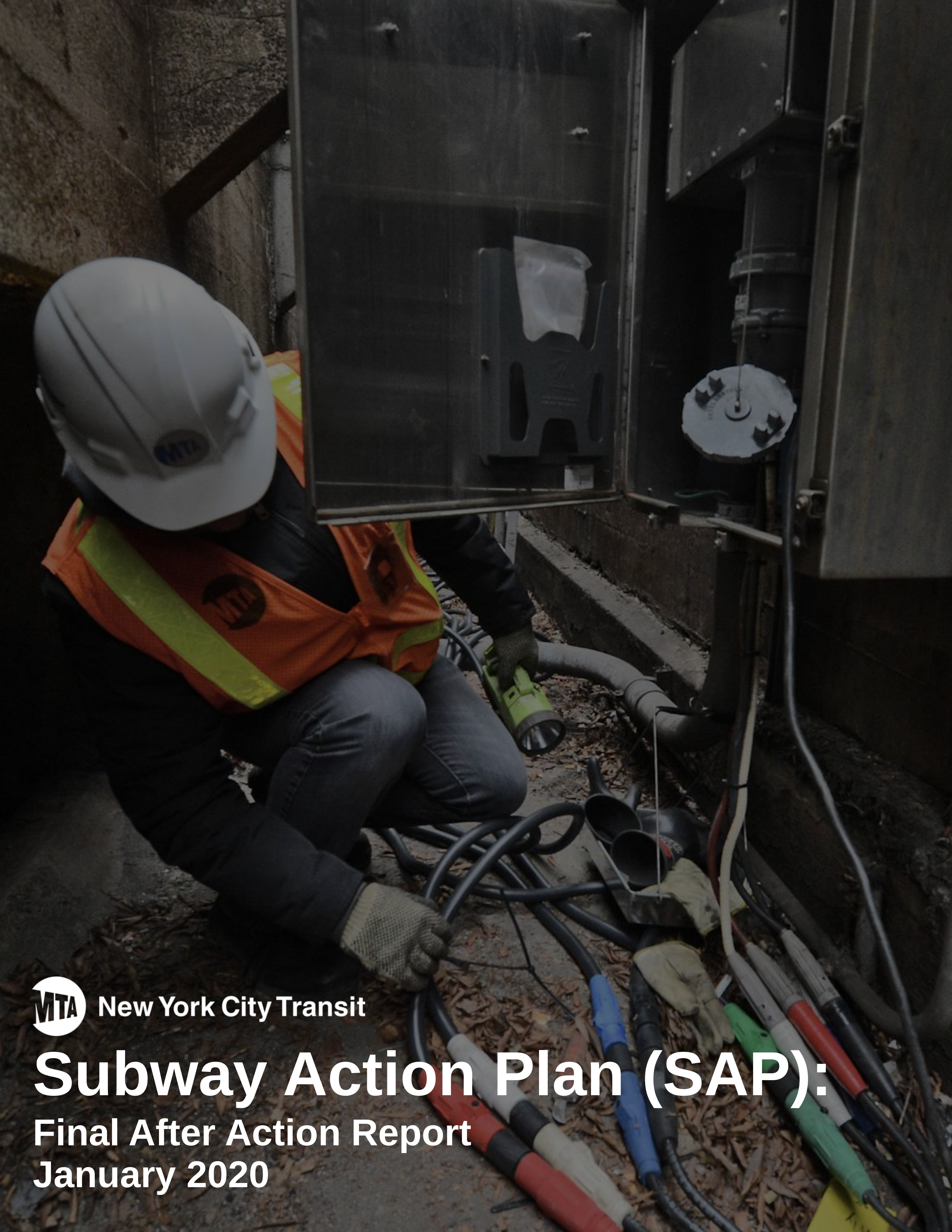


New York City Transit

Subway Action Plan (SAP):

Final After Action Report

January 2020

Background

In 2017, the subway system was in crisis, suffering a years-long decline in performance and reliability. During the first six months of that year, there was a dramatic increase in the number of disruptive incidents, including a near doubling of incidents delaying more than 200 trains. This reflected overall deterioration of the subway system with clear negative impacts to the customer experience. The system needed emergency investments to reduce these incidents and improve reliability. On June 29, 2017, Governor Cuomo declared a state of emergency and less than a month later, the Metropolitan Transportation Authority (MTA) launched the Subway Action Plan (SAP). This plan was a comprehensive stabilization and modernization initiative to address the challenges facing the New York City subway - the busiest transportation network in North America. New York City Transit (NYCT) led the implementation of SAP initiatives within the MTA. SAP consisted of two phases: Phase One stabilized the system. Phase Two developed a long-term focus to institutionalize the progress of SAP, as well as continued critical maintenance and investment activities to increase reliability of the subway system.

