01 New York City Transit

Subway cars, maintenance facilities, and yards

Buses, depots, and bus maintenance facilities

Passenger stations

Subway infrastructure systems: Line structures, track, signals, traction power, line equipment, and communications infrastructure

Overview of agency and assets

New York City Transit (NYCT), together with Staten Island Railway (SIR) and MTA Bus, operates the most extensive and highest ridership subway and bus systems in the United States. We operate 24 hours a day, 365 days a year. Our trains, buses, stations, and all auxiliary equipment and infrastructure—like rail yards, bus depots, signals, power, and communication systems—are the foundation of our network, and require substantial and sustained capital investment to address historical underinvestment and to allow us to deliver the frequent and reliable service our riders have come to expect.

Our vision for New York City's transit system 20 years from now is one with more reliable and frequent service that is more resilient and sustainable, runs with more modern equipment, and is more accessible. The 20-Year Needs Assessment lays out a plan for us to get there.

NYCT, SIR, and MTA Bus by the numbers:

- Weekday ridership: Approximately 6.8 million (4.5 million subway and 2.3 million bus)
- 6,540 subway cars, 56 shops, and 24 rail yards
- 5,840 buses, 38 bus depots and facilities
- 493 passenger stations
- 306 station elevators and 231 escalators
- 266 miles of line structures
- 694 miles of mainline track and 1,825 track switches
- 794 miles of signal equipment and 217 signal interlockings
- 233 substations and 321 circuit breaker houses
- 209 fan plants
- 254 pump rooms and 23 deep wells
- 680 work train cars

J train entering Broadway Junction station

Investment needs highlights

Over the next 20 years, our priority investment needs include:

- **Subway cars, maintenance facilities, and yards**
  - Purchasing over 3,900 subway cars to replace aging cars, expand the fleet, and improve reliability, accessibility, and passenger experience.
  - Reconstructing and upgrading car maintenance facilities at Livonia Yard and 240th Street Yard to address poor facility conditions and enable them to accommodate modern subway cars.
- **Buses, depots, and bus maintenance facilities**
  - Continuing cyclical replacement of buses, replacing about 9,000 buses over the next 20 years.
  - Transitioning to zero-emissions buses as buses are retired, achieving a full transition to a zero-emissions fleet by 2040.
  - Installing infrastructure to support the zero-emissions bus transition at depots and maintenance facilities.
- **Passenger stations**
  - Continuing station component repair programs with quicker implementation of projects as deteriorated components or other needs are identified.
  - Installing modern public address and digital information screens in every station.
  - Building new elevators and ramps to expand the number of accessible stations, in line with MTA's goal of at least 95% of subway stations being accessible by 2055.
  - Addressing water infiltration conditions in at least 40 stations, targeting the root causes of structural deterioration.
  - Reducing extreme heat conditions in stations' critical equipment rooms.
- **Subway infrastructure systems**
  - Ensuring structural soundness of elevated steel structures by repairing all significant defects and routinely applying or renewing protective coating systems.
  - Improving power reliability across the network by renewing or upgrading approximately 190 substations, addressing critically poor power cable and circuit breaker house conditions, and upgrading the Power Control Center and its remote control system (SCADA).
  - Improving subway performance and reliability and unlocking additional capacity by modernizing over 300 miles of signals, ensuring 90% of riders are served by modern signals.

Q train, NYCT

New York City Transit appendix structure

This appendix provides an overview of our assets, their current condition, and expected investment actions to maintain these assets over the next 20 years. This appendix is divided into asset groupings, based on how our categories function together. For example, our passenger vehicles are supported by our shops, yards, and facilities. We provide a summary of each asset grouping, describe how the asset categories support each other, and then provide a 20-year vision for their maintenance and enhancement. Each asset category section then provides a more detailed description of the asset, an inventory showing their ages or the percentage of assets in poor or marginal condition, followed by the agency's investment needs and priorities for the next 20 years.

Our asset rating methodology

We perform regular and comprehensive inspections of all of our assets. Through these inspections, all assets are given a condition rating on a scale of 1 to 5, based on various factors, including age, condition assessment, performance, reliability, safety history, and location. Assets with a rating of 1 (poor) or 2 (marginal) help us identify where we need to focus investment needs the most. This rating scale is consistent with the Federal Transit Administration's Transit Economic Requirements Model scale. A brief description of the rating scale is provided below.

1. Poor (Deteriorated): Critically damaged or in need of immediate repair, well past useful life. Assets are operable with extraordinary maintenance, but have serious functional deficiencies and/or can be expected to experience potentially unacceptable stoppages over the next five years, which could have serious negative impacts on service within the existing maintenance framework. Assets require operating-funded interventions, which may include more frequent inspections and/or repairs that may include removing the asset from service until repairs can be performed. Capital investment in these assets is needed on a priority basis.

2. Marginal (Deficient): Deteriorated, in need of replacement, and may have exceeded useful life. Assets have functional deficiencies and/or can be expected to experience above-normal stoppages over the next five years, but severity of customer impacts or changes to operational practices can be held within acceptable bounds for a time within the existing maintenance framework. If capital investment is/was deferred for these assets, added maintenance and operating expenses would be expected.

3. Adequate (Acceptable): Moderately deteriorated, but has not exceeded its useful life. Assets that are not necessarily meeting all current technical and functional standards, but are considered adequate for service and can be expected to experience normal stoppages that can be fully accommodated within the existing maintenance framework. These assets may require cyclical replacement in the next five years.

4. Good: No longer new, but in good condition and still within its useful life. Assets may be slightly deteriorated, but are overall functional within the normal maintenance practices.

5. Excellent (Modernized): No visible defects, new or near new condition and may still be under warranty (if applicable). Considered to meet most or all important technical and functional standards.

It is important to note that an asset condition rating is not an indicator of safety. Safety and risk assessments are performed separately from asset condition ratings and are addressed on an ongoing basis.

SUBWAY CARS MAINTENANCE FACILITIES AND YARDS

NYCT and SIR operate and maintain about 6,500 passenger railcars, which are linked together to make up nearly 600 trains used for daily service. To keep our railcars in good condition throughout their 40-year lifespan, they receive regular inspections and maintenance at our railcar maintenance shops and occasionally get more extensive heavy maintenance work at our overhaul shops. When they are not in service, they are staged at one of the many yards located throughout the network.

Reliable railcars are critical to quality service and make up a significant portion of the anticipated investment needs over the 20-year timeframe. This level of investment is needed to maintain the high service level that NYCT has achieved through our past railcar purchases and comprehensive railcar maintenance program. Renewing the railcar fleet and keeping our subway car maintenance and storage facilities in good condition is essential for us to be able to provide reliable service and create a better transportation experience for riders.

Over the next 20 years, our investment needs include:

- Subway cars
  - Replace nearly 1,500 cars coming due for replacement in the next five years and continue lifecycle replacement of over 2,400 more cars as they reach 40 years of age.
- Subway shops and yards
  - Reconstruct and upgrade railcar maintenance facilities at Livonia Yard and 240th Street Yard to address poor facility conditions and enable them to accommodate the new train cars. We will also repair and rehabilitate hundreds of facility components at other shops where there are poor or marginal conditions.
  - Upgrade selected shops and yards, such as at 207 Street and Coney Island Overhaul shops, to accommodate increased maintenance needs, as well as expand Jamaica Yard to provide sufficient storage capacity for trains serving the Queens Boulevard and other lines.
  - Install low-emissions building systems and renewable power generation where feasible to reduce carbon emissions and advance MTA's sustainability goals.

Subway cars

Because our subway network is essentially two distinct systems,[1] we have two basic types of railcars which are divided into the A Division and B Division. Our current NYCT subway fleet has 2,890 railcars in the A Division and 3,589 railcars in the B Division, for a total fleet of 6,479 railcars. With the 61 SIR railcars, the complete fleet totals 6,540 railcars.

The B Division currently operates with two different railcar sizes (60-foot and 75-foot), but is now being standardized to the shorter 60-foot railcar length. As older 75-foot railcars are replaced with newer 60-foot ones, more railcars will be needed to make up the same number of train sets. SIR has a much smaller fleet, with a total of 61 railcars currently operating and scheduled to be replaced by the ongoing R211 railcar purchase.

