a stand-alone strategy to address congestion and safety or in combination with other traffic management strategies like variable speed limits or dynamic junction control.

Traffic management systems assets that may be needed include CCTV cameras to examine the status of the shoulder before deciding to open it and to monitor the shoulder for issues in real-time during operation. Changeable message signs to inform motorists of the status of the shoulder in lieu of overhead lane control signs or in advance of the shoulder. Overhead lane control sign that designate the status of the shoulder as open with a green down arrow or a red "X" to indicate that the shoulder is closed to traffic.

Speaker's Notes (4/22)

There are a number of benefits provided by PTSU:

- Add roadway capacity only when necessary, allowing the shoulder to remain as a refuge for most hours of the day.
- Reduce severity and number of crashes and improve reliability of travel during the times PTSU is in operation.
- Help agencies address political, physical, and financial constraints. Physical and financial constraints deal with a lack of resources, either physical space or funding. Political constraints deal with competing views of stakeholders and decision-makers. Some might want to reduce traffic congestion and others might want to limit additional pavement or additional full-time lanes. PTSU can be a compromise between these two views.
- Enable a flexible and cost-effective solution to managing traffic and improving overall transportation efficiency.
- One example of a benefit realized is the reduction of travel time from 22 minutes to 10 minutes by the Michigan Department of Transportation (DOT) along Route 23, which I'll talk a bit more on later.

Speaker's Notes (5/22)

Agencies implementing and managing part-time shoulders are faced with a number of challenges and issues.

Reason for these challenges include:

- Traffic conditions may change often or sporadically, for instance, incidents, planned special events.
- Traffic demand may exceed vehicle carrying capacity of travel lanes during these events.
- Traffic demand doesn't support adding a traffic lane, which can be expensive.

Speaker's Notes (5/22) (continued)

Procedures may differ from other traffic management operations, such as variable speed and lane control.

- The challenges faced by agencies may include:
- Operational strategies and agency policies or operating procedures may need altering.
- Legislation and policies may need to be developed to implement and manage the use of PTSU.

Additional TMS resources, capabilities (e.g., surveillance, monitoring), staff with special skills, or training may be needed.

So, it is imperative that agencies carefully plan for the integration of PTSU in their TMSs.

Speaker's Notes (6/22)

Desired outcomes of using PTSU include:

- Actively manage traffic management systems based on changing conditions and circumstances.
- Improve safety by reducing the number and severity of crashes.
- Alleviate congestion and increase system reliability by adding capacity at the times when it is most needed.
- Provide access for emergency responders to crashes and incidents.
- Understand the information operators need to actively manage and operate PTSU.

Speaker's Notes (7/22)

Key considerations when planning, implementing and operating PTSU include:

- Policies, procedures, and staff resources to support the active management and operations of PTSU.
- Operations staffing and scheduling to enable and operate PTSU.
- Operator position knowledge, skills, abilities and descriptions to manage PTSU operations.
- Enforcement of PTSU.
- Regulations – or statues – that may be needed to operate PTSU.

Speaker's Notes (8/22)

- The implementation of PTSU may present agencies with challenges such as:
- PTSU benefits may vary from site to site because of the following:
  - Driver awareness of reasons to use shoulder.
  - Driver behavior.
  - Road geometry.
- PTSU compliance may be low if restricted use is not enforceable.
- PTSU requires significant investment in ITS field devices, TMS capabilities, staff, and support resources.
- PTSU implementation may involve:
  - Agency policy changes.
  - Agency operating procedural changes.
  - Additional staffing.
  - Additional training for operators.

Speaker's Notes (9/22)

The engine that drives the operation and management of PTSU is the TMS.

The TMSs need:

- the capabilities and resources to support actively managing and operating the use of PTSU, and
- To perform functions including:
  - Collect and process data.
  - Disseminate information to travelers, emergency responders, and service providers.
  - Ensure the shoulder is clear of obstructions prior to opening.
  - Monitor the shoulder in real-time.

Speaker's Notes (10/22)

Agencies must consider a number issues when incorporating PTSU into their TMSs. These include:

- Whether to implement PTSU based on time and day of week or traffic conditions.
- Whether to implement PTSU with other TMS strategies (e.g., variable speed limits, dynamic lane management, queue warning)
- Whether to integrate ITS devices to support TMSs managing and operating PTSU.
- Whether to change legislation, regulations, or operating procedures for PTSU.
- Whether to automate the TMS operation of PTSU to achieve desired safety and operational results.
- Whether to increase TMC operator staffing and training.
- Whether to communicate the PTS status to vehicles upstream of the shoulder, and
- Whether to communicate with emergency responders and other agencies and how their TMS can do that.

Speaker's Notes (11/22)

When planning for TMSs to support PTSU, agencies may consider:

- evaluating staffing resources and capabilities to manage and operate PTSU.
- Identifying training needs to effectively operate PTSU.
- Integrating the PTSU operational strategy into the TMSs.
- Evaluating the capability of TMSs to allow operators to monitor, evaluate, and report on travel conditions.
- PTSU to mitigate adverse impacts of changing traffic and roadway conditions.
- Operational considerations when implementing or extending the use of PTSU along a roadway section, corridor, or entire region.
- Existing policies and processes to actively manage and operate PTSU.
- Existing legislation, policies, and procedures to operate PTSU.

