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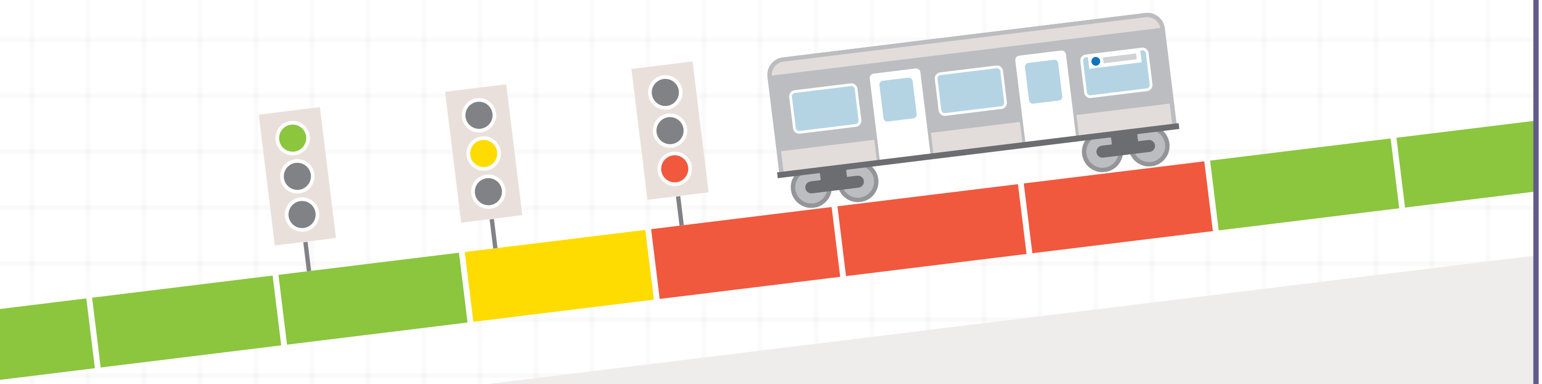
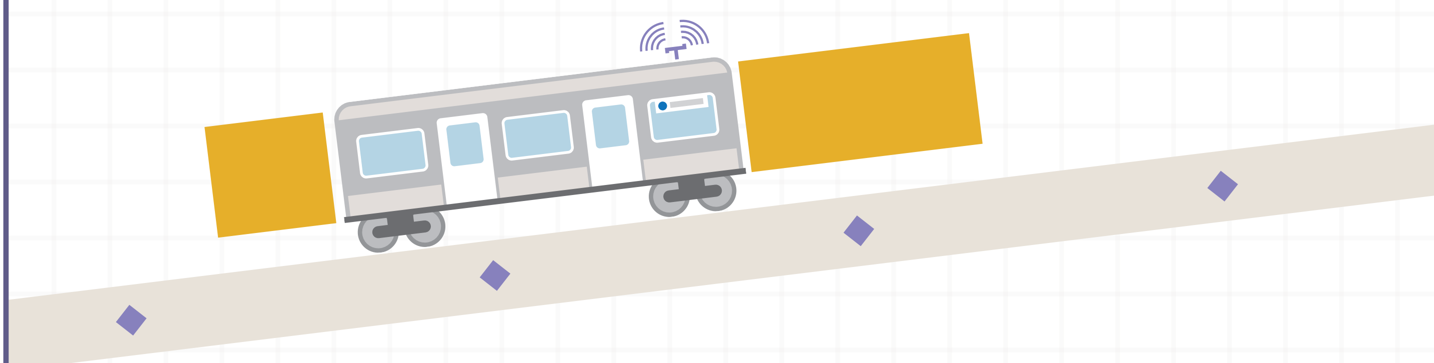


Moving Forward

Accelerating the Transition to Communications-Based Train Control for New York City's Subways



Executive Summary

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Executive Summary

The New York City subway system has made strides in recent years in upgrading stations, subway cars and passengers' experience. But in one crucial area – signaling - the subway system remains antiquated, relying primarily on century-old technology to keep trains running. While New York is in the early stages of converting to communications-based train control, the modern telecommunications system that many of the world's metro systems rely on today, the pace of change has been slow. At the current rate, a full transformation wouldn't occur for more than 50 years, putting the city decades behind its peers around the globe.