Interior of R211 subway car

Subway train cab

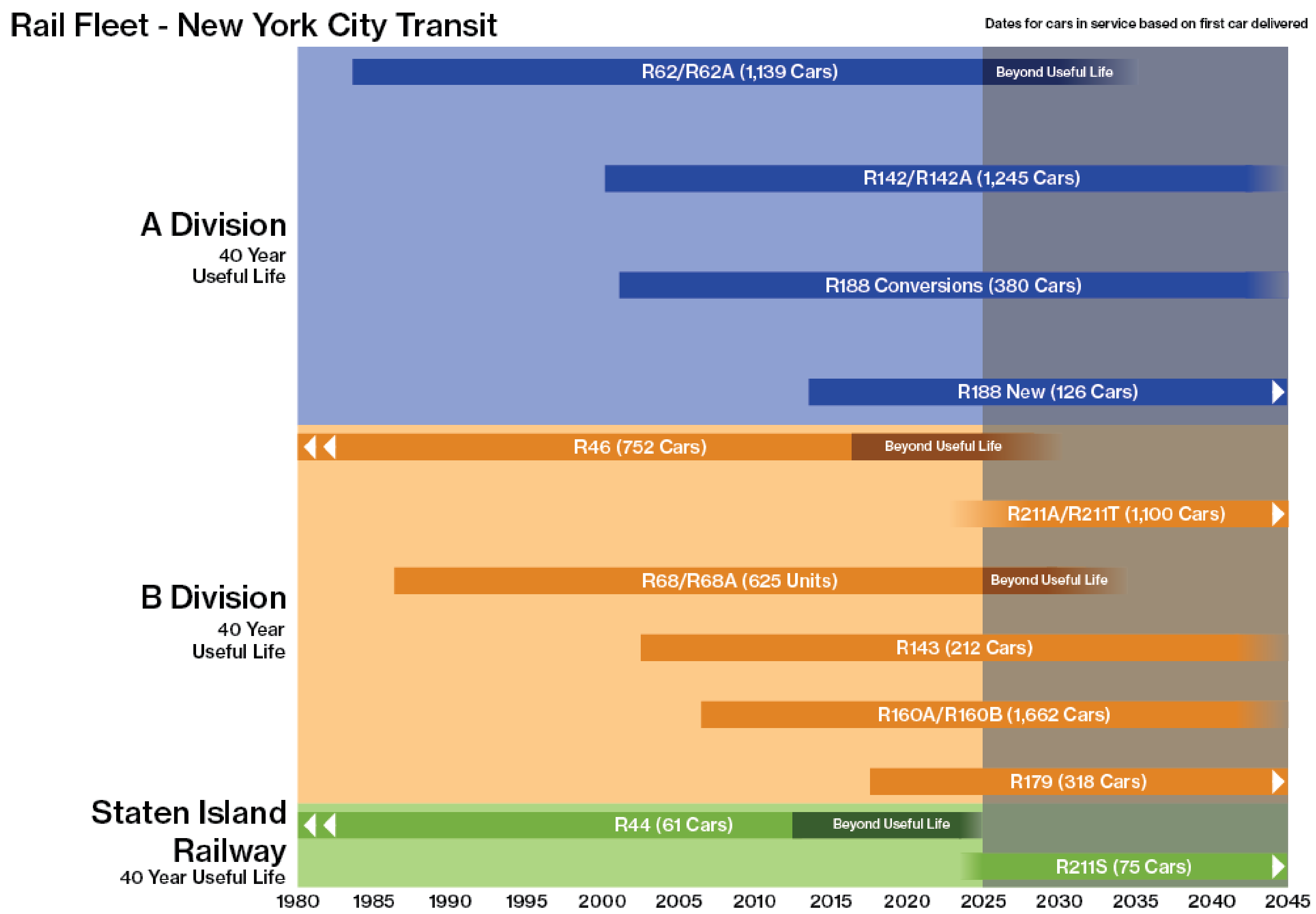
Asset inventory and status

We use two primary indicators to assess the condition and performance of our railcars, which together guide decisions on when further investment or replacement is warranted.

- **Useful life:** Older railcars are more prone to breakdowns, require more frequent and costly maintenance to keep in service, and are less comfortable for our passengers due to worn interiors. They also sometimes lack modern amenities or do not meet the latest accessibility standards we have for new railcars. Any railcar over the age of 40 is considered past its designed useful life. We plan to continue replacing railcars before they reach the end of their useful life.
- **Mean Distance Between Failures (MDBF):** This is a measure of reliability that expresses the subway car's mean (average) operating distance mileage traveled between all relevant train delay failures.
  - Investments since 1982 have increased reliability from an average of 7,000 miles between breakdowns to more than 127,000 miles today. Comparatively, today's newer railcars' MDBF can reach above 250,000 miles while the oldest railcars at the end of their useful lives can fall to about 40,000 miles—a six-fold difference.
  - Older railcar classes were three times more likely to undergo a "hot car" incident (revenue service vehicles with an HVAC component failure) over the past three years. These older railcar types are equipped with underbody-mounted HVAC units, compared to the newer railcar models with modern overhead units.

For the A Division, 39% of cars are reaching their expected useful life and are planned for replacement starting in the current capital program and continuing in the next. For the B Division all railcars except for the R46 model are within their useful life. Replacement of the R46s—the system's oldest railcars—is already funded under the R211 railcar project, which has entered the delivery phase this year. The current fleet of 61 SIR railcars has exceeded its useful life and is on track to be replaced with soon-to-be-delivered R211 railcars as well.

In addition to reliability benefits, new railcars will be equipped to utilize a more modern signaling system, known as Communications Based Train Control (CBTC), which leads to even greater reliability of service. See below the section on Signals for definition and benefits of CBTC.



1. The A Division has narrower car widths and includes the numbered routes and the 42nd Street Shuttle, the remaining parts of the former Interborough Rapid Transit Company (IRT). The B Division has wider car widths and is comprised of the lettered routes along with the Rockaway Park and Franklin Avenue Shuttles, the combined remaining parts of the former Brooklyn-Manhattan Transit Corporation (BMT) and the city-owned Independent Subway System (IND).

G train, NYCT

Investment needs

Periodically renewing the railcar fleet is essential to providing reliable service and creates a better experience for riders. Our newest railcars have equipment failures much less frequently than older railcars. They also have improved features like wider doors to expedite boarding and alighting, security cameras, digital information displays, and automated announcements. Over the next 20 years, we plan to continue to purchase railcars as they reach the end of their useful lives. New railcars will be delivered with CBTC equipment installed.

Over the next 20 years, we need to:

- Replace over 3,900 subway cars:
    - Approximately 1,500 railcars to replace R62, R62A, R68, and R68A railcars. (Some of these cars may be funded from the 2020-2024 Capital Program.)
    - Approximiately 1,600 railcars will be needed for the normal replacement of the R142/R142A and R188 converted car fleets starting in the 2040-2045 timeframe.
    - Near the end of the 20-year period, we will begin replacing the approximately 200 R143 railcars and 1,700 R160 railcars.
- Ensure we have the right fleet size for the future by assessing fleet growth needs before new subway car purchases.
- Evaluate retrofitting existing R142/R142A with CBTC equipment, depending on progress of planned signal system upgrades and if needed to expedite the conversion of more lines to the CBTC signaling system.

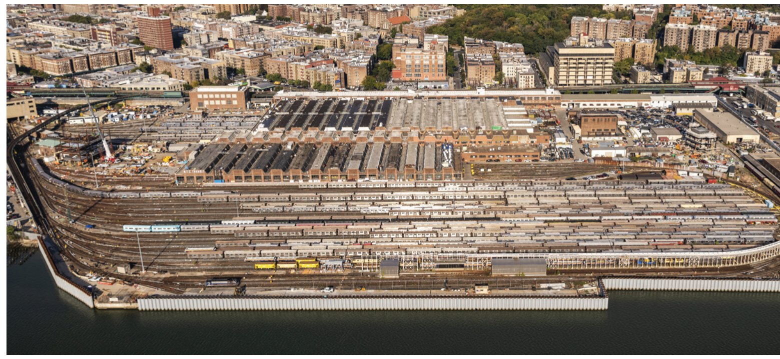
Shops and yards

Our railcar maintenance and overhaul shops are essential to keeping our subway railcars in good working order throughout their 40-year lifespan. Together, these facilities house the inspection, repair, and comprehensive component change-outs and overhauls, as well as other repairs that might be needed. We also have a separate set of facilities used to support Maintenance of Way (MOW) and other divisions and their work in keeping the signals, electronics, track, structures, stations, and other assets in good working order.

Our yards are large properties that we use for the storage of passenger railcars when they are not in service and where we do car cleaning and washing of railcar exteriors. As fleets expand, additional train storage space may be needed.

Asset inventory and status

Many of the maintenance shops and facilities have many critical elements that are not in good condition, and some facilities are over 100 years old. These facilities' components, their functional areas, production capacities, and space configurations are often not in good condition or are not adequate for our staff to be able to optimally perform work on new technology rail fleets that have more electronic components.



207 St Yard, NYCT

Inventory and status

Asset/Component		Total	Percent in Poor/Marginal Condition
Railcar Maintenance Shops (15 Shops)	Roof	15	47%
	HVAC	15	47%
	Exterior	15	33%
	Building Structure	15	73%
	Electrical	15	33%
	Elevators	8	63%
	Employee Facilities	15	80%
	Heavy Shop Equipment	41	10%

Inventory and status

Asset		Total	Percent in Poor/Marginal Condition
Railcar Overhaul Shops (2 Overhaul Complexes, 15 Sub-shops)	Roof	15	13%
	HVAC	15	67%
	Exterior	15	13%
	Building Structure	15	73%
	Electrical	15	13%
	Elevators	12	100%
	Employee Facilities	15	47%
	Heavy Shop Equipment	246	36%
Rail Storage Yards (24 Rail Yards)	CCTV*	2	50%
	Fencing	24	0%
	Hydrants	24	8%
	Lighting	24	50%
	Yard Track (miles)	102	25%
	Yard Signal	23	42%
	Yard Switch	874	19%

Inventory and status

Asset/Component		Total	Percent in Poor/Marginal Condition
Car Washer (8 Car Washers)	Enclosures	8	13%
	Equipment	8	13%
	Lighting	8	13%
	Electrical	8	0%
	Plumbing and Drain	8	13%
Maintenance Support Shops	Roof	29	69%
	HVAC	29	48%
	Exterior	29	48%
	Building Structure	29	38%
	Electrical	29	55%
	Employee Facilities	29	45%
	Heavy Shop Equipment	29	31%
SIR Maintenance Shops	Overall Rating	2	50%

** Only two yards currently have CCTV systems that meet the capitally eligible technical standards.*

Below, Livonia Yard, NYCT

Coney Island Shop, NYCT

Investment needs

Our investment needs include addressing poor and marginal building components and making upgrades to the shops and yards to provide a safer and more efficient workplace. Additionally, an ongoing condition survey of all subway facilities will provide a more comprehensive assessment of the facilities to be used to prioritize specific capital projects in future capital programs.

To meet energy efficiency and emissions reduction goals, we will also explore opportunities to upgrade building HVAC equipment, incorporate renewable energy technologies (e.g., rooftop solar photovoltaics), conserve energy, and reduce GHG emissions through other means. We will actively work towards integration of energy efficiency and renewable energy strategies, wherever feasible.

Over the next 20 years, we need to:

- Increase the pace of investment to address the repair and rehabilitation of hundreds of facility building components and systems that are in poor or marginal conditions. Over 200 facility components are rated poor or marginal at our passenger railcar maintenance and MOW facilities combined.
- Reconstruct and reconfigure selected facilities, such as the 240th Street and Livonia car maintenance shops. These facilities require reconfigurations and upgrades to allow them to service the new car fleets' roof mounted air conditioning (HVAC) units and to provide working aisle widths between shop tracks that meet industry standards and best practices.
- Improve car HVAC and A/C traction motor maintenance capacity at 207th Street and Coney Island facilities to meet expected workloads from thousands more railcar HVAC units and A/C motors coming online with new fleets.
- Add to SIR's car washing capabilities and address needs at its non-revenue vehicle repair shop.
- Install additional security systems including CCTV and Laser Intrusion Detection Systems at yards and maintain adequate fencing and lighting to prevent unauthorized entries and damage to railcars or yard assets.
- Expand shop and yard capacity where needed to support a larger fleet
- Upgrade non-revenue support facilities, such as at 38th St and Westchester Yards, which are vital hubs for our work train fleet.
- Install electric vehicle charging equipment dedicated for NYCT use in appropriate locations to meet MTA goals of transitioning to 100% zero-emissions light-duty non-revenue vehicles by 2035 and medium/heavy-duty non-revenue vehicles by 2040.
- Advance climate resilience measures in NYCT facilities facing climate change hazards, including flooding and extreme temperature risks.

