FTA RESEARCH

FEDERAL TRANSIT ADMINISTRATION

Peer-to-Peer Information Exchange on Bus Rapid Transit (BRT) and Bus Priority Best Practices

MAY 2012

FTA Report No. 0009
Federal Transit Administration

PREPARED BY

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U.S. Department of Transportation
Federal Transit Administration

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Metric Conversion Table

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC

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13. ABSTRACT

The purpose of this effort was to foster a dialogue among peers at transportation and planning agencies about their experiences with promoting public transit and, in particular, the challenges they face related to Bus Rapid Transit (BRT) projects, as well as the solutions they have developed in response. Agencies from dozens of large cities around the United States participated at three peer-to-peer exchanges in New York City, Los Angeles, and Cleveland. The facilitated discussions were structured to address the unique barriers to BRT implementation on the streets of dense and/or highly-congested large urban centers. Three major themes were the focus of the workshops: Network, Route and Street Design; Traffic Operations; and Building Political, Interagency and Stakeholder Support—BRT as a Driver of Economic Development. The results of the workshops make clear that better public transportation in general and BRT in particular can be cost-effective and useful tools for improving transportation and the environment and for restoring the livability of America's large cities.

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ABSTRACT

The purpose of this effort has been to foster a dialogue among peers at transportation and planning agencies about their experiences with promoting public transit and, in particular, the challenges they face related to bus rapid transit (BRT) projects, as well as the solutions that they have developed in response. Agencies from dozens of large cities around the United States participated at three peer-to-peer exchanges in New York City, Los Angeles, and Cleveland. The workshops focused on three major themes: Network, Route and Street Design; Traffic Operations; and Building Political, Interagency and Stakeholder Support—BRT as a Driver of Economic Development. The results of the workshops make clear that better public transportation in general and BRT in particular can be cost-effective and useful tools for improving transportation, the environment and for restoring the livability of America's large cities.

EXECUTIVE SUMMARY

Bus rapid transit (BRT) has generated great interest among large U.S. cities as they look for ways to improve mobility and accessibility as well as achieve a more efficient use of their street space, all at a relatively low cost. While there has been substantial success on these projects, the size and density of many U.S. cities has created unique challenges for implementing BRT, as does the age of the underlying infrastructure in many older cities. Issues such as traffic impacts, physical separation, and utility conflicts are of great concern and can often inhibit the fast and effective implementation of BRT in large cities, particularly within the central business district (CBD), or areas with mature road infrastructure and street grids developed more than a century ago.

The central feature of the BRT program at the Rudin Center for Transportation Policy and Management at New York University/Wagner was a set of facilitated discussions among practitioners from large U.S. cities. In organizing the workshops, the Rudin Center supported the Federal Transit Administration's (FTA's) objective of addressing the unique barriers to the implementation of exclusive BRT running ways on the streets of highly-congested, large cities. To support that objective, FTA seeks to:

- Identify agencies, economic enterprises, and other parties with a vital interest in promoting the more efficient use of traffic lanes.
- Engage such agencies and develop cooperative strategies among them based on shared goals and measurable economic costs and benefits.
- Support these strategies with engineering, economic, and planning expertise and documentation.
- Utilize the most advanced technology, financial instruments, and management techniques.
- Conduct and facilitate workshops and other exchanges among key agencies.
- Report findings plainly and quickly to FTA, the National Association of City Transportation Officials (NACTO), member cities, and the public.
- Reach out to interested large city agencies domestically and internationally

The major themes of each workshop were:

1. Network, Route, and Street Design
    - Integration with the entire transit network
    - Route planning and street selection
    - Street design to maximize dedicated right-of-way
    - Design and implementation of different running way configurations in large, dense and congested areas
    - Integration with walking and bicycling

2. Traffic Operations for Transit—Measures to Increase Ridership
    - Fare collection technology
    - Traffic signal priority
    - Dealing with BRT/general traffic conflicts
    - BRT and transit branding and marketing
3. Building Political, Interagency and Stakeholder Support—BRT as a Driver of Economic Development
    - Economic development potential of BRT in carefully-selected corridors
    - Political strategies for building consensus for BRT
    - Interagency and inter-jurisdictional work
    - Community and stakeholder outreach
    - Media/communications strategies
    - Working with community advocates

Though each workshop emphasized a different theme, many topics were covered during all three offerings. The intended participants for the three workshops were, respectively:

- Network, Route and Street Design – project directors and planners from highway and transit agencies
- Traffic Operations, Ridership Enhancement – traffic and transit operations staff and marketing specialists
- BRT as a Driver of Economic Development—Building Political, Interagency and Stakeholder Support – senior executives and/or project directors from city DOTs, planning departments, and regional transit agencies

The series of workshops explored the unique challenges of implementing BRT in the dense, highly-congested and physically-constrained environments found in most large central cities in the U.S. Presentations and discussions (and tours) demonstrated that BRT systems can provide substantial transportation and development benefits but that there are still many challenges and impediments to implementing them in central cities.

The results of the Peer-to-Peer Information Exchange on BRT and Bus Priority Best Practices program make clear that better public transportation in general and BRT in particular can be cost-effective, useful tools for improving transportation and the environment and restoring the livability of America's large cities. The reasons are numerous and cited extensively in the literature, but the benefits of BRT that were highlighted during the workshops from the perspective of central cities are:

- In highly-constrained, congested and transit-dependent places such as the urban cores of New York, Boston, Cleveland, and Los Angeles, BRT

has succeeded in increasing total transit. It has done so by providing the improved mobility for entirely new trips to be made and diverting significant numbers of existing trips from cars and taxis:

- In Los Angeles, 18% of the full-featured BRT Orange Line ridership came out of cars, and 33% of its users had cars available for their trips but chose to use transit. The percentage of riders using LACMTA's 27-corridor MetroRapid Bus–BRT Lite system that are new transit riders ranges from 4% to 16%, all in highly transit-dependent urban core corridors. These improvements are due, in part, to an average 23% increase in the speeds of buses.
- In New York's physically-constrained and congested Fordham Road Select Bus BRT Corridor, revenue bus speeds increased by more than 20%, while more than 10% of riders on the Select Bus service in that highly transit-dependent corridor were new transit users.
- In Cleveland, ridership on the HealthLine is about 30% new transit trips. In Boston, new-to-transit Silver Line Phase I ridership about two years after opening was more than 30%. Interestingly, more than 30 % of Silver Line Phase I riders previously used parallel MBTA subway lines.

SECTION 1

Introduction

The purpose of this effort, sponsored by the Federal Transit Administration (FTA), has been to foster a dialogue among peers at transportation and planning agencies about their experiences with promoting public transit and, in particular, the challenges they face related to bus rapid transit (BRT) projects, as well as the solutions that they have developed in response. Agencies from dozens of large cities around the United States participated in this peer-to-peer exchange and more can benefit from this effort via this report, which provides a synthesis of key findings and recommendations.

This was an important and valuable endeavor, given the increasing use of BRT service around the world over the past 25 years, and its recent proliferation in U.S. cities in particular. BRT has generated great interest among large U.S. cities as they look for ways to improve mobility and make more efficient use of their street space, at a relatively low cost. Projects such as the Metro Rapid system in Los Angeles, the HealthLine in Cleveland, and the Silver Line in Boston demonstrate the potential benefits of BRT.

While there has been substantial success on these projects, the size and density of many U.S. cities create unique challenges for implementing BRT, as does the age of the underlying infrastructure in many older cities. Issues such as traffic impacts, physical separation, and utility conflicts are of great concern and can often inhibit the fast and effective implementation of BRT in large cities, particularly within the central business district (CBD) or with mature road infrastructure and street grids developed more than a century ago. Large cities can also face unique challenges in areas such as public outreach, construction techniques, and interagency coordination. As major cities in the United States, Canada, and around the world have struggled with these issues and developed solutions, they have identified certain ideas and actions that have applicability in other locales facing similar challenges. Convening practitioners from these cities created an unparalleled opportunity to share lessons learned and strengthen BRT projects around the country.

The practitioner discussions convened for this project were complemented and supplemented by presentations and advice from outside experts in various relevant disciplines, including engineering, marketing and public outreach. These experts helped to frame the issues, discuss solutions used around the world and throughout the country, and provide expert opinions on the applicability of various options in different local contexts. This exchange took place through a series of in-person workshops, held in three different U.S. cities. It has been documented by the research team in order to develop a compendium of the discussions, including key findings, the options discussed and conclusions reached, and this final summary. As

a result, other practitioners and researchers beyond the workshop participants also stand to benefit from access to these materials.

In organizing the workshops, the Rudin Center for Transportation Policy and Management at New York University/Wagner supported FTA's objective of addressing the unique barriers to the implementation of exclusive BRT running ways on the streets of highly-congested, large cities. To support that objective, FTA seeks to:

- Identify agencies, economic enterprises, and other parties with a vital interest in promoting the more efficient use of traffic lanes.
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- Reach out to interested large city agencies, domestically and internationally.

SECTION 2

Methodology

The central feature of the Rudin Center program on BRT was a set of facilitated discussions among practitioners from large U.S. cities. The project featured three one-and-a-half-day workshops, each in a different city and organized around a specific theme with multiple sub-topics. Though each event included relevant formal presentations and lectures, the workshops were designed to provide ample opportunity for peer-to-peer information exchange.

The entire program was planned in consultation with a steering committee comprising representatives from many of NACTO cities—Chicago, Los Angeles, New York, Philadelphia, San Francisco, Seattle, and Washington, D.C. At least one conference call with the steering committee was held prior to each of the three workshops.

The steering committee determined that the workshops should (1) document best BRT practices from the real world as to how running ways, stations, and other physical elements can be successfully configured in complex urban contexts; (2) cover topics that were most pertinent to NACTO members, many of which historically are road-, bridge-, and traffic-oriented agencies; and (3) focus the topics at each workshop to match agency structure (e.g., signals being separate from street design) so that each participating agency could send the one or two people for whom the theme and topics would be most relevant. Mindful of these design constraints, the Rudin Center team proposed, and the steering committee adopted, themes for each of the three workshops. The major themes were:

1. Network, Route and Street Design
    - Integration with the entire transit network
    - Route planning and street selection
    - Street design to maximize dedicated right-of-way
    - Design and implementation of different running way configurations in large, dense and congested areas
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    - Economic development potential of BRT in carefully-selected corridors

- Political strategies for building consensus for BRT
- Interagency and inter-jurisdictional work
- Community and stakeholder outreach
- Media/communications strategies
- Working with community advocates

Though each workshop emphasized a different theme, many topics were covered during all three offerings. The intended participants for the three workshops were, respectively:

- Network, Route and Street Design – project directors and planners from highway and transit agencies
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New York City, Los Angeles, and Cleveland were chosen to be the host cities for the three workshops. While all could showcase successful BRT implementations and would offer participants the opportunity to make instructive site visits, each one, because of its particular circumstances, was particularly relevant to one of the three workshop themes. New York's routes demonstrated ways to implement and operate BRT within severe physical and operational constraints; Los Angeles had the most advanced technology for signal prioritization and traffic management and a world-class branding and marketing program; and Cleveland exemplified the building of broad political and stakeholder support for BRT and its use for the economic renewal of central city corridors.

At each workshop, a keynote speaker addressed that workshop's theme, and the keynote was followed by either moderated panel discussions or by additional presentations that enriched consideration of the theme. Field trips in all three cities, including travel on the BRT routes, gave participants first hand-experience with the vehicles, stations, and other elements of BRT lines. Each event also featured extensive peer-to-peer discussion periods. At the New York and Los Angeles workshops, the discussion topics were selected by the participants using a technique known as "open space technology" (in Cleveland, the discussion topics were selected in advance). The open space approach provides a time prior to the discussion period during which any participate can declare his/her desire to host a discussion on a particular topic; after all such topics have been listed, they are examined for possible consolidation, and after the hosts have agreed to a final list, locations for the various discussions are assigned and all participants are free to spend as much time as they like at any of them. At every workshop, two or more experts—drawn from among either the participants or the invited presenters—were assigned to each discussion group to serve as resources.

SECTION 3

Results

New York City: Integrating BRT into Constrained Central City Environments

On April 6, 2010, more than 35 NACTO representatives attended the first of the three BRT workshops. Convened by the Rudin Center, this workshop focused on Bus Priority Best Practices. It included topics such as the design and implementation of different running-way configurations in large, dense, and congested urban areas with mature, 19th century (or older) infrastructure and street grids. The workshop was structured to allow additional discussions of issues such as dealing with utility conflicts, integration with other modes (i.e., light rail, subway, bicycles and pedestrians), accommodation of vehicular conflicts, construction techniques, and others.The participants had the opportunity to hear from leaders in the field, learn from a series of elucidating case studies, and share strategies and best practices.

New York City Department of Transportation (NYCDOT) Commissioner Janette Sadik-Khan delivered the keynote address, providing a brief overview of NYCDOT's BRT initiatives as well as the advantages of BRT systems across the United States and elsewhere. Samuel Zimmerman, transportation consultant to the World Bank and AECOM, discussed the importance of considering contextual elements during BRT design and implementation. Case study presentations on Guadalajara, London, Boston, and New York followed.

Steve Palmer from Transport for London (TfL) noted the physical, fiscal, and political constraints that TfL had to overcome to introduce bus priority and other features common to BRT—though that term is not used in London. Rather, TfL has focused on improving bus services more broadly, offering an example to cities considering the adoption of certain BRT elements, in particular cities with old street grids such as London or New York. The Silver Line in Boston offered yet another perspective, as a route that runs partially on an exclusive lane and partly through a traditional, pedestrian-heavy neighborhood. An important lesson from Boston was the need to plan for connectivity between lines.

In contrast, Dario Hidalgo, speaking about lessons from Guadalajara, Mexico, noted a number of elements of "high-end BRT," some of which may be applicable to cities with relatively newer infrastructure and/or broader streets. He discussed segregated median busways in the center of the roadway; stations where passengers feel protected, with pre-payment features and level boarding; good quality, large buses with multiple wide doors (to reduce boarding and alighting

time); centralized control of bus operations; distinctive image and branding; and Intelligent Transportation Systems (ITS) to complement traffic engineering.

In New York, a major objective was increasing bus revenue and speeds and, after an in-depth analysis of bus travel times, NYCDOT focused on decreasing the amount of time buses spent at rest, both during passengers' boarding and alighting and at red lights. Off-board payment and transit-priority at traffic signals have yielded significant savings (20% +) in end-to-end route travel times and reliability improvements.

In the afternoon, participants identified three topics for the "open session," which included small group discussions: BRT on narrow streets; public outreach; and BRT vehicle maintenance and operations issues. On April 7, participants toured the site of the Select Bus Service (SBS) line in the Bronx as well as sites for new services on First and Second Avenues in Manhattan.

Los Angeles: Traffic Operations for Transit/BRT and Implementation

On June 28–29, 2010, close to 35 transportation practitioners attended the second of three workshops, hosted by the Los Angeles Department of Transportation (LADOT) with support from the Los Angeles Metropolitan Transportation Authority (Metro). This workshop highlighted the implementation of BRT services in the Los Angeles region and focused on design, public perceptions, ridership, branding, traffic engineering, and operations including traffic signal prioritization, fleet supervision, and system control.

During the first day of the workshop, Rex Gephart, then Director of Regional Transit Planning at the Los Angeles Metropolitan Transportation Authority (Metro), the transit operator in Los Angeles County, discussed the planning and implementation of LA's hierarchical bus network. He noted four major lessons for BRT operators: provide time-competitive door-to-door service (e.g., using bus signal priority, less frequent stops, faster boarding and alighting,); operate frequent service (10-minute or under headways during peak hours); deliver consistent departure intervals and travel times; and build a ubiquitous network that serves the many major activity centers that characterize land use in LA. He then led a guided tour of the LA Metro Bus Operations Control Center and of different lines (Metro Rail, Silver Line, BRT Line on Wilshire Boulevard, and Orange Line).

On day two of the workshop, LADOT Senior Transportation Engineer Kang Hu shared his agency's perspective on transit in general and BRT in particular. LADOT is not only responsible for its core function of traffic signal operations, but also directly provides public transportation services, assists LA Metro with its bus operations, and has partnered with Metro in the National BRT

Demonstration Program since 1997. LADOT and Metro have been working together to improve bus speed in 25 Metrorapid Bus ("BRT-Lite") corridors. LADOT is also responsible for traffic safety, which became a specific issue in 2005 after the Orange Line was launched and experienced some high-profile safety problems at several intersections.

LADOT introduced a Transit Priority System (TPS), a centralized signal priority system that was fully integrated with LA's existing Adaptive Traffic Control Traffic Control System (ATCS). The benefits of TPS are significant. Compared to previous services, Metro Rapid buses have achieved a 25% reduction in total travel time, and approximately 30% of the total travel time saving is attributed to TPS. Additionally, the delay to other vehicles caused by TPS is only about one second per vehicle per cycle, which is hardly noticeable.

The next speaker was Al Martinez, supervising engineer in the operations group of LA Metro. In 2004, he and his team recognized the need for vehicle information and implemented the Advance Transportation Management System (ATMS), replacing vehicle information infrastructure with voice annunciation systems and automatic passenger counting systems, voice radio and data, switching head signs and installing side signs, and developing bigger terminals.

Using the "open space" approach, participants selected three topics for the small group peer-to-peer discussion: standards and guidelines; branding and information; and TPS benefits and data matrices.

Cleveland: Building Political, Interagency and Stakeholder Support—BRT as a Driver of Economic Development

Held October 14–15, 2010, the Cleveland BRT workshop, the third and final one in the series, brought together more than 50 participants, including senior transportation officials from 16 cities around the U.S., along with public transportation planners, traffic engineers, and BRT experts from the private sector, non-governmental organizations, and all levels of government. Convened at the headquarters of the Greater Cleveland Regional Transit Authority (GCRTA), this workshop focused on BRT project implementation, including strategies for building public and private sector support, attracting new riders and using BRT to induce economic revitalization in central cities.

Conference participants learned about best practices in public transport, sustainable development planning, and implementation from panelists hailing from locations as varied as Montgomery County in Maryland, Cleveland, and York (Ontario) and from participants from cities as diverse as Chicago,

Eugene (Oregon), and Phoenix. Attendees also visited the successful Cleveland HealthLine BRT and discussed the common challenges facing BRT projects around the country. The combination of presentations, three moderated panel discussions, peer-to-peer breakout sessions and a site visit provided a range of opportunities for conference participants to gather information, ask questions, and network with their counterparts from around the county.

Recurring themes throughout the Summit were the significance of stakeholder outreach, communications, system branding, and the power of well-designed BRT systems to transform a central city corridor and bring economic vitality to surrounding communities.

Keynote speaker Enrique Peñalosa, former Mayor of Bogotá, Colombia, and current Board President of the Institute for Transportation and Development Policy, listed the key challenges in winning support for BRT implementation: overcoming perceptions that buses are an "inferior" form of transit, through branding and aesthetic upgrades; making the political case that a BRT system is an infrastructure improvement project; garnering the support of private real estate investors; and convincing the public that re-allocating space away from cars for BRT use is equitable and democratic and helps create a sense of place and community.

As part of a panel on the political dimensions of BRT, GCRTA General Manager Joseph Calabrese pointed out that many citizens, politicians, and business people in Cleveland now attribute the rebirth of the Euclid Corridor to the HealthLine services. Key design features of the system include broader pedestrian corridors, bicycle lanes, and streetscape treatments at stations and along the corridor, as well as the integration of public art. All of these features combined have helped to attract new development and supported commercial activity in the urban core during hard economic times.

Marc Elrich, a Councilmember on the Montgomery County Council in Maryland, represents a burgeoning suburban county just outside of Washington, D.C., and it is this context that helped him recognize the need to consider a quick-to-launch transportation solution like BRT, rather than a rail system extension that would take a much longer time and resources. Elrich has gained broad community support for BRT by highlighting its cost-effectiveness and modest cost and how this would minimize the need for increasing the tax burden. He also generated buy-in from business leaders by convincing them that the BRT services would benefit development by improving accessibility and mobility throughout the county, where increasing congestion is accompanied by efforts to manage growth. Such support gains significance in times of declining real estate values and financial constraints.

Janette Sadik-Khan, Commissioner of NYCDOT, joined the discussion and agreed with Calabrese and Elrich on the power of the cost-savings argument

when building support for BRT services and noted the importance of seamless connectivity to other transportation systems in gaining new transit riders.

A panel on federal programs featured Matt Welbes, Deputy Administrator at the Federal Transit Administration; Homer Carlisle, the American Public Transportation Association (APTA)'s Senior Programs Manager for Planning and Programs; and Linda Bailey, NYCDOT's Federal Programs Advisor. Welbes noted that the Cleveland HealthLine is the largest federal investment in BRT so far, and its success should help build support for projects in other locations. He also pointed out that in the age of YouTube, it is easy to dispel the sense of exoticism that sometimes surrounds the BRT concept by viewing BRT systems in Cleveland, Eugene, or another city on the Internet. Carlisle enumerated several arguments for Congressional support, including the fact that BRT works in cities of all sizes, and, of course, the comparatively low costs will appeal to a Congress interested in reducing government spending.

Following the panel, participants chose among three different breakout discussion sessions:

- Strategies for Marketing And Outreach
- Planning BRT to Improve the Overall Transit Customer Experience and Measuring Success
- Political Leadership, Communications, and Public Involvement Strategies

Each group featured several peer facilitators who served as resources and guides throughout these thought-provoking, productive conversations.

On the second day, GCRTA's Deputy Project Manager of Engineering and Project Management, Michael Schipper, spoke about how the HealthLine was planned and developed and noted its technical features in detail. He reiterated a key point that Joe Calabrese made the day before: the system represented much more than a bus line; it was an urban core infrastructure investment that supports Cleveland's economic development.

The subsequent panel brought in the voices of the commercial and business interests on the corridor and the perspective of "anchor" institutions. During a moderated discussion and question-and-answer session, the panelists discussed BRT as a tool for economic development in struggling urban corridors and the role of partnerships in getting the new system planned, funded, and implemented as part of a larger city infrastructure rehabilitation plan. Panelists included Debbie Berry, Vice President of Planning and Real Estate Development, University Circle Incorporated; Thomas Einhouse, Vice President, Playhouse Square Real Estate Services; Joe Marinucci, President and CEO, Downtown Cleveland Alliance; and Jeff Pesler, Assistant Director, MidTown Cleveland Inc.

The event concluded with a visit to the Euclid Corridor on a HealthLine vehicle with stops at the various commercial and institutional hubs introduced during the morning panel, such as the Cleveland Clinic and University Hospital. The HealthLine route runs 6.8 miles of Euclid Avenue from Downtown to East Cleveland, connecting the city's cultural and educational institutions, medical, and business centers and "mom-and-pop" shops located along its 58 stops.

SECTION 4

Conclusions

The series of workshops explored the unique challenges of implementing Bus Rapid Transit in the dense, highly-congested, and physically-constrained environments found in most large central cities in the U.S. Presentations, discussions (and tours) demonstrated that BRT systems can provide substantial transportation and development benefits but that there are still many challenges and impediments to implementing them in central cities.

The following synthesis includes challenges and recommendations for addressing them:

- General public, political and media skepticism about anything to do with the bus mode, and the lack of natural supporting lobbies akin to rail car manufacturers, engineering consultants and rail fans.

  Recommendations:

  – Use an aggressive communications program to demonstrate the benefits of BRT such as its affordable cost effectiveness at addressing a broad range of mobility and economic development objectives.

  – Treat BRT as a distinct rapid transit system, not just another bus route and market it accordingly by demonstrating aesthetic improvements to stations and that the buses can also look great and offer a comfortable riding experience. Make sure all its elements are branded as such, not just for "advertising value" but to inform new riders of BRT's unique features.

  – Plan and build a network that connects disparate major generators of travel and activity centers together and is deemed attractive because it provides competitive door-to-door travel times (e.g., using dedicated lanes, bus signal priority, less frequent stops, faster boarding and alighting); operates frequent service (e.g., 10–12 minute or under headways at all times); delivers consistent departure intervals and travel times.

  – Educate the real estate sector and other investors about the potential of BRT services and stations to provide focal points for sustainable urban development, with higher rent and sales values than elsewhere in the urban centers. Use pedestrian and streetscape improvements along with BRT development to reinforce the message that BRT is about infrastructure improvements.

