New York State Energy Research and Development Authority

Adaptive Traffic Signal Control for Tarrytown Road in White Plains, New York

Final Report

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Adaptive Traffic Signal Control

for Tarrytown Road in White Plains, New York

Final Report

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16. Abstract

The Sydney Coordinated Adaptive Traffic System (SCATS) uses a real time traffic adaptive approach to traffic control by measuring current traffic conditions and then adjusting traffic signal cycle lengths, splits and offsets. Its real-time response to changing traffic conditions ensures the most appropriate traffic signal phasing to safely direct traffic through intersections. In comparison, pretimed signal plans cannot act in real-time and are only effective when updated frequently, which at times can be cost-prohibitive. The City of White Plains installed and utilized SCATS for their Adaptive Traffic Signal Control of nine intersections along Tarrytown Road.

SCATS constantly adapts to the demands of changing traffic flows and can accommodate these variations without manual intervention. Therefore, it was selected to be implemented on a busy corridor in Tarrytown Road in White Plains. Along this stretch of roadway lays many shopping centers, the Westchester County Center Theater, a busy Metro North train station and a bustling downtown retail zone. The corridor is often used as a diversion plan in case of an incident on I-287. For all these reasons, traffic can be varying and unpredictable. SCATS can adopt a strategy to clear a sudden unpredictable traffic loads such as weather changes or theater event audiences. It also monitors rapidly changing traffic conditions that can occur in normal traffic or especially when there is a breakdown, accident or roadwork or adverse weather. It continuously adjusts signal timings cycle-by-cycle to optimize flow by measuring the density of vehicles in each lane. Reducing vehicle delays and therefore greenhouse gas emissions using advanced traffic technology without the cost or logistics of widening the roadway will benefit the people who live and commute in the City of White Plains.

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Executive Summary

ES.1 Background

This project was awarded as a Demonstration of Underutilized Commercial Technologies under Category 3 of Program Opportunity Notice (PON 2078), which was issued as a collaborative research solicitation by the New York State Energy Research and Development Authority (NYSERDA) and the New York State Department of Transportation (NYSDOT). The intent of the funding category is to research why certain successful transportation technologies are underutilized in New York State and evaluate the potential benefits from adoption. The goal of the project was to install an adaptive traffic signal control system (ATSC) along Tarrytown Road in White Plains, New York. The Sydney Coordinated Adaptive Traffic System (SCATS) was the chosen for deployment due to its many advantages over other adaptive traffic systems including its true real-time adaptive optimizations, self-calibrating features, and detection redundancy.

ES.2 Research Approach

SCATS was initially deployed on five intersections on Tarrytown Road and on two arterial intersections on streets intersecting Tarrytown Road. The communications, cabinets, detection, and controllers were upgraded for the deployment. Once all of the intersections were integrated with SCATS, the system went under a period of optimization for the corridor, which included observing the SCATS operation, monitoring how the system operated during different traffic conditions, and adjusting SCATS parameters to optimize system performance. After the system was functional, it was expanded to two additional intersections north of I-287 and included a second round of optimization.

ES.3 Analyses

After the original seven intersection SCATS installation was operational, a before and after study was performed. For the before analysis, SCATS was manually turned off and three trial runs were performed during the morning, midday, and afternoon traffic peaks. SCATS was turned on the second day and the additional trial runs were performed. Travel times and number of stops improved. Enhancements to the system were made with feedback from the City of White Plains while an additional two intersections were installed.

ES.4 Conclusions

The benefits of using adaptive traffic signal control over a pretimed system are numerous. It enhances the quality of life and increases safety for commuters by reducing traffic congestion. It benefits the environment by reducing greenhouse gas emissions as well as reducing fuel consumption and pollutants. Pretimed timing plans are only effective when updated frequently, which at times is cost-prohibitive. Therefore, an ATSC saves money, time, and resources.

1 Introduction

1.1 Adaptive Traffic Signal Control

Traffic signal control systems deployed in the different cities, towns, and municipalities in New York State are predominantly either central-based systems or closed loop systems. An adaptive traffic signal control system (ATSC) differs as it optimizes signal timing using current traffic conditions and offers many advantages over pre-timed based systems. ATSC has had limited implementation in New York State, which qualified it as an underutilized commercial technology. The intent of this project is to install an ATSC system along Tarrytown Road at nine intersections and follow up with a period of optimization for the corridor. This optimization includes observing the operation, monitoring how the system operates during different traffic conditions, and adjusting parameters to optimize system performance.

Tarrytown Road is a major arterial that has approximately 50,000–60,000 vehicles average daily traffic (ADT). It is a primary route for commuter access to and from downtown White Plains and also experiences traffic surges due to significant downtown retail activity including six major downtown malls/retail centers and events at the adjacent Westchester County Center (3,000 seat capacity arena). In addition, the route is the primary diversion route for incident traffic along I-287 and is a proposed route for two implantations of Bus Rapid Transit (BRT) projects as part of plans for both the Tappan Zee Corridor to the west and the Central Avenue Corridor to the south. Previous standard traffic control techniques such as time-of-day signal timing and responsive timing plan selection have failed to accommodate all of the variable and unpredictable traffic conditions. Therefore, a more advanced traffic control technique is desired in order to minimize energy use along the corridor.

The corridor experiences times of congestion all day long and experiences significant traffic congestion during the morning and evening peak periods. In addition, the downtown retail and other activities create unpredictable congestion timeframes during the off-peak and weekend hours. Advanced traffic control such as ATSC which collects real-time information and then optimizes traffic signal parameters on a cycle-by-cycle basis, can reduce congestion and energy requirements along the corridor. Therefore the use of an adaptive traffic control system that maximizes road network use will reduce fuel consumption and vehicle emissions, reduce greenhouse gas (GHG) production and increase energy efficient traffic operations in the area.

The Sydney Coordinated Adaptive Traffic System (SCATS), one of the most proven ATSCs with more than 40 years of field use, has been deployed across the United States and around the world. SCATS is an off-the-shelf software product that requires no software development for the project, and currently controls more than 37,000 intersections worldwide in 27 countries. The use of adaptive traffic signal control technology has been proven to save energy and reduce vehicle emissions through reduced stops and delays and overall reduced travel times along corridors.

The project team consists of co-project managers from NYSERDA, which was the main contracting agency, and NYSDOT Region 8. The City of White Plains hosted the system and provided the traffic planning and construction. TransCore ITS LLC (TransCore) was the prime system designer and integrator. TransCore is a leading transportation engineering firm in the United States (U.S.) and has provided an experienced installation and integration team that has the sole focus of installing adaptive signal control. TransCore has successfully deployed SCATS on over 20 separate systems throughout the nation, controlling more than 1,600 intersections at locations shown in Figure 1.