This After Action Report provides an overview and narrative evaluation of the program. The State and the City invested $836 million over an 18-month period (from July 2017 through December 2018) to improve the system through SAP, which delivered crucial initiatives that stabilized and increased performance across the system. In July 2019, the MTA announced a major milestone: weekday on-time performance crossed 81% for the first time in six years; December 2019 was the seventh consecutive month with on-time performance above 80%. Weekday delays decreased 40.6% from an average of almost 58,000 per month in 2018 to just over 34,000 per month in 2019. These can be attributed to concurrent campaigns including SAP and Save Safe Seconds, which includes the Subway Performance Evaluation, Education and Development (SPEED) unit. SAP prioritized reliability investments to reduce the number of service-affecting incidents in the system and deployed enhanced emergency response procedures to reduce the impacts of incidents that do occur, both of which served to lower the number of major incidents in the subway system. Weekday major incidents, which are unplanned occurrences that delay 50 or more trains, were down by nearly one-third, from 68 per month in 2018 to 45.5 per month in 2019. Total weekday incidents in 2019 were the lowest of any year since the MTA started recording this data in 2015. This report will detail the accomplishments under a variety of initiatives and expand on the level of investment in each category of work.

Beyond the day-to-day performance of the subway system, SAP focused on deploying new methods to sustain improvements in safety, customer service, and employing best practices. From using expedited procurement methods and support of outside contractors to complement the work done by in-house forces, the MTA has a better foundation for long-term modernization with changes in how resources are deployed. Going forward, the MTA can focus on optimizing future operating funds by continuing reliability-based maintenance and targeted responses to asset-based incidents.

In addition, the MTA expects over $300 million per year in operating dollars to support continued maintenance and renewal efforts to ensure SAP gains are sustained. This report will detail the permanent changes to practices that are designed to sustain gains from SAP.

Phase One: Stabilizing the System (July 2017 to December 2018)

An initial $836 million was allocated for Phase One, with the goal of stabilizing the system and reversing the decline in reliability. The table below shows key areas of investment with accompanying expense figures.

Phase One Category	Total Expenses (millions)	Contracting Expenses (millions)
Track	$ 133	$12
Signals	$ 116	$39
Infrastructure	$ 119	$64
Cars	$ 157	$11
Stations	$ 64	$5
Power	$ 232	$92
Communications	$ 15	$2
Total:	**$ 836 M**	**$ 225 M**

By targeting the deployment of additional personnel and equipment to focus on critical parts of the system with the highest incidence of failure, the MTA's goal was to reduce delays and major incidents.

One critical initiative was to address power-related issues and mitigate power disruptions to key locations in the subway network, in collaboration with the New York State Public Service Commission and Con Edison. As Phase One was underway, staff also deployed new practices and efficiencies under senior management leadership and guidance. Contractors were introduced in several areas to accomplish the unprecedented amount of work, complementing the in-house forces dedicated to these efforts.

Phase Two: Changing Practices and Institutionalizing Improvement

Phase Two is focused on changing organizational practices to ensure that SAP will continue to yield gains long after the initial phase of the program is complete. The key to future success lies in continuously taking a fresh look at individual operations and providing planning for future programs. Evaluation of the funds invested is critical to make the case for the need for these types of operating funds in the future. The table below highlights the budget for major categories of ongoing work planned during Phase Two for 2019. Projects within each category will be reviewed and adjusted annually as needed.

Phase Two Category	2019 Total Budget (millions)	2019 Contracting Budget (millions)
Track and Third Rail	$107	$27
Signals	$33	$6
Infrastructure	$62	$30
Cars	$79	$9
Stations	$71	$28
Communications	$10	$2
Total:	**$ 362 M**	**$ 102 M**

Overall, SAP was a successful initiative, under effective leadership and with the support of thousands of MTA frontline employees committed to improving reliability for the more than 5.6 million customers riding the subway system on an average weekday.

Phase 1: Stabilizing the System – Initiative Summary & Results

SAP initiatives delivered crucial maintenance and improvements to stabilize the system and lay the foundation for future modernization. Initial investments targeted resources where they would have the greatest impact on system-wide performance and reliability.

Track Improvements

SAP aimed to improve the condition of track by completing repairs, installing additional Continuous Wielded Rail (CWR), rail grinding, and cleaning track.

