Redesigning Transit Networks for the New Mobility Future: Resource and Toolkits

DRAFT Final Report

Prepared for TCRP

Transportation Research Board

of

The National Academies of Sciences, Engineering, and Medicine

Authors:
Foursquare Integrated Transportation Planning, Inc.
Lora Byala, AICP
Shana Johnson, AICP
Rebecca Slocum
Andrew Zalewski, AICP
Josh Weiland
Laura Culp

Eno Center for Transportation
Brianne Eby
Paul Lewis

AECOM
Guillermo Calves
David Sampson

FORWARD

To be added by Dianne Schwager

CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

Bus network redesigns have been a major trend in public transit over the past several years, in part due to the availability of much better data to use for planning purposes and the recognition that the bus can play a big role in improving mobility. While public transit providers have long altered their networks as a response to changing rider needs, the most important and significant distinction when identifying as a bus network redesign is that the redesign is comprised of an analysis of the fixed route bus network as an entire system, not just the analysis of one or a few routes, or even specific corridors. In the past few years, with the rise in app-based transportation network companies (TNCs) and microtransit providers, bus network redesigns have begun to consider how these modes can complement bus service.

This report—a follow on to *Transit Cooperative Research Program (TCRP) Synthesis 140: Comprehensive Bus Network Redesigns*—attempts to dig deeper into the details of conducting a bus network redesign, leveraging many interviews with transit agencies of all sizes across the country that are currently conducting or recently conducted a bus network redesign. It also considers the impact of new mobility that was just touched on in the previous synthesis. This report consists of two major sections. Section 1 consists of chapters 1 through 6, which contain resources on bus network redesign and new mobility. Section 2 consists of case studies of bus network redesigns at four transit agencies as well as toolkits to help transit agencies and stakeholders plan and implement bus network redesign, supporting bus as a mode of choice, and working with the private sector.

The report provides a range of guidance to help public transit agencies and other public entities with all aspects of bus network redesigns. These include:

- **Service Planning and associated tasks at a large scale**. While this is not a report on how to do transit service planning, the approach to service planning and related tasks such as outreach and equity analyses require additional elements not necessarily as important on smaller service planning tasks. These include setting overall goals and objectives at the outset, following set service design guidelines, and developing and evaluating alternative networks.
- **Bus network redesign implementation**. Bringing large scale changes to bus services in a city or region, often all at once, requires a very detailed approach to everything from scheduling, to bus stop signage to public education.
- **New mobility integration into bus network redesigns**. Evaluating the use of new mobility solutions into bus network redesign planning is an approach that has not yet been widely adopted. However, partnering with the private sector—or planning to—can address travel needs identified during the redesign planning process that may not be best served by fixed route transit.
- **Ancillary improvements to complement bus network redesign**. Effective bus network redesign is supported and bolstered by capital improvements that make the buses more efficient, such as bus lanes, Transit Signal Priority (TSP), and limited stops; passenger facilities such as improved bus stop signage, transit centers, and amenities; and operating facilities such as improved layover locations.

Transit agencies of all sizes might consider bus network redesigns, including those that have already conducted them in the past several years, particularly in light of new travel patterns and demands that may emerge in the years following the 2020 coronavirus disease 2019 (COVID-19) pandemic. With the near ubiquitous availability of data on transit usage patterns and the flexibility that bus service offers, maximizing the impact of a region's bus network can be a win-win proposition for the transit agency, the riders, and the community.

The report's findings draw on several sources. In addition to the survey results from TCRP Synthesis 140, this report draws on survey results from *TCRP Report 204: Partnerships between Transit Agencies and Transportation Network Companies (TNCs)*; and *TCRP Synthesis 141: Microtransit: Evolving Approaches to Providing General Public Demand-Response Transit*. The research also draws on the extensive in-depth interviews with transit agencies as well as existing literature.

Key findings from this research reflect policies and programs that were in place prior to the emergence of COVID-19. While the report was being finalized in spring 2020, an effort was made to include information regarding short-term effects of the virus on transit agencies. The long-term effects of the COVID-19 on transit are not yet known.

Key findings from this research include:

1. **Transit agencies see bus network redesigns as a way to implement better bus service, address recent changes in their service or their region, and pass through a variety of improvements under one umbrella.**
   - Even in regions with extensive rail (or other types of fixed guideway) networks, buses carry a significant percentage of transit trips, and changing the bus network has major impacts.
   - Bus network redesigns are seen as a way to bring wholesale change to the transit agency's offerings. While very labor and resource intensive, making many changes at once streamlines work that would have been done over several projects and also makes changes more palatable to the public. While people may not be happy with all the changes, they can at least feel like the changes are not just impacting them, but rather are for the benefit of the entire region. This also makes it easier for the transit agency when it comes time for public hearings before implementation.
   - Transit agencies are tying together a variety of improvements under the umbrella of a redesign. These include implementing high-frequency corridors with bus priority treatments, bus stop optimization, new and expanded transit centers, and even new branding and online and print materials. Most of these improvements are directly tied to supporting the service plan developed for the bus network redesign, but other, only peripherally related, items are also sometimes included.

2. **Bus network redesigns should be framed by strong decision-making processes and leadership guidance.**
   - Most successfully planned bus network redesigns have strong support and leadership from someone in a senior position, such as the transit agency chief executive officer (CEO) or an influential Board member. This high-level backing and guidance is key to buy-in across internal departments, cooperation with stakeholders and the local jurisdictions, and a face of support and leadership (i.e., a "champion" of the redesign) for the public.

3. **Transit agencies should establish parameters and goals early on for bus network redesigns to set expectations for stakeholders, the board, and the public.**
   - Goals for a bus network redesign can vary even across an organization, with some departments focused on maximizing operational efficiency, some on maximizing accessibility, and some on revenue generation. It is important to have well-articulated and coordinated goals so that everyone is working toward the same outcome for the bus network redesign.
   - Parameters for changes to the system should be developed and applied at all phases of the decision-making process so that the process has a strong reference point and keeps the plan on track to meet its targets and objectives. These targets and parameters can be related to, for example, planning for a cost neutral operating plan, a plan to increase bus operations, or a plan that is associated with a priority bus network to which the rest of the service should feed.

- While most transit agencies use bus network redesigns to develop a system that better serves the needs of the riders within their current operating budgets, even transit agencies that had additional money to spend often develop a cost-neutral plan to encourage the discussion of trade-offs.

4. **Bus network redesigns should be built on agreed-upon design principles, service types, and design guidelines.**
   - Because of the breadth of changes that will be recommended through a bus network redesign, transit agencies use the occasion to review and update some of their key service planning guidance documents, including service design and service performance guidelines. This not only provides the planners with a structure under which to conduct the planning but also provides the transit agency with documented reasoning that can be used in discussions with the public and stakeholders.
   - *Design principles* to be defined early include the approach to the planning process—such as starting from a "blank slate" or looking at comprehensive modifications to an existing bus network; how much of the transit agency's resources should be devoted to high ridership services versus local coverage services; how much should the bus network redesign focus on direct trips ("one-seat rides") at the expense of greater frequency; and what demographic and land-use characteristics should warrant fixed-route service at all.
   - *Service types* that a transit agency may include in their bus network redesign include types such as high-frequency/high-priority, feeder service to high-frequency and/or fixed-guideway transit, and local coverage routes.
   - Finally, establishing *design guidelines*—such as span, frequency, and stop spacing—for different service types provides justification for the recommendations that the transit agency can reference later in the process during public and stakeholder input phases.

5. **The importance of frequent and meaningful engagement with stakeholders and the public cannot be overstated; there is no such thing as too much outreach, engagement, and communication when planning and implementing a bus network redesign.**
   - Getting input is critical to developing a bus network redesign plan that will work for people and bringing them along in the process will ease the education process when planning turns to implementation. However, even with significant amounts of engagement, transit agencies should still expect challenges come implementation time, namely making sure all riders are reached and that they understand how the changes will impact their trips.
   - Bus network redesigns typically structure outreach to be a key element of all phases of the process, morphing over time from general input, to feedback on possible service changes, to education about the changes. A common challenge that transit agencies contend with is making sure that the public understands early on that the plan is intended to move toward implementation. Sometimes the sheer volume of changes can make people think it would never be implemented, so they may hold their comments and not provide input until very late in the process.
   - Transit agencies use a wide variety of strategies to engage the public, from workshops, to pop-up surveys at transit centers, to social media. While most transit agencies relied largely on in-person engagement with some complementary online engagement including crowdsourcing sites and surveys, bus network redesigns in the future may likely need to pivot to emphasize virtual engagement given the recent concerns about large gatherings.
   - Engaging disadvantaged and diverse populations is especially important in bus network redesigns. In cities that have multiple transit modes, bus tends to skew toward higher proportions of low-income and minority populations than other modes. Bus network redesigns impact all riders and potential riders, and the input that they provide can be invaluable to the plan development.

6. **Transit agencies are currently in the stage of piloting and experimenting with the integration of new mobility in their services; planning for new mobility has not been widely integrated into bus network redesigns.**
   - Likely due to the relative nascence of these modes, microtransit, transportation network company (TNC) partnerships, micromobility, and the development of mobility hubs are typically considered in parallel or as pilot efforts loosely associated with the bus network redesign.
   - While bus network redesign and new mobility integration is not common, most transit agencies interviewed have or are in the process of implementing a variety of new mobility options, including general-purpose on-demand transit, TNC partnerships, and coordination with local jurisdictions on micromobility for first-mile/last-mile access to transit. A few transit agencies incorporated on-demand zones into their redesign plans, and one incorporated planning for these modes into mobility hubs for multimodal connections.
   - In the cases where transit agencies have implemented microtransit service, their approach to dealing with fixed routes in that area are mixed, with some replacing fixed-route service with microtransit and some using it as a complementary service.
   - While many transit agencies are starting to offer new mobility options, many are funding them and presenting them publicly as pilot projects. Several organizations suggested that low ridership on new mobility services may be both because people do not understand the service and, more importantly, they do not want to invest the time in understanding if the service is likely to go away in a few months. Appropriate marketing and discounts for rides can help counteract some of this hesitancy.

7. **Equity considerations are integral to bus network redesign planning efforts.**
   - At most transit agencies buses carry a higher proportion of low-income, minority, and limited English proficient riders than other transit modes, therefore changes to the bus network may have a greater impact on these populations.
   - Many transit agencies are incorporating additional analysis into their planning to ensure that the planning process accounts for locations of minority and low-income households; the transit agencies that conducted impact evaluations early and worked closely with these communities were better able to serve these populations and address their concerns proactively. This goes beyond just Title VI of the Civil Rights Act of 1964 (Title VI) analysis but also looking at locations with high levels of employment in industries where low-income workers work and ensuring sufficient service to connect communities with healthcare and other social services.
   - While many bus network redesigns focus on improving efficiency and providing better service on high frequency corridors, increasing walk distances to transit can have a significant impact on people with disabilities and seniors. Bus network redesigns should also consider the needs of people with disabilities and the senior population when evaluating alternatives that require longer walks to fixed route transit; not only is fixed route transit often more appealing to this population, but it is a much less expensive trip to provide for the transit agency.
   - Additionally, many people with disabilities and seniors rely on paratransit service, and the service area is based on the fixed route network. Since the fixed route network will be changing as a result of the bus network redesign, some transit agencies that have implemented or are planning to implement bus network redesigns have "grandfathered" in either specific users or geographic areas to ensure continuity of paratransit service.

8. **Implementation of bus network redesigns—on the operating side and with supporting capital elements—are incredibly involved and require participation from all parts of the transit agency, the local jurisdictions, and other key stakeholders.**
   - Intense collaboration is required throughout the transit agency and with regional partners to implement the major changes planned in many bus network redesigns.

- At the simplest, a bus network redesign can be implemented with limited capital investments, such as new bus stop signs, new or expanded layover facilities, and additional space for transfers at existing facilities. More capital-intensive redesigns require transit agencies to work with their local jurisdictions to invest in bus priority treatments, new and expanded passenger stops and transfer facilities, and first-mile/last-mile improvements.
- Transit agencies vary in how they deploy bus network redesigns in terms of an all-at-once change or implementing the plans over time. Deploying over time can be for a variety of reasons, including availability of funds and/or resources, while an "overnight" implementation is logistically challenging but has the benefit of getting everything done at once.
- A proper launch ensures that the changes to the system are understood by the public, which therefore ensures that they system will continue to attract and retain riders. This requires extensive public education as well as educating and empowering front-line employees as ambassadors for the changes.

CHAPTER 1

Introduction and Purpose of the Report

Need for the Research and Context from Practice

Transit agencies are confronted with new challenges and opportunities as technology, demographic, land use, and economic trends all converge to change urban mobility. De-industrialization, the rise of the service economy, and workplace trends like teleworking and the gig economy, have impacted urban travel patterns. Reinvestment in urban areas has produced new markets for transit providers. New mobility providers, such as carshare, bikeshare, and transportation network companies (TNCs), have changed the way people travel and may compete with or complement traditional public transportation. The rise of mobile-based apps and technologies have made possible a host of real-time solutions that once were impossible.

These changes mean that the transit networks developed decades ago may no longer meet the needs of the traveling public. Public transit agencies are responding to changes in urban mobility by conducting comprehensive bus network redesigns – major changes to their bus networks that impact the fundamental structure of the transit system. Alongside this trend, transit providers are embracing new mobility solutions and working to integrate these modes and services with fixed route transit. The purpose of this study is to better understand bus network redesigns and how emerging mobility options are impacting them.

Research Approach

This study follows a lineage of previous studies on bus network redesigns conducted through the TCRP and it aims to build on, not repeat, the previous research. A robust research agenda was followed to develop a broad sense of the current state of Bus Network Redesign practice, as well as goals and challenges transit agencies are facing. This included a detailed literature review, interviews with transit agencies, a focus group with transit industry researchers and private sector companies, and interviews with additional, non-transit agency, organizations. These research activities led to the development of a state of the practice review, which was mostly informed by reviewing recently conducted relevant surveys. As of publication of this report, there are three recent TCRP projects with surveys that are directly relevant to this research, so those surveys were reviewed rather than approaching the transit agencies again.

Literature Review

The documents chosen for the literature review were selected based on their applicability, merit, and uniqueness. Documents were considered that addressed (1) bus network redesign, (2) the impact of emerging mobility on transit systems, and (3) bus network redesign, and emerging mobility in general. The overall goal was to capture existing research without repeating findings, so it was important to look for literature that focused on different angles, cases, and outcomes within the same general topic area. One clear gap in the existing literature is information on how new mobility services are affecting how transit providers approach bus network redesigns, but other aspects of the research addressed this topic.

Stakeholder Interviews and Facilitated Discussion Group

The primary method for this part of the research was in-depth interviews, with a pre-defined set of questions sent in advance to the interviewee so that they were able to gather information needed from others to be able to answer the questions. The research team primarily interviewed transit agencies, as listed in Table 1, and reviewed transit agency documentation, such as bus network redesign plans, for each interviewee. The transit agencies and operators interviewed are:

- Alameda-Contra Costa Transit District (AC Transit), Oakland, CA
- Arlington Texas
- Capital Metropolitan Transportation Authority (Capital Metro), Austin, TX
- Central Ohio Transit Authority (COTA), Columbus, OH
- Clinton County Public Transit, Plattsburgh, NY
- Denver Regional Transportation District (RTD), Denver, CO
- Gwinnett County Transit Division, Lawrenceville, GA
- Hampton Roads Transit (HRT), Norfolk, VA
- Indianapolis Public Transportation Corporation (IndyGo), Indianapolis, IN)
- Kansas City Area Transportation Authority (KCATA), Kansas City, MO
- The Lehigh and Northampton Transportation Authority (LANTA), Allentown, PA
- Los Angeles County Metropolitan Transportation Authority (LA Metro), Los Angeles, CA
- Maryland Department of Transportation Maryland Transit Administration (MDOT MTA), Baltimore, MD
- Utah Transit Authority (UTA), Salt Lake City, UT
- Victor Valley Transit Authority (VVTA), San Bernardino County, CA

The goal of the interviews was to understand how transit agencies and jurisdictions are reevaluating and redesigning their bus networks to address changes to demand, customer expectations, and the new mobility option landscape. This included discussions about partnerships, introduction of new service types, and other tools and approaches to meeting the customer needs of today and the coming years.

While this is a study about bus network redesigns and therefore most of the interviews were with transit agencies or jurisdictions that operate transit, the study also addresses how new mobility is being incorporated into bus network redesigns—or how it is being addressed separately. Therefore, in addition to speaking with the transit operators, interviews were also held with new mobility providers to understand the private sector's perspective, where they see the industry going, and how the public sector can help them to create a win-win result for the riding public.

The research team also held a facilitated discussion group at the offices of the Eno Center for Transportation in Washington, D.C., with participants from the American Public Transportation Association (APTA); Greater Washington Partnership; the Institute for Transportation and Development Policy (ITDP); Lyft; Transportation for America; Uber; and an unaffiliated industry expert. Finally, the research team spoke with representatives from non-transit agency organizations: Ford, TransDev, TransitCenter, Via, and World Resources Institute. The information presented in the subsequent chapters of this report, unless otherwise cited, is based on these interviews (and materials provided by the transit agencies) and reflects the status of the transit agency's bus network redesign at the time interviewed. Particularly in cases where the transit agency was still in the planning stage of the bus network redesign, the details are subject to change as the projects are implemented.

Table 1. Transit Agencies Interviewed and Bus Network Redesign Status

Transit Agency	Transit Agency Size*	Bus Network Redesign Name	Overview and Status as of Interview Date	Date(s) Interviewed
AC Transit	Large	AC Go	Service expansion with redesigned routes and more frequent service; also established microtransit zones. Implemented in phases between 2016 and 2018.	May 2019
Arlington Texas	Small	n/a	All fixed route service was eliminated and replaced with microtransit service.	May 2019
Capital Metro	Large	Cap Remap	Bus network redesign with intent to remove duplication and increase of frequency. Implemented 2018	April 2020
COTA	Medium	Transit System Redesign	Non-cost neutral bus network redesign and expansion, including bus rapid transit (BRT) component. Implemented 2017, BRT in 2018.	June 2019 April 2020
Clinton County Public Transit	Small	Not named	2011 Clinton County Needs Assessment partially implemented; In 2018 implemented change from paratransit to deviated fixed route and dial-a-ride.	June 2019
Gwinnett County Transit Division	Small	Connect Gwinnett	Bus network redesign implemented, 2018. Microtransit pilot 2018 to 2019.	May 2019 March 2020

Transit Agency	Transit Agency Size*	Bus Network Redesign Name	Overview and Status as of Interview Date	Date(s) Interviewed
HRT	Medium	Transit Transformation Project / Transit Strategic Plan	Bus network redesign with regional high-frequency network and microtransit zones. Phased implementation beginning late 2021.	May 2020
IndyGo	Medium	IndyGo NEXT	Bus network redesign that includes three new BRT lines. Transition from a hub and spoke model to a frequent grid rolling out over the next several years.	May 2019 April 2020
KCATA	Medium	RideKC Next	Bus network redesign to address growing perimeter of city and ridership declines. Planning in progress.	June 2019
LANTA	Medium	Moving LANTA Forward	Bus network redesign centered around enhanced bus corridors. Anticipated funding was not available for implementation but process laid groundwork for subsequent planning.	May 2019
LA Metro	Large	NextGen	Bus network redesign adding frequency, reliability, and connectivity particularly with other transit operators. Final planning in progress.	May 2019 April 2020
MDOT MTA	Large	BaltimoreLink	Cost-neutral bus network redesign with high-frequency grid and capital improvements. Implemented, 2017.	May 2019

Transit Agency	Transit Agency Size*	Bus Network Redesign Name	Overview and Status as of Interview Date	Date(s) Interviewed
RTD	Large	Reimagine RTD	Intended as comprehensive assessment of system. Work just getting underway.	May 2019
UTA	Large	Service Choices	Elements of the plan are being broken into smaller changes to be phased in over the next several years as post-COVID revenues allow. Piloting microtransit.	April 2020
VVTA	Small	2017 Comprehensive Operational Analysis	Bus network redesign to address geographic spread and increased travel times. Implemented, 2017.	June 2019

***Transit Agency Size by Annual Bus Revenue Hours:**

Large: 1.0 million or greater

Medium: 250,000 to 999,999

Small: Less than 250,000

State of the Practice Review

A review of the state of the practice in bus network redesigns was conducted to gain an in-depth understanding of the strategies being used to redesign public transportation in order to improve mobility. Because there have been several other recent TCRP studies related to bus network redesigns and new mobility topics, rather than conducting a new survey of transit agencies for this study, a review of these existing surveys was conducted to gain information on various aspects of bus network redesigns through several recently studied lenses: TCRP Synthesis 140: *Comprehensive Bus Network Redesigns*; TCRP Report 204: *Partnerships between Transit Agencies and Transportation Network Companies (TNCs)*; and TCRP Synthesis 141: *Microtransit: Evolving Approaches to Providing General Public Demand-Response Transit*. Each of these studies provided broad information from transit agencies about how they are approaching various aspects of the topics being covered in this report.

Terminology

New mobility describes a wide range of services and transportation solutions, of which a major component is shared mobility services. The Shared-Use Mobility Toolkit (Shared-Use Mobility Center 2016b) defines the following shared use mobility services: public transit; shuttles; bike sharing; carsharing; ridesharing/carpooling; ridesourcing and ride-splitting (both of which are provided largely by TNCs); and microtransit. These definitions, along with others provided by different sources, are summarized below and will be used throughout the report:

- **Bikeshare** are programs where users can unlock and ride publicly available bicycles on a short-term basis, usually for point-to-point or one-way trips.
- **Carshare** are programs where users rent a car, generally for a short period of time. These programs can be from a company that owns the cars, or peer-to-peer, in which individuals rent out their private vehicles to strangers.
- **Micromobility** is related term that describes bikeshare and related modes such as shared scooters and electric assist bicycles.
- **Microtransit** are technology-enabled services that serve passengers using dynamically generated routes, usually between designated stop locations rather than door-to-door. Because they provide transit-like service but on a smaller, more flexible scale, these new services have been referred to as "microtransit."
- **Ridesharing and Carpooling.** Ridesharing describes trips where passengers take advantage of vehicular trips that are already taking place by having additional riders utilize empty passenger seats. The most common examples are carpools and vanpools. While some sources consider TNCs a rideshare service, the Shared Use Mobility Center makes the distinction between the two as TNC trips are largely trips intended to satisfy the travel demand of the passenger and otherwise would not take place.
- **Shuttles** are private systems, generally made up of buses, run by institutions, employers, or residential management companies for a set of riders such as employees or university students.
- **TNCs** (also called ridesourcing) refer to services that connect customers with drivers via a website or mobile app. These services occur in privately owned automobiles and may be shared (i.e., ride-splitting) with other customers with complementary trip origins and destinations.

The convergence of all these shared mobility modes, including fixed route public transit, into one platform is often referred to as Mobility as a Service (MaaS)**.** MaaS describes any digital platform that offers origin to destination trip planning, booking, electronic ticketing, and payment services (Goodall, et al. 2017).

Overview of Contents of the Report

The remainder of this report is organized into two main parts. The first contains five chapters that contain the results of the research conducted and the key findings from it. Part 2 contains two chapters that provide reference materials, specifically case studies and toolkits that transit agencies and others can learn from and use.

Section 1: Research Report

- **Chapter 2: Background on Bus Network Redesigns and New Mobility** provides an overview of the concept of bus network redesigns, discusses key themes and trends in conducting bus network redesigns, trends in new mobility, and how new mobility is being incorporated into bus network redesigns.
- **Chapter 3: Components of Bus Network Redesigns** presents the details of bus network redesign planning, including: the process for service planning as part of a redesign, objectives and metrics for evaluating the plan, incorporating the impact of new mobility, equity considerations, public and stakeholder engagement, financial considerations, and capital improvements undertaken as part of a bus network redesign.
- **Chapter 4: Support and Collaboration** covers collaboration within the transit agency, including transit agency planning and administrative staff, bus operators, and union leadership; collaborating with other stakeholders, gaining community buy-in; and working with transit agency boards and elected officials.
- **Chapter 5: Bus Network Redesign Implementation** provides an overview of how to implement a bus network redesign plan, including phased implementation, engagement and education during implementation, and how to follow-up post implementation to ensure that the plan is dynamic and responsive over time.
- **Chapter 6: Conclusions and Next Steps** provides key findings from the research as well as additional research that would be useful to further the industry's understanding of bus network redesigns and new mobility.

Section 2: Resources

- **Chapter 7: Case Studies** provide in-depth looks at several transit agencies that have planned and implemented bus network redesigns.
- **Chapter 8: Toolkits** contain three sections, each of which provides guidance on a different topic related to bus network redesigns and new mobility. Appendix provides a list of interview and focus group participants.

  - **Toolkit #1: Bus Network Redesigns** is a how-to guide that includes more detail on such topics as developing goals, objectives, and performance metrics; framing trade-offs and constraints; involving boards and elected officials; involving bus operators and unions; conducting public and stakeholder engagement; and planning for implementation.
  - **Toolkit #2: Partnering to Make Bus the Mode of Choice** provides a detailed checklist guide that focuses on how to effectively engage with and leverage intra- and inter-agency partnerships to adopt new practices that increase the attractiveness of riding the bus, including strategies including bus priority, fare modernization, demand-responsive transit, and real-time passenger information.
  - **Toolkit #3: Working with the Private Sector** provides a detailed checklist guide to partnering with private sector new mobility providers, addressing topics such as regulatory and legal considerations,

data sharing, labor and safety considerations, and how transit agencies can develop a Request for Proposals (RFP) for partnering with private sector services.

- The **Appendix** provides a list of interview and focus group participants.

SECTION 1

CHAPTER 2

Background on Bus Network Redesigns and New Mobility

Introduction

A bus network redesign, as explained in the TCRP Synthesis 140 *Synthesis on Bus Network Redesign*, is the process in which a transit agency modifies the structure of its bus network in response to the results of a holistic network analysis. Although this is currently one of the "hottest trends" in mass transit, it is not a new concept (Vock 2017). Public transit providers have long altered their networks as a response to changing rider needs, although they may have been completed under a different title. Regardless of terminology, the most important distinction when identifying a bus network redesign is that the redesign is comprised of an analysis and plan for the fixed route bus network as a system—including the potential for substantive changes to the topology of the network and typology of services offered— not just the analysis and planning of one or a few routes, or even specific corridors.