- Lack of understanding on the part of elected officials, the general public, the private sector, and even transport professionals as to what BRT actually is (not "just another local bus route" or even express bus route), what it can

do, and the planning and development process and system elements that are critical to BRT's success.

Recommendations:

– Begin an aggressive, ongoing communications program early in the planning process to educate public officials, other stakeholders, and the media about the key features and benefits of BRT system; continue it throughout the planning and implementation process.

– Implement an ongoing consultation process with all stakeholders in the public sector (e.g., police), the private sector (e.g., merchants, real estate interests), and the general public as part of planning and implementation to address concerns as early as possible.

– Explain and/or document the benefits of BRT to particular sectors of society and various and different stakeholders, ranging from the surrounding communities, educational institutions, commerce and industry, the real estate sector, and others.

- Physically constrained rights-of-way and operational constraints posed by the significant general traffic and pedestrian volumes found in the cores of the largest U.S. cities.

Recommendations:

– Make sure that everyone understands that dedicating scarce street space to transit is democratic, i.e., public transport users have a right to expect that available space is allocated based on people, not vehicles, moved, when operationally feasible.

– Use a variety of transit operations (e.g., fewer stops, improved dispatching and scheduling with ITS, off-board fare collection) and traffic engineering strategies (e.g., "virtual" bus lanes, various types of signal priority, turn prohibitions) to increase transit revenue speeds even in the absence of sufficient road space to allocate to transit.

– Focus on improving bus service more broadly, adopting some but not necessarily all BRT features in many high-volume corridors such as London ("Quality Bus" corridors), LA (MetroRapid Bus), and NYC (Limited Stop Routes) have done.

- Competing priorities for scarce municipal transportation resources.

Recommendations:

– Treat the BRT project as an overall urban infrastructure upgrade that can then enhance the viability of the city (exemplified by Cleveland) and generate net income and economic activity for the city.

– Gain the support of a broad range of constituents, starting by identifying key parties that will act as champions and "anchor" the initiative during budget debates.

Participants in the workshops also learned about and discussed the difficulties of "getting it right the first time." These difficulties included a hostile media, politically-motivated implementation time constraints, unexpected costs and construction issues, and poor execution of well-thought-out plans. Luckily, for almost all case studies presented and discussed, local, regional, and state officials were able to overcome initial, short-term issues (e.g., public understanding of the honor off-board fare collection system in NYC, intersection traffic operations and safety issues in LA) and move to general- recognized success.

The workshop venues, the presentations, and the discussions provided excellent examples of how these challenges could be overcome and how BRT systems generating significant benefits could be planned, designed, and successfully implemented.

Lessons learned from successful central city BRT applications include:

- Because, in most cases, the main challenges to implementing BRT are political, it is important to gain the support from a strong, motivated, and knowledgeable champion(s); in most cases, a politician such as a mayor or city council chair (e.g., LA, New York, London); in some cases, senior officials such as transit agency heads (e.g., Cleveland, New York, Boston), city DOT commissioners (e.g., LA, New York), and/or state DOT secretaries (Boston, Guadalajara).
- Institute an aggressive, comprehensive public involvement and communications program, including a strong branding element (e.g., LA, New York, Toronto-York).
- BRT project planning and development is a truly cooperative effort of the respective (often regional) transit agency and city DOT (e.g., New York, LA); reflecting that cooperation, a planning and project development process can be carried out by a "seamless" team of city DOT and transit agency personnel, where professionals from each respective agency have an appreciation for the issues and concerns of the other and together provide a holistic array of skills and experience.
- Two-way communications should be a key part of every BRT planning, design, and implementation effort. Outreach programs directed to politicians, the private sector, and the general public can be critical to getting the first BRT line funded, built, and brought into operation. Making sure everyone (general public, business community, politicians) understands what BRT can be (high-performance, high-quality rapid transit) and what it is not (just another bus route) is important in gaining political support. At the same time, the varied interests and concerns of all stakeholders must be addressed in some way in detail during planning and design if a project is to move forward.
- Successful communications efforts use a variety of techniques, including focus groups and workshops, public meetings, surveys, and various media. LA and New York both illustrate that nothing breeds success like success.

The well-publicized successes of the LACMTA/LADOT's MetroRapid Bus lines on Wilshire and Whittier boulevards and the NYCT/NYCDOT Fordham Road Select Bus Route created momentum and support for subsequent funding and development of, respectively, LA's 27-corridor MetroRapid Bus system and Orange BRT Line and New York's new (10/10/10) 1st and 2nd Ave BRT line and funding for Nostrand Avenue in Brooklyn.

- Early involvement of the business community, both to avoid conflicts over station locations, parking, and right-of-way issues and to prepare the way for economic development, which requires a comprehensive public/private approach (Cleveland, Montgomery County in MD, Boston).
- When properly done, BRT can both provide much higher quality and performance in public transport for existing transit riders and attract new trips to transit, even in highly transit-dependent communities like the Bronx and Manhattan in New York and Cleveland's Euclid Corridor.
- BRT can demonstrate improvements in three important public transport performance benchmarks: capacity, travel time, and comfort. While even long bi-articulated buses have a lower per-unit capacity than subway trains, they run more frequently to carry the same number of people (especially at peak hours), thus reducing onerous waiting and transfer times. Travel time metrics should consider the passenger experience—by spacing stations closer together and minimizing the time to transfer between services, the origin-to-destination time spent by riders can be improved. Off-board fare collection, precision docking to guide wheels for no-gap, level boarding, and use of multiple doors all reduce passenger boarding and alighting times and, thus, overall travel times. BRT can also create a comfortable environment for its passengers, and that is important to its success; users enjoy natural light and views of the cityscape and do not need to take stairs or escalators to access and egress stations.
- In addition, a number of other features contribute to enhance the passenger experience. As illustrated by the Cleveland HealthLine, touch-screen kiosks, real-time information displays, emergency call boxes and security cameras at stations, and improved design elements at stations, including seating and architecturally pleasing arches and glass partitions to weatherproof each facility, all contribute to the comfort of passengers.
- Other metrics to consider are connectivity, funding possibilities, costs (capital and operating), and economic development potential. When comparing costs of running BRT services, it is important to note that shorter travel times means higher driver productivity, yielding increased service frequency with the same number of vehicles, drivers, and mechanics and, thus, savings on operating and maintenance costs.
- A BRT system package uses creative physical and service design, ITS applications, and traffic engineering/management to deal with the physical and operational constraints so prevalent in central city environments (e.g., LA, New York).

- Attention to detail and quality in all system elements (e.g., Cleveland, LA), including station architecture and art and BRT vehicle liveries and interiors. BRT stations can serve as focal points for the revitalization of central city communities as well as for new, more sustainable suburban development, especially when combined with other public investments and policies (e.g., sidewalk, bikeway, streetscape and landscape improvements, zoning incentives, tax abatements).

Recommendations

The results of the Peer-to-Peer Information Exchange on BRT and Bus Priority Best Practices program make clear that better public transportation in general and BRT in particular can be cost-effective, useful tools for improving transportation and the environment and restoring the livability of America's large cities. The reasons are numerous and cited extensively in the literature, but the benefits of BRT that were highlighted during the workshops from the perspective of central cities are:

- In highly constrained, congested, and transit-dependent places such as the urban cores of New York, Boston, Cleveland, and Los Angeles, BRT has succeeded in increasing total transit. It has done so by providing the improved mobility for entirely new trips to be made and diverting significant numbers of existing trips from cars and taxis.
  - In LA, 18% of the full-featured BRT Orange Line ridership came out of cars, while fully 33% of its users had cars available for their trips but chose to use transit. The percentage of riders using LACMTA's 27-corridor MetroRapid Bus "BRT Lite" system that are new transit riders range from about 4% to as high as 16%, all in highly transit-dependent urban core corridors. These improvements are due, in part, to an average 23% increase in the speeds of buses.
  - In New York's physically-constrained and congested Fordham Road Select Bus BRT Corridor, revenue bus speeds increased by more than 20%, while more than 10% of riders on the Select Bus service in that highly transit-dependent corridor were new transit users.
  - In Cleveland, ridership on the HealthLine is about 30% new transit trips. In Boston, new-to-transit Silver Line Phase I ridership, about two years after opening, was more than 30%. Interestingly, more than 30% of Silver Line Phase I riders previously used parallel MBTA subway lines.
- Transit ridership gains translate to fewer vehicles on the road with commensurate decreases in congestion, noise, and emissions and increased city life. Besides increasing transit's competitive attractiveness, transit revenue speed increases also translate to lower bus operating costs and emissions.
- In Boston and Cleveland, one of the objectives of BRT was the revitalization of inner-city neighborhoods. Success can be measured in the $750 million+ (Boston) and $4 billion+ of development that would probably not have

> otherwise occurred in the sustainable urban core locations of, respectively, the Silver and HealthLine corridors. This development translates to more mobility with fewer cars today and in the future and healthier central cities—the financial, government, cultural, entertainment, and educational capitals of our country.

One of the surprises of the program was the thirst for public transport knowledge-sharing, information exchange, and networking on the part of transportation officials in large central cities. Historically, city transportation officials have been focused on road, street, and parking planning, implementation, operations, and restoration. Interests outside of physical issues were limited to traffic engineering for vehicles and safety. Even though the roadways and streets under their purview are the "running ways" for the respective bus system and, thus, critical to its success, transit was seen as someone else's problem. Most city DOTs were, and are, very supportive of transit improvement initiatives undertaken by regional transit agencies; however, it is unusual for city DOTs to drive transit innovation themselves other than in the cases where there is a city-owned and -operated transit system.

This has changed in recent years, as city DOTs in places as diverse as New York, LA, Washington, and Baltimore are initiating new, exciting transit programs, most often with their transit agency partners but sometimes even independently. More and more regional transit networks are being reorganized along functional lines, with local neighborhood and major activity center bus and rail circulators complementing the regional network of trunk bus (e.g., BRT) and rail lines serving longer, cross-jurisdiction trips. Ownership of the former is often assigned to individual municipalities, while regional transit agencies coordinate all transit services, fares, and major investment planning/development activities and directly implement and operate services of regional significance.

One issue that was raised during the peer-to-peer sessions is that there is no comprehensive national database exclusively for BRT, despite the fact that FTA requires reporting for a National Transit Database (NTD). Reporting on the supply, demand, and performance of BRT services is included with data for bus systems as a whole. Therefore, the FTA staff managing the NTD are considering how to work with grantees to collect data specifically on BRT to permit benchmarking for new BRT projects and increase awareness of what BRT can and cannot do.

The open discussions that were part of every workshop emphasized this emerging trend and illustrated the emergence of a new city DOT transit constituency. It is clear that new transit capacity-building programs aimed at DOT policy leadership and the traditional highway and traffic senior management and engineers who make up the bulk of city DOT professionals would be very well received indeed.

Accordingly, building on the success of the Peer-to-Peer Information Exchange Program on BRT and Bus Priority coordinated by the Rudin Center, FTA might consider supporting a program for a more comprehensive capacity-building agenda specifically addressing the needs of a central city DOT constituency and others in the transit community as well. Such an endeavor should be coordinated by an independent organization with strong capacity-building credentials, in cooperation NACTO to ensure the best results.

Subjects to be covered by one or more series of mid-to-long-term programs might include but need not be limited to:

- Key considerations in transit planning, operations, and management, with an emphasis on hierarchical transit systems, including BRT.
- BRT and transit system integration.
- Context-sensitive road, street, and sidewalk design to facilitate transit.
- Traffic engineering and operations to provide public transport priority and improve its quality of service and safety.
- Transit-oriented site planning in central cities.
- Central city access and parking management to improve transit performance and reduce auto use.
- Communications, public participation in BRT, and transit planning, design, and marketing, including branding.

The intent of such an initiative is not to replicate what others have done or are doing with regard to transit capacity-building, but to focus on the central city constituency (transportation, development planning officials). This group is so important to transit's future success but has not been specifically targeted before. Moreover, the intention is not to offer general "basic training" but to emphasize those factors important to the success of full-featured BRT and other higher-order bus-based transit systems.

Activities, leveraging those undertaken by broader-purpose institutions such as the National Transit Institute, the National BRT Institute, and the Eno Foundation, would include workshops and seminars, study tours, and peer-to-peer exchanges. The difference from other programs would be that everything would be specifically targeted to a central city audience largely made up of mid- and high-level policy, managerial, and technical people who traditionally have been without the strong technical transit and BRT skills needed to move that important sector forward.

APPENDIX

A

New York Workshop Summary

"New York Bus Rapid Transit Summit: Integrating BRT into Constrained Central City Environments"

Sponsored by the Federal Transit Administration, USDOT
Presented by the National Association of City Transportation Officials (NACTO) and the NYU Rudin Center for Transportation Policy and Management

Overview

On April 6, 2010, approximately 36 representatives from the National Association of City Transportation Officials (NACTO) attended the first of the three workshops on Bus Rapid Transit (BRT) and Bus Priority Best Practices. With support from the Federal Transit Administration (FTA), the workshop was organized by the NYU/Wagner Rudin Center for Transportation Policy and Management in collaboration with NACTO. Convened at the Kimmel Center of New York University in New York City, this workshop was planned to discuss topics focusing on the design and implementation of different running way configurations in large, dense, and congested areas. The workshop was structured to allow additional discussions of issues such as utility conflicts, integration with other modes (i.e., bicycles and pedestrians), accommodation of vehicular conflicts, construction techniques, and others. The participants had the opportunity to hear from leaders in the field, learn from a series of elucidating case studies, and share strategies and best practices.

The Commissioner of the New York City Department of Transportation (NYCDOT), Janette Sadik-Khan, delivered the keynote address, providing a brief overview of NYCDOT's BRT initiatives. Sam Zimmerman, a noted expert consultant to the World Bank and AECOM, talked about the importance of considering contextual elements during BRT design and implementation and helped set the tone for the day's discussion. In addition, the workshop featured dialogue around four case study presentations. In the afternoon, Allen Zerkin, Adjunct Associate Professor of Public Administration at the NYU Robert F. Wagner Graduate School of Public Service, a designer and facilitator of the workshop, led the conversation to determine topics that participants wanted to discuss in small groups. Those discussions and subsequent reporting by each

group to the entire group culminated the day's workshop. Throughout the event, attendees discussed the advantages of BRT and its challenges, and the importance of understanding context when formulating plans. On April 7, participants were invited to tour the sites of several BRT initiatives in New York City. The following provides a detailed summary of the event's presentations and discussions.

Keynote Address: "BRT in New York City"
Janette Sadik-Khan, Commissioner, NYCDOT

New York City Department of Transportation Commissioner Janette Sadik-Khan linked BRT to the agency's goal of improving the country's largest, and slowest, bus system. NYCDOT has formed a partnership with the Metropolitan Transportation Authority (MTA) to advance BRT in New York City. The Rudin Center Team identifies such partnerships and inter-agency collaboration as a significant element to consider when promoting BRT projects. Ms. Sadik-Khan mentioned that NYCDOT views the city's streets as the tracks for the bus system. While the agency does not run the buses (MTA's NYC Transit does), it can reconfigure streets to increase the speed, efficiency, and ridership of the bus network. Technology and design are important elements of creating a fully integrated, rapid and reliable system.

The NYCDOT's approach to BRT thus far is called Select Bus Service (SBS), and the agency has been working with MTA's New York City Transit (NYCT) to implement it. SBS is not "true" BRT, as it does not have its own right-of-way, but it is proving to be a significant way to improve bus service. The BX12 SBS route on Fordham Road in the Bronx is the NYCDOT's and NYCT's first major foray into SBS implementation. The key elements of the SBS service include off-board fare collection, transit signal priority, and distinctive branding. Off-board fare collection was not easy to implement, but it is yielding 30% time savings without being a drain on revenues. Key to implementation of a proof-of-payment fare collection system is the philosophy of respecting customers and assuming that, in most cases, people are honest and will pay to use the system. Transit signal priority has also been found to be critical in boosting bus speeds and efficiency. As a result of these efforts, ridership in this corridor has increased by 30%, travel time has decreased by 24%, and rider satisfaction is at an unprecedented 98%. Reducing the rest time of buses during operation is an immediate way to increase bus speed, regardless of the bus lane configuration.

Building from this success, the Commissioner announced NYCDOT's plans for a fully-dedicated bus lane on 34th Street and for introducing SBS service on the critically-overcrowded 1st and 2nd Avenues corridor in Manhattan in the fall of 2010. The agency is effectively adding 16 miles of dedicated bus programming in the corridor, currently the M15 bus route. This service features three-door articulated buses running on an interior bus lane so that

the vehicles do not get trapped behind parked cars. NYCDOT plans to install bus bulbs by 2011.

One strategy worth considering when developing BRT programs in dense urban areas is to start with a handful of service lines that can showcase the benefits of BRT. Once the benefits are demonstrated, it is easier to gain support for extending BRT services to other areas.

Commissioner Sadik-Khan concluded her address by emphasizing three aspects of SBS services. First, she pointed out that the provision of SBS is part of balancing the needs of different street users, characterizing NYCDOT's initiative as a "third mobility network" to provide safe and sustainable transportation options in New York. Based on best practices from the European experience, NYCDOT is developing better ways to deal simultaneously with various issues, including parking, protected bike lanes, pedestrian safety, and public transit. Second, she stressed that low-cost changes that can be implemented quickly are a vital way to enhance mobility, as people are tired of waiting years and decades to see improvements. Last, the Commissioner emphasized the importance of an institutional framework, such as Mayor Bloomberg's PlaNYC, which enables agencies to act innovatively to make progress on important goals. The Sustainable Streets 2009 plan, emphasizing the safety and mobility of NYC's streets, is NYCDOT's blueprint for moving forward.

"Introduction to Case Studies: Key Elements of BRT Services"

Sam Zimmerman

Before the case study presentations, Sam Zimmerman, a well-known transit systems expert and a consultant to the World Bank, provided a broad overview of BRT. He defined BRT as a permanently-integrated and high-performance system with a quality image and a strong brand identity. He emphasized that "flexibility" is a key attribute of BRT; that is, its service can range from a "lite" system (a minimal and low-cost approach such as New York City's BX12 SBS) to a system with the highest capacity and performance, such as TransMilenio in Bogotá, which can move 45,000 passengers per hour, with an average commercial speed of 30 mph—probably better performance than 90% of metro systems in the world.

Different combinations of BRT system elements (e.g., vehicle types, running way configuration, station and terminal design, technology adoption, and service plan, etc.) can offer flexibility to develop a package that best fits the specific site. Though flexible, the BRT concept has some essential attributes. First, BRT needs to be a fully integrated and branded system. The vehicles need to complement the stations, which, in turn, complement the service. A BRT system should be context-sensitive—adapted to the physical and operating environment where it is developed and integrated with the rest of the transit system, such as rail/metro service and/or other bus services.

Through this attention to context, BRT provides a better overall service than the sum of its parts.

To illustrate different ways of approaching BRT, Mr. Zimmerman contrasted New York City and Seoul, South Korea. The elements of public transportation in New York City are the following:

- Local buses, the basic bus service that covers all the major arterials in the region: this service stops almost every other block (about every 667 feet or 200 meters) and forms the "workhorse" of the system. Local buses often function as feeders to other services (such as the subway) and, depending on routes, operate 24 hours per day. This is a flexible system with different types of buses and simple stops.
- Select Bus Service: BRT-Lite (as described above).
- Subway, the backbone of transportation in New York City: the subway serves high-volume turnover markets at a high level of performance. It also facilitates and supports transit-oriented development. The service runs 24 hours per day at a high frequency, with stations every 1 to 2 kilometers. It features high-capacity vehicles, unique branding and identification, off-board fare collection, and good passenger data collection and serves medium- to long-distance trips (e.g., to work and for other purposes).
- Commuter bus, a premium, long-trip, and peak hour service from low density residential areas to major CBDs: this service provides comfortable seating, minimal stops, high speed, and high-end service. Costs are higher than from the above services.
- Commuter rail: includes Metro North, the Long Island Rail Road (LIRR), New Jersey Transit (NJT) and the Port Authority Trans Hudson (PATH) rail services, all of which connect New York City with suburban counties in New York, New Jersey, and Connecticut.
- Ferries: includes free services between Staten Island and Manhattan.

Seoul, by contrast, completely reoriented its bus system, resulting in increased ridership, improved performance, increased service, and lower government subsidies. The city created an integrated hierarchy of BRT service, comprising blue trunk lines (regional service from suburbs to CBDs), green feeder lines (to trunk lines and subways), yellow circular lines (for intra-downtown service), and red express lines (for long distance connections from satellite cities and inner areas).

Mr. Zimmerman concluded that in terms of what it feels like, true BRT has attributes closer to light rail or, in some cases, a metro than typical bus service. This true BRT service includes running-way dedication, off-board fare collection, and station design, and becomes a marketable enterprise. He continued that reviewing relevant cases would demonstrate that BRT should be branded as a rapid transit service, not a bus service.

Case Study 1: Guadalajara's Macrobus System and other BRT Cases in Latin American

Dr. Dario Hidalgo, WRI Center for Sustainable Transport, EMBARQ

BRT Components

Dr. Hidalgo identified four key elements of sustainable urban transportation: (1) pedestrian and bicycle infrastructure, (2) public transit, (3) transit-oriented development, and (4) disincentives to car use. Sustainable transportation is necessary for long-term livability. In this sense, BRT can be an integral component of sustainable transportation, not just a way of improving bus speed or passenger movement.

Building on Mr. Zimmerman's definition of true BRT, Dr. Hidalgo added that a BRT system needs to be a high-quality public transportation service and oriented to the user, offering fast, comfortable, and low-cost urban mobility options. The following are the key supply side components that "high-end BRT" should have:

- Segregated median busways in the center of the roadway (rather than on the curb side), which makes a huge difference in speed and reliability.
- Stations where passengers feel protected, with pre-payment features and level-boarding (no step up to board the bus).
- High-quality, large buses with multiple wide doors (to reduce boarding and alighting time).
- Preferably, buses that feature hybrid fueling or low emissions.
- Centralized control of bus operations to ensure efficient and reliable movement. In Bogotá, there is a very good service, but there is no central control of the operations. This results in too many buses, with consequences in terms of pollution and congestion.
- Distinctive image and branding.
- Intelligent Transportation System (ITS) to complement traffic engineering, for optimum route operations.
- Appropriate measurement mechanisms to evaluate the performance of the BRT service. Factors that need to be evaluated include:
  - User acceptance (quality of service): Perception of the system is critical and is improved through better service. User acceptance is the most significant factor and is actually more important than travel times to maintain and attract riders.
  - Travel time: This indicator should measure the timing of the whole passenger experience (i.e., access time to stations and waiting time), not just the speed of the bus.
  - Reliability: Reliability is improved by minimizing variance in service intervals and speeds.

- Low rates of breakdowns and other disruptions are also important.
- Comfort: This is measured through acceptable occupancy levels on buses and platforms, seamless integration (connectivity) with other transportation modes, and improvement in the perception of security and safety.
- Cost: The goal should be to maximize cost effectiveness (i.e., relatively low capital and operational costs).
- Externalities: It is important to measure the impact of the BRT service in reducing pollution, congestion, and traffic accidents.

Lessons from BRT Implementation in Latin America

There are about 68 BRT systems throughout the world, not all of which are full BRT. There are 11 in the United States and Canada, 15 in Latin America, 20 in Europe, 2 in Africa, 16 in Asia, and 4 in Australia/New Zealand. Dr. Hidalgo provided a brief overview of several BRT systems in Latin America that consist of different combinations of BRT system components. He noted that BRT in Latin America has been well embraced because of its low costs and quick implementation timeframe. The ease of implementation has a significant political benefit, as it is easy for mayors to see the fruits of their labor during their own terms. Some of the notable examples are summarized below.

Curitiba, Brazil

Curitiba is a BRT pioneer, the first to implement full BRT and the first to develop BRT services 30 years ago, although the term "bus rapid transit" did not come into use until 20 years ago. Curitiba's RIT (Rede Integrada de Transporte) service includes 72 kilometers of dedicated median busways, stations with level boarding, and coordination with land development policy. Curitiba has been successful at implementing appropriate land use around the nodes of the bus system, thus providing evidence that contrary to the idea that rail is needed for transit oriented development (TOD), buses can also provide incentives for land use development, when appropriate policies are in place.

