Green Means Go:
Transit Signal Priority in NYC

NEW YORK CITY
DOT

Executive Summary

The New York City Department of Transportation (NYC DOT) and the Metropolitan Transportation Authority (MTA) are working to improve bus service in New York City. Transit Signal Priority (TSP) is a method used to coordinate transit vehicles and traffic signals to reduce the time buses are stopped at traffic lights along a corridor and therefore improve bus travel times.

Since 2012, NYC DOT has worked with MTA to implement TSP on 5 corridors, with excellent results. This implementation requires the installation of technology on buses by MTA and substantial traffic analysis from NYC DOT to ensure maximum traffic flow while maintaining sufficient pedestrian crossing time. This report provides analysis of the effectiveness of TSP on bus travel times, and provides updated details about the TSP program, including the following:

- **On average, TSP has reduced bus travel times about 14 percent during weekday peak morning and evening commuting periods. Results vary by corridor, direction and time of day with travel time savings ranging from less than 1 percent to up to 25 percent.**

- **As of June 2017, TSP is currently provided at 260 intersections on 5 bus routes.**

- **By the end of 2017, NYC DOT will be ready to implement 229 additional intersections on 5 additional TSP routes, contingent on MTA's planned procurement of additional bus technology.**

- **NYC DOT will accelerate its implementation of TSP, expanding the network by an additional 550 intersections (about 10 routes) by the end of 2020, in concert with MTA's new bus technology.**

- **TSP is most beneficial on two-way streets outside Manhattan, and when a full substantive traffic analysis underlies the work to maximize safety and transportation benefits.**

What is TSP?

Transit Signal Priority (TSP) is a technology that is capable of enhancing traditional transit services by facilitating bus movements through intersections controlled by traffic signals. On busy bus routes in New York City, buses spend about 21 percent of their time stopped at traffic lights, which is a major contributor to slow bus service around the City. In order to reduce these delays, NYC DOT and MTA are working in partnership to implement TSP through MTA's installation of technology on buses and robust traffic analysis from NYC DOT to ensure maximum traffic flow while maintaining sufficient pedestrian crossing time.

TSP in New York City involves both passive and active priority systems. "Passive" TSP means traffic signals are better coordinated, thus improving traffic flow for all vehicles along the bus route. "Active" TSP requires the transit vehicle to communicate with the traffic signals, in order to dynamically adjust the signal timing in its favor by either extending the green signal or shortening the red signal at the approaching intersection.

Where Does TSP Work Best?

DOT looks to implement TSP at locations that can provide riders with the greatest benefits. While every corridor needs to be analyzed uniquely, the circumstances that lead to the most success are:

- **Two-way streets, where there is typically not an existing "green wave" signal progression;**

- **At intersections that do not have a lot of cross traffic or many turn signals, where the largest amount of adjustment can be made to the traffic signal pattern;**

- **And streets that provide predictable bus travel times, such as streets that have bus lanes, so that the bus can correctly estimate how long it will take to arrive at an intersection.**

When looking at these criteria, certain areas of the city like Midtown Manhattan may benefit less from TSP, while other areas of the city may benefit more. DOT and the MTA also look at bus ridership to ensure that any TSP application can benefit buses where they are the busiest. Even on corridors equipped with TSP, not all intersections along the corridor may receive TSP based on the characteristics on individual intersections.

TSP is also one tool that works well with other measures to improve bus speeds, such as all-door boarding, and dedicated bus lanes. While these tools can be applied individually, in many cases they provide the most benefit when applied together, as on our Select Bus Service routes.

How Does Active TSP Work in NYC?

Active TSP in New York City uses in-vehicle GPS tracking devices and other on-bus TSP software to detect a bus location. The bus then sends a TSP request to the Traffic Management Center (TMC), relayed through MTA's Bus Command Center. The TMC uses the New York City Wireless Network (NYCWiN) to communicate with the traffic signal controllers to extend the green time and allow the bus to pass through the intersection, or shorten the red time and bring an early return to green (Figure 1). In order to create a safe and efficient intersection with TSP, a number of details are taken into consideration. The amount of vehicular traffic on cross streets, width of the street, number of pedestrians crossing, and timing of the walk signal are used to ensure pedestrians have sufficient time to cross the street safely.