Overview of Bus Network Redesigns

Although it varies from one transit agency to the next, all transit agencies have at least one motivation or impetus for choosing to undertake a bus network redesign, and all have goals that they ultimately hope to meet as a result of their bus network redesign. The motivation or impetus for conducting a bus network redesign is essentially the thing or things that incite a transit agency to embark on the undertaking. Goals for the bus network redesign define something that the transit agencies want to achieve as a result of the bus network redesign.

For the Metropolitan Transit Authority of Harris County (Houston METRO), which conducted a "system reimagining" and implemented its New Bus Network in 2015, their impetus for change centered around five key points (Houston METRO 2014):

- Ridership had declined on the local bus system
- The transit system had not evolved with the growing Houston region
- New light rail lines created a need to better integrate the bus and rail networks
- Provide a strong foundation for future growth
- The community asked for improvements to the local bus system

Some transit agencies view their "bus network redesign" efforts as simply part of an ongoing process or as a form of "system maintenance," where they regularly look at bus service and its performance. These transit agencies undertake regular "Comprehensive Operational Analyses" or "Transit Development Plans" perhaps every few years (e.g., every five or ten years). Many of these agencies view "Bus Network

Redesign" as being a simply another term for a systemwide and holistic process they undertake on a regular basis that can still essentially serve as a "full-on" bus network redesign effort.

Other transit agencies intentionally choose to conduct a process that is larger and broader than their typical operational analyses. Ridership increasing or decreasing rapidly can inspire an overall look at the bus network. Likewise, outside forces can prompt transit agencies to develop more ambitious, holistic plans. Such forces include increased or decreased funding or the establishment of other transit services, such as new investment in fixed guideway services such as light rail, some types of BRT services, or even new heavy rail rapid transit lines. Often, transit advocacy groups provide support and impetus for a bus network redesign; these groups often view the need for "comprehensive redesign" as being consistent with a desire to make the transit system the most efficient and effective it could be.

The impetus for a transit agency to undertake a bus network redesign might be one or more of the following:

- **Systemwide analysis and update.** For many transit agencies with limited funding and limited staff, holistic, systemwide bus service analysis and planning have long been put on the back burner. While smaller changes have been made over time, the bus networks as a whole often have not been updated in years and the bus routes no longer reflect the existing prevalent transit patterns (Byala, et al. 2019). For some transit agencies, this may be the first time since the inception of their bus network that it has been analyzed as a network instead of as individual routes or corridors.
- **Changes to the transit system**, such as the introduction or expansion of fixed guideway transit services may push transit agencies to alter their bus network to better align with the access needs of rail or BRT passengers and better leverage the new connections as a part of an overall network. (Byala, et al. 2019). On the other hand, cancellation of a planned fixed guideway service can spur an area to consider how other modes such as bus can provide improved service instead.
- **Decreasing ridership and high operating costs** are always on the minds of transit agencies. As national trends show transit use dipping over time, transit agencies may undertake a bus network redesign to update some of their outdated routes, save money by reducing service to areas with low demand, and refocus their efforts on areas that need and use transit (Byala, et al. 2019; Vock 2017).
- **Economic and demographic changes.** Transit agencies may be facing a changing economy or demographic makeup. Economies entering or leaving recessions may face changing transit demands, spurring transit agencies to consider bus network redesign. Likewise, changing demographics and/or demands for paratransit can change overall demand for bus services.

Whatever the motivation for conducting a bus network redesign, transit agencies seek to satisfy one or several overarching goals. Examples of these goals include:

- **Improve transit service for current and potential riders** was found to be the most common goal. Meeting this goal may involve increasing reliability and/or on-time performance, decreasing travel times, and improving frequency and span of service. Transit agencies also use service improvements to increase regional equity or better serve specific groups such as seniors and people with disabilities.
- **Better match the bus network with current and potential future ridership demand.** Transit agencies have made it clear that transit networks cannot stay static in the face of constantly evolving cities and regions (Bhattacharya, et al. 2014; Halifax Transit 2016; Central Ohio Transit Authority 2016). Transit agencies also have goals of service to specific trip generators, such as employment centers and affordable housing developments.
- **Increase bus operational efficiency and effectiveness and/or reduce overall operating costs.** This goal is one of the most commonly cited by transit agencies that have planned and/or implemented a bus network redesign (Byala, et al. 2019). Some transit agencies may be driven to redesign their bus

networks in order to cope with reduced ridership and to reduce the overall operating costs that may have suffered a loss in revenue due to this decreased ridership (Bhattacharya, et al. 2014; Dallas Area Rapid Transit 2016; Houston METRO 2014; Jacksonville Transportation Authority n.d.; New York City Transit Authority 2017; Vock 2017).

- **Accrue other important benefits.** Transit agencies may also be motivated by goals that span beyond improving their service, such as the desire to reduce dependency on personal cars and promote environmental sustainability (Kalantari 2014; Vock 2017). Other transit agencies cited a goal of making the region more competitive.

Many of these goals are related to one another, and it is common for transit agencies to have multiple goals in mind when initiating a bus network redesign (Byala, et al. 2019). This list is not exhaustive; there are many other reasons that may bring a transit agency to conduct a bus network redesign and other goals that they hope to achieve. This simply shows the connection between the prompts for a transit agency to consider a redesign and what they hope to gain as a result of completing it.

Trends in Bus Network Redesign

As more transit agencies have undertaken bus network redesigns in recent years, similarities in the ways that transit agencies are choosing to plan and implement these redesigns have begun to emerge. While bus network redesigns are, at their core, about planning bus service, there are some key elements that differentiate them from typical service planning or are just more common among bus network redesigns. Some of the considerations and trade-offs that transit agencies have been making with regard to bus network redesigns are outlined in Table 2.

Because a bus network redesign is a service plan in which the entire bus system is evaluated and planned for at one time there is the rare opportunity to examine the bus network and its utility in a holistic manner, and to examine the changes in land uses, activity centers, and travel patterns on a metropolitan or regional scale. The trend is that **transit agencies use one of two approaches** for conducting a bus network redesign when determining how to approach the bus network changes, either:

- A "**blank slate**" approach, which, as the name implies, involves essentially scrapping the existing system and starting over again, or more of a "**comprehensive modification**" to the existing system, which involves changing many aspects of the system, but bases its structure on what currently exists. This difference in approach is a more about the *how* of the service planning process; even transit agencies that plan this way may end up with some routes that are largely similar to those in their current system, as their highly performing routes are already meeting passenger's needs.
- **Bus network redesigns raise several fundamental choices** that must be considered; discussing how the public and stakeholders feel about a particular trade-off as input to the planning process is a common trend in bus network redesigns. One is the trade-off between providing transit service in as much of the service area as possible or focusing it upon those corridors and areas that are known to have a high demand for fixed route transit service. Given a finite set of resources, this is the classic "service coverage vs. frequent service on high ridership routes" trade-off inherent in any planning effort but at a much larger scale. Other trade-offs that are often considered in bus network redesigns are questions of more direct service at lower frequencies or service with higher frequencies that requires more transfers.

Table 2. Bus Network Redesign Considerations and Parameters

Consideration/Trade-off	Description
Blank Slate vs. Comprehensive Modifications	Starting planning from a completely fresh approach vs. making major (and minor) modifications to the current network.
Coverage vs. Frequency	Providing transit service in as much of the service area as possible vs. focusing on corridors and areas that are known to have a high demand for fixed route transit service.
Cost	Operating cost neutral vs. adding additional service hours.
Network Structure and Service Emphasis	Crosstown routes and high-frequency grid network (less direct, higher frequency) vs. the hub-and-spoke method (more direct, lower frequency); peak period service vs. midday and weekend; as well as integration with microtransit
Capital Improvements	From minor capital investments to existing infrastructure (e.g., bus stops and signage) to implementing major new capital projects (e.g., dedicated bus lanes and more robust bus stop "stations") as well as investments in operational support features (e.g., layover facilities, new vehicles, expanded or new maintenance facilities)

Bus network redesigns are often pursued as something that should be "**cost neutral**," i.e., that the same number of service hours be budgeted, with the allocation of where those hours are used to provide service being the key difference. Often the final plan does not adhere to that goal and additional funding can be required to "close some gaps" and appease stakeholders. Even if the transit agency does have capacity to increase its operating expenses, approaching the plan initially as cost neutral can lead to fruitful discussions with the public about the trade-offs in network planning when transit operators are constrained by limited resources.

Another trend is the emergence of **crosstown routes and high-frequency grid networks** as opposed to the traditional hub-and-spoke method. This allows individuals to travel without having to pass through the often congested "downtown" area. Having a grid network also allows the transit agency to reallocate resources on fewer parallel corridors, requiring potentially longer walks between routes but allowing for higher frequency, which not only reduces wait time but also provides further justification for bus priority treatments. This is also related to the overall trend of transit services becoming more user-friendly. Bus routes have also become straighter, which is both easier for riders to understand and more efficient for the bus. In addition to the physical service being changed, the level of service and span have been redeveloped along with the routes; weekend and evening service have both seen an increase after these bus network redesigns are complete (Byala, et al. 2019).

Transit agencies are also taking the opportunity of conducting a bus network redesign to make other changes to their system, such as **implementing capital improvements**. This can include improvements to existing infrastructure, such as bus stops and signage, as well implementing new capital projects, such as dedicated bus lanes, more robust bus stop "stations," or supporting pedestrian and bicycle access infrastructure (Byala, et al. 2019). Some capital improvements are required when undertaking a bus network redesign; for example, new stops that did not previously exist need bus stop infrastructure such as shelters and signage, as well as ADA accessibility infrastructure. However, the trend seems to indicate that transit agencies are taking the opportunity of having a bus network redesign to improve infrastructure beyond what absolutely must be changed.

Finally, while a relatively new trend, transit agencies conducting bus network redesigns over the past couple of years have begun to **incorporate new mobility** into what had traditionally been entirely a focus on fixed route service. While this incorporation is still not universal, more transit agencies are looking at new mobility and on-demand services as a potential service type, either incorporated into the bus network redesign or as an ancillary project.

Trends in New Mobility

While public transit ridership has been declining in recent years across the country and bus ridership now at its lowest point since 1973 (Watkins, et al. 2020), many newer forms of shared mobility experienced rapid growth in the 2010s.

- **Carsharing**. The carsharing industry has seen a number of entrants and exits over the past two decades, as well as a variety of models (e.g., round-trip, point-to-point, peer-to-peer). In 2018, there were 21 active carsharing operators in the United States, with over 1.4 million members and over 15,000 shared vehicles. Of these 21 operators, 13 are for-profit businesses that together account for nearly 100 percent of all carsharing program members and vehicles. While the number of carsharing program members increased by 345 percent between 2009 and 2018, in recent years the rate of growth in carsharing memberships has slowed; between 2014 and 2018 the number of carsharing program members grew by 8 percent (Shaheen and Cohen 2020).
- **Micromobility.** Micromobility options have evolved particularly rapidly over the past decade. In 2010, the first modern, station-based bikeshare programs (Capital Bikeshare in the Washington, D.C. area and Nice Ride in Minneapolis, MN) launched (Arlington County, VA 2012) and a total of 321,000 bikeshare trips were completed. In 2018, over 36.5 million trips were taken on station-based bikeshare systems across 30 U.S. cities. Today's bikeshare options include both station-based bikeshare systems and dockless bikeshare systems; many systems have introduced electric bicycles (e-bikes) or have fleets that are comprised entirely of e-bikes. At the end of 2018 there were over 85,000 e-scooters deployed in around 100 U.S. cities (National Association of City Transportation Officials 2019).
- **Microtransit.** Interest in microtransit among transit agencies grew substantially in the 2010s as the technology to enable on-demand scheduling and routing became available to transit providers. More recently, a number of new microtransit technology providers and turnkey operators have emerged and are currently working with transit agencies. Desire for operational efficiency, equity, and accessibility have thus far motivated transit agencies to offer microtransit service. Over time, changing customer expectations and technology have also given transit agencies reason to consider microtransit service; as customers become accustomed to private service offerings, there is a sense that the transit agencies need to evolve their offerings to meet new expectations (Volinski 2019). Survey respondents queried as part of *Microtransit: Evolving Approaches to Providing General Public Demand-Response Transit* treated demand response transit (DRT) as just one aspect of a transit agency's overall service offering, as DRT open to the general public complements the existing transit network. This sentiment is evidenced by service models that connect with the existing transit network (Volinski 2019).
- **Ridesharing,** or carpooling and vanpooling, is not a new form of shared mobility, but technology-enabled ridesharing is a key component of the new mobility landscape in many of the nation's major metropolitan areas. In 2008, the first privately-run, general public, real-time, smartphone-enabled ridematching system was launched. In the 2010s various private firms entered and exited the real-time ridematching marketplace (Shared Use Mobility Center 2020). Vanpooling, shared rides taking place in a van, may be operated transit agencies, owner-operators, leased from private providers, or by individual employers or transportation management associations (Shaheen and Chan 2012). Between 2009 and 2018 the number of vanpool trips reported to the National Transit Database (NTD)

increased by 36 percent to 34 million trips (Federal Transit Administration Office of Budget and Policy 2019).

- **Shuttles.** While comprehensive data on the availability and use of shuttles is unavailable, large operators of these services have contracts with employers, business parks, and others to deliver thousands of rides across the United States (Feigon and Murphy 2018). Certain regions of the country, notably San Francisco and Seattle, see shuttles as a large and key part of their transit networks.
- **Transportation Network Companies (TNCs).** Since the inception of TNCs in 2010, the use of these services has grown dramatically across the world. By 2018, the two largest ridehailing companies had completed more than 11 billion trips worldwide. In the United States, an estimated nearly four billion TNC or taxi trips were taken in 2018, vs. approximately 1.5 billion ride hail or taxi trips were taken in 2012 (Union of Concerned Scientists 2020). As the prevalence of ridehailing has grown, transit agencies have undertaken various types of partnerships with TNCs. A survey conducted as part of *TCRP J-11 Task 26*: *Partnerships between Transit Agencies and Transportation Network Companies (TNCs)* revealed that transit agencies' top goals for TNC partnerships were "to provide first-mile/last-mile connections" (75 percent), "demonstrate innovation" (69 percent), and "improve customer experience" (61 percent). When asked about the target customers of the TNC partnership the two most common responses were to serve "people with disabilities" (57 percent) and "people in areas difficult to cover by fixed route services" (51 percent) (Curtis, et al. 2019).

New Mobility and Bus Network Redesign

When bus network redesigns initially had a resurgence in popularity in the early 2010s, new mobility was not a big consideration – in large part because many of the new mobility options were nascent. There is limited literature and not very many transit agencies that have directly tied new mobility services to bus network redesigns. Nevertheless, there is recent evidence that new mobility providers are having some impact on both how and why transit agencies undertake service planning efforts; the potential tie-ins between new mobility and bus network redesigns are depicted in Figure 1.

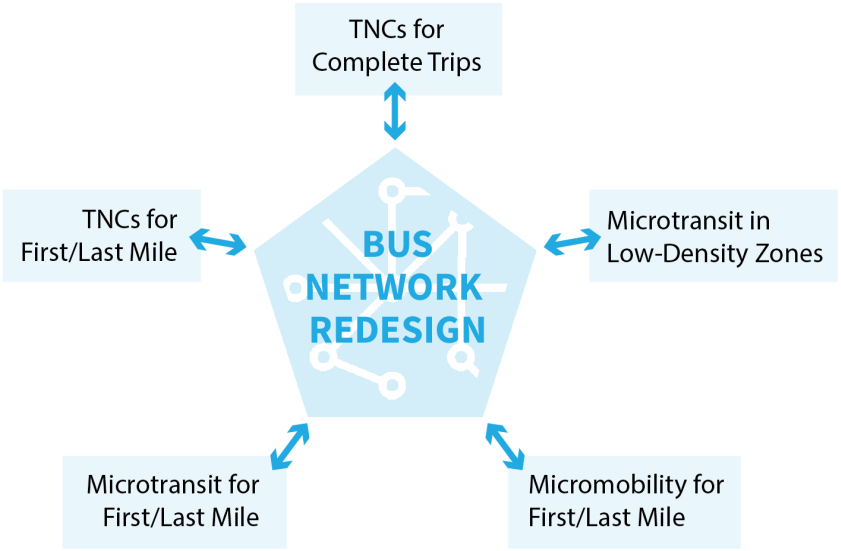


Figure 1. Connections Between New Mobility and Bus Network Redesigns

Generally, transit agencies view favorably the idea of incorporating new mobility services into existing transit services. A 2019 survey by the Eno Center found that:

- Three-quarters of transit officials expressed interest in integrating MaaS technologies into their system, with small transit systems especially positive about MaaS.
- Seventy percent of operators also expressed interest in working with TNCs to provide transit-operator-based on-demand ridehailing services, though this opinion was largely held by medium-sized operators (80 percent expressed interest), rather than large operators (40 percent expressed interest).
- Almost 80 percent were interested in testing digital on-demand services of some kind (e.g., TNCs, microtransit services).
- Transit agencies expressed less interest in exploring carpooling services and dockless bike and scooter share technologies (Eno Center for Transportation 2019).

New mobility services cannot compete with high-quality, fixed route transit from a capacity, and therefore efficiency standpoint, and would thus prove ineffective as a direct substitute for highly utilized transit service (Tsay, et al. 2016). This idea is further supported in TCRP Report 195, which found that the majority of TNC trips are short, many within one ZIP code, and patrons tend to only use TNCs occasionally versus as a primary mode of transit (Feigon and Murphy 2018). TNC usage is most common in areas containing an airport, likely as a way for people to get to and from the airport without having to drive and park their car.

The transit agencies that participated in this research have incorporated new mobility into their bus network redesign process, or as a follow-on to their bus network redesign, in a wide variety of ways (Table 3).

Table 3. Examples of Bus Network Redesigns and New Mobility

Transit Agency	New Mobility in the Bus Network Redesign Process	Information Current as of
AC Transit (Oakland, CA)	AC Transit replaced one low frequency fixed route service with two microtransit zones. These zones are currently averaging four boardings per hour; the transit agency feels that when a fixed route is between 6-10 boardings per hour it merits consideration of transitioning to DRT. Ridership on the microtransit services is around 20% lower than the fixed route service it replaced.	May 2019
Capital Metro (Austin, TX)	Capital Metro recently transitioned their “Mobility Innovation Zones” (zones for flexible on-demand transit) created in their bus network redesign. They were initially operated by a non-profit TNC but have since been converted to microtransit operated by the transit agency to address accessible services and payment by unbanked riders. The flex zones replaced local bus with the aim of connecting communities to high-frequency buses. However, the service in two of the four Mobility Innovation Zones currently has lower ridership than the ridership lost on the fixed route services.	June 2020

Transit Agency	New Mobility in the Bus Network Redesign Process	Information Current as of
HRT (Norfolk, VA)	HRT's Transit Transformation Project and subsequent Transit Strategic Plan included a comprehensive plan to redesign the existing fixed route system, plus incorporation of microtransit zones that would supplement and potentially replace lower performing fixed route service. The transit agency and its funding partners viewed the inclusion of microtransit as a way to develop a more financially responsible plan. The transit agency then engaged with a microtransit provider to model the costs and refine the zones developed during the bus network redesign.	May 2020
IndyGo (Indianapolis, IN)	As a follow-on effort of IndyGo's bus network redesign, IndyGo is piloting several community-based microtransit solutions in conjunction with an account-based fare collection system.	June 2020
KCATA (Kansas City, MO)	KCATA viewed the planning process for their bus network redesign as being informed by their experience with an unsuccessful microtransit service pilot with a private operator. They learned that the transit agency needs to conduct planning work for the service area to determine the appropriate service parameters for the implementation of future microtransit services. In the redesign planning, the transit agency set a threshold for passengers per hour, under which the area would be a candidate for microtransit.	June 2020
MDOT MTA (Baltimore, MD)	At the time of the launch of the BaltimoreLink bus network redesign, bike share stations and carshare stations were co-located at Maryland Area Regional Commuter (MARC) Train, Light Rail, and Metro Subway stations to provide first-mile/last-mile access. The transit agency is exploring ways that microtransit options can connect lower-density areas with the MDOT MTA system.	April 2020

Conclusions

Having provided an overview of bus network redesigns—including their goals and the impetus for conducting them—along with an overview of new mobility, this chapter ties the two together to show how bus network redesigns and planning for new mobility are starting to be integrated. While new mobility is still nascent, it is playing a much larger role in transit agency offerings and is being considered as a viable complement to fixed route transit service; it is therefore looked at as a key consideration as transit agencies conduct their bus network redesign planning. The following chapters provide detail on the many components of bus network redesigns—including planning, public and stakeholder engagement, financial considerations, capital elements, and equity—and provide the reader with examples of how transit agencies across the country have risen to the many challenges inherent in creating and implementing transit plans of this magnitude.

CHAPTER 3

Components of Bus Network Redesign Planning

Introduction

This chapter provides an overview and examples of many of the key components of conducting a bus network redesign:

- Bus network redesign planning process
- Goals and objectives
- Metrics
- New mobility and bus network redesign
- Equity
- Public and stakeholder involvement
- Financial considerations
- Capital elements that support a bus network redesign

Bus Network Redesign Planning Process

Overview

At the heart of a bus network redesign is the process of bus service planning, which looks at how resources can best be allocated across a transit system so they create an effective network, provide service where needed, maximize ridership, and many other objectives. Regardless of whether bus service planning is being done at a system level or on a small scale within a larger system, at a high level the service planning process remains the same: gather information, analyze and recommend, and engage stakeholders and the public. While it is common for bus operators to complete small, incremental changes to their bus network by modifying a single route or a few routes, a full overhaul of the entire system, or a bus network redesign, involves significantly more time, effort, coordination, and funding. However, despite the variation in scale, the basic steps of bus service planning remain the same and can generally be broken down into the following three components:

Gather Information

- The outset of bus network planning is focused on creating a framework of understanding to guide the development of recommendations. Typical elements of the information gathering phase include:

  - A complete evaluation of all current bus service at the most granular level possible, such as at the route, trip, and segment level.

  - A market assessment to determine how well existing service meets demand. This includes determining parts of the service area with some level of transit propensity, i.e., likelihood for transit demand, as well as reviewing travel flows, often from external sources such as the regional travel demand model and/or purchased cell phone data.
  - The development (or revision) of performance standards for individual routes or the network; and, documentation of resource, budgetary, and fleet resource constraints.
- Information should also be collected to inform the planning process from stakeholders that represent many perspectives, both those outside the transit agency as well as internal stakeholders including bus operations, bus operators, and union leadership. The more input that is received early the better it can be incorporated into the planning process.

Analyze and Recommend

  - The second component begins by analyzing the performance of the existing service at the route and network level and comparing it to the service standards. Changes to service are then proposed that improve adherence to performance standards, address gaps in the market, and adhere to resource constraints.

Engage Stakeholders and the Public

  - This component is pivotal to ensuring the success of any proposed changes. Transit agencies engage the public—both in general and through community groups and non-profits—to get their feedback on existing transit service, preferences, and proposed service changes. Recommendations are adjusted to reflect public feedback.
  - At the outset of the planning process it is important to make it clear that the changes developed through the bus network redesign process are not just conceptual (i.e., the changes discussed will be made) and difficult trade-offs and decisions happen during a redesign. This can engender more support later in the process.
  - Bus network redesigns also require a large component of public education prior to implementation. There is a need for extensive public education on the finalized new network so that people are prepared for how to get around once the changes are implemented.

These components of service planning, combined with the many other related aspects of conducting bus network redesigns, can be generalized as shown in the approach shown in Figure 2.

Figure 2. Example of Common Planning Process for Bus Network Redesigns

While bus network redesigns are, at their core, about planning bus service, some of the key elements that differentiate them from typical service planning include:

Evaluating and planning the system from a holistic and systems approach. Because a bus network redesign is a service plan in which the entire bus system is looked at initially, and not solely one route (or group of routes) or certain specific corridors, there can be an opportunity to examine the bus network and its utility in a holistic manner, and to examine the changes in land uses and activity centers on a metropolitan or regional scale. Bus network redesigns require extensive data analysis, both from within the transit agency and external. Any service planning that a transit agency conducts for its fixed route bus service necessarily relies on their own data, including ridership and on-time performance. As Automatic Vehicle Location

(AVL) and Automated Passenger Counters (APCs) are common in medium and large transit systems, getting this data at the route, trip, and segment level provides transit planners with incredible amounts of useful data for any transit service plan, including bus network redesigns. However, the use of data from the regional travel demand model and "big data," or purchased data that shows travel patterns throughout the region, is something that transit agencies are using to get a better sense of where the demand for trips exist. This allows the planners to consider travel needs outside of the service currently being offered by the transit agency.

Redefining service types and design standards. A common initial step in conducting a bus network redesign is to reexamine and reapply service design standards and the development of new service types to plan around them. By initially defining what is meant by certain types of service—i.e., high frequency, local, coverage—communications can be framed, expectations can be set, and a solid set of guidelines for each service type produced. It can also be an opportunity to introduce new service types, such as general use on-demand transit, to areas where the transit agency seeks to remove low-productivity coverage service.

Evaluating trade-offs on different types and characteristics of service. Bus network redesign often raises the fundamental choice between providing transit service in as much of the service area as possible or focusing it upon those corridors and areas that are known to have a high demand for fixed route transit service. Given a finite set of resources, this is the classic "service coverage vs. frequent service on high ridership routes" trade-off inherent in any planning effort. A systemwide bus network redesign can be one part of effectively allocating resources from low-productivity coverage service and high-productivity frequent service (or vice-versa). Planning at the network level can make it easier to communicate trade-offs between focusing on one type of service over another. Systemwide-level redesigns can be "easier to sell" to the entire community than when a specific route is examined in isolation.

Bus network redesigns are often pursued as something that should be "cost neutral," i.e., that the same number of service hours be budgeted, with the allocation of where those hours are used to provide service being the key difference. Often the final plan does not adhere to that goal and additional funding can be required to "close some gaps" and appease stakeholders. Approaching the plan initially as cost neutral system can lead to fruitful discussions with the public about the trade-offs in network planning when systems are constrained by limited resources. Additionally, the planning process should be flexible; one transit agency that started its bus network redesign process anticipating significant new funds needed to change everything to complete the redesign in a "resource neutral" manner when the funding did not come to fruition.

Bus network redesigns are sometimes done in conjunction with other major transit system changes. Sometimes an impetus for redesigning the bus network is that the transit agency has recently implemented new fixed-guideway service, e.g., rail or BRT, that can prompt the transit agency to reconsider how to deploy its local bus services. For some transit agencies, this means reallocating service hours that are now covered by the fixed-guideway route and for others it is more about reorienting service around the new fixed-guideway(s).

Each of these ideas is described in more detail below.