Figure 1. SCATS Deployments in the United States

Source: TransCore ITS, LLC
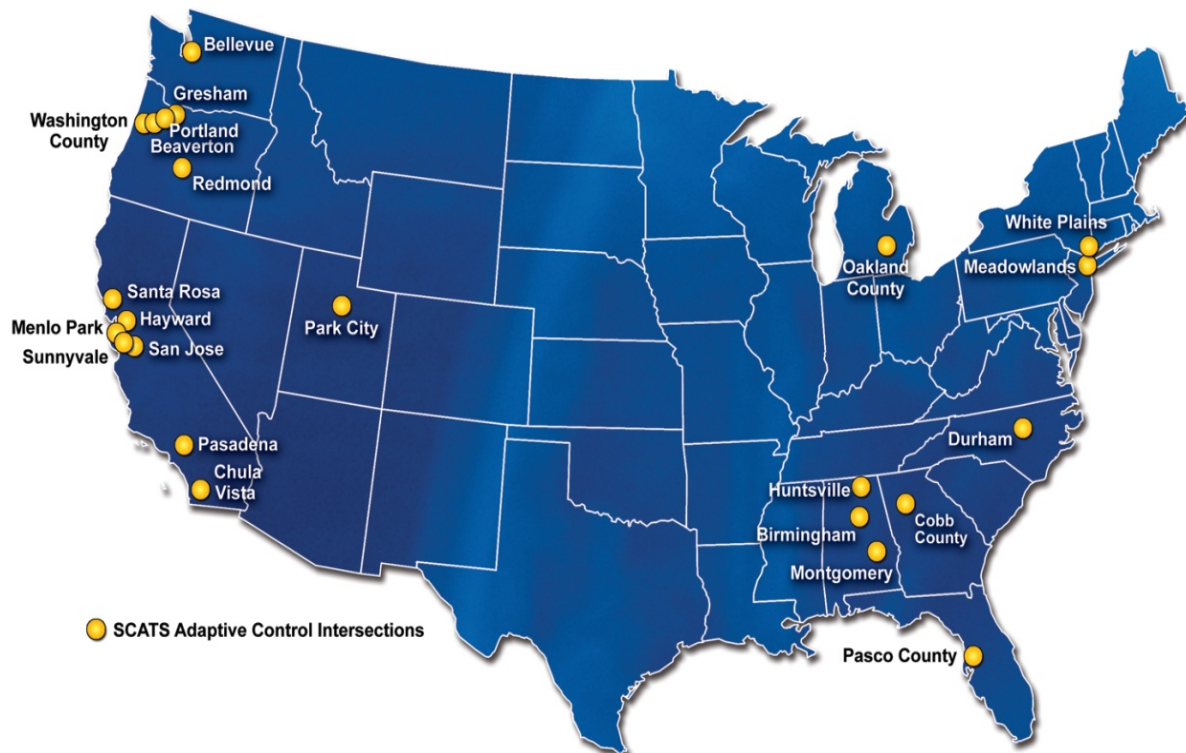
Almost all of the systems installed in the U.S. have been or are in the process of being expanded. SCATS can expand in size (to up to 16,000 intersections) and is highly configurable to meet changing traffic needs. This expansion is testimony to the ability of SCATS to provide traffic flow improvements. SCATS field performance has been proven time and time again in third-party independent studies on previous SCATS installations. These studies, performed by transportation agencies, consultants, and universities have shown SCATS to be extremely effective in accommodating both recurring and special event traffic conditions with minimal oversight. SCATS is currently being installed throughout the 30-square mile of the Hackensack Meadowlands District in New Jersey. When completed, it will be the largest deployment of SCATS in the Northeast and the fourth largest deployment of adaptive signal technology in the country. Figure 2 provides a summary of benefits from the deployment of SCATS in other parts of the country that contributed to providing a more efficient movement of traffic, reduction of emissions and fuel consumption and increase in safety.

Figure 2. SCATS Installation Results

Source: TransCore ITS, LLC

The results from the City of Sunnyvale in California are particularly relevant to the traffic conditions expected along Tarrytown Road in White Plains. Those results are from a recent system expansion project that was completed along Sunnyvale-Saratoga Road in 2007. This corridor is a high-volume corridor with volumes exceeding 40,000 vehicles per day. The corridor is also characterized by the heavy commercial development along its length and it serves as a primary route to Highway 280. After implementation, it was observed that the SCATS system provided superior performance over the prior Time of Day system. Along the coordinated route, both the travel times and the number of stops were found to be significantly lower with SCATS[1].

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[1]   An Adaptive Traffic Signal Study for the City of Sunnyvale Final Report, Pages 16 and 22, DKS Associates, Aug 11,2008

As shown in Figure 1, while SCATS and adaptive control in general have been installed throughout the United States, the technology is underutilized within the State of New York. However, this commercial, off-the-shelf product requires no software development for this installation, thereby reducing the risk and timeframe required for project completion.

The installation of SCATS presents a low-risk approach for NYSDOT and NYSERDA in an economic environment where funding for transportation projects is limited. Deploying SCATS, a proven adaptive traffic control system that has a demonstrated record of performance, will provide benefits to the motorists around White Plains.

1.2   SCATS Background

SCATS was developed by the New South Wales Department of Transportation in Australia, and they use it on about 4,000 intersections themselves. The fact that the software is widely used in Australia assures the system is being supported with new versions released typically every 12 to 18 months. Worldwide, it is the most deployed system with more than 30 years of proven history in more than 34,000 field installations in various conditions. In the U.S. market alone, SCATS is used in more than 1,600 signals. SCATS has full adaptive operations without the need for background checks or modeling of current and future conditions. This configurable system can be controlled and modified to suit various needs. Figure 3 provides details about how SCATS installations work with various existing traffic conditions and roadway uses.

Figure 3. SCATS Installation Uses

Source: TransCore ITS, LLC

SCATS Installations

Existing SCATS Uses	NJ Meadowlands	Pasadena, CA	San Jose, CA	Hayward, CA	Alabama DOT	White Plains, NY	Portland, OR	Washington County, OR	Bellevue, WA	Beaverton, OR	Redmond, OR	Marietta, GA	Atlanta, GA	Santa Rosa, CA	Gresham, OR	Park City, UT	Cobb County, GA	Pasco County, FL	Sunnyvale, CA	Menlo Park, CA	Chula Vista, CA	Durham, NC	Oakland County, MI
Congested / Bottleneck Areas	•		•	•	•	•		•				•	•	•	•		•	•		•		•	•
Reduced Capacity Areas	•		•	•	•		•	•	•	•		•	•	•	•		•	•		•			•
Rapidly Developing Areas	•		•		•			•								•	•	•	•		•		•
Schools	•		•		•			•				•	•	•	•							•	•
Shopping Areas	•	•	•	•	•	•			•	•							•	•		•	•	•	•
Construction				•											•								
High Capacity Roadways	•		•		•	•	•	•	•	•	•						•	•	•	•	•	•	•
Special Events	•	•	•	•	•	•			•		•						•	•					•
Recreation Traffic	•	•	•	•	•	•		•	•		•						•	•	•				•
Economy Fluctuations			•					•	•	•										•		•	•
Freeway Traffic	•		•		•		•	•	•								•	•	•			•	•
Light Rail Areas		•						•		•													

4

True real-time cycle-by-cycle optimization is the key differentiator between SCATS and most other adaptive systems that do not do cycle-by-cycle optimizations. Doing optimizations every cycle means the changes are smaller making them unnoticeable to the driving public. The same can't always be said for systems that make their changes every 5 or 15 minutes. For each and every cycle, SCATS optimizes cycle length, splits, and offsets. Adaptations are automatically based on demand with the associated optimization goals varying by observed activity.

- Light demand → Minimum Stops
- Normal Demand → Minimum Delay
- Heavy Demand → Maximum Throughput

SCATS has true stand-alone system functionality and has flexibility for use with various controller types and cabinets. SCATS relies primarily on Stop Bar Detection to sense a vehicle and provides for better redundancy. For example, should an inductive loop malfunction, the system keeps working because the input for the entire approach isn't lost. Existing advanced or dilemma zone detection (optional) can be used and are helpful for calls and extensions, but not for optimizations. All types of detection can be integrated, such as loops, video, magnetometer and radar.

