NEXT STOP, BUS RAPID TRANSIT:

ACCELERATING

NEW YORK'S BUS SYSTEM

INTO A NEW CENTURY

The CUNY Institute for Urban Systems

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About the CUNY Institute for Urban Systems

The CUNY Institute of Urban Systems (CIUS) conducts research on current issues in infrastructure management and policy, with a focus on the implications of new technology, institutional change and innovative financing strategies. CIUS research is led by interdisciplinary teams of visiting fellows and distinguished faculty members from throughout the City University of New York system.

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Preface.

This study was undertaken to examine how to introduce bus rapid transit (BRT) in New York City. In recent years, the idea of bus rapid transit – innovative bus services providing superior speed and convenience to traditional bus service – has attracted growing interest both here and across the United States. The tremendously successful BRT systems in Bogotá, Colombia and Curitiba, Brazil, have stirred worldwide interest in whether BRT could be introduced elsewhere. In 1998, the Federal Transit Administration initiated a Bus Rapid Transit Demonstration Program that has fostered projects in twelve cities. New York City, where more passengers use buses than in the next five largest U.S. transit cities combined, has adopted many innovations over the last two decades to improve the quality of its existing bus service. But it has been slow to pursue the potential of BRT.

The popular image of bus rapid transit has largely been shaped by Curitiba's specially designed buses, loading tubes, and exclusive running ways. Due in part to the Curitiba model, bus rapid transit is often explained to the public as the equivalent of light rail transit on rubber tires. But this presentation of BRT as a "silver bullet" solution to transit problems has the effect of distracting public attention from solutions that are better suited to the complex characteristics of large, mature cities.

Large cities that have taken the lead on bus rapid transit have organized their efforts around a strategic goal: providing a level of bus service that can successfully compete for discretionary riders. They have pursued this goal through multi-element service strategies that are tailored to local circumstances and integrated with the area's overall program of bus service. Viewed as a low-cost attempt to duplicate the features of light rail service, BRT has had few practical applications for New York. But understood as a combination of road management and service strategies that are integrated with an overall customer service approach to bus service, BRT can become a powerful tool for promoting bus ridership in New York.

The goals of this study were (i) to determine suitable characteristics for a BRT system in New York City, and (ii) to identify candidate projects that could be considered for immediate implementation. This paper begins by setting out in Chapter One an overview of the components of bus rapid transit systems. Chapter Two identifies two promising immediate opportunities to introduce and gain experience with implementing bus rapid transit in New York City. Chapter Three recommends a process of upgrading existing bus services by adopting BRT technologies and strategies appropriate to each type of service. Chapter Four discusses the key need for successful implementation of these bus service enhancement strategies: interagency and interdepartmental cooperation and problem solving. Finally, Chapter Five offers a brief conclusion and a look beyond the city to the surrounding region.

The CUNY Institute for Urban Systems (CIUS) would like to thank the J.M. Kaplan Fund for providing the financial support that made this report possible. The funding was provided as part of Kaplan's program to support new ways to reduce congestion and improve mass transit in New York. CIUS has undertaken this work as part of its commitment to develop programs to modernize urban infrastructure systems through the application of new technologies, the use of information technology, and the development of innovative and cost effective management strategies.

Dr. Robert Paaswell, CIUS Director, and Albert Appleton, Visiting Fellow at CIUS, provided project direction. Dr. Todd Goldman, Senior Research Fellow at the University Transportation Research Center, served as principal researcher. The assistance and guidance of Herbert Levinson, member of the National Academy of Engineers, and one of the country's leading experts on BRT, is particularly and gratefully acknowledged. The authors would also like to thank Michael Friedman, Jerry Lutin, Ryan Russo, Bruce Schaller, Paul Schimek, Norman Silverman, Jeff Zupan and many others for their insights and advice, and the University Transportation Research Center for making its resources and facilities available.

Executive Summary.

Around the nation and around the world, cities are discovering that low-cost investments in their bus systems can bring disproportionately large benefits. They have found that improving the speed, reliability and convenience of traditional bus services can attract new riders, help to reduce traffic congestion, and make the economics of transit service more favorable. The strategies used to achieve these goals are collectively known as "bus rapid transit" (BRT). The successful implementation of bus rapid transit in New York City could benefit tens of thousands of bus passengers daily, reduce congestion and improve street life.

Bus rapid transit is not defined by any single feature or technology. Instead, it coordinates innovations in service patterns, rights-of-way, vehicle design, fare collection, passenger information, branding, and intelligent transportation systems to meet the needs and constraints of the particular urban area it wishes to serve. In the New York City context, BRT should not be seen as an inexpensive alternative to light rail transit, or a step toward its eventual implementation. That would be a formula for inaction, because it leads to design choices that put buses in direct conflict with other modes. Instead, BRT strategies should seek to mitigate competition over New York's shared but limited street space, identifying solutions that improve the streets' efficiency at accommodating the needs of all users. New York City has pioneered many of the operational strategies that are incorporated into bus rapid transit systems elsewhere, but has not yet assembled the "packages" of technologies, service patterns, amenities, and other characteristics that have been the essence of successful BRT systems in other cities.

BRT is a significant departure from traditional bus service in that it requires close integration of bus service provision and street network management. In New York – as in most American cities – separate agencies bear responsibility for providing these two critical functions. For many reasons, transit agencies and municipal departments of transportation have distinct sets of objectives, some of which may hinder the ability of the two types of agencies to cooperate on BRT implementation. In cities where BRT has been adopted successfully, political and agency leadership was needed to overcome these institutional obstacles by introducing cooperative working arrangements, new ways of doing business, and creative system designs that helped BRT investments achieve both agencies' objectives.

This report lays out a blueprint for the creation of a comprehensive, world-class BRT system in New York City, based on experiences elsewhere in the country and an examination of New York's unique challenges. The key elements of that blueprint are:

1. *Learn by doing*. The successful implementation of BRT in New York will require that transportation agencies build their capacity to work together, with other city agencies, and with affected communities. Near-term implementation on a small number of corridors would enable MTA and the NYC Department of Transportation to develop these relationships and learn from experiences with BRT implementation in the field. To illustrate what could be achieved in the near term, this report proposes initial projects on two very different corridors:

    - <u>First and Second Avenues</u> in Manhattan are home to the city's busiest bus route. The current limited-stop bus service operates on a reserved curb lane during peak hours, but is hampered by conflicts with a large and unavoidable volume of truck

deliveries. This report proposes moving the dedicated bus lane out into the second lane from the curb. This would free the curb lane for delivery vehicle parking and facilitate enforcement, easing the intense competition for curb space that contributes to congestion in the corridor, and speeding bus traffic. It would also provide room for the construction of more substantial bus stations at key locations along the route.

- <u>Northern Boulevard</u> in Queens runs between two important commercial centers (Flushing and Long Island City), and through some of the city's fastest growing neighborhoods. The corridor's existing bus services are too slow to adequately serve the long-distance trips most potential passengers need to make. The introduction of higher-quality transit services could tap this demand, and combined with appropriate zoning guidelines, could help encourage more transit-oriented development in this corridor. New limited-stop bus services and signal priorities for transit vehicles would be suitable strategies here.

2. *Plan a comprehensive system*. New York has an important foundation for BRT in the three existing forms of service (local, limited-stop, and express or commuter buses) currently provided by the MTA and other agencies. Each of these could benefit from the systematic introduction of BRT strategies and technologies:

- Existing limited-stop services and selected high-ridership conventional bus routes can become the basis for a <u>new citywide BRT network</u>. This network should aim both to enhance service to existing riders and to attract a new market of discretionary transit users whose needs are not addressed by the existing bus and subway systems. It should strive to provide the accessibility and ubiquity of the conventional bus network, while achieving faster speeds and greater ease of navigation. It should feature more frequent service on the system's busiest routes (particularly in the midday and early evening hours) and strategies to accelerate fare collection and passenger boarding. Where feasible, it could also include dedicated bus lanes, automated camera enforcement, and traffic signals that give priority to transit vehicles. The system should also have a unique identity to improve its visibility. Because this system would need to integrate MTA's capital and operational programs with those of the NYC Department of Transportation, it should be developed cooperatively between the two agencies.

- <u>Local bus services</u>. A number of measures can be adopted systemwide to improve the speed, reliability, and convenience of traditional bus services. These include using low-floor buses, posting detailed bus system maps, implementing automatic vehicle location systems to help combat bus bunching, and installing real-time signage that allows passengers to know when buses will arrive.

- Further expansion of the region's <u>express bus infrastructure</u>, such as new rush hour bus and HOV lanes on highways and river crossings, would benefit riders of commuter buses operated by NYC Transit and private companies. It would also benefit carpoolers and improve emergency vehicle response times. Currently, decisions about whether to provide express lanes in highway construction projects are made on an ad hoc basis, as part of major investment studies for individual links in the highway system. A plan that establishes goals and priorities for the further development of the city's express bus infrastructure should be used to guide future corridor studies. The Metropolitan Transportation Authority, the New York State and New Jersey Departments of Transportation, and the Port Authority should cooperate in producing it.

3. *Develop new approaches to interagency cooperation.* The region's key transportation agencies are showing an increasing willingness to work together. They have already created services and facilities that could form the cornerstones of a comprehensive bus rapid transit system. But while the region's piecemeal approach to improving bus infrastructure has yielded some great successes, the path forward requires a new level of cooperation and strategic planning. Bus rapid transit poses a particularly difficult challenge because it blurs the traditional bounds of each agency's home turf and requires them to explore new directions. Leadership from the top will be needed to give staff leeway to take a fresh look at their agencies' internal assumptions and constraints. Leadership will also needed to reach interagency agreement over a shared set of planning objectives:

    - MTA can demonstrate leadership by setting aside funds in its next capital plan for the implementation of BRT initiatives, including funds to help finance bus-supportive street improvements carried out by the city Department of Transportation. It can also actively pursue strategies to reduce bus dwell times, make an explicit effort to help improve overall traffic flow, and improve the performance of the surface transportation system for all users.

    - The New York City Department of Transportation can demonstrate leadership by working with the MTA to select a small group of corridors for the early implementation of BRT, as recommended in this report, and by dedicating staff time to the development and evaluation of BRT-supportive improvements in these corridors. It can begin identifying appropriate corridors for the implementation of intelligent traffic signal control systems that would help improve the speed and reliability of transit service while also managing signal timings in real time to minimize traffic congestion.

    - The New York State Department of Transportation can demonstrate leadership by developing a long-term plan for dedicated bus and HOV lanes in the Gowanus-Staten Island Expressway corridor, and selecting alternatives in their ongoing studies of these two highways that are compatible with these long-term plans.

As this report is issued, the MTA and the NYC Department of Transportation are planning a study of potential BRT corridors in New York. This study represents a very promising first step toward the recommendations above. If this study focuses on early implementation of at least two BRT projects, it can become the building block for creating a 21st Century system of bus rapid transit and launching a new era of transportation innovation in New York.

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Introduction: Surface transportation for a new century.

After two decades of intense investment to rescue its subways and buses from the brink of collapse, New York City is now turning its attention to expanding and improving its public transit systems. But if efforts to modernize transit include only rail transit projects, New York may overlook some of its most promising and cost-effective opportunities for improving the quality of its transit service. Many cities are finding that modest investments in their long-neglected bus systems can provide disproportionately large benefits. Perhaps now is an appropriate time for New York to think strategically about bus services as well. With encouragement from community leaders, political will among elected officials, and an embrace of innovation by transportation planners and engineers, real improvements in congestion-relieving bus service can be implemented quickly and at relatively low cost.

New York City's streets have always been congested. Every generation has faced the challenge of making city streets and highways function more effectively and efficiently, and keeping the worst effects of congestion at bay. From early controls (such as New York's pioneering implementation of one-way streets) to more recent innovations (including E-ZPass and the new "Thru Streets" program), New York has continually adapted the management of its roadways to meet changing demands.

Today, the quest to improve the city's surface transportation system remains as important as ever. The city's strong economic growth and residential revival in the 1990s and the success of MetroCard have led to substantial increases in transit ridership. At key points in the rail transit system, there is no capacity left to accommodate any growth in peak hour demand. At street level, the city continues to experience chronic traffic congestion. With construction of new roads both physically and financially impossible, crowding on many subway lines reaching the saturation point, and structural reforms like congestion pricing still not a reality, the question is what, if anything, the city can do now to improve its surface transportation system and reduce road congestion.

Better bus service is a particularly promising option. Buses, despite their mixed public image, play a critically important role in the city's transportation system. Bus ridership is already growing rapidly (6.3% per year between 1994 and 2001) but for what are generally explained as budget reasons, the provision of new bus services has lagged (just 1.7% growth per year). Buses fill an important, intermediary niche between automobile travel and rail transit. Like automobiles, they take advantage of the ubiquity of the surface road system and enable travelers to reach points close to their destinations. Like the subway, they enable travelers to avoid the high expenses and personal stresses of vehicle use and parking, and move passenger more efficiently. Of course, buses experience some of the inconveniences of these modes as well: like automobiles, they are delayed by traffic; and like subways, their routes and schedules cannot be tailored to the needs of the individual traveler.

Bus rapid transit (BRT) is a different approach to bus service, that attempts to overcome these limitations by focusing on the development of innovations that enable bus services to run faster, more reliably, and more responsively to the public's needs. Such approaches include changes in running ways, signalization, passenger amenities at stops, vehicle designs, service patterns, fare payment strategies, information systems and signage. The experiences of other cities have shown that when such multiple bus innovations are combined, they can bring great improvements in service and ridership. Some of those elements have been individually used in specific instances in New York. But New York has not yet created a unified, multi-element strategy for raising the level of bus service in the city. This report attempts to point the way to such a strategy and where to begin to implement it.

Chapter 1. Technologies and strategies for improving bus services

The boldest experiments with bus rapid transit have been born of necessity. Some innovations were pioneered by smaller cities, many of which lacked rail transit systems and the densities needed to justify building them. Other innovations were pioneered by large cities struggling to find an immediate way to provide better bus service and reduce road congestion in a shorter time frame than would be required to build fixed rail facilities. The result has been a diverse array of bus rapid transit initiatives that have successfully emerged throughout the country over the last decade. This chapter describes the main BRT approaches and policies that appear more suitable for use in New York City.[1]

1.1. Rights-of-way

1.1.1. Exclusive, dedicated busways

Grade-separated, exclusive bus rights-of-way are the classic image of a bus rapid transit system. Buses clearly reach their highest levels of performance when they do not have to mix with other traffic. But creating a true dedicated right-of-way within a city is difficult and expensive, as it often requires new tunnels or elevated structures.

Two North American cities are often cited as the models for successful dedicated roadway BRT systems. Pittsburgh has developed a system of busways using abandoned or underutilized rail corridors. It opened the first of its three busways in 1977, and today its system totals 18.5 miles in length, with park-and-ride lots located at many of the stations along its route. Together, they serve more than 48,000 passengers daily (not including riders attracted by a 2.3-mile extension that opened in June 2003). Passengers experience increased reliability in travel times, and save 6-25 minutes per trip, depending on traffic conditions.[2]

Ottawa has developed an even more successful system. Its Transitway, opened in 1983, today stretches 19 miles and carries about 200,000 passengers per day.[3] It features local bus services that stop at each of the Transitway's 22 stations, plus over 50 express routes that provide collector services in surrounding neighborhoods and then use the Transitway to provide nonstop, transfer-free services to downtown. This network was developed from old rail rights-of-way, as well as corridors that had been reserved decades earlier for future transportation use. Buses operate in dedicated traffic lanes through the downtown area.

Both the Pittsburgh and Ottawa systems enable buses to provide local collector service in surrounding neighborhoods, and then enter the busway for higher-speed service into the center. They had the rare luxury of building busways on old, unused rail rights-of-way that led directly into the center of the city, or corridors that had been preserved by earlier generations. While this is an attractive model, New York has few such rights-of-way available for conversion to bus use.

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[1] For descriptions of successful BRT experiments in other cities around the world, see Schaller Consulting (2002a); Federal Transit Administration (2003a); Levinson *et al*. (2003a).