Fig. 1: Signal timing diagrams showing how TSP can extend green signal time for buses at the beginning or end of the signal phase.
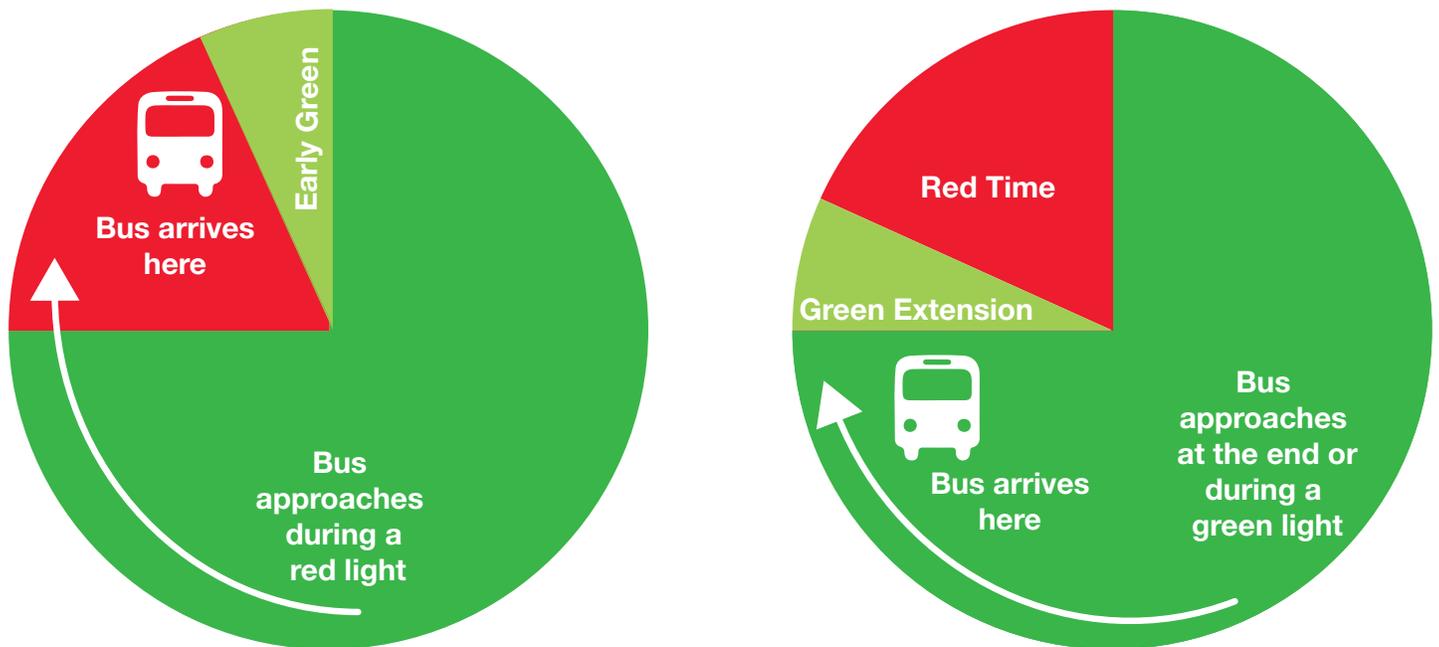
TSP In NYC

TSP was first introduced in 2006 on Victory Boulevard in Staten Island using infrared line-of-sight technology. The second corridor to be introduced with TSP was the Bx12 Select Bus Service route using Radio GPS technology. Both of these systems required new equipment to be placed on buses and at the intersection. While both technologies provided reductions in bus delay, both had high equipment installation cost. TSP using these technologies are no longer in use in NYC and TSP is not currently active on either of these corridors.

In 2012, the DOT Division of Traffic Operations developed a new TSP system which takes advantage of NYC Wireless Network (NYCWiN) and new signal controllers already installed at each intersection, thereby not requiring new equipment at each intersection and making TSP more efficient to implement. Traffic analysis is performed at each location to determine how much time can be provided to TSP requests, but no new signal hardware is required. This form of TSP also takes advantage of GPS technology that is already installed on all MTA buses as part of their Bus Time vehicle location system. While some additional hardware and/or software is required on buses to activate TSP, this system is more cost efficient than previous TSP generations.

This new generation of TSP has been implemented on 5 corridors (about 260 intersections) since 2012: M15 SBS/ Lower Manhattan (2014), B44 SBS/ Nostrand Avenue (2015), S79 SBS/ Hylan Boulevard (2015), Bx41 SBS/ Webster Avenue (2015), and most recently B46 SBS/ Utica Avenue (2016).