1.3   Original System Operations

The original traffic control system along Tarrytown Road in White Plains utilized both time-of-day and responsive plan selection to control traffic along the corridor. Both of these control methods involve the use of pre-defined timing plans that are loaded into field controllers and then scheduled either by a traffic engineer as to when they should run throughout the day and week (time-of-day) or installed by the system in responsive to changes in volume and occupancy values recorded on system sensors (responsive). The City of White Plains had developed seven basic timing plans in an effort to provide a specific timing plan for the various timeframes of the week including morning, mid-morning, midday, afternoon, evenings, night, and weekend retail peaks. The exact times that each timing plan were scheduled to run are developed by the engineering staff based on data collected from system sensors. These set plans and schedules were not easily modified to account for the entire daily or season variables in the traffic such as the variances between school and summer traffic, holiday retail traffic variations, and weather- or incident-related variations.

The time-of-day timing plan method required data collection of traffic volumes at each intersection so that engineering staff can model the traffic conditions. The engineering staff then built and maintained a modeling database that was then used to run simulations of traffic conditions so that timing plans can be developed. Once the timing plans had been simulated and developed, they were installed into the field controllers and fine-tuned in the field by the engineering staff for average conditions experienced during the time the engineering staff was in the field. One issue with this method is that the average conditions experienced during that one week likely do not accurately reflect the varying conditions seen week-to-week or even day-to-day. For example, Figure 4 shows signal

timing plans for two consecutive Sundays at the same intersection. The traffic conditions were incredibly different from the first Sunday to the next Sunday, and conventional time-of-day plans would have had no ability to accommodate for these differences. Cycle lengths and splits are clearly seen to be adjusted in real-time, as traffic demand fluctuates during the day. In other words, the signal plans are being proactive instead of reactive or not even being addressed at all.

Figure 4. Example of Variations in Traffic Patterns on Two Sundays

Source: TransCore ITS, LLC
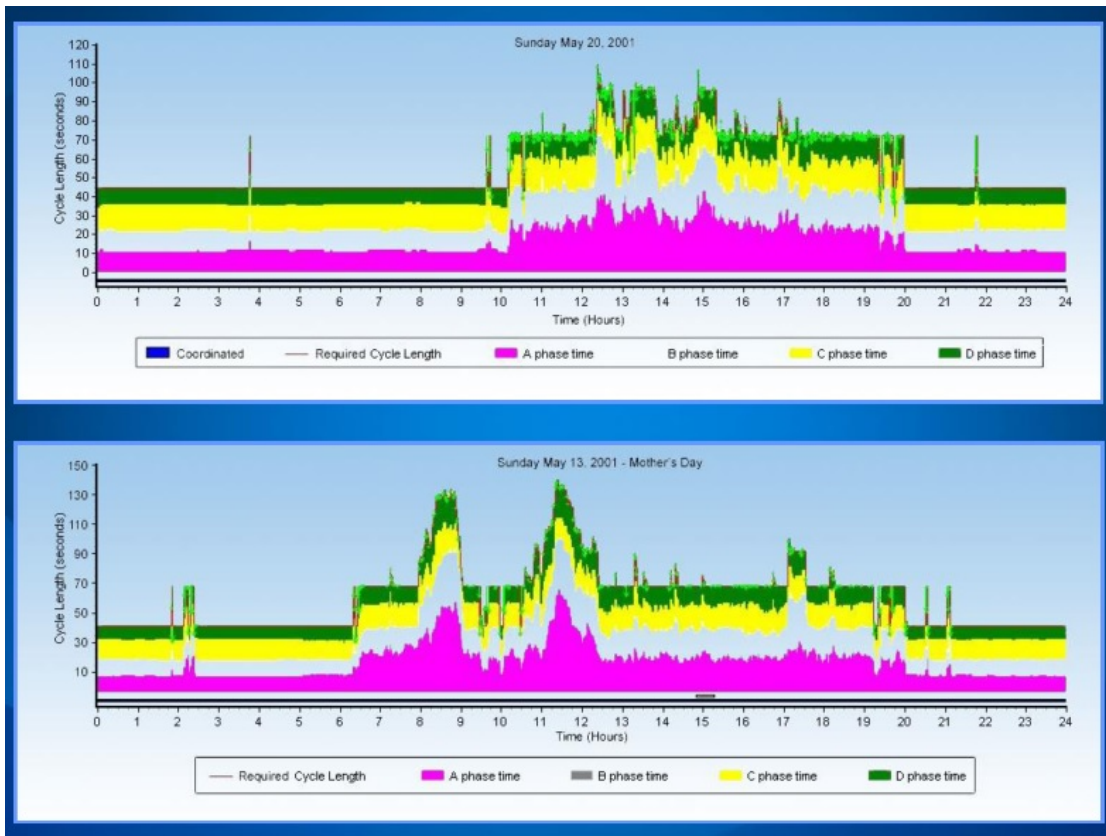
The use of time-of-day plans and responsive plan selection requires periodic updates to ensure that both the signal timings and responsive plan selection tables are still relevant for the current traffic conditions. Best practices suggest updating every two to three years, however, due to lack of agency staff time, updates are typically done every three to seven years. Each time the time-of-day plans are revisited, new traffic counts need to be collected, the simulation models updated and new plans developed, implemented, and field fined-tuned, which is a very time intensive process that often slips to longer intervals.

1.4   Proposed System Operations

Key portions of the 2009 State Energy Plan[2] address the significance of investments in transportation infrastructure to New York State's energy objectives. In Volume 1 of the Plan, Strategy 2 (Invest in Energy and Transportation Infrastructure) states that: "In the case of transportation, investments can be used strategically to reduce vehicle congestion, expand mass transit and encourage more efficient transportation system". The Energy Plan goes on to state that: "Energy use in the transportation system can be made more efficient through improvements in vehicles, the fuels that power them and through management of and investment in the transportation system to make it more efficient. The State Transportation Master Plan[3] states the following goal: "To improve the multimodal transportation system by addressing customers' expectations for dependably, travel time, efficient and effective transportation choices, accessibly, travel information and quality of service." The Plan states that "the primary focus for future congestion relief investments will be on strategies to more effectively operate the existing transportation system particularly incorporation the use of technology."

ATSC matches well with key New York State goals as articulated in the State Energy Plan and State Transportation Master Plan. Additionally, the Westchester County Action Plan[4] states that: "To reduce Greenhouse Gases (GHG) generated through transportation, the Community of Westchester must find ways to …….reduce fuel consumption." Furthermore, any metropolitan transportation plan invariably articulates goals and objectives that led to the reduction of congestion and GHG emissions and improve the reliability of travel. The known benefits of adaptive traffic signal control deployment would be wholly consistent with these goals.

The use of ATSC allows for real-time optimizations and efficiencies to be realized along the corridor. Recent studies have shown that system payback on SCATS installations can be measured in months versus years and is based solely on reduced emissions. Further calculations including driver time delays would reduce the system payback to even smaller timeframes.

The reduction in emissions and GHGs is directly attributed to more efficient traffic operations along the corridor. These efficiencies are provided through reduced delays and stops along the corridor as well as reduced travel times along the roadway network. The correct combination of these operational improvements is key to reducing fuel consumption and vehicle emissions.

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2   State Energy Planning Board. 2009. State Energy Plan, Volume 1.

3   NYSDOT. 2008. Strategies for a New Age: New York State's Transportation Master Plan for 2030..

4   Westchester Global Warming Task Force. 2008. Westchester Action Plan for Climate Change and Sustainable Development.

Furthermore, safety along the corridor is often enhanced as there is less traffic congestion and therefore less likelihood for traffic accidents. Adaptive control has also been proven to reduce GHGs during incidents by clearing the traffic congestion faster than conventional time-of-day plans.

An example of incident management enhancements under SCATS became evident during the data collections for a study in California. The study found that during an accident on the freeway, which caused all freeway traffic to use the local arterial, that the travel time along the corridor only increased by 30% even though an increase in traffic volumes of 100% was recognized. This change was due to the fact that the SCATS adaptive system used real-time detection information to understand the volumes had increased and appropriately modified the signal timing to account for this increase in traffic.