[2] Pittsburgh Case Study, p. 14 and Table 4 in Levinson *et al*. (2003a).

[3] Cervero (1998), p. 246.

Seattle has also built a successful grade-separated bus facility: a 2.1-mile bus tunnel through its downtown. This project is noteworthy because it was built within the central business district in a place where no land had previously been set aside. The tunnel's five underground stations serve over 23,000 passengers daily, saving an average of five minutes per passenger trip.

1.1.2. Express bus lanes on highways

In cities that that have bus services dispersed over a broad area, the number of buses using any single corridor is rarely high enough to justify building a dedicated bus facility from scratch. Instead, the development of new bus rights-of-way typically requires borrowing or sharing space on highways.

One of the most common approaches is to build new bus and carpool facilities as part of larger freeway expansion projects. Large networks of bus/carpool lanes have been built throughout California, Texas, Virginia, Washington, and other states, but in most cases these rights-of-way have been designed primarily with automobiles in mind. One exception has been Houston, which built an integrated network of bus and carpool lanes with park-and-ride facilities that function together as a transit system that is well adapted for Houston's sprawling urban form.[4]

However, most of New York City's primary arterials lack wide medians and are located in very dense areas, making opportunities to add bus lanes rare. One exception has been the Staten Island Expressway, which has a dedicated eastbound bus lane in its median running about one mile between the Staten Island Railway tracks and the Verrazano Narrows Bridge toll plaza.

Where space is not readily available to create a new bus lane, another alternative is to borrow temporarily underutilized highway space. New York can take pride in pioneering the development of "contraflow bus lanes," which typically convert an outbound traffic lane for the use of inbound bus traffic during the morning rush hour. From early pilot projects in the 1960s, New York's network of contraflow lanes has gradually grown through careful experimentation and cooperation by the region's transportation agencies. Today it is the country's largest and most successful contraflow bus lane system. Examples around the region now include:

- Lincoln Tunnel: In 1970, New Jersey and the Port Authority opened the first contraflow bus lane the country on a 2.5-mile stretch through the Lincoln Tunnel to the Port Authority Bus Terminal in Midtown. The bus lane saves passengers an average of 18 minutes and improves the reliability of their morning commutes.[5] During the AM peak hour, over 940 buses currently use the tunnel, carrying 31,500 passengers.[6] If each of these passengers were in a single-occupant vehicle, 18 additional lanes would be required to accommodate this traffic.

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[4] Cervero (1998), p. 434.

[5] New York City Case Study, Table 3 in Levinson *et al*. (2003a).

[6] New York Metropolitan Transportation Council (2003), p. 3-8. Figures cited are for inbound bus traffic through the Lincoln Tunnel, not just the contraflow lane. An estimated 700 of these 940 peak-hour buses use the exclusive bus lane.

- Long Island Expressway: The following year, New York opened a 2-mile bus/taxi lane leading to the Queens-Midtown Tunnel during the morning peak. As of March 2003, this lane is now also open to carpools with three or more occupants. The lane saves bus riders an estimated 12-15 minutes.[7] During the morning peak hour, the L.I.E. accommodates 197 buses, carrying 6,700 passengers.[8] It would take four additional traffic lanes to move the same number of passengers in automobiles.

- Gowanus Expressway: The Gowanus contraflow lanes are the heart of an important if improvised express bus network that also includes the Church Street bus lanes in Manhattan, the median bus lane on the Staten Island Expressway, and a contraflow lane on the Prospect Expressway. Established incrementally over a 25-year period, a morning contraflow bus/HOV lane now reaches almost the entire four-mile length of the Gowanus Expressway, serving vehicles with three or more occupants. On the northern portion of the Gowanus, between the Prospect Expressway and the Brooklyn-Battery Tunnel, there are dual morning contraflow lanes. In the AM peak hour, 239 buses use the northern portion of the Gowanus, carrying 7,800 passengers into Lower Manhattan.[9] Five lanes would be required to handle an equivalent volume of single-occupant vehicle traffic.

- Queensboro Bridge: The New York City DOT also operates dual morning contraflow HOV lanes on the Queensboro Bridge. These are lightly used by buses, compared with the other contraflow lanes around the city: only about 90 inbound buses use the bridge in the AM peak hour.[10] Part of the reason for this is that the MTA routes its inbound express buses through the Queens-Midtown Tunnel, where they can take advantage of the Long Island Expressway contraflow lanes. But the Queensboro Bridge lanes are still an important component of the system.

The advantage of contraflow lanes is that they can significantly increase road capacity at a very low capital cost, and minimal inconvenience to other road users. Their main disadvantage is that the bus lanes are available only in one direction, and during very limited hours. Also, it can be difficult to provide access to and from the lanes at intermediate points between their starting and ending locations.

The New York State Department of Transportation now routinely studies the addition of bus lanes any time it plans major improvements of arterial highways in New York City. Several expansions of the highway bus lane network are currently under consideration, including on the Staten Island Expressway, the Gowanus Expressway, the Long Island Expressway, the Cross-

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[7] New York City Case Study, Table 3 in Levinson *et al*. (2003a).

[8] New York Metropolitan Transportation Council (2003), p. 3-7. Traffic figures cited are for inbound buses traveling through the Queens-Midtown Tunnel, and include buses entering through the contraflow lane as well as mixed traffic lanes.

[9] New York Metropolitan Transportation Council (2003), p. 3-6. Figures cited are for all inbound bus traffic through the Brooklyn Battery Tunnel.

[10] New York City Department of Transportation (2002), p. 65. Data is for all lanes on the bridge.

Bronx Expressway, and the Tappan Zee Bridge. In addition, the Port Authority is studying improvements to the Lincoln Tunnel bus lanes. These will be discussed further in Chapter 3.

1.1.3. Bus lanes on streets

Most buses operate on city streets. Innovative street designs and management policies can help prevent buses from becoming unduly impeded by car and truck traffic, while still accommodating the needs of other road users. In some cases, it may be appropriate to install new, dedicated lanes or other infrastructure to help the bus system operate as efficiently as possible. But this poses difficult planning challenge, because an appropriate balance must be found between the interests of transit riders and those of the many other groups who depend on street access. Finding the optimal design requires an ability to innovate, a sensitivity to unique local conditions, and a willingness to learn from experiences in the field.

In New York City, it can be particularly difficult to develop solutions that give bus service the benefits of a fully dedicated right-of-way. Some of the factors limiting the ability of buses to claim greater access to street space in ways acceptable to other road users include:

- *Lack of alleys*. Many large cities feature alleys or other off-street access points that enable commercial businesses to receive deliveries without parking trucks on major arterials. New York's street grid was designed without alleys, so buses must compete with commercial vehicles for curb access.

- *Narrow streets*. Few streets in New York are wide enough to provide space for distinct bus and car lanes. Even some of the widest roads in Manhattan, such as First Avenue, are only 70 feet curb-to-curb – relatively narrow by national standards.

- *Heavy traffic*. The extremely high employment and population densities in New York's business districts generate a large volume of traffic that must be diffused across the entire street grid. As a result, there are no streets that can easily surrender a major portion of their space to bus service.

- *Short blocks*. The dense street grid in Manhattan and many other parts of the city means that buses can only travel a short distance before encountering an intersection and possible delays due to traffic signals and turning vehicles.

New York City has attempted to respond to these challenges by developing and gradually expanding a network of bus lanes, typically single lanes located against the right-hand curb. The city began experimenting with bus lanes in the 1960s and 1970s, when it created a large network of rush hour bus lanes in Midtown and on the Upper East Side. In 1981, it created the first-of-their-kind dual bus lanes on Madison Avenue, and discovered that separating buses from other traffic can speed traffic flow for everyone.[11] In the early 1980s, it created the "Red Zone" program of increased enforcement of no-parking restrictions in these lanes. In order to maintain maximum flexibility of the roadway, these lanes are not physically separated from other traffic

[11] New York City Case Study, page 6 in Levinson *et al*. (2003a).

lanes. Access to the bus lanes is usually only restricted during rush hours; otherwise they are open to delivery vehicles, parking and/or mixed traffic.

Despite these early innovations, the curb bus lanes have not kept up well with changing times, and much of the momentum behind this program has been lost. Over the years, the number of delivery trucks in the city has grown sharply. Growing pressures for on-street parking and expanded hours for truck delivery access, both legitimate social needs, have eroded the political consensus behind continuing, effective enforcement of the bus lane restrictions. Today, during a typical rush hour, taxis and trucks frequently can be seen blocking the bus lanes on nearly every avenue. This has, for all practical purposes, negated much of the original promise of the bus lanes in the city.

Curb bus lanes are only one strategy for reserving street space for buses. Other strategies have been developed that resolve these access issues in different ways.

Transit malls. Many cities have created "transit malls," streets that may be used only by buses (with exceptions made for emergency vehicles and trucks making deliveries to local businesses). They are usually created as a way of improving the overall quality and safety of the pedestrian environment on a commercial street, often in conjunction with economic development efforts. To be successful, they require high pedestrian volumes, and viable alternatives for other vehicular traffic.

One such transit mall exists in New York City: Fulton Street in Downtown Brooklyn. Fulton Street in Lower Manhattan and various crosstown routes in Midtown have also been suggested as possible locations for transit malls. So far, the Midtown proposals have not gained traction because the major crosstown streets are extremely important for vehicular traffic and do not carry high bus volumes. Even if they were solely or largely dedicated to bus use, it is unlikely that crosstown streets could provide significantly faster bus service than they do today, since traffic congestion is not the primary factor slowing service on these routes. Transit malls work best when they also make sense as pedestrian malls and support a broader local economic development strategy.

Curb-separated busways. Another alternative is the conversion of several lanes of a particularly wide street into a dedicated, physically separated busway. Such busways can be located to one side of a street, or in the median. Each option creates its own operational challenges, such as accommodating left-turning vehicles and trucks making deliveries. Solving these problems has proven especially challenging in Manhattan, where streets are generally narrower than the 75-90 foot minimum width generally recommended for a curb-separated median busway.[12] A design for a median busway on First Avenue is examined in the Appendix to illustrate the complex and difficult issues involved and assess its feasibility and overall benefits and costs.

Dual bus lanes. In some cases, a single bus lane is not enough. It can become congested at high bus traffic volumes, especially if different types of bus services need to make stops at different intervals. Dual bus lanes can provide space for buses to pass one another without becoming

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[12] Levinson *et al*. (2003b), p. 3-16.

stuck behind stopped vehicles or crossing into the mixed traffic lanes. They are generally recommended for streets that carry more than 90 buses in the peak hour.[13]

Madison Avenue has dual peak-hour bus lanes that are heavily used by local, limited, and express bus services. Established in 1981, these lanes serve six local bus lines, 17 NYC Transit express bus routes, and numerous commuter lines run by private companies – a total of 200 buses in the peak hour. Few other streets in the city carry comparable levels of bus traffic. These lanes have improved the speed of local bus service on Madison Ave. in Midtown by 65% and doubled the speed of express buses through the area. At the same time, it has helped other traffic on Madison Ave. move 10% faster, even as traffic volumes have grown.[14]

<u>Interior bus lanes</u>. Another strategy is to create a single bus lane that does not conflict with the need for curb access. One way to do this is to operate buses in the second lane away from the curb, essentially moving them away from competition with other curb lane activities. At major bus stops, special "bus bulbs" are built, extending the sidewalk out to meet the second lane. Ten years ago, a report by Transit Authority staff recommended that the city consider establishing interior bus lanes, which it dubbed "New York City Bus Lanes."[15]

Interior bus lanes preserve 24-hour curb access for vehicle parking and loading and enable bus lane restrictions to be in effect for as many hours as they are needed. They also reduce potential delay to buses from right-turning vehicles that need to wait for passengers to cross the intersection. In addition, the creation of the bus bulbs creates space for shelters and other passenger amenities without blocking pedestrian traffic on the sidewalk, and shortens the distance that pedestrians must travel when crossing the street. Interior bus lanes are most appropriate for wide streets with multiple traffic lanes.

<u>Improved visibility</u>. Bold markings can make it more difficult for motorists to ignore the special status of bus stops and bus lanes, and help improve compliance with the rules. Other cities have experimented with alternatively colored pavements, bold lines or raised markers segregating bus lanes from the rest of the roadway.

The city Department of Transportation and the MTA recently signed an agreement to begin installing special markings to improve the visibility of key bus stops and lanes in Manhattan. This is a noteworthy development because it enables MTA to pursue transit-related improvements on city streets, the traditional domain of NYCDOT.

<u>Smart enforcement</u>. Successful bus lanes require effective enforcement. This could be achieved through more aggressive patrols and ticketing, but police departments focused on crime are often unable to sustain the commitment of resources necessary to provide a deterrent to bus lane violations.

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[13] Levinson *et al*. (2003b), p. 3-11.

[14] New York City Case Study, p. 6 in Levinson *et al*. (2003a).

[15] New York City Transit (1994).

A cost-effective alternative is the use of bus lane enforcement cameras. In London and other cities in the U.K., both stationary and bus-mounted cameras are being used to detect and identify vehicles violating bus lane restrictions.[16] These systems can automatically read the license plates of offending vehicles, while videotaping the context of the violation so that any extenuating circumstances can be taking into account in court proceedings. Electronic permitting procedures can be established to allow certain vehicles (e.g. those involved in construction projects) to park at the curb without being ticketed. Fiscally, such enforcement can pay for itself through the collection of fines. It would also smooth traffic flow on both the bus and the mixed traffic lanes, providing safer and faster travel to both motorists and bus riders.

In New York, legislators in Albany have been reluctant to allow greater use of cameras to enforce traffic regulations in New York City, despite the extensive evidence that camera enforcement not only improves traffic flow and driver compliance but also contributes significantly to pedestrian and transit passenger safety (especially for children, senior citizens, and disabled passengers). Political leadership from the Mayor, the Governor, and the leaders of the Senate and Assembly will be necessary to move these technologies forward.

1.2. Vehicle designs

Vehicle design is an essential element of any bus rapid transit strategy. The inefficient loading and unloading of passengers is one of the primary factors slowing bus service in New York. Because of New York's uniquely high passenger volumes, its buses require an unusually large amount of "dwell time" at stops. This adversely affects passengers (and transit agency operating costs) by reducing bus running speeds, and is also disruptive to overall traffic flow. New York City Transit has started a customer education campaign aimed at encouraging passengers to exit from the rear doors, but it is unclear how much of an impact this has had. Switching to vehicle designs that enable passengers to enter and exit the buses faster could make a more significant difference in overall travel times.

High passenger volumes increase dwell times in several ways. First, a large number of passengers boarding and alighting directly translates into longer queues, particularly at the front door, where entering passengers must wait for others to exit. Second, crowding on the bus can slow passenger access and egress, due to the difficulty of moving within the bus. Third, crowded buses can cause more passengers to exit via the front door, further delaying boarding passengers. Finally, unusually long boarding times at one stop can lead to longer loading times at the next stop, since the bus will arrive later. This last problem is endemic in bus service: adherence to schedules is inherently unstable, as small deviations from the schedule tend to accumulate, particularly on crowded lines. It results in long gaps without bus service, followed by multiple buses arriving in close succession (bus bunching).

One feature that limits the efficiency of passenger loading is the width of the doors. Typically, only one passenger can pass at a time through the doorways on New York City buses. Wider doors would enable use by two passengers at a time, perhaps enabling passengers to enter and

[16] Transport for London Street Management (2001).

exit simultaneously through the front door.[17] Designing wide-door buses that can withstand the unique stresses of operating on New York City streets is an engineering challenge that bus manufacturers have been reluctant to tackle. The cooperative development of multi-agency procurement standards may be required to encourage manufacturers to do the necessary research and development.

The need for passengers to climb or descend stairs is another characteristic of buses that increases dwell time. It slows all passengers, and poses a particular problem for elderly and disabled riders. Estimates suggest that low-floor buses reduce boarding times by 15-25%.[18] The city has already started purchasing low-floor buses for some routes. The city's highest-volume routes, such as those that offer limited-stop service, would realize the greatest benefits from using these buses.