What are the consequences of going too slowly?

More delays, increased safety risk and an inefficient use of resources. Because the network relies on old technology, repairs and replacement parts are costly. As the system ages, that burden will only increase.

What is holding New York back?

Resources, certainly. While CBTC will save money in the long run, it requires a substantial upfront investment in new systems and equipment. Future capital plans need to significantly increase funding beyond current levels. Converting to CBTC also could be done sooner with modifications to procurement rules and more flexibility to work on the tracks throughout the day. These are hard decisions that involve changes to longstanding procedures, but could speed up other projects in addition to signal work.

This report will explain what CBTC is and how it works. It will discuss the status of CBTC in New York City's subway system, and make recommendations to implement it more quickly and efficiently.

What is Communications-Based Train Control?

Today, the New York City subway relies on a central nervous system made up of 15,000 signal blocks, 3,500 mainline switches and 339,000 signal relays. These components, which have hardly changed since the subway opened in 1904, let train operators know when it is safe for them to move trains forward.

The type of signaling system used by New York's subway, called fixed-block wayside signals, divides the subway tracks into blocks of around 1,000 feet and creates a buffer of one or more additional trailing blocks to ensure safe separation of train traffic. The buffers limit the number of trains that can flow through the tracks at any one time.

The effects of these constraints have increased as subway ridership has grown. In the last 20 years, the number of passengers has climbed to its highest level since 1950, with more growth expected in the coming years. During peak periods, trains are forced to wait in stations while crowds of passengers exit and enter the cars, causing delays that ricochet through the system. The result is fewer trains running per hour. In off-peak hours, where ridership growth has been greater, it has become increasingly difficult to find adequate time to inspect, maintain and replace the signal blocks, switches, relays and automatic train stops without major effects on service. Dispatchers can only determine so much now about train location, and lack the precision and ability to centrally monitor and manage the entire system.

By contrast, CBTC combines the firepower of higher-speed computers and fiber-optic data communications to link tracks and vehicles into a seamless system. Computerized signal equipment installed along the tracks and on subway trains establishes precise knowledge about the location and speed of each vehicle, making it possible to centrally monitor and respond rapidly as conditions change.

Benefits for riders, operators, businesses and the public

The benefits of CBTC flow from the greater efficiency, reliability and flexibility that it provides. Because trains can safely run closer together, they can circulate with greater frequency, reducing bunching and uneven service. Theoretically, CBTC can accommodate 40 or more trains an hour, compared with at most 30 using traditional signal systems. Although running at full CBTC capacity would require other improvements to the subway network, such as straightening curved track and expanding stations, passengers would see substantially less waiting and crowding with CBTC.

Instantaneous communications would improve reliability, allowing New York City Transit to work around and respond quickly to both rare and commonplace events such as stalled trains, accidents, flooding and police actions. Customers also would experience more accurate and timely countdown clocks and other important information. While the upfront capital costs are high, the annual savings from reduced energy, maintenance and operations would substantially reduce the costs of running the system. Energy would be saved by smoothing rates of acceleration and deceleration, which also would make for a more comfortable ride. Since signal maintenance would be much less labor-intensive, the MTA would be able to maintain CBTC for far less than the $106 million annual cost for the current sig-

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nal system. Trains could be operated with a crew of one instead of two, or even without a driver. That would allow the MTA to reduce overall costs, shift labor to other operational or service needs or implement a combination of cost reductions and service improvements.

The benefits from full implementation of CBTC will flow well beyond those who ride the subways. A more cost-effective transit system will reduce pressure on the three main sources of MTA revenue—fares, bridge and tunnel tolls and taxes from both residents and businesses. It won't eliminate the need for additional revenue to maintain and expand the transit network, but it should be an essential part of a long-term financing strategy that includes both revenue increases and cost savings. Service improvements will allow the subways to comfortably absorb additional riders to support a growing economy for New York City and its suburbs. Without these improvements, New York will become less competitive with cities around the world that have more modern systems.