SCATS ability to analyze real-time data allows it to always run optimal signal timings for the current traffic conditions. In addition, SCATS has the ability to automatically accommodate more long-term changes in traffic conditions that may be related to new developments. These developments can include housing developments, factories, or even the addition of a new traffic generator such as a Walmart or Costco store. When using conventional time-of-day plans, the engineering staff would need to modify all of their timing plans manually to account for this change. With adaptive control, the SCATS system automatically accounts for this change in traffic conditions because it is developing its signal timing based on real-time detection information from the field.

This ability to automatically accommodate traffic changes is also why SCATS has been proven to provide greater long-term benefits to agencies as well. The ability to automatically account for changes in traffic instead of requiring manual intervention like time-of-day signal control is critical in providing cost-effective long term energy savings. Again, the energy savings result directly in reduced emissions and GHGs by ensuring optimal timing is always being used for the current traffic conditions.

For example, Figure 5 shows the increase in traffic over a 5-year period along a SCATS corridor. During this period, the agency has made no modifications to the system at all, yet the system has automatically modified signal timing aspects to account for the sharp growth in traffic volumes. The ability to modify timing without agency staff intervention increased agency staff availability for other work but also continued to provide efficient traffic operations for reduced energy consumption and emissions.

Figure 5. Example of SCATS Ability to Accommodate Long-Term Growth

Source: TransCore ITS, LLC
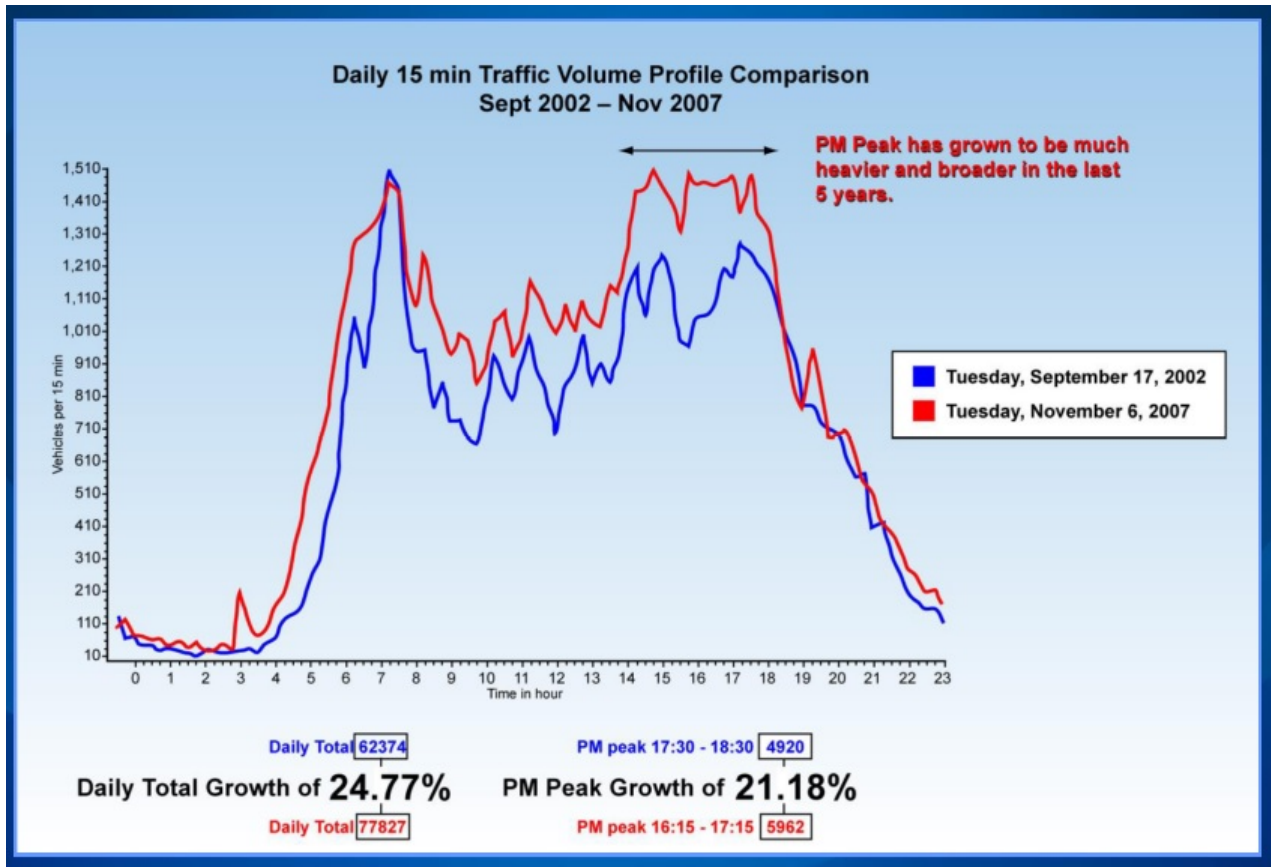
2　System Implementation

2.1　Project Area

The initial installation of the SCATS system in White Plains consisted of seven intersections along Tarrytown Road and adjacent streets and was made operational in November 2011. Two additional intersections north of I-287 for a total of nine were added to SCATS and were made operational in October 2013. Each installation required a week of optimizations. The system support and warranty followed each installation. The final coverage area for the corridor starts north of I-287 on Tarrytown Road and Route 100B and ends at Tarrytown Rd and Chatterton Avenue. The corridor is shown in Figure 6.

Figure 6. Project Area
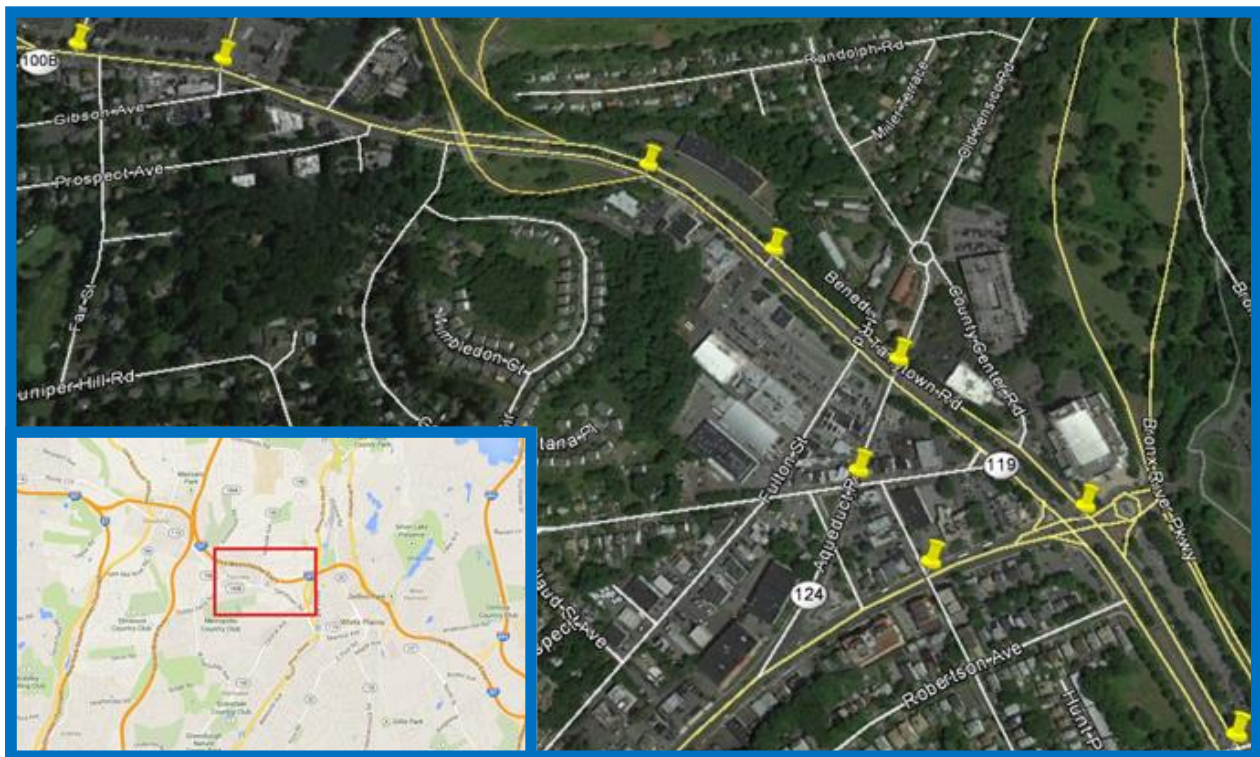
- Tarrytown Rd @ Rte. 100B and Rosemont Blvd
- Tarrytown Rd @ Rte. 100
- Tarrytown Rd @ I-287 E/B Exit 5 Ramp
- Tarrytown Rd @ Shopping Center Driveway (Bowling Alley)
- Tarrytown Rd @ Aqueduct Rd
- Tarrytown Rd @ Central Ave
- Tarrytown Rd @ Chatterton Ave
- Aqueduct Rd @ Russell St
- Central Ave @ Harding Ave