Finally, NYC Transit has also started purchasing longer, articulated buses for use on its very highest volume routes. The reasoning behind these new buses is that they provide more seating capacity to the public while the agency lowers its operating cost by providing slightly less frequent service. But there is also a significant drawback: serving more passengers per bus with the same number of doors as a conventional bus has created even greater inefficiencies in passenger loading and unloading during peak periods. Passengers must walk farther and wait on longer lines to exit via the rear door. This in turn encourages even more passengers to exit through the front doors, further delaying the boarding process. Articulated buses that have three doors instead of the two used in New York would provide for faster passenger egress and less delay for boarding passengers.

1.3. Fare collection

Another factor that slows buses is the need to collect passengers' fares upon boarding. Fare payment slows the amount of time it takes passengers to board because it requires that they queue up to use the front door, and stop at the farebox before proceeding to the interior of the bus. NYC Transit has already made an effort to improve this problem through the adoption of the MetroCard. But other cities have shown that additional options for moving toward a friction-free fare system, some of which are compatible with fare collection technologies already in place here.

1.3.1. Accelerating the collection of fares.

Elimination of cash fares. Boarding of passengers paying cash fares takes significantly longer than boarding of passengers using MetroCard. Requiring all passengers to purchase MetroCards before boarding the bus would reduce passenger loading times. To make this policy successful, the current difficulties bus passengers have in purchasing MetroCards at certain locations and times of day would need to be overcome. One response to this problem could be to allow cash

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[17] Robert Paaswell, an author of this study, addressed this issue while serving as Executive Director of the Chicago Transit Authority in 1986. He implemented new bus procurement guidelines that called for double-width front doors to accommodate boarding and alighting simultaneously.

[18] Kittelson and Associates (1999), p. 2-17; Kittelson and Associates (2002).

during late nights and weekends, or on certain lines in the more remote parts of the city. NYC Transit could also use vending technology more widely, and offer incentives to business to insure that MetroCards are universally available for purchase.

Dual fareboxes. Section 1.2 described some of the ways that wide-door vehicles can speed passenger boarding times. Another option made possible by wide-door vehicles is the addition of a second farebox on the left side of the front entryway. The addition of a second farebox would reduce dwell times by enabling passengers to board two at a time. Each farebox would make a distinct "beep" when fares are successfully read, enabling easy verification of fare payment by the bus operator.

1.3.2. Changing the nature of fare collection.

The subway's access-restricted platforms separate fare collection from train boarding, enabling passengers to board far more quickly than they can on buses. Curitiba's innovative boarding tubes offer a way to achieve similar results in an outdoor situation. However, in most places, New York lacks the sidewalk space to implement such a system. Yet there are several ways comparable time savings benefits can be achieved at a relatively low cost, by adopting entirely new approaches to fare collection.

Prepaid boarding queues. A recent report on BRT in New York recommended stationing fare collectors at the busiest stops along key lines at peak hours.[19] Passengers could pay fares on a portable MetroCard reader, and then enter a queue, which would allow them to board any door of the next bus that arrives. This system would require the dedication of transit staff, fare collection equipment, and the development of appropriate barriers to discourage queue jumpers (ideally these would be lightweight, portable barriers, like those used in airports, that could be stowed nearby when not in use). Since NYC Transit already posts personnel at many of its busiest bus stops during the morning rush hour, the staffing requirements of this approach should not be insurmountable.

This innovation would require a bold step on the part of NYC Transit, given its high dependency on passenger fares to meet operating costs, and its long and difficult battle to create a high-compliance fare payment culture. But there is reason to anticipate that carefully defined fare collection experiments would be embraced by the public, especially if riders understand that they have a stake in the experiments' continued success. Transit passengers in New York are not lawless: at busy stops, they spontaneously form orderly lines and wait their turn to board buses during the morning rush hour, even in inclement weather. With proper marketing and outreach efforts, passengers would gain the understanding that lawful compliance with new fare payment procedures is necessary to help BRT achieve real time savings and improve reliability for their daily commutes. Fare evasion would likely be minimized by queueing passengers who self-monitor the line because they recognize their interest in ensuring that the new fare collection strategy is a success, and would most likely not be any higher than that already occurring within the subway system.

[19] Schaller Consulting (2002a).

At major bus terminals, permanent pre-paid waiting areas could be built with access restrictions more like those in subway station. But the number of places there this is feasible in New York is likely to be small, and they would not help improve the quality of service *en route*.

Proof-of-payment. Another option would be a system that is in widespread use in Europe: "proof-of-payment" fare collection. Under this approach, passengers are responsible for carrying receipts that demonstrate that their fares have been paid. Random enforcement and steep fines for passengers caught without valid tickets replaces the slower but more secure access controls used in traditional fare payment systems. Proof-of-payment fare collection has recently started gaining favor in the U.S. (including San Francisco's Muni system, the Hudson-Bergen Light Rail, and the Newark Subway).

This approach could easily be adopted on a limited basis, and still be compatible with a farecard system like that used by NYC Transit. Each bus stop along routes implementing this system would feature special card readers that issue printed tickets stamped with the time and location of issue. These readers would register fares just like bus fareboxes: they would check the validity of cards, take into account free transfers, and block multiple swipes by unlimited ride cards. They could be portable devices wheeled into place for use during rush hour, or built into permanent kiosks or new bus shelters for 24-hour use. Passengers riding designated lines would be required to carry valid tickets to prove that they had paid their fares. The tickets would not be valid for transfers or for fare payment on any other lines – passengers would need to swipe their MetroCards once again when they transfer.

1.4. Intelligent traffic and vehicle management

By its nature, bus service must struggle to stay on schedule. A bus that runs behind schedule will tend to find more passengers than usual waiting along the way, and picking them up will delay the bus even further. If the next bus is running on time, it will tend to have fewer passengers to collect and will begin to pick up speed eventually catching the first bus. A third bus will then again encounter a heavier than average passenger load, and might begin to run behind schedule. This instability is what creates the familiar problem of "bus bunching" over long and busy routes.

Failure to stay on schedule degrades the quality of bus service in several ways. If only a few buses run each hour, passengers must arrive especially early to ensure that they don't miss their bus. This increases the amount of time passengers must reserve for the trip, and thus increases its real cost. Even if buses run frequently, uneven bus spacing increases the wait time and slows the travel speeds for the average passenger. Finally, stress related to the passengers' uncertainty over how long the trip will take further deteriorates the quality of the travel experience.

The key to providing more reliable bus service is the development of systems that can detect and address bus bunching before it spirals out of control. A variety of technologies and operational strategies can help to accomplish this, including automated vehicle location systems (to enable centralized detection of bus locations and speeds), and automatic passenger counters (to relay information on when buses or bus stops are getting overcrowded). Once these technologies are in place, bus dispatchers will be able to provide more regular service by giving drivers more detailed instructions about whether they should increase or reduce their speeds, sending out additional buses to fill large service gaps that open up mid-route, or varying the timing of when buses begin their routes.

The MTA has started investing in developing these technologies, and Mayor Bloomberg has pledged to encourage their deployment. But implementing them successfully in New York City has been slow because of the difficulty of operating global positioning systems in a high-rise environment, where line of sight contacts between buses and GPS satellites are frequently interrupted. One contractor is currently developing a system that would estimate bus locations on the basis of speed and direction since the last satellite signal. Other strategies are also possible, such as the placement of repeaters and relays on light stanchions. Because uncertainties remain over which strategy will ultimately prove successful, and identifying a cost-effective solution as quickly as possible would provide significant benefits, it may be worthwhile to have two teams working on competing technologies.

An additional step beyond that would be to integrate positioning technologies with intelligent management of the traffic control system. Once centralized control centers are able to track the location each bus and whether or not it is behind schedule, they can potentially alter the timing of traffic signals to reduce the chances that certain buses get stuck at red lights. If a bus is running late (with respect to a fixed schedule or the preceding bus), a traffic signal's green phase can be lengthened by up to 10% of the signal cycle, provided that the same was not done in the previous cycle. Such approaches have improved the speed and reliability of buses in a complex urban environment, without disrupting other traffic. It has been implemented successfully in Los Angeles, long a pioneer in traffic control systems.

New York City's traffic signals are controlled with less advanced technologies than those used in Los Angeles, and in most areas are not currently capable of this type of dynamic operation. As it updates its traffic signal control systems, the city Department of Transportation city could ensure that the new systems are capable of selective transit prioritization. These intelligent signal controllers, together with systems that monitor overall traffic conditions, may be a cost-effective strategy for reducing traffic congestion and providing faster and more reliable bus service. They could also provide significant benefits for automobile traffic, since they enable operators to adjust signal timings as needed to deal with the city's constantly changing traffic patterns.

It is important to note, however, that these systems do not work effectively in environments with four-way patterns of congestion and bus service, long pedestrian crossing times, and short block lengths. In Midtown Manhattan, where streets are busy and wide, and traffic signals timings must be carefully managed on both streets and avenues, enabling transit vehicles to extend green signals would likely cause more disruption than benefit. Transit signal priority is better suited to corridors in the other boroughs, which are less likely to have to contend with high volumes of cross traffic.

1.5. Customer services and system identity

There is a tendency to think that the sole goal of bus rapid transit is to increase bus travel speeds. But if the bus system adopts the goal of attracting riders from other modes, then improvements in customer convenience should be part of its strategy. Other bus systems around the country are finding that investments in making their systems easy and pleasant to use can bring significant increases in ridership. The experiences of Los Angeles, Boston, and other major cities are instructive: they realized large gains in ridership by making their rapid bus systems highly visible, reliable and straightforward to navigate, even in unfamiliar parts of town. Some of their strategies for achieving this included:

Branding. There is a growing consensus that branding and marketing has been essential to BRT systems' success in attracting new riders. Most BRT systems seek to create unique identities for themselves, in order to remain highly visible in the urban environment, and to establish an image as a distinct transportation mode providing different features from conventional bus service. This differentiation has proven important for helping potential new customers recognize that a distinct choice is being offered.

NYC Transit has worked for decades to create a seamless, integrated identity for a transit system that in reality has been patched together from many distinct systems. Many of the elements of its "brand" (e.g. the colored bullets designating subway routes) were refined over many years and are now recognized worldwide. But its introduction of the MetroCard and its phaseout of tokens demonstrated that the agency is able to introduce new products skillfully in ways that extend and reinforce the coherence of its image.

Other cities have found creative ways to establish a new identity for BRT services without confusing riders or fragmenting the image of their transit systems. The Los Angeles Metropolitan Transportation Authority gave its Metro Rapid BRT system a distinct name and color scheme, as well as a distinctive "comet" shape that is incorporated into the system's logo and physical infrastructure, but otherwise ensured that it would remain immediately recognizable as a component of the MTA transit system. Boston gave its new Silver Line BRT system a color designation just like a subway route, and treats the line as part of its subway system on many system maps and other materials.

Bus stations instead of bus stops. To assist riders in using the system, BRT stops consist of more than a sign on top of a pole. At key stops, enhanced bus "stations" provide passengers with a range of services and amenities. BRT systems typically label each station with a unique name, install well-lit shelters that include seating and partial weather protection, and provide ticket vending machines. Where bus bulbs have been installed, ample sidewalk space would be available for all of these features; otherwise, scaled-down versions may be necessary.

Bus maps. An essential key to developing a new bus rapid transit system that supplements the subway system is the development of navigational aids that enable the occasional passenger to get around. At a minimum, this requires that bus system maps be posted at stations. But cities are going a step further and developing BRT system maps that use more of an abstract format like a subway map. Every stop on the system has a name, and the map clearly identifies transfer points to subway stations, major bus routes, and key destinations. Some cities have gone even further, incorporating interactive navigational tools and informational downloads for PDAs and handheld computers.

Real-time information. One of the most important new services that BRT systems can offer is accurate, real-time information on expected bus arrival times. This can significantly improve the convenience of bus travel by empowering the passenger to make informed decisions about what travel options to take. This reduces the uncertainty-related stress of bus travel and enables passengers to use their waiting time more efficiently (e.g. by using the available time to run an errand). The displays used to provide this service could also supply many other types of information: the current time, expected arrival times for multiple bus lines, estimated running times, and notices about bus and subway service disruptions.

In addition to these station-based information services, transit agencies are also adding real-time passenger information systems onboard their buses. These include automated station announcement and transfer information, traffic congestion or diversions that lie ahead, and even text- or video-based news and advertising.

Adequate Minimum Service Frequencies. Passengers will be attracted to bus rapid transit systems if they have confidence that service will be available when they need it. Different service levels might be provided for different types of routes; for example, feeder bus services at the city's fringe don't need to meet the same service standards as major routes that run through major business districts. But for each type of service, passengers should be able to rely on certain minimum service frequencies and operating hours.

Institutional Identity. BRT works best when there is a strong institutional commitment to manage it on an ongoing basis to make it work. This means that BRT in New York cannot be managed merely as an supplement to bus service. It will need some internal institutional structure that will ensure it has the resources and is run with the entrepreneurial spirit needed to succeed.

1.6. Summary.

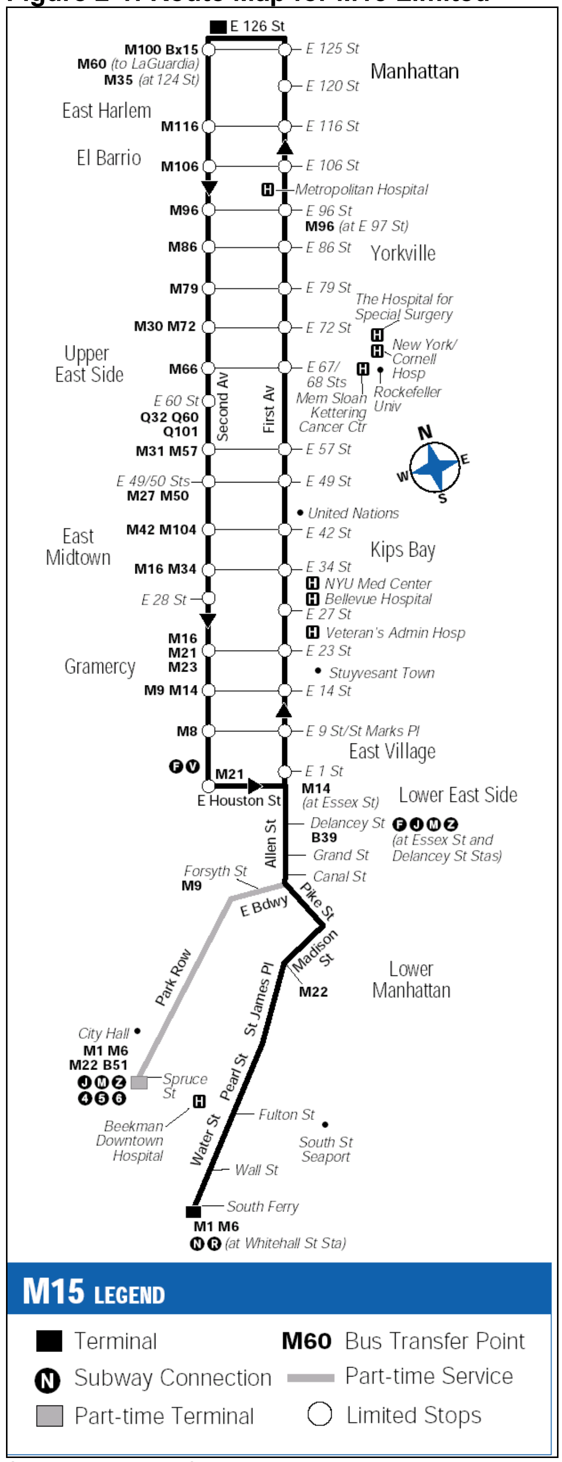
As this discussion suggests, bus rapid transit is about more than just physical design of streets. Ultimately, it is about management and service. It is not about making buses faster as an end in itself. It is about making bus travel more reliable and convenient so that the discretionary traveler will begin to choose bus travel over cars and taxis. It is about a shift in philosophy, from providing a bus service for those who cannot use cars to making bus service in selected instances a more attractive option than the use of cars. While bus ridership in New York is certainly high, there is still significant room for it to capture additional riders.