As part of the plan, maintenance workers completed over 28,000 track repairs. During the peak of the SAP in 2018, they cleared about 14,000 potentially problematic defects (P2-priority defects[1]), compared to about 8,000 in 2016, and 2,100 in 2015.

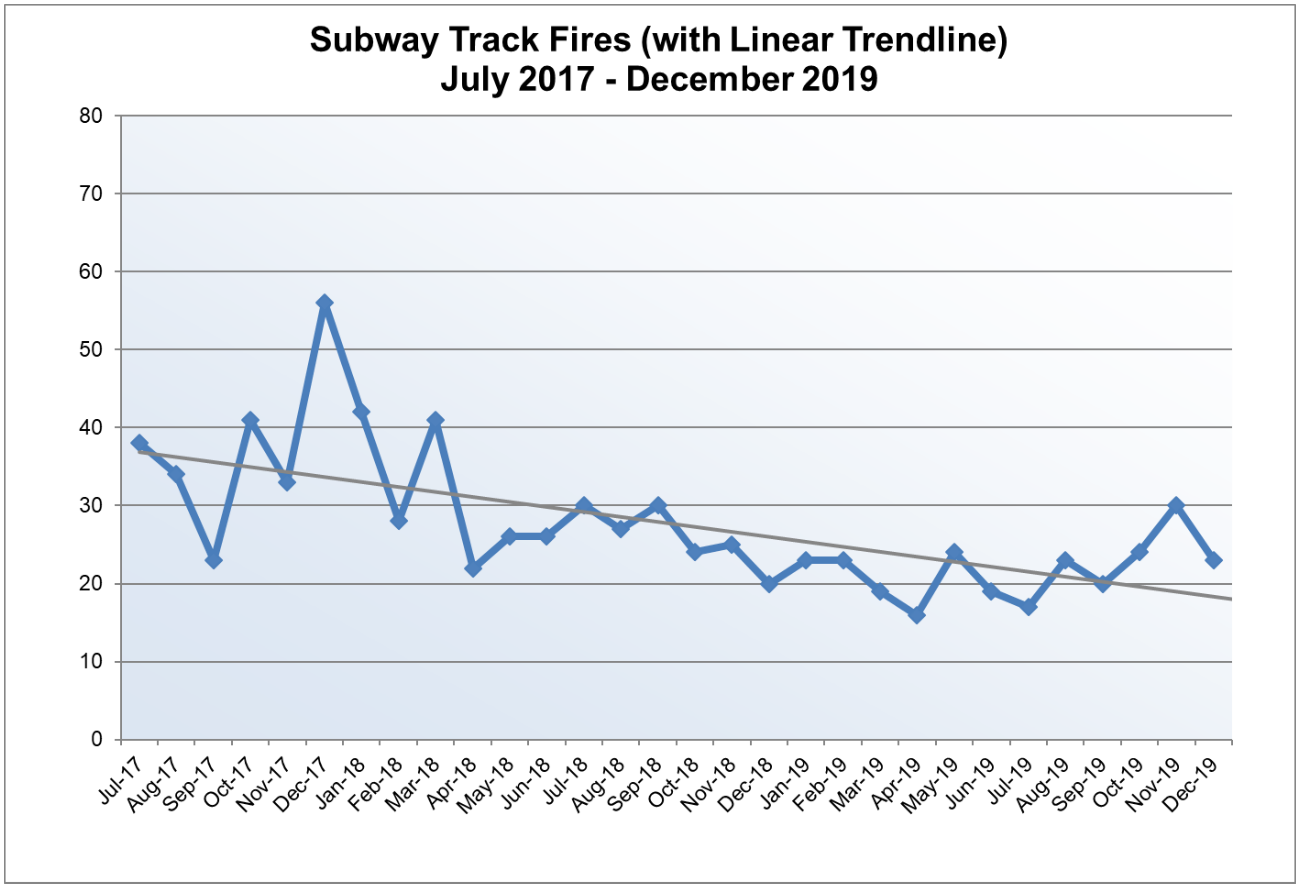
The MTA tripled the rate at which it replaced jointed rail with CWR throughout its entire system, installing approximately 55 miles from July 2017 through December 2019. Because there are fewer joints in the rail, CWR is more durable, requires less maintenance, and provides a smoother ride for customers.

Under SAP, the rail grinding program was accelerated. The MTA now has three rail grinders running through the entire system to remove rail imperfections and prevent defects. In 2019 alone, these rail grinders covered over 187 miles of track.

These track improvements reduced track-related major incidents by over 55% from 15.5 per month in 2017 to less than 7 per month in 2019.