**Fig. 2:** Existing and future TSP corridors
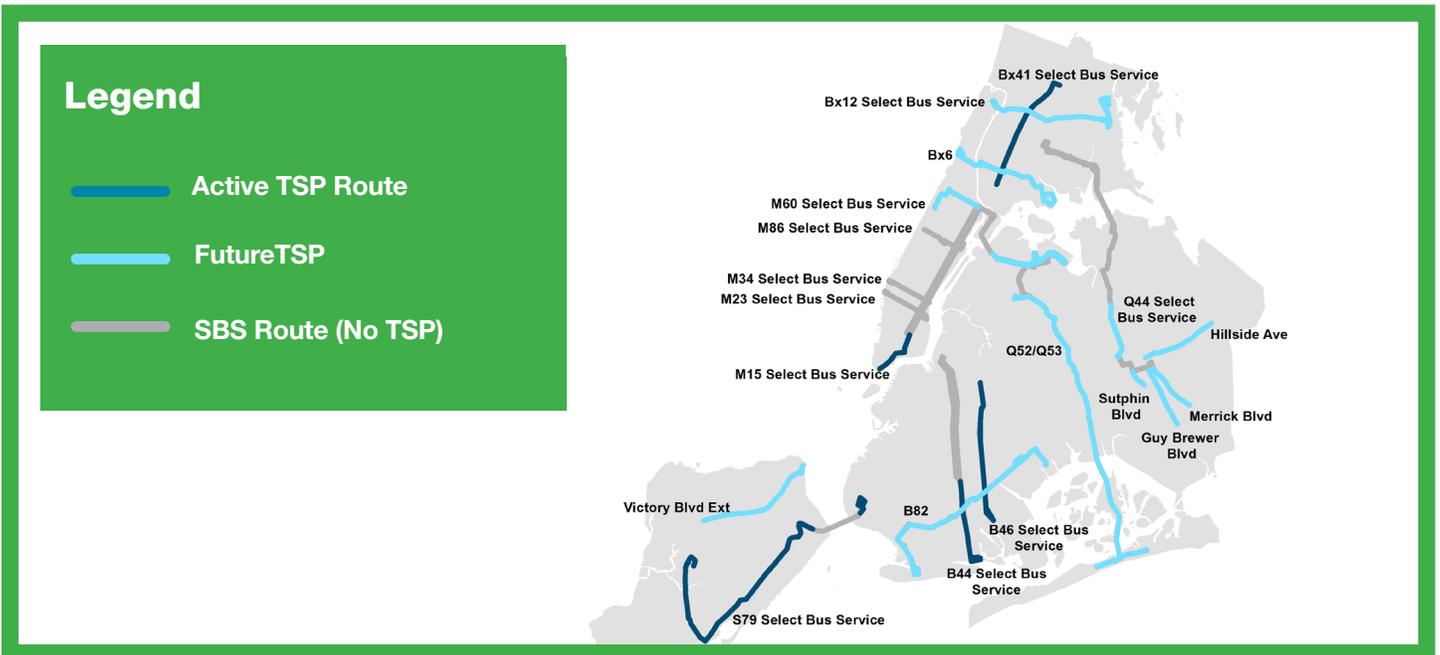
Figure 2 shows where TSP is located in NYC in relation to SBS routes as well as future TSP locations.

Evaluation Methodology

DOT has evaluated four corridors to assess the effectiveness of TSP; evaluations for other implemented corridors are underway. For each corridor, travel times were collected at peak time periods before and after TSP implementation through field observations* or MTA Bus Time GPS data when available. Travel times were collected over multiple bus trips on multiple days. Peak times vary from corridor to corridor based on when the corridor is most traveled. MTA Bus Time GPS data records times and locations of buses in order to determine travel speed. In the results below, the "before TSP" column represents the assessment of existing traffic operations and evaluation of a proposed TSP system. The "after TSP" column represents the benefits of the TSP system in reducing bus travel times once the system becomes fully operational. Travel times are ascertained by examining MTA records of TSP activity, as well as MTA Bus Time GPS data. The "after" data is then compared to the "before" data to quantify travel time savings. Travel time data below represents only segments of each corridor equipped with TSP. It does not represent the entire length of the bus corridor. The travel times represent data when the after study was completed, and may not match current travel times.

*To use field observations, a sizeable number of samples must be collected. In cases where a sizeable sample was not available, in this case in the "before" condition for the M15 SBS, the microsimulation software, Aimsun©, was employed to assess pre-implementation operations, which extrapolated the limited field observations into more detailed running times.