To implement SCATS for White Plains, the following requirements are needed: a SCATS-compatible traffic signal controller, vehicle detectors at each intersection, a reliable communications network to exchange data with the traffic signal controllers and a centralized computer system.

2.2 Traffic Signal Controllers

At each of the intersections, the City of White Plains replaced the existing model number 170 controller with a model number 2070 controller. TransCore loaded SCATS controller firmware into each new controller and converted the existing controller timing plan for use as a back-up time-of-day (TOD) plan that resides in the local controller's database. In addition, TransCore also programmed the basic timings of each intersection to match the timings in the previous local controller program based on agency-provided timing sheets. The existing pre-emption sequences were also programmed to provide the emergency vehicle priority. The TOD plans will be used whenever the signal is in fallback mode.

TransCore developed and tested controller databases prior to installing them in the field. Once the controller databases were verified, the controller change out took place by simply swapping out the controller in the local cabinet. This approach provided two primary benefits associated with intersection safety. First, the new database was checked and verified in a lab environment before installing them in the field. Second, the controller change out was performed quickly, with the intersection flash operation limited to a couple of minutes at each intersection. Both of these factors served to greatly reduce the traffic disruptions associated with the controller change out process.

2.3 Detection Work

Vehicle detectors are required to operate an efficient fully adaptive traffic control system. SCATS can be field-integrated with many types of traffic detectors because the only need is presence detection, i.e., to determine if there is a car there or not. Primary points only require stop bar detection. The optimal detector configuration for SCATS is a 15–18 foot detection zone for each lane, but anywhere from 6–25 foot zones have been used with no degradation of performance. The detection work for this project consisted of modifying the existing detection in the form of inductance loops and adding wireless detection embedded in the pavement for SCATS operations. For the existing inductance loops to be reused, work included the re-splicing and re-terminating to lead-in cables to provide new detections zones per lane. A typical hybrid detector layout for this project is shown in Figure 7.

Figure 7. Detection Layout – Tarrytown Road at Aqueduct
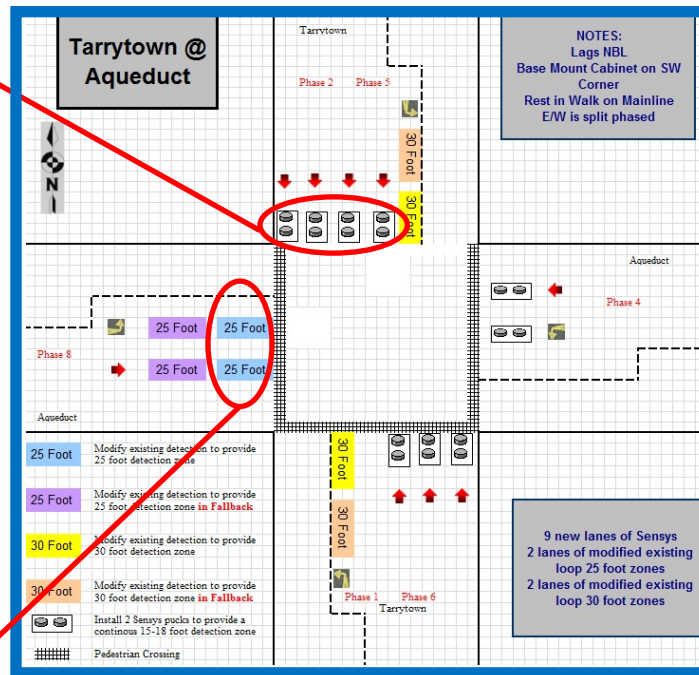

The Sensys Networks wireless vehicle detection system utilizes an in-ground traffic sensor embedded in the pavement, and was added to this project due to its rugged durability and low maintenance cost which will benefit the city of White Plains for years to come. Each VDS240 wireless sensor uses magnetoresistance to detect vehicle presence and movement, and has a ten year expected battery life. Serial Port Protocol (SPP) digital radios attached to the traffic cabinet poles wirelessly obtain roadway information from the sensors up to 150 feet away and the traffic data is then relayed back to the Access Point Controller card in the traffic control cabinet to be used for real-time traffic signal actuation, as shown in Exhibit 8.

Figure 8. Typical Sensys® Detection Application

Used with permission from Sensys Networks
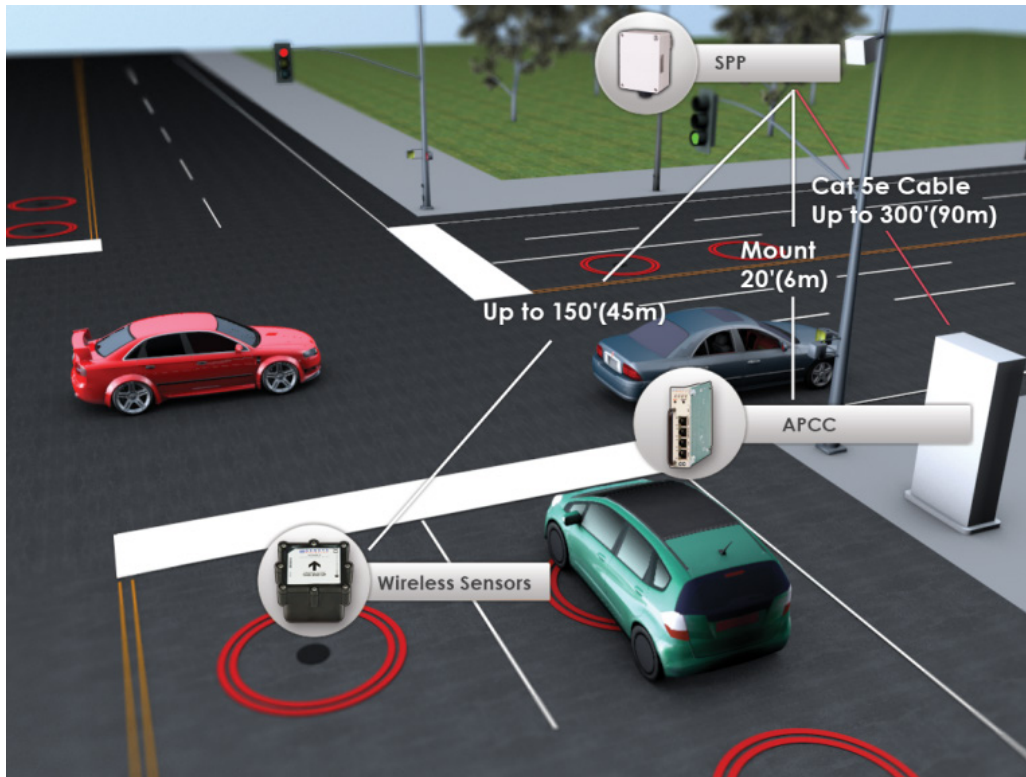
Reusing existing inductive loops resulted in a cost savings for the project. A total of 14 loops of were re-spliced along with the installation of 65 Sensys Network® detection zones. Figure 9 summarizes the detection use.