Figure A-1
RIT, Curitiba, Brazil

Quito, Ecuador and Bogotá, Colombia

Both of these cities have dedicated bus lane systems. These transitways are only for buses and remove cars from the streets, rather than people or other bus services. Implementing full BRT systems requires appropriate political support and consultative processes. After implementation, businesses have been shown to thrive, and it has been generally accepted that these policies are the right thing to do. Quito's Metrobus service has 37 km of median busways and 440,000 passengers per day, with initial service in 1995.

TransMilenio in Bogotá has 84 km of median busways and carries 1.6 million passengers daily, with initial service in 2000. TransMilenio has expressway BRT lanes and, whereas cars move 5 mph, the buses move 30 mph, thus increasing and enhancing overall mobility.

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Figure A-2
TransMilenio, Bogotá

Mexico City, Mexico

Metrobus in Mexico City runs on 30 km of median busways, carrying 450,000 passengers per day. The original corridor opened in 2005; the system has now grown to three routes. Mexico City's BRT was implemented quickly, especially in comparison to its Metro system. The Metro is also undergoing expansion, but at a slow pace and with much greater cost.

Pereira, Colombia

This is an example of BRT implementation in a setting with very narrow streets in the downtown city. To deal with this challenge, the downtown routes are one-way, with public space improvements, including sidewalks. Because of the space constraints, the city has chosen to remove cars on these streets. This system runs more than 27 km, has 155,000 riders per day, and began operations in 2006. Cities across the United States with very narrow streets may take into account this experience and consider closing streets to cars, at least for corridors leading to the CBD.

Santiago, Chile

This system was implemented with the goal of reducing bus congestion and crowding through consolidation. It features 19km of busways and 63 km of road

improvements. The system did not start well, but is getting better with these improvements that started in 2007. Santiago's system is the only fully integrated bus/train system identified; this hybrid service carries 5 million users per day. The integration of BRT and other mass transit services (e.g., light rail, subways) is a key element in improving passenger's mobility and accessibility.

Guadalajara, Jalisco, Mexico

The main case study presented by Dr. Hidalgo is the BRT system (Macrobus) developed in Guadalajara. This city of 4.3 million implemented high-end BRT even though it already had an LRT system, which they could have extended. However, a cost analysis found that the construction cost of BRT is only one-tenth of LRT—a far more cost-effective investment, besides being quicker to implement. An alternatives analysis and study were completed in two months (this expediency may not be possible in the U.S. because of different and more complex processes).

System Features. The Macrobus system features 10 miles of service, 27 stations, 41 articulated buses, 100 feeder buses, and full integration with other services. The key elements of the system are:

- Segregation: The system features a separated lane, not just a painted lane. This is needed in an environment where it is difficult to enforce traffic laws.
- Removal of left turns: Since the buses operate in the medians, allowing car to make left turns would have negative congestion and safety effects. This decision ensures speed and reliability.
- Roadway geometry changes: wide lanes, use of technology.

Results. The operation of Macrobus began on March 10, 2009. The system carries 127,000 passengers per day, which corresponds to 5,000 passengers per hour per direction. The average speed is 12.2 mph. In terms of efficiency, it achieves 10 boardings per bus kilometer per day, which is, according to Dr. Hidalgo, a very high level of productivity. The service also has clear branding to distinguish BRT from other transit services and allows for transfers to other modes, such as rail. The cost of the new system was relatively low, at $1.7 million per mile and $0.5 per mile in equipment. The fare charged is $0.38, with surcharges for integration with feeder buses for less than $0.10 cents, and transfers to LRT for less than $0.20.

Success Factors. Overall, Dr. Hidalgo considers the operation of Macrobus successful. There are several critical factors that support this system, including:

- Efficient integration with LRT and feeder services.
- High-quality stations: wide, allowing for internal circulation, and illuminated.
- Passing lanes at every station—a key feature to accommodate future demand and capacity, which would be difficult to add later.

- Good quality pavement and protection devices in bus lanes to reduce future maintenance efforts.
- Advanced emission control and ultra-low sulfur diesel technology.
- Wide zebra crossings at intersections.
- Good passenger information systems.
- Flexible payment systems (coins and fare cards).

Figure A-3
Macrobus Station, Guadalajara

Performance Analysis. In terms of its performance, the BRT service has high user approval (90%) and satisfaction rate (7.8 out of 10 point scale). Travel times have also been reduced, as the system features 5-minute headways and 20.8 km/hr speeds. The prepayment system features smart cards as well as coin payments. Therefore, "one-trip users" do not need to be redirected to buy tickets as in NYC, which enhances convenience. In terms of comfort, the service has well-ventilated stations to deal with heat; however, the buses are not air-conditioned. Costs have been very low and affordable. Externalities have not been measured, but evidence exists of lower emissions, fewer crashes, and additional TOD development spurred by BRT. The system has also been adept at making needed changes, such as installing high-quality shelters for bus stop waiting areas.

Key Questions about Implementation of a BRT System

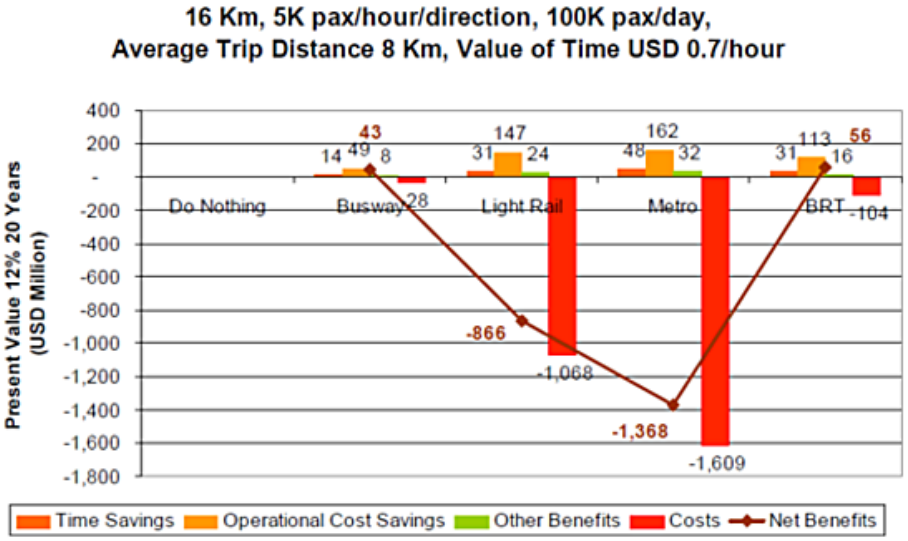
For a successful implementation and identification of a context-sensitive BRT system, Dr. Hidalgo posed four key questions for assessing the system moving forward, based on the Macrobus experience:

- *Is BRT the best technological option for transit improvement in the selected corridor?* To answer this question, he provided a cost-benefit analysis of different transit system construction with an assumption of a transit system

carrying 5,000 passengers/hour/direction (or 100,000 passengers/day) on a 16 km route. The analysis also compared the benefits and costs of five scenarios. As shown in the chart below, BRT is the most cost efficient mode, followed by a more traditional busway, then LRT, then metro rail. A model that calculates the present value of costs and externalities, estimates a positive value of $56 million for BRT, a negative value of $866 million for LRT, and a negative value of $1.4 billion for a metro.

Figure A-4

Cost-Benefit Analysis of Alternative Transit System Construction



A counter-argument contends that LRT or a metro has more opportunities for TOD than BRT. However, TOD has not been developed for existing LRT in Guadalajara. Dr. Hidalgo argued that TOD can be developed with BRT just as for rail, as long as the appropriate policies are in place. (For a discussion of BRT-anchored transit oriented development, review an article by Simon McDonald, *New York Transportation Journal*, Winter 2009).

- *Is it appropriate to start operations without all the components in place?* Dr. Hidalgo argued that even with incomplete BRT components at the beginning, BRT can make positive impacts on most users. Indeed, Macrobus began operating without all the system components in place, including some stations, and the fare collection system. While there was a political necessity for the early operation (i.e., upcoming elections), the system was successful. BRT in Guadalajara has been improved incrementally.
- *Are trunk-feeder operations better than an open system?* In terms of operations, there was a debate between a feeder-trunk versus an open system. The open system entails many different routes coming together, which reduces overall traffic but is difficult to control. On the other hand, in a feeder-trunk system, a very good control of the truck section is possible, while a high proportion of the trips require at least one transfer between feeder lines

and the trunk line. Currently, Macrobus is a feeder-trunk system, which in the future will be transformed to a hybrid model (a mix of a feeder-trunk and open system).

- *How much is the reserved capacity?* An important factor to consider is reserved capacity. For the Metrobus project, reserved capacity was calculated with some variation of the standard formula.

$$Ca[Pax/hour] = \sum_{i=1}^{Nsp} X_i * \frac{3600[sec/hour]}{Tsb[sec/bus] * (1 - Dir_i) + To[sec/bus]} * Cp[Pax/bus]$$

Ca[pax/hour]	Capacity in a given section, passengers per hour per direction
Nsp	Number of stopping bays
Tsp[sec/bus]	Loading/unloading time
To[sec/bus]	Interval between two successive buses
(1-Dir$_i$)	Percent of the buses that stop at the stopping bay
Cp[pax/bus]	Bus load
X$_i$	Accepted saturation level

Assuming that for peak stations with two stop bays and the opportunity for buses to queue at the station and 150 passengers per bus, the capacity of the system is 28,000 passengers per hour per direction. This number represents a higher capacity than most rail lines in New York City. A caution, however, is that this calculation may assume overloading the buses. However, if the assumption is reduced to 110 passengers, the result is 20,000 passengers per hour per direction, which is still very high. Some studies purport to show that only 10,000 capacity is possible on BRT, but Dr. Hidalgo said that it is possible to do much more than such figure.

Conclusion

BRT in Guadalajara has been a successful project, with rapid implementation, relatively low cost, high quality, good performance, and high user acceptance. It features median busways with good pavement, strong segregation, wide and well-ventilated stations, passing lanes, and good operational planning. The system also has an extraordinary reserved capacity. There are some improvements that are still needed, especially the implementation of a performance monitoring system to enhance reliability and comfort. Overall, BRT is a great opportunity to provide high-quality service and capacity within a short time period and with limited resources.

Q & A Session

While throughout the presentations, participants were able to engage with the speakers, during a formal question and answer session participants had an opportunity to raise the following concerns:

- *How well do the stations in the middle of the road work for people and drivers?*

  In the case of Guadalajara, buses have doors on both sides of the bus or the left side only. The placement in the median is the result of a public consultation, as local businesses did not want to have bus stops blocking the front of their stores; therefore, the stations were placed in the middle of the street. Turning movement is easier with this configuration, as curbside stations would create a hazard due to conflicts with cars turning right and the median, left-hand turns are eliminated. For a worst-case scenario, see Delhi, India, where there are some of the worst intersections in the world.

- *Spacing between bus stations system seems to be short—27 stations on the 16 km corridor. Does such short spacing impact the overall performance of the BRT system?*

  In Guadalajara, short spacing of stations was used because it helps to increase capacity and reliability. The system also provides express service, so not all services stop at each station. It is not just a matter of the speed of the bus but the quality of the overall passenger experience.

- *What were the traffic and transit use levels in Guadalajara prior to the plan? Are you shifting the capacity, since old buses are already taking capacity?*

  BRT replaced low-quality private services in Guadalajara. The new service is private but maximizes the use of the corridor. There was some reduction in capacity for normal vehicles, but overall throughput of the corridor has been increased due to buses moving more efficiently. The reallocation of capacity (local vs. express BRT) means the frequency for certain services was reduced, but overall throughput increased; more people are being transported in fewer vehicles. In terms of mode shift, the impact was minimal. Instead, this organized system has replaced chaotic, stop-and-go operations, which significantly improved the quality of service. For example, transit speeds were 10 km/h before the improvements and have increased to 21 km/h today. Transit users are the predominant user of the corridor. Good quality of service will reduce shifting from transit to private cars. The level of impact on cars was not large enough to spur a backlash.

- *How much right-of-way do you have on your streets and highways?*

  Curb to curb, the normal arterial width in Mexico is 24 meters (close to 80 feet) plus some space for sidewalks; there is limited space.

- *What signal priority do you have in Guadalajara?*

  There is no current signal priority for buses, but we want to make this happen soon. The current frequency of buses is about 2.5 minutes, which would make it difficult to give buses priority, or else there would never be a green light for anyone else. This could be improved with some technological improvements, such as GPS to help space vehicles.

- *Are there any ticket vendors in the station's interior?*

  Yes, there are booths for loading cards, ticketing, and changing coins. No debit or credit card is accepted at this point. There is open technology, so this could be implemented in the future. Sixty percent of users pay by coin. The use of prepaid cards is increasing, which is good because it provides integration and transfer, which coins do not.

- *Does Guadalajara or any other city use enhanced pavement on roadways?*

  We use concrete (22cm) and special design for stop-and-go traffic operation (like what is used at toll booths). In Mexico City, they changed to this type after six months of operation, as they did not install it at first.

- *What were the costs to launch this BRT system in Guadalajara?*

  It was US$1 million for project preparation in total, including engineering plus another US$500,000 for management and implementation, or a total of approximately US$1.5 million. In Mexico, there is not as much analyses required. In general, the plans take roughly two months to complete, in contrast to a year or more in the U.S.

- *In terms of the scale of system, how many roadways of BRT were involved?*

  The current system involves just a 16 km corridor, with feeder services. We are now planning three more. They are small in terms of size, but high in terms of ridership.

- *Is the feeder a separate system?*

  Yes, it is. There are three exchange points with feeder buses, and one with light rail.

- *Is there any evidence of the BRT system's impact on land use yet?*

  Such analysis should be conducted in the future. The corridor already had mixed use. Having the Pan- American games in Guadalajara is going to create opportunities for new development.

- *How did you determine the station design?*

  Standard station design was adopted from a design competition.

- *Observation regarding Latin America: development just happens, it is not part of the initial plan?*

  Curitiba was formally planned, good land use development with high-rises and TOD. In other places, the areas are usually already mixed-use. With new BRT, there have been opportunities for new development, and the land use guidance (e.g., Bogotá) has been changed because of the implementation of BRT, but no economic incentives were in place. Land use guidelines often changed with the BRT system. This is definitely true in Bogotá, where they up-zoned certain areas to take advantage of the adjacent system.

- *Was there any political controversy?*

  There were two big controversies. First, there were private operators benefiting from operating as many buses as possible, and these were not regulated. To them, the more vehicles they operated, the more profits they obtained. They were opposed to BRT because it could cut into their profits. This opposition was handled by giving them the first right to reorganize themselves and operate the new systems, as has been the case in many Latin American countries. This has drawbacks because having fewer operators (due to reorganization) means less competition and, thus, it initially resulted in higher costs. However, given a certain regulatory rule in Mexico City, the bidding process brought costs down. Second, there was opposition from car users, who felt car space and parking space were being removed. Business owners and car users were concerned that BRT is a low-quality service and advocated for rail instead. Therefore, it was important to implement high-level BRT services. Other controversies include the location of stations as well as community involvement and participation. Finally, the political leadership needs to assert that it is providing/implementing a service to the majority (transit users). Political endorsement is important to support BRT systems.

Case Study 2: London's Bus Priority Services

Steve Palmer, Head of Strategy, Transport for London

The London Bus System

London is constrained physically, fiscally, and politically, yet has doubled its bus ridership over the past 10 years. The bus network in London is more complex than the Tube network. London has one of the largest urban bus systems in the world—8,200 buses carrying about 6.5 million passengers each day on 700 different routes, with 18,000 bus stops. There are about 2.26 billion passengers per year. London also has a regulated bus network, unlike the rest of the UK, which was deregulated in the 1980s. The Greater London area was omitted from this policy change, and today, bus services are administered by Transport for London (TfL). The term "BRT" is not used, and TfL has determined that rather than operate a "two-tier system," as BRT implies, it preferred to have a single excellent and efficient system that works well for everyone.

Challenges: Meeting Increasing Demand

The Transport 2025 visioning document was produced in 2006 to plan for how to accommodate population and job growth and improve transportation services. The plan notes that employment and population growth will be in different locations in London. Job growth will be in a central east-west corridor (for instance, the Docklands, Canary Wharf, City of London, and Central London), while population growth will be more dispersed. The bus system will play a key role in supporting economic growth, tackling climate change,

and improving social inclusion. The implication of this growth pattern is that bus service needs to form a radial network that connects the center and the periphery. The flexible nature of the bus service makes it the only mode that can serve such diverse needs. Travel growth will be significant in 2025, increasing from 27.2 million journeys each day in 2005 to 31.2 million in 2025. In order to meet climate change and air pollution targets, the extra journeys need to be accommodated by public transit, walking, and cycling. Moreover, the number of bus passengers is expected to increase by 50%. An additional 40% bus capacity will be needed in London by 2025. Prior to the delivery of new rail schemes, bus is the only feasible way to support London's growth. Effective "end-to-end" bus priority measures will be a critical success factor.

History: A Decade of Robust Bus Priority

The first generation of London bus improvements was planned in 1994, when a Bus Priority Package for funding was introduced. This plan included a radial and circular bus priority network with a focus on localized improvements. The second generation of improvements, the London Bus Initiative (LBI), was announced in 2000. LBI was part of a national strategy to improve transportation. LBI included 67 corridor treatments that touched all 33 boroughs in London (boroughs have control over their local roads). One aspect of LBI is Whole Route Implementation. Under this philosophy, the TfL moved to a philosophy of improving every element of entire bus routes rather than making localized improvements. New bus lanes were a vital component of this plan. For these lanes to work effectively, robust enforcement was key, as drivers often misused bus lanes when they were first introduced. Enforcement was primarily via cameras on buses and in lanes. As a result, it is now almost unheard of for people to be caught driving in bus lanes. Other components of LBI improvements include signaling technology, better buses, bus driver training, and countdown clocks for passenger information.

The Third Generation Bus Priority (3GBP) program arrived in 2005. This 10-year program included a partnership with the boroughs, including 36 routes and 60 other coincident routes, capturing about 40% of passengers in London. Elements of 3GBP include whole-route treatment with consistent strategy application, as the bus route passed from one borough to the next. The strategy also incorporated a plan to improve the urban realm adjacent to the route such as removing unnecessary street furniture and sign clutter, new hard landscaping, tree planting, etc. This strategy managed to achieve more effective priority and increased integration of interventions through strong policy direction, which allowed for measures that would not have been achieved otherwise. A further component of 3GBP is a Freight Environment Research Study (FERS), which set out to identify freight loading and unloading curbside parking needs along the bus routes while examining the needs of businesses.

Some recent studies have found, for example, that curbside parking is often dominated by shop owners and workers, not customers.

According to an analysis of the 3GBP plan, the net financial effect of the plan is positive at £47.3 million over 10 years. An estimation of a benefit-cost ratio is well over the TfL's minimum standard of 1.5. In addition, this plan will bring safety benefits for road users, which was measured to be £12 million in the first 5 years of the plan.

System Improvements

Under LBI, a number of improvements were made:

- More than 100 bus lanes were added. In London, only 5–6% of bus routes have protected lanes, but that is expected to increase in the future.
- Signal modifications to provide priority signals were made at about 300 intersections.
- To improve pedestrian accessibility to bus stops, leading pedestrian signals or "all green" phases for pedestrians were introduced.
- Approximately 1,000 stops got passenger information such as countdown clocks and spider maps (Tube maps).
- New fleet of buses.
- Driver training (including courtesy).
- Cleaning regimes.
- Enforcement policies: Boroughs are usually the enforcement agents. TfL signed service level agreements for them to enforce bus lanes and added cameras and agents.
- Consideration of all aspects around this service: in-vehicle service, access to stops, and other modes.

As a result of these improvements, annual ridership on all 27 LBI routes increased by 22.1%, from 163 million passengers in 1999 to 200 million in 2003. During the same period, the total ridership of the London bus network increased by 20.8%.

Dwell time has reduced dramatically and represents 15–20% of total journey time. Multiple doors (three) plus prepayment reduced dwell time by 75%. There is cashless boarding in Central London; passengers must have a smart card (Oyster) or buy a ticket before boarding.

Example 1: Route 38 (www.busroute38.co.uk)

This high-frequency bus route (20 bph) runs between Victoria and Hackney, passing through Bloomsbury, which is in the heart of the West End and one of the most congested areas in London. The route section is somewhat different in that it runs in a counter-flow bus lane, with general traffic in the center lane only. The total road width is 10 meters, which is relatively wide for London. Cyclists,

motorcyclists, and taxis can use most bus lanes in London, but not the counter-flow bus lane. The result of this project was a two-minute travel time saving per bus.

Route 38 then continues on Essex Road, to the east of Bloomsbury. On this section, TfL installed inset loading bays for deliveries. Freight vehicles are not allowed to drive in bus lanes, and this improvement helps give them a means to load and unload without interfering with general traffic and bus movement. Route 38 also runs along Shaftesbury Ave., which is in the heart of the West End theater district, adjacent to Soho and Chinatown and shares the route with numerous other coincident routes. This is a very congested area with narrow streets. The bus improvement project further narrowed the roadway by an additional 1–1.5 meters, while widening sidewalks. Similar to Essex Road, inset loading bays (with 40 mm curb height) were installed to aid deliveries. One objective was to reduce curbside friction by making the road too narrow for people to stop/park. This project cost approximately £1 million (US$1.5 million) and provided time savings for buses of 27 seconds per trip.

Piccadilly Circus is an area with brand new improvements. To shorten bus routes between one-way and two-way roadways, TfL created a counter-flow bus lane here, as in Bloomsbury. This change seems to be working well, but is still new and requires further observation. This improvement was made in partnership with the local council and is part of pre-Olympic funding to improve transportation and key tourist centers in time for the 2012 games.

East London Transit

As part of the planning for the Olympics, Central London was modeled using a range of scenarios and improvements to show that the schemes would work and the trips could be handled. An area that has been a focus of Olympic planning is East London. East London Transit opened in February 2010. This project was first conceived as a light rail scheme, to be incorporated with the successful Docklands Light Rail system in the East End. However, the decision was made to include bus initiatives. This route is not "true" BRT, as it does not have special branding and some other elements such as express stops. Buses on this route are equipped with special tires that enable them to run alongside the curb, which enhances and quickens boarding. The route includes the iBus GPS system, which is cutting-edge traffic signal technology. Each bus in the fleet has this system, which communicates with traffic signals. A total of 2,000 traffic signals in the city have been upgraded to communicate with the iBus system. Each bus gets about four-to-six seconds benefit per signal cycle per bus from the priority signaling that the technology enables. Differential priority is planned, but not yet implemented. When it is implemented, system operators will be able to make priority changes, depending on the on-time performance of buses in real time. This will be relatively easy and cost-effective to implement, as they need software, not hardware, to build on the current system. The iBus system also aims to collect better data about occupancy to enhance system planning. Since

only 5% of fares on London buses are paid by cash, TfL is able to gather good trip data from smart cards. Largely due to the technological advances, the East London Transit project cost £120 million (US$200 million).

Summary

There are now 1,236 bus lanes in London, which run over about 300 km in total. Bus improvement projects take effort and patience, but are possible and desirable. The bottom line is that reliability is the number one concern of users and should, therefore, be the feature of focus for bus service. Reliability in London is measured by excess wait time, which now stands at a very impressive 1.1 minutes. Mr. Palmer noted that he does not believe that it is possible to improve on this low number. However, it could actually increase if investment is reduced, which is possible in current fiscally-constrained times. TfL's research has found that 80% of Londoners (and 90% of cyclists) support bus priority and bus lanes. Integration is important, as multimodal corridor schemes are the way forward. Moreover, community engagement is essential to the success of these projects. The earlier it is conducted, the greater the benefits.

Q & A Session

- *Was the 90% cyclist support because they can use the lanes, or because driving is down?*

  Cyclists are allowed to use bus lanes. Cycling is growing rapidly, while accidents are down. Bus lanes are seen to be the safest place for cyclists. Where there is heavy cyclist traffic, a wider 4.5 meter bus lane is recommended (regular is 3 m).

- *NYC bikers do not like the bus and bike integration idea.*

  Separated bike and bus lanes can be good. But London does not have the room to do that, so sharing has to work. And they have found that cyclists do not generally want to use minor roads, as they want the fastest road possible and will stick to main roads.

- *Do cyclists in front of buses slow them down?*

  Bikes go about as fast as a bus. Average bus speed in London is about 14 km/h, so there is not much speed difference.