Results

The TSP evaluations have consistently shown positive results of about 1 to 25 percent improvement in bus travel times. General traffic flow has also improved due to better signal coordination. Presented below are the pre- and post-implementation results of the four TSP corridors that have been evaluated to date. The analysis results below represent travel time between the dates shown. This may not represent travel times on any given day.

M15 SBS/ Lower Manhattan:

M15 SBS Travel Times Before (April 2010)/ After TSP (May 2014) (NB/EB)

Limits of TSP: South Ferry to East Houston Street

Chart: Minutes (0–25)

- AM Peak (7:30 am- 10:00 am): Before TSP 18.7, After TSP 15.3, 18.2%
- Midday (12:30 pm- 2:00 pm): Before TSP 17, After TSP 16.2, 4.7%
- PM Peak (4:00 pm- 7:00 pm): Before TSP 20, After TSP 16.8, 16.0%

Legend: Before TSP, After TSP
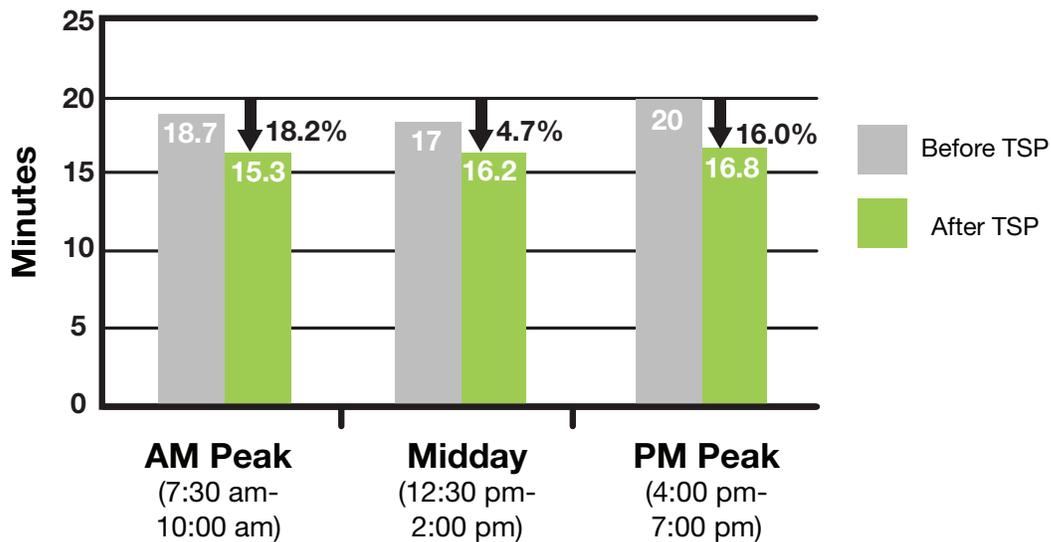
M15 SBS Travel Times Before (April 2010)/ After TSP (May 2014) (SB/WB)

Limits of TSP: East Houston to South Ferry

Chart: Minutes (0–25)

- AM Peak (7:30 am- 10:00 am): Before TSP 19.1, After TSP 16.5, 13.6%
- Midday (12:30 pm- 2:00 pm): Before TSP 18.4, After TSP 16.7, 9.2%
- PM Peak (4:00 pm- 7:00 pm): Before TSP 18.1, After TSP 15.5, 14.4%

Legend: Before TSP, After TSP
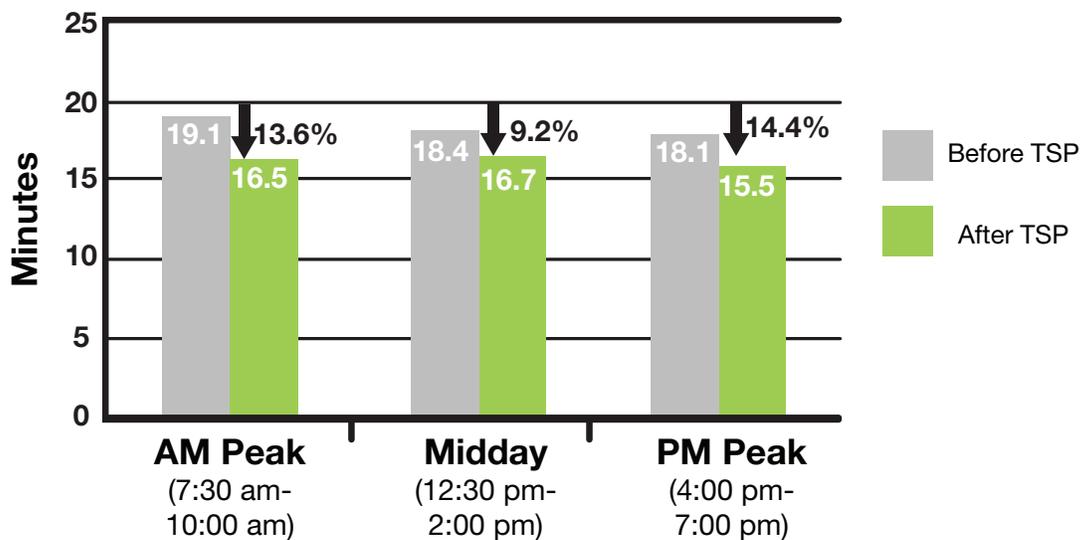
S79 SBS/ Hylan Boulevard:

S79 SBS Travel Times Before (October 2012)/ After TSP (April 2016) (To Brooklyn)

Limits of TSP: Richmond/Yukon Sts to Hylan/Steuben & 92nd/Dahlgren to Ft Hamilton/90th St

Bar chart — Minutes (y-axis, 0 to 60):

	Before TSP	After TSP	Change
AM Peak (6:15 am–9:30 am)	43.8	39.2	↓ 10.5%
Midday (12:00 pm–3:00 pm)	29.4	29.9	↑ 1.5%*
PM Peak (3:00 pm–6:45 pm)	47.1	43.2	↓ 8.2%

*This is not statistically significant
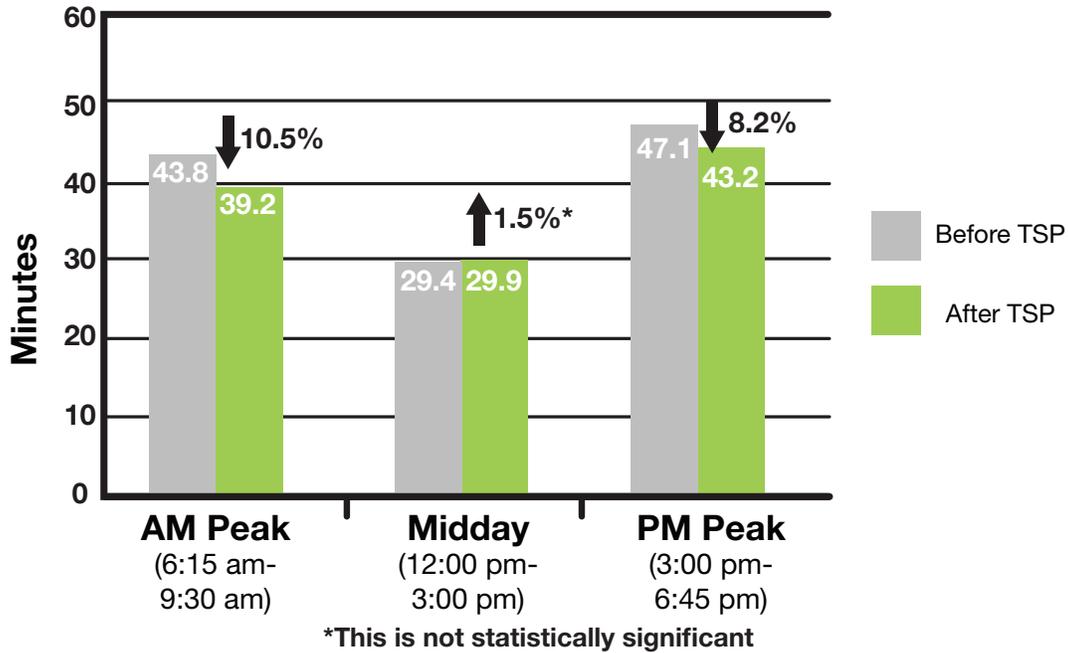
S79 SBS Travel Times Before (October 2012)/ After TSP (April 2016) (To Staten Island)

Limits of TSP: Ft Hamilton/90th St to 92nd/Dahlgren & Hylan/Steuben to Richmond/Yukon Sts

Bar chart — Minutes (y-axis, 0 to 60):