Figure 9. Summary of Number of Detection Zones

Intersection	Re-splice lane of existing inductive loops for 30 Foot detection zone	Re-splice lane of existing inductive loops for 25 Foot detection zone	Re-splice lane of existing inductive loops for 20 Foot detection zone	Re-splice lane of existing inductive loops for 10 Foot detection zone	New Sensys 15-18 Foot detection zone
Tarrytown / Chatterton	2	0	1	0	10
Tarrytown / Central	0	0	0	0	16
Tarrytown / Aqueduct	2	2	0	0	9
Tarrytown / Shopping Center	0	0	2	0	7
Tarrytown / I-287 Exit Ramp	0	0	2	0	3
Aqueduct / Russell	0	0	1	1	2
Central / Harding	0	0	1	0	2
Tarrytown / Rte 100B & Dobbs Ferry Rd	0	0	0	0	9
Tarrytown / Rte 100 & North End	0	0	0	0	7
TOTALS	**4**	**2**	**7**	**1**	**65**

2.4   Traffic Signal Cabinets

Traffic signal cabinets used were both White Plains existing and new NYSDOT-furnished that consisted of pole and ground mounted models (Type 330 and 332). Modifications to the cabinets were made at each intersection to accommodate the new field infrastructure. The first requirement is the revising of the existing detector terminations and the second is adding the SCATS flash relay kit to each cabinet. This relay is used to detect cabinet flash (i.e. flash via the police panel or flash switch in the cabinet) so that flash status can be properly shown at SCATS central. This modification was completed and tested prior to the controller swap out.

2.5   Communication System

An active and reliable communication system is crucial for SCATS implementation. SCATS provides many communication options, and the most relevant for this project was the point-to-multipoint communications option. SCATS uses a TCP/IP communication protocol with a typical bandwidth of around 8 kilobytes per second per controller, with the central software communicating with each controller once per second. Some critical messages require a response within 400 milliseconds.

Actelis Networks® was chosen for this project because they specialize in intelligent transportation systems communications and currently used in other SCATS installations. White Plains electricians tested for noise in the existing twisted pair cable from the White Plains Traffic Management Center (TMC) to the SCATS intersections and suitable pairs were chosen for communications. Actelis Ethernet devices were procured and installed using Internet protocol (IP) over copper in a daisy chain configuration with Actelis ML622 device serving as end points and an Actlelis ML684 device serving the intermediate intersections.

## 2.6   Advanced Traffic Management System Software

A central server was procured and installed and the Advanced Traffic Management System (ATMS) software for this project included the SCATS suite of software products. All elements were commercial off-the-shelf software products and required no development for the project. The SCATS suite of software includes the following items:

- SCATS: The region software.
- SCATSCMS: The central management software.
- SCATSAccess: The SCATS graphical user interface.
- SCATSPicture: Used to build and modify SCATS graphics.
- SCATTERM: The command line interface used for some advanced functions.
- Traffic Reporter: Used to display (graphically or in text format) the strategic monitor data and traffic volume counts.

TransCore developed SCATS intersection graphics for all intersections and developed a system graphic that detailed congestion levels and coordination groups. The graphics were developed using SCATSPicture, the graphics package that comes with SCATS. TransCore also installed the central server loaded with the SCATS software at the White Plains TMC. Figure 10 provides an example of the graphics provided by SCATSPicture software.

Figure 10. SCATS Intersection Graphics

Source: TransCore ITS, LLC
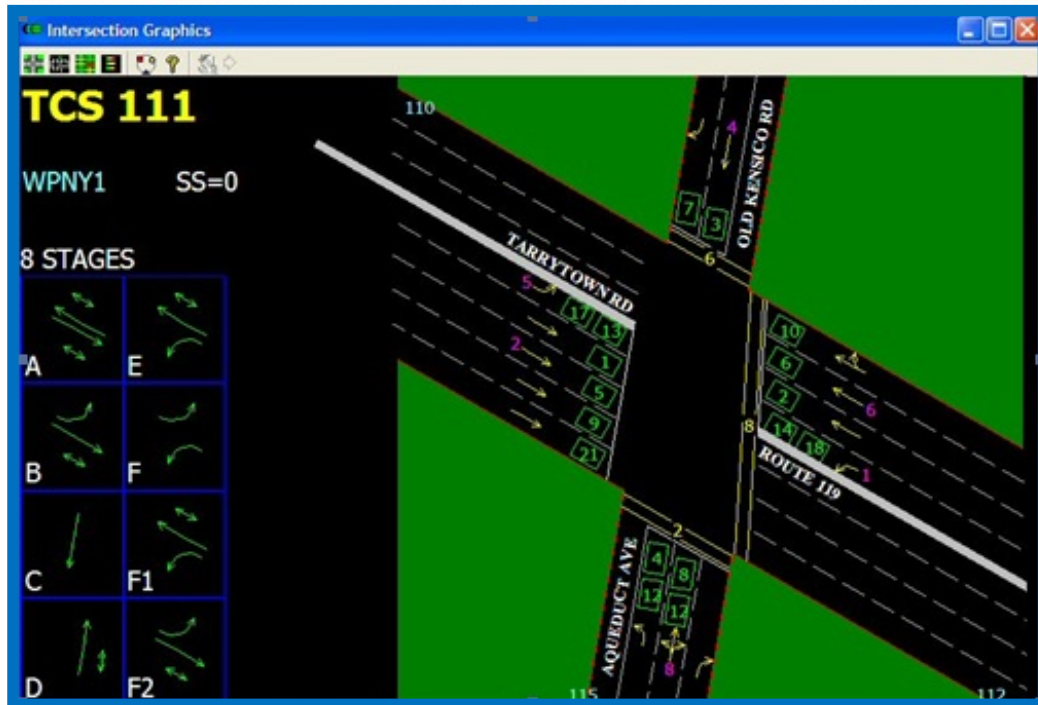
Once the SCATS system had been turned on, TransCore monitored the intersection signal timing parameters to ensure that adequate service was being provided the movements. At the same time, the capabilities of the real-time time/space diagram were demonstrated to White Plains staff. This feature is invaluable during the fine tuning process and is one of the key reasons that SCATS fine-tuning can be accomplished so quickly.

TransCore provides warranty support on all system components and software to assure that they are free from defects and will operate properly. TransCore prepared system design documentation that detailed the system configuration and provided three days of hands on training to White Plains staff for both field and system elements that ensured a proper transfer of technology took place.

3   SCATS Evaluation

3.1   Traffic Reporter Analysis

Traffic Reporter is a module with the SCATS application that is a valuable resource in evaluating performance. Traffic Reporter can view and compare historical data like cycle lengths, splits, and volumes at all intersections with installed SCATS. Figure 11 shows two Traffic Reporter graphs of signal plans taken from this project last holiday season on Tarrytown Road. These graphs compare heavy holiday traffic versus typical weekday traffic along the corridor, and shows that SCATS reacted to the heavy traffic and usually it only goes up to 120 seconds cycle. However, when people were going out for shopping between 8:30 a.m. and 10:30 a.m., it went all the way up to a 140-second cycle. Also from the second graph you can see that usually cycle length varies between 100 seconds and 120 seconds. But because of holiday traffic, it stayed at 120 seconds from 11:00 a.m. to 4:00 p.m. Traffic increased at the afternoon peak, so the cycle increased to 140 seconds and remained there until 7:45 p.m.