- *In Seattle, we have carpools in bus lanes. How about taxis in bus lanes in London?*

  Taxis have been allowed to use bus lanes for many years. Some people would prefer taxis to be excluded from bus lanes, particularly in Central London and near to the main rail stations. The Mayor has recently decided that electric vehicles would not be allowed to use bus lanes. There is a constant struggle to keep bus lanes for buses: It is why they are called "bus lanes."

- *What is the bus flow rate per hour?*

  A rule of thumb for bus lane justification is a minimum 15 buses per hour. First-year rate of return for bus lanes is 30–45% based on monetized time savings. The average long-term time saving is roughly 30 seconds per bus per bus lane journey.

- *Is there difficulty when bus frequency is low?*

  Low flow bus lanes can still be successful if other types of vehicles (e.g., heavy goods vehicles) are allowed in as well.

- *What is the community input process during the design phase?*

  In the 3GBP initiative, stakeholders were identified first. For each route, a project board was established and met with local leaders and elected members in order to get them on the project board. Political buy-in is vitally important. Allow them to shape the project to suit their objectives. Then, community groups can be involved. For Route 38, it has taken five to six years from the beginning to the end. Arguably, it is still not finished, as there are more improvements to be made. However, it does take an enormous amount of time and effort, but we do need to reduce time and cost. Also important is that a plan has to be conscious of political timelines.

- *Signal priority system: what technology do you use?*

  A GPS system on the bus and sensors on doors are used to figure out when the bus is starting and stopping. There is a "virtual detection point" in the bus software so that radio signals are sent out ahead of time to intersections for priority. Everything is done locally and in real time (using a system on the bus); this does not go back to the central control system. This is a large investment for each bus. Nothing is on the street—no poles, no beacons; it is all on the bus and not seen.

- *Importance of enforcement?*

  Enforcement is primarily camera-based CCTV. But street enforcement officers are also available so that there is a mix. Street attendants can get assaulted, so there are risks. Few, if any, buses in London now have onboard cameras. This is because most bus lanes are covered by CCTV and monitored in real time.

- *What is the relevance of stop spacing to route improvements?*

  TfL combined some stops whenever it was sensible and acceptable to customers. Bus stops are usually 300–400 meters apart (roughly 4 per mile), which represents no more than a 5-minute walk between stops. There are no express routes as such. Many bus stops are "request," so the bus doesn't stop other than for passengers alighting or pick up.

- *Does TfL provide any parking or other accommodations for suburban riders?*

  TfL does not operate park-and-ride buses in London. There are some local retail centers with park-and-ride services, and there are similar services for rail passengers. The basic policy is to discourage car use; thus, bus routes are designed to be no more than 400 meters from where people live, so they can take the bus to interchange with rail or other public transport, etc.

- *Corridor initiatives and citywide initiative?*

  The Route 38 bus priority service was part of the 3GBP London-wide strategic initiative. The importance of developing bus city-wide services cannot be overstated—they provide a network of connections, thus increasing the range of alternative travel options for passengers. The lack of such transit networks is often cited as the main motivation for the use of single-occupancy vehicles in urban settings. However, given the tough economic climate and changes political priorities, the London city-wide program faces funding cuts. Moreover, a number of light rail and tram schemes that had been planned for London may also be postponed for the foreseeable future. The West London tram plan along the Uxbridge Road corridor has been abandoned, and an alternative local bus-based system is being considered.

- *Safety of counter-flow lane?*

  There is intense debate about the safety of counter-flow lanes. At Piccadilly, for example, some drivers have inadvertently followed buses in to the counter-flow lane. The counter-flow lane can be a safety hazard. Pedestrians crossing the carriageway may not always appreciate bus traffic flowing against the general traffic direction of flow. However, studies by TfL indicate that there are no particular safety difference between counter-flow and normal bus lanes.

- *Maintenance of bus lane surface?*

  TfL has found that red coloring of bus lanes is effective because they make lanes more conspicuous. Alternative, permanent pavement is costly and unnecessary, in part because drivers tend to stay out of dedicated bus lanes.

Case Study 3: Boston Silver Line

Andrew Brennan, Massachusetts Bay Transportation Authority

Background: Boston Silver Line

The Silver Line/Washington Street corridor project exemplifies a different BRT experience, as it is a context-sensitive project reflecting the specific nature of a neighborhood. Unlike the earlier case studies, this service is not a regional bus system but rather a short corridor (approximately 4 miles) located in a residential neighborhood located in historic downtown Boston, a bustling pedestrian area

with on-street retail and moderate density. The first phase of the Silver Line BRT opened on July 20, 2002, and it runs from Dudley (Boston's largest bus hub) to Downtown Crossing, where much of the city's employment is located.

Figure A-5
Boston BRT System

The second phase of the Silver Line that runs along the South Boston Waterfront began in December 2004. This route is unique in that it is an underground BRT route, including the Ted Williams Tunnel, and connects to surface routes to Logan Airport, providing access to a circular system to the airport. These were all built in conjunction with the "Big Dig" project, officially called the Central Artery/Tunnel project (CA/T); thus, the project has been characterized as "BRT on steroids." Mr. Brennan noted that BRT is the best option for this system, even without considering its cost-efficiency. He added that while there is already a heavy rail link to the airport with connections to the BRT line, a light rail transit (LRT) system would not be feasible for running through the tunnel or for providing circulation access to every terminal.

There are now plans for a connector tunnel to make one continuous link between the two BRT lines. However, this plan is now on hold due to financial constraints. The buses are dual powered—they run on electricity via overhead wires while in the tunnel and on a gas motor when on a surface roadway. The system was built to have large stations with grand designs, but unfortunately some sections are underutilized.

Silver Line/Washington Street

Until the 1980s, Washington Street had an elevated railway, which was then demolished and replaced by a subway line to the north of this corridor. When

the elevated railway was removed, a commitment was made to establish equivalent transit service on Washington Street. However, no specific mode was defined at that time, and it took several years for the community to come to a consensus as to how to implement a service equivalent to the old elevated rail line; thus, the planning process before initial construction took 15 years. Today, Washington Street has become a pedestrian-friendly corridor in a high-end neighborhood. The project began in 2002 when there was much less discussion of BRT in the U.S. than today. The technology-selection phase of the project was highly controversial. Significant resources had to be invested into educational and outreach efforts to promote the benefits and feasibility of BRT. Many residents wanted light rail transit (LRT) and considered BRT an insufficient alternative because it was viewed by much of the public as a disinvestment compared to LRT.

Silver Line/Washington Street System Elements

The system uses compressed natural gas buses, which are now being upgraded to 60-foot articulated buses. The introduction of vehicle technology is a significant element of the Silver Line program and includes building a new facility. The system features an off-board fare collection system that has three alternatives: trolley card, ticket, and cash. Another system feature is a colored bus lane, which visibly stands out (although there is no physical separation). Except for a few drivers (including some bicyclists), the bus lanes are well-respected. Some additional improvements have recently been made to the system using ARRA funds. These include both station and travel lane improvements that give the system a distinctive look.

The introduction of BRT on the Washington Street corridor did not change its fundamental characteristic as a wide roadway with on-street parking space. As this is a mixed-use district, maintaining parking was important to local businesses, but this arrangement has posed challenges for the BRT service, as the constant flow of parked cars in front of businesses can become a barrier to bus traffic. The system does have a bus lane, but it is not fully dedicated. The incompleteness is partially a result of compromises that were necessary to project acceptance and implementation. Additionally, the route features only minimal design, stops, and stations. The main consideration during design was the neighbors, as opposed to the ridership. While there was some debate about what stations should look like, the need to keep the community satisfied was paramount. The bus stops do feature directional maps and real-time information.

After eight years of operating the system, the lack of connection between the two branches (Silver Line Phase I and Phase II) has become an obvious problem. Connecting the two branches (Silver Line Phase III) is planned, but the resources to do so are scarce. Nevertheless, it is important to design BRT networks that provide for connectivity among various services.

Figure A-6

Silver Line/ Washington Street: Station, Off-Board Ticket/Card Validation System, and Painted Bus Lane

Q & A Session

- *If people want a light rail, then why not locate buses in the middle of the road?*

  First, at both ends of the corridor, BRT had to be mixed with other traffic, which might cause some problems with buses maneuvering to and from the median bus lanes to the curb side. Second, related to the first, in order to operate a bus on median lanes, the buses would need to have doors on the left side.

- *What is the penalty if private vehicles are caught driving on a red lane?*

  The fine is $125 but it is rarely enforced; furthermore, there is no consensus on whether police should be used to patrol bicycles. In addition, using cameras to enforce is not a clear option since the Massachusetts law does not allow to ticket using just a photograph.

- *How does fare validation work?*

  It works on the honor system.

- *How many stops are there?*

  Stops are one-quarter or one-third of a mile apart. In the case of local buses (not BRT), there is a stop at every corner.

- *How was freight loading treated?*

  In Boston, parking for loading and unloading is still shared—first come first served. However, this approach results in double parking.

- *What are the pros and cons of using buses?*

  When the BRT program started, only diesel buses were being used. The main reason for using diesel fuel, which is not the cleanest, was that there were no facilities to maintain CNG vehicles nor were there trained technicians, and there were lots of difficulties in maintaining CNG vehicles, which usually took longer to maintain. Today, with trained workers and appropriate facilities, these problems are no longer an issue, and associated air pollution is much less. However, CNG buses may emit methane gas—a serious greenhouse gas—if there are any leaks during the fueling process or at fueling stations.

- *What was the MBTA approach to convincing DOT to grant rights-of-way for BRT in downtown Boston?*

  The agency spent time and effort to coordinate with the Boston DOT as well as with the Washington Place and Boston Landmarks Commission to develop a corridor-wide plan. The agency also worked hard to gain a general consensus among stakeholders about the corridor. The decision about detailed elements of the corridor required a lengthy political process, including getting public buy-in; however, the stimulus money has eased this process.

Case Study 4: New York City Select Bus Service

Joe Barr, NYCDOT, and Ted Orosz, NYC Transit

New York City's Select Bus Service (SBS) currently functions on Fordham Road in the Bronx and is planned for Manhattan (First and Second Avenues) as well as three other corridors. The Fordham Road SBS project was a deliberate attempt to find a good location to test BRT in New York City. The city has more than 100 streets with more than 10,000 passengers per day on their bus routes, all of which were potential candidates for the service, but it was determined that Fordham Road was the best place to start.

The goal of SBS is to improve bus speed, reliability, and attractiveness in order to increase services and thus also ridership. The key features of SBS include pre-payment, visible bus lanes, enhanced bus shelters, bus signal prioritization, and branding of SBS buses. Inter-agency partnerships at all levels were the key to the success of the SBS project. NYC Transit—part of the Metropolitan Transportation Authority—is the operator of this system, while the NYCDOT controls the traffic signals and street infrastructure. In other words, DOT owns the streets while MTA runs the transit system.

Background: Why BRT?

NYC buses are the slowest in the country. The average bus speed in New York City is roughly 8.1 mph, which is slower than that of its counterparts in other cities (e.g., 9.7 mph in Chicago, 10.5 mph in Boston, 11.2 mph in Washington,

D.C., and 12.3 mph in Los Angeles). Of most concern is that the average bus speed has worsened—from 9.1 mph in 1996 to 8.1 mph in 2006. In addition, bus ridership has not grown over the past 6–8 years, while subway ridership has grown substantially. There has been significant population growth in NYC in the past two decades, and their transportation needs have been primarily absorbed by subway services. The goal of this SBS initiative, therefore, is to arrest the decline of the bus system. To meet this goal, the service improvements have focused on improving in-motion time. Currently, buses in NYC are stopped about half the time (54% in-motion time). Thus, efforts to get them moving faster will increase speed and reliability and boost ridership.

At first, the project team envisioned conducting at least one pilot projects in each of the five NYC boroughs, but opposition in Queens ended that project. Fordham Road emerged as the most obvious candidate for BRT. Before the project was implemented, market research was conducted with the Fordham Road Business Improvement District (BID). This research found that about 10% of customers entered the BID by car, while 90% arrived by transit or on foot. Therefore, the BID supported transit improvements as they were also good for business. For the Fordham Road project, the alternative analysis was completed in 2½ months. For other projects that have used federal funding, the agency worked creatively with FTA to streamline the process and avoid lengthy reviews.

Fordham Road SBS System Elements

The BX12 SBS runs east-west on Fordham Road from Manhattan to Co-op City. The route combines painted bus lanes and running through traffic sections. Because the main roads and transit predominantly flow in a north-south direction (to move people to and from Manhattan), the BX12 SBS links to every subway line and commuter railway line in the Bronx. Therefore, demand for this bus line is heavy, as it is one of the few east-west corridor transit services.

Expanded/Improved Bus Lanes

Existing peak-period bus lanes were expanded to all-day operation (7am–7pm). Additionally, the length of the corridor was increased, and the bus lanes were painted in a distinctive terra cotta red. Other improvements including overhead signs along SBS lanes were added. The New York Police Department (NYPD) is responsible for traffic enforcement for the corridor, as MTA does not have an in-house enforcement agency.

Coordination with Business: Freight Delivery

During the consultation process it became evident that regular parking was not a major concern of local businesses but rather space for freight deliveries. Indeed, this is a very busy commercial corridor, busier than many in Manhattan.

Therefore, the SBS project accommodates different delivery time windows for the corridor (12–2 pm on westbound and 10am–12pm for eastbound buses), which also helps the businesses in terms of delivery reliability. This particular arrangement for deliveries requires the collaboration of businesses and freight companies.

Signal Priority

Signal priority is a significant feature of the project, and it has improved travel time for all traffic. Priority signals were installed at 20 of 35 intersections along the route. BX12 uses Opticom radio GPS technology. This element is responsible for 5–10% of the overall 20% improvement in movement in this corridor. The signals allow for a leading bus interval or queue jump, where there is a six-second advance signal for buses entering bus lanes.

Figure A-7
Bus Priority Signal

Off-board Fare Collection

Two types of fare collection machines are in use:

- Re-purposed MetroCard "express" machine (used in subway stations) for customers with MetroCards
- Re-purposed Parkeon multi-space parking meter for customers with coins

The MTA is ordering a new generation of these machines with language options and full ADA compatibility. The existing card vendor, which was designed for the subway, does not work well when it rains. Customers pay at Metrocard vending machines and cash fare collectors and obtain a proof-of-payment receipt before

boarding. A passenger can board the bus at any of many doors and hold the receipt for inspections. The receipt is valid for one hour after purchase.

Figure A-8
Off-Board Proof-of-Payment Fare Collection

Almost no staff interaction is required from this system, besides a team of fare inspectors. The inspectors issue fare evasion summonses ($100 per summons) to those who cannot provide proof of payment. They issued about 6,000 citations over the past year and a half. There are on-board cameras for incident recording that support off-board fare collection.

Improved Service Plan: Local Bus Service

Fordham Road also has a supporting local bus service that operates 24 hours. This service runs on the densest part of the corridor, between Sedgwick Avenue and Pelham Bay Park with summer extension to Orchard Beach.

Enhanced Shelters

Shelters were paid for by vendors who purchase commercial advertising. There is currently a problem with the shelter size—there is not enough space for passengers waiting at the busiest stops.

Branding

The system also features branding on the exterior and interior of buses as well as the shelters. There are distinctive SBS graphics everywhere, and there are also strip maps on the bus, akin to a rapid transit vehicle, which improve customer information. A number of elements were also included to ensure a successful program launch, such as customer ambassadors. For the first few weeks, staff were on the ground to educate riders, which was very successful and necessary

strategy. There was also an initial enforcement blitz, although no tickets were issued initially, until the public was aware of the SBS program.

Figure A-9
SBS Branding Elements

Results

By all accounts, this has been a successful project. The results include:

- 30% increase in daily ridership for BX12 SBS service (from 24,777 in October 2007 to 32,176 in October 2008).
- 9% overall increase in the BX12 route (local + SBS), which is a significant increase in a mature market (from 44,291 in October 2007 to 48,510 in October 2008).
- 98% of customers polled stated they were satisfied or very satisfied.
- Dwell time per trip reduced from 16 minutes to 9.5 minutes.
- Traffic light delay reduced from 12 minutes to 7.5 minutes per trip.
- In-motion time increased to 61% from 49%.
- 98% dependability of fare collection machine.
- Fare evasion rate comparable to or better than before implementation.
- Very low implementation costs: approximately $10.5 million for the 9-mile corridor.

Challenges

There are plans to install solar-powered fare collection machines. They are desirable because power disruptions to the existing machines cause problems. For example, there have been five instances to date when various utility crewmembers accidentally cut the power conduit during construction, leaving machines out of commission for extended periods of time. There are some additional drawbacks to this system, from a management perspective:

- $6 million in increased annual operating costs, including additional service, and new staff for maintaining fare equipment, revenue collection and enforcement.
- Red painted bus lanes and on-street branding (e.g., signs) have been worn out over time—replacement cycle still needs to be determined. Increased travel speed is associated with faster wearing out.

Lessons Learned

- Partnerships at all levels are important.
- Simple and inexpensive solutions work well in improving bus speeds—e.g., red-marked bus lanes, off-board fare collection, and transit signal priority.
- Training/education is important for operators as well as riders, through customer outreach.
- Community outreach is critical. Eight community boards were involved in this project.
- A Community Advisory Committee also provides greater community engagement, and this approach is being used on future corridors (but was not used on Fordham SBS).

Next Steps: Expanding SBS to 1st and 2nd Avenues

The plan for SBS on 1st and 2nd Avenues foresees a smaller increase in operating costs. It is anticipated that the speed improvements will pay for the upgraded frequency. First and Second Avenues will be developed with full elements of BRT infrastructure such as bus bulbs, transit signal priority, low-floor buses, and all the elements that made BX12 SBS on Fordham Road successful. The Lexington Avenue subway line is the most overburdened line in the city, while the opening of the Second Avenue subway is still a considerable time away from even partial completion. SBS in this corridor will provide immediate service relief and overall transit improvements. There are, however, challenges with running SBS down the same street as subway construction, in terms of the logistics.

Currently, there are local and limited bus services on these avenues, with no other features. The limited service will be eliminated in favor of SBS. The route will feature bus lanes operating at extended hours and cover a greater distance. In the future, bus bulbs will be added to provide space for local buses; so that BRT can pass local buses. Public outreach and engagement are vital for this project.

Figure A-10

SBS Branding Elements

First Avenue and Second Avenue SBS is to commence in late 2010. The plan will see improvements for bicycles and pedestrians as well, making this a multimodal project. Furthermore, this will be the most aggressive design so far, including:

- Parking at curb.
- Separated bike lane ("floating parking").
- Bus lane and car travel lanes.
- Pedestrian island in middle of intersections to shorten crossing distances.
- Trees and other green elements.
- Separate stops for local buses and an SBS bus, so that SBS buses can pass local buses and move faster at all times.

Overall Lessons

- Leadership and staff collaboration and interagency cooperation.
- Context is essential: bus priority is a goal of the city and is included in main policy statements, especially PlaNYC.

"Open Space" Conversations

Following the case studies, Allen Zerkin introduced the "Open Space" conversations. This section was an opportunity for participants to learn from one another by gathering in small groups to talk about the topics they determined to be useful to them. The most distinctive aspect of the Open Space approach is its initial lack of an agenda, enabling the participants to create the agenda for themselves. During the initial organizing period, any individual can declare his/her intention to host a discussion on a particular topic. Each topic is posted with the host's name on a flipchart. Participants can suggest that related topics be merged into one discussion, but the decision to do so

lies with the respective hosts. When a final set of discussion topics has been produced, the group breaks up. Each participant is free to select whichever topic is most interesting, and participants can move freely among the discussion groups. Each host is responsible for kicking off the conversation with whoever shows up and for ensuring that notes are taken for later compilation and distribution. If at any point a host thinks that the topic has been discussed as much as it is useful, s/he can declare the discussion over and can join another group, though the other participants are free to continue the discussion if they want to.

With Mr. Zerkin's facilitation, the participants identified four conversation topics, two of which were consolidated. The final three topics were:

- BRT on Narrow Streets
- Public Outreach
- BRT Vehicles and Maintenance Issues and Operations

Reports from "Open Space" Conversations

After a 1.5-hour-long conversation period, the three groups were reconvened to the main workshop room and, using flipchart notes taken during the discussion, reported on the main conclusions.

BRT on Narrow Streets

- Latin American examples were discussed. While most projects were built on mega-boulevards, there are some BRT systems implemented on narrow streets (e.g., Curitiba).
- The participants agreed that political leadership (i.e., a top-down initiative) is a key to implement bus lanes on narrow streets.
- Gating strategies in London for bus priority signal can be used to meter traffic, with implementation changing according to time of day. For example, this strategy can reduce traffic flow during AM and PM peak hours.
- Like the Wilshire Boulevard (Los Angeles) example, transit malls can generate key segments in downtown to only transit use.
- To implement BRT services, the potential thresholds for BRT bus lanes should be considered in terms of, but not limited to, the severity level of congestion, the number of buses needed, and station spacing.
- Guidance systems can be used as a strategy to optimize BRT.
- Time-of-day restrictions on bus lanes with the coordination of businesses regarding freight delivery time need to be considered in order to assure a seamless movement of bus passengers and goods.
- London's bus lanes set back from intersections; non-queue jump or queue jump is another option for narrow streets.
- Measures such as person delay and other person-based measures need to be considered. In particular, person throughput is important.

- Enforcement is the key. For example, a "short blast" approach worked well in London.
- Right-turn issues need to be addressed.
- The transit agencies and related departments need to explore the link between land use and transit.
- Bus bulbs can be built to create passing space.
- Real-time passenger notification is very important for customer satisfaction.
- The minimum lane width should be identified.
- Areas to study to identify the level of acceptable standards for implementing BRT on narrow streets may include:
  - Can off-board fare collection pay for itself?
  - Optimal station spacing
  - Dealing with physical barriers
  - Rider perceptions of "lite" BRT
- It seems that "counter flow bus lanes" work fine in London, but safety may be compromised to some extent.

Public Outreach

- Lack of public outreach creates tension. Identifying and engaging appropriate stakeholder groups helps make changes happen.
- There will always be a tension between wanting to get a project done in a fast manner and conducting thorough outreach and consultation processes. Nevertheless, proper outreach is important to ensure long-term success.
- Trust: how you build it before you go to the community?
  - Interagency coordination
    - Coordinating with elected officials. The importance of this is exemplified by a project in Chicago, where an alderman blocked the project after community consultation, thus creating mistrust within the community because their input was ignored
  - Acknowledge mistakes, especially when agencies are going back to a community after a significant blunder.
  - Don't take ideas from the community and then ignore them.
- Message
  - Know who your audience is and tailor the message accordingly.
  - Use language that the community can understand.
  - Avoid dwelling on unnecessary details.
  - Gather key data including benefits, trends, future impacts, and costs. Doing so provides a full picture including future trends and consequences of inaction.
  - Communicate both the short and long term benefits.
  - Show results from pilot projects or other experiences.

- Outreach strategies
  - Ensure wide representation
    - Important to reach out to those who will benefit from the changes, such as bus riders and business owners, not just those who will oppose the project.
    - Build momentum by meeting with those who are in favor of the project.
  - Involve people early on and throughout the process.
  - Format: open houses, workshops, task force, charrettes.
  - Stay away from lecture-style "pontificating" type meetings.
  - It is important to facilitate dialogue between the public and practitioners working on the project, as opposed to senior staff or agency representatives.
  - Use innovative technologies to disseminate information: web sites, blogs, social media.
- Who: Is it always the transit agency that leads?
  - Consider roles of in-house outreach and whether consultants are needed. Train the agency staff members if in-house outreach is chosen.
- Important to evaluate the efforts and quantify the benefits.

BRT Vehicles and Maintenance Issues/Operations

- Service in general
  - Lack of BRT number generator TIC—bus systems have different fares and services.
  - First priority should always be "service."
- There are two reasons why doors are usually on one side:
  - BRT operates along either curbs or the median but not both.
  - Passengers tend to board onto the same platform at each station.
- Lanes in mixed traffic
  - The makeup of downtown one-way streets comprises 4 to 6 lanes, and having a dedicated contra-curb lane may have some drawbacks. In Chicago, for example, pedestrians were killed when crossing a contra-flow bus lane.
- Seats vs. doors
  - In London there are double deck buses—one vehicle has 80 seats and the public is satisfied.
  - Need to fully evaluate the benefits and costs of having two doors vs. three or even six doors or at least 1 double door as in Cali (Colombia), where most boarding is on the left side.
  - In New York, there are two doors and then a third door would be near the driver's seat. Implementing three doors is a major challenge.