One of the most important planning realities for a city whose level of congestion has reached that of New York is that small increases in auto use have a disproportionately large impact on increasing congestion. Similarly, small reductions in car use can provide large benefits in congestion reduction. In this context, strategies than help buses maintain or expand their market share can bring significant benefits to the entire surface transportation system.

Chapter 2. Proposed immediate targets for BRT corridors

This chapter examines two very different examples of where bus rapid transit strategies could immediately help create a more efficient surface transportation system in New York City. It first focuses on the city's busiest bus route, the M15 on the East Side of Manhattan, a complex and high-density corridor that has been the object of much interest in whether it has the potential to host a BRT line. Next, it turns to an entirely different type of transit corridor: Northern Boulevard, which runs through a rapidly-growing area of Queens that is balanced between a transit-oriented and an auto-oriented future.

Figure 2-1: Route Map for M15 Limited



Source: New York City Transit

2.1. Speeding NYC's busiest bus line: Next steps for the M15

With 67,000 daily riders, the M15 is the most heavily-traveled bus route in New York City. With few transit alternatives on the subway-deprived Far East Side of Manhattan, improving the M15 has long been a focus of efforts to improve bus service in the city.

The M15 includes both local service the full length of the route between 126^{th} Street and the Battery or Park Row and "limited stop" service on the portion of the M15 route north of Houston Street. During the hours at which it operates, the M15 Limited carries roughly half of the route's passengers, a balance that is maintained as part of NYC Transit's scheduling strategy.

2.1.1. Current status of the M15.

The northbound M15 runs along First Avenue (see Figure 2-1).[20] First Avenue is dense and busy, but is relatively simple by Manhattan standards because it also has an ample and consistent width, and long stretches without intensive commercial activities.

For most of its length, First Avenue is seventy feet wide and has seven lanes (See Table 2-1). It

[20] The M15 Limited also runs on other streets to and from South Ferry, but the focus here is the portion north of Houston Street, over which Limited Service is provided.

features a part-time dedicated curb bus lane north of 34th Street, which may be used only by buses and turning vehicles during 7-10 am and 4-7 pm; parking and/or deliveries are allowed at other hours. North of 72nd Street, one traffic lane is removed, and the space is reallocated to a bicycle lane and the remaining traffic and parking lanes. In the vicinity of the United Nations, the middle "through" lanes are submerged into a tunnel, with the outside lines remaining on the surface for local circulation.

Table 2-1: Typical space allocations on First Avenue, existing conditions

Segment	Street Width (feet)	Lane Widths and Functions						
		Lane 7	Lane 6	Lane 5	Lane 4	Lane 3	Lane 2	Lane 1[21]
72nd St. – 125th St.	70	9 Parking	4 Bike	11	11	11	11	13 Bus
49th St. – 72nd St.	70	8 Parking	10	10	10	10	10	12 Bus
40th St. – 49th St.	Varies: 1-3 lanes left of tunnel; 3-4 lanes through tunnel; 2-3 lanes right of tunnel (including bus lane)							
34th St. – 40th St.	70	8 Parking	10	10	10	10	10	12 Bus
1st St. – 34th St.	70	8 Parking	10	10	10	10	10	12
Houston St. – 1st St.	Varies							

Source: NYC Dept. of Transportation

Second Avenue, which hosts the southbound M15, is more dense and complex than its neighbor to the east (see Table 2-2). It has commercial activity along most of its length, heightening the competition for curb space for parking and deliveries. It also features a variable width that produces substandard lane widths in some places (such as 10-foot bus lanes), and prevents optimal allocations of street space in others.

Table 2-2: Typical space allocations on Second Avenue, existing conditions

Segment	Street Width (feet)	Lane Widths and Functions						
		Lane 1	Lane 2	Lane 3	Lane 4	Lane 5	Lane 6	Lane 7
96th St. – 126th St.	60-70	12	10-11	10-11	10-11	10-11	8-14 Parking	
59th St – 96th St.	60-70	12 Bus	10	10	10	10-12	8-16 Parking	
23rd St. – 59th St.	70	12 Bus	10	10	10	10	10	8 Parking
14th St. – 23rd St.	58	10 Bus	10	10	10	10	8 Parking	
3rd St. – 14th St.	58	10 Bus	10	10	10	10 Bike	8 Parking	
1st St. – 3rd St.	60	12	10	10	10	10 Bike	8 Parking	
Houston St. – 1st St.	61	12	11	11 (Bus)	12	5 Bike	8 Parking	

Source: NYC Dept. of Transportation

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[21] Throughout this report, lanes are numbered starting from the right-hand curb, when facing in the direction of the traffic.

Because of its varying widths Second Avenue offers its users six or seven lanes, depending on the location. It has a dedicated bus lane between Third Street and 96th Street, which operates under the same rules as the lane on First Avenue. It adds an additional traffic lane in Midtown, and trades a traffic lane for a bicycle lane south of 14th Street.

The M15 Limited makes eighteen stops on its 6.1-mile journey between Houston Street and 126th Street, one more than the #6 Lexington Avenue Local subway makes in the same distance. This averages one stop every 7-8 blocks, or one about every 1900 feet. Depending on the time of day, it saves passengers 6-19 minutes on a full-length trip between Houston and 126th Street, or up to 3.1 minutes per mile (see Table 2-3).

Table 2-3: Current M15 Travel Times

Direction	Service	Travel Time (Minutes) By Time of Day					
		5 am – 6 am	**6:30 am – 7 am**	**8 am – 10 am**	**10 am – 2 pm**	**4 pm – 6 pm**	**7:30 pm – 9 pm**
Southbound: 126th St. – Houston St. (Second Avenue)	Local	41	54	73	76	73	61
	Limited	33	38	61	63	60	46
	Diff.	*(8)*	*(16)*	*(12)*	*(13)*	*(13)*	*(15)*
		Mid. – 6 am	**6 am – 6:30 am**	**8 am – 9 am**	**11 am – Noon**	**1:30 pm – 5:30 pm**	**7:30 pm – 9:30 pm**
Northbound: Houston St. – 126th St. (First Avenue)	Local	35	45	59	56	61	49
	Limited	29	26	44	43	48	38
	Diff.	*(6)*	*(19)*	*(15)*	*(13)*	*(13)*	*(11)*

Source: New York City Transit, *Route Running Times and Recap Reports* (April 2003).

Because it is so heavily utilized, considerable attention has been given to making the M15 run faster and more reliably. A recent study found that about half of the total travel time on the M15 is spent moving in traffic, while the remainder is split between time loading and unloading passengers at bus stops, and time stopped at traffic signals (see Table 2-4). Because of its greater ability to take advantage of traffic signal timing patterns, the M15 Limited tends to spend a much smaller share of its travel time stopped at red lights.

Numerous proposals have been advanced for enhancing surface transit services along the M15 route, some short-term and some long-term.[22] The density and complexity of this corridor make it a significant challenge to design physical changes that balance the interests of the many stakeholders who rely on it.

Table 2-4: Average observed time budget for the M15

Route type	Avg. Southbound AM Peak			Avg. Northbound PM Peak		
	Time at bus stop	Time at lights	Time in motion	Time at bus stop	Time at lights	Time in motion
Limited	23.7%	22.9%	53.4%	30.5%	19.9%	49.6%
Local	22.4%	31.5%	46.0%	25.0%	27.9%	47.1%

Source: Iqbal (2002), p. 7.

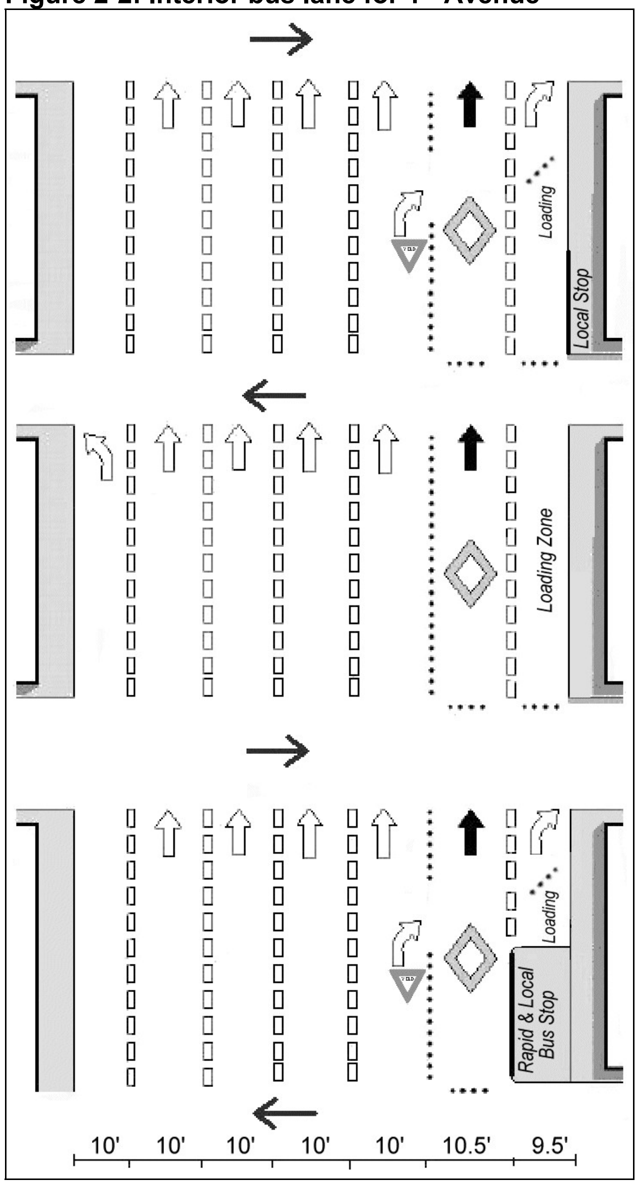
22 Rode (1999); Schaller Consulting (2002a).

2.1.2. An "interior" bus lane for First and Second Avenues.

Of the many options for the M15 corridor, an interior bus lane along First and Second Avenues would produce the greatest benefits with the least adverse impact, and could be easily and almost immediately implemented (see Section 1.1.3 for a description of interior bus lanes and Figure 2-2 for an illustration). This design would reserve the second lane away from the curb for the exclusive use of buses (and other vehicles accessing the curb lane for parking or making right turns). Several years ago, New York City Transit staff reviewed this approach favorably, and nicknamed it the "New York Bus Lane."

Under this approach, the curb lane would no longer serve as a bus lane. Instead, it would serve multiple purposes. At BRT stops (most likely the same as those currently used by the M15 Limited buses), the curb lane would be taken up by an extension of the sidewalk known as a bus bulb. Elsewhere, it could accommodate deliveries, right-turning vehicles, local bus stops, and at selected hours, carefully chosen to ensure that trucks had adequate time for deliveries, local parking. This design recognizes that both curb access and bus service are critically important activities along the corridor and shouldn't be in direct competition with one another, as they are under the current arrangement. Using an interior bus lane provides up to 24 hour curb access for truck loading and unloading, while providing dedicated bus lanes for as many hours as needed. Restrictions on other traffic using the bus lanes could be in effect during the same hours that M15 Limited service currently operates (roughly 6 am – 8 pm weekdays and 10 am – 7 pm weekends).

Figure 2-2: Interior bus lane for 1st Avenue



Local and BRT buses stopping at the bus bulbs would remain in the dedicated bus lane. Local buses stopping at non-BRT stops would pull over to the curb lane, allowing any BRT buses to maintain speed and to pass without disrupting traffic flow by changing lanes. The bus lane itself could be clearly marked with alternative pavements and/or lined by rumble strips to discourage drivers from entering the lane unnecessarily.

Most importantly, with the conflicts for curb space between users reasonably resolved, it would now be possible have high-profile, ongoing enforcement of the bus lane restrictions to insure that all users, buses, trucks and cars have their fair share of access to the lanes set aside for them. Enforcement would be most effective if automated using both fixed and bus-mounted cameras.

This system would also facilitate other service enhancements. The bus bulbs would allow for the provision of benches for comfortable seating, attractive shelters for weather protection; MetroCard vending machines, and displays for real-time transit information, without taking away from any existing pedestrian space on First or Second Avenues. They could also be designed to facilitate the use of low-floor, three-door articulated buses that would provide ample passenger capacity while minimizing boarding and alighting times. They would also reduce walking distances for pedestrians crossing the avenues.

Table 2-5: Proposed features of 1st/2nd Avenue BRT

Running Way	Six-mile route between Houston St. & 126th St. Dedicated interior bus lane, available all day Eighteen BRT stations in each direction, with bus bulbs Clear visual markings and rumble strips Cars and trucks may use curb lane at all hours South of Houston St. to Lower Manhattan Rush hour curb bus lanes where feasible
Vehicles	Low-floor buses with extra-wide doors Three doors if articulated models are used
Fare Collection	Dual fareboxes Elimination of cash fares Prepaid boarding queues, all-door loading at peak hours
System Mgmt.	ITS based management to maintain bus headways Headway-based signal prioritization where feasible Intelligent camera-based bus lane enforcement Metering strategies to maximize the curb access efficiency
Customer Services	Attractively designed stations with special signage Shelters and seating provided at bus bulbs Information kiosks with maps and navigational aids MetroCard vending machines Real-time bus arrival and travel time information

Lastly, this BRT system could be the pioneer for the City and the MTA in the use of intelligent transportation systems that, using automatic vehicle location technologies, would provide dynamic management of bus operations in the corridor to minimize bus bunching and other delay causing problems. The close bus spacings, carefully coordinated signal timings in the Manhattan grid, and high traffic volumes in the First and Second Avenue corridor rule out using preferential signalization to increase bus running speeds overall. However, dynamic dispatching of additional vehicles, and other ITS strategies provide new, potentially comprehensive tools to deal with the worst of current bus bunching.

In practice, the basic design illustrated in Figure 2-2 may need to be modified to work at specific locations. On First Avenue, the area surrounding the United Nations, between 40th Street and 49th Street, will require further study, but could most likely retain the peak hour curb bus lane arrangement that currently exists. On Second Avenue, because of high volumes of turning traffic near the entrance to the Queensboro Bridge, the bus lane may have to remain along the west curb between 59th Street and 63rd Street.

In addition, the city could evaluate the feasibility of extending a peak hour curb bus lane south of Houston Street, where the street widths make an interior lane unworkable. On some portions of its route, the M15 runs on very narrow streets, where dedicated bus lanes are impractical. And on other portions of the route, such as the market areas of the Lower East Side and Chinatown, intensive curb activity precludes providing curb bus lanes. But elsewhere, such as on St. James and Pearl Streets, there should be sufficient flexibility to operate curb bus lanes at during rush hours.

Despite the additional curb access hours that the interior bus lane will provide to delivery vehicles, along much of the route demand for loading and delivery access will remain high throughout the day. A thoughtful plan for managing curb access would also benefit the M15 corridor by reduce congestion at the curb that interferes with the bus lane. One option may be to designate certain zones exclusively for truck parking, or to adopt the kind of truck parking fee system now used elsewhere in Midtown.

On paper, this proposal for a BRT route on First and Second Avenues would eliminate one driving lane in each direction. This may raise fears of increased traffic congestion, but in fact the current system with its rampant parking violations and buses constantly switching lanes renders the curb and second lane of only limited use during rush hours. By resolving the conflict over access to curb space, making enforcement politically feasible, and helping rationalize the various streams of traffic flow in the corridor, this proposal may actually improve the flow of traffic on First and Second Avenues. This was the experience when dual bus lanes were installed on Madison Avenue.

Overall, this BRT concept would make a variety of contributions to reducing congestion along First and Second Avenues. It would replace a bus lane full of obstacles that buses must constantly pull out to pass with a viable obstacle-free one; enable rapid buses to pass local buses without moving out of the bus lane; cut loading times and eliminate the worst of bunching; and offer a far more satisfying customer experience. It would also freed up sidewalk space thanks to the use of bus bulbs, and benefit businesses by extending the hours at which they could receive deliveries.