BUSES, DEPOTS AND BUS MAINTENANCE FACILITIES

NYCT and MTA Bus together operate the largest public bus system in the U.S., carrying 1.4 million riders each weekday (16% of the nation's bus passengers) and operating 10% of all the public transit buses in the nation. More than 90% of New York City residents live within a quarter mile of a bus stop, and buses provide affordable and safe mobility throughout the five boroughs. Our buses are fully accessible to riders with mobility disabilities, and each bus, regardless of propulsion or type, combats congestion and greenhouse gas emissions by carrying far more people than a private vehicle.

Depots and bus maintenance facilities are where buses are fueled, inspected, serviced, and parked when not in use. We have dozens of bus depots and other support facilities located throughout the city, and these facilities range in age from brand new to more than 100 years old.

The MTA has initiated a transition to a 100% zero-emissions bus fleet by 2040, a central component of our agencywide goal to reduce greenhouse gas emissions 85% by 2040. The zero-emissions bus transition will reduce operational emissions by 530,000 tons annually compared to a 2015 baseline. The transition will also eliminate carbon monoxide and nitrous oxide emissions and significantly reduce particulate matter compared to the current bus fleet.

Over the next 20 years, our investment needs include:

- Buses
  - Continue regular replacement of buses, replacing about 9,000 buses over the next 20 years. As buses are retired, we will transition to zero-emissions buses, achieving a full transition to a zero-emissions fleet by 2040.
- Depots and facilities
  - Upgrade all 28 depots, the two central maintenance facilities, and other support locations with the infrastructure to support zero-emissions buses, as well as non-revenue vehicle fleets.
  - Continue depot facility component repairs and normal replacement of depot heavy equipment, based on their condition and in coordination with zero-emissions depot modifications.
  - Install zero- or low-emissions building systems and renewable energy generation infrastructure at all depots.
  - Reduce exposure to flood risks that are exacerbated by climate change.

Buses

Express bus

Our bus fleet consists of approximately 5,800 buses of various vehicle and propulsion types. Prior purchases coupled with our service program, including preventative maintenance and general overhauls, have resulted in fleet reliability improving from less than an average of 1,000 miles MDBF in 1982 to more than 7,000 miles today

Asset inventory and status

To best serve our customers, our buses must uphold a high standard for comfort and reliability. As buses age, maintenance needs increase, increasing operating costs to keep older buses in service. As such, we have a cyclical replacement program for buses, and we plan to replace every bus as it reaches approximately 12 years in age. As a part of the planning for each five-year capital program, fleet age is reviewed along with expected changes in capacity requirements to accommodate growth, conversions, and other potential service adjustments.

The current bus fleet is composed of clean diesel, hybrid diesel-electric, compressed natural gas (CNG)-fueled buses, as well as zero-emissions buses. We made our first purchase of zero-emissions buses in 2019, with an order of 15 articulated battery-electric buses. We have either procured or are in the process of procuring 560 battery-electric buses to replace those buses reaching their maximum age. In addition to the existing 15 articulated buses, 60 standard buses are expected to start to be delivered in 2023, and the remaining 485 will be delivered starting in 2025. As of 2020, all CNG buses are fueled with renewable natural gas, a biogas derived from organic waste. This offers a reliable and clean fuel solution without sacrificing vehicle performance.

- **Standard bus:** These operate on most local routes; typically, 40 feet long. Currently there are 3,662 standard buses, and 7% are at or beyond expected useful life.
- **Express bus:** Many operate only during weekday rush hours; looks like a coach bus, with routes generally between Manhattan and another borough; typically, 45 feet long. Currently there are 1,020 over-the-road buses, and 5% are at or beyond their expected useful life.
- **Articulated bus:** Vehicles have increased capacity and length compared to standard buses; look like two standard buses connected by a flexible middle; typically, about 60 feet long. Currently there are 1,158 articulated buses, and 14% are at or beyond expected useful life.

Investment needs

The transition to a zero-emissions bus fleet represents a significant commitment of the 20-year capital needs for NYCT. As we transition, the normal replacement cycle for buses will include an increasing number of purchases of zero-emissions vehicles, and beginning in 2029, all new bus purchases will be zero-emissions. For the next few years, since there are limited bus suppliers with increased zero-emissions demand, we anticipate challenges with supply. However, our phased-in approach, as well as our test and evaluation fleets, give us an opportunity to apply lessons learned while we undergo this transformation.

Our current bus purchase plan for 2025-2044 is summarized in the table below. The full fleet is replaced on a staggered basis, and buses bought in the first five years will be replaced again at the end of the period. Approximately 9,000 replacement buses will be needed over the coming 20-year timeframe.

Changes in ridership or policy that determines bus frequency may affect future bus inventory needs. Inventory needs and planned purchases will be assessed periodically.

NYCT and MTA Bus Fleet Replacement / Transition Plan

		2025-2029	2030-2034	2035-2039	2040-2044
Standard Buses	New Bus (any bus type)	758	-	-	-
	New Bus ZEF	700	1,455	1,880	1,022
Articulated Buses	New Bus (any bus type)	425	-	-	-
	New Bus ZEF	200	195	760	395
Express Buses	New Bus (any bus type)	300	-	-	-
	New Bus ZEF	-	335	695	138
Total		2,383	1,985	3,335	1,555

Additionally, we are working on several new bus seating configurations that will better accommodate riders of all abilities, as well as opportunities for visual and audible communications, such as hearing induction loops (a special type of sound system for use by people with hearing aids). Other enhancements like exterior cameras for Automatic Bus Lane Enforcement will continue. To improve passenger security, we more than tripled the number of cameras onboard buses in 2022 and are adding at least 600 more in 2023. While many of our new buses will have these features built in, staying up to date with bus innovations like these requires regular investment.

Articulated electric bus

Standard bus

Depots and bus maintenance facilities

Supporting our extensive bus fleet are dozens of major facilities encompassing over 6 million square feet across our bus depots, central maintenance facilities, and shops throughout the region. Each of these require ongoing maintenance, major modifications to serve our evolving bus fleet, and strategic investments to tackle the challenges posed by climate change. Due to the facilities' various ages and design, there are many different structure types and sizes, equipment and machinery housed, types of buses stored, and kinds of work that each facility can support. For example, some bus depots are equipped to service CNG buses, while other depots have been modified for articulated buses.

Zero-emissions bus charging

Inventory and status

Depot/Facility Component	Total	Percent in Poor/Marginal Condition
Roof	38	29%
Boiler	38	21%
Air Curtain	31	26%
Ventilation	38	42%
Architectural/Structural	38	24%
Electrical	38	37%
Lighting	38	26%
Elevator	19	16%
Employee Facilities	38	39%
Admin Office	38	45%
Emergency Generators	31	42%
Fire Alarm and Suppression	38	21%
Bus Wash	29	7%
All Rated Bus Depot/ Facility Components	452	31%

Asset inventory and status

We monitor the condition of bus depots, shops, and maintenance facilities on a component basis, and we make investment prioritizations based on the physical conditions and/or age of each component, depending on the component. These components include things like structural elements, building systems, lighting, repair and cleaning equipment, and more. Moving forward, we will analyze the needs for new assets that will reach the end of their typical lifespan over the next 20 years.

Investment needs

With the expansion of the zero-emissions bus fleet, depots must be adapted for electric bus charging, use of alternative fuels, and other functions. This transition will require an unprecedented investment in new charging infrastructure and power supplies, like pantographs and chargers. In addition, we will have to make significant investment to substantially increase the electrical loads (two to four times the capacity needed for depots without electric buses), as well as HVAC modifications to maintain optimal functionality of charging equipment, structural modifications to support the weight of charging equipment, data and communication infrastructure, and enhanced fire suppression. Installing these capabilities requires significant modifications to the buildings' structural and electrical systems. As depots are selected for zero-emissions bus fleet deployments, we will ensure that zero-emissions upgrades are done in tandem with other depot component and condition investments.

In parallel to these ongoing maintenance needs, we will evaluate opportunities for energy-efficient equipment, to phase out fossil fuel building systems, and to incorporate on-site renewable energy generation. For facilities vulnerable to coastal and inland flooding, we will consider strategies such as porous pavements and subsurface detention to reduce stormwater runoff, back-flow preventers to prevent flood water flow into buildings, deployable coastal flood panels at garage doors and other openings, and ensuring exterior walls at buildings are watertight.

Over the next 20 years, we need to:

- Increase the pace of repairing, renovating, and replacing poor or marginal depot and facility components and equipment to clear a backlog of assets that are not in adequate condition. Hundreds of facility components (approximately one third of all major components) are currently in poor or marginal condition.
- Repair depot components as they reach their lifespan limits, including roofs, facades, and systems.
- Implement depot upgrades and modifications to achieve zero-emissions fleet transition goals.
- Incorporate materials, equipment, and designs that reduce exposure to climate risks and the facilities' carbon footprint.

Mother Clara Hale Bus Depot, NYCT

PASSENGER STATIONS

With 493 stations, our transit network has more stations than any other subway or metro network in the world. Some of these stations are nearly 120 years old, with many others at or over 100 years in age. The age and sheer size of our stations' overall footprint—more than 16 million square feet and 16,000 components—leads to substantial capital and maintenance needs. Below we discuss our stations' structural component needs, and we also address some of the other major asset types found in our stations, which we summarize in two sub-sections: one on accessibility, elevators, and escalators and another covering station communication systems.

Over the next 20 years, our investment needs include:

- Station structures and components
  - Continue station component repair programs with quicker implementation of projects when deteriorated components or other needs are identified.
  - Enhance security by improving lighting, CCTV, and other station elements. New lighting is also part of our strategy to make stations more energy efficient.
  - Improve passenger circulation at chronically overcrowded locations by adding stairs or reconfiguring station elements.
- Accessibility, elevators, and escalators
  - Build new elevators and ramps to expand the number of accessible stations, in line with MTA's commitment of at least 95% of subway stations being accessible by 2055.
  - Ensure the reliability of existing elevators and escalators by replacing approximately 350 station elevators and 150 escalators as they reach the end of their useful lives.
  - Replace emergency exit doors at fare arrays with wide-aisle gates to improve access to the system.
- Station communication systems
  - Upgrade customer communication systems in stations so that all stations have public address systems and customer information screens that can convey audio and text messages sent from staff at our centralized train control centers.