- Type of fuel
  - How about CNG and hybrids? Hybrids are the cleanest compared against CNG.
  - CNG belongs in the parallel series of mechanics of low sulfur and filter.
  - Series vs. parallel hybrid:
    - The series hybrids have relatively high speeds and great transmission. There is more stress on fuel.
    - The series hybrid on a generator batteries split determine by computer—no connection because of low speed.
    - Parallel hybrid is on most cars, i.e., when you are going to reach high speeds and fewer stops are necessary.
    - Cities big on parallel include San Francisco, Toronto, London, Denver, Seattle, and Beijing.
    - The typical fuel bus standard in New York is parallel hybrid but they are worse for NYC. It would be preferable that NYC use series hybrid.
- Supply problems
  - Usually, there are not any problems with obtaining diesel fuel. In fact, one can get low sulfur diesel quite easily.
  - Need to carefully review the literature on renewable energy.
  - There are different types of batteries, lithium and cadmium. Cadmium is known to be a contaminant of concern.
- Benefits of BRT in Washington, D.C.
  - There are huge cost savings to using BRT versus building a new railroad track.
  - 25% of World Bank deals are related to transportation, so why does Washington, D.C. have the worst bus system in the United States? Residents dislike buses; people just prefer rail. Need to change bus service and image as well.
  - Competitive contracts cost the same as other grants. If an agency uses federal funds, then it must use union workers or have their approval.
  - The Circulator in DC is an attempt at BRT but is geared towards tourists, and there are heavy maintenance costs involved.
- Buy American
  - It is hard to avoid buying international brands of buses.
  - The biggest challenge is how to secure a facility service into using contract services.
  - Are foreign buses better or cheaper? It is difficult to answer that question.
- Policy concerns
  - Bike racks on buses
    - Are bike racks contrary to the goals of BRT? In Las Vegas, there are bikes in bus lanes already. How about bike parking near BRT stations?

    - A case study in San Francisco assessed the effects of a downtown area free of bicycles.
  - Sewage and other utilities and services
    - How do you accommodate sewage lines and other utilities? The case of Cleveland provides some answers.
    - There are curebs that are only 2" and snow tends to pile up. It would be much more difficult to remove snow with smaller curbs.
  - Transit oriented development
    - Some growth is likely around BRT lines, but not much in cities such as San Francisco, which are already densely populated.
    - In Phoenix, land use development around stations has not been considered, in part because of urban sprawl.
  - Control center
    - Are there any spatial requirements with operator radio?
    - Central control room and operator radio features from Latin America have been challenging to control. It is very tough for every bus radio signal to keep in contact with the control center.

Mr. Zimmerman concluded the session by noting that agencies should begin with the identification of market needs for public transit in the corridor and devise a service plan. This can be a guide in determining hardware choices for each corridor. He added that a low-floor bus is 30% more expensive than a conventional high-floor bus and has less capacity (e.g., 20% less as in Santiago, Chile). Instead of purchasing new low-floor vehicles, agencies can consider simply raising the boarding platform to serve high-floor buses, which has the potential to save money and increase capacity. Hardware choices are a derivative of the market and service.

APPENDIX

B

Los Angeles Workshop Summary

"Los Angeles Bus Rapid Transit Summit: Traffic Operations for Transit/BRT and Implementation"

Presented by the National Association of City Transportation Officials (NACTO) and the NYU Rudin Center for Transportation Policy and Management

Overview

On June 28, 2010, near 40 representatives from NACTO attended the second workshop on BRT and Bus Priority Best Practices. With support from the Los Angeles Department of Transportation (LADOT), the workshop was organized by the NYU Wagner Rudin Center for Transportation Policy and Management in collaboration with NACTO. It was convened at the Los Angeles County Metropolitan Authority (LA Metro) on June 28 and at the Caltrans Building on June 29, both in Los Angeles. This workshop was planned with a focus on the implementation of BRT services in the Los Angeles region. This included issues of design, public perception, ridership, branding, traffic engineering, and operations including traffic signal prioritization, fleet supervision, and systems control. The participants had the opportunity to hear about the challenges and successes of recent developments from leaders of LA Metro and the LADOT, to learn from a series of illuminating case studies, and to share strategies and best practices from their own experience.

Los Angeles Metropolitan Transportation Authority

Rex Gephart, Director of Regional Transit Planning, LA Metro

The first day of the workshop was convened at the Los Angeles Metropolitan Transportation Authority (LA Metro), the transit operator in Los Angeles County. Rex Gephart, Director of Regional Transit Planning, discussed the planning and implementation of LA's hierarchical network; then he led a guided tour of the Metro Bus Operations Control Center and of different metro lines (Metro Rail, Metro Rapid on Wilshire Boulevard, and Metro Orange Line).

Figure B-1
LA Metro High-Capacity Bus

Why BRT in Los Angeles?

Metro and the City of Los Angeles collaboratively developed the Metro Rapid BRT system to provide faster and more reliable bus services to passengers, with the hope that it would attract more riders. In general, the public in the Los Angeles area were not satisfied with the slow pre-existing bus services. The low average bus speed, which had declined by 12% since the late 1980s, was attributed to the fact that the in-motion time of buses was only around 50%.

Metro Rapid (BRT) Attributes

Metro Rapid has nine primary attributes:

1. High-capacity buses: Compressed Natural Gas (CNG) buses with low-floor, 3 doors, and 60 seats are being operated.
2. Branded buses and stations.
3. Bus signal priority. Loop detectors installed in the pavement and transponders equipped with the buses are used to compute the exact location of buses and make possible the estimation of the time a bus will arrive at the next intersection; each bus is equipped with an onboard computer and, using a wireless communication device, the computer transmits a signal priority request to the control center.
4. Frequent service
5. Headway-based schedules.
6. Simple route alignment.
7. Less frequent stops.

8. Integrated with local bus service.
9. Level boarding and alighting.

BRT Program is a Success

The regional BRT network, consisting of 27 Metro Rapid corridors, 420 peak hour buses, 405 system miles through 33 cities, and 1,200 intersections with bus signal priority, is nearly complete. As a result of these improvements, passenger travel time has become 23% faster, and ridership has increased between 12% and 49%, depending on the corridor. Moreover, one-third of the ridership increase is new riders to public transit.

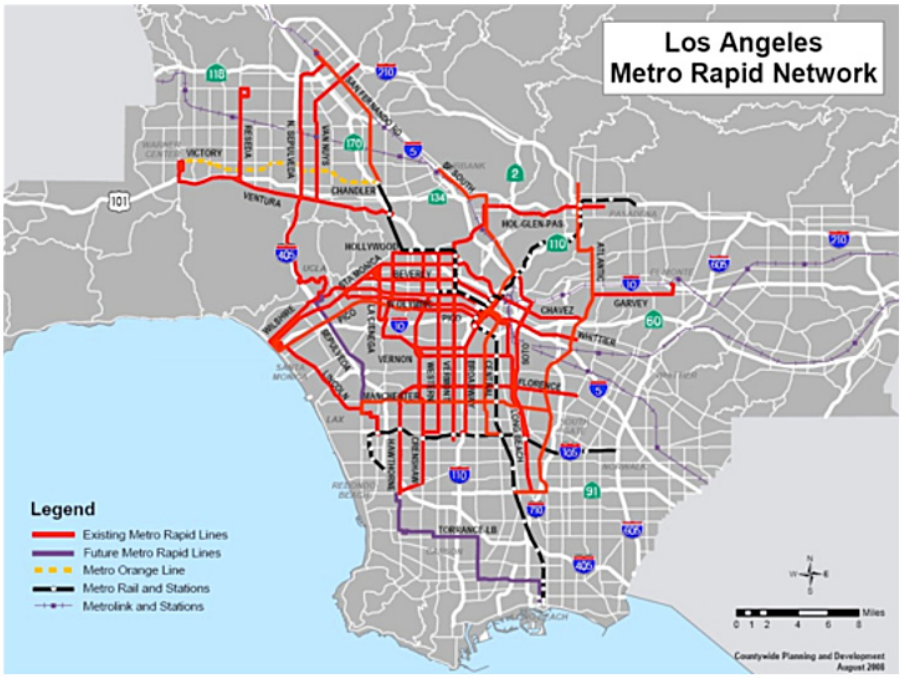


Figure B-2
LA Metro Rapid Transit Network

What's Next?

LA Metro and the City of Los Angeles are planning further improvements to their transit services. In addition to completing the planned corridor network in the near future, they will construct exclusive bus lanes and install off-vehicle fare collection devices.

Orange Line BRT

After providing an introduction to BRT in general, Mr. Gephart focused his discussion on the development and implementation of the Orange Line BRT, which opened in October 2005.

Unlike Metro Rapid, the Orange Line can be considered a full BRT. The 14-mile line has its own right-of-way. All 14 stations (1 station per mile)

Figure B-3
LA Metro Bus

have a distinctive look, which is a component of the branding effort. Six park-and-ride lots were built along the corridor, and landscaping provides a scenic buffer between the corridor and local traffic. The safety of bikers and pedestrians has also been taken into account. In a sense, the Orange Line is a light rail line on rubber tires—BRT at its best. Other system elements include off-vehicle fare collection, next stop announcements, passenger information displays, and bus signal priority.

The operation was successful from its debut; more than 83,000 people rode on opening day, and now 25,000 passengers use the Orange Line on an average day. One-third of the ridership increase is new riders to public transit. In addition, 77% of customers state that their travel times are comparable to auto travel.

Lessons Learned – Create Market Value

Mr. Gephart concluded his presentation by pointing out four lessons learned that any BRT system

must have to be successful:

1. Speed—the system needs to provide time-competitive door-to-door service. This is achieved by bus signal priority, less frequent stops, headway-based schedules, fewer transfers and shortened dwell times (station placement and design).
2. Frequency—operate frequent service—10-minute or less headway-based schedules.
3. Consistency—deliver consistent departure intervals and travel times. Exclusive bus lanes, reduce bus bunching (using ITS), traffic signal timing (improve directional flow), passenger information displays.
4. Connectivity—build a network that connects places together. This includes direct bus-to-bus and bus-to-rail connections, shape regional growth.

Day 2 Welcoming Remarks

Rita Robinson, General Manager, Los Angeles Department of Transportation

Increasing Transit Ridership: Behavioral Change

Rita Robinson, General Manager of the Los Angeles Department of Transportation (LADOT) and a member of the LA Metro Board, linked Los Angeles' traffic problems to behavior and personal choices. Without a change in public transportation usage, she said, the heavy traffic that commuters experience on a daily basis will not be alleviated. A large part of the struggle in increasing ridership in Los Angeles is getting people to take their first public transportation ride. While Los Angeles residents share a common goal of increasing efficiency and decreasing congestion, they must challenge themselves to get a real feel for what public transit is like and adopt a realistic view of the Los Angeles commute and the time that it takes to get from one place to another. This involves a major change in perception and to change rider expectations; LADOT once convened a group of people who had never taken public transit in Los Angeles to provide a first-hand experience about transit and teach them how to take the Metro Red Line. As a result, this group now uses public transit.

Beginning of a New Generation in Public Transit

Ms. Robinson, who fills the important role of facilitator between the political front and the transportation implementation side, considers transportation to be the most challenging sector she has worked in, by far. However, despite negativity and criticism from leaders and the public alike, LADOT has successfully implemented safe and secure lines and has overseen the beginning of a new generation in public transit for Los Angeles. LADOT and Metro have worked together to implement the highly-successful BRT system that started operations in 2000. The Advanced Transportation Management Systems (ATMS) Center controls the traffic signals along 25 BRT priority systems throughout the city of Los Angeles.

Ms. Robinson highlighted several notable recent LADOT improvements, including:

- The Metro Orange Line, which opened in 2005, has been very successful and has high ridership despite initial pessimism. The program is set to be expanded —an extension to the Warner Center by 2012.
- The third leg of the new system involves a dedicated busway along Van Nuys Boulevard, a major thoroughfare in the San Fernando Valley.
- The Wilshire BRT system is in its final stages of environmental review.

Moving Forward

Current efforts to improve the Los Angeles transportation system is part of a vision for the future. As part of her involvement with LADOT for the

next three years, Ms. Robinson plans to build a strong group of younger people to run the department and to run transportation. It is their legacy, Ms. Robinson says, that will enhance the future of Los Angeles as a thriving city. Many young people have a vision of public transit in Los Angeles, and it is important to improve the system so that the next generation can live in a city where public transit is a popular mode of transportation. Young people need to be prepared to run public transit and keep making improvements to the system. Ms. Robison said that running the system and implementing it are two different things, especially in California. All plans undergo an Environmental Impact Review (EIR) process, which can be very onerous, and state laws are very strict with respect to environmental legislation.

Ms. Robinson concluded by stressing the importance of working together with lawmakers, politicians, residents and potential riders to improve the system and make progress by using available funds and resources in order to reach consensus on any plans. Ms. Robinson was thankful for Ray LaHood, the U.S. Secretary of Transportation, who impressed her with his knowledge about each city's particular transportation issues and challenges.

Q & A Session

- *How do you distinguish the public transport as provided by the city (LADOT) from that provided by LA Metro? How do the two agencies fit together?*

  LA Metro is concerned with regional transit, while the city DOT has just a small carving of local transit—the DASH, the small legs of the transit serving downtown Los Angeles and surrounding communities, which has more of a community flavor, and more specialized programs like City Rides for elderly and disabled riders. Also, the DOT runs charter buses for school activities.

Case Study 1: Metro's Branding and Communications: Transforming Transportation

Michael Lejeune, Creative Director, LA Metro

Mr. Lejeune set the stage for this presentation by explaining that in 2002, when he had first started with LA Metro, the agency was under duress. Ridership was decreasing and the agency did not have the number of programs and lines that they currently have. The LA Times and other publications repeatedly criticized the agency's ability to provide transportation. Since then, there have been a lot of improvements in terms of people's perception about public transportation in Los Angeles due to the growth of the system and better communication efforts. Transportation, Lejeune says, is a product and must be marketed as such.

Objectives of Communications Program

The communications program at LA Metro has simple objectives: increased ridership, improved perception, and increased funding. The primary goal was to make LA Metro essential to the Los Angeles so that the city could decrease the highest traffic and pollution levels in the country. Automobiles (especially single-occupancy vehicles), which are mostly responsible for traffic congestion and air pollution, are the main competition to transit. Therefore, the marketing strategy has stressed that there are other available and efficient alternative modes of transportation, such as BRT, rail and other personal transportation options.

Image is important especially in Los Angeles, where the car culture was born. Image tells you how you are going to feel about something. The public prefers to sit in traffic in their cars because not only is it their own space, but because it portrays a likeable image that is specific to Los Angeles. Public surveys found that LA Metro's image was poor, and there was confusion and negative perceptions about its services, ranging from a lack of consistency to poor public and voter confidence—approximately 80% of those surveyed felt that LA Metro was not doing a good job and 77% felt that it was unsafe. Since then, the agency has worked hard to improve its service and operation.

Logo Updated and Made Proprietary

To improve its own image, LA Metro decided to use quality art and design. Since the first rule of marketing is consistency, and at that point LA Metro was inconsistently represented and portrayed by multiple and diverse symbols, the agency worked on standardizing its image. First, it tackled its logo, which was not yet proprietary. It was inconsistently displayed using different sizes, colors, and fonts, resulting in non-cohesive marketing efforts from various agencies within Metro. Now, they own three configurations of the Metro logo, using the word "Metro" rather than MTA because that is the term people most identified with, similar to the way FedEx rebranded from Federal Express.

Figure B-4
LA Metro Logo

Along with the new logo came the question, "Who are we?" Documents and advertisements referred to the agency as Metro, LACMTA, MTA, LAMTA, and PTSC. Some of these are incorrect and mean nothing to the public. Public surveys found that 83% identified Metro as the service that runs in Los Angeles, along with other agencies. Because they were best known as Metro, it was clear that all branding and marketing efforts must use Metro as the face of the agency. All new materials were developed in the same way, using the same name so as to avoid customer confusion and present the organization cohesively.

Rebranding Transit Fleets

Next was the look of the actual vehicles. Using a paint shop at Metro, a new paint scheme was designed for the buses that would be much more appealing than the unassuming plain white buses that were on the streets of Los Angeles. Because there was no budget for rebranding, the new image was incorporated gradually when vehicles needed to be repainted, thus resulting in lower total costs (between $60 and $100 more per bus). Eventually, the entire fleet was transformed with eye-catching and modern colors, decals produced by 3M, silver undercarriages, and upper air conditioning units, making Metro's vehicles brighter and more stylish. The revamped buses driving all over the city provided free advertisement in itself, showing the public the new face of Metro. The trains were also made sleeker and given a retro 1930s feel, resembling trains from the Golden Age of rail. Marketing campaigns were developed featuring buses in similar fashion as Corvette cars used in advertisements, thus directly targeting the competition. A car photographer was hired to take highly stylized photographs of the newly-designed vehicles supporting the Southern California image.

Figure B-5
Orange Line Branding

When it came to marketing the Orange Line, the agency wanted to stress everything that the new line was avoiding the obvious pitfalls of having to explain what it was not. With the implementation of the dedicated busways, the Orange Line provided transportation for the San Fernando Valley, a service that had been anticipated for a long time. The campaign slogan used to advertise this service stated that the Metro Orange Line is faster, smarter, and the bus that acts like a train, and people always prefer trains because they run on time and they run frequently.

Marketing

The feeling of reliability and accountability was tackled, in part, through marketing efforts. People always want the product to meet their expectations. With regards to the logo, it was decided that it would be portrayed in black or in white, and the marketing department developed a grid system using bright photography, humorous comments and a single typeface to blend together the look of Metro, resulting in a product that denotes strength, dependability, and reliability.

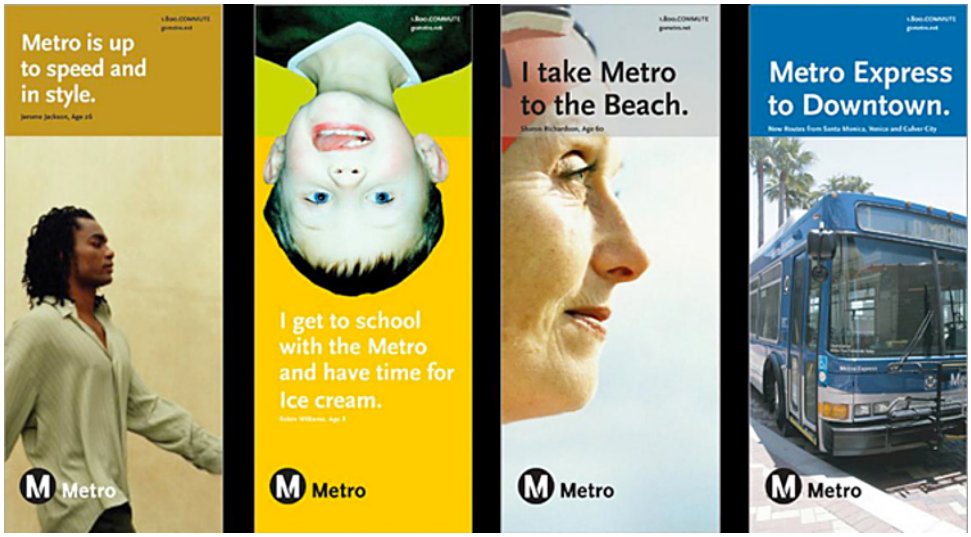


Figure B-6
LA Metro Station Signage

The logo is always presented in the lower left of any given space, that space being designed to capture Los Angeles. Los Angeles is seen as a progressive, colorful, modern and interesting city, and Metro's materials were designed to represent just that. Advertisements consist of bright photography, illustration, blocks of color, and interesting conversational language. Metro has its own photography staff, print shop, and paint shop, and they perform all of the copywriting themselves rather than using an advertising agency, and thus can maintain the desired level of cohesion.

Metro also developed its own maps; after looking at others samples from around the world and studying best practices, the agency printed service

maps for riders as well as planning maps to explain changes throughout the implementation process. The Metro map is a simple footprint of Los Angeles County. The 12-minute map was devised to be read without timetables, so that a rider can show up at any station and expect his/her ride to be there within 12 minutes. This is a way of presenting easy service, easy ideas, and an easy way to get around, which is very important to discretionary riders, especially those who are riding for the first time and are unsure of the experience and environment.

Art Program Engaging the Community

Through legislation and built-in budgeting, 1% of construction costs go to public art. LA Metro has developed an art program that involves the vibrant art community of Los Angeles. The art program finds artists from around the county to install art in a wide variety of mediums of art, not just the tile work that is expected of bus and rail stations. About every three months, sets of photographs, beautifully illuminated using back-lit boxes, are rotated among the stations. Workshops are also held where artists can come to find out what opportunities are available, thus opening doors to those who would not have considered public art an option for them. The works of more than 200 artists have been installed across the network. Some of them are part of changing exhibits, while others are more permanent. They range from tile work to sculpture to photography. In this way, Metro's art program not only develops Metro's look but also helps support and gain exposure for the Los Angeles community art scene.

The Neighborhood Poster series is a program that asked artists to visually represent issues and ideas that they have about their own neighborhood. The posters are displayed on buses, trains and stations and are distributed throughout the community. Moreover, selected posters are displayed in store windows and galleries and at online stores from which they can be purchased, and the artists receive royalties from these sales. In this way, LA Metro is really representing Los Angeles while supporting its community.

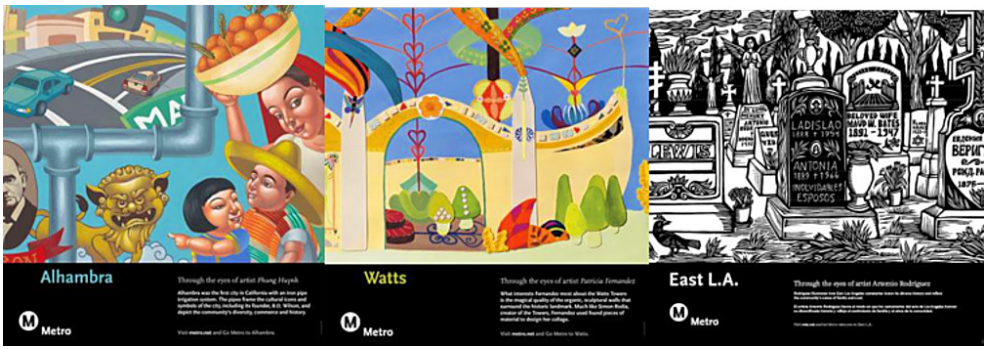


Figure B-7
LA Metro Neighborhood Posters

New Image Well Accepted

Metro's branding efforts have received a lot of exposure in television and film and have won a variety of design awards, including the Re-Brand Award, which is a highly-recognized international award—past winners include Coca-Cola, Four Seasons Hotels, and Virgin Atlantic Airlines. In addition, public surveys and polls have shown improved public perception: Metro's "strongly favorable" rating has increased 17% while "unfavorable" responses are down 15%. Whereas 78% previously found Metro unsafe and would not consider riding public transit, now 78% have answered that Metro's image is improving and that its service is much better. Discretionary ridership is now at 29%, a 7% increase over a one-and-a-half-year period. Metro also began to get positive mention in publications such as *The Fast Lane*, *Fast Company* magazine, the *New York Times*, and even the *LA Times*, the latter having historically been very critical of Metro.

Using imagery and language that is unique to Los Angeles is a major part of Metro's rebranding success. Mr. Lejeune has promoted for ideas to be presented using vernacular language instead of overly massaged and reviewed marketing ideas. Lines such as "It beats the 101" targets locals who know exactly what that means—that public transportation is faster and more efficient than driving your car on the 101 freeway. They also went against the grain of a prevailing bias towards rail by pushing buses as the primary new mode of transportation. Mr. Lejeune felt their buses were aesthetically pleasing and modern enough to develop a bus-oriented community. Using their signature bright color photography and clever slogans, buses were presented as a stylish shortcut, a way to get home early in a relaxed and leisurely manner (e.g., reading, checking e-mails) instead of experiencing traffic congestion and delays when driving a car.