Speaker's Notes (12/22)

Here is scenario for opening and managing a part-time shoulder based on changing traffic conditions.

- TMS senses reduced speed and increased traffic along a section of freeway.
- TMS analyzes current and projected conditions to recommend opening the shoulder to accommodate traffic and improve travel reliability.
- TMS operator accepts the recommendation to implement PTSU.
- TMS operator uses CCTV cameras to verify there are no obstructions on the shoulder where PTSU will be implemented.
- TMS operator dispatches service patrol or maintenance vehicle to confirm it is safe to open the shoulder to traffic.
- TMS operator issues command to open the shoulder to traffic after receiving confirmation.

Speaker's Notes (12/22) (continued)

- TMS places a message on a CMS to inform approaching motorists of the opening.
- TMS changes the overhead lane control signs over the shoulder from red "x"'s to green arrows.
- TMS operator monitors traffic flow on the shoulder using CCTV cameras.
- And lastly, the TMS operator initiates the procedure to restrict traffic from using the shoulder by changing the green arrow to a red "x" when traffic conditions return to acceptable levels.

Speaker's Notes (13/22)

Five State DOT's that use PTSU will be presented on the following slides. I am going to give you a very brief overview of the implementations as my fellow presenters will discuss each in more detail.

The DOTs include:

- New Jersey DOT
- Michigan DOT
- Virginia DOT
- Georgia DOT
- Washington State DOT

Speaker's Notes (14/22)

- New Jersey DOT implemented PTSU along a 4-mile section of US 1.
- The need for PTSU stemmed from congestion at a lane-reduction bottleneck.
- The PTSU operates based on time of day and day of week.
- It includes the use Lane Use Control Signals, CMS, and CCTV cameras that allows using PTSU when conditions warrant allowing more flexibility during changing conditions.
- Operation required a NJDOT Traffic Regulatory Order to implement PTSU. An amendment was necessary to extended the hours of operation.
- Dedicated operators in TMC initially managed the operation of PTSU. Now this is a function all operator support.
- NJDOT used extensive stakeholder and public outreach was used for this first implementation

Speaker's Notes (15/22)

- Michigan DOT implemented PTSU along US 23 in Ann Arbor as a result of a need for additional capacity during peak hours and special events.
- The implementation did not require policy of staffing changes
- Existing on-road maintenance personnel are used to sweep the shoulders to verify obstacles are not present which restrict the use of shoulders for traffic lanes.
- A challenge MDOT experienced was the timing of a deicer application that requires traffic to activate it.
- As noted earlier, travel time was reduced from 22 minutes to 10.

Speaker's Notes (16/22)

Virginia DOT has operated PTSU for several years.

The original implementation along I-66 in Northern Virginia in no longer in operation after implementation of managed lanes.

On I-264 in Hampton Roads, the shoulder is opened for two hours in each direction on weekdays.

- It may be opened when predicted or current conditions support changes.
- Commercial vehicles are restricted from using the should when opened to traffic.

TMS operators manage PTSU as part of routine duties; no PTSU-specific operators are necessary.

TMS operators must develop the needed capabilities before they are assigned the management and operation of PTSU.

No additional staff was necessary for TMSs to support the management and operation of PTSU.

Speaker's Notes (17/22)

Georgia operates PTSU along SR 400 and I-85 NB.

Like Virginia DOT, these operate on a peak period schedule, however the TMS may also activate and manage as needed.

Buses are restricted from using the SR 400 shoulder, and trucks are restricted from using the shoulder on both routes.

Senior TMS operators – called "TMC Specialists - manage the part-time shoulder.

Other, less experienced TMS operators perform sweeps of shoulders for obstacles before making recommendations to for activate PTSU to the TMC specialists.

The SOPs for activation and management of PTSU are reviewed annually.

Speaker's Notes (18/22)

The last example is Washington State DOT's implementation of PTSU. WashDOT has implemented PTSU on various corridors, including:

- I-405
- Highway 2, and
- Highway 14

The PTSU operation is managed by their TMS

WashDOT recognized the complexity of operating PTSs, so they designated transportation engineer positions to manage the operation…..

Speaker's Notes (19/22)

Various lessons have been learned by these five DOTs in their implementation of PTSU.

- Dynamic PTSU – based on changing conditions – required more staff that static time-day, day of week PTSU
- Agencies that initially used dedicated operators to manage the PTSU found that dedicated operators were not necessary, and that the management of the PTS could be done by all operators with appropriate training.
- Because of the complexity of PTSU, agencies benefitted from training their TMS operators in traffic operations and traffic flow theory.
- Standard operating procedure and operations plans for operating and managing PTSU should be reviewed regularly and modified as necessary.
- There is benefit in examining whether policy and legislation is needed to implement PTSU early in the planning process.

Speaker's Notes (20/22)

None.

Speaker's Notes (21/22)

None.

Speaker's Notes (22/22)

None.