[1] P2 status is assigned to near-critical defects; P1 status is assigned to defects requiring immediate attention, which are addressed right away.

Maintenance workers also cleaned the entire network of over 418 miles of underground subway tracks. That new level of cleanliness is being maintained by three new vacuum trains, which have completed well over 3,000 miles of cleaning in 2019 alone. Consequently, fires related to debris along the subway right of way are down by 44%, falling from 462 in 2017 to 261 in 2019. The below chart compares debris fires on the right-of-way spanning over the last three years.



Signal Reliability:

Prior to the SAP, 40% of signaling and communications equipment was half a century old, and equipment was deteriorating at an increasing rate. In the year before the plan was implemented, the number of major incidents due to signal failures increased by 24%. The MTA's goal under SAP for signaling was to improve performance and reliability through heavy signal repair and maintenance.

Under SAP, the MTA completed an unprecedented full system inspection of signaling along the entire subway right-of-way. The MTA repaired and rebuilt more than 2,000 signal components to date. Maintenance workers have replaced signal stops, air lines, and cables, focusing on those most likely to affect service.

As a result, signal-related major incidents have fallen by nearly 30% from 2017 to 2019. The MTA now uses new types of components and tools that are more reliable.

Water Management[2]:
Prior to the SAP, water-related damage was a significant cause of subway delays. 418 of NYC's 665 miles of subway track are underground and vulnerable to water infiltration. The SAP contained a comprehensive water management plan to address water infiltration.

With the help of contractors, the MTA has sealed more than 8,200 leaks, which can cause signal problems, lead to fires, and deteriorate track and stations. To accomplish this intense effort, the agency doubled the resources to address leaks from 5 teams using 10 grouting machines to 10 teams using 20 machines.

The MTA cleaned and repaired the entire system of subway drain lines, which serve 418 miles of track. The agency is also developing a new schedule to maintain drains based on measurements of silt buildup taken throughout 2019. Under SAP, the MTA added 5 new staff teams, and doubled heavy cleaning equipment. When debris blocked drain networks, the system was unable to eliminate water from the subway tracks. This impaired the ability to run service because it could lead to flooding, and because water exposure deteriorates equipment.

The MTA also cleared debris from the entire system of over 40,000 street grates as part of the first phase of the SAP. Street grates allow for the ventilation of the subway, but when litter and leaves from the street build up, any entering water cannot be channeled as designed and will directly impact the surface below, including tracks and station platforms. Prior to SAP, the agency aimed to clean vents every 2 to 3 years, but this schedule was not always met due to resource constraints. The entire network was cleaned again in 2019 and is scheduled to be cleaned annually going forward.

A targeted focus on water management and the funds from SAP supported completion of these monumental tasks. The advances in water management have enhanced the subway's ability to handle incidents such as downpours and water main breaks, so these types of incidents now rarely have a significant effect on subway service.

Car Equipment:
Before SAP, subway cars were in need of better repairs and inspections. The average subway fleet was 22 years old, and 16% were more than 40 years old. Approximately 40% of car breakdowns were caused by door malfunctions. The MTA's objective for subway cars was to improve the condition of equipment by improving heavy maintenance regimes, reducing downtime of trains in repair, and upgrading critical components.

The MTA accelerated its Scheduled Maintenance System (SMS), the cycle for major car overhauls, from 7 to 6 years. This reduces the likelihood of failures while in service, improving

[2] The MTA initiative under the SAP initiative for water management is part of Subway Infrastructure and Station Maintenance.

the reliability of this critical equipment. SAP also installed customer amenities such as LED lighting and double pole stanchions.

The MTA expedited inspections and repair for car mechanisms with frequent issues, such as power converters, master controllers, and door components. This maintenance work drastically reduced preventable failures. The Mean Distance Between Failures (MDBF), a measure of how long a vehicle can run before it must be taken out of service, has shown consistent improvements, increasing year-over-year by 13.5% from 118,854 to 134,947 miles in December 2019, while 12-month average MDBF reached 127,743, the highest in almost four years.

The plan also improved work equipment availability. By restoring 38 flatcars, the available fleet was expanded by 20% - making more equipment available for in-house and contractor crews to use in performing capital or maintenance work. The addition of rail car movers in yards freed up diesel locomotives for work sites. Greater access to work equipment, such as flat cars and locomotives, improves both system maintenance and capital program delivery.

Under SAP, the MTA also completed a new program to deep clean over 3,000 cars.