	Before TSP	After TSP	Change
AM Peak (6:15 am–9:30 am)	37.9	34.4	↓ 9.1%
Midday (12:00 pm–3:00 pm)	29.7	27.1	↓ 8.7%
PM Peak (3:00 pm–6:45 pm)	43.4	42	↓ 3.2%
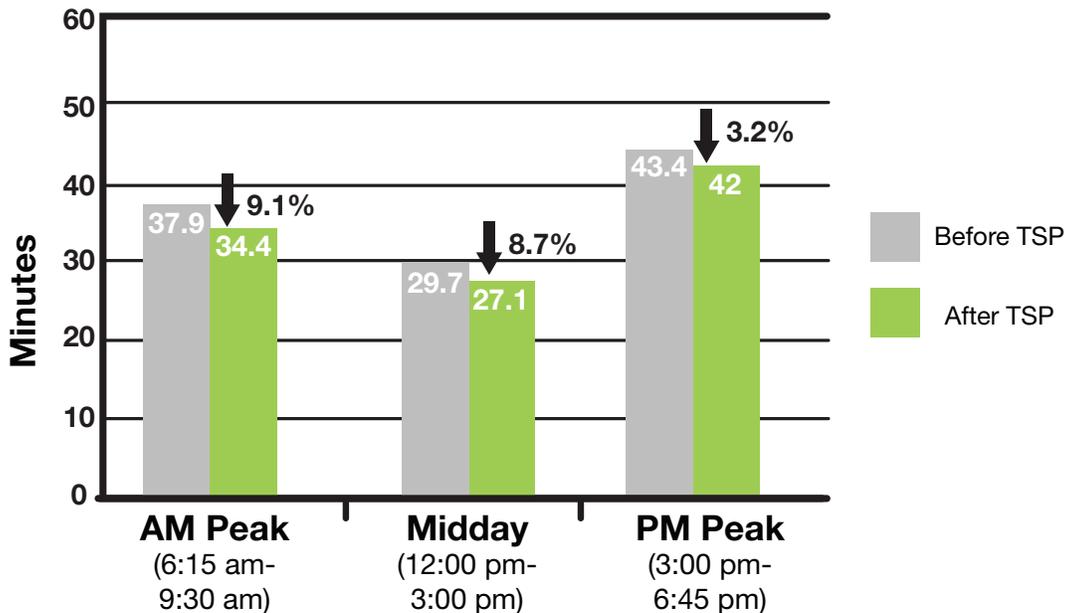
B44 SBS/ Nostrand Avenue:

B44 SBS Travel Times Before (December 2013)/ After TSP (April 2016) (NB)

Limits of TSP: Knapp/Shore Pkwy to Flatbush/Rogers Aves

Bar chart showing Minutes. AM Peak: Before TSP 25.3, After TSP 25.1, ↓0.7%. Midday: Before TSP 27.4, After TSP 26.2, ↓4.4%. PM Peak: Before TSP 29.6, After TSP 26.2, ↓11.5%.

Legend: Before TSP (gray), After TSP (green)

AM Peak (6:45 am-9:45 am) | Midday (12:30 pm-3:30 pm) | PM Peak (4:15 pm-7:15 pm)
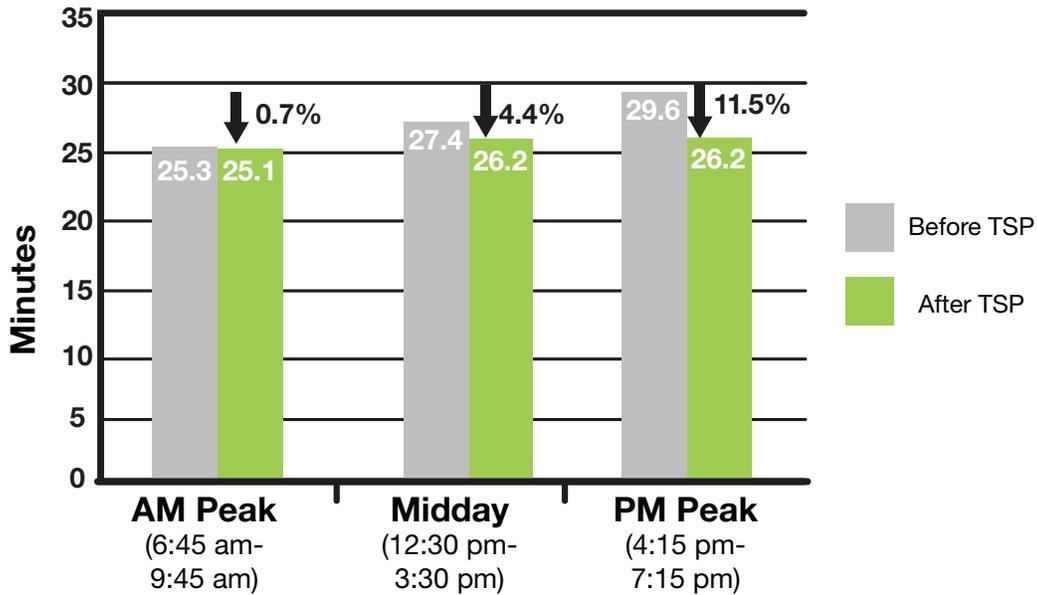
B44 SBS Travel Times Before (December 2013)/ After TSP (April 2016) (SB)