As to implementation costs, other cities have found that the capital costs of BRT are modest compared with other transit capital projects. In building the first phase of its Silver Line, Boston spent $20 million to reconstruct 3.7 miles of roadway, move curbs, and add other street design improvements, such as brick sidewalks and historic street lights. The Silver Line’s 15 stations – which include custom-designed shelters, bike racks, phones, information kiosks with LED displays, and transponders for transit signal prioritization at four intersections – cost $2.5 million, or about $170,000 each.

New York’s package of improvements will of course be different from Boston’s. But if the costs were similar, streetscape improvements along the 6.1-mile portion of the M15 above Houston Street would cost about $33 million, and creating BRT stations at the 36 existing M15 Limited stops would cost an additional $6 million.

2.2. Supporting growing neighborhoods: A BRT corridor on Northern Blvd.

Northern Boulevard, an east-west arterial running nearly the entire width of Queens, is a very different type of corridor. It is not currently a major transit route, so it has not been studied before as a potential location for BRT services. But Northern Blvd. is interesting because it is emerging as one of the city’s key growth corridors. It connects three important growth areas:

- *Long Island City* has been identified by the city and by Senator Charles Schumer’s “Group of 35” report as one of the city’s most important emerging centers. The city has recently rezoned the area to allow for the development of five million additional square feet of office space. The planned East Side Access project will also provide the area with a major new intermodal transit hub. Sunnyside Station will link seven subway lines with a new Long Island Rail Road station that could potentially also serve Amtrak, New Jersey Transit, and Metro-North trains.

- Northern Boulevard is the main arterial serving the residential neighborhoods of *Jackson Heights*, *North Corona*, and *East Elmhurst*. These thriving, diverse immigrant neighborhoods are the fastest growing areas of Queens, which itself added more new residents than any other borough during the 1990s. The supply of housing in these areas has not kept up with population growth, and the Department of City Planning has recently approved zoning changes that would allow modest increases in allowable densities along Northern Blvd. But the lack of subway access clearly limits the area's growth potential. Northern Blvd. is a long walk from a subway line, and the average automobile ownership rates of its neighborhoods are far lower than those in the rest of Queens, so the unmet demand for high-quality transit is likely very high.

- *Flushing* is Queens' most vibrant commercial and business center, but it is served by only one subway line, which runs near capacity during peak hours, in addition to the LIRR. Flushing is served by numerous bus lines that serve as feeders into the subway system. Transit demand at Flushing is extremely high and bi-directional. During the morning peak, more passengers enter the subway system at Flushing Terminal than at any other subway station, except Times Square and Penn Station. During the afternoon peak, more passengers enter the subway system there than at any other station outside of Manhattan.

Today much of the development along Northern Boulevard is designed to be accessed by automobile, but this will not be sustainable if population along the corridor continues to grow at its present pace. Well-chosen transit and streetscape investments can help influence the character of new development and help travel patterns evolve in a more efficient direction. In short, Northern Boulevard offers an opportunity to link transit development to local growth in mutually supportive ways.

Several cities are pursuing bus rapid transit as a strategy for stimulating economic development in difficult-to-reach areas. For example, Boston's new Silver Line is part of a comprehensive plan to revitalize and redevelop the South Boston Waterfront. A bus rapid transit line on Northern Blvd. can play a similar role, creating a new transit corridor that links the fastest-growing neighborhoods in Queens with two key commercial centers. With the right set of investments and supportive public policies, bus rapid transit along Northern Blvd. can co-evolve with and support higher-density, transit-oriented development.

2.2.1. Description of Northern Boulevard.

For most of its length, Northern Blvd. is 70 feet wide, with three lanes running in each direction, and an alternating left turn lane in the median (see Table 2-6). It narrows at several locations due to railroad bridges that have not been widened, and undergoes numerous complex changes between the Grand Central Parkway, the Van Wyck Expressway, and downtown Flushing.

Table 2-6: Typical space allocations on Northern Blvd. west of Flushing.

Segment	Street Width (feet)	Lane Widths and Functions						
		EB Lane 1	EB Lane 2	EB Lane 3	Median	WB Lane 3	WB Lane 2	WB Lane 1
Queens Blvd. – 114th St.	70*	10	10	10	10	10	10	10
114th St. – Van Wyck Expy.	Varies	Two 12-14’ traffic lanes each way plus various on/off ramps.						
Van Wyck Expy. – Main St.	90	14	12	12	13 (EB)	13	12	14

Source: NYC Dept. of Transportation

* Narrows to 60’ at train crossing at Broadway; Widens to 80’ under the Brooklyn-Queens Expressway

Two bus routes currently use the portion of Northern Blvd. west of Flushing. The Q101 runs on the westernmost segment, in Long Island City near the Queensboro Bridge. It operates at a peak headway of 10 minutes, and carries 3,700 passengers a day. To the east of that, the Q66 runs for 4.7 miles between northern Long Island City and Flushing. Its peak headway is 5 minutes, and it carries 9,900 passengers per day. But the Q66 does not serve the areas of Long Island City south of the Queensboro Bridge, or along Jackson Avenue, and takes a roundabout route to reach Queensboro Plaza.

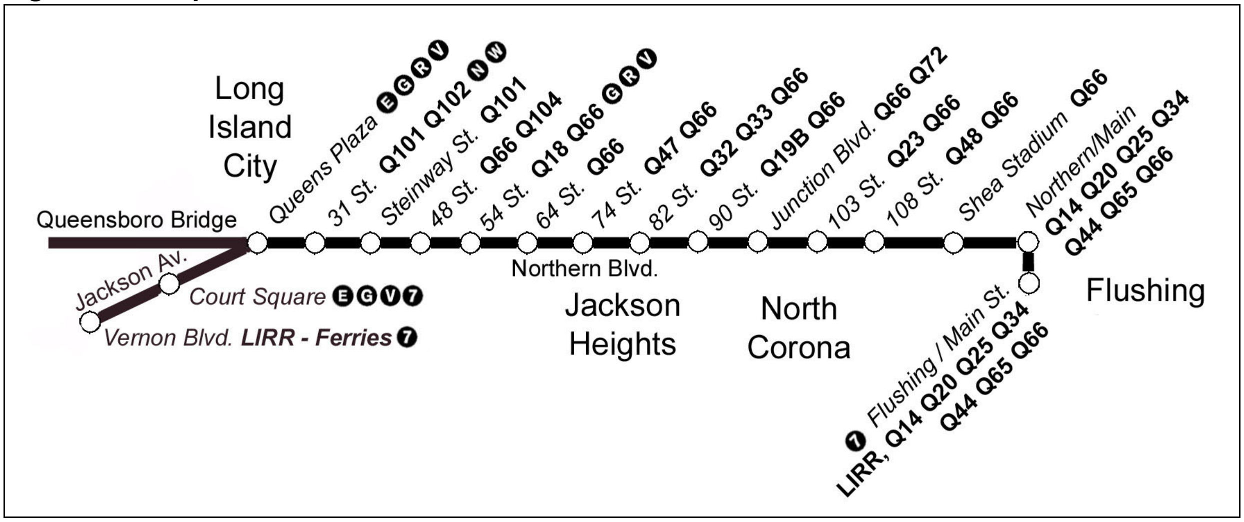
Most of the other bus lines in the Northern Blvd. corridor run north/south, providing feeder services into the subway lines that run along Broadway or Roosevelt Avenue. By establishing more frequent service, reducing the number of stops, eliminating the need for a bus-subway transfer, and providing a more direct route to Queensboro Plaza, BRT service on Northern Blvd. would be competitive with the existing combination of bus and subway service for many riders in terms of both speed and convenience. It would also help create new economic linkages among growing Queens commercial centers.

2.2.2. Incremental development of a new transit corridor

Given the low level of existing demand, creation of bus rapid transit can proceed incrementally and in tandem with growing density, provided that enough new service is offered to meet the criteria of improved reliability and enhanced performance discussed earlier.

An initial phase could establish a new limited stop bus service between Flushing and Long Island City. A suggested route for this service is illustrated in Figure 2-3. It would begin its run at the #7 Subway terminal in Main Street, Flushing. From there, it would run along Northern Blvd., with stops spaced an average of 1900 feet apart (a slightly wider spacing than the M15 Limited) at all major intersecting bus lines. At Queens Plaza, it would stop near the new Sunnyside Station. From there, it would turn down Jackson Avenue, the primary growth corridor for Long Island City. It would terminate at Vernon Boulevard, or as close as possible to the Hunters Point Ferry Terminal. During off-peak hours, when ferry service is less frequent and traffic congestion is less onerous, an alternate route could run over the Queensboro Bridge and into Midtown.

Figure 2-3: Proposed Northern Boulevard BRT Service



To clearly identify the service to the public and support its appeal to new riders, the purpose of the new route must be made clear: it would be among the first of the new BRT services, not just an ordinary bus line. Each stop would have a name, and the buses, maps, schedules, and signage would feature distinctive designs. Attractive new shelters with seating could be added to the route. These elements would help give the system a coherent identity and sense of permanence, which is essential if the line is to support growth and stimulate transit-oriented economic development.

A second phase would begin as new development along the corridor starts to materialize. Even as demand increases, NYC Transit would maintain higher service frequencies than would ordinarily be justified by its loading guidelines. It could also include creating a second BRT service along the corridor, running between Midtown and LaGuardia Airport via the Queensboro Bridge, Northern Blvd., the Brooklyn-Queens Expressway, and Ditmars Blvd.

Table 2-7: Proposed features of Northern Boulevard BRT

Running Way	6.5-mile route between Flushing Terminal and Hunters Point Ferry Dedicated interior bus lane, available all day Seventeen BRT stations in each direction Potential bus-only ramps to Queens-Midtown Tunnel
Vehicles	Low-floor buses with extra-wide doors
Fare Collection	Dual fareboxes Elimination of cash fares
System Mgmt.	ITS-based management of bus headways Headway-based signal prioritization
Passenger Amenities	Attractively designed stations with special signage Shelters and seating provided where space permits Information kiosks with maps and navigational aids MetroCard vending machines Real-time bus arrival and travel time information

At some point as demand grows it may become appropriate to establish peak hour curb bus lanes along Northern Blvd. and Jackson Avenue. Development policies, particularly the permitting of curb cuts, should be guided and limited in ways that do not compromise this future potential. The city and MTA should also begin making other capital investments in the corridor, including electronic passenger information systems, and a new bus priority traffic signal control system. Because Northern Blvd. experiences far lower levels of crossing traffic than Midtown, it is a good candidate for the implementation of transit priority signals that can help buses maintain regular headways.

As BRT service grows, the possibility of expanding this more efficient service to improve travel between Long Island City and Manhattan could also be addressed. To support that effort, State DOT could explore building new bus-only access ramps between Jackson Avenue and the Long Island Expressway.

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These two options, BRT on First and Second Avenue to help relieve a highly congested corridor, and BRT on Northern Boulevard to integrate growth with new transit services, illustrate the flexibility of BRT and its potential advantages as a positive strategy for transit service. These two proposals appear to be suitable starting points for MTA and NYCDOT to focus on implementing BRT in the near term.

Chapter 3. Bundling BRT strategies to improve New York's bus services

With the many innovations that it has adopted so far — including its extensive system of limited-stop buses, its small but highly effective network of express bus lanes for the morning rush hour, and its extensive system of curb bus lanes — New York has a strong foundation for developing state-of-the-art bus rapid transit services. It has the underlying demand for transit that is needed to help make well-designed new initiatives a success. And it already has expertise and operating experience with many of the elements that are used to create BRT systems. This chapter suggests an overall framework for using those elements to create an initial set of BRT lines, as well as to put in motion a more comprehensive BRT and bus service improvement strategy.

When a manufacturer designs a new product, it starts with a concept of the market segment it is trying to serve, and tries to tailor its design, features, technologies, marketing and price to complement one another and appeal to that market. No industry has done this more successfully than the automotive sector. It produces vehicles that are not only optimized for a wide range of distinct performance objectives (going off-road, transporting large families, etc.), but are also designed to suit the tastes and personalities of their prospective purchasers.

While the design of public goods cannot be as flexible as the design of consumer products, product differentiation and market segmentation can make important contributions to the design of competitive new transit services.[23] To the extent feasible, the components of the bus system (including running ways, vehicles, fare collection strategies, service plans, and passenger amenities) should be optimized to meet the needs of various groups of potential riders and to make the experience of using the bus system as attractive and convenient as possible.

Several large cities have taken this approach to developing bus rapid transit, and have met with considerable success. As noted in an earlier report (Schaller Consulting, 2002a), useful lessons can be learned from many cities that are currently experimenting with BRT, but London and Los Angeles provide two of the best models for New York:

<u>London</u> is currently one of the leading transportation innovators worldwide. Its new toll on vehicles entering Central London on weekdays has helped reduce downtown traffic congestion significantly, and has cut bus travel times by 15%. London is also investing in expanding service and modernizing its bus system. Its "BusPlus" program is upgrading the city's 70 busiest bus routes, creating bus lanes, providing bus priority at traffic signals, installing real time passenger information and innovative new bus maps, enforcing bus lanes with hundreds of automated cameras, purchasing low-floor and three-door articulated buses, building shelters with better seating and lighting, investing in additional training for bus drivers, improving pedestrian safety, and implementing systems that reduce bus bunching. BusPlus service was proposed in 1999, and implemented on the first 27 routes beginning in 2002. The total cost of this first phase was £84.6 million (about $142 million). In a separate program to speed passenger boarding in the central city, London has eliminated cash fares, and installed hundreds of ticket machines at bus stops.[24]

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[23] Elmore-Yalch (1998).

[24] Transport for London Buses (2003), Transport for London Street Management (2003).

Los Angeles is developing an ambitious network of BRT routes called Metro Rapid. The first phase of the Metro Rapid program, which was built for just $195,000 per mile, features a distinct system identity, wider station spacings, level-boarding buses, more frequent service, a transit signal priority system designed to reduce bus bunching, automatic passenger counters, and subway-like route maps. These improvements have brought considerable success. The 26-mile Wilshire/Whittier Corridor, which before the improvements carried about as many passengers as Manhattan's M15, saw bus speeds increase by 29% and ridership grow by 33% after Metro Rapid service began. Over the next five years, the Metro Rapid program will be expanded to 28 routes, and add exclusive lanes, advance fare payment, rear-door boarding, and coordinated land use planning. Los Angeles is also using the Metro Rapid system to function as an extension of its subway system: the San Fernando Valley Metro Rapidway, due to open in 2005, will use an abandoned rail corridor to create a 14-mile, 13-station landscaped busway that will connect with the Red Line. Los Angeles is also working to expand its network of HOV lanes, which will help improve travel times for express and commuter buses. It currently has two freeway-based HOV/bus lanes totaling 23 miles, serving over 27,000 bus passengers daily.[25]

New York City Transit has long recognized the need to tailor service levels to customer needs. It operates three main types of bus service (local, limited, and express), as well as many variations within each type that it uses as circumstances warrant. It collects extensive data on passenger volumes and operating performance, and periodically updates its service patterns to match changing demand. It also does market research to assess its passengers' satisfaction with new services and perceptions of their benefits. Recently, it has started to diversify its bus fleet in order to provide more seats on its busiest routes, and more comfortable buses on its longer-distance express routes.

But despite pioneering or using many of the operational strategies that are incorporated into bus rapid transit systems elsewhere, New York has not yet assembled the "packages" of technologies, service patterns, amenities, and other characteristics that have been the essence of successful BRT systems in other cities. To move in this direction, and begin prioritizing the various investments that would be required, the city needs a coherent, long-term vision for its surface transportation system. It needs a clear delineation of the services, infrastructure, and technologies that will serve as the component parts of this system.