System Level Evaluation and Planning

Unlike traditional bus service planning, bus network redesigns allow the transit agencies to restructure the transit network to better match regional travel demand in a way not possible through incremental or piecemeal service changes. It requires a more in-depth and extensive analysis of the performance of the bus network compared to network-level planning and design objectives (Byala, et al. 2019, 75). These efforts

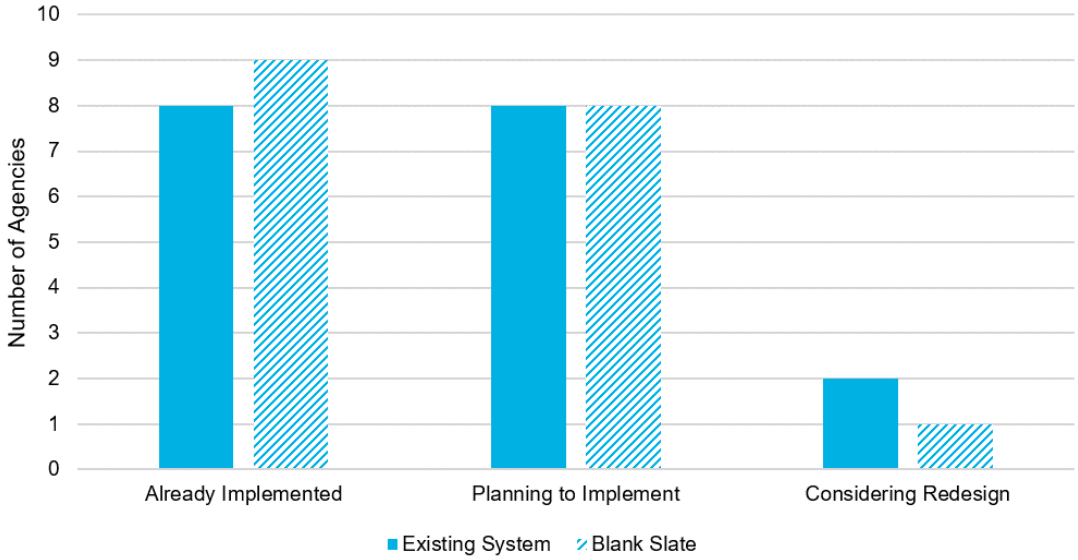
often result in significant changes to the organization and structure of a transit network (Byala, et al. 2019, 6-7). In addition to the general components of bus system planning that were stated previously, the bus network redesigns usually also include more in-depth analysis into the market, demographics, and travel flows to determine key trip generators and attractors and common travel flows to ensure that the bus network is serving passengers according to their desired movements (Byala, et al. 2019, 7). This includes confirming service on existing significant corridors, as most transit systems have corridors where transit is performing well; planners should not lose sight of where service is working well as the planners evaluate the system and develop recommendations.

Transit agencies often use one of two approaches for conducting a bus network redesign when determining how to approach the bus network changes.

- **Blank slate.** The first is called the "blank slate" approach, which, as the name implies, involves essentially scrapping the existing system and starting over again (Byala, et al. 2019, 73). The benefit of this is that systems can be completely reimagined without the constraints of previous planning and existing service. When using this approach, however, it is important not to unnecessarily change high performing routes for the sake of change, and also to manage the change and communicate in a way that assures riders that the new system will easily get them where they need to go.
- **Comprehensive exiting system modification.** The other option for the planning process in a bus network redesign is more of a comprehensive modification to the existing system, which involves changing many aspects of the bus system, but bases its structure on what currently exists. The benefit of this is that existing functioning routes can be kept, which reduces the later difficulties that come with implementation. When using this approach, however, transit agencies must take care to be open minded about how revised route structures and service typologies could help them meet their objectives and not feel tied to current services that could provide mobility and accessibility in a better way.

In many cases, while the approach is different the results of the two approaches may not differ to a great extent. Older cities with established development patterns, particularly in the urban core, and the existing roadway networks and other geographical features put a limit on what changes might be needed and physically feasible.

In a survey of transit agencies conducted in early 2018 as part of *TCRP Synthesis 140: Bus Network Redesigns*, responses were fairly evenly split between transit agencies who reported taking a "blank slate approach" (54 percent) and transit agencies who made or intended to make changes that built upon their existing network (46 percent) (Byala, et al. 2019, 151). This split was relatively consistent between transit agencies that had already implemented, those that plan to implement, or were considering a bus network redesign (Figure 3).



Source: Adapted from *TCRP Synthesis 140: Bus Network Redesigns, 29.*

Figure 3. Planning Approaches to Bus Network Redesigns by Status of Redesign

Regardless of the approach to bus network redesign planning, taking a fresh look at the entire network focused on meeting the goals and objectives defined by the transit agency – such as efficiency, accessibility, and customer focus – can result in a new system that can turn the tide of bus ridership decline.

Service Types and Design Standards

Another key element of bus network redesigns is often the reexamination or creation of updated service standards for different types of bus service, such as high-frequency service, local service, circulator, coverage service. Before a transit agency plans the new service, it can reexamine these definitions in terms of the design parameters, including frequency, span, directness, stop spacing, route spacing, levels of density, and ridership for which each service type is applicable. By setting these guidelines up front, the transit agency can better design its service to appropriately meet customer needs as well as have a ready explanation for why certain types of services were placed where they were. This gives the transit agency backup for explaining why a certain route is recommended at a given frequency, or why the route cannot deviate into a neighborhood.

While transit agencies look at new employment and other activity centers as part of their bus network redesigns, these new areas may not have sufficient density and/or are pedestrian unfriendly, so setting design standards can help keep the focus—especially in a blank slate bus network redesign—on areas where transit can be more effectively offered.

- **HRT** Transformation project updated the transit agency's service types and design guidelines. While its cost-constrained service plan was not able to include every route quite meeting the design guidelines, bringing the routes up to the level of service that they are designed to have is included in an expanded plan to take advantage of anticipated new state revenue.
- **IndyGo** new service standards were under development during the creation of the bus network redesign, and formally adopted after the redesign planning was completed.

Having a support structure for its planning decisions was of great help to these two transit agencies as they proceeded to plan their bus services.

Trade-offs

Many transit agencies weigh the inherent trade-offs that must be made when trying to accomplish different competing goals with a set budget, such as:

- **Expanding or maintaining coverage** to provide transit service in as much of the service area as possible
- **Increasing frequency** or focusing it on corridors and areas that are known to have a high demand for fixed route transit service.
- **Providing more direct service** between locations or requiring transfers between higher frequency service.
- **Requiring longer walks** to service with higher frequency or shorter walks to less frequent service.
- Increasing service during the peaks, midday, evenings, Saturdays, and/or Sundays.

One trade-off transit agencies face is the allocation of a fixed supply of buses and how that allocation is balanced between **how much area the service covers and how frequent the buses are on high-demand routes.** This trade-off is often associated with the population density of the service area because higher density areas, such as urban cores and walkable, mixed-use development have more people that live and/or work within a reasonable distance of a transit station, and therefore have higher demand. Lower density areas, on the other hand, tend to have lower ridership because there are fewer people living/working near each station. Fixed routes in high-density areas tend to have higher ridership and are therefore often more desirable for transit agencies. Determining how to create a bus system that accommodates these two groups while maximizing ridership is a challenge for any transit agency or operator that is redesigning their bus network.

Another trade-off transit agencies face is **whether to provide direct connections between many origin and destination pairs or to require more transfers** – the latter of which makes riding the bus system more complex but also can result in shorter travel times by enabling the transit agency to provide more frequent service on more routes. The transfer question becomes additionally pertinent if a modal transfer is involved, particularly if a new fixed guideway mode (or a forced transfer to an existing one) is replacing what may have been a “one-seat ride”, i.e., without any transfers, on a bus.

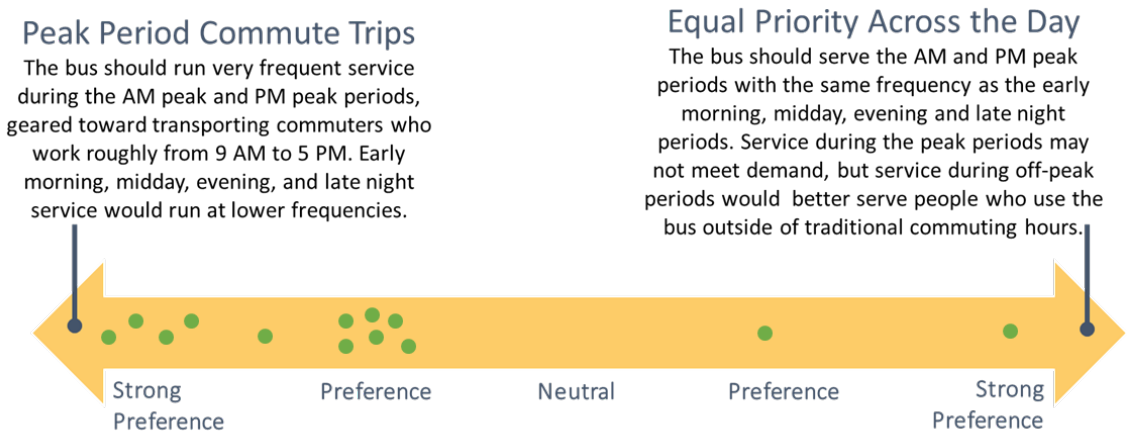
Transit agencies and their customers also face the trade-off of **when to provide more service.** Adding more peak period service is typically limited by the size of the fleet, but transit agencies can choose as part of their bus network redesign not to maximize the use of the entire fleet during peak hours but rather reserve some of those operating costs to improve service during middays and on weekends. For example:

- **LACMTA** determined that 85 percent of Los Angeles County residents used transit at least once in the prior year, and that short distance midday and evening trips represented the greatest opportunities to grow ridership.
- **MDOT MTA’s** bus network redesign in Baltimore in 2017 improved weekend service to accommodate the needs of the many riders that do not work traditional shift jobs and who use the service for many other purposes than getting to work. As a result, weekend ridership on the bus system increased upon implementation.
- In **Los Angeles**, it was determined that 85 percent of Los Angeles County residents used transit at least once in the prior year, and that short distance midday and evening trips represented the greatest opportunities to grow ridership.

Discussing the trade-offs between different levels and types of service within a set budget can be a useful tool for stakeholders and the public to understand how limited resources manifest themselves. If a transit agency focuses its limited resources on providing high-frequency service on more routes, for example, it necessitates reducing frequency on lower-performing routes or removing them entirely. It also could result in shortened travel times (due to shorter waits) but becomes more complex, especially for the uninitiated rider. Likewise, if a transit agency values coverage and direct connections—ensuring that more people in their service area have access to some type of transit and that people have the "one-seat ride" that customers find desirable—the quality of service on the more productive routes will suffer. Transit agencies must also consider how the results of these decisions will impact seniors and people with disabilities, such as those who are not able to walk or roll longer distances and find transferring buses more complicated and difficult than others in the population.

Options to address these issues include keeping more coverage, keeping some direct connections on particular routes or connections that would have a higher proportion of these populations, adding flexible service in certain areas, and relying more on paratransit.

As part of bus network redesigns, transit agencies often pose questions to the public about preferences to help guide the plan, such as "would you be willing to walk farther to higher frequency service or would you prefer a shorter walk with longer waits between buses," "would you prefer a direct connection on a lower-frequency route or would you be willing to transfer buses for higher frequency service," and "do you prefer that the transit agency focus its resources on more peak, midday, late-night, or weekend service?" The results of these questions (see example in Figure 4, where each dot represents the opinion of a meeting participant) can guide a transit agency in terms of how much their riders are willing to "give up" to receive better bus service and also what times of day and days of week they should focus improvements on.



Source: Foursquare ITP

Figure 4. Trade-off Question and Participant Responses from HRT's Transit Transformation Project

While these questions are very effective in explaining the difficult decisions that must be made in an environment with limited resources, the limited reliability of input on stated preference questions should not be overlooked. For example:

- **MDOT MTA.** During initial outreach by MDOT MTA in Baltimore as part of its bus network redesign, public participants stated a preference for improved frequency over coverage and a willingness to walk for better frequency. Once specific service recommendations were developed, however, public pushback led to the MDOT MTA re-introducing some of this coverage service. This experience suggests that even when there is theoretical preference for higher levels of service in lieu of better coverage, in practice such changes may prove to be unpopular.
- **IndyGo. F**or the most part, IndyGo headed off this concern about loss of coverage by following the strategy of maintaining coverage service and adding more service to ridership-oriented routes with additional resources.
- **COTA**. To guide COTA's redesign of its fixed-route network, COTA's Board of Trustees supported a policy to allocate 70 percent of resources to ridership service and 30 percent to coverage. However, during the bus network redesign process, stakeholders in downtown Columbus expressed their desire to reduce the number of buses operating on High Street, the primary north-south arterial of the city. While changes were made to COTA's Downtown operations at the request of these stakeholders, despite the resulting impact of increased travel times the ridership/coverage split did not change.

As part of its bus network redesign, IndyGo approached accommodating those who wanted to focus on higher frequency bus service and those who wanted to focus on broader accessibility by "maintaining service." Essentially, any new service added would be "ridership-oriented" (it would go where there is high demand), but "coverage-oriented" service would generally not be removed as long as it was serving a need. Their long-term plan is to have 80 percent of their service be ridership-oriented and 20 percent be coverage-oriented, while they currently are closer to 60 percent ridership-oriented and 40 percent coverage-oriented. One of the trade-offs they are working with to increase frequency is that some trips that previously did not require any transfers now do. This allows for shorter bus routes along major corridors, which increases the frequency of service. This planning was undertaken with the assumption that a ballot measure would be passed, and therefore with the anticipation of increased funding, which limited the trade-offs that had to be weighed.

Many transit agencies that conduct bus network redesigns state "goals" of a certain percentage of their service defined as "ridership-oriented," or high-frequency and high ridership service and the remainder of the service defined as "coverage-oriented," or lower frequency service to ensure transit access to a larger part of the service area. While this is a way to think about how to plan service, typically transit agencies are trying to achieve different goals—such as accessibility, ridership, efficiency, as outlined above—and these percentage "goals" are more planning parameters to guide them in designing service to meet their true goals.

Cost Neutral Planning

Even with smaller scale service planning projects, transit agencies always need to be mindful of their operating budgets and fleet availability. Bus network redesigns also are frequently conducted as cost-neutral plans. For example, bus network redesigns in Houston, Austin, and Baltimore were all planned for cost neutral operations (although Austin and Houston's plans eventually implemented systems with increased operating costs). However, with bus network redesigns, the cost neutral requirement is often something that seems to run counter to their high-profile nature.

Denver Regional Transportation District (RTD) addressed low-density areas by offering FlexRide, an on-demand service that has existed for approximately 20 years (though it was initially branded as Call-n-Ride when service began in 2000). This program provides service in low-density communities that do not have access to fixed route service, or whose fixed routes may have limited frequency/span of service. There are approximately 1,800 boardings per day in 21 service areas, and the transit agency's rationale for providing these services is to provide more cost-effective services in suburban, low density areas. Depending on the needs of each of these 21 service areas, FlexRide can offer on-demand service based on trip requests; timed pickups at transit stations or park-and-rides, where riders specify their destination upon boarding; and/or pre-set routes with designated pickup locations and passenger-requested drop off locations. In addition, a number of private companies have piloted first-mile /last-mile services in partnership with specific cities around the Denver metro area to link to RTD stations, but to date these services have not been offered specifically by RTD.

If a transit agency has been relatively diligent about making changes to meet new land use and demographics over time, a net-neutral plan will not necessarily provide the "wow-factor" of a new system unless the transit agency is willing to make drastic changes to coverage to reallocate that service to significantly improved core service, force transfers between higher frequency service, and/or reallocate the limited service hours between different times of day and different days of week. In other words, without a willingness by the transit agency—which depends heavily on the desire of the community—to make big changes, there is only so far reallocation of existing resources can take things. That said, many of the other elements of a bus network redesign beyond the service planning—such as improvements in passenger amenities, bus priority, branding, and education—can still result in a big impact and provide some of that "wow-factor."

Houston METRO and Baltimore MTA were both able to make a big impact even with small operating cost increases (Houston, at four percent or $12 million) or no operating cost increases through other investments—which differ by city but included bus stop optimization, new bus stop signage, new branding, bus priority treatments, and the benefits of a re-planned bus network, such as straighter routes, higher frequency, and service better suited to the current travel patterns, including more midday and weekend service.

Incorporation of Fixed Guideway Services

The opening or expansion of fixed guideway transit can be the impetus for a bus network redesign, or in some cases part of the redesign planning process. Some transit agencies have planned bus network redesigns around future or recently implemented fixed-guideway transit, including BRT and rail. For example, one transit agency used a bus-rail interface plan to provide adequate service during rail construction and scaled back bus service over time once the rail opened. Other transit agencies have stated that bus network redesigns serve as an impetus to future BRT service by planning for high-frequency corridors that would be best suited to additional bus priority treatments that would eventually become BRT. Regardless of the order in which the planning occurs, transit agencies should consider how the bus network feeds into and leverages fixed-guideway transit, regardless of mode.

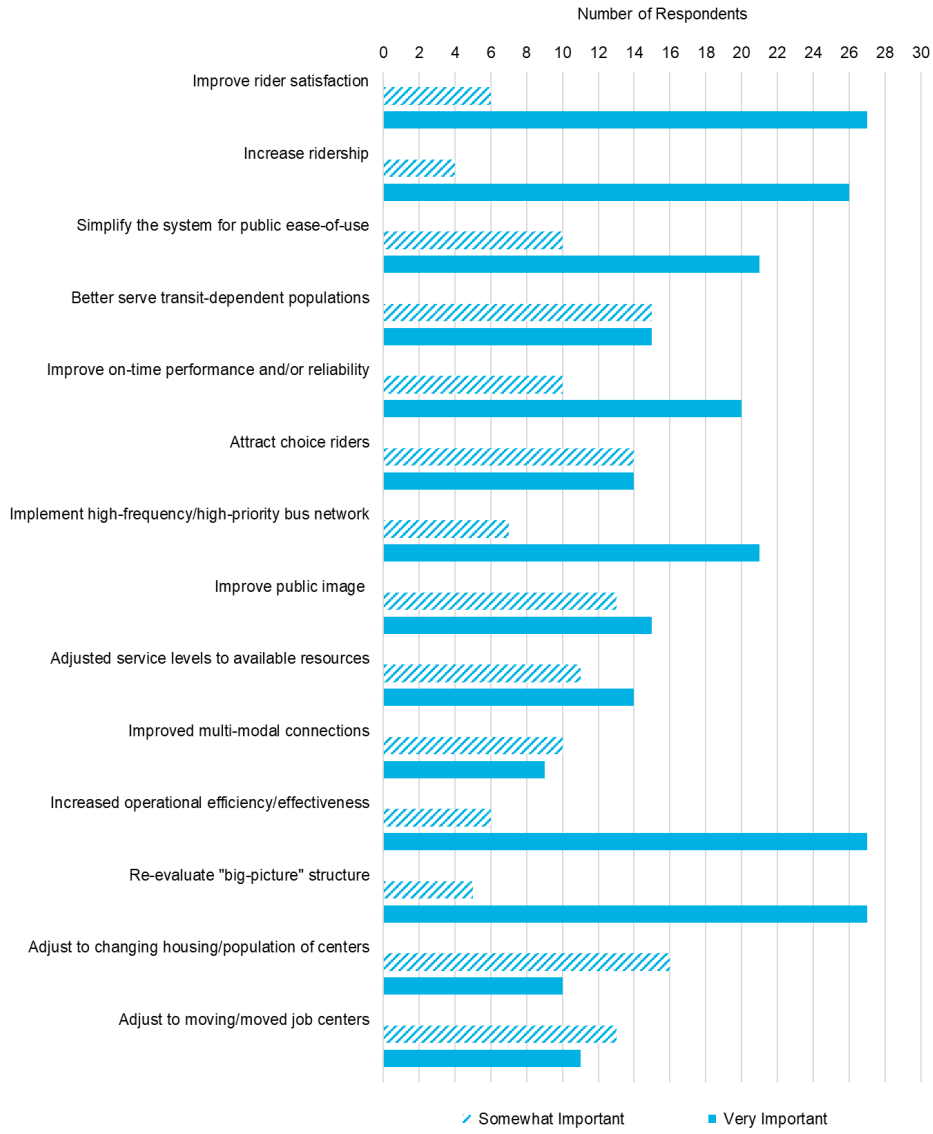
- **AC Transit's** bus network redesign AC Go was initially oriented to better feed the regional rail system, Bay Area Rapid Transit (BART), but had to be reoriented into a high-frequency bus plan after it was determined that BART did not have sufficient capacity for additional riders.
- **COTA's** full implementation of the new, grid-based network planned for June 2020 was postponed due to several factors related to the COVID-19. IndyGo is continuing to assess staffing, equipment, and ridership levels to determine the most effective time to move forward with the full bus network redesign. COTA also planned a BRT route in an effort parallel to the bus network redesign, which considered the BRT route as part of the redesign planning process; the BRT opened about eight months after the redesign was launched.
- **IndyGo's** bus network redesign incorporated planning around three new BRT routes – the Red Line opened in 2019, the Purple line planned for 2023, and the Blue Line anticipated in 2025 after the transit agency implements more capital improvements.

Goals and Objectives

Through a bus network redesign, transit agencies seek to satisfy one or several overarching goals. As discussed in Chapter 2, examples of these goals include but are not limited to:

- Improving transit service for current and potential riders
- Better matching the bus network with current and potential future ridership demand
- Increasing operational efficiency and effectiveness and/or reducing overall operating costs
- Accruing other important benefits, such as reducing dependency on personal cars, promoting environmental sustainability, or making the region more competitive.

Beneath these overarching goals, transit agencies define more specific objectives. Commonly cited big picture objectives stated by transit agencies with bus network redesigns underway or complete are shown in Figure 5. Regarding service planning objectives, these same respondents were most interested in "decreasing the peak vehicle need" (94 percent), "reducing travel times" (79 percent), and "increasing span of service" (73 percent) (Byala, et al. 2019, 28). Though transit agencies considering bus network redesigns at the time of this survey were represented by a small sample size, it may be worth noting that this group was most interested in "reducing travel times," "increasing span of service," "increasing opportunities for transfer," and "increasing frequency" (Byala, et al. 2019, 53).



Source: Adapted from TCRP Synthesis 140: Bus Network Redesigns, 31-32.

Figure 5. Commonly Cited Big Picture Objectives (Note: Respondents had bus network redesigns underway or complete)

Metrics

Measuring System Improvements

An important part of conducting a bus network redesign is for transit agencies to determine what metrics to use to compare the planned system to the current system. This step is critical both to gain support from the community as well as within the transit agency. The metrics discussed in this section should not be confused with performance metrics that transit agencies use to evaluate bus service on an ongoing basis; while some of the measures may be the same, the focus of this section is on anticipated outcomes of a bus

network redesign and how transit agencies can evaluate anticipated outputs and outcomes of their new systems compared with their current ones.

Transit agencies base the metrics on which to compare their current and future systems on the goals they lay out for their bus network redesign so that they can show how the new system will help them meet these goals. An example, from Baltimore, is shown in Table 4. Metrics can be measured through a variety of means, including counts (e.g., number of high frequency routes), geographic information system (GIS) analysis (e.g., number of households within a certain distance of transit), and modeling (e.g., ridership).

Table 4. Example Bus Network Redesign Goals and Metrics (from Baltimore)

Goals	Sample Corresponding Metrics
Improve service quality and reliability	Average transit travel time Change to daily transfer rate Runtime changes due to dedicated lanes
Maximize access to high frequency transit	People within ¼ mile of frequent transit network Number of destinations (e.g., hospitals, supermarkets, public schools) within ¼ mile of frequent transit network
Strengthen connections between bus and rail routes	Number of connections between high frequency bus routes and rail stations
Align the network with existing and emerging job centers	Average number of jobs accessible to households within 30 and 45 minutes by transit Number of jobs within ¼ mile of frequent transit network Change in number of transit trips by job center

Most transit agencies conducting bus network redesigns look at the **number of routes** in the current and proposed networks that provide high frequency service. For example:

- **Capital Metro.** Capital Metro's 2018 Cap Remap bus network redesign in Austin impacted more than half of the transit agency's 82 routes, with the number of high frequency routes going from 6 to 14.
- **COTA.** Columbus, Ohio's bus network redesign implemented in 2017 led to the introduction of twice as many high-frequency bus routes that arrive every 15 minutes or better on major streets.
- **Houston METRO**. Before the Houston METRO bus network redesign was implemented in 2015, there were 11 routes plus the rail line that ran every 15 minutes or better during the peak and midday hours on weekdays, with only three frequent routes on Saturday and one on Sunday. Once the bus network redesign was implemented, there were over 20 bus routes in addition to the now three rail lines, and these maintained that level of service seven days a week (Houston METRO 2016).
- **MDOT MTA** in Baltimore had 14 routes plus one heavy rail line and one light rail line that operated every 15 minutes or better during the peak and midday hours on weekdays prior to the launch of BaltimoreLink. Following BaltimoreLink's implementation, there were 18 frequent bus routes in addition to Metro SubwayLink and Light RailLink.

Some systems set metrics for **how many of their routes should be "ridership" routes and how many should be "coverage" routes**, where ridership routes are those with higher frequency and higher ridership per hour of service offered and coverage routes have lower frequency and lower ridership and serve the purpose of providing some transit to areas that otherwise could not support it. While not a metric per se,

this is a planning tool that can be used to generally guide where resources should be allocated. Nevertheless, transit agencies conducting bus network redesigns often report on how resources are allocated before and after the planned changes.

Many transit agencies conducting bus network redesigns evaluated how many people and jobs would have **access to transit** in general and high frequency transit in the current and planned network. Some transit agencies looked at more granular data as well, such as the change in numbers of low-income people with access to high frequency transit. Ideally, access to transit is calculated based upon distance to a bus stop or station as opposed to the route. For example, Houston METRO looked at the number of people, jobs, and current riders that would have access to frequent service, riders that would face longer walks to service, and the rough magnitude of ridership increase that could be expected.

Likewise, transit agencies evaluate change based on change in coverage: the **proportion of the area population with access to transit** in general, or frequent transit in particular. Transit agencies may also consider not just the gross population served, but conduct **demographic analyses** on populations served, looking at the change in proportion of people of different demographic groups—such as low-income, people with disabilities, seniors, carless households—that are served by the current and planned networks (Bhattacharya, et al. 2014; Houston METRO 2014; MDOT MTA 2018a). This high-level accessibility analysis is not a replacement for formal Title VI Service Equity Analysis.