Times Square Shuttle, NYCT

Station structures and components

This asset category refers to all the major structural elements that comprise our stations, such as floors, walls, ceilings, columns, and stairways, as well as the many architectural finishes that make up our stations' platforms and mezzanines.

Asset inventory and status

Beginning in the 2010-2014 Capital Program, we adopted a component-based strategy for station capital investment, which focuses on fixing or replacing the most deteriorated station components at a greater quantity of stations rather than performing more costly comprehensive station renovations at a more limited number of stations.

In implementing this methodology, we begin by inspecting and assessing the condition of our stations' structural components—platforms, stairs, canopies, ventilators, floors, columns, walls, ceilings, and more—every five years. We assess and keep track of over 16,000 unique station components throughout our network. This strategy emphasizes essential structural components and allows us to address prioritized needs at a sustainable pace that also considers the varying lifespans of different components.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Platform Canopies	436	8%
Mezzanine Floors, Columns, Walls, and Ceiling	3,246	10%
Platform Edges	1,198	36%
Platform Floors, Columns, Walls, and Ceilings	3,276	13%
Stairways	5,502	13%
Passive Ventilation Systems	2,425	39%
Windscreens (above-ground station platform fencing)	214	21%
Electrical Distribution Rooms	916	15%

96 St Subway, NYCT

Investment needs

Going forward, we plan to accelerate the capital repair and renewal process and quickly implement the results of rolling comprehensive condition surveys that are currently taking place.

Over the next 20 years, we need to::

- A faster pace of repairing or replacing station components (approximately 1,500 per each capital program): over 5,000 platforms, 4,000 platform components, and 2,400 street vents, as well as ventilators, electrical utility rooms and other elements in poor condition.
- Reduce water infiltration conditions at approximately 40 station locations.
- Evaluate ways to control temperatures in stations' critical equipment rooms that house electrical and telecommunications equipment.
- Reduce energy usage by upgrading lighting to LED or other energy saving types of lighting. Currently, about three-quarters of station lighting is less energy efficient than modern standards.

Accessibility, elevators, and escalators

Elevators and ramps are critical assets that ensure subway access for customers with disabilities and others who cannot use the stairs, such as caregivers with strollers, older adults, or customers with luggage. These assets also are also necessary for us to comply with the Americans with Disabilities Act (ADA). In 2022, we reached a historic settlement with accessibility advocates that affirmed our commitment to accessibility in the subway system and outlined a commitment to make at least 95% of the subway and SIR stations accessible by 2055, if our capital plans are adequately funded.

In addition to elevators and ramps, escalators are also important assets for facilitating access from the street to the platform, particularly at deeper stations. At some deep stations, elevators and escalators are the sole means of access and egress to the platform, and if they fail to operate, trains must bypass the station.

Asset inventory and status

Our primary considerations for elevator and escalator lifecycle replacements center on age and projected lifespan. Older elevators and escalators are likely to break down more frequently. We also consider obsolescence and unavailability of spare parts, reliability, and the number and frequency of maintenance calls. Because elevators and escalators require increased maintenance as they age and some parts become more costly to replace, we generally aim to replace elevators and escalators as they reach the end of their approximate 17-22-year useful life.

Using existing funding, we are progressing rapidly on expanding accessibility and ensuring continued access to stations that are already accessible. We are replacing 78 existing elevators and 66 escalators as part of the normal lifecycle replacement process, as well as installing over 170 new elevators and ramps to expand accessibility.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Elevator - Hydraulic	246	0%
Elevator - Traction	60	0%
Escalator	231	6%

Right, Escalator at 96 St Station

Far right, Elevator at E 149 St Station

Investment needs

We need to continue our increased pace of investment to make subway stations accessible and to ensure that our existing elevators and escalators remain functional and reliable. In addition to replacing our existing station elevators, as we install more elevators and expand accessibility throughout the network, we will have an increasing number of elevators to maintain in the future.

Over the next 20 years, we need to:

- Continue the increased pace of elevator and ramp installation to make more stations accessible, in line with our commitment for 95% subway and SIR accessibility by 2055.
  - When identifying specific stations that will be made accessible during each capital planning cycle, we consider many factors including coverage, destination significance, ridership and transfers, demographics constructability, and cost.
- Continue to replace elevators and escalators as they reach their useful age.
  - The large expansion of the station accessibility program over the next 20 years will ultimately lead to a doubling of the lifecycle replacement needs by the 2040-2044 timeframe; approximately 350 elevators will be due for replacement over the next 20 years.

Station communication systems

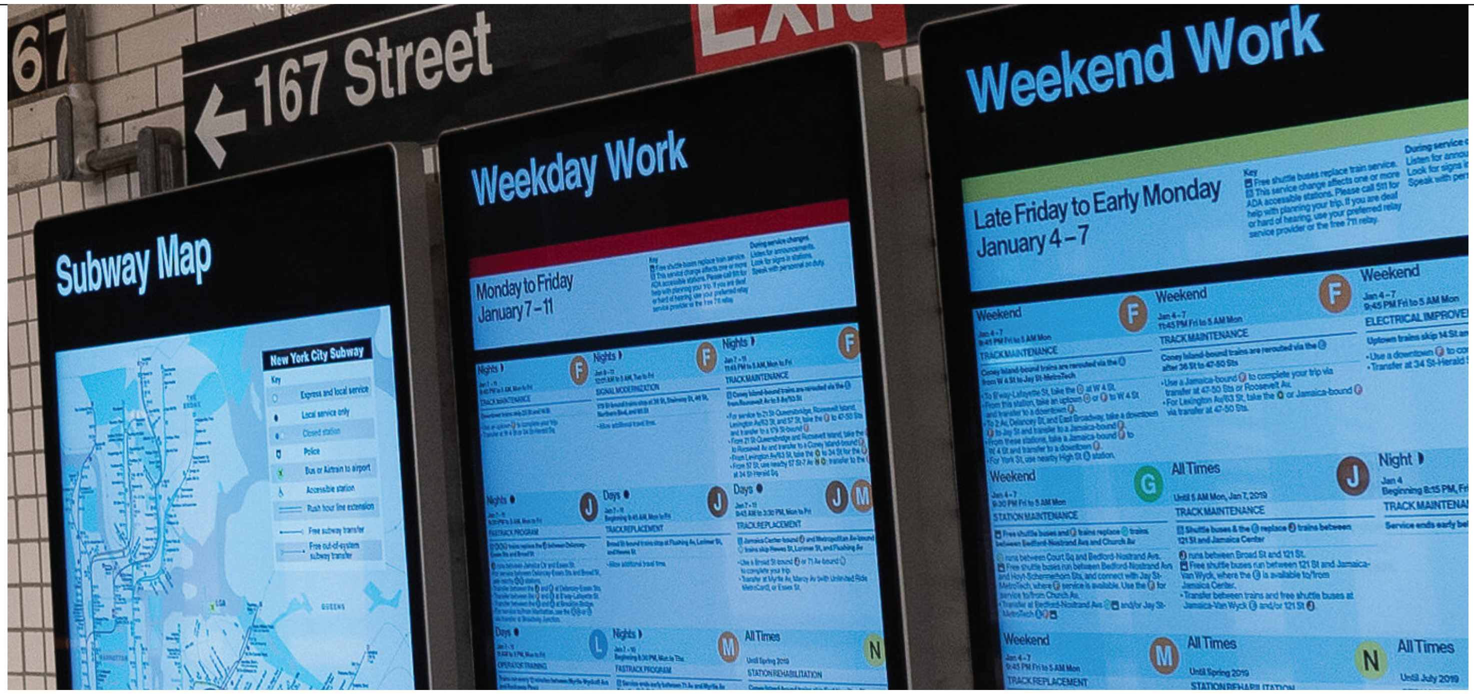
Our communication infrastructure is comprised of several comprehensive and interrelated systems that support several other asset types such as signals. In this section, we will focus specifically on communication assets that are found in subway and SIR stations, while the system's underlying communication infrastructure is addressed in a separate section below.

The communication system elements found in our stations include station public address systems, digital screens in stations, and Help Point intercoms, all of which are key ways for us to provide passengers with train arrival times and other information that may affect their trips. Because our station fare collection system (and its related components), as well as our station security systems are dependent on the communication systems in our stations, these systems are also discussed here.

All of these communication systems and their dependent assets and components are composed of many elements that need frequent upgrade or renewal.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Public Address/Customer Information Screens	472	52%
Help Points	1,886	1%
ADA Farecard Access System	278	0%
Fare Collection Vending Machines (transitioning to configurable vending machines and changing quantity for OMNY cards)	1,720	0%
Fare Collection Electronic Turnstiles	4,461	0%
Emergency Booth Communication System	478	0%
NYCT Station CCTV (cameras, monitors, and recorders for emergency alarm, passenger ID, police security, platform edge, and crowd control)	11,210	55%
SIR Station CCTV	406	100%



167 St Station service information displays, NYCT

Asset inventory and status

The condition of our station communication system assets is assessed based on age, parts obsolescence, and capability. It is essential for these assets to meet current functional requirements, so communications assets that do not are considered to be in poor condition.

One of the capabilities we are planning for in the next twenty years is the ability for riders to receive both audio and visual messages in real time in every station.

Investment needs

Over the next 20 years, we are also prioritizing installing and upgrading audio and visual communication so we can provide timely and accurate travel information, providing better station security, and completing roll out of a simpler fare payment and more secure fare control systems.

Over the next 20 years, we need to:

- Award projects to upgrade public address and customer information screens at 244 stations by 2030.
- Help Points will be renewed or replaced over the next 20 years as these devices reach the end of useful life.
- CCTV is an integral part of the security and safety strategy at stations as well. In the coming 20 years, we will improve our passenger identification and other CCTV systems to the latest security standards, replacing all poor condition passenger identification CCTVs and at access control locations. We will also install camera systems at stations with only passenger identification CCTVs.
- Improve fare collection by completing transition to the OMNY system, making lifecycle replacements of existing electronic turnstiles with upgraded turnstiles, and introduce other fare collection solutions guided by the findings of the MTA's Blue-Ribbon Panel on Fare Evasion.
- Improve access to the system by replacing ADA farecard entry units at current and future accessible stations with wide-aisle gates.
- Implement technological advancements such as track intrusion detection once they have been evaluated and proven effective in our station environment.