Stations

In collaboration with partners at the TWU, the MTA accelerated efforts to clean stations and provide an improved customer experience through a program to bring station environment across the network to a higher standard of quality. Through mobile washing, the agency was able to increase both the quality and frequency of station cleaning. New tools, materials, and mobile wash trucks were added to the fleet. To support the cleaning effort, the MTA formed multi-disciplinary teams to address the backlog of maintenance items at the stations including ceilings, platforms, walls, lighting, plumbing, and benches.

To quickly bring stations to new standards for cleanliness, the agency hired contractors that were able to bring over 100 stations up to these new standards in under 6 months. SAP's in-house cleaning and repair campaign continued as well, now led by Group Station Managers, and has enhanced over 200 stations. In customer surveys, satisfaction with cleanliness increased 5.8 percentage points from 3Q2018 to 3Q2019 (rising to 61.9% from 56.1%).

The MTA has increased its elevator and escalator maintenance efforts, developing and implementing new strategies. The agency hired contractors to support improved maintenance and repairs system-wide, focusing outside resources on priority projects. In one instance, dedicated contractor resources were allocated to Washington Heights, where stations are deep and elevators are particularly vital. Employing contractors allows the MTA to complete crucial elevator and escalator maintenance without draining our in-house resources. Elevator availability in Washington Heights rose to a peak of 97.1% in early 2019 from a low of 86.2% in 2017. System-wide elevator availability reached a peak of 97.5%, the highest level since to 2013 before a temporary reduction related to a systemwide inspection and upgrade campaign. Escalator availability has similarly been affected by a system-wide inspection and repair campaign that has temporarily reduced availability, but has shown a positive trend of the past several months. Reducing response time to outages is a now a focus for SAP and a metric that is tracked weekly.

Power

The entire subway system is dependent on a reliable and consistent power supply. Under SAP, the MTA aimed to inspect, test, and replace deteriorated cables and signal power components to enhance signal reliability, reducing the number of major service interruptions.

The MTA conducted a full inspection of all signal-related structures receiving power from the utility Con Edison, over 100 in total. This led to the replacement of thousands of electrical components.

More than 2,000 Con Edison smart meters have been put in place, covering all locations that power enters the subway system. These devices allow two-way communication between the MTA system and Con Edison, allowing the agency to determine the status of the electrical power being supplied.

Con Edison also put in place 384 sag correctors, which are devices that even out momentary voltage drops (or “sags”) to protect signal equipment. The voltage fluctuations can routinely occur from power suppliers. Previously, these fluctuations in power supply could have directly impacted the signal system. In 2019, there were 986 separate voltage drops across the Con Edison network. Before SAP, these could have caused power disruptions to thousands of signals. However, the sag equipment is now able to maintain proper voltage for the signals. As a result, subway service interruptions related to power quality variations are now extremely rare. Ongoing SAP funding ensures proper maintenance of the new sag equipment.

Con Edison also installed more than 200 new emergency generator ‘quick connects’ (EGI’s) in high priority locations to enable faster restoration of power supply during outages.

In addition, the agency completed installation of newly-designed third rail insulators in 550 fire-prone areas to prevent smoke conditions that could impact service, and additional installations will continue into the future.

Customer Communication:

Improving service requires bolstering communication with customers. The MTA added more than 50 new dedicated announcers to better inform customers about service status and delays. Specially-trained MTA customer representatives were placed at high-traffic stations to provide guidance to riders in real time and retrained staff to improve communication with customers. The MTA also accelerated the system-wide completion of countdown clock installations.

The MTA also overhauled digital communication assets, including the launch of a new integrated app. The agency increased its social media activity by 77%, sending over 15,000 social media responses in December 2019. The agency also trained and deployed over a hundred Wayfinders to provide enhanced customer service. Customer satisfaction ratings for service and delay communication are up 5.2 percentage points from 3Q18 to 3Q19.

Emergency Response[3]:
The MTA's response to incidents improved under SAP. The MTA tripled the number of Combined Action Teams (CAT) from 8 to 24, which deploy Track, Signal, and Third Rail personnel to strategic locations to rapidly respond to and resolve any incidents. As a result, the average CAT response time improved by 32%, and the average CAT resolution time improved by 39%.

The MTA also added 20 new Road Car Inspectors to address any in-service subway car issues, and established new teams to address any infrastructure emergencies. All of this has led to faster response and resolution times.

Additionally, the MTA placed EMTs at 12 key stations (more than doubling the number of stations with EMTs), which have assisted hundreds of sick customers and reduced response time to sick customers at those stations by an estimated six minutes.