The potential for improvements to the city's bus system has already received a significant amount of study and analysis.[26] Collectively, these studies point to the conclusion that a comprehensive plan for next-generation bus service in New York City should have three key components: creation of a distinct BRT network that would build upon the existing limited-stop services; improvements to local bus service that will be implemented systemwide; and a long-term plan for infrastructure investments that would improve the efficiency of commuter and express bus services.

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[25] Los Angeles Case Study, in Levinson *et al*. (2003a); Los Angeles Metropolitan Transportation Authority (2003).

[26] Examples of such studies include Urbitran Associates and Levinson (1986); Transportation Research and Training Center (1990); New York City Transit (1994); and Schaller Consulting (2002b and 2003).

3.1. Creating a citywide Bus Rapid Transit network

Through its network of "limited-stop" bus routes, New York already has in place much of what many other cities are striving for in terms of bus rapid transit service: high-volume, high-frequency bus routes that provide measurably faster service that traditional local bus routes. Beginning with this valuable foundation, there are many other steps that New York should take to further improve the level of service and convenience of the limited-stop buses, and to give them a coherent identity apart from the local bus system. These measures are essential if the limited bus system is to attract new patrons; compete against cars, taxis, vans for a larger share of the city's transportation market; and have a positive impact on street congestion.

New York City Transit and other agencies run limited-stop service on 30 bus routes in all five boroughs. The portions of these bus routes that actually provide limited-stop service are shown in relation to the subway system in Figure 3-1. As can be seen from this illustration, these routes employ different service patterns in different parts of the city:

- *Bronx*. Most of the routes in the Bronx run parallel to the subway system. Two lines, the Bx1 and Bx2, run on the Grand Concourse, directly over the D train. Other lines serve north-south corridors that lack subway lines. The Bx12 provides crosstown service between Coop City and the northern tip of Manhattan.

- *Brooklyn* is dominated by crosstown routes that intersect multiple subway lines. Many of the high-volume routes in Brooklyn not currently served by limited-stop service also complement the subway system in this way.

- *Manhattan*'s limited-stop routes primarily provide access to passengers traveling in corridors not well served by the subways, including parts of the East Side not well served by the Lexington Avenue Subway, and West Harlem/East Midtown. Other routes run directly over subway lines, providing a surface-level alternative to the subway system.

- *Queens* features limited-stop routes that act as feeder services to subway terminals in Jamaica or Flushing. These tend to run peak-hour and peak-direction only. One route (Q44) runs a much fuller schedule and provides crosstown service between Flushing and Jamaica.

- *Staten Island* has extensive networks of both express and limited-stop bus services. The express services run locally in neighborhoods before jumping onto the highways and running non-stop into Manhattan. The limited services primarily run locally in neighborhoods, then make selected stops on arterials on the way to the St. George Ferry Terminal. One limited-stop route (S93) terminates at a subway station in Bay Ridge, Brooklyn, instead of the ferry terminal. A couple of the express buses run all day, but the limited-stop buses run peak hour and peak direction only.

Figure 3-1: Bus route segments offering Limited Service

New York City Transit has developed its limited-stop bus routes through the application of several planning principles: zero incremental cost, equal loading levels on local and limited buses for a given route, maximum headways of 5 minutes to split a route into local and limited services, and other factors. The benefits have been substantial: in Manhattan, the average speed of service on a limited-stop route is 27% faster than for its local counterpart; in less-congested Staten Island, limited-stop buses run 14% faster. Citywide, NYC Transit estimates that limited-stop services reduce costs by an average of 16% (due to reduced travel times), and credits the program with helping stem the gradual decline in bus ridership.[27]

The cost-neutral criteria that have been applied to develop the limited-stop routes are prudent and appropriate for an initiative that has been driven from the staff level within the agency. Yet with agency commitment to provide financial support for a start up and service building phase, far more would be possible. Building on its limited-stop routes, and the approaches taken by London and Los Angeles, New York should develop a new high-quality BRT network that would provide the accessibility and ubiquity of the conventional bus network, while striving to achieve faster speeds, and greater reliability and ease of navigation. Because of its faster travel times, BRT should have lower unit operating costs than conventional bus services, and should therefore free up operating funds to offer more service on BRT routes or elsewhere in the system.

Suitable elements of this new BRT system for New York City appear to include:

<u>Establishment of a citywide network</u>. The city's BRT network could start with the current limited-stop bus routes and the two pioneering bus rapid transit lines proposed earlier in this report. But it need not be limited to lines that already have limited-stop service. On routes where existing service levels fall below NYC Transit's 5-minute headway standard, but where the route has high ridership and could serve as an important link in the emerging Rapid Bus network, additional resources should be applied to increasing the service frequencies and making limited-stop service available. For example, one particularly strong candidate is the B35, which has been recommended for limited-stop service for over a decade.[28] Other high-volume routes that should be considered for limited-stop service and inclusion in the BRT network are listed in Table 3-1.

Manhattan's high-volume crosstown routes (including M14, M23, M34/16, M79, M86, and the proposed "Liberty Loop" in Lower Manhattan) should also be incorporated into the BRT network. Limited-stop service is not feasible on these routes, because of the long crosstown block lengths, and because demand at every local stop is very high. But their high passenger volumes and importance to the city's transit network suggest that it would be appropriate to upgrade them in other ways (e.g. by implementing fare payment innovations that reduce passenger boarding times) and incorporate them into the rapid bus system.

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[27] Silverman (1998).

[28] Transportation Training and Research Center (1990).

Table 3-1: Top New York City Transit routes without limited-stop service.

Route	Daily Ridership (Oct. 2002)	Average AM Peak Headways in 2003 Schedules (minutes)	
		Eastbound / Southbound	Westbound / Northbound
M 14	44,012	**2.4**	**1.7**
B 35	41,347	**5.0**	**2.5**
BX 19	37,203	**4.6**	**4.6**
M 86	34,082	**4.0**	**3.9**
B 82	32,652	**5.0**	**4.6**
BX 40/42	31,410	5.7	6.0
M 104	31,305	5.7	10.9
BX 36	29,231	**4.8**	5.5
BX 9	27,946	**4.6**	**5.0**
Q 58	26,198	5.7	5.2
B 12	26,023	**4.3**	**3.8**
B 68	25,767	6.2	6.3
B 8	24,833	6.7	**4.8**
B 1	24,420	6.7	8.6
B 38	24,304	7.1	**2.9**

Bold = passes headway test (5 minutes or less) for being upgraded to limited-stop service.
Source: New York City Transit.

A final set of routes that might be considered for inclusion in the new BRT network could be a new group of “shuttle” routes that provide nonstop short-distance service between major subcenters that are not well connected to one another by the existing transit system. Potential routes could include Flushing-Jamaica Station; Long Island City-Downtown Brooklyn; and Long Island City-Bronx Hub. At relatively low cost, these and other shuttle services could be initiated and advertised to test the level of demand for them.

Levels of Service. Currently, most limited-stop routes enjoy fairly frequent service during peak hours, but many do not offer service in the midday and evening hours. The BRT system could attract riders by offering a greater degree of uniformity of service across different routes. The system would gain a reputation for availability and reliability if it committed to providing certain minimum levels of service, because potential customers would know that service frequencies would never fall below certain minimum levels during the BRT operating hours. These service levels could vary across different types of routes, but would provide a common minimum standard within each category (e.g. a maximum of 10-minute headways on crosstown routes, and 10 minute headways on feeder routes; crosstown routes operate 7 am – 7 pm, feeders operate only peak hours and peak direction).

Unique system identity. In order to help increase the visibility of this premium service, other transit agencies have adopted distinctive names and color schemes for their BRT services. These design elements have then been worked into maps, schedules, vehicles, shelters, and other system components, where they can help create a distinct user-friendly identity for the system. A key element of this strategy is often the development of a BRT system map closer in spirit to the subway map than a conventional bus map. These maps, which would be posted at each BRT stop, would display each borough’s BRT routes in a simplified graphic format, together with connections to other bus lines and the subway system. These efforts help draw in the occasional, discretionary rider by making the system easier to navigate. If designed well, these features can convey the distinctiveness of the BRT system without diluting the broader identity or coherence of the broader transit system.

Stops/stations. Most BRT systems include new, attractively designed bus shelters. On wider sidewalks, or where bus bulbs have been installed, these could include seating and side weather protection. On narrow sidewalks, an alternative design might provide only overhead weather protection without seating. In all cases, these stations should have maps for the local and BRT bus systems, user-friendly schedules, MetroCard vending machines, and more detailed information screens indicating approximate bus arrival times, estimated travel times, and real-time information on system delays and diversions.

Vehicles. In recent years, the MTA has shown a willingness to diversify its vehicle fleet to meet a wider variety of needs. It has started purchasing higher-capacity articulated buses for use on its very busiest lines, and more comfortable coach-style buses for its express routes. It has also purchased small quantities of low-floor and alternative fuel vehicles.

For the future, the MTA should adapt its procurement objectives to ensure that reducing dwell times plays a greater role in vehicle purchasing decisions. As mentioned earlier, low-floor, wide-door buses would help reduce dwell times on all routes, but the BRT system would benefit substantially because it has higher average passenger volumes at each stop. It would also be beneficial to limit the purchases of articulated buses to three-door, low-floor models that would only be used on the very highest-volume routes.[29]

All BRT vehicles could feature a distinctive look and color, so that they can be easily identified as part of the bus rapid transit system, and could incorporate on-board passenger information technologies. If distinctive paint schemes are not feasible due to the need to maintain flexibility in the deployment of vehicles, the buses could instead incorporate muliticolor LED route indicators, which would convey at a great distance the type of service being offered.

Beyond the vehicle designs that are currently commercially available, NYC Transit should use its market pull to encourage manufacturers to design vehicles that are better suited for New York's operating environment. The Federal Transit Administration has been promoting the development of new vehicle designs, but it has generally focused on fanciful designs more suitable for a suburban operating environment. NYC Transit should work with manufacturers, the Federal Transit Administration, and other large city transit agencies to develop designs that are technically and operationally feasible, and has optimal characteristics for fast passenger loading, including low floors, extra-wide doors, dual fareboxes, and (if adding transponders to MetroCards is feasible) fareboxes that can read transponders and operate contact-free. A key challenge will be the development of wide-door buses that incorporate structural designs or materials that can withstand the punishing conditions buses must endure on New York City streets. But procurement standards should not be set so high that they discourage innovations in vehicle design or reduce competition among potential suppliers.

[29] The Wilshire-Whittier corridor in Los Angeles, which carries 84,000 riders per weekday on its local and BRT bus routes (far more than the busiest route in New York City, the M15), operates successfully without using articulated buses. It is planning to switch to articulated buses only after it implements an advance fare payment system.

Fare payment. BRT fare payment systems are designed to facilitate more efficient operation of the bus system. On Midtown crosstown bus routes and lines with especially dense boarding crowds, NYC Transit should consider switching to a proof-of-payment system or prepaid boarding queues as described in Section 1.3.2. On lines where only one or two stops have very high boarding volumes (such as the York Avenue and Lexington Avenue stops on crosstown routes on the Upper East Side), these could be implemented on an experimental basis, in order to evaluate the passenger and employee time savings, and to estimate any loss of farebox revenue. During the morning rush hour, NYC Transit already stations route managers at many of these stops, and contrary to New York's image, morning commuters are quite amenable to standing in lines. The use of lightweight portable barriers and MetroCard readers would enable passengers to board buses by all available doors at these stops, greatly reducing dwell times.

Running ways: Wherever conditions warrant, additional bus lanes should be designated and better enforced on the BRT network. Additional interior lanes like those proposed for First and Second Avenues should be considered on other wide avenues with similar conditions and needs. Elsewhere, improvements to the existing curb bus lanes should be considered. All dedicated bus lanes should be clearly marked with alternatively colored pavements, paint schemes, and rumble strips to discourage lane violations. Intelligent camera-based systems would increase the effectiveness and reduce the costs of bus lane enforcement. Where interior bus lanes are used, the risk of the lane being blocked by double-parked trucks should be reduced by managing curb access to maximize turnover. Outside areas like Midtown where it cannot be implemented, headway-based traffic signal priorities should be installed to help buses maintain even spacings.

Finally, the city should design and adopt a "transit first" policy to govern the management of streets hosting BRT routes. Transit first policies, such as those adopted by San Francisco and Ottawa, specify that to the extent feasible, transit vehicles be given top priority in all transportation and street management decisions, such as signal timings, curb access, and allocations of street space. These policies do not dictate any specific practices or outcomes, or mean that all decisions made will favor buses, but rather loosen the criteria for deciding whether to make changes that favor buses. Transit first policies incorporate a growing recognition that street management needs to turn from its traditional goal maximizing *vehicle* throughput to a more modern goal of maximizing the number of *people* that can be moved quickly, safely, and comfortably.

3.2. Improving local bus service systemwide

In the interest of continuous improvement of the bus system, a number of BRT features should be pursued throughout the NYC Transit bus system. These include:

Low-floor buses. Traditional high-floor buses should be phased out and replaced by low-floor models as the fleet undergoes normal replacement. These would provide the greatest benefit on the busiest routes, but those have been receiving new high-floor articulated buses.

Automatic vehicle location. As NYC Transit perfects an AVL technology that meets its needs, it should add this technology to all of its buses. This would enable all bus locations to be monitored, and would facilitate efforts to improve reliability by counteracting bus bunching.

Next bus arrival information. Once the AVL system is in place, indicators should be installed at bus stops that estimate the amount of time before the next bus arrives. This should be phased in starting with the busiest routes, or only at stops above a certain ridership threshold. If it proves infeasible to estimate bus arrival times with a meaningful degree of accuracy, these indicators should instead provide passengers with real-time information on how far away the nearest buses are (measured by blocks or miles), and whether they are currently running on schedule.

Map availability. Bus system maps should be added at bus stops.

Signage. Bus route indicator signs should be added at all bus stops. Currently, information is not necessarily posted for non-MTA bus routes.

MetroCard availability. NYC Transit should develop a program to install MetroCard vending machines at major bus stops, partner with banks to make them available at ATM machines, and work with drug stores or fast food chains to increase the number of places they can be purchased on a 24/7 basis.

3.3. Building infrastructure to support a comprehensive express bus network

A third key component in the city's bus service enhancement strategy should focus on expanding and upgrading the city's network of freeway bus lanes. As discussed earlier, the region has found inventive ways to provide contraflow lanes to speed buses and high occupancy vehicles through Manhattan's major gateways during the morning rush hour. Peak hour bus lanes on the Gowanus Expressway, the Staten Island Expressway, the Long Island Expressway, and the Lincoln Tunnel have become critically important components of the region's transit system. While the benefits of these projects have been dramatic, they can only be used for a few hours and operate only in one direction.

Improvements to this network are made on an *ad hoc* basis, as no agency is responsible for managing and planning improvements to it. The greatest opportunities for freeway bus lane improvements generally come within "major investment studies," led by the state Department of Transportation, that seek to determine which large-scale improvements should be made to a specific highway corridor. The cost of building new bus facilities can be minimized if they are integrated into such a larger project. Re-evaluations of the fundamental designs of highway corridors are rare, and so it is important not to miss these opportunities to provide room for future transit growth.

Although New York has met with great success in building its express bus lane network incrementally as opportunities have presented themselves, it may be reaching the limits of this strategy. With the most cost-effective improvements already in place, each marginal addition to the system becomes less attractive when considered in isolation. For example, despite being parts of the same functional system, proposed bus lane improvements to the Gowanus Expressway and Staten Island Expressway have seen no formal coordination of planning or evaluation efforts. There is a significant risk that considering these projects in isolation may undercount the apparent benefits of bus infrastructure improvements on the two facilities. If the proposed bus lane improvements on either of these facilities are not implemented, an important opportunity will be lost to improve regional mobility.

Instead of relying on individual corridor studies to weigh the merits of incremental improvements to the express bus network, the state should develop a long-range plan and vision for express bus infrastructure. This planning effort should address a wide range of issues that relate to express and commuter bus operations: the locations and hours of bus priority lanes, bus parking and storage facilities, and related policies such as the implementation of congestion pricing on bridge and tunnel crossings. The resulting document should then guide future corridor studies, as well as the infrastructure programming efforts of the various transportation agencies in the region.