Some metrics are better examined at the system-level rather than by looking at individual routes. One method of showing improvements to the system is to show how much **time riders are spending traveling** along the system, including walking to and from the stations and traveling on the bus, as well as evaluating transfer rates (though an increase in transfer rates does not necessarily imply longer travel times, as transfers may be between faster and more frequent service). A decrease in the time spent traveling shows an increase in the efficiency of the transit system (Bhattacharya, et al. 2014; Houston METRO 2014; MDOT MTA 2018a). For example:

- **Houston METRO** evaluated travel time change by analyzing travel time between nearly 900 representative trips around the city.
- **IndyGo** conducted several analyses on how its proposed grid-based network and improved route interconnectedness and frequency improvements would result in shorter waits and shorter trips.
- **MDOT MTA** in Baltimore analyzed changes in average transit travel time overall using the regional travel demand model.

Transit agencies also use travel demand models to project **changes to transit ridership**, as was done for BaltimoreLink using the regional travel demand model and for the HRT Transit Transformation project.

Another metric that is used is **area commute mode share**—a decrease in driving can be indicative of a successful bus network redesign. This generally can only be measured by using the regional travel demand model. LA Metro has focused on mode share by origin-destination pairs by aiming to provide sufficiently fast service on transit; the transit agency noted that for trips that are just as fast or faster by transit, those origin-destination pairs achieved a 13 percent mode share.

Some systems, particularly those with cost reduction or cost neutrality goals, calculate the **number of miles that buses are physically traveling**. This metric was used by New York City Transit in the Staten Island Bus network redesign where the transit agency used existing resources to improve the reliability, travel time and frequency of Staten Island's express bus routes. Route mileage allocated to congested Manhattan streets was reduced, providing faster trips and improving reliability (New York City Transit Authority 2017).

In addition to estimating the improvements beforehand, monitoring the updated transit system and making adjustments accordingly is also important to the implementation process. Enacting a new transit system will almost certainly have some bumps along the way, and everything cannot be predicted in the planning phase. Therefore, post-implementation monitoring metrics are key to creating the best system possible. In Barcelona, Spain, the transit agencies analyzed ridership trends post-implementation to see how effective the system was. They noticed evidence of increased ridership, which led them to believe that their bus network redesign was successful (Badia, et al. 2014). In Baltimore, MTA has implemented a robust performance measurement process to continually update the system since it began in 2017.

When determining the performance of a route using any of the given metrics, transit agencies may have specific tools that they use to take measurements and experiment with route changes. For example, in its bus network redesign AC Transit made use of a transit data-analysis tool**,** which they used to sketch designs and create maps. This type of program can allow a transit agency to make changes to the network in the software and simulate how those changes would impact overall ridership.

New Mobility and Bus Network Redesigns

Given the rapid introduction and adoption of new mobility options in the 2010s, most of the bus network redesigns implemented between 2013 and 2018 did not consider their integration in the bus network redesign planning process or how new mobility options interact with transit systems and change travel behavior. An exception to this is the Dallas Area Rapid Transit (DART), which referred to its plan as a Comprehensive Operations Analysis though it had all the necessary components for it to be considered a bus network redesign. DART has offered on-call zone service for more than 20 years to serve low density areas that are not supportive of traditional fixed route service. Their Draft System Plan called for expansion in the numbers of zones as well as conversion of the zones to allow for more real-time reservations (Byala, et al. 2019).

In the late 2010s, increasingly bus network redesigns have either sought to directly incorporate elements of new mobility into the redesign process, or more commonly, new mobility pilots or initiatives have occurred in parallel as an intermediary part of the redesign process or immediately following it. By 2016, over 30 transit organizations in the United States have partnered with new mobility providers to lower their costs and/or expand their service coverage (Tsay, et al. 2016, 46). For example:

- **HRT,** through its Transform Transit Project, identified six on-demand zones to complement the planned new bus network. The service is planned to be offered through microtransit and provide customers with rides within the zones and to nearby fixed route services, and implementation is now (as of spring 2020) being pursued in parallel with the bus network redesign.
- **LA Metro** as of spring 2020, had a pilot underway for on-demand services that would allow the transit agency to test the feasibility of microtransit to complement fixed route services in different parts of the County before deploying microtransit more widely throughout the system. If the pilot is deemed successful, the transit agency will then consider phasing out those less-used fixed route services; depending on timing these decisions may be incorporated into the ongoing NextGen system redesign planning.
- **UTA's** Service Choices bus network redesign did not initially include new mobility in its planning process, however, concurrently the transit agency conducted a microtransit pilot that exceeded expectations very quickly. As a result, UTA subsequently incorporated the examination of expanding microtransit as part of its Service Choices planning process.

For many transit agencies the new mobility elements incorporated into recent bus network redesigns or as separate pilots remain experimental, with various service delivery models and use cases under investigation. Integration with future service planning efforts, including bus network redesigns, will likely be informed by the performance of today's early new mobility partnerships and pilots.

Incorporating Planning for New Mobility in the Bus Network Redesign Process

Transit agencies have sought to incorporate new mobility with their existing services and into the bus network redesign planning process with distinct goals for how these new transportation options can enhance service quality, cost effectiveness, system access, geographic coverage, or transportation equity.

A survey of transit agencies conducted for *TCRP Synthesis 140: Bus Network Redesigns* assessed how transit agencies viewed emerging modes as impacting bus network redesigns. Twelve of the 33 transit agencies (36 percent) with bus network redesigns underway or complete reported their redesign effort was impacted by or was anticipated to be impacted by emerging modes. A plurality of transit agencies responding to the survey indicated that they were exploring working with transportation network companies (TNCs) in "partnerships that provide service" (67 percent), or through "assistance in filling first-mile/last-mile gaps" (17 percent). One transit agency explained that they intended to divert some paratransit trips to TNCs (Byala, et al. 2019, 39).

Table 5 provides an overview of how transit agencies interviewed for this project incorporated new mobility planning into their bus network redesigns and/or into other concurrent plans. Of the transit agencies that were interviewed for this research, seven transit agencies incorporated some form of new mobility planning into their bus network redesign planning, and another six planned for new mobility through a separate or parallel effort.

Table 5. New Mobility Planning and Bus Network Redesigns

	During Planning Process:			
Transit Agency	**Incorporated Microtransit**	**Incorporated TNCs**	**Incorporated Micromobility**	**Incorporated Other New Mobility (e.g., carshare, MaaS, mobility hubs)**
AC Transit (Oakland, CA)	Yes	-	-	-
Capital Metro (Austin, TX)		Yes*		-
COTA (Columbus, OH)	Yes*	-	-	Yes*
Clinton County Public Transit (Plattsburgh, NY)	-	-	-	-
Denver RTD (Denver, CO)	Yes	-	-	Yes
Gwinnett County Transit Division (Lawrenceville, GA)	Yes	Yes	-	-
HRT (Norfolk, VA)	Yes	-	-	-

During Planning Process:				
Transit Agency	**Incorporated Microtransit**	**Incorporated TNCs**	**Incorporated Micromobility**	**Incorporated Other New Mobility (e.g., carshare, MaaS, mobility hubs)**
IndyGo (Indianapolis, IN)	-	-	-	Yes*
KCATA (Kansas City, MO)	Yes*	-	-	-
LANTA (Allentown, PA)	Yes	-	-	-
LA Metro (Los Angeles, CA)	Yes*	Yes*	-	-
MDOT MTA (Baltimore, MD)	Yes*	-	Yes	Yes
UTA (Salt Lake City, Utah)	Yes*	-	-	
VVTA (San Bernardino County, CA)	Yes	-	-	Yes*

Note: * Indicates that the planning for incorporation of new mobility was conducted as a separate or parallel effort to the bus network redesign.

Several approaches to incorporating new mobility providers in the context of bus network redesigns have been identified:

- Microtransit to Enhance Coverage and Service Quality
- TNCs, Micromobility, and Carshare to Enhance System Access
- New Mobility as an Alternative Service Model to Reduce Costs
- New Mobility to Increase Transportation Equity
- Transit System as the Foundation for MaaS

Each of these approaches is explored in detail in the remainder of this section.

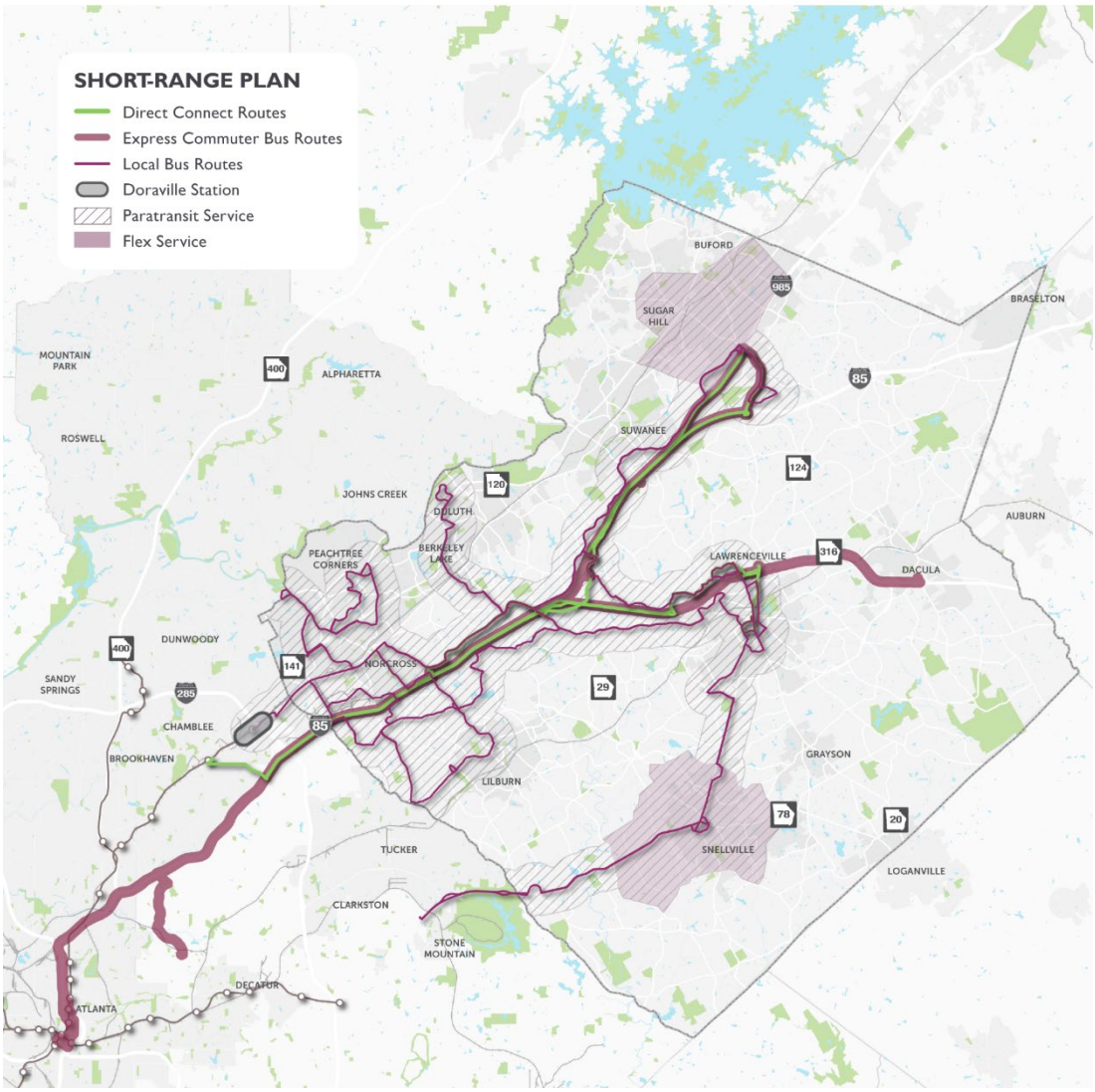
Incorporating Microtransit to Enhance Coverage and Service Quality

Transit agencies have long provided dial-a-ride services to offer more cost-effective and flexible service in low-density areas, but with the app-driven transit that is now available—making the trip request process both easier and more real-time—this shared ride type of service is having a renaissance. Transit agencies may choose to subsidize new mobility services in instances where traditional transit service is poorly suited to meet travel needs in an efficient or cost-effective manner. Partnerships with private companies can potentially allow transit agencies to reduce service in areas with low demand, thus allowing transit agencies to funnel more resources to their core services (Tsay, et al. 2016, 8). In practice, transit agencies experiences with the incorporation of microtransit into their existing services and/or their bus network redesigns have varied.

A reoccurring theme among commenters who noted technological, financial, and other issues with DRT service delivery was that the evolution of technology and customer expectations have forced transit agencies to rethink regulations, funding, and mode coordination. One commenter explained how their transit agency's "main barrier" to providing DRT to the public is competition with TNCs; their transit

agency lacks the monetary resources or fleet size to deliver services of the same caliber as private companies like such as TNCs (Volinski 2019, 40-41). Transit agencies that have proceeded with microtransit in connection with their bus network redesigns include:

- **AC Transit** incorporated microtransit into its bus network redesign by looking at areas with low performing bus routes, and the transit agency introduced two microtransit zones to replace low-frequency fixed route service. However, ridership on AC Transit's microtransit "Flex" service is 20 percent lower than that of the fixed route bus service that it replaced.
- **Gwinnett County** identified two areas with the potential for "flex" microtransit service within their Comprehensive Operational Analysis and Transit Development Plan, their bus network redesign (Figure 6). Only 17 percent of the county's residents could access fixed route bus service within walking distance given the County's suburban nature. Flex service was viewed as a potential service model for providing access to transit for greater proportion of county residents. The transit agency subsequently elected to implement a microtransit pilot in one of the identified zones, a socio-economically diverse area with a variety of trip generators (e.g., retail, hospitals) to test the potential of microtransit as a model for attracting riders and enhancing transit access. Implementing a pilot allowed the transit agency to adjust to the technology, make iterative changes based on lessons learned throughout the pilot, and demonstrate that it can work before committing to deploy microtransit service on a regular basis. The pilot gave all the stakeholders, including the transit riders and transit agency staff, a chance to understand it without having to try to learn an entirely new system all at once. The pilot had dedicated funding allowing it to be offered fare-free; while it was very successful, it is unclear whether future implementations of microtransit in Gwinnett County would be fare-free nor what the impacts of charging a fare would be on future success.



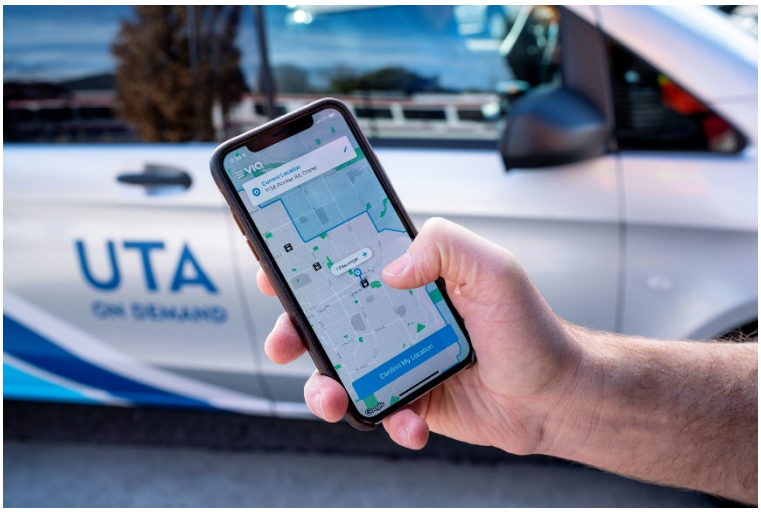
Source: Gwinnett County Transit Division

Figure 6. Gwinnett County Transit's Proposed Short-Range System Includes two Flex Service zones.

- At **HRT**, the transit agency developed preliminary on-demand zones as part of the planning process for its bus network redesign, which it subsequently refined through work with a microtransit provider to ensure that the zones would be the right size and cover the right areas to meet performance metrics. HRT wanted to make sure the on-demand zones did not conflict with existing and planned fixed route service on major arterials but rather provided access to it. The plan culminated in a submission to the state for a demonstration grant request which, if granted, is intended to see if demand is generated, if people are willing to share a ride, and for the private operator to determine if the service is financially sustainable.
- **KCATA** also utilized its experience with a microtransit pilot to inform future microtransit planning in their RideKC Next bus network redesign for the Kansas City, Missouri part of their service area. In March 2016, KCATA became the first transit agency in the United States to launch a microtransit

pilot in conjunction with private sector partners. While the initial microtransit pilot did not produce the ridership results expected, it did provide a crucial insight on integrating on-demand services at a transit agency. While the initial 2016 microtransit pilot was in downtown Kansas City which is well served by existing services, KCATA's subsequent microtransit pilot was conducted in suburban communities in Kansas City, Kansas with limited fixed route service and has been far more successful in attracting ridership, including many riders who are using the microtransit service to access KCATA's fixed route bus service. KCATA's experience has led the transit agency to viewing routes with fewer than 10 riders per hour as candidates for different types of service—either microtransit or service through TNC partnerships.

- As of spring 2020, **LA Metro's** three-year microtransit pilot, scheduled to be launched in January 2021, includes six zones, narrowed down from 30. The planning for these zones was done in close coordination with the NextGen bus network redesign planning team. All selected zones have fixed route services that are not efficient in serving all markets, disadvantaged communities, and have demonstrated demand for alternative transportation services. The zones are designed to test distinct use cases, including enhancing first-mile/last-mile access to rail or high frequency bus; bringing people from a rail station to a job center (Los Angeles International Airport); or to better serve suburban areas with very circuitous streets. The microtransit pilot is giving the transit agency a chance to understand how microtransit may or may not work in various parts of their service area before they were to commit to deploying it more widely throughout their transit system. Success in some of the pilot locations would allow the transit agency to completely replacing existing low productivity fixed route bus service. Microtransit may be incorporated as a part of the NextGen Draft Plan, as LA Metro awaits the results of the pilot locations.
- **UTA** began a microtransit pilot (Figure 7) in November 2019 with the aim of exploring how microtransit could potentially serve part of their service area that currently has relatively low ridership on their route deviation services. Within the first three months of UTA's microtransit pilot, ridership expectations were met even though the existing route deviation transit service in the pilot's service area was remained unchanged, though ridership on the route deviation service fell by 23 percent. Due to COVID-19, however, microtransit ridership did not meet targets in spring 2020. Half of trips taken on microtransit connect to UTA's rail stations; initially UTA expected a quarter of the trips would connect riders to UTA's rail system. UTA staff believe that the microtransit pilot's strong performance indicates previously unmet transit demand in the pilot's service area, and they have since incorporated microtransit into the Service Choices bus network redesign planning process. Service Choices examined incorporating microtransit in parts of UTA's service area that are similar to the microtransit pilot; areas with low-productivity fixed route bus service or no current transit service but that demonstrate demand for transit service.



Source: Utah Transit Authority

Figure 7. A rider requests UTA microtransit service

Incorporating TNCs, Micromobility, and Carshare to Enhance Access

Micromobility (i.e., bikeshare and scooter share) and carshare have been included in bus network redesigns, including:

- **MDOT MTA** worked with the City of Baltimore to install bikeshare stations at key transfer points implemented in their BaltimoreLink bus network redesign, although the bikeshare vendor later discontinued services.
- **IndyGo** worked with a publicly-owned bikeshare system and a private carshare service in planning for potential mobility hubs as part of their bus network redesign, though the carshare service later withdrew from the regional market. In the spring of 2020, IndyGo decided to pause development of mobility hubs. IndyGo is also exploring developing a relationship with a software company to help integrate Mobility on Demand (MOD), micro-mobility, microtransit, MaaS, and first/last mile operations efforts.
- **MDOT MTA** worked with the City of Baltimore to install bikeshare stations at key transfer points implemented in their BaltimoreLink bus network redesign, although the bikeshare vendor later discontinued services.

New Mobility as an Alternative Service Model to Reduce Costs

The potential of replacing existing fixed route bus service with lower cost new mobility options factors into many transit agency's initial motivations for exploring new mobility. For example:

- **Clinton County Public Transit** eliminated their paratransit service in 2018 in favor of a combination of deviated fixed routes scheduled in advance and a "rural zone" dial-a-ride service with trips arranged in advance. Clinton County Public Transit made this change due to the changes in Medicaid reimbursement rules resulting in a loss of 10 percent of the system's annual revenue. The transit agency believes that many of those who were former paratransit users have access to the deviated fixed routes or rural service, the change has resulted in additional transfers for passengers. A local volunteer driver program and taxis have also replaced trips formerly taken on paratransit. Ridership

has fallen by 20 percent, and while the changes have been unpopular with the public there are no plans to introduce additional services or to re-introduce paratransit at this time.

- **The Pinellas Suncoast Transit Authority (PSTA)** of the St. Petersburg, FL, area had to reduce its operating budget significantly following a failed transit funding ballot referendum in 2014. To preserve service in areas with low-productivity fixed route bus service that would be eliminated, PSTA worked with a TNC and a local taxi company to provide trips at a discounted rate (Tsay, et al. 2016). The program, called Direct Connect, allows riders to be picked up or dropped off from anywhere within 800 feet of a designated bus stop and receive a fare discount of $5 for a TNC or taxi ride or $25 off a wheelchair-accessible taxi ride (PTSA 2020).
- **VVTA**, which serves a 425 square mile in Southern California, conducted a microtransit pilot in a rural area with the primary purpose of serving ski resorts (though this was a separate effort from its bus network redesign). VVTA views microtransit as rebranded dial-a-ride service, and not necessarily a new or lower cost mode of transportation. The transit agency has also considered potentially partnering with a TNC for their program that provides rides at a discounted fare for senior citizens, due to expansive geography and the very low presence of TNC vehicles in the region, it was found to be cost prohibitive.

Another interviewee representing a suburban community expressed a sense that it is easier to get public support for a project that is "market-driven," (meaning partnering with a private provider) than it is for fixed route transit. This transit agency, which partners with a private company for on-demand services, felt that their public viewed traditional bus services in a low density, suburban area as not the best solution, and that the community feels that more comprehensive coverage can be provided in a cost-effective way through flexible services. This feeling is not unique and manifested itself in another urban area conducting a bus network redesign where elected officials all wanted their jurisdiction to have microtransit because they viewed that as the "prize," when fixed route service would actually have provided better service for their constituents.

New Mobility to Increase Transportation Equity

Issues related to equity and accessibility have motivated transit agencies to provide microtransit and DRT service. Motivations include jurisdictional equity (the notion that the entirety of the region contributing to transit via their taxes should receive some form of service); an expansion of economic opportunity for individuals who need the service to meet their daily needs; and continuing service for seniors and people with disabilities (Volinski 2019, 5, 16). Underpinning the expansion of economic opportunity is the idea that socioeconomically disadvantaged persons may need assistance in accessing opportunities (Volinski 2019). Finally, the idea is that microtransit can provide service for seniors and people with disabilities in a more agile manner than traditional paratransit (Volinski 2019, 16-17). Some examples of the use of new mobility to enhance transportation equity include:

- **Capital Metro.** As part of Cap Remap, Capital Metro created Mobility Innovation Zones for on-demand service, with three of the four zones in minority communities. The zones were initially proposed in response to the planned loss in fixed route service in communities where the residents and the board felt that more service was still needed. Capital Metro partnered with a non-profit TNC to connect people to frequent routes.
- **IndyGo** is piloting an app that helps individuals with cognitive disabilities prepare for travel, alert them when they need to leave, and provide step-by-step directions to get to their destinations using pictures, vibration prompts, audio or text, thereby affording them with the opportunity to use public transit with greater ease and independence. IndyGo has also partnered with a neighborhood community center to launch a neighborhood rideshare program.

- **LA Metro's** MOD pilot partnership with a microtransit provider aimed to reduce barriers to first-mile/last-mile access to two rail stations and a bus terminal for disadvantaged communities. Initially the pilot provided service only to or from the stations or bus terminal; during the COVID-19 pandemic the pilot expanded to include point-to-point trips for to grocery stores or medical facilities within the zone.

Exploring the Transit System as the Foundation for Mobility as a Service

Integration of service and fare payment options across public transportation systems is a well-established goal for many transit agencies, and one that has been achieved in some regions with multiple providers. Transit agencies often prefer a common online platform for all public transportation systems including using the same fare structure and payment methods to simplify the process for customers (National Association of City Transportation Officials 2018, 7-8; Volinski 2019, 24).

MaaS takes the concept of service and fare integration one step further, by integrating access and payment for both transit service and new mobility options into a single application. While no region in the United States has yet achieved this concept, many in the transit industry are considering how transit agencies can prepare for, or become the backbone of, future MaaS implementations. APTA undertook a MaaS focused European study tour in 2019 and identified several key findings for North American transit agencies in preparing for the implementation of MaaS. Among these are that public transportation should be the foundation and the backbone of future integrations of mobility options, the governance (as opposed to the technology) of MaaS is a key challenge, and that prior to transit agencies in the United States undertaking a central role in the provision of MaaS solutions that they should understand and leverage their own infrastructure and data and re-think their organizations to enhance innovation (APTA 2019)

In the discussion group held for this study, participants expressed the belief that transit agencies should be more focused on increasing not just ridership, but transit's overall mode share and the overall non-single occupancy vehicle mode share for all trips. They noted that performance metrics and discussion of transit's overall mode share are largely absent from bus network redesigns, but that a shift in viewing public transportation as the backbone of the transportation system will require this type of thinking. This will represent a true "mentality shift" not just among transit agency staff, but boards and political leadership as well. APTA, in partnership with TNCs, has begun work with five cities across the United States to measure transportation system performance in terms of non- single occupancy vehicle mode share for all trips.

- **IndyGo**, in partnership with other transit and community service providers, is currently pursuing funding for the creation of a full-service Mobility Concierge program capable of facilitating the complete trip and ease trip payment by brokering mobility trips across modes, payment systems, and transit providers. IndyGo's partnership with several local social services organizations and educational institutions includes offering sponsored rides, whereby a third-party transit agency purchases (often at a discount) and distributes fare value to program participants, allowing participants to ride transit at no direct cost to themselves.
- **LANTA** is continuing to improve their mobile application to ease use, including to enable riders to track bus locations in real-time. In the future, they hope to enhance their mobile application further to enable paratransit users so they can order a service, live track, and pay for it all within the application.

Impacts of New Mobility on Transit Agencies

Beyond integrating new mobility services into a transit agency's services or into a bus network redesign, transit agencies may also consider the impact that these services are having on their systems today in the

context of planning for redesigns. Two of the commonly explored impacts of new mobility on transit agencies include their impact on transit ridership and mode choice.

