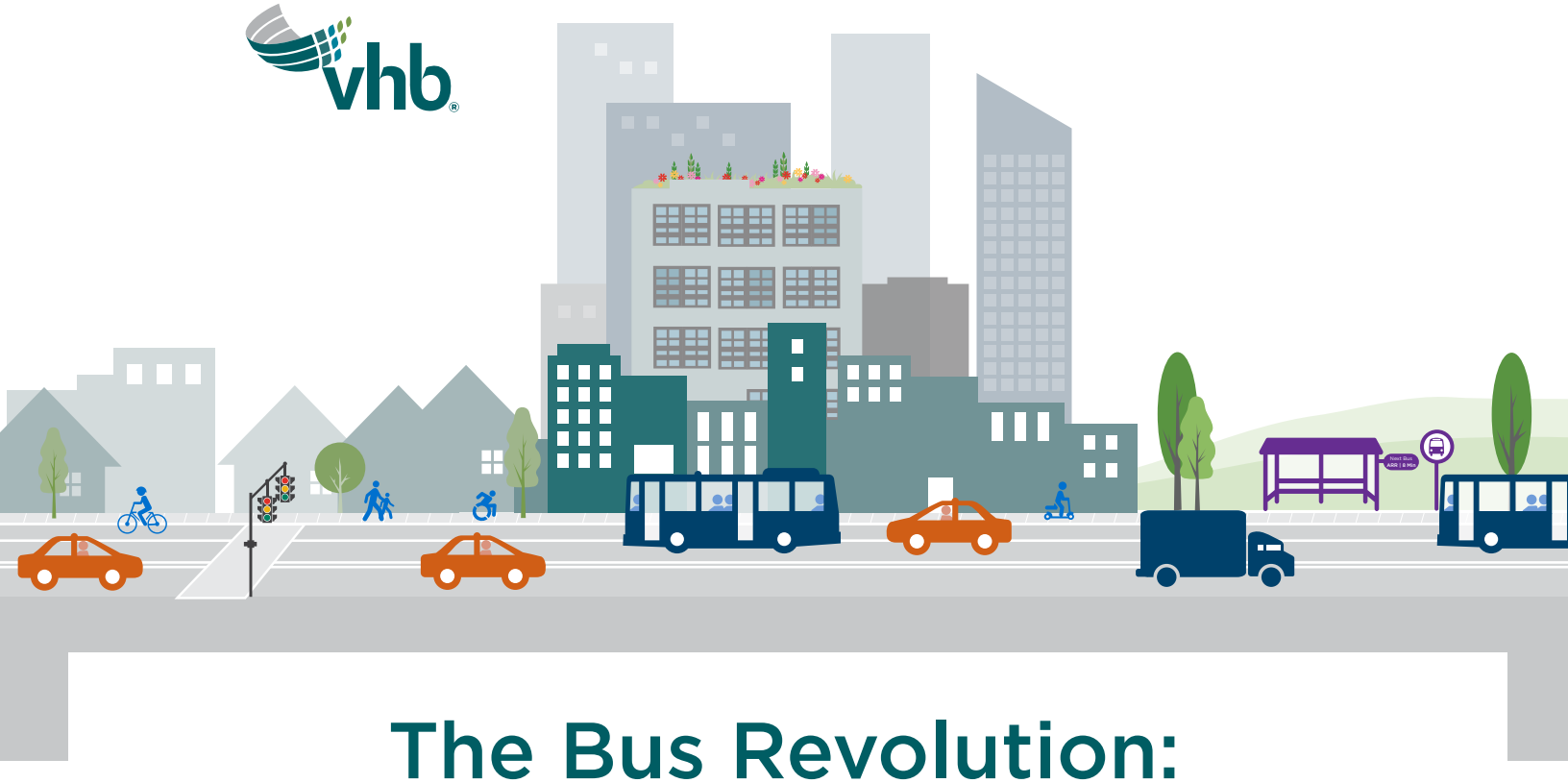

The Bus Revolution:

Adapting to Population Growth, Passenger Demands, and Evolving Technology

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In major metropolitan areas, where the cost of living is high and parking is limited, public transit is the travel mode of choice due to its convenience, accessibility, and cost. Those who are transit-dependent rely on specific modes of transit due to cost, accessibility, and station or stop location. Buses are widely used and a popular form of public transportation for many, especially those who may not own or have easy access to a car, or may have disabilities that limit driving.

To remain a viable transportation option for both transit-dependent and choice riders, bus systems and operations need to evolve with the changing needs of communities and travelers—as well as with innovations in technology.