System-wide Results:
Today, the rate of major weekday incidents is lower than at any time since 2015, when the MTA started recording data on this metric. Weekday incidents delaying more than 50 trains have decreased by more than 40% since implementing the SAP. The subway system also dealt with 149 fewer fires in the first six months of 2019 than the first half 2018. The below chart highlights the number of major weekday incidents (delaying more than 50 trains), and the dramatic reductions in major incidents that SAP helped achieve.

	Pre-SAP Monthly Average *	**2019 Monthly Average**	**Difference**	**% Change**
Weekday Major Incidents	77.0	45.5	(31.5)	-40.9%
Track	16.5	6.9	(9.6)	-58.1%
Signals	24.0	15.1	(8.9)	-37.2%
Cars	4.5	4.0	(0.5)	-11.1%
Stations and Structures	6.0	1.8	(4.2)	-70.0%
Emergency Response Incidents	15.2	11.0	(4.2)	-27.5%
Other	10.8	6.7	(4.2)	-38.5%

** Pre-SAP is defined as January to June 2017.*

Changes to Practice
The 2017 crisis required more rapid and significant changes than could be accomplished by just adding more staff, forcing the agency to act more strategically. As a result, the MTA has

[3] Spending falls under track, infrastructure, and cars.

significantly advanced its practices and procedures for reliability-based maintenance. Improved business practices and higher quality assets have made the agency more efficient and productive, laying the foundation for long-term modernization.

Maintenance Practice Changes

The agency moved away from a cyclical maintenance system that is time-based or mileage-based, and is replacing it with informed, targeted campaigns that are driven by performance metrics and asset condition data to focus on mitigating delays:

- *Repairs* – The agency now prioritizes track, signal, and car equipment repairs for assets that are the most critical, that exhibit performance problems, or that are located in areas where failure is especially detrimental. For example, by identifying leaks that have a high flow rate and are impacting electrical components, the agency can handle leaks on a priority basis. By tracking the performance of priority switches, the agency can dedicate its vital resources to the maintenance work that will provide the best benefit to subway performance.
- *Cleaning* – The MTA learned which deep cleaning initiatives were most effective and reorganized the deep cleaning team structure and processes. The agency also added field-level accountability to enhance heavy duty cleaning quality assurance, and introduced new chemicals and equipment for in-house work. SAP added between-station track cleaning as part of routine maintenance which was previously performed on a very limited basis. This has reduced the amount of litter and garbage on the tracks – thus mitigating delay incidents caused by debris and limiting the occurrence of track fires. Cleaner tracks are less likely to have buildups of water that can damage track and signal components, improving the longevity of our infrastructure.
- *Rail grinding* – SAP implemented an extensive rail grinding program, with ongoing maintenance that resurfaces and extends the life of rails, eliminating defects.
- *Drains* – The MTA developed an inventory of track drains during the cleaning process, which for the first time allows for a complete mapping of the underground drainage system. Together with the on-going monitoring program, this will provide a sustainable maintenance cycle for the future.
- *Elevators and escalators* – SAP instituted maintenance procedures and a schedule for elevators and escalators to ensure every machine is visited with greater frequency.

Improved Assets

A major focus of SAP was making emergency investments to repair, replace, and enhance assets. In addition to the maintenance and repair work itself, SAP also resulted in better planning and analysis, for maintenance and repair cycles. Going forward, the agency has made plans to leverage these assets for efficient and enhanced services and maintenance.

The MTA introduced magnetic wands to reduce steel dust and metal slivers which can trigger electrical faults and cause delays in the system.

SAP also put in place additional non-revenue vehicles to make maintenance more efficient. The MTA is now cleaning trash from tracks at an unprecedented rate, through platform-based mobile vacuums and three new high-powered vacuum trains. The agency has also dedicated vehicles to transport equipment and personnel for emergency response.

Improved assets also leave the agency better prepared for external threats to the system. The MTA's new equipment protecting against voltage sags in the power supplied by the utility protects the system against power fluctuations. The better-functioning drainage system is now able to handle influxes of water, such as water main breaks or sudden downpours.

General Orders Practice Changes

General Orders (GOs), the process for taking tracks out of service, are necessary for maintenance and capital improvements. Under SAP, the process for GOs was revamped.

The MTA created longer weeknight work windows by routinely starting track outages earlier, at 10:00 PM instead of midnight. Through SAP, the efficiency of implementing GOs significantly increased. The plan also brought in a third-party consultant to make recommendations based on GO practices in place at other transit systems.