Ridership and Mode Choice

Since the mid-2010s, transit agencies across the country have reported declines in ridership, and in fact increasing ridership was cited as a very important or somewhat important motivator for the bus network redesign in 31 out of 33 survey respondents who had recently conducted or were in the process of conducting a redesign (Byala, et al. 2019, 31). In a recent survey of transit officials, 20 percent stated that ridership declines were a major concern for their organization, and nearly all indicated that boosting ridership was important for improving service (Eno Center for Transportation 2019, 4). The emergence of new mobility options, and the relationship between their use and transit ridership, was a topic of key concern for the transportation research community in the late 2010s.

The relationships between the use of TNCs and transit ridership was the subject of numerous studies that resulted in conflicting results. TCRP Report 195 found that "there is no clear relationship at the regional level between peak-hour TNC use and longer-term changes in a region's public transit (Feigon and Murphy 2018, 2). This report studied six cities and found that weekday TNC trips predominately (about 75 percent) take place during off-peak hours, which tends to be when transit ridership and frequency are the lowest. It additionally found that TNC usage and transit ridership have an unclear correlation to one another; some cities, such as Seattle, saw both high transit ridership and high TNC usage, while others, such as Washington DC, saw an increase in TNC usage with a decrease in transit ridership (Feigon and Murphy 2018, 8; Shared-Use Mobility Center 2016a). Other cities, such as Nashville, and Jacksonville, have also seen transit ridership increase alongside the introduction of TNCs (Tsay, et al. 2016, 17).

However, despite what some studies have revealed, surveys from various transit agencies have shown discrepancies as to what the impacts of TNCs are and how much they effect transit. A survey of public transit providers performed by the Eno Center for Transportation shows that 18 percent of respondents identified competition from TNCs as a concern in regard to ridership declines (Eno Center for Transportation 2019, 5). A previous Eno survey found similar results: there is a strong perception among transit providers that TNCs are absorbing some of their riders. The Eno report summarizes contrasting research that suggests that TNCs are capturing new riders who previously traveled via a non-transit mode, or are acting as a substitute for transit when and where transit is weak, such as in sparsely populated areas or to address the first-mile/last-mile nexus (Eno Center for Transportation 2019, 5). The relationship between TNC use and transit ridership may vary from city to city.

The use of other shared modes, including carshare, bikeshare, rideshare, and on-demand taxis, has been shown to correlate with an increased use of public transit. When compared to those who have not used shared mobility other than public transit and those who irregularly use shared mobility services, "supersharers"—those who routinely incorporate shared modes into their travel—have lower rates of personal vehicle ownership and transportation expenses. In one survey, 57 percent of "supersharers" indicated that public bus or train is the shared mode they use most often (Shared-Use Mobility Center 2016a, 5-9). There is also data to suggest that these modes are also less likely to replace transit trips:

- A study of the travel behavior of dockless carshare users in five North American cities found that in most cities there was no change in public transit usage due to their usage of carshare, and in cities where there was a difference there were more carshare users increasing their trips on transit than decreasing (Martin and Shaheen 2016).

- An evaluation of bikeshare and shared scooters in Santa Monica, California found that nearly half of trips using these modes would have otherwise been made by car, while 39% otherwise would have been made on foot (City of Santa Monica 2019).
- In the Washington, DC region, users of shared scooters and bikeshare would have otherwise used a car for around a third of trips, and only 6 percent of these trips would have otherwise taken place on transit (Meese 2019).

There is no clear consensus on the impact of new mobility services on fixed route transit ridership, as interviewees have differing experiences and the inclusion of new mobility services in transit agencies' offerings is still nascent. In fact, many interviewees were a bit pessimistic and wary about the actual motives of "new mobility" companies and their actual intent to complement vs. supplement transit.

One transit agency, IndyGo, expressed hope that while transit ridership could decline in the short-term given the greater availability of new mobility options and an increase in competition between existing transit service and areas served by new mobility, people who give up personal vehicles may ultimately increase demand for transit in the long-term. IndyGo staff expressed an interest in shaping transit service to complement, rather than compete with, new mobility, in order to foster connections between these two modes of travel. Integrating these services into one complete system can help to cover gaps in the existing transit system such as first-mile/last-mile connections and adequately serving in low-density and low-demand areas.

Equity

Equity considerations are integral to bus network redesign planning efforts. Transit agencies are required to ensure that their planning activities comply with Federal Transit Administration (FTA) regulations that pertain to Title VI and the Americans with Disabilities Act of 1990 (ADA). However, many transit agencies have sought to go beyond these regulatory requirements and explore how bus network redesigns can enhance access to high frequency transit, jobs, medical care, educational, and social services for traditional disadvantaged populations. Some examples of how transit agencies have incorporated equity considerations into their bus network redesign planning include:

- **Transit propensity analysis.** UTA's Service Choices bus network redesign is employing an analysis called the "Transit Propensity Index" in which they weight areas with higher proportions of low-income and minority populations than the general population more heavily than others, and they are actively planning for more access to transit and microtransit in these areas.
- **Equitable access to transit.** Many transit agencies including MDOT MTA, IndyGo, and Capital Metro, analyzed how the planned bus network changes will impact the share of the minority and low-income population that will have access to transit to ensure that they are increasing access to transit (and frequent transit) with the planned changes.
- **Access to jobs and healthcare.** COTA's CMAX BRT, planned as part of its bus network redesign but implemented after all other changes, was designed with the explicit aim of increasing access to jobs and healthcare services for residents in a low-income, predominately minority neighborhood. This neighborhood's high infant mortality rate, and the potential to reduce it through reliable access to convenient, frequent transit, was a key motivating factor in implementing CMAX. IndyGo's bus network redesign also features three new BRT routes, that increase access to frequent transit in some of the city's most underserved neighborhoods.
- **Accessible on-demand microtransit.** Arlington, Texas**,** which provides transit only through an on-demand microtransit service operated by a third-party (Figure 8), requires their mobility systems company partner to provide a quality of service for riders needing wheelchair accessibility at the same

level as those who do not. However, because of Arlington's comprehensive and pre-existing Handi-Trans paratransit service, their microtransit service receives very few requests for rides that require ADA accessibility. The microtransit service does provide accessible service using a few Handi-Trans vehicles on the mobility systems company's platform and is working to convert part of their vehicle fleet to accommodate passengers with disabilities.

While this section covers how transit agencies can plan for these communities, outreach to these communities during the bus network redesign planning and education process is covered in **Chapter 4: Support and Collaboration**.

Source: City of Arlington

Figure 8. Via Van in Downtown Arlington, Texas

Title VI of the Civil Rights Act of 1964

Transit riders – especially bus riders – trend lower-income and higher minority in comparison to overall regional demographics. Bus service is often their lifeline to job opportunities, education, shopping, and social interactions. It is critical that transit agencies conducting bus network redesigns consider the needs of these populations front and center as they rethink their bus networks as a matter of good public policy first and foremost. In addition, transit agencies must also comply with federal requirements related to serving low-income and minority populations.

Title VI protects people based on their race, color, and national origin from discrimination when accessing services supported by federal funding. Although socioeconomic status, particularly low-income status, is not a protected group under Title VI, the FTA regulations in FTA Circular 4702.1B require that transit agencies with 50 or more vehicles in peak period service determine whether proposed service or fare changes will result in a "disproportionate burden" burden low-income persons, just as they are required to determine if proposed service or fare changes will result in a "disparate impact" to minority populations. When redesigning a bus network, it is imperative that transit agencies ensure that any changes made to the bus system do not result in a disparate impact to minority populations or a disproportionate burden to low-income populations. Developing a sound methodology (consistent with FTA guidelines) and scheduling the Title VI service equity analysis appropriately into the planning process are key to ensuring the redesigned system is completed in a non-discriminatory fashion.

Many transit agencies incorporated equity and Title VI throughout the bus network redesign planning process—either through formal Title VI analysis or a close proxy. Some examples of how transit agencies addressed Title VI during their redesign planning process are:

- **IndyGo** took a proactive approach to not only ensuring that their bus network redesign changes would not result in a disparate impact or disproportionate burden, but to use their redesign as an opportunity to increase transportation equity more broadly. This approach included first identifying where Title VI protected populations lived within their service area. Areas with high concentrations of Title VI protected populations coincided with neighborhoods with high proportions of low-income persons as well as neighborhoods with high transit ridership. IndyGo focused their redesigned service heavily on increasing ridership through high frequency routes instead of direct service, with the aim of benefiting low-income and minority communities that had high transit ridership pre-redesign. Additionally, part of the new BRT system will be in areas of the city that have sizable low-income populations.
- **MDOT MTA** incorporated Title VI analyses throughout their bus network redesign process with a preliminary service equity analysis conducted with each draft plan. Equity was a major consideration in their redesign efforts; 70 percent of all MDOT MTA bus routes traverse areas with high concentrations of Title VI protected populations, and many of these areas generate a lot of ridership. MTA determined that a traditional route-by-route service equity methodology could not accurately capture the system-wide impacts of a full system design, and as a result the transit agency designed a new system-wide service equity methodology that analyzed changes in frequency (i.e., number of buses per hour), presence or absence of bus service, and the span of service at the census block group level. This new methodology provided the transit agency with the ability to identify the impact of proposed service changes to individual populations and important community facilities at very small geographic levels. During the planning process, service planners examined service changes in each census block groups that were identified as having potential disparate impacts to minority communities or disproportionate burdens to low-income communities in each iteration of the draft plan through the final plan and modified plans to address identified issues. Because of their careful planning and their Title VI analysis throughout the bus network redesign process, coverage in these communities actually expanded as a result of the redesign.

Other transit agencies conducted Title VI analysis either just before finalizing the bus network redesign plans or separately, closer to actual implementation:

- **COTA** conducted a Title VI analysis prior to the finalization of its bus network redesign. As a result of the Title VI analysis, three specific changes to the redesign were made that impacted the preferred network; these modifications were specifically identified as part of the Title VI analysis incorporated in the final plan before implementation of the redesign. As part of its Title VI analysis, COTA also altered the metrics the transit agency utilized to measure the impact of proposed service changes; similar to MDOT MTA, the transit agency measured the number of scheduled bus trips per census block. If a census block's number of daily bus trips decreased by 25 percent or more, it was identified as an adverse effect that could result in a disparate impact or disproportionate burden.
- For **KCATA** and **LA Metro**, the analysis for Title VI was conducted separately from the bus network redesign process. For LA Metro, the service equity analysis was conducted by the planning department, while most of the redesign was done by the operations department. Similarly, KCATA conducted a separate Title VI analysis from their bus network redesign planning. They have not encountered any issues thus far, but this may change as the redesign is implemented.

- **LANTA** did not include Title VI as part of their planning process because they viewed the studies they performed as providing a "high level" overview of what the system should look like at a regional scale.

Americans with Disabilities Act (ADA) and Service to People with Disabilities

FTA regulations stipulate the fixed route transit service ensure the provision of complementary paratransit service within corridors with a width of three-fourths of a mile on each side of each fixed route and an area with a three-fourths of a mile radius at the ends of each fixed route that aligns with the route's span of service. While some transit agencies opt to provide paratransit service beyond what is required by the regulations, for transit agencies whose paratransit service area extends within three-fourths of a mile of fixed routes a bus network redesign has the potential to greatly alter transit service available to paratransit users. Additionally, there are riders who are eligible for paratransit but are able to use fixed route service. Bus network redesigns should consider their needs when evaluating alternatives that require longer walks to fixed route transit; not only is fixed route transit often more appealing to this population, but it is a much less expensive trip to provide for the transit agency. Some examples of how transit agencies accounted for the needs of people with disabilities include:

- **Capital Metro** provides complementary paratransit service within three-fourths of a mile from their fixed route service. During the planning for their Cap Remap bus network redesign, Capital Metro did not have data to conduct a detailed analysis of specific trip patterns (both on the fixed route service and paratransit) within their service area. However, their Access Advisory Committee which includes people with disabilities as well as external advocacy groups for the disability community, was involved throughout the Cap Remap planning process. The transit agency received positive feedback from the disability community on the introduction of more frequent service on key corridors, as the availability of more service would reduce the frequency of wheelchair users being unable to board a bus due to all tie-downs being in use. While Cap Remap resulted in a simpler system with more consistent fixed route spans that also simplified their complementary ADA service, it did result in a smaller paratransit service area. Paratransit users that would lose access to the system brought their concerns to Capital Metro's board, and as result existing paratransit users were "grandfathered" into the system and did not lose their service.
- **LA Metro's** NextGen bus network redesign similarly explored how the redesign would impact paratransit coverage. Working with the transit agency's Access Services department, they identified areas currently within three-quarters of a mile of fixed route bus service that would no longer be eligible to be served by paratransit post-implementation of the bus network redesign. As of early 2020 Access Services, the Consolidated Transportation Services Agency for Los Angeles County, was planning to continue to provide service to current paratransit users in these areas, but they have received requests to include any eligible individual in the future.

Public and Stakeholder Involvement

Introduction

When a transit agency scopes its bus network redesign, one critical element is a public and stakeholder involvement or engagement plan. This section lays out a detailed strategy for how a transit agency can involve the public in the planning process from start to finish; further information is provided in Toolkit #1: Bus Network Redesigns.

Bus network redesigns involve at least two rounds of public engagement, in addition to ongoing maintenance of communications through website updates and other means. The objective of the first round is to identify issues and priorities ("visioning" stage), the purpose of the second round (and perhaps subsequent rounds) is to present the public possible service alternatives ("planning" stage). Simply put, the "visioning stage" should be used to identify issues and establish priorities and set goals, while the engagement conducted during the "planning" phase should be used to both identify whether further modifications to the plans are desired, to educate the public and stakeholders on how the improvements will benefit them, and to obtain stakeholder buy-in (Figure 9). Some transit agencies also opt to engage the public after the Final Plan is released, typically as part of the public education process.

While there are certainly discrete outreach phases where the transit agency makes large efforts to reach the public and stakeholder groups, it is key that the transit agency have an ongoing outreach program to keep interested parties engaged and up to date on the process. This can be done through website updates, social media, earned and paid media, on-board advertisements, and continued meetings with key stakeholder groups.

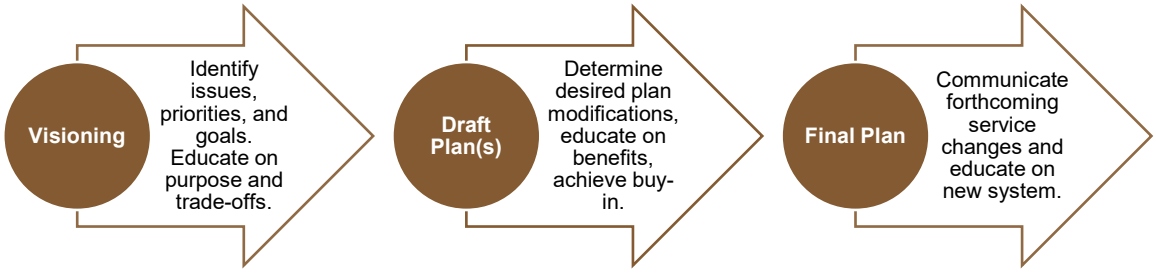


Figure 9. Public Engagement and Education Objectives for Each Bus Network Redesign Stage

Engaging Disadvantaged Populations

A bus network redesign will not be successful if the community it is meant to serve is not generally on-board with the concept of conducting such a wide-ranging service plan. Outreach is necessary to all members of the community, but studies show that outreach is even more important for specific subgroups, particularly historically disadvantaged groups such as low-income, persons of color, seniors, and people with disabilities. These groups are more likely to be transit-dependent and therefore could be dramatically impacted by a bus network redesign (Shared-Use Mobility Center 2016a, 20). Transit agencies should, at a minimum, follow their Title VI Public Participation Plan and Language Assistance Plan to ensure that outreach is conducted to minority groups and that materials are translated into appropriate languages.

Specifically, outreach with disadvantaged groups should be frequent and comprehensive to ensure the transit update meets their specific needs. Neglecting to engage the public early and often could not only result in an inferior product, but could easily delay the bus network redesign process further down the road, as individuals in the community may not recognize the benefits of redesign and feel that they did not have a say in the matter and therefore resist the change (Boyle and Rey 2012).

Existing literature points to the role effective engagement has on the public's perception of service changes. A study of a low-income community in Tallahassee suggested that, despite gaining improved service from a bus network redesign, the community perceived the redesign as disadvantageous. The community believed that their voices had not been heard in the process and therefore were not reflected in the bus network redesign. Despite service being improved in that area, the belief that they were not benefited

deterred people in the community from using the service to its full advantage (Bhattacharya, et al. 2014, 2-7). This shows that successful bus network redesigns go beyond simply building a system that is better for people; they involve showing the patrons the advantages of the system and showing the community that their opinions are being both heard and incorporated into the final design.

Engaging disadvantaged populations and getting their input can shed light on aspects of a bus network redesign that planners might overlook. For example, during the BaltimoreLink bus network redesign outreach, some residents of low-income communities pointed out that while they were in general willing to walk farther to high-frequency service, they felt unsafe doing so at night near where they lived.

Diversity in Input through Stakeholder Groups

Diversity in input was a common theme among interviewees as an important element to achieving community buy-in. Transit agencies were generally very deliberate in ensuring that public engagement was conducted with all communities, including low-income, minority, and those with limited English proficiency.

In addition to holding public meetings and events in places that will reach these communities, working with organizations and stakeholder groups that represent the community at large and specific groups within the community is an effective way to reach many people. Across all transit agencies interviewed, the following were listed as the types of organizations and stakeholders involved in the outreach process:

- The business community
- The disability community
- Employment agencies
- Healthcare providers
- Faith-based groups
- Neighborhood groups
- Refugee community representatives
- Senior citizen groups
- Transit advocates
- Transit agencies
- Universities and school districts

The research revealed the following examples of outreach and public engagement through stakeholder groups to reach a diverse audience:

- **Gwinnett County Transit Division** worked with a local community organization to help engage the local Vietnamese and Korean community to ensure their needs were considered in the process.
- **Jacksonville Transportation Authority (JTA)** not only held community meetings and public hearings, but spoke with community leaders representing different communities, such as United Way and Rotary clubs. They also made a concerted effort to ensure that the people conducting the outreach to these communities matched the community demographics (Jacksonville Transportation Authority n.d.).
- **LA Metro** relied on a robust external working group to vet its recommendations; this group includes representatives from aging and disability committees, the transit agency's paratransit provider, and other organizations that represent traditionally hard to reach populations.
- **IndyGo** had a similar approach when looking to meet the needs of vulnerable populations, more specifically people with disabilities They conducted outreach targeted at transit riders with disabilities, as well as through organizations that work with such individuals, including AARP. They

also have a specific committee called the Mobility Advisory Committee that is made up of community volunteers representing people with disabilities, each of whom are either a transit user with disabilities, someone who provides services to people with disabilities, or someone who employs people with disabilities. This committee is responsible for remaining engaged on any issues related to equity and the mobility-impaired populations.

When to Engage

When undertaking a bus network redesign effort, transit agencies face the challenge of determining when to begin engagement and how much engagement to undertake. The short answer is that one cannot begin early enough nor do too much. Public outreach should be "early, comprehensive, and exhaustive," and the public's participation in this outreach should be "actively encouraged" (Byala, et al. 2019, 21). Engaging the public at the beginning of the effort is critical to establishing an understanding of the purpose of the effort and gaining the trust of the public and key stakeholder groups. This initial education period typically includes sharing information on the goals and objectives of the bus network redesign, system performance, market assessment and demographics, and discussions and exercises to educate the public about trade-offs that are necessary when planning transit service with fixed resources and competing needs.

All transit agencies that responded to the survey conducted as part of *TCRP Synthesis 140: Bus Network Redesigns* either consulted or were intending to consult with the public during their bus network redesign planning process. Among systems that already completed a redesign, the public was usually (88 percent of respondents) consulted after draft and final versions of scenarios were developed, and slightly less often (71 percent) at the visioning stage. Transit agencies with bus network redesigns underway followed a similar pattern of outreach, but had a stronger preference to consult the public after final scenarios were developed, likely as part of the education process for implementation (Byala, et al. 2019, 44).

Transit agencies also admitted they sometimes fail to fully communicate what they are doing until late in the process, including public education about what was to be lost and gained by proposed changes. According to one transit agency interviewed, loss of "one-seat rides" was not made apparent until implementation of the plan, resulting in last minute challenges. Another transit agency expressed similar concerns regarding public input that arrives only once service changes have been implemented. In another transit agency's experience, the public often assumes that service change studies are merely conceptual instead of realizing they are meant to be implemented in their communities.

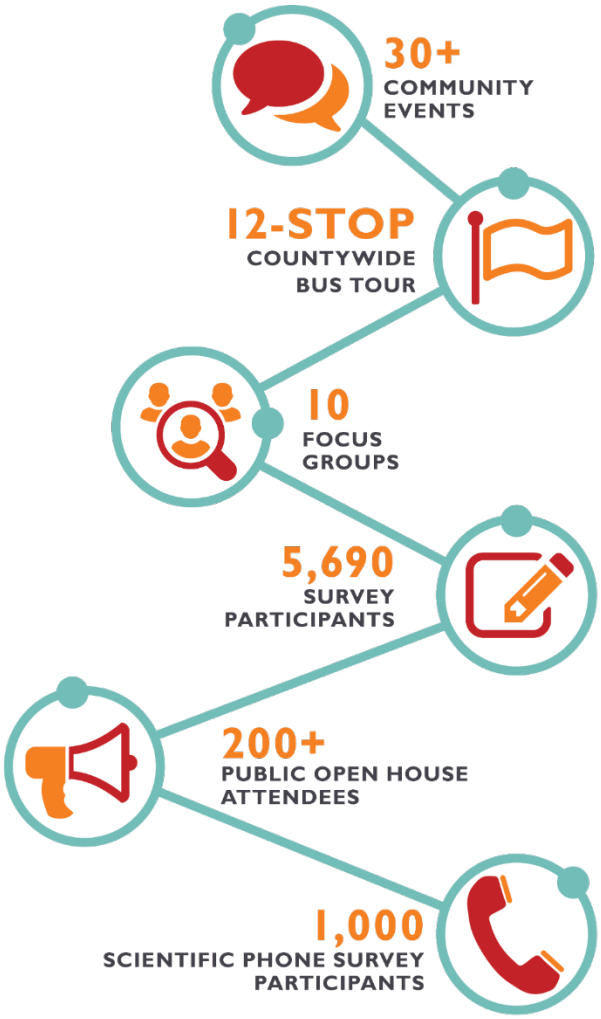
How to Engage

Meetings and Online Engagement

Transit agencies utilize a variety of tools to perform public outreach. Public meeting**s** remain a common tool for public outreach and were performed by transit agencies throughout bus network redesign processes (Byala, et al. 2019, 19). Transit agencies may choose to perform these for both the general public, and/or specific groups, such people with disabilities or limited English proficiency (New York City Transit Authority 2017, 5-7; MDOT MTA 2017; MDOT MTA 2018a). Public meetings also are sometimes done as a "pop-up," which is when transit representatives go to transit stations or other centralized locations to do outreach (Halifax Transit 2016; MDOT MTA 2017; MDOT MTA 2018a). In addition to public meetings, the internet—either part of the operator's website or as a standalone site—is also a common tool for outreach. Some transit agencies created new online tools to help engage the public, and many chose to utilize social media such as Twitter to provide information and answer public question (New York City Transit Authority 2017, 5-7; Dallas Area Rapid Transit 2016, 7).

Nearly all of the transit agencies interviewed listed public meetings and web outreach as methods for engaging with constituents. Transit agencies reported varying degrees of success with public engagement efforts for their bus network redesigns. Public engagement is a time and resource intensive process and can highlight significant resistance to any change when the transit agency's focus is on gathering input on how best to shape the change.

- **IndyGo** cited robust public engagement as a critical factor in ensuring support of their bus network redesign; among the public agencies conducting outreach for their redesign there were more than 500 engagements and over 30,000 individuals who were directly reached throughout the public engagement process, including through public meetings, stakeholder group presentations, and pop-up meetings at festivals and fairs. This was in addition to the public engagement and advertising that was undertaken by partner community groups such as IndyCan, which made over 150,000 phone calls to residents and conducted outreach at meetings and through speaking with riders at bus stops (Touhy 2016). The transit agency also had a robust website-based engagement and education with over 110,000 webpage visits and 300,000 webpage views.
- **Gwinnett County Transit Division** used a variety of engagement methods (Figure 10). When working on the early stages of their bus network redesign, the transit agency reached out to the public using rider surveys, which ensured that those who use transit have a strong voice in any changes that may be made to the system. Other transit agencies also used surveys to gain input from the community; for example, MTA in Baltimore conducted an intercept survey of transit riders through pop-ups at major bus transfer locations at the beginning of their bus network redesign process to gauge opinions on trade-offs that was then used to inform the planning process.



Source: Gwinnett County Transit Division

Figure 10. Summary of Connect Gwinnett Outreach Efforts

Clear Information and Discussions of Trade-offs

Community engagement can go a long way to gaining the support of the community, as illustrated by the example of Houston METRO bus network redesign effort. Houston METRO worked with the public to communicate the financial trade-off that must be made when performing a redesign. Transit agencies have limited budgets and capital resources that restrict the amount of new service they can provide. Houston METRO had a goal to allocate service in a way that maximizes ridership, which usually means concentrating service in the densest areas and leaving some areas with very little or no service. To convey this dilemma, Houston METRO staff held a meeting with members of the public including individuals who represented specific disadvantaged groups. Members of the community participated in a charrette where they allocated the limited budget among different needs. According to Houston METRO staff, this helped to get stakeholders onboard with the proposed changes, which ultimately helped to get the design implemented. In addition, the experience proved educational for the staff, who gained deeper insights about the system from those who depend on it, and ultimately made changes to make the system more equitable.

Use of clear information to convey changes to the public was a common refrain. This can take a variety of forms. For example, transit agencies listed use of transit analysis technologies, such as online mapping, and highlighting specific documents (e.g., strategic plans) as helpful in engaging the public. Others cited creating platforms to show riders how their trip would change, such as a side-by-side trip planner using current and planned General Transit Feed Specification (GTFS) feeds.