Lessons from other cities

CBTC is a proven technology that has been used on most subway systems around the world for many years. Some newer systems are completely operated with CBTC, while most older systems are in different stages of transition. CBTC is now the global standard, and a review of four noteworthy examples—London, Paris, San Francisco and Vancouver, as well as New York's experience to date—provide evidence of CBTC's benefits and some lessons for its future development.

- Full automation can dramatically increase the flexibility of the system, allowing operators to rapidly increase service or reroute trains in response to events.

- The largest capacity increases come not from running more trains, but from allowing more efficient utilization of existing trains that are more evenly spaced.

- CBTC systems rarely fail, and when they do the failures are localized. For this reason, some systems are finding that backup systems are unnecessary.

- The entire system doesn't need to be converted to CBTC to see benefits. Hybrid systems, networks with CBTC on trunk lines and conventional signals or street running on branches can still gain capacity, reliably and efficiency benefits.

- New signal technologies are easier to maintain and can save tens of millions of dollars on maintenance costs.

- CBTC dramatically changes how the system operates by centralizing the control of the network. Management must be prepared to adapt to the new operational possibilities that CBTC affords to fully realize its benefits.

- Labor needs to be brought into the discussion early. Implementation can take many years, often decades, and many current tasks will be phased out over time. This can provide an opportunity to create new roles for employees that increase their prestige - greater responsibility and skills – while improving service for passengers.

- Additional brick-and-mortar investments, like improvements in station circulation or correcting system bottlenecks, can magnify the benefits by eliminating limits on throughput that would otherwise be possible with CBTC.

Costs and challenges to implementation

Converting the entire subway system to CBTC is a major undertaking that will take many years to complete. It will cost more than building the first leg of the Second Avenue Subway or connecting the Long Island Rail Road to Grand Central Terminal, and comes with organizational hurdles that rival those enormous construction projects. Installing CBTC equipment throughout the system would cost an estimated $13.8 billion, or about $20 million for each mile of track. This doesn't include the costs of upgrading all of the interlockings – large junctions between lines - that aren't compatible with CBTC. Equipping the subway fleet would cost an additional $5.4 billion, or about $1 million for each car, for a total of $19.2 billion or almost $20 billion. As with signal and track maintenance, the conversion would need to take place in a 24-hour system that never shuts down.

Beyond the costs and complexities of construction, CBTC will require a new mindset for operating the system and challenging negotiations between management and labor. Technology creates opportunities to run the system in different and better ways, but requires more than simply adapting the system to the current operating environment.