Making Systems Better: Network Redesign

As communities and neighborhoods change, the bus systems need to change with them. **Cities are re-examining the effectiveness of historical bus networks and service to make them faster, more cost-efficient, and modern to meet current travel patterns and user demands**. Transit agencies that approach service and bus network planning from both a system-wide and a route-by-route perspective are finding success. In some instances, balancing route adjustments with a staged framework for system redesign is the best approach. Regardless of the approach, improvement planning must be based on an understanding of how the system is currently being used, an assessment of whether it meets user/non-user travel needs, and an evaluation of route productivity (riders using the route balanced with the costs to operate it). Armed with this knowledge, system-wide changes should then consider these modifications needed to achieve a modern bus system:

- Sufficient service coverage
- Well-spaced bus stops
- Appropriate service span
- Appropriate and consistent headways
- Direct service
- Route diversity
- Multi-modal connectivity
- Reliability
- Flexibility/redundancy
- Ease of use
- Fiscal responsibility
- Suitable priority infrastructure (i.e., exclusive signal lane priority)
- State-of-the-industry technology
- Effective fare policies, options, and seamless payment methods

Redesigned bus network systems yield both short- and long-term benefits, including promoting economic development by providing more effective travel choices, providing a lifeline for transit-dependent populations, reducing parking demand/roadway congestion/carbon emissions, and providing travel choice/redundancy. **A well-designed system enables transit investment to be used to its maximum effectiveness, benefiting the most riders and attracting new ones**.

However, transforming a historical bus system into a modern bus system is not a simple task. It requires many interrelated and strategic steps that are influenced by a variety of factors, such as funding, a political willingness to share roadway capacity among multiple modes, and social equity. Ultimately, bus network improvements need to evolve publicly, with significant education and feedback. Stakeholders need to spend considerable time preparing for the launch of the improvements and, following implementation, must remain flexible to quickly change some elements of the plan that are not working as envisioned so the ultimate goals of the redesign are achieved.

Making Systems Smarter: Innovative Technology

To expand public transit services, agencies are integrating on-demand dynamic route transportation technology. This results in efficient, integrated travel with in-service connectivity, allowing commuters to effectively utilize their wait and travel times during their daily commutes. Evolving transit technology includes:

Real-time information

Real-time information refers to any information available to transit providers or customers about the current status of vehicles, including approximate locations and predictive arrival times. Most real-time information relies on automated vehicle location technology and global positioning systems (GPS) to estimate approximate arrival times for passengers and transit system operators. Passengers can access real-time information through dynamic signs at stops and stations, or through the internet at home and on smartphones. **Real-time information gives riders a realistic idea of when transit vehicles will arrive and reduces time spent waiting at a stop or station. Real-time information can also improve bus and train connections, which could help make public transportation more appealing to the average traveler**. When buses are delayed, real-time information allows passengers to make informed decisions about alternate routes or modes.

Farebox technology

Farebox technology is paving the way for easier, customized trip payment. **This type of technology enables the use of smart phones or prepaid cards to quickly "tap and go" for quicker boarding, improved connectivity among multiple systems/modes for a seamless trip, and the ability to use multiple payment options**. In some systems, the option for off-board collections requires riders to pre-pay before boarding, eliminating payment delays. With this type of technology, all doors can be used for access rather than just the driver door, allowing for quicker boarding. However, significant system resources are needed to enforce off-board fare collection and to deter fare evasion.

Transit signal priority

Priority tools, such as transit signal priority (TSP), include technology components utilized to improve traffic flow, especially at signals. **TSP can improve both reliability and travel time, especially on corridor streets with long signal cycles and distances between signals, allowing traffic signals to change in response to bus movement**. Advanced signal systems use this information to prioritize signal priority requests by buses, select the most appropriate TSP strategy for the situation, and end a transit priority phase as soon as it is no longer needed. TSP can be implemented at individual intersections or across corridors or entire street systems. In urban contexts, TSP benefits are significantly amplified when implemented alongside other strategies like dedicated bus-only lanes. **The benefits of TSP improvements include reduced transit travel times, improved schedule adherence (reliability), and improved transit and road network efficiency.**

Smart vehicles

Given the trends towards urbanization and the rise of mega-cities, bus carriers must reinvent bus service operations. **Smart bus services can improve operational efficiency, urban mobility, and environmental sustainability**. Vehicles are equipped with integrated multiple communication and sensing technologies to gather vehicle location and movements for enhanced efficiencies. Wireless communications allow bus service providers to use vehicle telematics—a synergy of telecommunications and vehicle technologies—to their advantage for service improvements and fleet maintenance. LTE networks enable bus locations and transport statistics to be shared in real-time to provide bus arrival information, mitigate bus bunching, actively adjust to bus frequency to minimize passenger waiting time, and direct voice communication for drivers and dispatchers in case of emergency.