SAP also changed the process for planning GOs, restructuring weekly meetings between key players to prioritize resources (including locomotives, flat cars, train operators, and flaggers) for scheduled GOs. GOs are no longer routinely cancelled. New protocols were also instituted at the Rail Control Center to secure the track, remove power, and move work trains into place efficiently. SAP established a dedicated dispatcher for GOs and a dedicated work train coordinator to support routing movements.

SAP initiatives cut in half the average "time-to-track" (time to execute GOs), from about 60 minutes to approximately 30 minutes. The plan also increased average "wrench time" (amount of work time provided by the service outage) by 62%, to about 5 hours and 40 minutes for the 10:00 PM starts.

Use of Consultants and Outside Experts[4]

Through SAP, the agency established relationships with outside experts and consultants to review practices and make recommendations. In the future, the agency is more prepared to leverage strategic recommendations from outside partners. So far, they have offered several key recommendations:

- *Incident management* – Recommendations led to optimally locating the emergency response teams, so that we can respond to serious incidents faster, allowing service to resume.

[4] See appendix for more details.

- *Signal and track* – Outside consultants helped with project management resources and activities that accelerated a reliability-based maintenance and repair program. Consultants also established the use of locking hardware and silicone-based lubricants.
- *Flagging and work trains* – Recommendations led to changes in flagging rules, leading to reduced time to track.
- *Rail grinding* – Recommendations enabled the rail grinding program to be greatly expanded.
- *Station cleaning* – The agency introduced new equipment and techniques from the private sector such as glass and sand blasting kits, portable scaffolding, floor buffers, escalator cleaning tools, steam machines, and paint stripping machines.
- *Mobile washing* – Working with consultants helped the agency to achieve greater performance from the mobile wash truck fleet. Consultants provided program management, fleet logistics, and data management. They also made a series of recommendations about equipment and procedures that the agency adopted.
- *Elevators and escalators* – Recommendations led to new preventive maintenance programs. Consultants also evaluated resource allocation and outlined optimal deployment of maintenance personnel.

Use of Contractors[5]

The MTA has also expanded approaches that integrate and leverage contractors to supplement in-house forces in critical efforts, increasing efficiency and productivity. Contractors have aided the agency on several key projects:

- *Cleaning the track drainage system* – Contractors supplied additional resources to allow cleaning of the entire system, including large vacuum systems on trucks. They created large custom storage tanks to increase capacity of vacuum tanks and reduce the number of times tanks need to be emptied.
- *Elevator and escalator maintenance and repair* – Contractors dedicated their efforts to specific areas. This provided more accountability and faster response times than being part of a shared zone with other E&E equipment.
- *Deep cleaning of subway cars* – Contractors were able to quickly bring the fleet up to new standards. For internal and external car cleaning, contractors used a variety of enhanced equipment and increased manpower.
- *Support for maintenance of SAG correctors* – Contractors brought expertise for the newly introduced equipment.
- *Signal repair and replacement* – The use of contractors allowed additional work to be completed without draining internal resources.

[5] See appendix for more details.

- *Deep cleaning of subway stations* – Contractors were able to rapidly bring stations up to new standards. They used new equipment, including glass and sand blasting kits, steam machines, and stripping machines.

Conclusion

MTA's execution of SAP was a success. The MTA delivered crucial maintenance to stabilize the system, which is in dramatically better condition now than it was in 2017. The subway system now has fewer regular incidents, as well as improved infrastructure and signal reliability.

SAP has also made the MTA and NYCT more strategic, reforming procedures to prepare for long-term sustainable growth. Moving forward, the agency is better prepared to handle incidents and improve reliability throughout the system. The attached appendix provides more details and statistics about the status of Phase One and Phase Two projects.

Appendix:

Contractors/Consultants: SAP changes in means and methods

In order to accomplish the extraordinary amount of work needed in a short amount of time, the MTA's Subway Action Plan made use of outside contractors and consultants to supplement in-house forces for critical efforts. By integrating and leveraging contractors and their expertise, the MTA developed new maintenance and cleaning practices, increasing efficiency and productivity. Contractors have aided the agency on the following key initiatives under SAP.

Deep cleaning of subway car interiors – Contractors were able to quickly bring the fleet up to new standards:

- For internal car cleaning, contractors used pre-dampened reusable micro-fiber mop heads and floor buffers.
- Contractors used lightweight all-in-one floor scrubbers and wet vacuums.
- Contractors used newly approved cleaning chemicals.
- Contractors wore tool belts equipped with spray bottles and pouches for reusable micro-fiber rags.
- Contractors used low platforms with wheels to facilitate access to low floor areas.
- Contractors used long-handled scrubber pads to clean hard to reach areas, such as ceilings and vents.