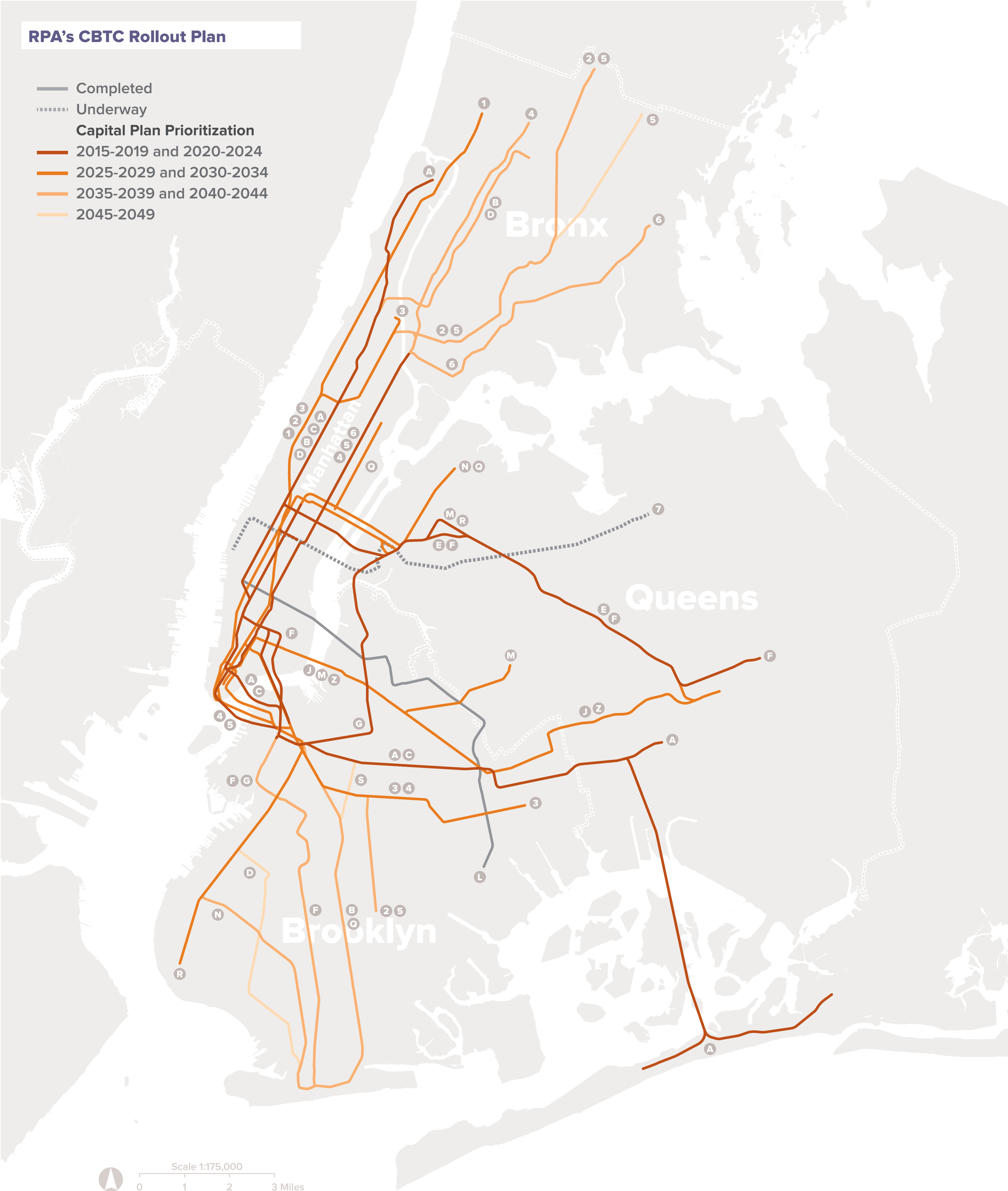
Labor must be a partner in this transformation. Under CBTC, train operators will no longer operate trains but will monitor them. CBTC, while not a requirement for one-person-train-operations, further eases the transition to it by offering another level of safety over fixed-block signaling. Transit agencies around the globe are making investments in technology that will allow them to increase their service and reliability with the same or smaller workforce than they have today. But technology doesn't have to result in a reduction of the unionized work force. Systems like the one in Paris have strong unions, but have reached consensus between labor and management on new practices to increase service to respond to growing passenger demand. Train operators and conductors in other systems have agreed to transition to roles at stations and control centers. New York will need to develop its own solutions, but the status quo will become increasingly untenable.

Transforming New York's Subways with CBTC

The process is already under way, but will take years to complete and must overcome a number of hurdles. In fact, only four miles of track per year have been converted since 1999. The MTA's Twenty Year Needs assessment envisions a pace of 16 miles per year. Assuming the initiative is fully funded, this would mean only half the system would be using CBTC by 2034. To keep pace with other regions and realize the full potential of CBTC, this effort needs to be both accelerated and expanded. Based on an extensive study of the subway's signal system, RPA is recommending the following measures:

Upgrade an average of 21 track-miles annually to CBTC during every five-year Capital Plan, completing the transition to moving-block technology in 35 years or less.

This program would cost an average of $393 million annually – more than $2 billion in each of the next seven five-year capital plans. When compared to the MTA's most recent Twenty Year Needs Assessment, RPA's proposal would almost double the investment in CBTC over the next two decades. To meet this goal the MTA will need to expand its Fast Track program and also explore extended overnight, weekend or other types of closures that might last weeks or months at a time. Lines should be prioritized based on their age, capacity and ridership growth potential, as illustrated in Chapter 5.