Figure 11. SCATS Holiday vs. Normal Traffic

Source: TransCore ITS, LLC
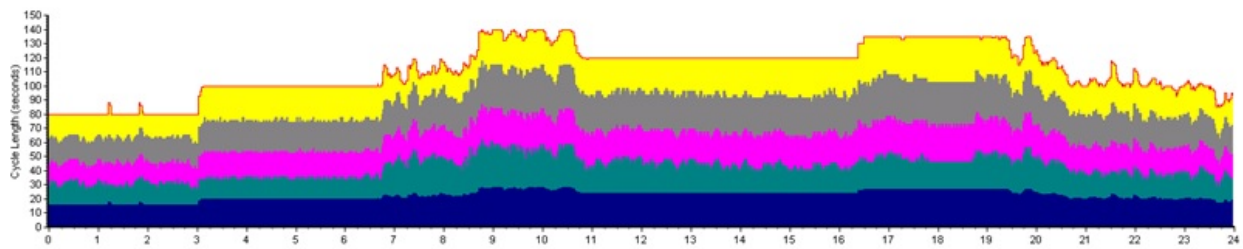
Holiday Traffic - Monday before Christmas - December 23rd, 2013
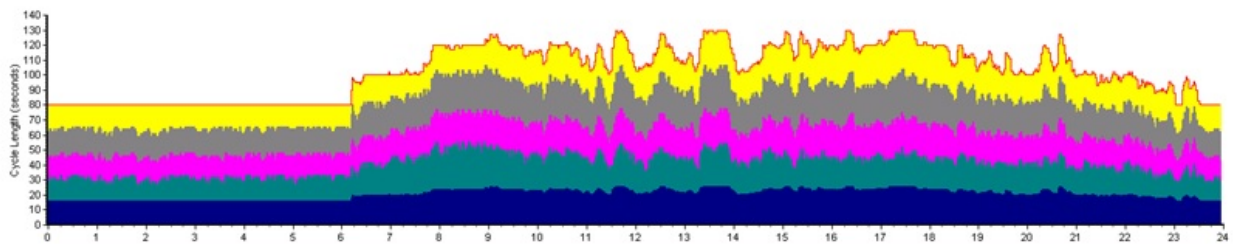
Normal Traffic – Typical Weekday – December 10th, 2013

Figure 12 shows a graph from January 1, 2014. Notice the cycle length increased after 1:00 a.m. when Dec 31 activities are over and people started to drive home (circled). This peak was not seen in Figure 11. Also because of holiday activity, the day profile was completely different (more flat, no peaks), and cycle length stayed around 100 seconds throughout the day except for a few peaks when it jumped to 120 seconds.

Figure 12. SCATS Traffic January 1, 2014

Source: TransCore ITS, LLC
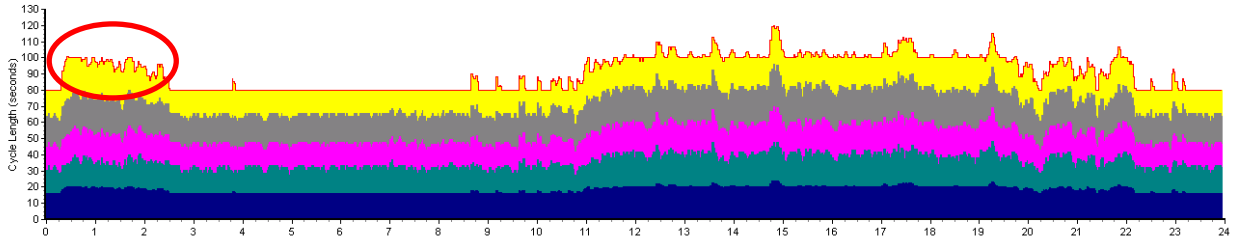
SCATS saves all of the volume data, which can be accessed graphically from Traffic Reporter and also imported as a CSV file in Excel for study purposes. Figure 13 show the volume data graph for phase 6 and phase 2 at Tarrytown Rd at Central Ave intersection.

Figure 13. SCATS Traffic Volume Data

Source: TransCore ITS, LLC

3.2   Corridor Enhancements

During the final optimization period, TransCore worked with White Plains traffic managers on several plan enhancements. White Plains staff discussed their desire for enhancements that will address their needs during special events or traffic conditions. One enhancement is a diversion plan that will address an overflow of traffic from I-287 onto Tarrytown Road in a case of an incident on I-287. In this case at the intersection of I-287 off-ramp, by effectively managing split times, it can better manage the overflow traffic queuing on the I-287. An example of SCATS accommodating unpredictable increases in traffic due to a neighboring freeway closing is shown in Figure 14. The two graphs show the differences between normal morning peak traffic and one with a diversion plan implemented. The SCATS adaptive system recognized the increase in traffic and automatically accounted for it, and most importantly, did it without any manual intervention.

Figure 14. Normal AM Peak versus SCATS Modifying Timing to Account for Freeway Diversion Traffic

Source: TransCore ITS, LLC
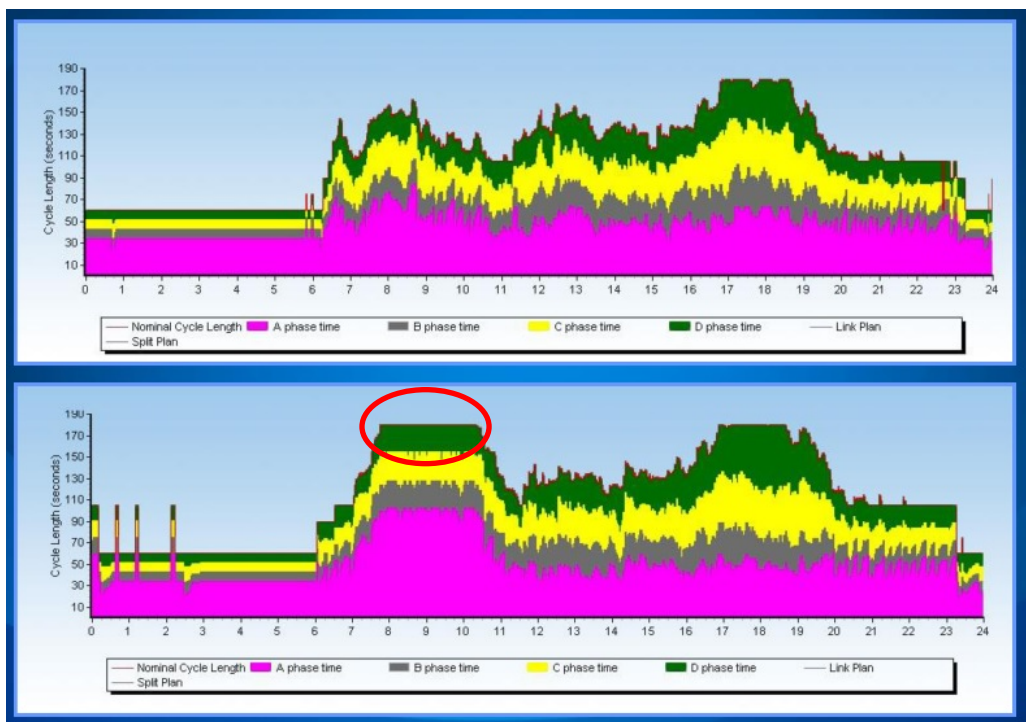
Other SCATS customizations to the corridor developed for White Plains were:

- Heavy left turn traffic into shopping center at Tarrytown Rd and Shopping Center Driveway
- Heavy shopping activity utilizing Aqueduct Rd from Central Ave
- Heavily favored Inbound (towards downtown) traffic
- Heavily favored Outbound (towards I-287) traffic
- Different late night operation (coordinated vs. free)

3.3   Before and After Study

A before and after study was performed during two days in May 2012 after the installation of the first 7 SCATS intersections. SCATS was turned off during the before study and turned on during the after study and traffic volume data was collected for measurement. When turned on, SCATS ran its adaptive algorithms (Masterlink mode). When turned off, TOD plans, which reside in SCATS's background, operate (Flexilink mode). Travel time runs were collected manually on 12 outbound and inbound runs and were conducted for three periods: morning peak, midday, and afternoon peak as defined in the Federal Highway Administration's Travel Time Data Collection Handbook.