Limits of TSP: Flatbush/Nostrand Aves to Knapp/Shore Pkwy

Bar chart showing Minutes. AM Peak: Before TSP 26.6, After TSP 21.2, ↓20.4%. Midday: Before TSP 27, After TSP 22.3, ↓17.4%. PM Peak: Before TSP 29.4, After TSP 22.1, ↓24.8%.

Legend: Before TSP (gray), After TSP (green)

AM Peak (6:45 am-9:45 am) | Midday (12:30 pm-3:30 pm) | PM Peak (4:15 pm-7:15 pm)
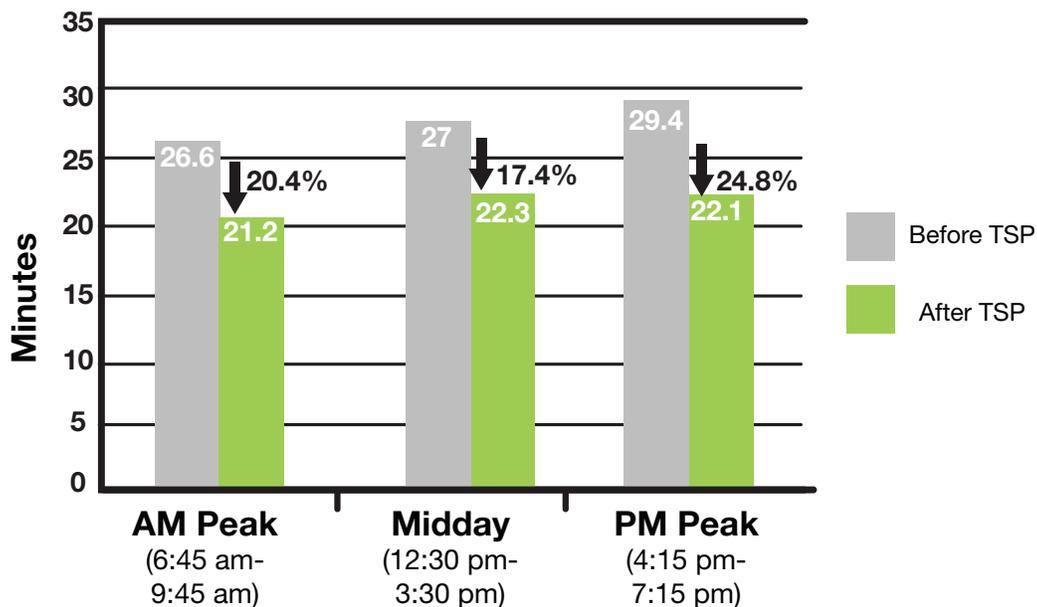
Bx41 SBS/ Webster Avenue:

Bx41 SBS Travel Times Before (November 2011)/ After TSP (April 2016) (NB/EB)