SUBWAY INFRASTRUCTURE SYSTEMS LINE STRUCTURES, TRACK SIGNALS, TRACTION POWER LINE EQUIPMENT AND COMMUNICATIONS INFRASTRUCTURE

Subway cars, maintenance facilities, and yards

Buses, depots, and bus maintenance facilities

Passenger stations

Subway infrastructure systems: Line structures, track, signals, traction power, line equipment, and communications infrastructure

Our right-of-way infrastructure includes line structures, track, signals, traction power, and line equipment. All are essential to get our riders to and from their destinations safely and on time.

- Line structures are the structures on which the tracks sit, which include bridges, elevated steel, viaduct sections, under river tubes, subway tunnels, embankments, and open cuts.
- Track and switches constitute the fixed guideway on which trains travel and are two of the most critical assets for safe, efficient, and reliable train service.
- Signals are a train control system that ensure trains maintain safe distances from each other and travel at safe speeds.
- The traction power system provides electricity via the third rail that provides propulsion power for trains, as well as lighting and AC on trains.
- Line equipment refers to the array of equipment distributed along the right-of-way, including tunnel lighting, ventilation plants, pump rooms, and deep wells.

Over the next 20 years, our investment needs include:

- Line structures
  - Maintain and ensure structural soundness of elevated steel structures, repair all significant defects, and routinely apply or renew protective coating systems.
  - Continue the line structure component repair program for subway, viaduct, and other line structure types with an increased investment pace than has been conducted in previous years.
- Track
  - Continue to replace 60-70 miles of mainline track and hundreds of switches in each capital program as their condition warrants.
- Signals
  - Improve subway on-time performance and reduce crowding by modernizing 315 more signal miles, from 234 signal miles already complete or underway to 549 total signal miles, improving service for about 90% of all trips. This will:
    - Reduce delays due to signal failure by 44% systemwide.
    - Lower signal maintenance incidents by 22% systemwide.
  - Where modern technology signals have already been installed, ensure continued reliability by replacing the signals as they reach the end of their expected useful life.
- Traction power
  - Ensure service continuity and improve power reliability network-wide by addressing critically poor power cable and circuit breaker house conditions and addressing a backlog of repairs for about 300 major substation components. Beyond that, we will need to invest in hundreds of major substation components over the next 20 years to keep them in adequate condition.
  - Improve management of the power system by completing the modernization of the power system's remote management system.
- Line equipment
  - Continue component replacement and upgrades at pump and fan locations based on condition.
  - Evaluate tunnel ventilation and construct new fan plant facilities as needs and priorities dictate.
  - Continue periodic upgrades of deep wells and tunnel lighting.

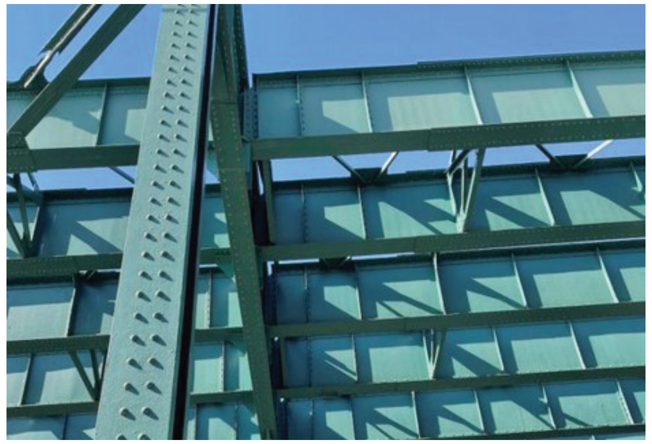
Line structures

Line structures have a long lifespan and slow deterioration rate, so most of our line structures date back to original construction of the subway system. Proactive maintenance mitigates the need for extensive repairs or costly rehabilitations in years to come

Asset inventory and status

Over time, exposure to the elements and heavy usage results in structural defects that are identified through periodic inspections. These defects are classified and prioritized for repair according to a defect's severity or concentration of defects in an area. Unfortunately, the historical pace of defect correction has not been sufficient due to constraints on conducting structural work along the active right-of-way. The inventory and status table shows line structure inventory and the respective high defect concentration mileage, which is an indication of high priority needs.

Exposed elevated structures benefit greatly by being protected with a robust paint system that can prevent defects due to corrosion. Therefore, we track elevated structures and monitor where the paint coating is reaching the end of its useful life so that paint investments can be made that minimize future costly defects. Additionally, we are implementing a new elevated steel structure painting technique that addresses any existing corrosion on the steel structure through the application of an abrasive blast technique and applies a more durable paint that will protect the elevated steel structure from critical defects. The pace of painting needs to increase, in order to ensure that all paint is in good condition.



Elevated structure, NYCT

Inventory and status

Structure Type	Route Miles	Percentage of Miles with High Defect Concentration
Elevated	61.0	8%
Viaduct	9.3	58%
Open Cut	10.6	5%
Subway	155.4	29%
Embankment	15.2	2%
Total	**251.5**	**22%**

SIR Inventory and status

Structure Type	Route Miles	Percent in Poor/ MarginalCondition
At-Grade	12.0	83%
Bridge	0.4	24%
Elevated	1.1	100%
Open Cut	1.0	0%
Tunnel	0.2	100%
Fencing	27.0	8%

The table below shows the status of NYCT's steel structure paint.

NYCT Elevated steel structure paint status

	Good	Poor/Marginal	Under Construction
Miles	31.2	11.3	20.8
Percent	49%	18%	33%

Investment needs

Over the next 20 years, we need to:

- Increase the pace to clear backlogs of thousands of high priority defects on all line structures with emphasis on high defect concentration areas.
- Repaint steel structures using the most thorough techniques - abrasive blasting that removes paint to bare steel-and applying new high performance and durable coatings; repainting provides these structures with the best protection from corrosion.
- Completing a full painting cycle on elevated structures.
- Waterproof SIR bridges, making drainage improvements and repair existing bridge deck damage.

Rockaway Park Shuttle train crossing Hammels Wye, NYCT

Track

Our subway system contains 665 miles of mainline track and 1,770 mainline switches. The 24 rail yards also contain storage track and switches.

This page, Track panel replacement work on elevated track, NYCT

Right page, Track replacement work in subway, NYCT

Asset inventory and status

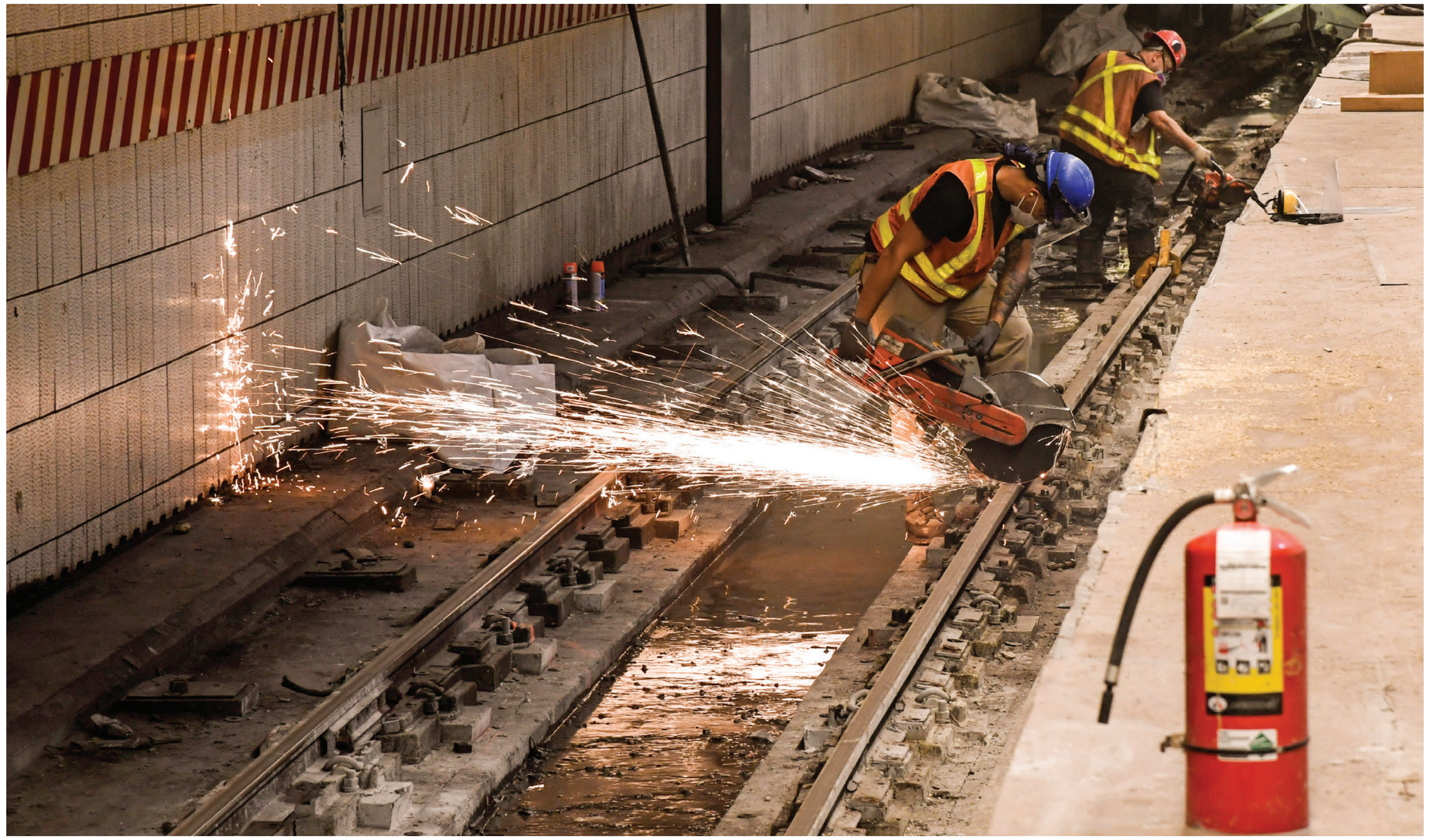
We assess the condition of every segment of track several times each month on a scheduled basis to identify locations needing maintenance repairs. We inspect switches with joint teams of track and signal maintainers so they can perform immediate maintenance. For capital investments, we assess all track segments and switches for their remaining useful life approximately every four years. These remaining life assessments yield information that enables the track and switch replacement program to target priority location supports, which mean we have kept track and switches in 100% good repair since the 1990s.