Metro continued to deliver the message that cars and traffic are the nuisance and Metro is the solution. They started using their copyright to produce materials like stress balls and T-shirts to further develop themselves as a recognized product. They opened a campaign called "Imagine" that depicted public transportation as riders would like to see it in the future and opened an Internet dialogue, asking people to share their visions. Through Metro.net, people can take surveys, see the latest poll results, share their own ideas (instead of just receive those of Metro), make comments, and view interactive videos on current service and future plans, all of which led up to the 2008 election, when Metro introduced a referendum to poll about a tax measure (Measure R) that would increase the sales tax by 0.5%, a dedicated revenue stream strictly reserved for Metro improvements and operations.

A very cohesive and well-put-together brochure was developed to explain measure R. Metro had to be very careful about the language it used, never using the word "vote" and never advocating for the measure. Metro needed

a 68% vote to win Measure R, and in November of 2008 it won by 68.23%. Many agency staff members were against introducing the referendum, feeling that they were not ready for a move as monumental as this. However, the polling victory validated and encouraged workers throughout the agency, proving their efforts had borne fruit. Measure R opened the gates for five new rail lines, more rapid transit service, and BRT in Wilshire Boulevard. Roughly $40 billion will become available over the next 30 years for these and future projects.

Lack of cohesion had previously prevented Metro from receiving federal funding. Now, with clear, precise, easy-to-read presentations, and with the prospect of the Measure R sales tax revenues, they were able to take their case to Washington and demonstrated that their transit program deserved funding support.

Mr. Lejeune concluded by citing the results of Metro's rebranding and marketing efforts. It gained higher discretionary ridership—considered the "Holy Grail"—improved the public's perception, and brought enough voters to the polls to gain expanded funding. What Mr. Lejeune found particularly interesting is that more than 70% of those surveyed found Metro's service to have improved, when service had not changed that dramatically. Rather, their program had increased advertising on a monumental scale, reinforcing the important "lesson learned" that art and design can completely transform public perceptions.

Q & A Session

- *Has there been any backlash from board members on investing a lot of resources on branding?*

  The agency put a lot of funds into service and operations, and the marketing budgets are very small in comparison to the cost of the service itself. LA Metro overall budget is $4 billion, but the Marketing Department had to cut approximately $1 million out of its budget last year. The problem is that in time of financial crisis, it is so easy to cut back advertising budgets, because nobody gets laid off—the team just spends less. Nevertheless, these budget cuts have real repercussions: LA Metro is on the cusp of a big movement of moving people towards transit, and if the agency stops talking to the public, then progress is going to stop. Lejeune added that there are probably areas of the agency where the budget could be trimmed down without cutting advertising funds. LA Metro's farebox revenue is down, and it is not going to increase if the agency stops advertising. To save money, the staff are really trying to find ways of being creative in the media space, e.g., with Facebook pages to promote all of the agency agendas and programs. Lejeune added that the LA Metro Facebook page has 2,100 "friends." When the staff read things in blogs, they add it to the agency's own blog, called "The Source," which was the agency's end-run around media like the *LA Times*

that consistently wrote negative comments about LA Metro. Now that the services and image have improved, this newspaper has stopped writing about public transportation. Before it used to have three or four reporters dedicated to public transportation, but now they rely on freelancers. LA Metro has hired an *LA Times* Pulitzer Prize-winning journalist to write the agency's blog. The Source is now the real source for public transportation information in Los Angeles and the *LA Times* will pick up and reference materials published in this blog.

- *How many people are on staff, and how much of your resources is marketing budget?*

  Lejeune answered that the year he started the advertising, budget was at approximately $800,000. After deciding to have an in-house public relations unit, the budget rose to close to $3.5 million, but currently it has shrank to $1.5–2 million. The staff are using advertising money in different ways now—it doesn't pay to advertise in the *LA Times* anymore because people aren't reading the paper. Nevertheless, they advertise online sometimes with the *LA Times*, but the agency is also using its own stations and buses. LA Metro uses its own king-size ads on the sides of buses—roughly 2,200 buses, of which 800 king-size ads are used for the agency's advertising campaigns. He added that the communications group has shrunk consistently each year because it's very easy for the board of directors to say, "cut communications, cut communications, cut communications." Therefore, this group's activities have been curbed a bit, but it still has about 200 people, including 80 phone operators. The design group that he works with and oversees has roughly 30 people but only 4 full-time Metro employee designers, supplemented by 4 contract designers who work in-house with the team every day. In addition, the group has 4 people who are called "as needed," but they're very much needed, and that is an easier way for the HR department to approve employing additional personnel that works full time when needed, and then the team often resorts to consultants.

- *Are there any areas in which you feel you have to improve your image or is there a field that you are not servicing very well?*

  One of the areas that the team is really concentrating on is the public involvement process in projects. LA Metro has roughly 23 new projects, which are in every part of the county. For most projects—from the widening of the I-405 freeway with a carpool lane, to extending the subway all the way to Santa Monica along Wilshire Boulevard—the agency is involved in short-term disruptions due to construction, such as digging in a lot of places, and that is often upsetting to surrounding communities because when one constructs, often one messes things up. These temporary changes range from closing access to businesses and taking away parking in front of their

stores to relocating utilities. For example, the agency is going to dig under $3 million homes next to the Wilshire Country Club, and that is scary. So the Metro communications team has developed all the materials for public meetings, including videos for new projects and has involved really great producers and directors. The team created a whole system of illustrations for all these new projects, using the same artists for all of them, so whether people live in Brentwood and go to public meetings about the new subway services, or are riding the system, or reading the Metro blog, or visiting the Metro.net to find out about new activities, they are all seeing the same type of presentation for all of the agency's projects. Therefore, they can start to see the isolated project that affects them as one of many improvement projects that are going on in Los Angeles, as opposed to feel that the agency "just wants to build that subway under my house and I'm not sure about that;" and that goes a long way in relieving the tension felt by various communities when the agency starts a construction project. Lejeune added that one area that he wishes he could assert some influence would be the actual planning or re-planning process, and he has many ideas about ways to improve such process. Finally, he added that he wished that the communications team could do seminars for all of the agency's bus operators on customer perception and customer friendliness. All of the above suggestions would go a long way in improving people's perception about LA Metro.

Case Study 2: Los Angeles, Traffic Engineering and Operations to Support BRT, including Traffic Signal Issues and Approaches

Kang Hu, Senior Transportation Engineer, LADOT

LADOT's Involvement in BRT

Mr. Hu began by providing some background information about LADOT – an agency with a multi-million dollar budget that is not only responsible for its core function of traffic signal operations, but also provides transportation services, supports a strong parking meter program, assists LA Metro with its bus operations, and has partnered with LA Metro to advance the National BRT Demonstration Program since 1997. There has been a strong commitment from the city's recent mayors to improve transit services in Los Angeles. The main focus has been increasing bus speed, which is slow in many corridors; therefore, LADOT has been working with Metro to improve bus speed in 25 corridors. LADOT is also responsible for traffic safety improvements, which became a specific issue in 2005 after the Orange Line was launched and experienced safety problems that garnered much attention and concern.

Transit Priority System (TPS)

A centralized transit priority system was developed by the agency in order to have a fully integrated system linking signal priority to the existing Adaptive

Traffic Control Traffic Control System (ATCS). Integration was a key concern so as to avoid the creation of two separate traffic control systems. LADOT was clear in its goal of helping the cross street circulation as well as the main streets.

The new traffic control center is called the ATMS Center, where there are 27 traffic controllers. The system already had an existing communication backbone, which was then built upon and developed into TPS (Transit Priority Survey). There is a database that connects to the local networks and displays on TPS work stations, which then uploads to the web server.

A critical piece of TPS is bus detection. Three different technologies were tested for several months before the decision to use a loop transponder-based technology, which is an inductive loop on roadways that uses antennae to receive ID codes. They place advance detectors just past the upstream bus stops and also release detectors, so that buses send information from both check-in and check-out points. Within one second, check-in information is sent to a controller, which then sends information to central. The control center will then check the schedule to assess the situation, to see if the bus is running according to schedule, on the basis of which it determines whether to send a command back to the local controller of the Transit Priority System. Intelligence built into the software allows the bus's speed to be calculated, which makes for more accurate predictions.

Traffic priority is executed in one of three ways: early green, green extension, and phase hold. In early green, a signal phase is started earlier than normal to minimize delays for approaching buses. In the green extension phase, the light continues past its normal endpoint to help a bus pass through a critical intersection. Phase hold is unique in that it holds a phase, such as holding a green light until a bus clears the intersection. It is also useful for buses making left turns, where an electronic arrow can be held until a bus completes its turn.

Mr. Hu then illustrated how traffic engineers operate using numbers. Time lengths for lights will be broken up into percentages. If a three-phase signal operation designates 45% for the main street, 35% for the cross street, then the left-turn reserves 25% of the time, they can extend the green and allow the percentages to fluctuate if a call comes in from the control center that requires an additional 10% time to clear an intersection. The other two percentages decrease automatically. The width of streets is also a factor, because at many larger intersections pedestrians need more time to clear the intersection safely. Pedestrian clearance is untouchable. On the Wilshire Boulevard street project, they plan to increase the allowance to 15% for many stations, calling it "Super Priority." Mr. Hu added that in Los Angeles, they have a lot of full capacity intersections.

LADOT provides Metro's dispatch center with fiber optic communication from its central control center, providing Metro with footage from LADOT's 400+ video cameras. This allows them to troubleshoot, and look at maps and traffic operations. Multiple agencies have access to TPS, Metro being just one of them. Using these video cameras, LADOT is able to predict the amount of time it takes a bus to clear an intersection based on its check-in and check-out times, and prepare signals based on those predictions.

TPS Performance Benefits

The benefits of TPS, which are significant, were then quickly described by Mr. Hu. The Metro Rapid buses achieved a 25% reduction in total travel time, and approximately 30% of the total travel time saving is attributed to the deployment of TPS. In addition, bus delays at signalized intersections were reduced by between 33% and 39%. Additionally, the delay to other vehicles caused by TPS is only about one second per vehicle per cycle, which is unnoticeable to most vehicles and helps overall traffic in Los Angeles City.

Orange Line

Mr. Hu then discussed the traffic operations behind the successfully implemented Orange Line. A major challenge for traffic engineers was in controlling the different types of crossings and ensuring safety. Much of the Orange Line busway is in the median, and such alignments have experienced problems all over the world, with most problems arising from left-turning vehicles. Signals needed to be appropriately designed to accommodate both the non-turner and turners in a way that will not result in back-up traffic while also accommodating room for train or BRT movements. The Orange Line was given priority in these situations because of its large ridership. Diagonal intersections create problems with right turns, so LADOT worked with LA Metro to widen stretches to allow right turn pockets and maintain traffic flow for the non-turners. That was not enough, however, because right-turners did not realize that buses also had green lights. As a result, they implemented isolation areas and staggered pedestrian crossings, creating visually-pleasing landscaped areas along the median to provide an isolated mid-crossing safety feature. Repainting of crosswalks and implementation of electronic arrows aided in the communication between traffic controllers, pedestrians, and drivers.

LADOT, according to Mr. Hu, is also designing an underground connection from the Orange Line to the Metro Rail system. This will make the pedestrian connection much safer and quicker, ultimately encouraging public transportation use.

Similar to the rebranding efforts discussed by Mr. Lejeune, LADOT is standardizing features for the Orange Line. Most of the violations and accidents that occurred when the line first opened were due to peoples' unfamiliarity with the busway operations. Therefore, the agency installed photo cameras at every

major crossing to alert drivers when they drive through them. In the first two months after the cameras were installed, the agency was able to identify plenty of violations. A lot of people either didn't know the location of the busway crossing, or they just ignored it. Since then, LED lights have been embedded into the pavement and flashing lights have been installed to let drivers know that buses are approaching. The agency installed this LED lighting system in mid-2010.

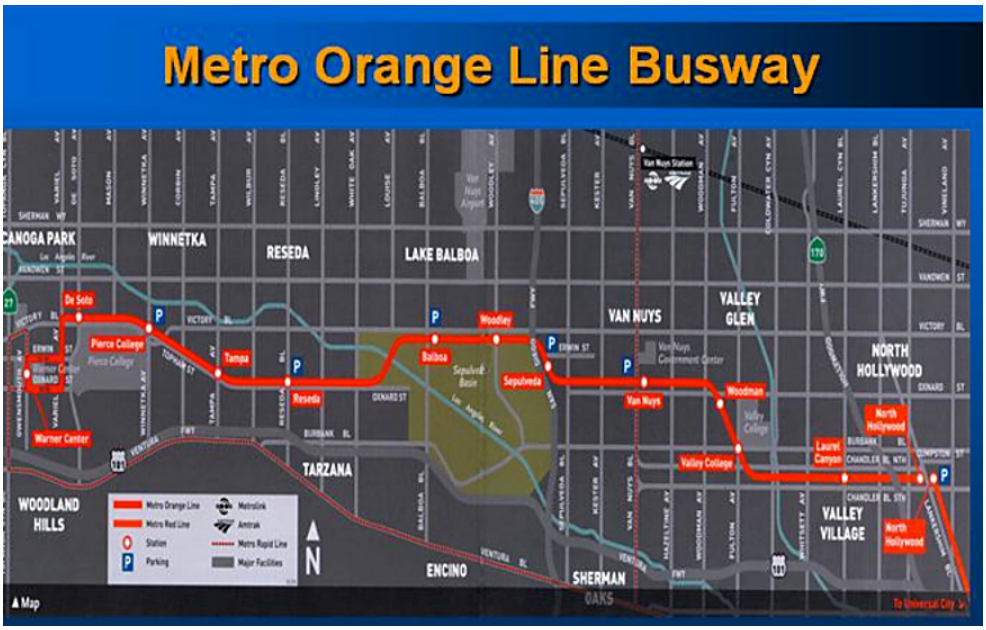


Figure B-8
LA Metro Orange Line Bus Route

The LADOT is also developing the San Fernando Valley North-South Transit Corridor Project. Currently in construction, the 4-mile extension includes 12 signal light crossings. Also under development is the Second Corridor, which is one of the heaviest corridors in the San Fernando Valley, and median transit bus lanes are to be implemented. Along with Metro, LADOT is working to clear the project environmentally.

Although the Orange Line has been highly successful, Mr. Hu found that some community members still prefer LRT (Light Rail Transit). To conclude, Mr.Hu addressed the need for LADOT to thrive towards higher standards and while they have experienced great successes, they still have some way to go. However, he is working for the common goal: to alleviate traffic in Los Angeles by ensuring safe and efficient public transit.

Q & A Session

- *During his presentation, Rex Gephardt mentioned that LADOT was considering crossing gates; could you please elaborate on this?*

  Mr. Hu said that this issue was discussed extensively, but according to the California Vehicle Code, crossing gates are not recommended for busways,

though they are recommended for light rail. The agency beefed up a lot of signs reminding people to look both ways, because often pedestrians are dashing into the station on one side of the busway and not checking for an on-coming bus on the other side. LADOT has bus crossing signs and a lot of pavement markings, to ensure that people stop at the crossings and cross at the right place. The bus crossing signs are really eye-catching, so they can't be missed. The agency has also installed another type of signs for when the buses are approaching rapidly to alert pedestrians that a bus is coming. The huge success of the Metro Orange Line really created a lot of pedestrian traffic crossing the thoroughfare between the ends of the Red Line and the Orange Line, so the agency had to put in new signals and paint white pedestrian crosswalks and is also working with Metro to create an underground connection that will make the Orange Line connection with the Red Line subway station safer and quicker.

- *Will that connection happen?*

  Yes, it's in the design stage. The funds are available.

- *How are LEDs installed? Any problem with them breaking down due to heavy traffic?*

  The light is embedded in the pavement. The surface is actually flat with the street surface, but the LED is actually two or three inches below but nevertheless visible to drivers.

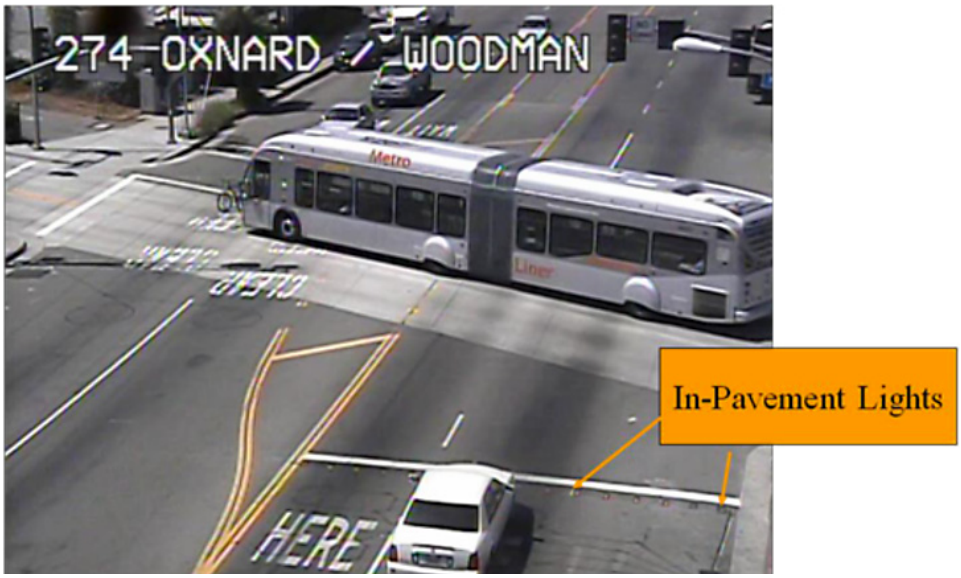


Figure B-9
In-Pavement Light System

- *Do you have any intersections where you have different signal priorities by routes because they are coming in at a different angles, for example, or because you have one that goes straight and another that makes a left turn?*

Mr. Hu answered that the LA street system is a grid, so angles aren't a problem. There are Metro Rapid buses running on both east-west and north-south streets, for example at the intersection of Wilshire and Santa Monica Boulevards, probably the two busiest corridors. The current system is that whichever bus was going to reach the intersection first would receive priority, and the other will not. Of course, the ideal way would be to figure out which bus needs the priority most, so as to get the most people through that intersection.

- *Have you considered banning left turns at complicated intersections where there might be a safety issue?*

  The agency staff has considered this issue but there is a lot of traffic in LA and there is a lot of demand for the left turns. There are some locations where prohibiting a left turn is possible, and so that could be done. But at some other locations with access to major destinations, the agency has to just to allow left turns.

- *What percentage of the signal time is for pedestrian crossing?*

  Ten percent is the general number used, according to Mr. Hu. The LADOT engineering team wants to make sure that cross streets are not overly burdened, but on the Wilshire Boulevard street project, it is going to increase it to 15% for many of the stations. The agency is going to provide what we call Super-Priority. In addition, a lot of times, the 10% is also constrained by how much slack time there is—"If you are a traffic engineer you know what I'm talking about," said Mr. Hu, adding that when "you cross a major street, the minimum green time will have to be maintained." That is governed by the distance of the crossing, and enough time for pedestrians to clear that intersection needs to be provided, and wherever two major arteries cross, then the pedestrian clear time is going to be very high. In short, the amount of slack time also determines how much priority is available for buses, and he suggests 10%, which is a large number and is also looking at increasing it up to 15% for major corridors. Finally, the agency is also looking at some far side priorities. For the Transit Priority System to work well, it is important to put the bus stops on the far side. At the Wilshire corridor, a lot of bus stops are on the near side because it's right at the entrance to the subway, so we don't want the Metro Rapid to be on the far side of the cross street. For those locations, since we are tracking those stations, we're going to estimate and take into account the boarding time.

Case Study 3: Los Angeles—Improving Service Reliability through Advance Information Systems

Al Martinez, Supervising Engineer, Advance Transportation Management System, LA Metro

Al Martinez, supervising engineer in the operations group of LA Metro, again cited the goal of his agency as increasing ridership. The primary component of

increasing ridership is getting discretionary riders onto the bus, and service reliability is what gets those discretionary riders on board. He recognizes the challenges of attracting potential riders who are unsure if they would find Los Angeles public transportation to their liking.

Creation of the Advance Transportation Management System

In 2004, Mr. Martinez and his team recognized the need for vehicle information. Once the information infrastructure was addressed, the issue of what to do with the mass of information and how to synthesize and organize it into readable formats arose. This is why that same year, 2004, the Advance Transportation Management System (ATMS) was implemented, replacing vehicle information infrastructure with voice annunciation systems and automatic passenger counting systems, voice radio and data radio, replacing head signs and installing side signs and developing bigger terminals. The cost of implementing ATMS was $100 million, and this was supported by the leadership because the Orange Line and BRT in Los Angeles has been a success.

Mr. Martinez sought ways to make the job operators easier through infrastructure that would also allow the system as a whole to improve. This was a key step in maintaining LADOT's 190 lines, more than 16,000 stops, all with their own audio files for voice annunciation, and serving over 1 million passengers per day. Because they have a particular radio frequency, they asked Motorola to design the data fusion system that holds it all together. It starts with scheduling data. Then, the schedule is synthesized with Human Resources so that the software knows which operator is in which vehicle and at what time they are scheduled to hit their first checkpoint. Shown below is an operator entering her badge number. The SmartMDT system verifies the operator badge and work assignment and tracks schedule adherence by indicating how early or late the vehicle is compared to the published schedule.

Figure B-10
Smart MDT

On-time performance information is gathered through Automatic Passenger Counter (APC) hardware. From there, all information goes to the Bus Operations Control Center (BOC), the "brains of the operation," where bus operators control bus movement in real time. New systems have made data entry easier for the vehicle operators and therefore easier for fleet supervision.

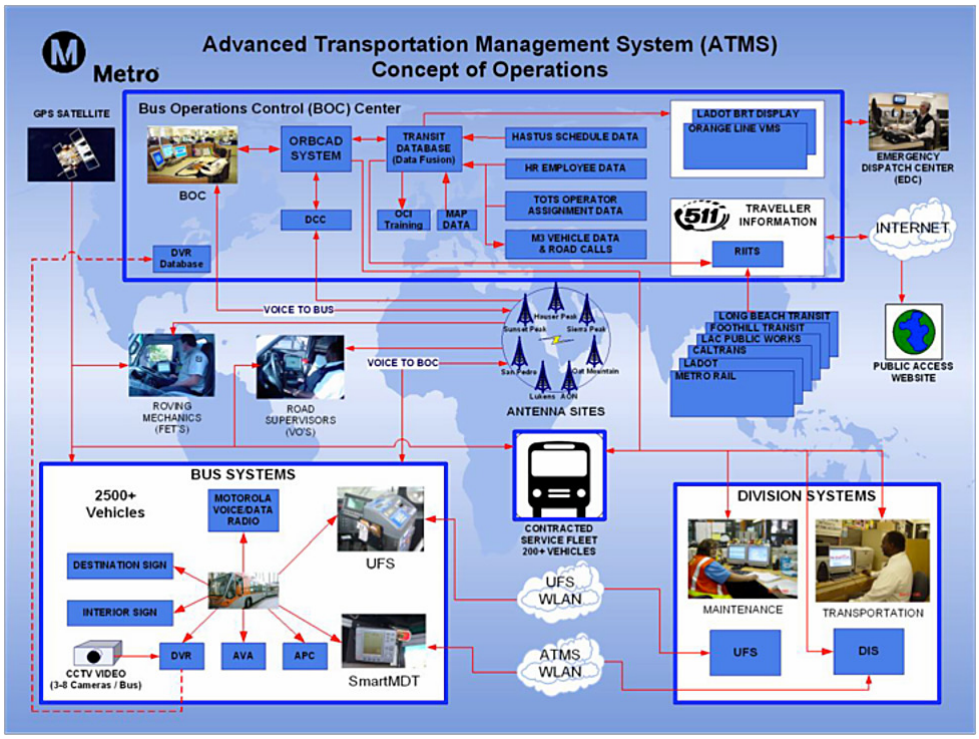


Figure B-11

Advanced Transportation Management System Concept of Operations

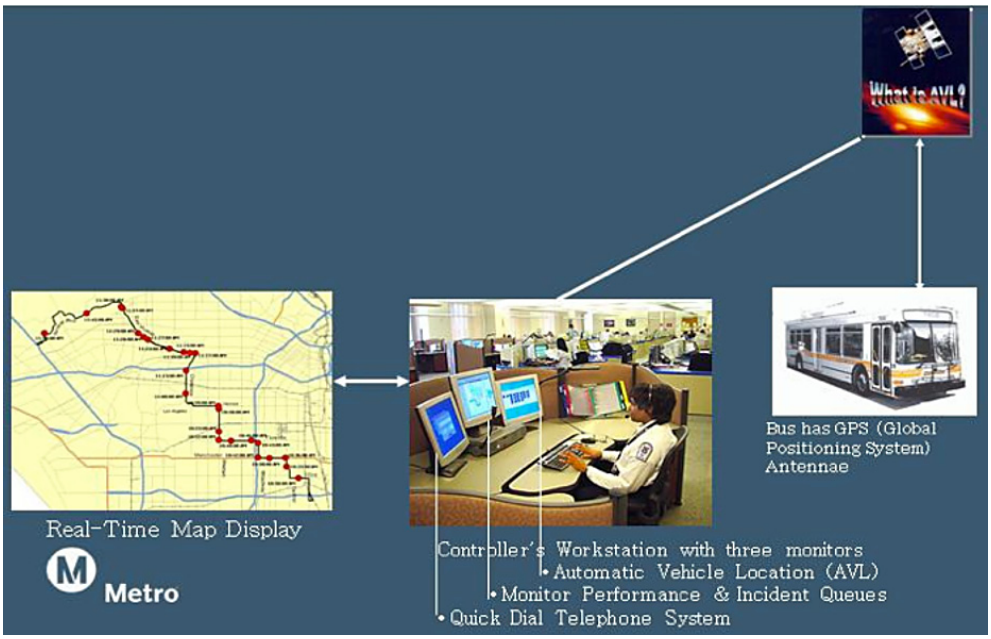
Newly-implemented tools have made communication between bus operators and systems controllers much easier. While ATMS have to invest in expensive radio frequencies, they now own them. Cameras installed both inside and outside the vehicle ensure more accurate evaluation of accidents and performance (large amounts of funding became available through Homeland Security for the installation of video feed). Through voice or text, communication has been improved in cases of emergency, for schedule adherence and passenger load information. ADA passengers have also been considered, especially with regard to Voice Annunciation, which externally announces bus line and destination information. Operators can notify BOC of wheelchair passenger loading information as well, letting them know if buses are at capacity and if there are wheelchair patrons waiting at a specific station.