Making Systems More Efficient: Changing Fleets and New Alternatives

As our communities continue to grow and technology continues to change, buses are evolving to better accommodate the needs of the traveling public. Along with the implementation of various technologies into the bus system, many transit agencies are looking towards greener, more efficient, and cost-effective options.

Electric buses

Electric buses are on the rise in many cities. Battery electric buses (BEBs) are cleaner, quieter, simpler, and smoother with their all-electric propulsion and auxiliary systems. Challenges that agencies need to consider, however, include planning for the vehicle deployment, the ability of utilities to provide power when and where battery charging is needed, the effectiveness of a single charge in meeting route requirements, the time needed for charging, as well as the maintenance facility configuration and operations that will be needed to maintain the fleet. There is no one size fits all solution with BEBs, and charging infrastructure, procurement, and planning decisions must be made carefully based on the individual needs and characteristics of the transit agency to achieve and maximize benefits of this technology.

Micro-transit

Across the country, transit agencies have been implementing micro-transit, or on-demand transit, to fill coverage gaps in areas that have low fixed route transit ridership or are not dense enough to support a fixed route. Changing patterns of transit use, in part due to the prevalence of Transportation Network Companies (TNCs), such as Uber and Lift, have prompted traditional transit agencies to borrow aspects of rideshare technology to investigate extending shared on-demand car or shuttle bus alternatives to their passengers (with or without TNC partnerships). This micro-transit alternative generally allows passengers to access shared rides where the pick-up time and/or location is scheduled by the user, and the routes, origins, and/or destinations may contain some element of flexibility. **The flexibility of on-demand service potentially allows transit providers to reach a more widely drawn and thinly populated area more economically than with fixed route bus service**.

Connected vehicles

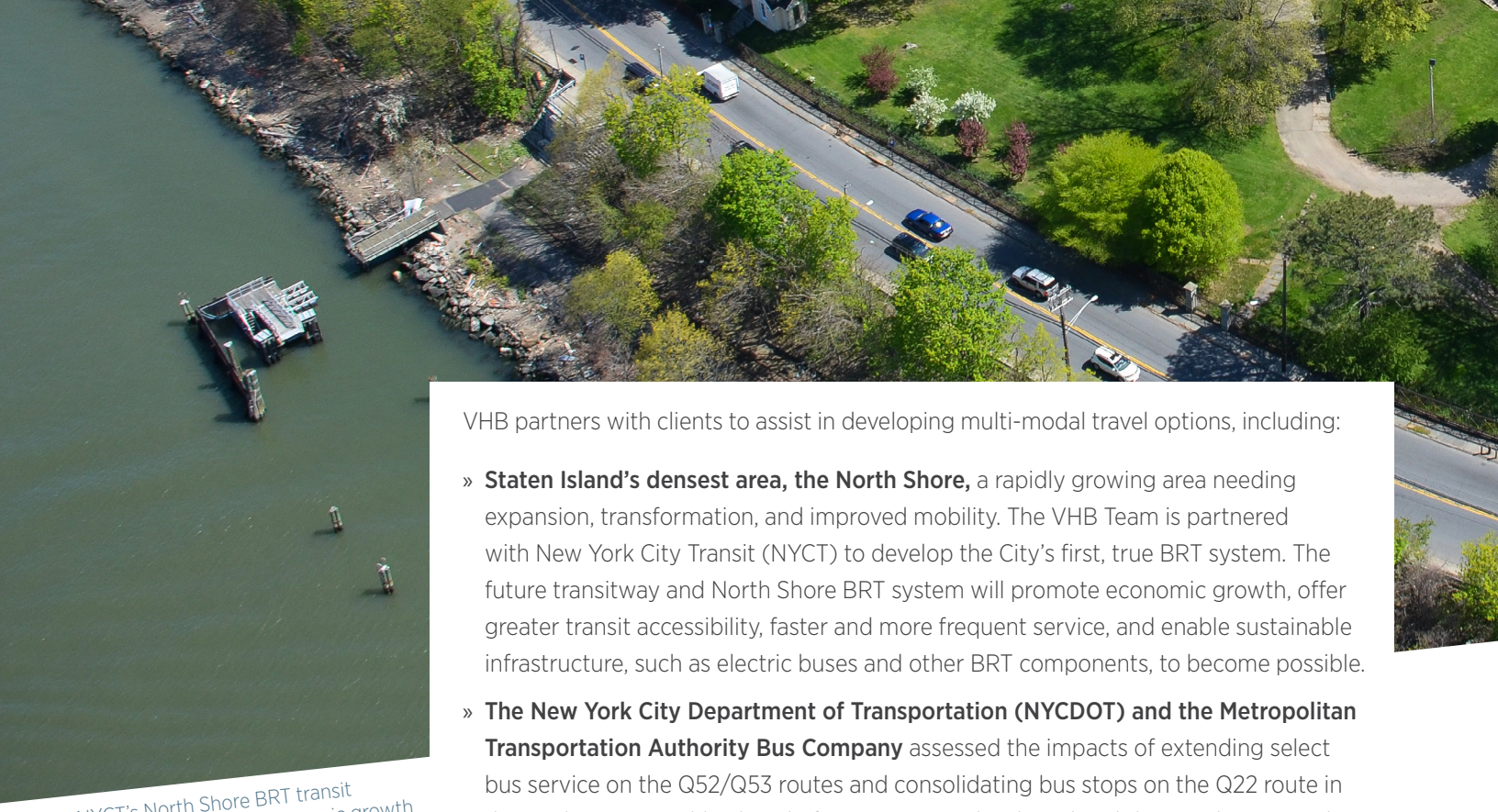
Connected vehicle technologies—technologies that communicate with the driver and other vehicles on the road—aim to tackle some of the biggest challenges in the transportation industry; specifically, throughput, safety, mobility, and sustainability. **These technologies will enable system users and operators to make smart choices that reduce travel delay and safely increase bus throughput by platooning—incorporating a group of buses traveling closely together at a safe speed**. Connected vehicles feature safety warnings that alert drivers to potentially dangerous conditions. They can also use wireless technologies to communicate with traffic signals, work zones, toll booths, school zones, and other infrastructure to ease congestion and improve safety.