Two parameters were measured: travel time and number of stops. The early results of the study indicate that the SCATS adaptive system outperformed TOD plans. Although some data collected indicated a flat performance, significant results of the study occurred during the following peak periods where traffic volume was the greatest (based on performance per 1,000 vehicles):

- Morning: Travel time was improved by 14% for Inbound and the number of stops decreased by 25%.
- Midday: Travel time improved 16% and number of stops decreased by 32% for Outbound.
- Afternoon: Number of stops decreased by 30% for Inbound and 23% for Outbound.

3.4   Project Benefits

The potential future benefits of using an adaptive traffic control system instead of a pretimed system are numerous. It enhances the quality of life for New Yorkers with energy, environmental and economic factors. Therefore, an adaptive traffic control system can save money, time and resources, as outlined in the following sections.

3.4.1 Reduction of Transportation Carbon Intensity

The benefits of ASTC deployment are reported in numerous studies published in the past 30 years since the first practical applications of these systems.[5] According to the NCHRP Synthesis 403 report, 60% of agencies observe a reduction in travel times/delays when an ASTC is deployed. Furthermore, 70% of the surveyed agencies reported that the performance of ASTC was better or much better than their previous system. In more than half of the instances of ASTC deployment, improved measures of effectiveness included stops, queues lengths and intersection delay, measures directly correlated with reductions in GHG emissions. Thus, it can be safely said that the majority of ASTC evaluations have resulted in the reduction of transportation carbon intensity.

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[5]   Alexander Stevanovic. 2010. NCHRP Synthesis 403, Adaptive Traffic Control Systems: Domestic and Foreign State of Practice, Transportation Research Board.

3.4.2 Increased Mobility and Reliability

Figure 2 demonstrates mobility improvements with reduction in travel time and delay and increase in speed. These measured improvements all indicate a reduction in congestion on the routes where ASTC is deployed. Comparable improvements are expected on Tarrytown Road in White Plains. Based on the results in Figure 2, travel time reductions between 8% and 19% during peak periods and up to 32% in off-peak periods are expected to improve mobility in Tarrytown Road corridor.

3.4.3 Decreased Energy Use

As pointed out previously, reducing stops closely correlates to reducing fuel consumption. To translate stop delay to fuel usage, SIDRA,[6] a traffic engineering simulation model, uses a conversion of 0.41gallons per hour of stopped delay. Reduction in stops comparable to those in Figure 2 will result in significant fuel reduction on Tarrytown Road.

3.4.4 Decreased Environmental Pollution

The expected reduction in fuel consumption closely correlates with reduction in GHG. Generally burning one gallon of gasoline creates 19.57 pounds of CO_2. Thus the reduction in emissions and GHG are anticipated with the deployment of adaptive traffic signal systems and the concomitant reduction in fuel consumption.

3.4.5 Increased Economic Benefit

Using adaptive signal control results in economic benefits for both the operation agency and the motorist. When using conventional central or closed loop systems, agency staff hours are needed to modify timing plans to account for changes over time in traffic flow patterns. As a result of budget constraints, these staff hours may not be available and agencies either defer needed signal timing plan updating, or perhaps do nothing at all. Adaptive control eliminates the need for plan updating since it automatically accounts for changes in traffic conditions by calculating signal timing based on real-time detection information from the field. Thus, the signal system requires less agency oversight in cost savings to the agency. For the motorist, reduced stops and delays translate into fuel savings and thus reduced cost of travel.

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6   SIDRA Input Guide, 1988, p. 123 (www.sidrasolutions.com)

3.4.6 Increased Safety

ATSC deployment improves the safety of traffic operations through reduction in the number of stops which are correlated with the probability of rear-end collisions. ATSC deployments have resulted in reductions in stops of 28 to 41%.[7] A corresponding reduction in rear-end collisions can be expected at ATSC equipped intersections thus providing a safety benefit from the SCATS deployment.

3.4.7 Other Benefits

While SCATS has been installed throughout the U.S. as shown in Figure 1, it is and underutilized commercial technology within the State of New York. Furthermore, it is a commercial off-the-shelf product that requires no software development for this deployment and results in a low-risk approach to NYSDOT and NYSERDA. In the current economic environment where New York State is having difficultly providing funds for transportation projects and agencies are experiencing shrinking budgets, the ability to deliver benefits to the public is paramount. Through the use of SCATS, both NYSDOT and NYSERDA will be deploying a proven ATSC that has a demonstrated record of performance.

3.5 Conclusions

The City of White Plains was interested in implementing adaptive traffic control in the Tarrytown Road Corridor for two major reasons: The traffic volumes for the corridor are very high (as many as 60,000 vehicles per day on busy days), and it was difficult to match the traffic volume activity with pre-scheduled or responsive plans due to the variability of peaks in traffic flows.

According to White Plains traffic managers, SCATS has been very effective at making the cycle-by-cycle changes to better match signal timings with actual flows. Even with cycle lengths varying as much as 15 seconds from one cycle to the next, a relatively seamless transition along the main corridor goes unnoticed by the travelling public. This feature is important in providing a more comfortable travel experience for drivers. Even when travel times are not reduced significantly, the travel experience is much smoother due to fewer stops and a reduced chance of experiencing the frustrating event of waiting for more than one cycle. A good indication of the public view of this implementation was demonstrated by a brief time period of four to five weeks in late 2012 when the system had to be reverted to the old timing plans due to resurfacing work that eliminated the road sensors. The City of White Plains almost immediately started receiving complaints about timing problems. The complaints went away with reversion to the adaptive operation.

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[7]   USDOT. 2000. "What Have We Learned about Intelligent Transportation Systems?"
http://ntl.bts.gov/lib/jpodocs/repts_te/13316.pdf

White Plains is also pleased with is its flexibility in handling more severe events. By having detection in every lane on all approaches, the system can react more appropriately to surges in traffic flow due to accident events on adjacent highways or scheduled events such as graduation ceremonies at the Westchester County Center theater. It is believed that expansion of the system to the downtown intersections and the Bronx River Parkway intersection at the Westchester County Center would help to take full advantage of this feature, but there have been significant efficiencies realized with the current nine-signal network. The system also performed well during the 2013 holiday season where some unusual peaks occurred.

From the extensive database of information collected for each cycle, it is easy to see what has occurred during very high peaks. However, the data set also provides a record of how the system can react during low volume time periods such as those that occur on a regular basis during times of inclement weather, holidays, and vacation seasons. Additional benefits, including reduced emissions and delays, are realized due to better management of these off-peak times, which in many cases represent a much larger portion of the total time than peak periods.

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Adaptive Traffic Signal Control for Tarrytown Road in White Plains, New York

Final Report
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