Limits of TSP: Third/Melrose Aves to E. Gun Hill/White Plains Rds

Bar chart showing Minutes. AM Peak (6:30 am- 9:30 am): Before TSP 45.1, After TSP 36.4, 19.3% decrease. PM Peak (3:15 pm- 6:15 pm): Before TSP 51.6, After TSP 41.5, 19.6% decrease.
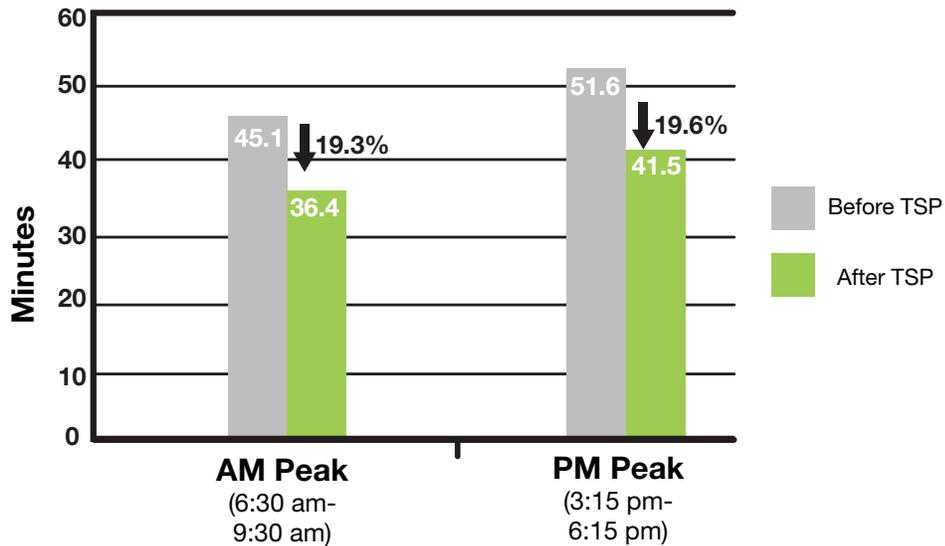
Bx41 SBS Travel Times Before (November 2011)/ After TSP (April 2016) (SB/WB)

Limits of TSP: E. Gun Hill/White Plains Rds to Third/Melrose Aves

Bar chart showing Minutes. AM Peak (6:30 am- 9:30 am): Before TSP 40.6, After TSP 33.6, 17.2% decrease. PM Peak (3:15 pm- 6:15 pm): Before TSP 45.8, After TSP 36.2, 21.0% decrease.
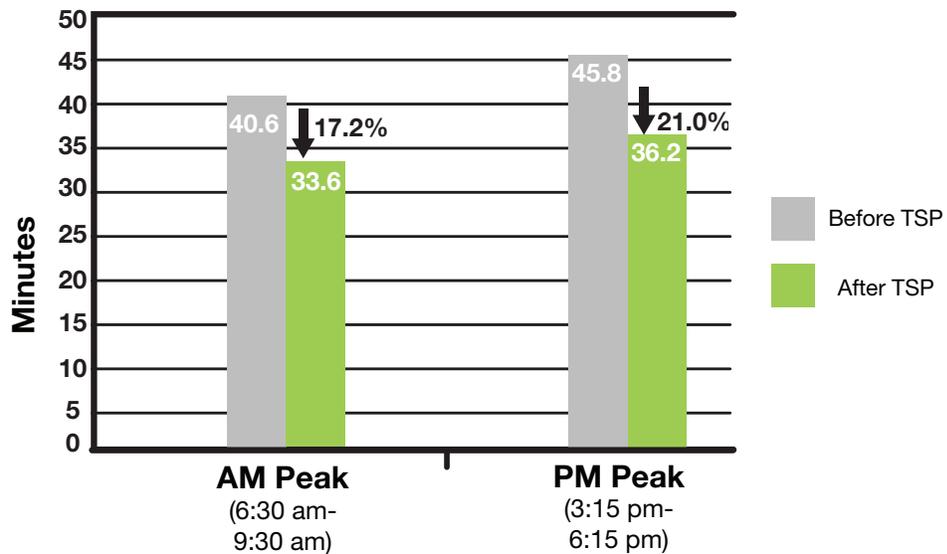
TSP Expansion and Next Steps

NYC DOT and MTA plan to continue expansion of TSP on key bus routes throughout the city. As of July 2017, TSP is being planned on the following corridors:

- **Main Street - Q44 SBS**

- **LaGuardia/125th Street - M60 SBS**

- **Utica Avenue extension – B46 SBS**

- **Victory Boulevard extension - S62, S92**

- **Kissena Boulevard - Q25**

- **Hillside Avenue - Q43**

- **Merrick Boulevard - Q5**

- **South Bronx - Bx6 SBS**

- **Southern Brooklyn - B82***

- **Woodhaven Boulevard - Q52, Q53 SBS**

- **Fordham Road - Bx12 SBS**

*SBS planning in progress. For more information, visit nyc.gov/brt

By the end of 2017, NYC DOT is ready to implement TSP along the M60 SBS, Q44 SBS, B46 SBS (extension), S62/S92, Q25 and Q43 upon the MTA's procurement of new bus technology.

As the MTA will soon have the TSP technology available for all buses, NYC DOT will accelerate its implementation of TSP, expanding the network after 2017 to an additional 550 intersections (about 10 routes) by end of 2020.

Correction: After publishing the TSP report in July 2017, we have since found it contains some data that is no longer accurate. The report has been updated.