Investment needs

Based on the condition survey results, track replacement and renewal projects are prioritized for locations where there are switches or track segments rated as having less than six years of useful life remaining. Additionally, the ongoing rollout of CBTC in the 2025-2044 period will require all switches within the limits of CBTC projects to be assessed to determine their utility and confirm if they should be replaced, reconfigured, or removed altogether. A portion of the planned switch investment may be packaged with this CBTC work.

Over the next 20 years, we need to:

- Rebuild or replace approximately 60-70 miles of mainline track and 250 mainline switches per five-year program. Additional switches or track may also be replaced on specific lines to work with the new CBTC systems as well.
- Address SIR track, we will address locations approaching the end of their service life with approximately 32 miles of track and 57 switches forecasted needing replacement over the 20-year timeframe.



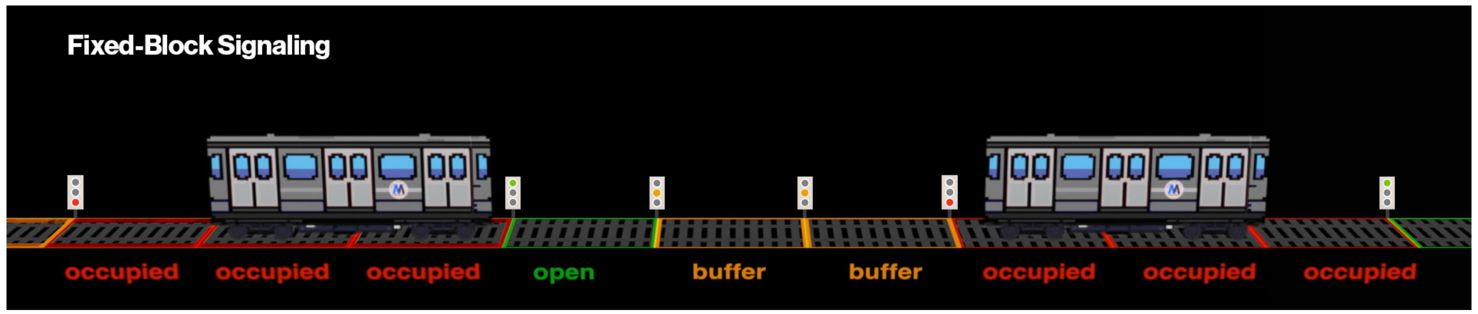
Inventory and status

Asset	Total Miles or Number	Miles/Number (Remaining Life Less Than 6 Years)	Percent with Remaining Life Less Than 6 Years
Mainline Revenue	665 Miles	68	11%
Non-Revenue	39 Miles	5	12%
Yard	102 Miles	14	13%
Mainline Switches	1,770	275	16%
Yard Switches	874	97	11%
SIR - Mainline	29 Miles	2	7%
SIR - Non-Revenue	3 Miles	0.3	11%
SIR - Switches	62	8	13%

Note: Track segments and switches with less than six years of estimated remaining useful life are prioritized for replacement.

Signals and train control

Our signal system governs the movement of trains along the right-of-way, ensuring that trains operate at safe speeds and maintain safe distances from other trains. Signals also provide instructions to train operators so they know when they can proceed safely. The more modern signals within the system share train location information to centralized train service supervision at the rail control center. The signal system also consists of interlockings, which are interconnected arrangements of switches and signals that allow for safe movement of trains.



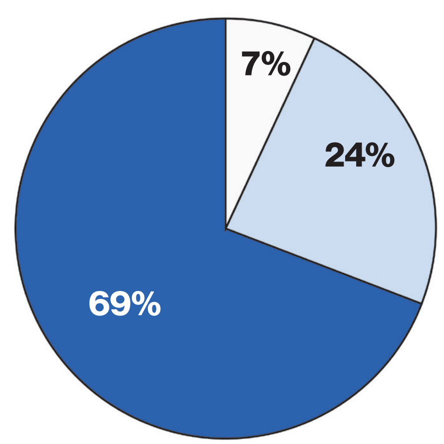
Currently, NYCT's signal system utilizes two types of technology: fixed-block electro-mechanical signaling and modern digital moving-block technology known as Communications-Based Train Control (CBTC). Fixed-block relies on technology that dates to the opening of the subway over 110 years ago. It uses wayside track circuits, signal heads, and train stop arms to enforce speed restrictions and safe distance between trains, as shown in the figure above.

CBTC uses carborne and wayside radio equipment, train operator displays, and computerized dispatch systems to enforce "virtual blocks" that govern speed and train separation. CBTC allows trains to move closer together than fixed block signaling, which increases throughput capacity and allows service to be recovered from disruptions more quickly. Paired with advanced Automated Train Supervision (ATS) systems, CBTC also allows more accurate train movement monitoring at the Rail Control Center (RCC) and more accurate customer information.

So far, signal modernization has been completed on the L and 7 lines, which are our highest performing lines in terms of on-time-performance. Signal modernization is currently underway on the Queens Boulevard, Culver, 8th Avenue, and Crosstown lines. Significantly increased investment in the 2020-2024 program also means we plan to award signal modernization projects on the Fulton, 6th Avenue, and 63rd Street Lines by the end of 2024.

Beyond the projects above, 529 miles of signaling and 118 interlockings use conventional fixed block signaling.

Modernized signaling status



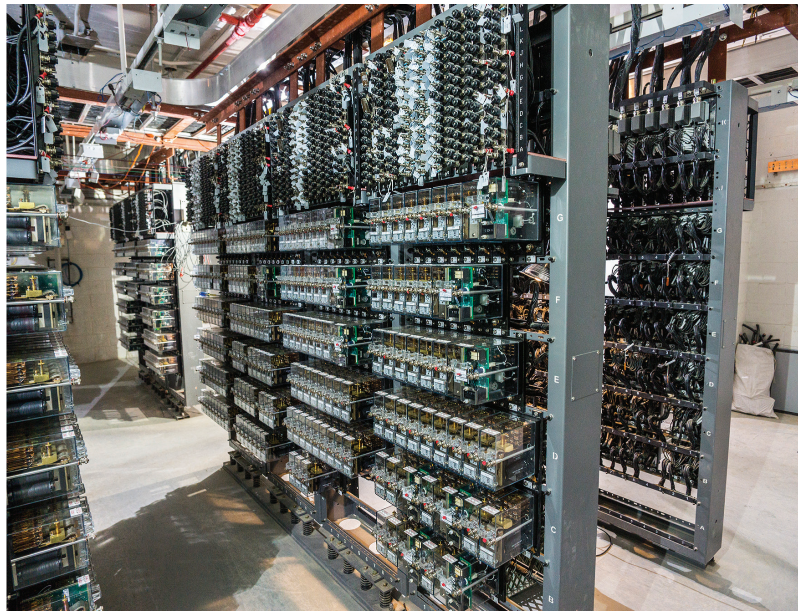
Modernization complete: 52 signal miles

In-Construction or to be Awarded by 2024: 182 signal miles

Conventional Fixed Block: 529 signal miles

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Mainline Signals	763 Miles	24%
Mainline Interlockings	183	23%
Yard Signals	23	43%
Yard Interlockings	20	30%
SIR - Signals	31 Miles	3%
SIR - Interlockings	14	7%



Relay room, NYCT

Investment needs

To increase service reliability, minimize disruptions and delays, and provide the ability to increase service, we must continue modernization of our signaling system. To facilitate this modernization effort, substantial investment is also required in CBTC enabled railcars, work trains, RCC information systems, power capacity improvements, as well as fiber and radio infrastructure upgrades.

Modernization will be prioritized in areas where signals are beyond their operational lifespan or will reach it by 2044. In addition, to drive five-year capital program prioritization and sequencing, we will continue assessing ridership patterns, signal asset reliability, on-time performance, and operational constraints.

Over the next 20 years, we need to:

- Improve subway on-time performance and reduce crowding by expanding modernized signaling from approximately 234 signal miles (already complete or underway) to 549 total signal miles, resulting in improved service for about 90% of all trips.
- Renew hardware and software on lines that already have CBTC as part of cyclical replacement to keep the systems up to date.

F train and signal indicators

Traction power

Our traction power system delivers electric power to the trains for propulsion. These assets include substations, circuit breaker houses (CBH), power cabling, and third rail. The traction power system for NYCT consumes nearly 2 billion KW-hours of electricity annually. NYCT substations receive power generated by the New York Power Authority as high voltage alternating current (AC) distributed by Con Edison via high tension transmission feeders. The substation's transformer and rectifier transform this power into 600-volt direct current (DC), which is fed to the third rail where it is accessed by the trains. The traction power system is divided into zones, which are under the Supervisory Control and Data Acquisition (SCADA) remote-control system centered at the Power Control Center (PCC).

Maspeth Substation, NYCT

Investment needs

Investments in our traction power infrastructure are needed to replace aging assets. Substations are prioritized for investment based on the condition of their major power unit components, the criticality of their location, and the level of redundancy in a power zone. In addition to these basic investments, upgrades to the system are needed to accommodate future load growth, and these upgrades will also enable better demand management. We will explore mechanisms to utilize electricity more efficiently, for example, by making more effective use of the developing technology to capture and utilize regenerative braking energy and managing power load demand.

Over the next 20 years, we need to:

- Upgrade the PCC's SCADA remote control systems, as well as the facility itself (PCC conditions and investment needs are detailed within the Operational Facilities section below.)
- Renew substations or substation components and address existing backlog of over 300 major components at approximately one-third of our substations.
- In the latter half of the 20-year period replace hundreds more major components at approximately 100 locations as they reach the end of their service life.
- Replace critically poor power cable and rehabilitate circuit breaker equipment or structural components at approximately 260 CBH locations.
- Replace poor condition or obsolete Emergency Alarms and Emergency Telephones.
- Include additional design and specification changes to make power equipment more able to withstand prolonged heat conditions and less vulnerable to coastal flooding and extreme participation, which can be particularly damaging to electrical equipment.