Bus rapid transit

Bus Rapid Transit (BRT) is a high-quality bus-based rapid transit system that delivers fast, comfortable, and cost-effective services at metro-level capacities. BRT elements include dedicated lanes with busways and stations, off-board fare collection, transit signal priority, smart bus technologies, unique branding, and fast and frequent operations. **Service is provided to fewer stops, and BRT routes are direct, providing minimal diversions from the straightest path. This type of travel is more reliable, convenient, and faster than regular bus services**. With the right features, BRT can avoid the issues that traditionally delay bus services, like heavy traffic or paying on board. BRT corridors can become anchor routes that provide a foundation to transform an entire transit system.

How VHB Can Help

The bus is an integral piece of the transit puzzle, providing links and flexibility for a variety of users. At VHB, we recognize the important role transit plays for those who rely on it for travel—not just for work, but as a lifeline within their everyday lives. Transit provides the connectivity needed for cities to thrive economically and in a socially-equitable manner. We understand the intricacies of each component of a transit system when planning and designing a corridor system and the need for flexibility to meet the needs of the people it serves. Through data analytics and strategic planning, we help to create transit networks that meet the needs of the commuters who use it, and the agencies maintaining and operating it.



NYCT's North Shore BRT transit system will promote economic growth and accessibility for all users, and incorporate sustainability elements into the buses.

VHB partners with clients to assist in developing multi-modal travel options, including:

» **Staten Island's densest area, the North Shore,** a rapidly growing area needing expansion, transformation, and improved mobility. The VHB Team is partnered with New York City Transit (NYCT) to develop the City's first, true BRT system. The future transitway and North Shore BRT system will promote economic growth, offer greater transit accessibility, faster and more frequent service, and enable sustainable infrastructure, such as electric buses and other BRT components, to become possible.

» **The New York City Department of Transportation (NYCDOT) and the Metropolitan Transportation Authority Bus Company** assessed the impacts of extending select bus service on the Q52/Q53 routes and consolidating bus stops on the Q22 route in the Rockaways neighborhood of Queens. VHB developed and designed street and traffic operational enhancements to improve bus travel times and service reliability.

» **A Better City (ABC),** a membership organization dedicated to improving the economic competitiveness and quality of life in the Boston area, partnered with VHB to study multiple areas of bus operations within the city. Recommendations for improvements included traffic signal priority, queue jumps, stop eliminations, and changes to bus routings.

» **The Greater New Haven Transit District, along with the City of New Haven and Connecticut DOT,** partnered on the "Move New Haven" Study to improve transit access to jobs and education, upgrade quality of service and operating efficiency for all riders, and provide an integrated multi-modal network. VHB led a comprehensive operations analysis, development/implementation of an origin-destination survey, generation of service plans and network/priority infrastructure improvements, ridership projections, and a phased and implementable system transformation plan.

» **The Broad Street Corridor BRT line for The Greater Richmond Transit Corporation (GRTC)** focused on improving efficiency and customer convenience for the addition of the main transfer system. VHB conducted route system modeling and traffic simulation to support ongoing efforts to improve efficiency with transit operations.

Who to Contact>

Contact **Lisa DiTaranti** to learn more about our integrated services approach used to evaluate each scenario, create a bus system that benefits all parties, and optimally runs with the highest efficiency.