The express bus infrastructure plan should have a twenty year time horizon and seek to develop an express bus network that achieves the following goals:

- Accommodates both MTA and private buses
- Serves both inbound and outbound traffic. If a corridor has single, reversible lanes, traffic could be monitored and the direction of lane operation based on real-time demand (outside of hours during which express buses are operational).[30]
- Provides multiple access/egress points, and dedicated infrastructure providing access without entering congested highway lanes.
- Creates park-and-ride facilities in outlying locations, and adequate bus storage facilities in central business districts.
- Provides sufficient space to allow buses to circumvent disabled vehicles
- Creates an automated incident detection and emergency response system
- Expands express bus services as demand warrants
- Provides more complete signage about express bus stop locations in the central business district, including for non-MTA buses.
- Uses more comfortable, coach-style buses suitable for longer-distance trips, as MTA is already doing.

While it would be beneficial to begin planning express bus infrastructure as an integrated system, several corridor studies currently underway provide near-term opportunities to secure important improvements in the express bus infrastructure network:

<u>Gowanus Expressway</u>. As discussed earlier, the Gowanus Expressway contraflow bus/carpool lane is the centerpiece of a network of these lanes that includes the Prospect Expressway in Brooklyn, Church Street in Manhattan, and the Staten Island Expressway. The existing contraflow lane, while a significant achievement, has some shortcomings: it is not operational in the outbound direction during the evening rush hour, and access to it is impeded by merges with the Shore Parkway and the Prospect Expressway.

[30] The Caldecott Tunnel in Oakland, California is currently managed this way.

The New York State Department of Transportation is currently evaluating a wide range of options for the rehabilitation or replacement of the Gowanus Expressway, including replacing the existing viaduct with a tunnel, or supplementing it with a second, upper-level viaduct. As part of its analysis, DOT is considering building a dedicated, reversible bus lane that would run the entire length of the Gowanus. The Regional Plan Association, a leading advocate of a Gowanus Tunnel, has proposed a dedicated and exclusive express bus lane system, tied into feeder points on Brooklyn and Staten Island that could become a model for linking bus rapid transit and express bus service. An important design challenge will be creating appropriate entrance and exit designs such as the construction of flyover ramps or interchange improvements to prevent buses from getting snarled in traffic on the other lanes. Construction of the bus lane could partially be financed by operating it as a "high occupancy toll" (HOT) lane that may be used by single-occupant vehicles that pay a toll.

Staten Island Expressway. A mile-long dedicated bus lane currently operates in the median of the Staten Island Expressway during the morning peak hours. By 2005, the state expects to extend this lane another 1.5 miles to the west. The recent Staten Island Expressway Corridor Major Investment Study included a wide range of options for further improvements, including a reversible or two-way busway with stations and dedicated access ramps, lanes that would be shared between buses and carpools, or even a "high occupancy toll" option in which single-occupant vehicles would be able to pay a fee to access the bus/carpool lane. The study found that the various busway alternatives rated "high on all performance/evaluation measures."[31] Next, an environmental impact study will refine the alternatives and select a preferred option. Providing the option of integrating this service with a future Gowanus service should be an important criterion of choice. If construction of a busway does proceed on the Staten Island Expressway, the Port Authority should also consider extending it over the Goethals Bridge and into New Jersey.

Lincoln Tunnel. The contraflow bus lane operated by New Jersey DOT and the Port Authority that lead to the Port Authority Bus Terminal handle more traffic than any other bus lanes in the country. While it is certainly effective, there are several problems that limit its efficiency. Currently, New Jersey-bound traffic can back up in the tunnel during the morning rush hour, preventing buses from leaving the bus terminal in a timely manner. This creates congestion inside the tunnel, which creates delays on the inbound bus lane. Another problem is that when the motor vehicle lanes become congested, the Port Authority allows cars to use the bus lane, undermining its effectiveness. At final problem is at the terminal, where private bus services using the inbound bus lane must cross multiple lanes of traffic to reach the lower levels of the bus terminal. This arrangement has been the frequent cause of bus congestion and traffic accidents.

The Port Authority has recently called for bids on a study that would examine the possibility of further improving the speed and reliability of the Lincoln Tunnel's morning inbound bus lane. The creation of a second dedicated inbound bus lane will be one major component of the study. To address the problem of outbound congestion delaying buses seeking to enter the terminal, the study should also explore the possibility of creating an off-terminal bus queuing facility. To

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[31] New York State Department of Transportation (2002).

remedy the unsafe conditions for private buses entering the tunnel, the study should also examine the feasibility of a grade-separated crossover lane that would enable buses to reach the lower level of the terminal without conflicting with other traffic. If this is not possible, the Port Authority should work with the New York City Department of Transportation to examine whether bus priority pre-signals can be used to improve the situation.[32]

Beyond these measures, the Port Authority and New Jersey DOT should also study the establishment of an outbound dedicated bus lane during the evening rush hour. Currently, four lanes operate outbound through the Lincoln tunnel during the evening rush hour, just as four operate inbound during the morning peak. But unlike the morning peak, when one lane is dedicated exclusively for buses, in the evening buses must sit in congested traffic along with other vehicles. Reassigning one of these lanes for the exclusive use of buses would significantly increase the quality of express bus service and the carrying capacity of the roadway and encourage additional commuters to switch to bus service.

Long Island Expressway. New York State DOT should continue its efforts to expand the Long Island Expressway's morning contraflow bus lane further east, and should begin planning for an outbound lane during the evening peak. Currently, most express buses that use the inbound bus lane in the morning sit in mixed traffic approaching the Queensboro Bridge during the evening rush hour. DOT should also study the feasibility of building ramps at Jackson Avenue exclusively for the use of buses and emergency vehicles. This would provide important additional transit connectivity between Midtown and Long Island City.

Cross-Bronx Expressway. When the Cross-Bronx Expressway was cut through several South Bronx neighborhoods in the 1950s, it severed the area's street network and created two semi-isolated communities. As part of its Bronx Arterial Needs Major Investment Study, the state DOT is evaluating repairing this damage by partially decking over and creating "connector roads" over portions of the expressway. These would aid local circulation by connecting many streets that were cut off by the construction of the expressway. It would also provide a crosstown route for local traffic, something sorely lacking in the area. The study is also considering the feasibility of using these connector roads to provide BRT service between the Parkchester station on the #6 Subway line and the George Washington Bridge bus station in Manhattan. Evaluation of this proposal and the other alternatives is ongoing, and DOT plans to recommend a specific package of improvements in the near future.

[32] Wu and Hounsell (1998).

Chapter 4. What's needed to make bus rapid transit a reality?

Historically, low capital costs have always been one of the great advantages of the bus system. After World War II, as deferred maintenance and other factors bankrupted street trolley systems in city after city, buses were a convenient replacement because they required no dedicated infrastructure to maintain. The pavement, signals, and nearly all other elements needed to keep the bus system running were funded from local residents' property taxes, or the gasoline taxes paid by motorists. But over time, this emphasis on a low cost, low benefit approach to investment in bus service has held the bus system back from serving its customers as well as it could. Because they operate on borrowed infrastructure, most transit agencies have no ability to adjust and improve this infrastructure to make their buses operate more effectively.

Over the past twenty years, as New York's subway system has fought its way back from its own deferred maintenance crisis, the bus system has generally received only the resources it needed to survive and hold its own. Even the ridership surge of the nineties was met with only minimal increases in service, so that the actual amount of bus service offered today is roughly the same as it was in the mid-1980s. The result has been that even with the modernization of the bus fleet and no-cost innovations such as the development of limited-stop service, buses have struggled to avoid losing public appeal.

The agencies responsible for the various aspects of city bus service – including those directly provide bus service, as well as those that create the physical and policy environments in which buses operate – have the technical and planning abilities to make bus rapid transit work. What they need to empower them is permission to break out of the box in which bus system planning has been locked in recent decades. This will require institutional changes and political leadership.

> *"It is the character of mature bureaucracies to govern systems by focusing on how efficiently infrastructure is used rather than on how efficiently public infrastructure serves users.... The true efficiency test is not how many people or vehicles can be squeezed onto public highways and transit but rather how much economic product and quality of life can be generated through their use."*
>
> *—Gifford (1999), pp. 60-61.*

There are two main institutional obstacles to the development of innovate BRT systems in New York. First, there has been no explicit commitment made to help transit agencies compete for new riders, either at a management level inside the agencies, or from a sufficiently high political level from the outside. Conforming to a common pattern for mature public agencies, agencies operating bus services in New York have focused on how to minimize costs and maximize asset use, not how to manage mobility more generally or meet the multiple needs of their customers.[33] Embracing the types of multi-tiered strategies needed to make BRT work requires a paradigm shift in the priorities and strategic approaches of transit operators.

[33] Cambridge Systematics *et al*. (2000).

A second obstacle to creating bus rapid transit in New York has been the fragmentation of responsibility among the area's major transportation agencies – the City and State Departments of Transportation, the Metropolitan Transportation Authority, and the Port Authority – as well as within the agencies themselves. For example, decisions on bus service planning, scheduling, and vehicle procurement are made within separate offices at NYC Transit. Traffic engineering, operations, and signalization are in different departments within the city Department of Transportation. And planning for highway bus lanes takes place within major investment studies that are corridor-specific and not coordinated regionally by the state Department of Transportation.

The future evolution of the bus system into a range of services that can win the allegiance of the discretionary traveler will depend on the willingness and ability of the region's transportation agencies to overcome this fragmentation. Similar problems have existed in most major U.S. cities, but have been overcome through innovative inter-agency partnerships in the cities that have successfully implemented bus rapid transit systems.

The two key transportation agencies that control the major elements of bus service are the MTA and the NYC Department of Transportation. If proposals for improving the bus system are to move forward, these agencies need to begin creating and implementing a long-term vision for surface bus transportation in New York City. They should articulate a plan that would identify the key services and infrastructure that will serve as the component parts of this system, identify which agencies that will need to take the lead role in implementing each of these components, and set out realistic financial needs and strategies. This would take a significant amount of institutional leadership from both agencies, but if they commit to it they can provide bus programs that will offer more hope of congestion relief than any other short term measures that the City and State could take except for congestion pricing. At a staff level, the Metropolitan Transportation Authority has demonstrated considerable interest in rapid bus strategies. It has implemented limited-stop bus services along most routes where sufficient demand exists, and has developed proposals for priority bus lanes citywide. It has also invested in pilot projects for developing the technologies needed to make automatic vehicle location systems work in New York's high-rise context. However, because it lacks jurisdiction over the management of city streets, in the past the MTA has generally taken a passive role on the development of the city's bus infrastructure network. It will cooperate with the other transportation agencies on site-specific studies when asked to, but has not expended political or financial capital attempting to assert its vision of how the street network could be managed more efficiently.

One way in which the MTA can provide leadership toward the development of BRT-supportive transportation infrastructure is to set aside funds for BRT in its next capital plan. In its 1999-2004 Capital Plan, the MTA dedicated about a billion dollars for buses over five years, or about 5.5% of the total MTA capital plan. The vast majority of these funds were earmarked for normal replacement of aging buses and improvement of bus depots. Very little funding was allocated for expansion of the fleet, implementation of new technologies, or other initiatives that directly affect the level of service offered to the public. In the upcoming 2005-2009 Capital Plan, the MTA should set out on a new course of investment in improved bus service by procuring the new bus designs, deploying the new communications and passenger information systems, and funding the street and bus stop improvements needed to make BRT a reality. MTA's acceptance of the need to invest in the planning, engineering design, and implementation of bus rapid transit would go a long way to winning technical and policy cooperation from other transportation agencies.

A second way the MTA can provide leadership is to seek ways to maximize the benefits of BRT for all users of the transportation system, not just bus riders. By actively pursuing strategies that minimize dwell times, such as new approaches to fare collection, MTA would also contribute to the broader goal of improving the flow of traffic on city streets. Interior bus lanes and intelligent traffic signal control systems are other strategies that would benefit transit riders and non-riders alike.

The New York City Department of Transportation has shown a promising interest in bus-related infrastructure. It has embraced peak hour curb bus lanes, and has given the city the largest network of on-street bus lanes in the country. It reacted quickly after 9/11 to implement new bus lanes and carpooling policies to improve mobility in Lower Manhattan. But it has been reluctant to embrace proposals that would improve bus service during off-peak hours, such as full-time bus lanes, traffic signals with bus priority, and other strategies.

Under the present administration, New York City DOT has shown a willingness to consider innovative management strategies that improve the efficiency of the available street space, such as the new “Thru Streets” in Midtown. Building on this foundation, the DOT should raise the sights of its efforts to promote higher-quality bus services in the city. It can begin negotiating memoranda of understanding that would enable it to pursue these goals cooperatively with the MTA, with the MTA providing the bulk of the funding for the studies and capital investments needed for the street improvements needed to fund bus rapid transit. The standards could include implementation of bus location technologies, passenger information systems, bus shelters, bus bulbs, lane striping, and curb management policies, and appropriate signage. Los Angeles and other cities that have gotten BRT off the ground have shown the benefits of such active interagency cooperation.[34]

Such cooperation has often not been the norm in New York, but fortunately these two agencies are now working together in important ways. There have been quiet discussions between the two agencies about possible BRT corridors in the city. These are expected to lead soon to a more formal study of BRT options on a handful of corridors. This study should be implementation oriented, include analysis of the costs and benefits of proposed BRT approaches (for MTA operations, bus riders, and other transportation system users), and be followed by ongoing efforts to evaluate and learn from BRT experiences in the field.

In another small but important step, the DOT and MTA recently signed a memorandum of understanding for a program to provide clearer markings of bus stops on major arterials. The DOT set standards for the new markings – which include stripes on the curb and the words “BUS STOP” on the pavement – but will authorize the MTA to pay for and perform the actual work of installing them on designated routes. This effort demonstrates a practical, common sense approach to developing mutually-agreeable standards and an appropriate division of labor on

[34] Miller (2002).

projects that lie outside the agencies' traditional roles. This will hopefully serve as a model for a strategic partnership in support of other elements of bus rapid transit.

Establishing MTA-NYCDOT cooperation on the strategic level would also send a clear message to the other agencies and the public that buses are an important element of meeting transportation needs, not just a default system for use by those who have no other transportation alternatives. And the participation of other agencies will be needed. Coordination with the Police Department on the enforcement of bus lanes is essential, and the curb access needs of the Department of Sanitation must also be taken into account.

Finally, other regional transportation agencies also have important roles to play. The New York State Department of Transportation has shown its willingness to innovate on behalf of more efficient bus service through its cautious but effective incremental development of contraflow bus lanes during the morning commute hours. It has recently included consideration of bus lanes in several of its corridor studies within the city. But the piecemeal basis under which this has been done risks undervaluing the potential benefits of bus lane improvements, and producing less than optimal results. Together with the New York Metropolitan Transportation Council and other agencies, the state DOT should develop a comprehensive busways plan for its rights-of-way within New York City, identifying the corridors most in need of bus priority lanes, and committing to incorporate relevant features within any new highway projects that arise. Foremost on the agency's list of priorities should be the establishment of bi-directional or reversible dedicated bus lanes along the Gowanus and Staten Island Expressways.

A similar effort should be made to address trans-Hudson travel. The Port Authority, New Jersey Department of Transportation, and New Jersey Transit already cooperate to address issues related to the Lincoln Tunnel bus lanes. As mentioned earlier, the Port Authority is already studying ways to expand bus capacity in the Lincoln Tunnel. The New York State and New York City Departments of Transportation can join these efforts, and also engage their New Jersey partners in discussions of extending the Gowanus-Staten Island Expressway system of bus/HOV lanes beyond the Goethals Bridge.

A well-designed bus system improvement strategy for New York would clearly benefit the bus riding public. If it can attract just a small proportion of travelers who now use automobiles, it would have disproportionately large benefits in terms of reduced delay due to congestion. It can become part of a strategy for modernizing traffic signal control technologies along key corridors, enabling the city to reduce congestion by adjusting signal timings in response to demand. In some areas, it can also benefit delivery trucks and commercial businesses by reducing competition over curb space. It would also help relieve congestion in the subway system, which is pushing the limits of its capacity.