Asset inventory and status

Traction power is service-critical and has a sizeable backlog of equipment rated poor or marginal. In recognition of this, the 2020-2024 Capital Program doubled the level of investment in traction power assets. This allowed us to rehabilitate double the number of substations and CBHs as well as replace and upgrade the majority of the traction power SCADA system.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Substation Overall	224	36%
Transformers	392	15%
Rectifiers	394	13%
HT Switchgear	393	25%
DC Feeder Breakers	1,461	18%
Structural Elements	224	26%
Circuit Breaker Houses	317	27%
Breakers	1,802	30%
SCADA System Control Zones	93	34%
Emergency Alarm/Emergency Telephone	2,627	26%
SIR - Substations	9	11%
SIR - Substation Components	119	45%
SIR - Circuit Breaker Houses	4	100%
SIR - Circuit Breaker House Breakers	13	100%

Line equipment

Line equipment refers to a diverse set of assets that protect our tunnel infrastructure, primarily including tunnel lighting; fan plants to ventilate and mitigate smoke events; and pump rooms, deep wells, and drain lines that remove water from the subway into the New York City sewer system on a daily basis and are particularly critical for quick recovery following an extreme weather event.

Asset inventory and status

The condition of our line equipment assets is assessed through inspection. Ratings are primarily based upon physical condition and, in some cases, functional sufficiency such as pumping capacity or lighting type. Assets that do not meet current functional requirements set forth by the agency are prioritized for investment in order to achieve appropriate levels of efficiency or effectiveness that ensure agency goals for service reliability and safety are met.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Deep Wells	23	0%
Fan Plants	209	29%
Pump Rooms (ROW)	254	11%
Tunnel Lighting	440 Miles	4%

Deep wells

Fan plants

Pump rooms (ROW)

Tunnel lighting

Pump room, NYCT

Prince Street Fan Plant

Investment needs

Over the next 20 years, we need to:

- Address components at 28 priority pump rooms, as well as improved sump pump capacity, and increased water detention capacity to temporarily hold large volumes of stormwater at hot-spot stations that are vulnerable to flooding from extreme precipitation and/or are in areas where nearby sewer capacity is limited.
- Address components at 39 priority fan plant locations to eliminate backlog of poorly rated components and enter a normal replacement cycle in the latter half of the 20-year timeframe. Fan plants in locations vulnerable to inland risks were mitigated already at the SLOSH Cat2 + 3 via the Sandy program. Flooding will be prioritized for flood risk mitigations, such as elevating equipment. New fan plant facilities will be constructed as needs and priorities dictate.
- Perform periodic backflushing and equipment renewals at deep wells to maintain needed performance and monitor impacts of changing ground water levels.
- Eliminate tunnel lighting backlogs and invest on a normal replacement cycle. Enhance tunnel lighting by replacing older lighting types with more energy efficient lighting, like LED.

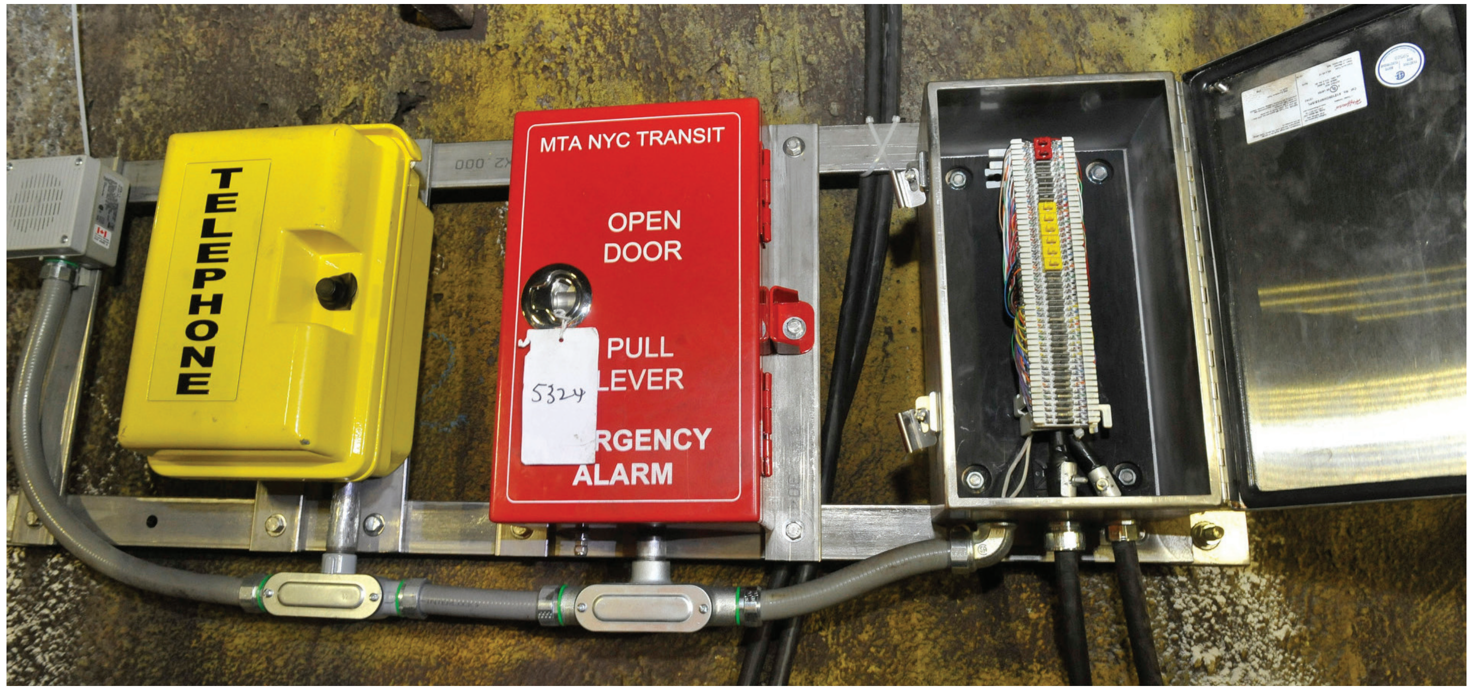
Communication infrastructure and systems

We have an extensive portfolio of communication infrastructure to facilitate many aspects of our daily operation. Though not as visible as other assets, communication networks span our entire system and enable our customer communications, system operations, fare collection, safety, security, and business operations.

Our communication backbone consists of systemwide fiber optic, antenna, and copper cabling, as well as networking equipment, which handle a vast array of voice and data communications between control center head-ends, operators in the field, and equipment like cameras, fare arrays, and radio devices throughout the system.

Our secondary telecommunication networks include passenger station local area networks (PSLAN) connected to fiber optic cable, private branch exchanges (PBX), Connection Oriented Ethernet (COE), and communication rooms, which are located in our subway stations.

A variety of communication applications and systems utilize components of the infrastructure listed above. Station public address and customer information screens, as well as Help Points, depend on PSLAN. SCADA systems are used for remote control and monitoring of power equipment; fan plants and pump rooms use the fiber and copper networks. The newer safety and security systems in stations and tunnels depend on fiber optics, PSLAN, and COE. Additionally, our radio systems for in-service operations and emergency response utilize antenna cable and radio base station infrastructure.



Radio systems

Asset inventory and status

Communication technology becomes obsoletefaster than other assets due to rapid technological advancement. Whereas other assets have a typical lifespan of 25 to 50 years, communication assets tend to have a shorter lifespan of 10-15 years. Each technology also has different challenges, dependencies, and vulnerabilities, as well as compatibility requirements. For example, there have been instances of rapid decline in the fiber cable condition in outdoor, elevated locations, as well as transitional locations where the cable routes from outdoor elevated structures to indoor below ground subways.

We have been making advances in rehabilitating and upgrading communication assets. Our 2020-2024 Capital Program included a 97% increase in funding for communication infrastructure over the previous capital program. When 2020-2024 capital projects are complete, we will have reached several key milestones, including having rolled out connection oriented ethernet (COE) across the system, upgraded 60% of network ring equipment and replaced 20% of our legacy fiber cable. Even with these investments, most of our fiber cable was installed between 1988 and 1990, and fiber optic network and cable infrastructure will need continued investment and accelerated upgrades to support the latest standards for data communication, increased bandwidth needs, and to address obsolescence of old equipment.

Inventory and status: Backbone communication infrastructure

Asset	Total	Percent in Poor/Marginal Condition
Fiber Cable	896 Miles	82%
Fiber Nodes (support transmission equipment)	85	37%
Fiber Rings (supporting critical functions composed of interconnected nodes)	7	43%
Antenna Cable	200 Miles	21%
Copper Cable	561 Miles	65%
UHF/VHF Radio Equipment	464	69%
SIR - Fiber Optic Cable	145 Miles	11%

Inventory and status: Secondary communication infrastructure

Asset	Total	Percent in Poor/Marginal Condition
Communication Rooms	478	27%
Passenger Station Local Area Network (PSLAN)	472	46%
Connection Oriented Ethernet (COE)	1 System	0%
Private Branch Exchanges	8	0%

Further investment in our communication infrastructure assets will greatly improve the reliability and capacity of our communication system. It will also improve reliability and functionality of assets that depend on that infrastructure.

- The antenna cable throughout the subway system is essential to the transmission of radio signal for the VHF system used by service delivery, and the UHF radio system used by the police, FDNY, and EMS. Between deteriorating antenna cable and poor condition radio equipment, there is a critical need for a sustained replacement program over the next 20 years.
  - An additional goal is to increase antenna cable capacity to support various radio frequencies and radio technologies and expand system frequency and modulation capabilities to support VHF, UHF, 700MHz, and 800MHz. We need to increase the ability of the antenna infrastructure to carry not only additional analog systems, but also narrowband digital technologies.
- Copper supports analog phone service, the 6-wire, emergency alarms/emergency telephones (mentioned in the power section), and other communications.
  - Over the 20-year timeframe, we should continue the accelerated replacement of radio antenna cable and copper cable.
- Communication rooms. Each passenger station has a communication room that provides secure enclosure and connection points for communication assets. These rooms house fiber distribution panels, radio infrastructure, telephone terminals, PSLAN access nodes, COE, and other systems.
  - Communication room temperatures should not exceed 108°F, but often do. Equipment inside communication rooms cannot function when exposed to this level of extreme heat for a prolonged time without sustaining damage.
- PSLAN interconnects many devices together within a network at passenger stations, allowing for connectivity between various communications assets.
  - Currently, about half of the stations have full networks with nodes sufficient for 21st Century technology. Partial PSLAN coverage results in suboptimal information delivery to and within stations.
- PBXs are major switching centers for tens of thousands of phone, copper cable, and fiber optic cable lines. PBXs allow the managing of data and voice traffic of the system's phones, communication rooms, and emergency telephones along the right-of-way.
  - PBXs have been updated and currently are in good condition from a recent capital investment, but keeping them in good condition will require regular investment in the next 15-20 years, as well as normal replacement of PBX components.