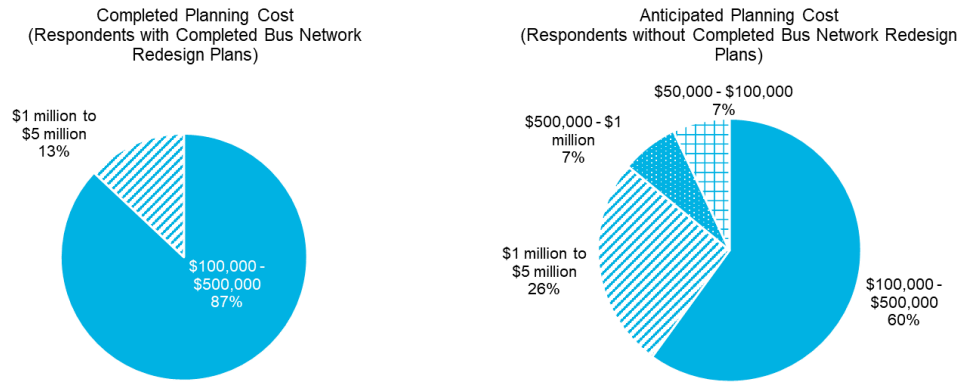
Determining the right level of specificity in the information provided to riders is critical to the outreach process. MDOT MTA discussed a need to better educate riders about how they would get to their destinations once the changes were in place. However, the transit agency indicated that framing the discussion in terms of trade-offs—for example, emphasizing that service improvements would result in the elimination of "one-seat rides"—only frustrated riders and directed attention away from the improvements they would be seeing. Another transit agency indicated a need to express to the public that the outreach process was not just part of a conceptual study but was rather indicative of real changes they would see in their community.

Financial Considerations

Bus network redesigns must consider costs for conducting the redesign plan (and all of its many parts, from planning, to public and stakeholder engagement, to implementation planning); operating cost impacts of redesigned service; associated capital costs; and fares.

Planning Cost

A survey conducted in early 2018 as part of *TCRP Synthesis 140: Bus Network Redesigns* asked transit agencies several questions regarding the cost of bus network redesign planning. As shown in Figure 11, most respondents reported having spent between $100,000 and $500,000 dollars planning their bus network redesign, however larger transit agencies tend to spent much more (Byala, et al. 2019, 188, 190), and depending on what the transit relies on a consultant for, the cost can vary greatly. In fact, according to some interviewees, mid-size to larger transit agencies should expect to spend at least $1,000,000 and up to several million dollars for a complete system evaluation, service plan, public engagement, and implementation plan. By and large, transit agencies reported funding their bus network redesign planning efforts through Agency General Funds (Byala, et al. 2019, 185). Most respondents (85 percent) undergoing or with completed redesigns indicated planning work was done by a mix of transit agency staff and consultants. Within this "mix," respondents indicated that consultants were responsible for most of the work (85 percent) (Byala, et al. 2019, 46).



Source: Adapted from *TCRP Synthesis 140: Bus Network Redesigns, 180-182.*

Figure 11. Bus Network Redesign Planning Cost

Operating Cost Implications of Redesigned Service

When asked what impact the bus network redesign would have on their annual operating budget, two-thirds of respondents to the survey conducted as part of *TCRP Synthesis 140: Bus Network Redesigns* with a redesign either underway or completed stated the redesign has or will impact their operating budget, with the clear majority of those transit agencies specifying this as a budget increase. The only two transit agencies to report an operations budget decrease also indicated "increase operational efficiency and effectiveness" to be a very important big-picture goal of their bus network redesign. However, the way the two transit agencies achieved operations cost reduction was likely quite different, as evidenced by the fact that they reported contrasting service design priorities (Byala, et al. 2019, 47). To support increased operations costs, transit agencies report relying on a "reallocation of existing operating budget" and "tax/dedicated funding sources" (Byala, et al. 2019, 193).

- **Capital Metro**'s initial plans for Cap ReMap were cost neutral in nature, however, as the plan developed community and board engagement led to changes that increased the operating hours by 8 percent resulting in an $8-$10 million increases in total operating costs. Many of these changes involved retaining local service, i.e., service to all stops, on new high frequency corridors; this approach was continued in the subsequent planning effort for high capacity transit. . Planning staff emphasized the benefits of the "true network" that the Cap ReMap plan would provide to public, key stakeholders, and decision makers to gain support for increasing the transit agency's budget.
- **COTA's** Transit System Redesign bus network redesign was not cost neutral, as they were expecting to expand service through 2019; in 2006 a temporary, 10-year, renewable quarter of percent sales tax to support transit passed, adding to the transit agency's permanent quarter percent sales tax. In 2013, COTA provided 918,000 service hours, and by 2019 that figure had risen to 1.24 million service hours.
- **Houston METRO's** New Bus Network implemented in 2015 aimed for a cost-neutral operating plan. Even though the bus network redesign followed on the heels of two new light rail lines opening, most of the savings gained from replacing bus service with light rail was reinvested in a parallel corridor. Houston METRO's plans initially kept the operating costs neutral through other changes like elimination of route duplication, straightening routes, and providing limited stop service. However, before the plan was finalized the transit agency ultimately increased operating costs by 4 percent, or $12 million, to reinstate some services to address community concerns.

- **MDOT MTA's** bus network redesign implemented in 2017 in Baltimore was operating cost neutral, however service changes centered around a branded high-frequency network indicated by colored route names instead of numbers provided improved service and the impression that drastic changes were being made. That was complemented by significant capital investments in branding, bus stop optimization and signage, and bus priority, so even though it was cost neutral from an operations perspective, the implementation was a major change for riders.

Capital Cost Implications of Redesigned Service

On top of the costs of additional service that may be recommended as part of a bus network redesign, the transit agency must consider the costs associated with implementing the new service. These include necessary items such as additional vehicles if the plans require more peak vehicles than the current system requires, expanded and new transfer facilities, and bus stop signage and curb space investments, including ADA accessibility investments, to accommodate the new service. Additionally, other capital costs that can maximize and leverage the service plan—such as bus priority treatments—also must be considered. More information about these specific capital needs is provided in the Capital Elements section in this chapter.

The LA Metro bus network redesign team is framing the redesign as a three-step process, the second of which is focused on capital investments: 1) Reconnect: improve bus levels of service—within the current operating budget—by redesigning routes and schedules to attract trips where there is the greatest market potential; 2) Transit First: invest in a large capital program to support the service plan developed in the "Reconnect" phase; and 3) Future Funding: once existing levels of service are performing better through a redesigned network and investments in priority, determine the amount and locations of additional service to meet demand.

Fares

Another challenge faced by transit agencies is whether and how to adapt their fare systems as they implement bus network redesigns. A bi-product of developing a high-frequency network and reducing network inefficiencies is that a greater share of riders may have to transfer to reach their final destination; in systems that charge to transfer between buses and/or between modes, this can have an impact on ridership and equity. Some of the challenges and approaches to fare system and fares related to bus network redesigns are:

- **MDOT MTA.** When the BaltimoreLink bus network redesign was implemented, the fare policy did not allow for free transfers on buses, regardless of whether the fare was paid by cash or a fare card. Prior to implementation, allowing free transfers for users of the fare card, or CharmCard, was discussed but ultimately not implemented. However, about a year after implementation the transit agency adopted the CharmPass, a mobile payment application that allows for free transfers within a set time. While this happened later than the implementation, part of the push for a free transfer fare was to reduce the cost for riders taking advantage of the bus network redesign's high-frequency grid network.
- **LA Metro**. The transit agency is not considering fare policy in its bus network redesign but acknowledged that there are considerations regarding transfers as there is a small transfer fee between LA Metro and the municipal operators, and also there are no free or reduced-price transfers allowed if the rider pays cash, which accounts for 30 percent of riders on LA Metro buses and a much higher number on the municipal operators.
- **UTA**. The transit agency is not examining their fare policy in conjunction with their Service Choices bus network redesign, but they are conducting a contemporaneous, independent evaluation of their

fare policy. UTA is also hoping to integrate fare payment with its microtransit service and to facilitate seamless transfer between all modes within the system, but they must first implement a fare payment technology that will enable this. UTA designed their microtransit service so that passengers are able to use UTA passes and fare media, although this fare media is not validated on the vehicles currently. This was important to the transit agency as they wanted the microtransit service to be seen as another mode with UTA's services, with the same fares and rules, and not an entirely separate entity. This arrangement was unusual for the vendors that operates their service, but it has worked. Although it is possible to pay the fare for the microtransit service using a credit card, information UTA has indicates that 80 percent of riders are using UTA fare media.

- **IndyGo** prepared for the implementation of its bus network redesign both by adopting a new fare policy and moving forward with the modernization of its fare collection system that will include an account-based system with physical fare cards and mobile Quick Response (QR) codes that can be scanned to ride. Central to these changes are two new fare policies: free transfers within two hours and fare capping at the daily and weekly levels (IndyGo 2019, 9). As IndyGo prepared for the launch of its bus network redesign (subsequently postponed by the COVID-19 pandemic), IndyGo wanted to roll out a retail network to allow riders to easily acquire and/or refill their transit cards, which is viewed as being particularly important for the unbanked population and is a key recommendation of the Title VI analysis of the new fare policy. However, coordinating integration with multiple vendors has proven to be a challenge. For example, IndyGo learned that many retail stores will not accept new inventory of any kind starting in October due to holiday inventory practices, something that IndyGo's transit planners had no background to know.

In terms of new mobility, several transit agencies interviewed mentioned that any future fare system would likely need to account for and allow for payments to "new mobility" providers, should they become a complementary part of the transit network. Survey results evidence the fact that transit agencies have taken various approaches to structuring fares for DRT service. Among survey respondents in the study *Microtransit: Evolving Approaches to Providing General Public Demand-Response Transit*, it was common for DRT/microtransit to be governed by the same policies as the transit agency's fixed route services. When this was the case, transfers to and from DRT service are treated the same as transfers between fixed routes. When fares were not structured the same as fixed route transit, transit agencies took different approaches to DRT fares, offering fares free of change, for one dollar, and at other amounts that deviated from fixed route fare structure (Volinski 2019, 24).

Capital Elements to Support Redesigned Bus Service

Introduction

Beyond bus network redesign planning expenses, costs may also be incurred for capital improvements aimed at improving transit system functionality. In the survey of transit agencies *from TCRP 140: Bus Network Redesigns*, the majority of providers (66 percent) who implemented or are planning a bus network redesign answered "yes" when asked if capital costs were associated with their redesign. They added that these capital costs were most commonly used to support vehicles, passenger facilities, and bus stop signage (Byala, et al. 2019, 43).

Several of the transit agencies interviewed leveraged the bus network redesign project to advocate for and implement capital improvements to improve bus speed and reliability, such as bus lanes or TSP. Some interviewees noted that the benefits that may be achieved through a system-wide redesign may be significant and relatively easy to illustrate trade-offs, giving them an advantage in that they make it easier for the community to accept what could be some significant modifications to the streetscape.

As noted in the section on Financial Considerations there are a variety of capital investments that may be necessary to support implementation of a bus network redesign.

Bus Priority

Some interviewees noted that bus network redesigns either helped support ongoing BRT projects or provided the initial makings of high capacity transit by indicating which corridors would be best suited for such high-frequency/high-amenity services.

Implementation of the new bus network in Baltimore in 2017 included 5.5 miles of new bus and right turn lanes identified with red paint and TSP along priority corridors. LA Metro's bus network redesign team is coordinating with two ongoing BRT projects and is aiming to use the NextGen service plan as the basis and use their funding measure to pay for the capital components. Houston's New Bus Network implemented in 2015 included updates to the network in response to two recently opened light rail alignments. Part of the region's transit referendum that passed in 2019 is intended to implement capital improvements to leverage the high frequency service implemented as part of the transit agency's bus network redesign.

Additional or New Vehicle Types

If a bus network redesign plans more service at peak times—when all of the transit agency's non-spare fleet is already in use—additional vehicles will be required. With many redesigns focused on cost-neutral operations, additional vehicles are not a common expense. Some bus network redesigns result in additional types of vehicles to be purchased, such as longer or articulated buses for high-capacity services or microtransit vehicles.

- **Houston METRO.** Houston added some operational costs to the network but did not need to add vehicles as the amount of service offered in the peak periods actually declined by four percent (service increased on the weekends).
- **Capital Metro.** Capital Metro's Cap Remap program ended up requiring the transit agency to essentially use the entire existing fleet, including keeping buses they were going to retire in the fleet longer. The transit agency projects a need to buy 10 to 15 more buses in the future to cover the new schedule, which peaks when the University of Texas is in session. These additional vehicles were mainly related to the need for additional vehicles to allow for longer running times due to poor on-time performance resulting from the impacts of congestion and roadway construction.

Expanded or New Transfer Facilities

Bus network redesigns can result in new locations where transfers between buses are occurring or identify needs for expanding existing facilities. For example:

- **MDOT MTA.** While already a small, on3-street transfer location before the bus network redesign, the West Baltimore MARC station in Baltimore became a much more desirable location to accommodate the new system redesign; the transit agency created a large, off-street transfer facility with bus bays, layover spaces, better passenger amenities, and operator restrooms.
- **IndyGo.** IndyGo is tying the future construction of mobility hubs to the bus network redesign to develop last-mile connections to existing and planned transit services, such as end of the BRT line transit facilities and amenities that can accommodate riders transferring between rural transit service to urban transit service or "kiss and rides." This is in addition to the construction of the three BRT lines, phased both before and after the redesign implementation.

- **Capital Metro.** The transit agency's revised service plans through the bus network redesign necessitated a major bus stop renovation into more of a transfer facility in order to address bus stacking issues.

Bus Stop Signage and Curb Space Investments

Most of the bus network redesigns studied in TCRP Synthesis 140 included some form of bus stop optimization and/or bus stop amenity program as part of the redesign, but even if that is not a part of the redesign, there are minimum changes that are still needed, such as updating bus stop signs to reflect the new routes and additions of signage and accessibility improvements on roadways that previously did not have bus service. Some of the improvements made as part of redesigns related to bus stop signage and curb space include:

- **Capital Metro** added about 30 new bus stops as part of its bus network redesign.
- **COTA** worked with stakeholders in the city of Columbus, real estate development community, and the downtown special improvement district to determine the best alignments and stop locations for a downtown BRT. These efforts were also actively supported by their metropolitan planning organization and Columbus' bicycle advocacy community. One major private employer also invested in capital improvements around a new stop at their location as well. The results of these efforts led to both successes in achieving desired roadway improvements for bus operations, and areas where desired improvements or projects have been unable to come to fruition.
- **JTA's** bus network redesign included a bus stop optimization that removed 30 percent of bus stops in an effort to speed up the service, accompanied by investments in updated signage (Jacksonville Transportation Authority n.d., 12).
- **MDOT MTA's** bus network redesign in Baltimore similarly removed 20 percent of bus stops and the transit agency installed new signage at all 4,000+ bus stops remaining.

Electric Vehicle Charging Facilities

While most transit agencies currently do not have electric vehicles or have just a small fleet in a pilot program, in the future bus network redesigns may need to account for both range and topography limitations of electric buses as well as en route charging facilities. COTA, while they are considering electric buses, felt that when they conducted their bus network redesign planning in 2014 and 2015 planning for them would have been premature; the transit agency is working to deploy a fully electric bus fleet in the 2020s.

CHAPTER 4

Support and Collaboration

Introduction

Even if the resulting bus network will be better for riders, it is difficult to muster the political will to implement a comprehensive bus network redesign. Compared to other bus planning efforts, public and stakeholder engagement should be very robust during a redesign, with more touchpoints throughout the process. Once the process is underway, the outreach and engagement elements – both the external one, with various community stakeholders (including transit advocacy groups), and the internal one, engaging decision-makers, bus operators, union leadership, and other internal stakeholders – should be continuous throughout the entire redesign process, from initial market assessment through implementation.

The transit agencies interviewed and surveyed in this research pointed to several common challenges associated with gaining support for the large-scale service changes that come with a bus network redesign, such as addressing different goals among transit agency leadership, balancing service needs and desires for riders, and overcoming internal resistance to significant operational changes. However, the largest challenge that was consistently cited by transit agencies was that riders have shaped their lives around the existing system and were resistant to change.

Internal Agency Collaboration

Planning and Other Administrative Staff

Bus network redesigns can upend long-standing practice and may generate opposition within a transit organization. Transit agencies have also reported disagreement between staff members over the plan for an updated system, and some staff members felt that the proposed redesign was unnecessary. In addition, a full redesign requires coordination from across a transit agency's many branches, which can prove difficult, particularly for large transit organizations (Byala, et al. 2019, 34). Getting the staff on board with a redesign takes both engagement within the organization and strong leadership and champions working through concerns to reach a place where the entire organization can work together. Within the transit agency, the extent to which departments collaborate in transit service design and delivery can help or hinder the redesign process.

At the transit agency level, the delegation of tasks related to bus network redesigns can create challenges if departments do not typically collaborate. Different transit agency departments often have different goals for services. For example, some departments may emphasize gaining operational efficiencies while others focus on improving mobility for riders. The former is easier for the transit agency to measure but matters less to riders. For some transit agencies, these and other goals may be integrated within one department but for others they are separate. This creates a situation not only of divergent goals within one transit agency, but also of using different metrics to assess those goals.

Internal agency collaboration on the bus network redesign among planning and other administrative staff was strong in many transit agencies:

- **Gwinnett County Transit Division** attributes their success to internal persistence, with internal champions consistently pushing the same agendas.
- **Houston Metro's** CEO appointed a core management team, including a project lead, two project managers, and a board liaison. It was noted that building this core structure and having them supported by the CEO was pivotal to getting the project approved by the board. The management staff then formed a working group made up of senior staff from with specific roles within Houston METRO, such as financing, public affairs, planning, press, and operations.
- At **MDOT MTA**, the engaged and enthusiastic Administrator of the MDOT MTA took the lead in instituting transit agency-wide retreats, called "advances," where the directors of the long range planning /capital planning and service planning departments led representatives from all parts of the transit agency in collaborating on all aspects of the bus network redesign, from final service planning, to fares, to capital improvements being implemented concurrent with the service changes.

Union Leadership

Survey responses from *TCRP 140: Bus Network Redesigns* indicated that union engagement and support was critical for plan implementation (Byala, et al. 2019, 55); engagement with union leadership and with union members are two separate audiences and both must be engaged and integrated throughout the process. In general, there was a sense among interviewees that it is beneficial to the transit agencies for bus operators and the organized labor groups that represent them to be brought into the bus network redesign process early.

At Capital Metro in Austin, Texas, the operators are unionized through their private operators. The Capital Metro bus network redesign team engaged with the union leadership through a senior-level transit agency staff member going to the union hall, initially just to listen to their concerns and later to relay how the concerns would be addressed. The union then participated in finalizing the plans to address operator concerns and therefore was in support of the redesign. Ultimately, the union and many operators are happy with the network implemented, and the process built trust between the short-range planning department and the union. Another transit agency that uses an operating contractor struggled to actively engage union leadership, in large part because the transit agency is required to go to the union through their contractor, making direct collaboration challenging. Additionally, the contractor had gone through eight general managers in four years, making it difficult to maintain relationships. Nevertheless, the transit agency's consultant team did interview union leadership as part of their work.

Bus Operators

Most transit agencies implement some level of operator in-reach as part of their bus network redesign planning process to inform and engage, gather input, and foster buy-in from the bus operators. Bus operators are the transit agency's front-line staff who have extensive knowledge and experience from their time driving the routes and interacting with passengers. Several transit agencies interviewed noted that, ultimately, bus operators will be the ambassadors to the public and will need to be provided with the information needed so that they can make the transition easier for the customers. Figure 12 provides an example of an approach for reaching out to bus operators during a redesign.

Almost all of the interviewees stated that bus operators were involved in the bus network redesign, either formally or informally. For one transit agency, operators were involved in redesign planning as a constituent

group rather than a formal planning group. The transit agency's operations team, which led the redesign process, was in contact with supervisors and drivers to coordinate on scheduling. In another, the consultants leading the redesign met with operators and went to operator safety meetings through a detailed in-reach "syllabus" that engaged the operators in all divisions at all stages of the process. In addition to the input that the planning team gained from the regular discussions at the bus divisions, each division superintendent nominated one of their most senior and informed operators to be part of the core service planning team. These operators provided invaluable insights for the planning team as they were developing and finalizing the service plan.

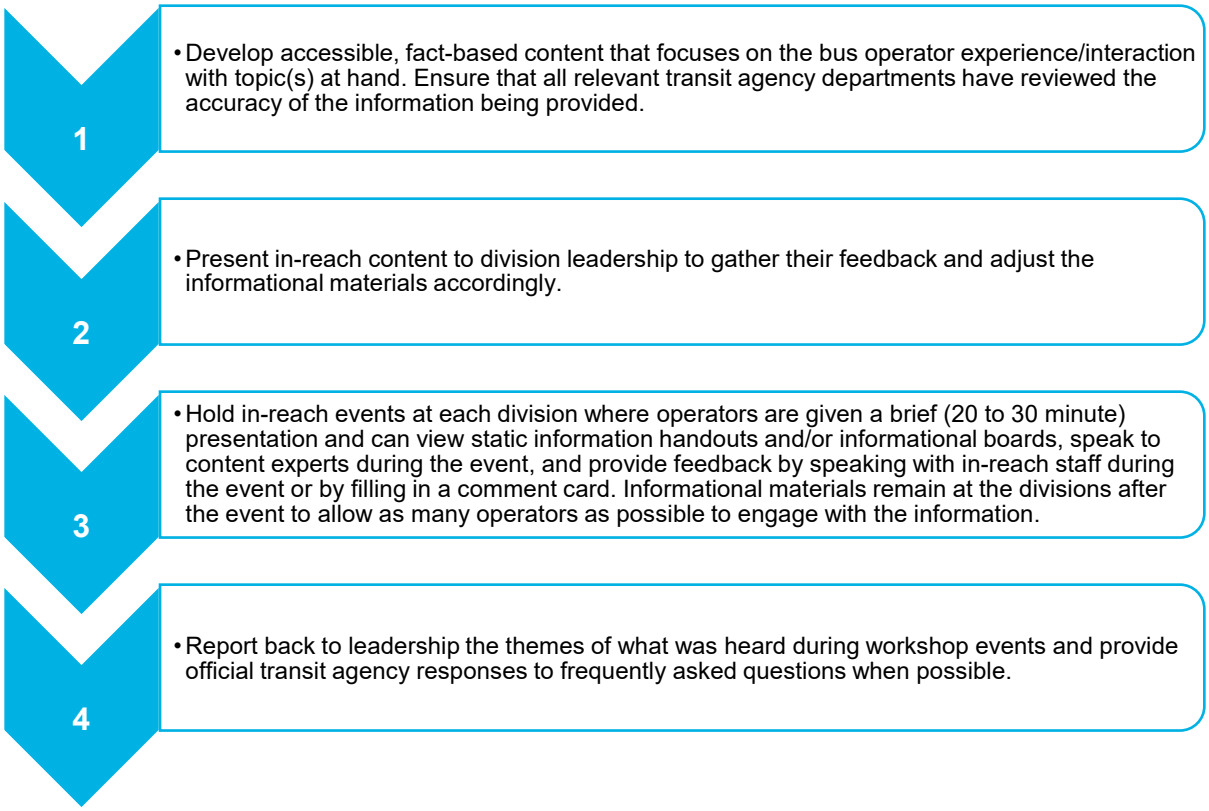


Figure 12. Example Operator In-Reach Event Approach

One transit agency engaged with a hand-picked subgroup of senior operators during the planning process. This group was not engaged after the plan was drafted, something the transit agency would have done if they could do it over again. In part, the operators—at the union's suggestion—protested using transportation network companies (TNCs) in the county, one of the recommendations of the bus network redesign for the more rural parts of the service area. Ironically the plan called for an 800 percent increase in service, so once the operators realized that they supported the plan; nevertheless, the TNC recommendations were dropped.

Another transit agency that involved its operators addressed their concerns about running times and recovery times in part by engaging the operators in running simulations of the routes to provide assurance that the time to complete the routes would be sufficient. They also did a lot of in-reach with the operators

in the bus garages through small meetings, and then during implementation working with the operators in terms of what routes they would drive.

Community Buy-In

Introduction

About two thirds of transit agencies with bus network redesigns underway or complete reported their redesign effort was championed by transit agency staff, local politicians, or board members. In most cases, the champion behind the redesign was a transit agency head or CEO (Byala, et al. 2019, 36). The goals of many redesigns center on helping the customers and the community, such as improving transit service for current and potential riders and better matching the bus network with current and potential future ridership demand. However, the process to get to the new system is long and difficult, and gaining buy-in from community leaders and community groups can make the difference in a successful plan.

Dealing with Public Pushback

Any change to bus service can cause concern in the community, but bus network redesigns bring the potential for widespread pushback. While making system-wide changes has the benefit of everyone being affected—and therefore does not single out one community over another—often the mere idea of change is challenging. Some common areas of public concern regarding redesigns are:

- **Too much change.** Capital Metro felt that a "barrier" to the implementation of the Cap Remap service plan was convincing the general public that the plan was "the real thing" and not solely a conceptual study; people started speaking out in great numbers only once changes were being implemented. The scale of the changes being done all at once caught the public's attention more than a typical service change would have.
- **Too much public spending.** One transit agency conducing a bus network redesign faced opposition from community members who were vocal about their belief that investment in increased transit was either unnecessary with the introduction of TNCs or was fundamentally at odds with their personal belief in limited government.
- **Changes to parking location or availability.** Another transit agency faced opposition from property owners located along a planned BRT line, who protested changes in street parking. When parking changes were made to accommodate their concerns, these property owners found new reasons to oppose the BRT. However, the transit agency was able to overcome this opposition through a public survey that found over 70 percent of residents were in favor of the planned BRT and service improvements. This survey data provided public officials with a clear understanding of community sentiment, rather than just the stakeholders who frequently voiced their opposition.
- **Reduction in fixed route and/or paratransit services.** Clinton County's bus network redesign involved service reductions including eliminating paratransit service and modifying fixed routes to be deviation routes. These changes naturally resulted in the public being upset. Nevertheless, due to funding limitations the transit operator had, as of spring 2020, there are no plans to revert back to more paratransit operations.

Across transit agencies, initial public pushback on new mobility services was a recurring theme, but there was often a sense that once the new services were in place, the public viewed these changes positively. Echoing this, one of the private companies interviewed stated that the riding public is more likely to invest in changing their behavior to ride a new or updated service if they trust that the service will last. According to this interviewee, pilots are critical to testing out a new idea with the public, but it is important to evaluate

ridership trends over an appropriate timeframe. People do not change their habits very quickly, and commuters are more likely to stick with a service if they know it will be around in the long term. This is especially challenging with respect to pilots of paratransit services for the disability community and may also have implications for services that are venture capital-funded like ridehailing and micromobility (i.e., dockless bikes and scooters) services.

Creating Broad Coalitions

Projects that had support from a broad range of community stakeholders–such as faith-based groups, transit advocates, and development and real estate groups–were more likely to succeed, according to interviewees. A broad coalition of stakeholders signals that a project has obtained widespread interest and support. It can also signal to political leaders that there is community engagement.