Through the newly-implemented data systems, fleets can be supervised and managed when issues arise. Information is collected when an operator swipes his/her card, ensuring accuracy. Each night, schedules are organized and compiled for the next day, replacing operators if necessary—schedules are never adjusted to prevent confusion among passengers about the service runs. During the day's

run, roving mechanics can be called through BOC to fix minor problems, thereby avoiding having to remove vehicles from service. At the end of the day, data are uploaded through a wireless bandwidth while vehicles remain powered on. It takes three days to get a full picture of traffic for any particular day, which is a constraint that is currently being worked on. DVR, Smart Drive (which includes external cameras), and remote videos must be downloaded within five days or the video information is permanently lost. Videos are then sent to an agency in India that screens the video based on a list of significant events, such as an operator using a cell phone. The videos of significance are then made available on the web for viewing by agency staff.

Figure B-12

How the LA Metro Bus Operations Control Center Works



Every six months, they alter the staff schedules, and changes are made with respect to long-term construction and detours. These changes greatly impact on-time performance, and the tools they have to deal with these issues are "archaic," in Mr. Martinez's words. As a source of relief, LADOT contracts out three divisions with about 200 vehicles. Contracting out service saves LADOT large sums of money with respect to benefits, pensions and seniority issues while for lines still controlled by LADOT, a program called TOAST links payroll with operator schedules, which directly receives information from operators' Smart Cards.

Mr. Martinez concluded his presentation by summarizing the ongoing developments of ATMS. More digital devices are being used to communicate arrival times to riders such as smart phones, thus saving money on paper schedules. They have improved headway management, which is primarily concerned with a bus returning to the division on time, and the Orange Line extension is a much anticipated development.

Q & A Session

- *How does the agency monitor bus flow? Is it based on routes or a different system?*

  Mr. Martinez answered that LA Metro just recently transitioned, from a sector-based agency (Los Angeles County was divided into five different sectors) to a current arrangement that divides the county into eleven divisions. Each dispatcher runs his/her particular division with a backup person who is monitoring additional calls, etc., and that's basically how it should be. However, the agency can mix and match the two approaches, so that during slow periods it's possible to get away from the division-wide system and either merge divisions or fill in wherever more support is needed.

- *How does a particular controller get linked to specific groups?*

  Every bus has a number, and that bus number is linked to a specific line, and controllers know whether it is "running hot" or it is "running cold" or it is on time. So, there is status report on that vehicle. If the vehicle is seen as "running hot," for example, the color will change to a flashing red.

- *How many buses is an operator expected to monitor?*

  Typically, 200, but the controller always has a backup person. Depending on the division, and some are busier than others, one person is monitoring both the incidence queue and the performance queue, and managing which bus is ahead and which one is behind schedule, etc. while another person is managing the maintenance, with issues ranging from flat tires, incidents, sick passengers, or some issue requiring law enforcement, all of which are on a separate queue.

- *Do you have one specific person to monitor the Orange Line?*

  Yes. LA Metro has the mass of bus operations control and there is a person specifically for the Orange Line.

- *Monitoring staff are working in pairs?*

  They're basically working in pairs. At very, very busy divisions or early mornings runs during the peak commute period, there are two people working together on the same run. The work requires managing the performance queue as well as the incidence queue, so two people are needed. Later on during the day, when you don't have to manage the queues, you're doing radio queues to the operators and you're saying, "Hey, you're supposed to be at time points A, B, C and you're running ahead of schedule, why don't you sit tight at the next stop and wait until you get back on schedule and then continue," or they may tell you to wait at the end of your layover point or whatever direction that you're going to give them.

- *How do you measure "on time"?*

  "On time" performance is between 1 minute early and 5 minutes late. Prior to 2004, that was done manually. Post-system implementation, our

performance is not based on schedule adherence; it's based on passenger encounter information, so we know where and when they're getting off and at what time. So here's what, typically, the fleet supervision is doing. They know where the buses are, they've got the schedule, they're saying "Is Sally Smith at the corner of First and Second at 8:03 like she's supposed to be?" If she's not, they can't do voice communication but they can go data communication. So they can communicate with that vehicle via their mobile data terminal. Sally Smith will know that "I have to get my act together because I have a time schedule, or I might be running too fast," which sometimes is because they need a restroom break.

- *Do you have situations where you have on-street divisions that are supposed to be working together? And if you do have it, how often do you have disputes?*

  "All the time, yes, I never said it was easy," said Mr. Martinez. He added that they have multiple lines, including limited stop services that are running on the same line but stopping every third stop, and so there are two vehicles that are running the same line, running the same exact service but a little bit differently, so yes you do have those kinds of issues. You look for the dispatcher and the field supervisor to assist whenever it is needed. We also have roving mechanics. In the past, if anything happened to a bus, such as a big delivery truck side-swiped one of the big mirrors on the side of buses and the mirror fell off—does that mean you're going to stop service? Not necessarily, and so when something like that happens you communicate via BOC, then BOC sends out a road call and that road call goes out to the roaming mechanics, who typically will have a spare mirror, and they'll meet the bus at location XYZ and they'll change the mirror, or whatever else is required, if it's something that will only take a few minutes to repair. That typically helps us from taking the bus out of service and moving it to the division and trying to back up the service with a replacement vehicle. We have 10 of these roving mechanics; typically, there is one assigned per division. This has been very successful and efficient, and they have the same equipment as our operations. This is the high-level schedule data process. Every night, we are looking to update our schedule, so we need to know whether this is a Monday through Friday or a Saturday or Sunday. We also need to know if it is a holiday, if it's a special event day, etc. So, every night, we can tell what the next day's service going to be like, so we do that every night unless there is and "ad hoc" type schedule. We want to do operator assignments, and I mentioned that we know that if tomorrow is Monday, "Sally Smith" is to be assigned line number 721 and she will be working from 8:00am to 7:00pm. So we load that information, and the intent of loading that information is that when she swipes her card, the machine is going to beep and identify her as the right person, provide her the particular schedule and vehicle for the day, and the system is able to confirm and match everything, to make life for the operator easier.

- *But you change that every six months?*

  Every six months we have a "shakeup." And then we match our vehicle data to our maintenance vehicles. We typically assign a maintenance vehicle to every division, but if a vehicle crashes or something happens, it is going to go to the shop and the division receives a replacement vehicle and everything needs to be monitored.

- *How does driver validation work?*

  Typically, a driver is going to know his/her schedule; the system just validates it. So if you are "Sally Smith" and you are supposed to be at division one at 7:00, you're supposed to be there. Or, if Sally Smith happens to be sick that day, we will know that she has been replaced by Tom Jones. There are updates every 5 minutes. So if Sally Smith needs to be replaced, we know who the new driver is now on that scheduled run. We're never adjusting the drivers' schedule during a particular day; we only adjust the overall schedule every six months. All we're doing is validating a person to a scheduled run that's already predefined.

- *Voice announcements*

  Mr. Martinez added that he knows they have had a lot of policy discussions about voice announcements in the Metro fleet. On the internal side, there is an announcement at every "on" street, but the agency just changed its policy on the external side. First, they were announcing line number and destination all the time, but the agency had switched to only making announcements from 9am to 6pm. This change was in response to a lot of complaints we got from the neighborhoods that nobody wants to hear line number and destination on a loud external speaker at 4:00 in the morning. Indeed, the agency received a lot of complaints, and so it changed the voice announcements routine. On the other hand, the ADA community has since been complaining that they can't hear announcements, so we have changed our policy and now we do both internal and every external announce on a 24/7 timeframe. It is still too soon to tell if we're going to hear complaints from the general public, but for now we're going to address the ADA community concerns.

- *With your external speakers, does that allow you to change the way that you pick up ADA customers? For example, our system required ADA customers to be at the head of the zone so drivers are required to stop and announce at the front of the zone. So, if you have external announcements, does that mean that they can hear anywhere in the zone?*

  Yes, typically there is one zone at a time point. When the vehicle passes that time point, it will trigger the announcement. That external announcement will say "Line 720 to Santa Monica." The blind person will hear that that is the bus I want to take and will board that vehicle.

- *Do you have cameras outside of the bus?*

  Yes, we typically have between three and ten cameras per bus pointing at the side of the bus, the front of the bus, various locations within the bus. We have something new called Smart Drive, which has the front-facing camera and the rear-facing camera. That Smart Drive is external to all the rest of these cameras. When the bus comes into the division that video is wirelessly downloaded on an external wireless system and that video is sent to India where that video is synthesized, and they select all of the information that we have determined we want, e.g., any time that an operator is distracted, or when there's a jolt, etc. That video comes back to us the following day; we match it with the operator. We know which vehicle it is and who is driving it, and we have that video available on the web so that we can retrieve it as we need it.

- *Are you doing progressive discipline over at LA Metro?*

  Not quite yet. That's a future labor discussion. Right now, I think our official term is operator training. You need to be trained if this video shows that you're using a cell phone. There are only so much of those measures you can do, however, since we can't typically fire a person based on this information alone, but we can do some training and can redirect their hours, their lines, etc.

- *Are you looking to do any enforcement of any bus lines using cameras? For example, if a private vehicle wants to drive on the Orange Line, can a video camera capture a license plate? Is that a violation?*

  We have a sheriff in our operations center 24/7 and can alert the sheriff if someone is parked on the bus lane. The sheriff can dispatch someone to intervene, but typically we cannot operate as a transit agency would. We are copying and producing probably seven-to-ten thousand videos per year. Typically it takes forty-five minutes to download a video for each bus. If you do 45 minutes times 7,000 or 8,000 buses, that's a lot of maintenance time that it's taking to get this video off. Whenever we are requesting a video, it is because a supervisor thinks they saw a driver with a cell phone, and that is our own problem. There's a tradeoff between wanting to have a tight supervision of our operators and how long it takes our maintenance team to pull video; and we have a long way to go on that because, I would say, maybe 30–40% of our video is pointless. In keeping with the FCC requirement that all of our wideband channels have to be converted to narrowband, our voice system is now narrowband, and we're looking to improve or modify our data system to meet the FCC data narrowband requirement by 2012. Our poll rate is every five minutes, and we're integrating two additional channels to get from 5 minutes to 3 minutes. In a perfect world, I'd like information every 30 seconds, but the information I'm getting every 5 minutes is useful. If I'm a passenger at the corner I want to know if the wait is going to be 5, 10, 15, or 20 minutes. If I'm getting information every 30 seconds it is helpful,

but do I really care if the bus is 7 minutes away or 7.5 minutes away? Not necessarily. And so there is always been a difference of opinion. The arrival information is most valuable to the people that wait the longest. If you ride the Orange Line with 4-minute headways at peak time, you can see the next bus coming. Do you really care how much time your poll rate is when you can see the bus coming? It's a cost issue. We have our own radio system, and we generally have very good coverage, I would say about 97% coverage on both our voice and radios, so we actually have fairly good coverage. Everything we do is based on NTD reports, and we have a long way to go to get a very simple dashboard to say this is what happened yesterday. You can do dashboards for maintenance, dashboards for transportation, etcetera, and we have a big effort ahead of us in that area.

- *What other information do you convey to passengers?*

  A lot of people get lost or lose their sense of direction as they exit the VMS line, so we're trying to help them. What we are working on is information that tells people when you get off, this is the corner you should stand on, the direction you want to be going, and the line that you will take, etc. It helps them find their way to whatever stop they want. On the bottom sign we are providing the next bus and the arrival time for buses in either direction.

- *The top one—would that be a screen or would that just be paper?*

  What we're doing is flashing the physical location sign for about 7 seconds, and then we are scrolling the time for about 3 times that timeframe, maybe 20 seconds, because people are more interested in time than they are in the physical location, unless you're a tourist and then you really don't know where you are.

"Open Space" Conversations

With Mr. Zerkin's facilitation, the participants identified two conversation topics, two of which were consolidated. The final topics were:

- Standards, Guidelines, Branding and Information
- TSP Benefits and Matrices

After a two-hour long period conversation, the three groups reconvened and, using flipchart notes taken during the discussion, reported on the main discussion points.

Standards, Guidelines, Branding and Information

- Participants suggested the creation of a standard guideline like the *Manual on Uniform Traffic Control Devices* (MUTCD) published by the American Association of State Highway and Transportation Officials (AASHTO). The suggested name is Manual on Uniform Transit Information (MUTRI).

  - Such a document is to address the needs of different passengers, thus encouraging them to take transit.
  - The manual would provide a step-by-step guide so that passengers can find out relevant information on travel by transit from point A to point B.
  - This manual would also include maps, route information, and travel times (like the "12 minutes map" of LA Metro Rapid).
- Participants pointed out that the general perception is that passengers can figure out how to use rail much easier than when using bus services.
- Conveying a sense of permanence is important; this suggests investing more in information.
- The following points were suggested by the participants:
  - Conduct a best practices survey of existing transit information (U.S. and international cases).
  - Develop concepts for transit information standards/templates, incorporating current and emerging technology.
  - Address needs of a wide variety of passengers.
  - Seek public/private partnerships where possible to fund this type of effort.

TSP Benefits and Information

- Participants tried to answer what are the TSP's benefits and what information planners and engineers need in order to implement TSP.
- The basic questions participants asked were:
  - How did LA gather detailed information to generate precise benefits?
  - Is LA using buses as probe data?
  - How do other agencies measure TSP benefits (i.e., reliability, travel time, human observation, and peak hour vehicle reduction, GPS on-time performance, etc.)?
- Participants suggested several performance measures to be collected to implement TSP.
  - What is really slowing down buses?
    - Long dwell time, which may be reduced by educating people (e.g., move beyond front door boarding), using contactless/cash-free smart card payment, off board payment collection, etc.
    - Travel time variability
    - Ridership
    - Traffic counts
    - How much signal priority should be given and to which buses?
    - The scope (system view vs. intersection performance) should be determined
    - Measure the impact on side streets and adjacent corridors

– What systems are used in other cities?
  - LA – loop detector and GPS
  - Boston – Center to center
  - Philadelphia – optical
  - Chicago – testing optical
  - Seattle – transition from radio to GPS/wireless
  - San Francisco – limited opticon, V-tag

– Funding should be identified

APPENDIX

C

Cleveland Workshop Summary

"Cleveland Bus Rapid Transit Summit: Building Political, Interagency and Stakeholder Support for BRT—BRT as a Driver of Economic Development"

Presented by the National Association of City Transportation Officials (NACTO) and the NYU Rudin Center for Transportation Policy and Management

Overview

More than 50 attendees participated at the Cleveland Bus Rapid Transit Summit on October 14 and 15, 2010, which brought together senior transportation officials from 16 cities across the U.S., along with public transportation planners, traffic engineers and BRT experts from the private sector, non-governmental organizations and all levels of government. This event was also sponsored by FTA and organized by the NYU Wagner Rudin Center for Transportation Policy and Management in association with NACTO. Convened at the headquarters of the Greater Cleveland Regional Transit Authority (GCRTA), the workshop focused on BRT project implementation, including strategies for building public and private sector support, attracting new riders to transit and using BRT to induce economic revitalization in central cities.

Over the course of two days, conference participants learned about best practices in public transport and sustainable development planning and implementation in a variety of local contexts, visited the successful Cleveland HealthLine BRT, and discussed the common challenges facing BRT projects around the country. The combination of presentations by featured speakers, three moderated panel discussions, peer-to-peer breakout sessions, and a site visit provided a range of opportunities for conference participants to gather information, ask questions, and network with their counterparts from around the county.

Recurring themes throughout the Summit were the importance of stakeholder outreach, system branding, and the power of well-designed BRT systems to transform a corridor and to bring economic vitality to surrounding communities.

Day 1 Welcoming Remarks

The workshop started with initial remarks from Valarie McCall, Chief of Government Affairs for the City of Cleveland, who welcomed participants to the city on behalf of Mayor Frank G. Jackson. Janette Sadik-Khan, Commissioner of the New York City Department of Transportation and President of the National Association of City Transportation Officials (NACTO), also welcome participants to the summit and discussed the important role that NACTO plays in moving the transit agenda forward. She then introduced the keynote speaker, Enrique Peñalosa.

Keynote Address: Enrique Peñalosa

President of the Board of Directors, Institute for Transportation and Development Policy, and former Mayor of Bogotá, Colombia

Many BRT advocates cite cost-effectiveness and affordability, compared to rail-based alternatives, as major selling points; Mr. Peñalosa suggested that there are more reasons to recommend BRT. He remarked that obviously the lower capital and operating costs of BRT are an important argument for bus over rail, and BRT systems combine the speed and reliability of rail at a fraction of the cost. In Sao Paulo, for example, construction costs are $250 million per kilometer of rail versus $10 million per km for buses. This means that for the same level of investment, many more lines can be built and operated.

In his keynote address, Mr. Peñalosa argued that BRT was the only solution to his city's seemingly intractable traffic congestion, which he described as "worse than chaos and hopeless." His efforts to transform Bogotá began with a commitment to redistributing road space by prioritizing public transit over the private car because it moves so many more people and does so with minimal impact and cost.

While Mr. Peñalosa was confident in BRT's promise of improved public mobility and access, as well as environmental sustainability and economic development advantages, the officials planning and implementing it in Bogotá had to overcome a range of primarily political obstacles. Transmilenio, the Bogotá BRT system, is widely recognized as a model, and many of the lessons learned in Bogotá are applicable to the United States.

To explain the main hurdles and how to overcome them, Mr. Peñalosa placed BRT in historical context. In the 19th century, rail was a new technology used to move people to city centers. With the rise of the automobile in the 20th century, the car replaced rail as a private, more luxurious and effective travel mode. However, in a growing movement towards sustainable living, there has been a powerful resurgence in support of transit. While global cities such as London, New York, and Paris are defined by their rail systems, that infrastructure was developed when cities were mainly mono-centric.

Today, cities have multiple activity hubs that individually may not be large or dense enough to justify rail investments but could be well served by bus-based rapid transit. Moreover, even for places with subways, buses play a crucial role in providing mobility and access for the city as a whole.

Understanding the Challenges

Bus systems face particular challenges in gaining community support. Mr. Peñalosa outlined four obstacles and corresponding strategies to overcome them:

1. *BRT is perceived as an inferior system.* Pre-implementation surveys in Bogotá showed that buses suffered from an image problem. Thus, Transmilenio has been marketed not as a "bus" but rather as rapid transit. Buses can look great, too, and aesthetic improvements to stations, terminals, and vehicles can greatly influence ridership.
2. *Bus systems are rarely seen as including infrastructure improvement projects.* Mr. Peñalosa argues that the most valuable resource a city has is its road space, and BRT can transform this space, representing an extremely visible and useful infrastructure improvement. Reallocating road space to create a more pedestrian-friendly environment is also vital to public transport and bringing life back to the streets. Traffic congestion highlights the need for public transit.
3. *Lack of support from private real estate investors.* BRT advocates need to educate real estate investors about the fact that BRT can be more than just a cost-effective transport mode. Not only can BRT attract and move large volumes of people, many of whom formerly drove, but it can also provide focal points for sustainable urban developments with much higher rent and sales values than they would without the system or elsewhere. This requires pedestrian and streetscape improvements along with BRT development and is a powerful way for a city to grow without creating congestion and environmental problems. In Bogotá, new high-end malls, apartment complexes, and mixed-use developments of the type advertised in airline magazines have sprung up around BRT stations and terminals.
4. *Taking space away from cars.* Mr. Peñalosa asserted that if "democracy" implies that all citizens are equal before the law, vehicles that carry more people for a given amount of road space should be given priority

Benchmarking Success in Bogotá

There are three important public transport performance benchmarks: capacity, travel time, and comfort. Mr. Peñalosa reported that Transmilenio averages 47,000 passengers per hour in each direction service with the flexibility to increase capacity to 68,000 passengers per hour per direction, which, he stated, is higher than 95% of the world's subways. Another advantage of the system is reduced total travel time from origin and

destination; users need to switch between lines fewer times, and the stations are close enough to one another to minimize walking time. Service can also be altered to accommodate "express" high speed routes at a low additional costs. Because even Transmilenio's 25-meter-long bi-articulated buses have a lower per unit-capacity than subway trains, they must run more frequently to carry the same number of people. This reduces onerous waiting and transfer times. Transmilenio has also created a comfortable environment for its passengers and that is important to its success. For example, users enjoy natural light, views of the cityscape, and do not need to take stairs or escalators to access/egress stations. Mr. Peñalosa believes these characteristics have universal appeal.

Mr. Peñalosa concluded that while some have argued that creating a BRT system is technically difficult, the most challenging part is making the political decision to redistribute public space in the face of the powerful "driving and car" lobby.

Joe Calabrese

General Manager, Greater Cleveland Regional Transit Authority (GCRTA)

Mr. Calabrese detailed the planning and political efforts that made the Euclid Avenue Corridor Project, now known as the HealthLine, a reality. In the late 1990s, Cleveland conducted an alternatives analysis of possible transportation investment scenarios for Euclid Avenue: subway, light rail, "do nothing" (maintaining an existing local bus line) and Bus Rapid Transit. Each alternative was evaluated against 5 measures: capacity, connectivity, funding possibilities, costs (capital and operating), and economic development potential. The BRT option, at about half the cost of the cheapest rail alternative and competitive on the other measures, was selected; construction of the HealthLine began in October 2004. Following its official opening in October 2008, this project was designated as a "Hub of Innovation" by the State of Ohio.

Many citizens, politicians, and business people in Cleveland attribute the rebirth of the Euclid Corridor to the HealthLine. The project, including both BRT and the urban core's "transit zone," extends over 9.38 miles of roadway (about 7 miles with BRT) with 36 bus rapid transit stations(instead of 100 local bus stops) and has effectively cut end-to-end travel time on Euclid Avenue from 40 to 28 minutes. Key design features of the system include broader pedestrian corridors, bicycle lanes, and streetscape treatments at stations and along the corridor, as well as the integration of public art. All of these features combined have helped to attract new development.

The HealthLine incorporates many of the elements that make BRT systems so rapid and attractive to transit customers, long-time riders and new: "branded" vehicles have an exclusive right-of-way for much of the route along with traffic signal prioritization to decrease travel time; off-board fare collection; and

"precision docking" (guided wheels) for no-gap, level boarding, both to reduce passenger loading and alighting times. Another feature lending a "rail-like" experience is the use of 63-foot-long articulated rapid transit vehicles (RTVs) with multiple doors. The system also offers features to enhance passenger comfort, convenience, and safety, such as touch-screen kiosks, real-time information displays, and emergency call boxes and security cameras at stations. Improved design elements at stations including seating and architecturally-pleasing arches and glass partitions to weatherproof each facility also enhances the passenger experience.