Other cities have shown that cost-effective BRT solutions can be an important part of modern urban transportation, if only the institutional hurdles to its establishment can be overcome. At this point in time, New York has an opportunity to join their ranks.

Chapter 5. Conclusion

This report has offered a multi-tiered blueprint for transforming New York City's bus system from a system that mainly serves passengers who have no other viable travel options to a positive alternative that can attract discretionary travelers and play an important role in reducing congestion on city streets. It proposes a framework for planning and implementing bus rapid transit in the city, including two specific projects for immediate action, and a three-tiered strategy for creating a 21st Century BRT system.

Beyond the boundaries of New York City, bus rapid transit has a potentially important role to play in the larger New York region. In less dense areas, BRT may need to take different forms. With lower passenger loading volumes, strategies that reduce bus dwell times will become less important, and strategies that help buses speed through traffic (e.g. queue-jumping lanes, bus pre-signals and other traffic signal prioritization techniques) and collect passengers efficiently (e.g. park-and-ride lots) will become more important. The extension of highway bus/HOV lanes will further shorten travel times for express and commuter buses, attracting new riders and enabling additional services to be offered.

The public is increasingly interested in and aware of the potential of bus rapid transit. The region's transportation operating agencies have all studied these issues, and have each taken incremental steps to put in place the rapid bus infrastructure that we have today. But stronger, more focused and above all cooperative inter-agency action will be needed to upgrade city bus service to take advantage of the potential of bus rapid transit. The benefits, to bus riders, street users, the city's economy and its environment, would be significant. This report hopefully will provide a useful road map for how to make that journey.

Appendix: Is an exclusive busway feasible on First and Second Avenues?

Because there has been longstanding interest in the potential to create a dedicated bus rapid transit or light rail transit corridor on the East Side, this report set out to identify feasible designs for such a facility, and evaluate their pros and cons. Numerous factors make it unlikely that a dedicated transitway would offer significant additional benefits over the BRT system proposed above. Manhattan's short block lengths and high volumes of cross-traffic limit the ability of buses to run significantly faster. It is difficult to close streets to through traffic and create longer blocks for buses. The avenues are not wide enough to accommodate curb-separated bus lanes comfortably without reverting to sub-optimal lane widths. And to maintain the viability of businesses along the corridor, provisions must be made for delivery vehicle access. To accommodate a dedicated busway, all these problems must be addressed.

This section presents two options for creating a dedicated transitway along First Avenue, given the many physical and operations constraints on the corridor, and explores their advantages and drawbacks. As noted earlier, First Avenue is a simpler and wider arterial than Second Avenue. This paper therefore focuses on First Avenue for its feasibility analysis.

The first option explored here is a bi-directional busway along the left-hand curb (see Figure A-1) of First Avenue. Under this alignment, First Avenue would have three ten-foot traffic lanes, and two 10.5-foot bus lanes. On blocks featuring busway "stations," the curb on one side would be widened by one foot, and an eight foot platform would be built in the roadway for northbound passengers. On blocks without stations, a two-foot sidewalk would separate the busway from the regular traffic lanes, and the other sidewalks would need to be narrowed proportionately. Where possible, left turn lanes and loading zones would be provided in the leftmost traffic lane.

This arrangement provides a separate right-of-way for BRT buses while minimizing the impact on other traffic. Because the curb bus lanes would be removed from First and Second Avenues, these lanes could be used for mixed traffic during the rush hour. And by significantly reducing the number of buses operating in mixed traffic, this proposal would help the traffic lanes operate more freely.

However, there are a number of ways in which it is less than ideal:

- The short block lengths mean that buses will still frequently encounter delays at intersections. Only if First Avenue is closed to cross traffic (except at key locations) will buses be able to attain significantly higher running speeds than the interior bus lane proposed above.

- If left turns are permitted, some safety precautions need to be provided. This would most likely require an additional traffic signal phase. But if an extra signal phase is added, this will shorten the effective green time for the busway.

- The two-foot sidewalk provided at the loading zones in this plan may not be adequate for the needs of delivery trucks, and may need to be widened. This would require further narrowing of the other sidewalks.

- There is not room to provide loading zones adjacent to the bus stations.

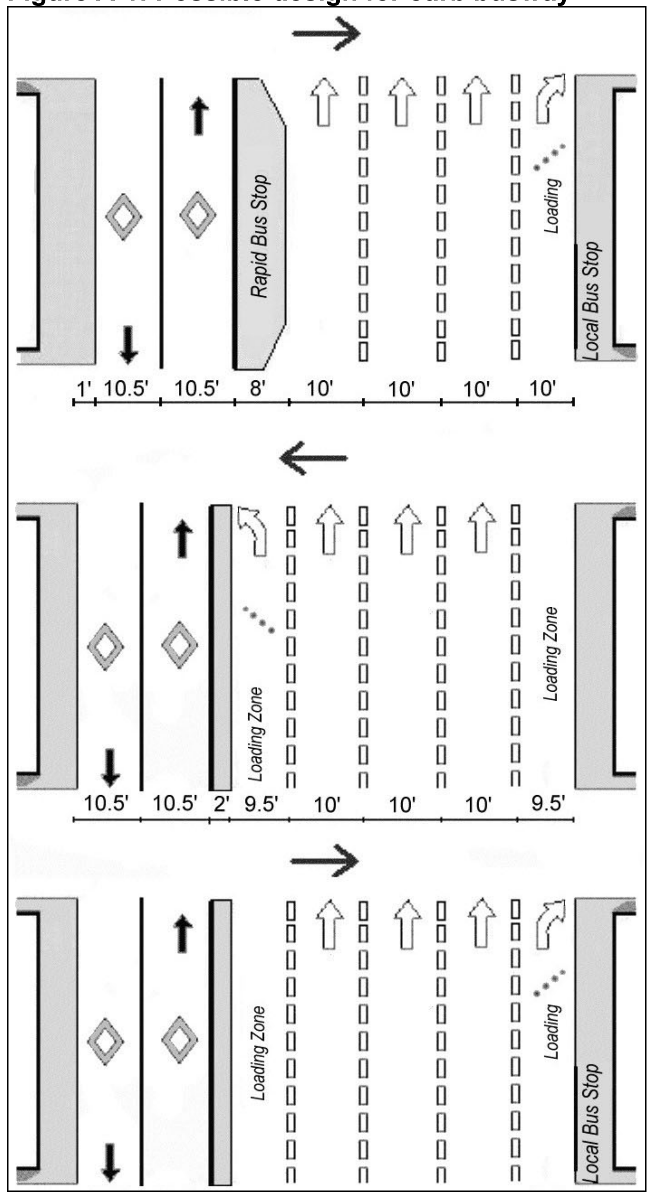
- There is a risk that pedestrians may step into southbound contraflow lane, unaware that buses might be coming from that direction. Partial pedestrian barriers and strong visual cues, such as alternately colored pavements, need to be provided to warn pedestrians of the potential danger.

- The busway is not wide enough to allow buses to pass one another, so local M15 service will need to run in mixed traffic. This will slow it down compared with current service, where it runs in a curb bus lane during rush hours on First and Second Avenue. Also, passengers would lose the convenience of having local and limited buses stop at the same locations.

- Southbound BRT service will be slowed because it will run counter to the progression of traffic signals on First Avenue.

- This proposal reduces by two the number of non-curb northbound traffic lanes on the East Side. As a result, during peak hours additional traffic will be diverted to Third Avenue, York Avenue, and the FDR Drive. There is no change in the number of traffic lanes on Second Avenue, but fewer buses running there will free up some additional street capacity.

Figure A-1: Possible design for curb busway

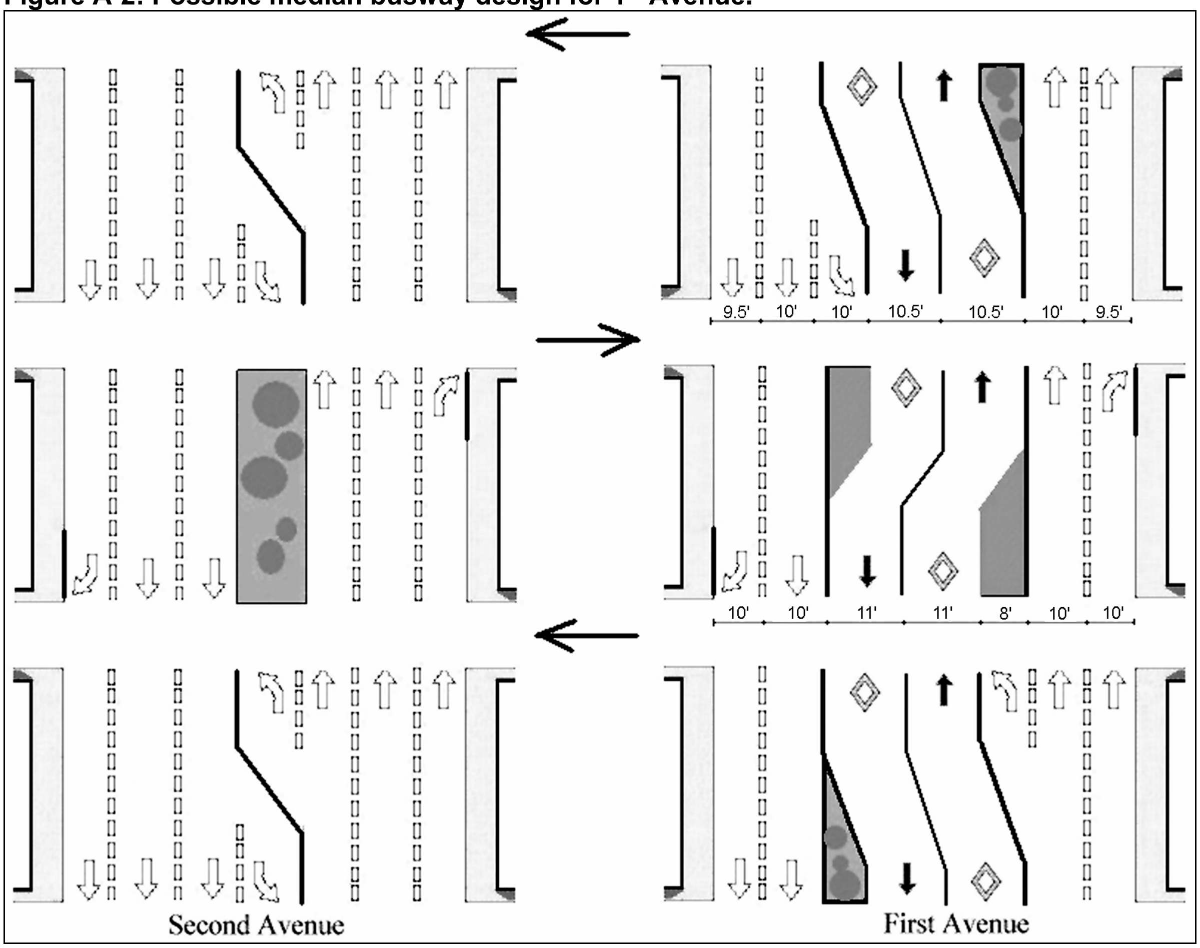


A second and more radical option is to create a bi-directional busway in the middle of First Avenue. To accommodate this, First Avenue would be converted to two-way travel, with two traffic lanes in each direction (see Figure A-2). The outermost lanes would be no-stopping zones during rush hours, but could be used for loading, parking, and right turns during off-peak hours. The median of the roadway would be converted to exclusive bus use, with platforms featuring advance fare payment and weather protection. On blocks without transit stops, left turn lanes could be provided as necessary.

To handle some of the northbound traffic displaced by the removal of lanes from First Avenue, Second Avenue would also be converted to two-way operation. Like First Avenue, it would feature curb lanes that would be reserved for traffic during the peak, but allow loading and parking during off-peak hours. It would also have two full-time traffic lanes in each direction. In Midtown, where the avenue has sufficient width for middle, seventh lane, left-turn bays or a tree-lined median could be provided as appropriate.[35]

Under this arrangement, the bus lanes will need to "wiggle" around the passenger platforms and left turn lanes (see Figure A-2). In station areas, assuming that buses will be moving at 20 miles per hour or less, it is possible to fit one bus length platform on each side of the busway and still provide room for buses to navigate the curve safely. But if double-length platforms are required, then the stations will need to be moved onto separate blocks. On blocks with left turn bays, buses will be moving faster – at least 30 miles per hour. In this case they'll need at least 150 feet

Figure A-2: Possible median busway design for 1st Avenue.



[35] On the Upper East Side, it will be more difficult to provide left turn lanes because Second Avenue is too narrow in most places. There is space to create left turn lanes at 112th, 113th and 115th Streets; otherwise any provision for left turns north of 59th Street would require the block-long removal of a curb lane. A similar situation exists south of 23rd Street, where the roadway is even narrower.

to navigate the curve safely.[36] For this reason, two left turn bays cannot be placed on the same block on First Avenue, as they can on Second Avenue. This will sharply reduce the number of intersections at which left turn lanes can be offered. On the positive side, it will create surplus space in the median, which can be used for plantings, or on blocks where an entire new lane becomes available, may be used as an additional parking lane.

The creation of a dedicated busway in the middle of First Avenue has several advantages over the previous proposal. It solves the safety problem associated with running a contraflow lane against the curb, as well as the problem of accommodating loading zones on the left side of First Avenue. It also fits more comfortably within First Avenue's existing 70-foot width.

More importantly, this option would transform the character of both First and Second Avenues. It would convert these two arterials from their current highway-like character to pedestrian-friendly streets more appropriate for a neighborhood setting. By narrowing the visible width of the roadway, providing green space, and encouraging vehicles to operate at slower speeds, it would create a safer and more pleasing urban environment for the neighborhoods it runs through.

However, these benefits are offset by several important drawbacks:

- As in the previous example, the short block lengths mean that buses will still frequently encounter delays at intersections, unless minor streets are closed to through traffic.
- If left turns are permitted, an additional traffic signal phase will be added, reducing the overall intersection capacity.
- Because of the absence of passing lanes, local and BRT bus services would have to be separated from one another. One option would be to provide local bus service in both directions on Second Avenue (in mixed traffic, or with rush hour-only curb bus lanes), and BRT service along the transitway on First Avenue.
- Because traffic will flow in both directions, this approach would eliminate the advantages of the wave-like traffic signal progression that keeps traffic flowing up and down the East Side. These would need to be replaced by a less-efficient traffic signal pattern.
- Most critically, this proposal eliminates two traffic lanes in each direction. This would have significant spill-over effects throughout the East Side, and may exacerbate traffic congestion and impede emergency vehicle response times during rush hours.

A precise conclusion is impossible without a full-scale modeling of traffic conditions on Manhattan's East Side. However, this dramatic a change in the character of First and Second Avenue would probably have significant ripple effects at least as far west as Park Avenue.

[36] Vehicles moving less than 40 mph, the distance needed to make this transition is $L=(WS^2)/60$, where W is the horizontal distance and S is the speed. In the case of the left turn lanes, where buses will be moving at about 30 miles per hour and shifting by 10 feet, the taper should be about 150 feet long. This does not leave enough room for two left turn bays in the same block. In the case of the platforms, buses will be moving at less than 20 miles per hour and shifting by only 8 feet. In this case, the taper can be as short as 50 feet long.

Moreover, the many problems detailed with these proposals, most notably the issues of numerous intersections and left turns further heighten the conclusion that the benefits of these proposals for bus travelers may not outweigh their costs. Given the significant benefits that a relatively simple interior lane and service enhancement approach would provide to bus users and other stakeholders, it is difficult to see a compelling case that a physically separated busway would provide enough additional benefits to justify its various costs and drawbacks. This report therefore recommends proceeding with an interior bus lane alignment for a BRT system on First and Second Avenues.

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