RPA's CBTC Rollout Plan
Completed
Underway
Capital Plan Prioritization
2015-2019 and 2020-2024
2025-2029 and 2030-2034
2035-2039 and 2040-2044
2045-2049
Bronx
Manhattan
Queens
Brooklyn
Scale 1:175,000
0
1
2
3 Miles

Accelerate the upgrades to rolling stock to operate in both moving-block and fixed-block environments. Without the operational flexibility of a larger CBTC-equipped fleet, the agency's options will be limited because of the interconnected configuration of the remaining lines that make up the subway. The full cut-over of the Canarsie line (L) to CBTC was delayed due to insufficient CBTC-equipped rolling stock, suspending most of the benefits of CBTC for years. The MTA most recent needs assessment states that it plans to retire its old and mid-life cars by 2027, making its entire fleet CBTC-ready or equipped. This schedule should be accelerated if possible. The agency also should take steps to overhaul its mid-life cars, which represent almost a third of its fleet. By extending the life of these cars, the agency will be able to increase the frequency of service throughout the system sooner, taking full advantage of the new capacity afforded by CBTC.

Replace old and damaged signals with CBTC, rather than replacing with old technology. The MTA should, whenever possible, replace fixed-block signals with CBTC when they reach the end of their useful life or are damaged. The MTA should conduct a systemwide survey so that the agency can prepare sites along the network for CBTC and possibly to install CBTC while workers have extended access, as the agency did during post-Sandy repairs.

Transform management practices to adapt to new approach to operations. CBTC is a transformative investment, but one that won't fulfill its potential if the subway is run as it always has been. Employees will need to adapt to maintain new equipment and managers must reconsider the 100-year-old approach they use to operate the subway.

The Federal Transit Administration's study of CBTC on the San Francisco Muni highlighted the importance of organizational reforms in tandem with the implementation of new train control technologies. It stated: "Transitioning from a fixed-block signaling based train control system to CBTC requires a dramatic shift in technological and business practices within the transit agency." The FTA also found that CBTC's "open architecture facilitates interoperability between equipment from different suppliers and maximizes the use of commercial off the shelf equipment."

Retrain and reposition workforce to take full advantage of technology investments and better serve customers. With fewer workers needed to operate the trains, the MTA should work with labor to shift conductors to customer-oriented services at stations. In Vancouver, for example, workers are cross-trained in many areas, from train systems to providing medical assistance. The MTA also could explore new roles for its train operators, such as monitoring and remotely operating trains in the railway control center – a similar approach to the one that has been taken in Paris. With a transition that will take at least three decades, there is an opportunity to negotiate a successful labor-management approach that can be implemented gradually across the agency.

Convert subway to driverless operations by 2040s. The MTA should begin to prepare the system for full automation in the 2040s once CBTC is installed. It will save the agency billions of dollars annually and allow it to increase service while keeping their operating costs in check. Full unattended train operations have been implemented around the world, even in older systems. Driverless metros more efficiently use existing fleets, are more energy efficient and offer greater flexibility.

Other actions that could enhance the service or cost-savings potential of CBTC go beyond its implementation. The following actions also should be considered:

- Eliminate the costly and unnecessary fixed-block back-up system envisioned for the system. Other systems have shown that CBTC can be reliably operated on its own.
- Enlarge stations, improve vertical circulation to address crowding and make adjustments to terminals and junctions where necessary. These changes will reduce dwell times and allow CBTC to run lines at full capacity.
- Eliminate major bottlenecks – inefficient terminals, at-grade junctions and sharp curves. The physical design and layout of the subway's track and stations limit the system's maximum attainable throughput.

These recommendations are explored in detail in subsequent chapters. In addition, a short video that can be viewed at www.rpa.org explores the difference between fixed- and moving-block technology.

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Regional Plan Association is America's oldest and most distinguished independent urban research and advocacy group. RPA works to improve the economic competitiveness, infrastructure, sustainability and quality of life of the New York-New Jersey-Connecticut metropolitan region. A cornerstone of our work is the development of long-range plans and policies to guide the growth of the region. Through our America 2050 program, RPA also provides leadership in the Northeast and across the U.S. on a broad range of transportation and economic-development issues. For more information visit, www.rpa.org.

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