Deep cleaning of subway car exteriors – SAP updated car exteriors to new standards using contractors:

- For external car cleaning, contractors used various power washers.
- Contractors used soap sprayers and scrub brushes to scrub the outside of cars.
- Contractors used newly approved cleaning chemicals.
- Contractors are better able to collect wastewater runoff.

Deep cleaning of subway stations – Contractors were able to quickly bring stations to new standards:

- Contractors employed glass and sand blasting kits, portable scaffolding, various floor buffers, and various escalator cleaning tools.
- Contractors made use of steam machines and capacity/design power washers.
- Contractors used paint stripping machines, tool belts for spray bottles and other items, and approved cleaning chemicals.
- Contractors used 6-foot, 8-foot, and 10-foot ladders.
- Based on consultant recommendations, SAP used surface spinners and quick-connects for high pressure washing.

Maintenance cleaning with high pressure equipment (Mobile Wash)

Changes to process:

- Consultants provide program development and review services for mobile wash.

- Consultants provide fleet logistics management and created an inventory control management system for mobile wash.
- Consultants developed new standard operating procedures and provide rollout training to mobile wash cleaners and supervisors.
- Consultants provide stations management with training and developed a new checklist for cleaning quality and standard operating procedures.
- Consultants created a new data management process, which the MTA uses to capture and validate data.
- Consultants created a 12-month base schedule for mobile wash station cleaning.
- Consultants created an interface for mobile wash activities to feed into a dashboard and provide management with real time information.
- Consultants created an electronic spreadsheet for current processes and an inspection checklist for station supervisors.
- Consultants created a Q&A checklist for stations management accountability enforcement.

New equipment:

- Consultants recommended the most effective nozzle size.
- Consultants recommended new temperature controller software.
- Consultants developed a preventative maintenance schedule for equipment based on operating hours.
- Consultants recommended a new inventory control of consumable items.
- Consultants recommended new procedures for warranty part tracking.
- Consultants recommended a hydrant fill strainer system with trash filter, pressure gauge, and pressure relief to prevent contamination and damage to the mobile wash filling system.
- Consultants recommended procedures to track and schedule major overhauls and unscheduled work.
- Consultants recommended water proof write-on tags to sign and date major system components as SMS work is completed.

Cleaning the track drainage system – Contractors supplied resources to clean the entire system:

- Contractors created large custom storage tanks to increase capacity of vacuum tanks and reduce the number of times tanks need to be emptied.
- Contractors placed large vacuum systems on trucks, enabling effective drain cleaning with street level based equipment.

Elevator and escalator maintenance and repair – Contractors improved procedures and dedicated their efforts to specific areas:

- Contractors increased wrench time by responding directly to work locations, increasing productive time.

- Contractors have been able to produce better results with their skilled mechanics able to specialize their focus, dedicating efforts to specific areas, drastically improving availability of the equipment.
- Under SAP, elevator and escalator contract workers that are deemed less skilled have been replaced more quickly than in previous years.
- Contractors have taken care of material procurement, so some of the task order work is now more efficient to complete using contractor resources.
- Consultants advised the agency to increase supervisor maintenance visit and to modify its monthly maintenance plan for elevators.
- Consultants advised the agency to distribute cleaning supplies to elevator motor rooms on a regular schedule.
- Consultants advised the agency to train specialists in elevator valve body adjustment.
- Consultants advised the agency to develop an elevator door refresher course and incorporate it into a training regimen for all maintainers.
- Consultants advised the agency to acquire and issue new tools bags with wheels.
- Consultants evaluated resource allocation and outlined an optimal deployment of maintenance personnel.

Power equipment – Contractors brought expertise for the newly introduced equipment:

- Contractors installed sag correctors into the system to reduce the effects of power fluctuations.
- Contractors will assist in maintaining these sag correctors, using expertise that the agency lacks.
- Contractors installed Emergency Generator Inlets (EGIs), and compiled a database to expedite their use.

Signal and track maintenance – The use of contractors allowed additional work to be completed without draining internal resources:

- Consultants taught the agency how to perform reliability-based analysis and maintenance procedures on signal and track equipment. Consultants also conducted a root cause analysis based on failures and delays.
- Consultants established the use of locking hardware and silicone-based lubricants for tracks.

Chemical Grouting – Contractors increased the capacity and effectiveness of water leak remediation efforts:

- Contractors used a proprietary chemical for grouting and introduced curtain grouting to our maintenance program.
- Contractors increased and reduced manpower based on forecasts for the volume of work.

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