- **Houston METRO** employed a stakeholder task force comprised of more than 120 people that represented a variety of groups including social service providers, schools and colleges, developers, and community advocates (as well as bus riders, Houston METRO operators, and government agencies). This group was selected to provide a representation of the transit interests in the community and a collective opinion that would be meaningful to the Houston METRO Board. Their input provided critical feedback at each step of the plans development and ultimately generated a de-facto coalition of support.
- **IndyGo** benefited from having a variety of community groups involved with improving transit service in Indianapolis going back to the early 2000s. The impetus for Indianapolis' investment in transit began with a 2009 assessment that identified transportation as one of the factors inhibiting economic growth in the city of Indianapolis and the region. At this time IndyGo had an aging bus fleet and declining ridership. A corporate task force was formed to explore transit system improvements, which (as described in the section on Federal and State Engagement and Support) helped coordinate state enabling legislation for a local option income tax to support transit, which ultimately led to the city putting the bus network redesign on a ballot as a non-binding referendum. Community partners including the local AARP, IndyCan (a coalition of faith-based organizations), and transit advocates also offered critical support leading up to and throughout the redesign process, including significant investments in advertising and outreach to engender support on the referendum.
- **Washington, D.C. region.** The business community should also not be overlooked as a way to generate interested and support around a bus network redesign. In the Washington, D.C. region, the Bus Transformation Project—a precursor to a redesign—included leadership by an executive steering committee comprised of broad interests, including a strong presence from the business community. The business leaders' support of improving the bus network as a way to sustainably support and grow the region economically was critical to the endorsement of the strategy by most local jurisdictions.

Ballot Initiatives and Expanded Funding

State, regional, and local ballot initiatives can also shape transit service governance and funding. For example:

- **COTA** also expanded service as part of its bus network redesign due to a levy passed in 2006 as a temporary sales tax to fund service expansion. While it barely passed in 2006, when it was renewed in 2016 it passed with more than 70 percent in advance of the implementation of the redesign in 2017.
- In **Gwinnett County,** the original enabling legislation for nearby Atlanta's Metropolitan Atlanta Rapid Transit Authority (MARTA) required that each county hold two votes to be served by MARTA: one to join, and the second to fund. While Gwinnett County voted to join in the 1960s, it

did not vote to fund MARTA, and since then has operated all transit service in the county. In 2019, the County Board of Commissioners called for a referendum to enter negotiations for services with MARTA and to provide the capital and operating expenses for MARTA to build and operate the recommendations of "Connect Gwinnett," Gwinnett County's long-term transit development plan. However, the referendum failed in a March 2019 special election in part because voters did not understand how expanded transit services would benefit them. As of spring 2020, Gwinnett is moving forward with pursuing another potential referendum, this time leveraging permission provided to the county through Georgia House Bill 930, which gave Gwinnett an additional option to raise funds for "Connect Gwinnett" through a Special Purpose Local Option Sales Tax. If passed, this tax would generate capital and operating funds for Gwinnett County to directly build and operate the recommendations of the plan, other than operating the rail extension which would be done by MARTA.

- At **Houston Metro**, after implementation of the bus network redesign in 2015, voters approved a referendum in November 2019 allowing Houston METRO to borrow $3.5 billion based on future transit agency revenue. The vote, with 68 percent support, is intended to fund numerous capital investments, including adding premium bus features to 14 high-frequency routes implemented as part of the redesign.
- **HRT**, which serves six cities in the Hampton Roads region of Virginia—including Norfolk, Virginia Beach, and Newport News—completed the Transit Transformation Project and subsequent Transit Strategic Plan that looked at the service area regionally, resulting in recommendations for redesigning the transit network from a regional rather than city perspective. This study was the final impetus – after many years of trying for dedicated funding from the state – for the transit agency to be allocated, through the state legislature, a fixed source of funding for operational and capital improvements for a regional backbone network of high frequency, priority services. This funding source will free up local funds to implement expanded, redesigned local service to feed the regional backbone network and the region's one light-rail line.

Inter-Agency Collaboration

Transit agencies are organized in many ways – some are independent agencies or authorities, while others are components of state or local government. Most transit agencies surveyed as part of *TCRP Synthesis 140: Bus Network Redesigns*, reported having either a department of transportation or public works department that was involved in stakeholder-level review and feedback.

Coordination with Cities and Jurisdictions

More small (40 percent) and medium transit agencies (45 percent) reported having strong collaboration with their cities, compared to large transit agencies (17 percent) (Byala, et al. 2019, 40). Collaboration with the cities and jurisdictions in which they operate is a key bus network redesign challenge. Besides working with the municipalities and jurisdictions in the service area on the service plans, collaboration is needed to access assets controlled by local jurisdictions (such as street and curb space) to implement priority for transit vehicles (Byala, et al. 2019, 55).

- **COTA.** The transit agency's BRT, CMAX, which was considered as part of the bus network redesign but implemented separately later on, added bus lanes during rush hour on one corridor. While removal of parking to accommodate bus lanes was not possible in all corridors COTA desired, the transit agency successfully worked with the city to modify the curb space to accommodate pull-in/pull-out space for buses at key locations. The corridor on which the CMAX BRT runs was already a bus lane prior to the Transit System Redesign, however, police enforcement (including extra police

hired by COTA) of bus lane violations increased following the implementation of the redesign. There was an effort that did not come to fruition to convert a one-way street to a two-way street, which would include capital investment from the city of Columbus to enhance traffic signals and modify the roadway. Post Transit System Redesign implementation, COTA and Columbus piloted a combination bus/bicycle lane on that was widely viewed as a success.

- **MDOT MTA.** When the BaltimoreLink bus network redesign was implemented in 2017, the transit agency worked with the city on simultaneously implementing bus stop optimization, bus priority lanes, and TSP. While the city was not very involved in the planning of the service for the redesign, the transit agency collaborated with the city on bus stop removals and new stops (the transit agency did the work but required city approval); on putting in bus and right-turn lanes on two major corridors (again, the transit agency hired the contractors to do the work, with city approval); and on implementation of TSP on several high priority corridors, which required involvement from city and state traffic engineers.

As transit agencies plan their service in the bus network redesign, they rely on significant amounts of data to ascertain travel flows in the region. The city or jurisdiction in which the transit agency operates can play a role in obtaining more robust data about demand between locations by requiring that data from private providers—such as TNCs and scooter share—be shared with the transit agency for their planning purposes.

Coordination with Neighboring Transit Agencies

The transit agencies interviewed for this report described a limited level of coordination with neighboring transit agencies. While schedules may be coordinated with other transit agencies at common transfer locations, very few interviewees described extensive levels of integration with the operations of another transit agency, such as interlining or sharing common route alignments between operators. This allows for any potential bus network redesign effort to focus solely on their own transit agency's operations. However, when other operators are part of the same metropolitan area travel shed, then opportunities for truly meeting the travel needs of the region can be lost due to the artificial boundaries of a transit agency's service area.

Generally, some level of coordination was most common in examples where other transit agencies may also operate within the same service area–for example:

- In the **San Francisco Bay Area**, AC Transit initially planned to rationalize its service to feed the BART rail system but had to change course when BART could not accommodate additional passengers.
- In the **Los Angeles region**, LA Metro is conducting its bus network redesign just for bus service provided by the transit agency itself. However, 17 major municipal operators provide about one-third of the bus service in the service area, with little overlap. During the planning process, LA Metro has worked very closely with all of the municipal operators on a variety of planning issues, such as to confirm or identify new transfer locations, coordinate services, and reduce duplication of service.

Federal and State Engagement and Support

Transit agencies often have to navigate state government as they develop a bus network redesign. IndyGo had strong support from a local corporate taskforce supporting their Bus Network Redesign, and that group took the lead on engaging with state legislators to advocate for state enabling legislation allowing for an income tax to support the redesign. Other transit agencies, like MDOT MTA, are state agencies themselves

and had to seek approval for all elements of their bus network redesign from the state department of transportation.

At the federal level, transit agencies have been able to obtain grants for key elements of their bus network redesigns. IndyGo was also the recipient of an FTA Small Starts Grant—which FTA funded at the highest level—for the construction of the Red Line BRT, the spine of the entire bus network and a critical piece of IndyGo's redesign. Nearly a year before the BaltimoreLink redesign was implemented, MDOT MTA received a USDOT TIGER grant to fund infrastructure improvements—including bus lanes and improved transit stops—on a corridor designated as one of the transit agency's high-frequency services during the redesign (MDOT MTA 2018b).

Additionally, through programs like the Integrated Mobility Innovation Demonstration Program or the MOD Program, the federal government provides funding for transit agencies to test new mobility approaches that may promote service effectiveness and provide options beyond fixed route bus. Such programs can allow transit agencies to explore different technologies for service delivery, such as the use of ridehailing services or micromobility providers (e.g., bikeshare, scooter-share) to help deliver first-mile/last-mile services, which could have implications for bus network redesigns. According to one private sector interviewee, the federal government should continue to expand such programs in order to enable new technologies to succeed. Additionally, the data coming out from the results of micromobility pilots will help inform service planners and transit agency leaders as to the actual usefulness of such services, including how they can augment bus networks.

Boards and Elected Officials

Bus network redesigns are heavily influenced by governmental and transit agency decision-making processes. Federal, state, county, and city governments affect factors like funding availability for research and development initiatives that are part of early stages of redesigns, funding for the planning process, and funding for implementation of redesigns – both on the operating and capital side.

Transit agencies typically have a governing body and/or a higher-level transportation department that can weigh in on the decision-making process. The exact role that these bodies take in the planning process varies from determining budgets and engaging the public, to giving the final approval on a project before implementation. It is therefore important for transit agencies to engage their governing bodies throughout the bus network redesign process to ensure that all are onboard with the changes. A powerful board with strong opinions can be are design's determining factor in terms of how much gets done, how long it takes, and what the final outcome will be (Byala, et al. 2019, 43-44).

Diversity in board or advisory committee representation was also listed as an important element to achieving buy-in. Whereas some transit agencies pointed to pushback from boards that were resistant to change, others indicated that having a board or advisory committee that represented a variety of interests and perspectives allowed for a richer discussion. IndyGo pointed to buy-in from political leaders, including an enthusiastic mayor, helping to make a bus network redesign successful because engagement from the mayor made it easier to build support within other city departments, and that this can last through changes in administration. A previous mayor was a leader for transit and supported a successful transit-funding referendum. The support evidenced by the referendum, as well as extensive community support, was a key factor in the transit initiatives continuing into the next mayoral administration. They noted that engagement is not a one-time event; interviewees said that the board and other transit leaders that are resisting change must be brought along during the entire process, and their concerns should be addressed.

Survey results indicated that boards have been involved in many different aspects of bus network redesigns. Transit agencies interviewed for this report and surveyed as part of *TCRP Synthesis 140: Bus Network Redesigns* indicated that transit agency boards of directors are often the largest barriers to implementing bus network redesigns. Among the survey respondents with complete or underway bus network redesign efforts, boards were most often involved in final approval for route recommendations (71 percent), policy guidance for the bus network redesign visions (74 percent), and final approval for operating budgets (71 percent) (Byala, et al. 2019, 39). Many transit agencies that had already implemented bus network redesigns also indicated their boards had conducted political advocacy (65 percent) and public outreach (53 percent) on behalf of the project (Byala, et al. 2019, 39).

While board representation can provide critical guidance on service changes, board members often have different, conflicting goals. Many board members are also very reactive to their constituents and resist change when their represented riders complain. This can result in delayed service change implementation or even a complete shift from what was otherwise planned for implementation. Board members must be "brought along" over the process and convinced by transit agency staff that the resulting bus network redesign will be a positive outcome; additionally, board changeovers can interrupt the bus network redesign process.

One example of success in gaining the board's approval to do a bus network redesign was demonstrated in Houston, Texas with the New Bus Network project. Well before the board was to vote on the project, the CEO of Houston METRO appointed a core management team, including a project lead, two project managers, and a board liaison. It was noted that building this core structure and having them supported by the CEO was pivotal to getting the project approved by the board. The management staff then formed a working group made up of senior staff from with specific roles within Houston METRO, such as financing, public affairs, planning, press, and operations. This complex structure helped incorporate the expertise of all the relevant parties within the transit agency while still maintaining the hierarchy necessary to run a successful project. Ultimately, this structure helped to get the project approved by the board and helped to get it implemented successfully (Houston METRO n.d., 1-3). Buy-in from top elected officials and other local leaders was another critical element for achieving public support. As one transit agency stated, "the local leaders [now] understand that widening roadways is no longer enough to address transportation challenges." In much of the country, this kind of thinking is not standard among top officials, much less the general public. When leaders champion bold new ideas, support from the general public is much easier to achieve. One city had a successful referendum on funding increased transit service. The detailed maps of constituents who voted for increased taxes helped bring along elected officials. The Indianapolis area passed a non-binding ballot initiative to increase funding for IndyGo's bus network redesign, which demonstrated public support for transit that helped enhance support from elected officials.

CHAPTER 5

Bus Network Redesign Implementation

Introduction

How a transit agency chooses to implement its bus network redesign can be as important to its success as all the other components of its preparation. A proper launch ensures that the changes to the system are understood by the public, which therefore ensures that they system will continue to attract and retain riders.

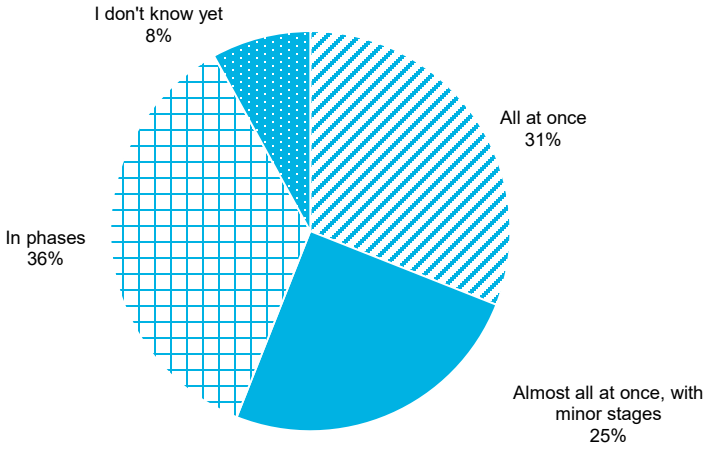
Phasing

Transit agencies face a choice between implementing bus network redesigns all at once or through a phased implementation. The "all-at-once" approach typically occurs in the course of one day, where on a set date all the route changes are implemented at once. The phased approach usually involves changing pieces of the system at a time and may take months or years to fully implement.

One challenge to an all-at-once implementation cited by several transit agencies interviewed for this study was their shortage of bus operators:

- **Capital Metro.** The lack of drivers needed to roll out the bus network redesign is the primary reason that the Red Line BRT service preceded the implementation of the service and routing changes that will eventually be made to the local bus network. The contractor working with Capital Metro was able to get enough drivers just in time, but despite ongoing recruitment operator hiring is a struggle. Bus operator shortages are a nationwide problem that has gotten worse over time and adds another level of complexity on top of an already complex bus network redesign process (Short 2017).
- **IndyGo.** Part of the impetus for the phased implementation by IndyGo was, and is, the inability to hire enough drivers for both the new BRT system and the full system redesign at the same time.

The implementation timeline followed by transit agencies surveyed for *TCRP Synthesis 140: Comprehensive Bus Network Redesigns* varied from "less than two years" to "10 years or more" (Byala, et al. 2019, 49). Transit agencies that took a phased approach to implementation phased it in various ways, shown in Figure 13. Those that implemented or planned to implement in phases were split between deploying phases by "geographic service area" or "service type" (Byala, et al. 2019, 75).



Source: *TCRP Synthesis 140: Bus Network Redesigns,* 134.

Figure 13. How did you implement/are you planning on implementing the redesigned system?

Byala et. al. found that one reason transit agencies may undertake a phased approach versus transitioning the whole system at once is due to capital and operating constraints.

- **Dallas Area Rapid Transit (DART)** incrementally implemented its bus network redesign in response to future increases in operating funds (Byala, et al. 2019, 76-77).
- **LA Metro**'s plans for implementation is to first fix the core network and do the most they can within current resources to make changes that will benefit the most people. Future phases will include a capital program to support the service plan and internal operations and, lastly, additional service if more funding can be secured.
- The **King County Metro** Transit Department in the Seattle, WA area phased its bus network redesign to coordinate with major capital investments (Byala, et al. 2019, 76-77).
- **IndyGo** is an example of a transit agency making incremental improvements as they phase in their bus network redesign. The transit agency chose to start making small changes to schedule frequencies. Its first BRT line, the Red Line, opened in September 2019. The implementation of the new, grid-based network planned for June 2020 has been postponed due to several factors related to the COVID-19 outbreak. IndyGo is continuing to assess staffing, equipment, and ridership levels to determine the most effective time to move forward with the route changes.

Conversely, other research highlights the benefits of a rapid implementation of network changes.

- **JTA** found that implementing the bus network redesign at once was important for success and that an incremental phasing strategy may result in delays and additional rider confusion (Jacksonville Transportation Authority n.d., 7)
- For **Capital Metro** in Austin, the redesigned network was implemented all at once, with approval in November and implementation the following June; the process was led by the Operations Planning department, but the project manager for Cap ReMap came from the Capital Planning department. The overall project manager was selected on the basis of their experience with managing complex and large projects, as opposed to technical specialty within the transit agency. Capital Metro spent six months focused on preparing for implementation. In retrospect Capital Metro staff expressed the view

that a full year of time to prepare for implementation would have been beneficial given the breadth of activity that happens during this period, to implement it to account for all the aspects of implementation, from hiring drivers (which was already a challenge) to signage, to public information.

Regardless of whether the implementation is immediate or gradual, transit agencies should expect an adjustment period as both the riders and the operators learn the new system.

Specifically related to the implementation of microtransit of demand-response transit, several transit agencies interviewed noted the usefulness of pilots before permanently implementing DRT programs. One transit agency specified that discontinuing fixed route bus service is often ripe with internal and external politics and, to this end, suggested it is wise to establish pilot DRT projects in areas where no transit service exists. The respondent explained that pending the success of pilots, a case for eliminating existing fixed route service in favor of DRT can be more easily made. In contrast, another transit agency reported having had success in launching DRT service in an area that previously had fixed route service. The new DRT service offering launched by this transit agency benefited from the existing customer base, and the transit agency viewed DRT as a "condolence offering," noting that eliminating service altogether would have faced greater opposition (Volinski 2019, 39).

Elements

This section provides an overview of the component key parts of implementing bus network redesigns. Some of these elements—such as public engagement and education and mobility partnerships have been introduced earlier in the report in Chapters 3 and 4—and some, such as capital elements and detailed implementation activities are covered in more detail in Toolkit #1: Bus Network Redesign and Toolkit #2 Partnering to Make the Bus the Mode of Choice.

Governance and Institutional Change

Bus network redesigns may involve an internal reshuffling or restructuring of the transit organization to account for the any new services being offered and older services being discontinued. This can involve consolidating leadership, adding staff, and creating a new transit agency division or department.

- **Charleston Area Regional Transportation Authority** (CARTA) in Charleston, SC consolidated its management to simplify the implementation process before beginning their bus network redesign (Byala, et al. 2019, 43-44)..
- **IndyGo** hired new staff to create the Planning and Capital Projects Division to support the bus network redesign initiatives (Byala, et al. 2019, 43-44).
- **SEPTA.** In advance of embarking on the planning and implementation of its bus network redesign, the Southeastern Pennsylvania Transportation Authority (SEPTA) created a new senior management position that reports to the General Manager to oversee planning at the transit agency, giving oversight of long-range and service planning to one person and elevating the importance of planning and in fact bus within the organization (Madej 2020).
- **UTA.** Prior to planning for their Service Choices bus network redesign, the UTA 2018 Strategic Plan examined peer transit agency structure as it relates to transit agency functions, with a particular focus on aiding future service expansion and the integration of new mobility modes. As a result, UTA established an Innovative Mobility Solutions department to develop pilots and research industry innovations for implementation at the transit agency. While the Service Choices project is being led

by UTA's Service Planning department, the Innovative Mobility Solutions department is an active participant in the planning process.

Implementation Engagement and Education

One challenge of implementing a bus network redesign, whether it is in phases or all at once, is ensuring the transit riders are aware of the changes to the system and have resources to help them navigate the system while they become familiar with it.

- **Capital Metro** implemented a robust outreach and education process prior to implementation. The transit agency had a new GTFS feed ready about a month before launch, and that allowed riders to compare their trips pre- and post-bus network redesign. The availability of this information helped significantly with outreach, especially for riders who had complex trips. One issue that appeared for Capital Metro after implementation is that some people who were not as tech savvy, had limited English proficiency, or other issues with the ability to access information (e.g., low literacy or barriers to access to technology) had not made use of the GTFS feed to plan their new trips and were trying to replicate their old routing with the new routes. These people were making three seat rides when they only needed two; about two weeks of post-implementation education, including bilingual staff, was key to ensuring that people knew how to best use the new bus network.
- **COTA** hired temporary workers, many of whom were transit users, as brand ambassadors to conduct direct outreach in the community. Every stop got a temporary sign explaining what would happen at that stop, and the customer service center was overstaffed before and after implementation.
- **JTA** created a group of retired operations team members who possessed the institutional knowledge to train others and make sure the trainers on the new system included a mix of seniors, youth, minorities, and people with disabilities.
- In **Gwinnett County**, the whole transit workforce received the same training making them all knowledgeable about the system and connectivity. If the operators were only trained on part of the network, they would have missed an opportunity for operators to act as ambassadors. As the front-line employees that most riders interact with, it was important that the operators could act "ambassadorial," especially in the Atlanta region where there are multiple bus operators.
- **IndyGo** has an "all hands-on deck" approach to public education, which is primarily led by a department other than service planning. This approach includes a robust engagement plan with on-site transit ambassadors to engage the public. Prior to the implementation of the Red Line BRT, IndyGo also conducted direct outreach to automobile drivers. The Red Line is the first rapid transit in the Indianapolis region. It was expected that many automobile drivers may not be familiar with the regulations surrounding the dedicated right-of-way (ROW) that comes with a BRT system.
- **MDOT MTA** conducted an extensive public education campaign ahead of the changeover to the BaltimoreLink system. Pop-up events with street teams, new bus stop signage, public notices, on-board announcements, and a new website with trip planning tool were all deployed to get the word out about the change. The education program also included sending a "BaltimoreLink Info Bus" to provide trips on all current routes, where passengers could talk with route experts to learn how the new system would affect their trip. MTA also partnered with the Center for Mobility Equity, a regional non-profit, to provide comprehensive training for senior riders, people with disabilities, and students.
- **UTA**, which as of spring 2020 was still finalizing its bus network redesign plan, planning for implementation, education began early on. The transit agency's Marketing/Public Relations department has been involved in project related outreach in detail and are already working with the planners on areas that they think will be "hotspots" of passenger question or concerns.

Implementation of Mobility Partnerships with Transit Agencies

Many of the more recent bus network redesigns incorporate planning for new mobility services as part of their service planning, identifying areas that may not have fixed route service as part of the redesign but could be served by microtransit, partnerships with transportation network companies (TNCs), or where mobility hubs may provide access to the transit system.

Experimentation and clearly defined goals can help transit agencies successfully integrate new mobility services into existing fixed route transit services. A 2016 TransitCenter report emphasizes multimodal rather than mode-specific mobility, a rebalancing of street infrastructure to prioritize efficient movement, fare integration, data exploration, and use of on-demand services as elements that transit agencies should consider as they explore partnerships with new mobility providers (Tsay, et al. 2016, 79).

UTA established its Innovative Mobility Solutions department as a testbed to explore potential implementations of new transit service models and technologies that may in the future be deployed more widely throughout the system. LA Metro's Office of Extraordinary Innovation, in a similar spirit, was created to aid the transit agency in developing new types of partnerships and deploying new technologies that show promise for future system-wide implementation (LA Metro n.d.).

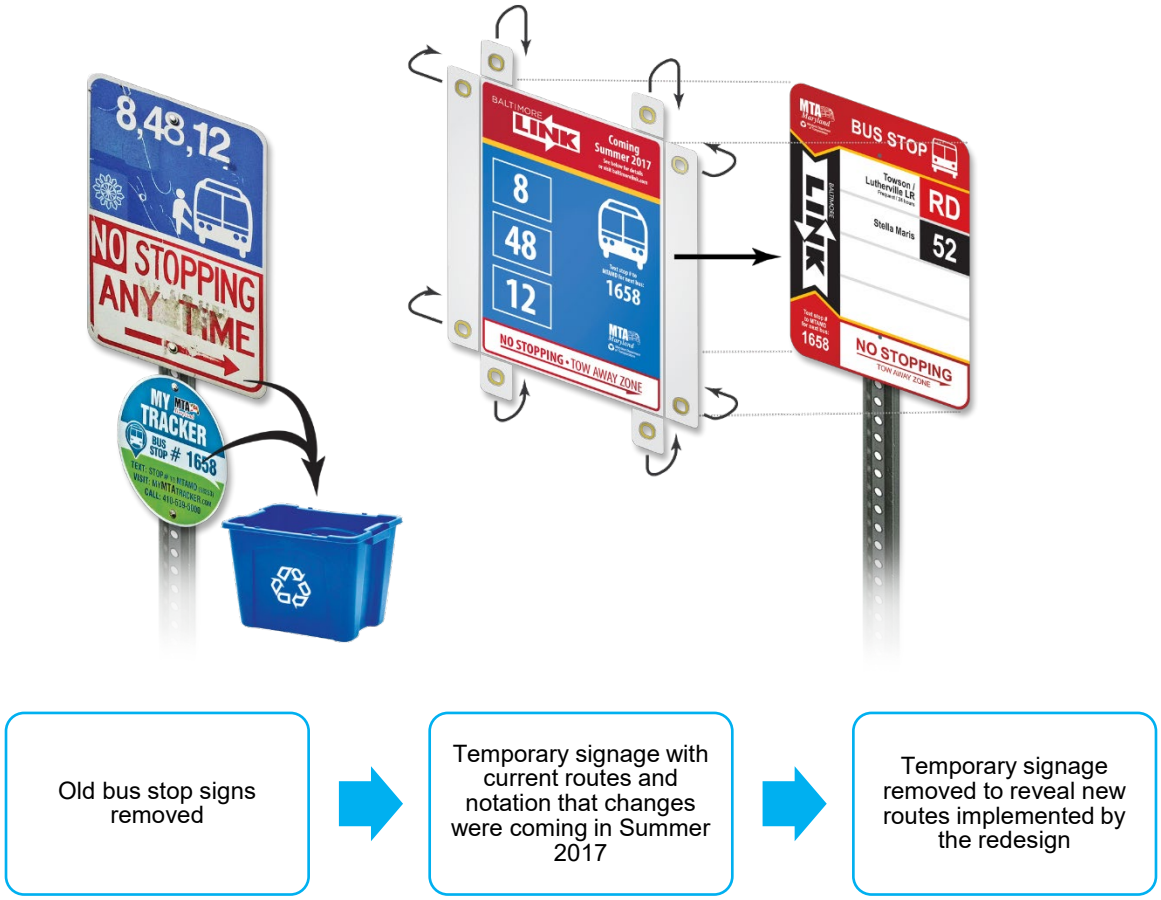
Most of the transit agencies interviewed for this report have approached the implementation of new mobility partnerships as pilots, with the aim of evaluating specific use cases and performance in meeting transit agency goals, as opposed to committing to full-scale implementation of a new service model within a broader bus network redesign process. However, many transit agencies also acknowledged the limitations of pilot programs, in that customers are not necessarily willing to invest in learning about a new option when it might only be available temporarily. This can result in lower ridership and a perceived lack of success of the pilot.