HealthLine ridership continues to grow. The former Route 6 Euclid Avenue bus line had a ridership of 9,000 trips per day. In its first year of service, there were exceeded 13,000 trips per average day on the HealthLine. In 2010, through September, ridership has grown to an average of over 14,000/day (an increase of 50% in 2 years, some totally new transit trips, some diversions from parallel bus and rail lines) despite the economic downturn and the reduction in ridership for the rest of Cleveland's transit system, bus, and rail. In a customer survey, HealthLine users provided positive feedback and other useful information on the new line:

Table C-1

Customer Survey—Response Summary

Reliability	92% - Service reliable
On-Time Performance	94% - Trip on time
Travel Time	95% - Travel time reasonable
Do you ride more often than the former #6 bus route?	42% - Ride more often
Cleanliness	92% - Vehicles clean 92% - Stations clean
How else would you be taking this trip?	48% - Other RTA bus service 16% Drive alone 13% - RTA rail service
Overall Satisfaction with HealthLine	87% - Overall satisfied

Panel 1: The Political Dimensions of BRT Implementation

Urban transportation projects are more politically feasible when they can be implemented in a short time frame (e.g., within a single supportive municipal administration) and where the costs are modest enough that limited financial resources can be leveraged to benefit more than one portion of a city. BRT meets these criteria and are therefore politically attractive. At the same time, traditional perceptions about the attractiveness of rail relative to bus transit systems have often made BRT a difficult sell. This panel discussion focused on how BRT's performance, customer appeal, relatively brief implementation period, and low unit costs have all been used to gain public and political support, often against great odds. Panelists included New York City Department of Transportation Commissioner and NACTO President Janette Sadik-Khan; Montgomery County, Maryland Councilmember Marc Elrich; and GCRTA's General Manager, Joe Calabrese.

Janette Sadik-Khan

Commissioner, New York City Department of Transportation and NACTO President

New York City launched its newest bus rapid transit line—branded Select Bus Service (SBS)—on October 10, 2010, along First and Second Avenues in Manhattan. This is the second Select Service line implemented by NYC's Department of Transportation (DOT) and Metropolitan Transportation Authority (MTA). The SBS line on First and Second Avenues currently carries about 54,000 passengers per day and boasts a package of features including off-board fare collection, transit signal priority, comprehensive branding, new stations and low floor vehicles, improved passenger information, and bus lanes. While SBS does not yet have a fully dedicated right-of-way, its presence on what Commissioner Sadik-Khan declares "the most multi-modal corridor in the nation" highlights the need to rethink how streets are used everywhere.

In describing how the city came to consider a rapid bus model, Ms. Sadik-Khan noted that 75% of New Yorkers do not have cars, and many car owners are also transit riders, walkers, or cyclists. To address the mobility issues that arise in such a low-auto use environment, an effort is under way to reapportion streets to better accommodate non-auto users including transit passengers, pedestrians, and bicyclists. Part of SBS's design includes pedestrian islands, which create a safe area amidst fast moving traffic. SBS fits into New York City's efforts to emphasize sustainable transit options, a commitment that will become more crucial given projections that the city will need to accommodate an additional one million residents by 2030.

Second Avenue SBS replaces the M15 Limited Bus Service (though the M-15 local, all-stops service is retained), making a long-established bus route both easier and faster to use. It features two off- board fare collection machines at every station that accept both "Metrocards" and exact change and issue "fare paid" receipts. The route runs between 125th Street and Houston Street, a distance of about 8.5 miles. A "before/after" analysis of SBS's first line, the BX-12 along Fordham Road in the Bronx, showed peak period travel times down 24%, ridership up 30%, and customer satisfaction at an unprecedented for New York 98%.

The next SBS corridor will be along 34th Street from 1st Avenue to 11th Avenue; 34th Street is currently designated as an "Enhanced Bus Priority" zone that features a curbside bus lane, real-time arrival information at stops, left-turn signal priority for buses and video enforcement. These features, while part of a less intensive intervention than for SBS, have already resulted in 17% improvement in end-to-end transit running time, reflecting a 29% drop in time at red lights.

Marc Elrich

Councilmember, Montgomery County Council, Maryland

As a legislator in a burgeoning suburban county just outside Washington, D.C., Mr. Elrich recognizes the need to consider quick-to-launch transportation solutions like BRT. Between 2007 and 2009, the Montgomery County Council instituted a growth policy to provide guidance to various government agencies and the general public on matters concerning land, development, growth management, and related environmental, economic, and social issues.

One of the driving forces behind Montgomery Council's growth policy is creating sustainable living options for the future. A study prepared for the Metropolitan Washington Transportation Planning Board indicated that carbon emissions in the region are expected to increase by 48% by 2030 if no interventions are adopted. Table C-2 below shows the impact of emissions as a result of increases in households and employment.

Table C-2

2002-2030 Changes in Households, Employment, VMT, NOx, VOC and CO_2 for 8-Hour Ozone Non-Attainment Area

	2002	2030	% Change
Households	2,893,646	4,162,621	44%
Employment	1,742,117	2,463,893	41%
Annual VMT (000,000s)	39,212	53,726	37%
NOx (tons/day)	259.232	34.899	-87%
VOC (tons/day)	101.117	39.41	-61%
CO_2 (tons/day)	23,273,168	34,450,922	48%

The creation of a growth policy gave politicians the chance to learn about different sustainable options available for a variety of government functions and services. Because jobs and homes are concentrated in different parts of the county and/or in different Maryland counties, the District of Columbia, or Virginia, there are huge travel volumes and thus a need for investment in more sustainable transportation modes. After a careful study of transit options, the Council determined that buses were the best alternative and also the most realistic, given fiscal constraints and private property ownership, though convincing the community of this was no easy task. Elrich spoke of his own experience in being converted from a rail supporter to a proponent of BRT, and he understood the need to make a strong case. Only extensive outreach could sway the public away from sometimes romanticized notions about railways. Part of generating buy-in was demonstrating that new bus-based rapid transit could effectively link the disparate locations where people live to where people work in Washington's rapidly growing suburbs.

Mr. Elrich also actively engaged the business community. He began with the Montgomery County Chamber of Commerce and then met with real estate developers. Though he has found himself in opposition to some of these civic and

business leaders in the past, Elrich said his honesty helped sway them in this case; he told them that the increased revenue and property taxes resulting from BRT would help fund the social programs he supported.

Discussion

Joe Calabrese, General Manager for the Greater Cleveland Regional Transit Authority (GCRTA), picked up on the theme of generating buy-in. He explained that the HealthLine had "great political support because it was an investment not just in public transit, but also in infrastructure." The FTA New Starts grant, along with other federal, state, and local funding sources, paid not just for buses but also for new water and sewer lines, sidewalks, traffic lights, and parks. The project's focus on increasing safety and economic development and alleviating congestion gained many supporters. Moreover, the city communicated to the public that the "option was between BRT and nothing," and many local and regional parties were eager to see investment improvements in Euclid Avenue.

The next issue discussed was operations and maintenance costs, and all three panelists agreed that BRT's efficiency allows for substantial cost savings. Indeed, lower costs have always been a major selling point for rapid bus systems, and this holds true not just compared to rail, but also to traditional local bus services. Mr. Elrich said that shorter travel times mean higher driver productivity, yielding increased service frequency with the same number of vehicles, drivers, and mechanics and, thus, savings on operating and maintenance costs. In Cleveland, for example, there are now 16 peak-hour drivers on the HealthLine, where there had been 28 local bus drivers on the route it replaced, despite significantly increased total capacity and ridership. However, the panelists cautioned that system operators may have to increase maintenance budgets because tidy, welcoming stations and clean, comfortable buses are a major part of BRT's appeal to riders.

The panelists also spoke to the importance of connectivity among transit and other mobility systems. Commissioner Sadik-Khan spoke about soon-to-come crosstown SBS on notoriously congested 34th Street that will better link riders to different subway lines and her hopes that one day the buses will connect to ferries. Mr. Calabrese noted that the HealthLine begins and ends near "Rapid" rail stations. These connections increase the usefulness of the entire system.

Panel 2: The Federal Program and BRT

Government agencies are typically interested in using their limited funds to leverage the greatest possible benefit, and this holds true for transportation. BRT can be a very cost-effective alternative for meeting mobility needs. This panel covered federal surface transportation programs and the place of BRT in relation to general transit investment needs. Panelists were Matt Welbes of FTA, Homer Carlisle of APTA, and Linda Bailey, Federal Programs Advisor at the New York City Department of Transportation.

Matt Welbes

Executive Director, Federal Transit Administration

FTA's Matt Welbes provided conference participants with an update on federal funding. Of the money allocated by the American Recovery and Reinvestment Act of 2009 (ARRA funds), approximately 1% ($8.4 billion) of the funding went to capital investments in transit, and he said that President Obama continues to be committed to funding surface transit projects and that he expected to see growth in federal financial support for BRT. The ARRA program is not the only mechanism for delivering BRT funding. For example, the Small Starts program recommended $52 million in funding for BRT in 2002, and this has grown to $176 million being proposed for 2011.

The Cleveland HealthLine is the largest federal investment in BRT so far, and its success should help build support for projects in other locations. Welbes pointed out that in the age of YouTube, it is easy to dispel the sense of exoticism that sometimes surrounds the BRT concept; it is now possible to go on the Internet and look at BRT systems in Cleveland, Eugene, and other cities to see the features of a successful a BRT system.

One issue affecting BRT is that there is no comprehensive national database on this mode, despite the fact that FTA requires reporting for the National Transit Database. Unfortunately, to date, reporting on the supply, demand and performance of BRT services is included with data for bus systems as a whole. The FTA staff managing the National Transit Database are considering how to work with grantees to collect data specifically on BRT to permit benchmarking for new BRT projects and increase awareness of what BRT can do.

Homer Carlisle

Senior Manager of Planning and Programs,
American Public Transportation Association (APTA)

Joining the chorus of many members of the transportation community, APTA's Homer Carlisle pointed out that traditionally transportation has not been a partisan issue and that it should be kept this way, rather than be used as a political tool. He emphasized a number of reasons why Congress is likely to support BRT in the future:

1. BRT works in cities of all sizes. This is a huge political asset as all sorts of communities struggle to meet their transportation needs
2. BRT's comparatively low costs will appeal to a Congress interested in spending cuts.
3. BRT's funding flexibility—FTA has come up with new programs such as Livable Communities and Small Starts that can efficiently provide funding resources for a variety of projects, including BRT.

He also noted that the next transportation bill will emphasize new means of financing, which may favor cost-efficient modes such as BRT, the importance of successfully integrating BRT into existing transportation systems and streamlining the process for delivering modest cost BRT projects and forging connections between the transportation community and new members of Congress.

Mr. Carlisle closed his remarks by acknowledging that the more conservative incoming Congress is more likely to question the transportation agenda set out by the Obama administration, saying that it will probably be impossible to increase the gas tax in the new Congress, thus making unclear how the need for increased transportation funding will be addressed in the new surface transportation authorization bill.

Breakout Sessions

Summit participants chose among three different breakout discussion sessions. Each group featured several peer facilitators who served as resources and guides throughout these thought-provoking, productive conversations.

Breakout 1: Strategies for Marketing and Outreach

Discussion leaders were Steve Bitto, Director of Marketing and Communications at GCRTA, and Alina Kelly, the President of AKelly Consulting, Inc., based in York, Ontario. In this session, participants discussed how to transcend the problem of "the mystery machine," a negative perception of buses that stems from a lack of information and prevents the attraction of new riders. This hurdle can be overcome through branding, positioning BRT in the transit marketplace and conveying important information on routing, schedules, fares, and so on, with the objective of attracting new riders. Creative marketing initiatives have been very useful in generating awareness of and interest in the opening of new BRT service.

Branding, it was suggested, is a promise or commitment to the customer from the transit agency. In Cleveland, the marketing theme was that BRT was a rail experience on rubber tires, the key elements of which were a premium service that is faster, simpler to use, more convenient, and more frequent and provides real-time information. BRT in Cleveland stands for "better rapid transit," and the marketing campaign's message was "Transit like you've never seen in Cleveland before." The Euclid Avenue HealthLine was initially referred to as the "silver line," a "premium" color. Creative marketing can take many forms. To minimize the perception of disruption during the long construction period of Cleveland's HealthLine, the marketing team tried to have fun in presenting BRT to the public, showing pictures of final designs and the promise of things to come by putting obviously fake flowers on top of the orange construction zone barrels.

Retail establishments along the corridor were severely impacted during the BRT line construction therefore the agency identified them as important constituency

to help. Cleveland RTA encouraged its staff to patronize affected stores, and low interest loans were offered to them, though they proved not to be of interest. In York, Ontario, artwork and signs instructed people on how to get to stores blocked by construction areas, and the Economic Development Corporation compensated them for losses that could be documented while hosting events in the corridor to help the local businesses. In addition, a local community liaison office was opened and was staffed full time by a person who could troubleshoot emergency repairs and help expedite problem resolution, disseminated flyers about what work was going to be happening each week. Web-based information on current impacts, e.g. detours, was constantly updated. Events were held along the route in Cleveland to call attention to the opening—a scavenger hunt on the first full day of operation, a concert event on the opening weekend, and a ribbon-cutting and fireworks, all paid for by the corporate community.

In York, a suburb of Toronto, the goal of the BRT was to get new riders, not just serve existing riders better, because the 8% who used the buses were already very satisfied. The demographics included the very wealthy and also a large immigrant community. Early market research determined that if the BRT just offered the same services as current buses, no one new would ride it, and that potential riders' priorities were comfort (especially for women), convenience and fun. Attention to detail was therefore very important—e.g., seat fabric was custom-designed and fare screens got a modern, clean look. The RTVs were made by Van Hool, the best that could be found; the color of the vehicles, though carefully chosen, didn't work when it was actually painted on the vehicles, and it had to be tweaked.

Great care was taken to select the name of the service and, after focus group testing, "Viva" was selected because it worked in all 14 dominant languages. Pre-launch activities included contests with inexpensive prizes and taking funny pictures of people making V's with their fingers and bodies. Big "V" fins were put on all the stations. By the time of the service launch, after just a few months since the start of the campaign, there was 80% name recognition. Greeters were at every station on launch day, and although the *Toronto Star* had criticized the project before it opened, it gave the launch front-page coverage plus a great two-page spread.

Breakout 2: Planning BRT to Improve the Overall Transit Customer Experience and Measuring Success

This breakout discussed targeted improvements to the customer's experience and how to measure results of these interventions on the ground. Discussion leaders were Greg Evans, Vice President, Lane Transit District in Eugene, Oregon; Bruce Schaller, Deputy Commissioner for Planning and Sustainability; and Sam Zimmerman, Consultant to the NYU/Wagner Rudin Center, the World Bank, and AECOM.

The discussion focused on the need to take a holistic view of the transit experience when planning a new BRT application, looking at trips from their real origin (e.g., home) to their destination, (e.g., work). Issues to be addressed would then include sidewalk connectivity, street lighting, and station amenities for customers waiting, as well as noise on board, cleanliness both in buses and at stations, and other concerns. A key statement by participants that reflected this approach was "BRT is more than just a busway or a bus service."

As for performance measurement, it was noted that detailed customer satisfaction surveys such as the one conducted last year for Los Angeles by the National BRT Institute at the University of South Florida are being used more and more to get at the intangible, unquantifiable aspects of public transport. The customer attractiveness of many of the quality features of BRT (e.g., real stations rather than stops, specialized vehicles instead of buses, off-board fare collection, branding, passenger information) can only be evaluated by detailed customer surveys. These are needed to supplement other, more conventional public transportation indicators such as customer travel times, revenue speeds, schedule reliability, and transfer requirements, among others.

Mr. Evans reported on the measures of success that many agencies track; for example, in Eugene, BRT brought about an 80% increase in ridership, for a total of 1 million riders per year on 110 buses. BRT ridership even held steady in the face of the recession-triggered departure of seven major employers. Some of the customer experience improvements the Lane Transit District made included installing covered stations with art and good designs and improved accessibility features for passengers with disabilities.

Mr. Schaller noted New York City's singularity, but went on to identify lessons applicable to many other contexts. In New York, the problem was not low ridership and a need to attract new riders, but low speeds due to heavy congestion on streets with many competing demands like freight vehicles, delivery trucks, and private cars. Many bus riders were unsatisfied with the service quality, though in a city with very low car ownership rates, people do not have the choice to give up on the bus, so NYCDOT focused on improvements to bus lines by delivering speed, reliability, and comfort. Mr. Schaller said that riders should be able to perceive the benefits of rapid bus service immediately. Passengers do notice things like evenly spaced bus arrivals, which result from better speeds. Measuring and reporting results is a key task; politically this allows DOT to "keep improved services and then replicate them elsewhere." Not only did New York's first Select Bus Service route speed up travel time, it drastically improved rider satisfaction.

Other attributes that enhance the customer experience, which were discussed during this session included off board fare collection, "understandability," a sense of permanence, and improved streetscape.

Breakout 3: Political Leadership, Communications and Public Involvement Strategies

This session focused on the political leadership, communications, and public involvement strategies for BRT projects. Discussion leaders included Danielle Willis, GCRTA's Project Officer for the HealthLine Corridor; David Woloch, NYCDOT's Deputy Commissioner for External Affairs; and Susan Bok, Senior Transportation Planner, LADOT.

The major takeaway from this group was the need for extensive stakeholder outreach as part of the BRT planning and design process. Mr. Woloch recounted the difficulties NYCDOT's first SBS project encountered in the Bronx. He said that the agency did not initially go to every business along the planned route; shopkeepers who were not informed were the most likely to oppose the project. Subsequently, NYCDOT has conducted outreach to each and every property owner along proposed SBS routes. It's an onerous effort, but in the long run it saves resources by preventing unnecessary conflict. Ms. Bok echoed the importance of this lesson and added that the right people with the right attitude (listening, not only speaking) must conduct the outreach campaign. She said that the Los Angeles County MTA failed to attract support, in part because some people perceived that they "behaved like a developer" who "just wanted to push things through" rather than listen to and address stakeholder concerns.

In Cleveland, an innovative "ambassador program" was a major component of the city's success. The ambassadors were a committee of businesses, civic, and religious leaders who were trusted by their own constituencies and who did much of the outreach legwork. Additionally, the city set up a construction hot line to field questions and sent email alerts to the 2,300 people who signed up for the service.

Other facets of Cleveland's strategy included the active involvement of five community development corporations (CDCs) along the corridor, each of which had its own newsletters and meetings; an "Open for Business" campaign to retain shoppers; public art related to the project, including wooden flowers where planters would later arrive; notices ahead of time; and ambassadors on hand on "day one" of construction for each phase of the corridor.

Case Study: The Cleveland HealthLine BRT

Building on GCRTA General Manager Joe Calabrese's presentation the day before, Michael Schipper, Deputy General Manager of Engineering and Project Management at GCRTA and one of the major architects of the HealthLine, spoke in detail about how the HealthLine was planned and developed and noted its technical features in detail. He reiterated a key point that Mr. Calabrese had made the day before—that the system represented much more than a bus line; it was an urban core infrastructure and development investment.

In total, the Cleveland HealthLine runs a 7.1-mile stretch, and BRT services operate 24 hours a day, 7 days a week. Four and a half miles of this route include dedicated BRT lanes, with the vehicles moving into mixed traffic as the route leaves the more congested city center. In order to establish a dedicated lane, the city removed 90 parking spaces on Euclid Avenue, which they justified by conducting an extensive parking inventory. They had data to assure wary shopkeepers that plenty of parking remained just a short walk off the corridor.

There are three different but related station designs, along the route, used according to the functions and demand served by the station. There is a major emphasis on "stations," instead of "stops" or "shelters," and these stations are meant to look permanent; in addition various sculpture and other art pieces have been incorporated along the corridor. There is also a unique vehicle look; indeed, the buses were custom designed, including doors on two sides to serve both center platform transitway and side platform bus lane and mixed traffic stations.

Figure C-1

Station Design: Articulated Bus Next to Sculpture Pieces Along Healthline BRT Corridor in Cleveland

As an example of the unpredictable obstacles that can arise, GCTRA found out that the State of Ohio did not allow articulated vehicles like the one proposed for BRT. GCRTA was able to make the case for changing this law and thus avoided heading back to the drawing board or settling for an inferior solution. Other considerations during project design were historic buildings with minimum sidewalk regulations, multimodal uses (a bike lane now runs down much of Euclid), and state and federal road standards. One key factor in getting the project off the ground was locating a source of funding beyond the critical early financing provided by FTA. Cleveland decided to auction the naming rights to the bus line. The Cleveland Clinic, one of the city's most renowned institutions, won the bidding and, thus, what had been planned as the "silver line" became the HealthLine.

Panel Discussion: The Cleveland HealthLine BRT

This panel followed Mr. Schipper's presentation, bringing in the voices of the commercial interests on the corridor and the perspective of "anchor" institutions. During a moderated discussion and question-and-answer session, the panelists discussed BRT as a tool for economic development in struggling urban corridors and the role of partnerships in getting the new system planned, funded

and implemented. Panelists included Debbie Berry, Vice President of Planning and Real Estate Development at University Circle Incorporated; Thomas Einhouse, Vice President of Playhouse Square Real Estate Services; Joe Marinucci, President and CEO of Downtown Cleveland Alliance; and Jeff Pesler, Assistant Director of MidTown Cleveland Inc.

Mr. Marinucci spoke of being inspired about the potential benefits of BRT during a trip to Curitiba. Prior to the trip, he had difficulty envisioning how a bus traveling on city streets could be as transformative as BRT proponents claimed, but once he saw it running so smoothly, he was convinced. He returned a strong advocate for bringing BRT to Cleveland.

Mr. Einhouse's organization manages real estate in Cleveland's historic Playhouse Square District. For him, the system's design elements and streetscape improvements were crucial to gaining his support. Playhouse Square has endeavored to create a cohesive entertainment and retail destination, and the new lighting and public art that were part of the HealthLine package have strengthened the area's unified feel. Moreover, the tenants are happy that tourists staying in downtown Cleveland and university students both have a dependable new means for reaching this stretch of Euclid Avenue. Further east, Euclid Avenue runs past through the campus of Case Western Reserve University and many of the city's leading cultural institutions, an area called University Circle.

Ms. Berry, representing the business improvement district there, spoke of BRT's ability to add to the area's vibrancy and attract new development. She reported that new restaurants have opened since the launch of the HealthLine, and business owners are investing in facades to keep up with the improved streetscape.

Mr. Pesler said that his organization is in the part of the corridor that has struggled the most with issues such as vacancy and unemployment, both historically and today. This section of the city has many vacant factory buildings and foreclosed industrial sites plagued by fragmented ownership. He lauded the HealthLine project as part of a "comprehensive approach to guiding renewal" in Midtown, in addition to zoning changes, land assembly to promote redevelopment, safety enhancements, and branding.

Key Conclusions and Lessons Learned from Workshop

1. Two-way communications should be a key part of every BRT planning, design and implementation effort. Making sure everyone (general public, business community, politicians) understands what BRT can be (high-performance, high-quality rapid transit) and what it is not (just another bus route) is important in gaining political support. At the same time, the varied interests and concerns of all stakeholders must be addressed in some way in detail during planning and design if a project is to move forward. Successful

communications efforts will utilize a variety of techniques, including focus groups and workshops, public meetings, surveys, and various media.

2. When properly done, BRT can both provide much higher quality and performance in public transport for existing transit riders and attract new trips to transit, even in highly transit-dependent communities such as the Bronx and Manhattan in New York and Cleveland's Euclid Corridor.
3. BRT stations can serve as focal points for the revitalization of central city communities as well as for new, more sustainable suburban development, especially when combined with other public investments and policies (e.g., sidewalk, bikeway, streetscape and landscape improvements, zoning incentives, tax abatements).
4. From a design perspective, "the devil is in the details." Every aspect of BRT lines, from vehicles and stations to street lighting and sidewalks parallel to and connecting to stations must be designed as an integrated package. Attention needs to be focused on how each element can contribute to both real performance gains and a customer sense of "quality."

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