Investment needs

With investments in communication assets over the next 20 years, we will enhance operations, improve incident response, manage obsolescence, and improve customer communication. Across these categories, investment in both new technology and in measures to protect existing assets will provide increased resilience during extreme weather events, including periods of extreme heat.

Over the next 20 years, we need to:

- Increase the pace of fiber optic cable replacement by replacing at least 20% of fiber optic cable in every five-year program, leading to full replacement by 2044.
- Continue regular investment and normal replacement of rings and equipment.
- Continue the accelerated replacement of radio antenna cable and copper cable.
- Invest in communication rooms' data cabinets, cooling, and ventilation systems.
  * To address heat and capacity issues in communication rooms, our plans include investments in communication rooms' data cabinet and ventilation systems, including split cooling systems.
- Equip all stations with a PSLAN capable of delivering reliable information to the public address and customer information screen system.
- Boost bandwidth to increase reliability for the security command center, CCTV, and access control.

Snow thrower at Coney Island-Stillwell Av

Work trains and service vehicles

NYCT maintains a fleet of 643 specialized railcars for work trains, along with hundreds of heavy-duty rubber-tire vehicles such as trucks and vans. Additionally, 37 work cars support the operations of SIR. As we look to push the pace on addressing a variety of maintenance and capital projects, it is vital that these support fleets are both large enough and reliable enough to get the job done. From locomotives and flat cars to refuse collection cars and vacuum trains, the diverse work train fleet supports capital construction and routine operational functions. When prioritizing service vehicle replacement, we look at a combination of asset age and condition.

A sample of work train types includes those listed below:

- **Ballast regulator:** Used to shape and distribute the gravel track ballast that supports the ties in the rail track.
- **Crane cars:** 1-ton, 3-ton and 10-ton cranes to lift and move materials like track panels.
- **Flat car:** MOW vehicle typically used for material handling or refuse management. It requires a locomotive for propulsion.
- **Hopper car:** Work vehicle used for material handling of track ballast.
- **Hose and reach:** Work vehicle that includes pumps and metal pipes used to extend the reach of the work train.
- **Locomotive:** Type of railway locomotive in which the prime mover is a diesel engine. An important goal is to transition to lower emission propulsion technologies for work locomotives.
- **Pump car:** A work vehicle that includes one or more pumps used for pumping liquids. Once the liquid is pumped, it will be channeled through "reach" vehicles for discharge.
- **Refuse flat:** A MOW vehicle used for refuse collection. It requires a locomotive for propulsion.
- **Rider car:** A MOW vehicle solely used to transport workers.
- **Snow thrower:** A machine that uses a two-stage impeller and side-mounted rotating brushes to churn up and throw snow up to 200 feet. These vehicles can remove 3,000 tons of snow per hour.
- **Tamper:** A MOW vehicle used to pack the track ballast under railway tracks.
- **Track geometry car (TGC):** An automated track inspection vehicle to test several geometric parameters of the track without obstructing normal railroad operations. The TGC is used to inspect tracks on a regular basis and produce reports of defects found during the inspection.
- **Vacuum train:** a vehicle that removes debris and eliminates steel dust from the right-of-way.

Investment needs

Highlights of these investments are the purchase of rail bound work vehicles such as flat cars, hopper cars, and locomotives for use in general maintenance and construction functions in the system. Among these, the retrofit and replacement of older model diesel locomotives with new engines meeting the latest EPA emissions standards, as well as hybrid locomotives that will employ battery technology in tunnels, will result in significant improvements to air quality for employees and customers, and reduce overall operational greenhouse gas emissions. We will also procure several specialized function vehicles such as vacuum trains, snow throwers, and track geometry cars, which facilitate specific maintenance functions along the right-of-way.

Work train with crane

Over the next 20 years, we need to:

- Purchase 230 work train cars of various types.
  - Approximately 44% of the work train fleet is beyond the useful service life. Some of these units are now in the process of procurement and others will be replaced to restore the full fleet to good repair.
  - Specifically, we will replace the following types of work train—crane cars, hopper cars, locomotives, and refuse trains. This change is part of our initiative to replace the aging diesel work locomotive fleet with low-emission alternatives, aiming to reduce greenhouse gas emissions and enhance air quality.
- Invest in equipment to permit work trains consists of all types to operate under CBTC.
- Steady replacement of rubber-tire service vehicles is planned at a rate of approximately 300 per program. The vehicles to be replaced in each five-year period will be selected based on the age, condition, functional needs, and to meet goals for fleet transition to zero-emissions models.
  - For all non-revenue vehicle fleets, the MTA is working to transition 100% of its light-duty fleet to zero-emissions by 2035, and 100% of its medium- and heavy-duty fleet to zero-emissions by 2040.

Inventory and status: NYCT work trains

Work Train Type	Total	Percent Beyond Useful Life	Work Train Type	Total	Percent Beyond Useful Life
Ballast Regulator	4	50%	Refuse Coll. Prop.	18	100%
Crane Car-1 Ton	17	29%	Refuse Flat	27	100%
Crane Car-10 Ton	9	0%	Rider Car	39	100%
Crane Car-3 Ton	12	0%	Signal Supply Car	2	100%
CWR Car	32	50%	Snow Removal Car	5	100%
De-Icer Car	8	100%	Snow Thrower	12	33%
Flat Car	243	31%	Tamper	4	0%
Hopper Car	28	100%	Tank Car	3	100%
Hose and Reach Car	9	100%	Track Geometry	4	50%
Locomotive, Diesel	100	17%	Vacuum Train Car	12	0%
Pump Car	9	100%	Weld Car	2	100%
Pump Flat Car	2	0%	Work Motor	39	100%
Rail Adhesion	3	100%	**Total**	**643**	44%

De-icer car

Employee and operational support facilities

Employee, operations support, and training facilities house critical operations and support elements of the NYCT subway system. Train crew and other employee rooms are located throughout the system. We supervise and manage train service and the power system from our central facility buildings. Training facilities are where we train our staff, and as technologies in the field modernize, we need our training facilities to follow suit. Importantly, as technologies in the field modernize, we need training facilities to follow suit.

Asset inventory and status

There are over 3,000 employee facility rooms within the subway system, making up about 800,000 square feet of crew rooms, offices, bathrooms, breakrooms, workshops, and locker rooms, all of which support the daily tasks of the train crews, maintenance workers, station employees, and others working across the system. Currently, there is a comprehensive survey underway to assess and identify the subway facility rooms across the system that are in marginal or poor condition and will require investment in the next 20 years. The results of this assessment will help determine investment priorities in the next capital program.

In addition, we have numerous stand-alone operational facilities. Several of these facilities were constructed for activities different than their current uses and have required continual retrofitting and upgrading to accommodate these changes. Principal operational facilities include:

- **The Operations Control Center consists of the RCC and in an adjacent building the PCC.** Together, these are the nerve-centers for service delivery, power system operations, and other operations divisions, which together operate and manage subway service.
  - **The RCC** is a five-story control center completed in 1997. An around-the-clock team monitors train movement and power distribution throughout the entire system. RCC is responsible for overseeing normal train service, directing responses to subway incidents, managing service diversions, monitoring field conditions, and directing emergency or inclement weather responses. Train service is monitored using radio communication, computer-based train tracking and control systems, and CCTV, with the associated technology equipment housed in the control center's data centers and communication rooms.
  - **The PCC** is an antiquated facility with systems and building components that are almost 50 years old. The three-story PCC structure was completed in 1974 and houses the power system operations, which manages substations, circuit breaker houses, and emergency ventilation plants. The PCC has major space constraints, and its configuration does not meet modern operations control center standards.
- **130 Livingston Street** is a 13-story building constructed in 1991 that houses numerous subway departments, including operating and engineering divisions, training facilities, information technology centers, security, emergency response, and administrative support offices. The building operates on a 24- hour, seven-day weekly schedule.
- **Signal Learning Center** comprises roughly 28,000 square feet within a subway station, with 13 classrooms utilized for a variety of in-house educational purposes. Importantly, as technologies in the field modernize, we need training facilities to follow suit, such as the development of a CBTC training facility.
- **PS 248 TA School** is in a former NYC public school building in Brooklyn, NY. Built in 1932, the four-story building currently serves as a NYCT training facility. Training activities include track, RTO, stations, car equipment, induction, infrastructure, and conductors.

Looking southeast across 86 Street and Avenue U, at New York City Transit Learning Center in Gravesend, Brooklyn

Employee locker Room, NYCT

Wakefield 241 St Employee Break Room, NYCT.

Above, Livonia employee restroom, NYCT
Left, Livonia employee break room, NYCT

Investment needs

Over the next 20 years, the operations control center (RCC and PCC) will exceed its original useful life and will need to have overall space and technology issues in its current location evaluated and addressed. Additionally, upgrades to various existing facility components, such as building envelope, HVAC, space layouts, and electrical generators will be required.

Over the next 20 years, we need to

- Address the PCC's immediate needs, by improving space configuration, replacing the roof, upgrading HVAC systems, completing replacement of obsolete power control systems, and pursuing longer-term improvements to make the PCC more functional and sustainable.
- Upgrade the RCC's systems and building components to keep pace with the increased technical requirements of service delivery that have advanced since the RCC's commissioning in 1997, including roll-out of CBTC and other field-management system. Additionally, the RCC's building systems and components require periodic upgrades, including to the building envelope, HVAC, space configuration, and generators.
- Invest in subway facility rooms, as most are in poor condition. Prioritized locations will need to be upgraded and modernized to fit their purposes, including providing appropriate breakroom and bathroom facilities to support employees as they perform their crucial work on the transit system. Priorities will reflect the results of ongoing surveys and are expected to prioritize facility HVAC, breakrooms, bathrooms, and other crew facilities.