Finalizing Capital Elements and Other Detailed Implementation Activities

During bus network redesign planning, as discussed earlier in the report, transit agencies identify capital elements that will be needed to support redesigned service. These items range from additional vehicles to expanded or new transfer facilities to bus stop signage to new layover facilities. These improvements will have been coordinated with route planning earlier in the process, but at the time of implementation there will be many final details to address. For example:

- **Video new routes for training.** Transit agencies such as MDOT MTA and Capital Metro's contracted operator conducted their final drive of each new route to video the route for operator training and check for any final safety concerns.
- **Conduct final safety checks**. MDOT MTA's safety checked for any needed "daylighting" design improvements as buses approach intersections.
- **Final improvements for bus priority lanes**. Any TSP that the transit agency and municipality were working on to complement high-frequency corridors needs to undergo final testing, and striping and painting for other bus-priority treatments must also be finalized.

In addition, there are many other small details that must be addressed before a bus network redesign can launch. At COTA, the transit agency hired a project manager specifically to manage all the details of the implementation. New, relocated, and removed bus stops all must be tagged in some way that shows current service information as well as the plans for upcoming changes, such as the image in Figure 14; this approach was followed in many cities that have implemented bus network redesigns.



Source: MDOT MTA

Figure 14. BaltimoreLink Bus Stop Signage Replacement Process

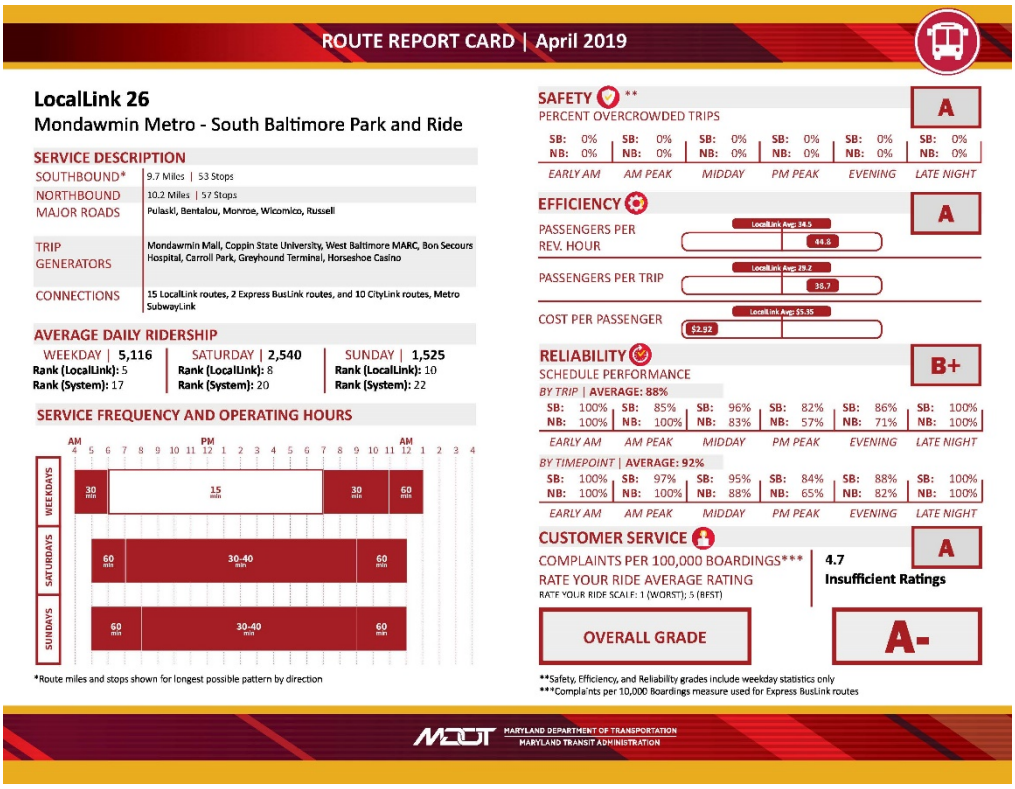
Once the final system plan is developed, transit agencies must schedule all the service in their scheduling software or whatever process they typically use for scheduling. If the planning work was done in a detailed manner—such as including accurate run times and layover time—the scheduling should result in a system that the transit agency can operate. If the planning did not consider all aspects, there have been transit agencies that, upon scheduling the service, found that more resources would be needed to operate the plan than initially thought.

Other items include driver training, which at several transit agencies included driving each route with a camera and posting the videos to a video site for operator training. Various Intelligent Transportation Systems (ITS) elements must also be addressed, including ITS data preparation for GTFS and for updating the on-board ITS systems—namely APCs and AVL—to include updated bus stop sequences and routing. Finally, print materials such as bus schedules, route maps, and system maps, must all be designed, printed, and distributed prior to implementation.

Follow Up Post-Implementation

Once the new system has been launched, transit agencies can monitor and continue to make improvements to the system. Using performance metrics developed earlier in the process—such as ridership, schedule adherence, and crowding—transit agencies can set up more formal performance monitoring programs to ensure that all the effort that went into planning and implementing the bus network redesign is followed up on. Despite the best planning efforts, bus transit is dynamic and ongoing performance monitoring, using easily collected data, is key to keeping the service at peak performance.

- **COTA.** One year after implementation of its bus network redesign, COTA had seen a ridership increase of between 1.6 percent and 3.6 percent based on comparing individual months from before and after the redesign at a time when transit ridership nationwide had been declining. It also monitored weekend ridership where the redesign had added a lot of service and saw increases as large as 24 percent on Sunday (Schmitt 2018).
- **Capital Metro** had seen at least 17 months of ridership gains following implementation, largely, they believe, by the implementation of "show-up-and-go" services that come frequently enough that passengers do not require a schedule. They have a board adopted goal for passengers per hour.
- **LA Metro**, which as of spring 2020 was still finalizing their bus network redesign plans, set forth a plan for measuring success when it approved the Regional Service Concept, or framework for restructuring the system. The transit agency adopted measures of success around three stages: Find, Try, and Rely, which are comprised of customer focused measures as well as traditional metrics of productivity and efficiency. These metrics include legibility, competitiveness, and customer satisfaction; some of these can be applied to the planned system and some once the new system is operational (LA Metro 2019a).
- **MDOT MTA** has adopted a very robust post-implementation monitoring process that includes creating an efficiency rating for each metric for each day type: cost per passenger, passengers per hour, passengers per trip. It also includes reliability, customer service, and safety ratings. This evaluation, which has been automated using data from MTA's on-board systems, is conducted monthly and trends are tracked to identify routes that require more in-depth analysis. An example of this is shown in Figure 15.



Source: MDOT MTA

Figure 15. MDOT MTA Post-Implementation Monitoring Process

CHAPTER 6

Conclusions and Next Steps

The research described in this report summarized bus network redesigns, including their planning and implementation, as well as how transit agencies have incorporated new mobility into their planning processes. There were several key findings that represent common themes, challenges, and considerations observed across this research. This is also an evolving topic; as of the writing, there are still numerous bus network redesigns being planned and considered across the country, and the impacts of those implemented are still not clear. With the COVID-19 pandemic that ravaged the country in early 2020 and its associated precipitous drops in transit ridership and the unknown long-term impact on travel, bus network redesigns may well be needed even more in the future to determine what types of transit services to provide. Finally, this research identified several gaps where additional research is required.

Key Findings

Based on the interviews, survey review, and literature and information review, the following are the key findings about bus network redesigns, new mobility, and the connection between the two.

1. **Transit agencies see bus network redesigns as a way to implement better bus service, address recent changes in their service or their region, and pass through a variety of improvements under one umbrella.**
   - Even in regions with extensive rail (or other types of fixed guideway) networks, buses carry a significant percentage of transit trips, and changing the bus network has major impacts.
   - Bus network redesigns are seen as a way to bring wholesale change to the transit agency's offerings. While very labor and resource intensive, making many changes at once streamlines work that would have been done over several projects and also makes changes more palatable to the public. While people may not be happy with all the changes, they can at least feel like the changes are not just impacting them, but rather are for the benefit of the entire region. This also makes it easier for the transit agency when it comes time for public hearings before implementation.
   - Transit agencies are tying together a variety of improvements under the umbrella of a bus network redesign. These include implementing high-frequency corridors with bus priority treatments, bus stop optimization, new and expanded transit centers, and even new branding and online and print materials. Most of these improvements are directly tied to supporting the service plan developed for the bus network redesign, but other, only peripherally related, items are also sometimes included.

2. **Bus network redesigns should be framed by strong decision-making processes and leadership guidance.**
   - Most successfully planned bus network redesigns have strong support and leadership from someone in a senior position, such as the transit agency CEO or an influential Board member. This high-level backing and guidance is key to buy-in across internal departments, cooperation with stakeholders and the local jurisdictions, and a face of support and leadership (i.e., a "champion" of the bus network redesign) for the public.

3. **Transit agencies should establish parameters and goals early on for bus network redesigns to set expectations for stakeholders, the board, and the public.**
   - Goals for a bus network redesign can vary even across an organization, with some departments focused on maximizing operational efficiency, some on maximizing accessibility, and some on revenue generation. It is important to have well-articulated and coordinated goals so that everyone is working toward the same outcome for the bus network redesign.
   - Parameters for changes to the system should be developed and applied at all phases of the decision-making process so that the process has a strong reference point and keeps the plan on track to meet its targets and objectives. These targets and parameters can be related to, for example, planning for a cost neutral operating plan, a plan to increase bus operations, or a plan that is associated with a priority bus network to which the rest of the service should feed.

While most transit agencies use bus network redesigns to develop a system that better serves the needs of the riders within their current operating budgets, even transit agencies that had additional money to spend often develop a cost-neutral plan to encourage the discussion of trade-offs.

4. **Bus network redesigns should be built on agreed-upon design principles, service types, and design guidelines.**
   - Because of the breadth of changes that will be recommended through a bus network redesign, transit agencies use the occasion to review and update some of their key service planning guidance documents, including service design and service performance guidelines. This not only provides the planners with a structure under which to conduct the planning but also provides the transit agency with documented reasoning that can be used in discussions with the public and stakeholders.
   - *Design principles* to be defined early include the approach to the planning process—such as starting from a "blank slate" or looking at comprehensive modifications to an existing bus network; how much of the transit agency's resources should be devoted to high ridership services versus local coverage services; how much should the bus network redesign focus on direct trips ("one-seat rides") at the expense of greater frequency; and what demographic and land-use characteristics should warrant fixed-route service at all.
   - *Service types* that a transit agency may include in their bus network redesign include types such as high-frequency/high-priority, feeder service to high-frequency and/or fixed-guideway transit, and local coverage routes.
   - Finally, establishing *design guidelines*—such as span, frequency, and stop spacing—for different service types provides justification for the recommendations that the transit agency can reference later in the process during public and stakeholder input phases.

5. **The importance of frequent and meaningful engagement with stakeholders and the public cannot be overstated; there is no such thing as too much outreach, engagement, and communication when planning and implementing a bus network redesign.**
   - Getting input is critical to developing a bus network redesign plan that will work for people and bringing them along in the process will ease the education process when planning turns to implementation. However, even with significant amounts of engagement, transit agencies should still expect challenges come implementation time, namely making sure all riders are reached and that they understand how the changes will impact their trips.
   - Bus network redesigns typically structure outreach to be a key element of all phases of the process, morphing over time from general input, to feedback on possible service changes, to education about the changes. A common challenge that transit agencies contend with is making sure that the public understands early on that the plan is intended to move toward implementation. Sometimes the sheer

volume of changes can make people think it would never be implemented, so they may hold their comments and not provide input until very late in the process.
- Transit agencies use a wide variety of strategies to engage the public, from workshops, to pop-up surveys at transit centers, to social media. While most transit agencies relied largely on in-person engagement with some complementary online engagement including crowdsourcing sites and surveys, bus network redesigns in the future may likely need to pivot to emphasize virtual engagement given the recent concerns about large gatherings.
- Engaging disadvantaged and diverse populations is especially important in bus network redesigns. In cities that have multiple transit modes, bus tends to skew toward higher proportions of low-income and minority populations than other modes. Bus network redesigns impact all riders and potential riders, and the input that they provide can be invaluable to the plan development.

6. **Transit agencies are currently in the stage of piloting and experimenting with the integration of new mobility in their services; planning for new mobility has not been widely integrated into bus network redesigns.**
   - Likely due to the relative nascence of these modes, microtransit, TNC partnerships, micromobility, and the development of mobility hubs are typically considered in parallel or as pilot efforts loosely associated with the bus network redesign.
   - While bus network redesign and new mobility integration is not common, most transit agencies interviewed have or are in the process of implementing a variety of new mobility options, including general-purpose on-demand transit, TNC partnerships, and coordination with local jurisdictions on micromobility for first-mile/last-mile access to transit. A few transit agencies incorporated on-demand zones into their redesign plans, and one incorporated planning for these modes into mobility hubs for multimodal connections.
   - In the cases where transit agencies have implemented microtransit service, their approach to dealing with fixed routes in that area are mixed, with some replacing fixed-route service with microtransit and some using it as a complementary service.
   - While many transit agencies are starting to offer new mobility options, many are funding them and presenting them publicly as pilot projects. Several organizations suggested that low ridership on new mobility services may be both because people do not understand the service and, more importantly, they do not want to invest the time in understanding if the service is likely to go away in a few months. Appropriate marketing and discounts for rides can help counteract some of this hesitancy.

7. **Equity considerations are integral to bus network redesign planning efforts.**
   - At most transit agencies buses carry a higher proportion of low-income, minority, and limited English proficient riders than other transit modes, therefore changes to the bus network may have a greater impact on these populations.
   - Many transit agencies are incorporating additional analysis into their planning to ensure that the planning process accounts for locations of minority and low-income households; the transit agencies that conducted impact evaluations early and worked closely with these communities were better able to serve these populations and address their concerns proactively. This goes beyond just Title VI analysis but also looking at locations with high levels of employment in industries where low-income workers work and ensuring sufficient service to connect communities with healthcare and other social services.
   - While many bus network redesigns focus on improving efficiency and providing better service on high frequency corridors, increasing walk distances to transit can have a significant impact on people with disabilities and seniors. Bus network redesigns should also consider the needs of people with disabilities and the senior population when evaluating alternatives that require longer walks to fixed

route transit; not only is fixed route transit often more appealing to this population, but it is a much less expensive trip to provide for the transit agency.
- Additionally, many disabled people and seniors rely on paratransit service, and the service area is based on the fixed route network. Since the fixed route network will be changing as a result of the bus network redesign, some transit agencies that have implemented or are planning to implement bus network redesigns have "grandfathered" in either specific users or geographic areas to ensure continuity of paratransit service.

8. **Implementation of bus network redesigns—on the operating side and with supporting capital elements—are incredibly involved and require participation from all parts of the transit agency, the local jurisdictions, and other key stakeholders.**
   - Intense collaboration is required throughout the transit agency and with regional partners to implement the major changes planned in many bus network redesigns.
   - At the simplest, a bus network redesign can be implemented with limited capital investments, such as new bus stop signs, new or expanded layover facilities, and additional space for transfers at existing facilities. More capital-intensive bus network redesigns require transit agencies to work with their local jurisdictions to invest in bus priority treatments, new and expanded passenger stops and transfer facilities, and first-mile/last-mile improvements.
   - Transit agencies vary in how they deploy bus network redesigns in terms of an all-at-once change or implementing the plans over time. Deploying over time can be for a variety of reasons, including availability of funds and/or resources, while an "overnight" implementation is logistically challenging but has the benefit of getting everything done at once.
   - A proper launch ensures that the changes to the system are understood by the public, which therefore ensures that they system will continue to attract and retain riders. This requires extensive public education as well as educating and empowering front-line employees as ambassadors for the changes.

Future Work

This effort identified several areas for additional study, including the following:

- Further evaluation of the benefits and outcomes of bus network redesigns once enough have been implemented with sufficient time to analyze the results. Following a typical service change, ridership often declines before rebounding as riders acclimate to new system changes. Ideally the impact of the service changes on key metrics (e.g., ridership, reliability) should be evaluated at least 18 months post-implementation.

  - One particular area of research may be to analyze the differences between linked and unlinked boardings both prior to the bus network redesign and after its implementation; in particular, it is important to understand if the increases in unlinked boardings observed after some bus network redesigns are attributable to "new" trips being made, or are solely the result of more riders requiring a connection where none may have been necessary previously.
  - Evaluation of the impact on riders of rapid versus phased implementation, and how long the adjustment period is for ridership trends.
- Evaluation of the long-term impacts of bus network redesign, in terms of land use changes, people's location decisions, and changed relationships with the local municipalities, e.g., did the bus network redesign prompt cities that were previously averse to bus priority change how bus is treated within the broader transportation system.
- Ongoing assessment of how the evolution of new mobility options and other transportation system changes impact travel behavior specifically as it relates to the use of fixed route transit. Given the

rapid evolution of new mobility options, as well as conflicting data on impacts, there is a need for continuous study of changes in travel behavior due to the introduction and rising prevalence of these modes in the near-term. Because the impact of new mobility on travel behavior has been shown to vary geographically across the country, gathering robust data on a variety of place types will be important.

- More research is needed regarding the influence of new mobility on transit networks and options for new mobility, specifically looking into the use of microtransit applications, their cost-effectiveness for transit agencies as compared to more traditional services, as well as their impact upon overall fixed route ridership. As microtransit becomes more prevalent throughout the country, research should be conducted as to how much of an impact microtransit services having on transit ridership overall, including both publicly funded and non-publicly subsidized programs.

  - This research might also consider an examination of the labor practices and financial situations (e.g., subsidization by venture capital funds) of new mobility providers in terms of their actual costs, the impact on labor, and the extent to which some new mobility providers may be expecting to substitute venture capital funding subsidy with that of the public sector.
- Issues of equity in access to and use of new mobility modes incorporated into existing transit systems merits further evaluation. FTA's Title VI guidance does not extend to the evaluation of these types of partnerships themselves. While ADA requires "equivalent service" that does not mean that new mobility is being planned with the needs of people with disabilities in mind. Several new mobility initiatives have explicitly sought to serve the needs of traditionally disadvantaged or underserved populations (including people with disabilities), but many others are being deployed based on the fit with a specific use case (e.g., areas otherwise not suited for service by fixed-route transit, provide rides only to a specific group such as senior citizens) that may or may not provide equal access to all.

SECTION 2

CHAPTER 7

Case Studies

This chapter consists of four case studies of bus network redesigns in various stages of planning and implementation, chosen to emphasize different aspects of the bus network redesign process.

- **Capital Metro**, which implemented its bus network redesign in 2018. This case study focuses on stakeholder and public engagement and education, incorporation of new mobility, and the planning and implementation process.
- **Houston METRO**, which implemented its bus network redesign in 2015. This case study includes information on the impetus to conduct the bus network redesign, the public outreach program, and the implementation process.
- **IndyGo**, which has planned its bus network redesign but has delayed implementation due to COVID-19. This case study discusses how the bus network redesign stemmed from long-range planning efforts, public engagement, trade-offs made during the planning process, coordination with capital elements, and the role of external partner support.
- **LA Metro**, which is finalizing its bus network redesign planning process as of spring 2020. This case study covers the coordination with microtransit efforts, inter- and intra-agency coordination, equity, using travel flow analysis for planning, and related capital elements.

Capital Metro

Overview

Capital Metro is the regional transit service provider for Austin, Texas. After a failed referendum for urban rail the transit agency completed a ten-year service plan called *Connections 2025* in February of 2017. This planning effort was viewed as a "high level" vision plan, as at that time Capital Metro was not in a position to significantly change service. However, the *Connections 2025* process identified enough issues within the Capital Metro bus system that suggested a more holistic planning process was necessary. This project, branded *Cap Remap*, was approved in November of 2017 and implemented in June of 2018.

Service Modification vs. "Blank Slate" Bus Network Redesign

Cap Remap was not a "blank slate" bus network redesign; rather, it was more targeted at removing duplicative services and increasing frequency on key corridors. Capital Metro prepares a ten-year service plan approximately every five years; Austin is a growing city, so the service needs to be as dynamic as the

city in terms of population and infrastructure. Typically, these plans are implemented either in their entirety or a significant part.

The bus network redesign *Cap Remap* was not started as a "redesign," but rather as part of the ten-year planning process, *Connections 2025.* That process highlighted the need for a more holistic redesign of the system, though the goal of *Cap Remap* was not a "100 percent redesign." Previous plans developed by Capital Metro had called for a frequent network, and four routes had been implemented before this planning process started; those four routes had seen a 30 percent growth in ridership while systemwide ridership declined by 6 percent per year. In order to build on the success of the existing high frequency routes yet adhere to financial constraints, a larger frequent network developed during *Cap Remap* could only be provided by removing duplicative and unproductive services.

The project utilized specific metrics to describe costs and benefits of the bus network redesign, primarily productivity and subsidy per passenger. The plan tried to achieve a productivity guideline of 15 passengers per hour at the corridor segment, not route, level. The subsidy per passenger guideline was $4.00 per boarding; through the analysis it was determined that unproductive segments had a very high subsidy per passenger, and these areas became candidates for the Mobility Innovation Zones for on-demand transit service.

Stakeholder and Public Engagement

The stakeholder involvement and public engagement process was robust throughout the *Cap Remap* process. The stakeholders involved throughout the *Connections 2025* process were retained when the *Connections 2025* study became the *Cap Remap* bus network redesign. Stakeholders included representatives of the city, state, University of Texas, school districts, health care providers, disability community stakeholders, neighborhood groups, transit advocates, and refugee community representatives. The stakeholders also included some student groups from the University of Texas, as Capital Metro provides University shuttle service and many frequent routes serve the University. The *Connections 2025* / *Cap Remap* planners also consulted with bus operators, went to safety meetings, and conducted driver briefings. Throughout the planning process, very few groups gave negative feedback to the Capital Metro Board – most were happy. Several representatives of the stakeholder groups were in favor and spoke positively about the plan.

In addition to stakeholders, there was also significant public outreach that led to changes to some aspects of the plan prior to its approval in November 2017. Capital Metro staff indicated that convincing the general public that *Cap Remap* was "a real thing, not just a conceptual study," was difficult. For example, people started speaking out only once changes were being implemented. Capital Metro staff noted that many of the challenges to the changes had more to do with the vast *scope* of the changes *Cap Remap* was proposing, not the proposed changes themselves, although members of the public also raised concerns with specific changes throughout the planning process as well.

Public Education

Public engagement efforts were undertaken to educate riders and the community about the upcoming bus network redesign immediately prior to implementation. Outreach in June 2017 was mostly of a "travel training" type; this process helped "shine light" on the final items that would need more attention. One month prior to implementation, Capital Metro had the new GTFS feed ready, and that helped immensely in communicating the new options and trip patterns. Every bus stop also received a temporary sign explaining what would happen at that stop. Capital Metro hired temporary employees as "brand ambassadors" to go

out and spread the word on the changes; many of these temporary employees were also regular users of the system.

Capital Metro kept outreach going for two weeks after the implementation. The customer service center was overstaffed (i.e., they typically had 20 operators, but always had 22 on hand during this period) and also worked overtime to be sure they had enough people answering the phones for a about a month.

Implementation

The *Cap Remap* implementation process was managed by Bus Operations with help from Capital Projects, who had experience in managing a large and complex implementation. In retrospect, Capital Metro staff feel that this was not enough time to implement the system modifications and that a full year would have been more appropriate. Normally, Capital Metro allows approximately three months between the approval of changes and their "mark-up" (the Capital Metro term for the bid selection process where drivers select their work assignments). Even with the additional four months provided the planners felt it was insufficient for implementing changes of this magnitude.

New Mobility

The *Cap Remap* planning effort also developed "Mobility Innovation Zones" to provide on-demand service. The intent was to "match the right type of service to the right market" and provide an alternative for areas that would lose access to transit. The "pickup" service began as a year-long pilot project using a microtransit provider, but after receiving complaints from areas that had lost fixed route service, Capital Metro also partnered with the local non-profit TNC *Ride Austin* to connect people to frequent routes. That service was later modified to be directly operated by Capital Metro to make it easier to provide accessible services. As of April 2020, ridership on the microtransit in the "Mobility Innovation Zones" is low; with fewer than 20 boardings per week, it is not recapturing lost fixed route ridership.

Houston METRO

Overview

Houston METRO initiated a Transit System Reimagining Project and System Reimagining 5 Year Service Plan in 2013, following on the community's request for improvements during the 2011 Long Range planning process. Some of the key changes made as part of the bus network redesign included reducing service duplication, straightening out routes, and increasing weekend service—Saturday by 30 percent and doubling Sunday service. After the first year of implementation ridership had increased by 7 percent, with most ridership gains seen on Saturdays and Sundays.

The process was managed by a core project management team as well as a working group that included senior leadership whose areas of responsibility were directly involved in implementation. These actively involved groups were critical in ensuring a smooth implementation, and in August 2015, Houston METRO implemented its aptly-branded New Bus Network. Implementation was preceded by a lengthy engagement and approval process that spanned nearly two-years. Much can be learned from Houston METRO's bus network redesign effort, especially regarding the redesign team's ability to articulate the need for change, devotion to public outreach, and well-structured implementation process.

Impetus

The impetus for Houston METRO's bus network redesign can be summarized by the five points the transit agency used to make its case for change:

- Ridership had declined on the local bus system
- The transit system had not evolved with the growing Houston region
- New light rail lines created a need to better integrate the bus and rail networks
- A strong foundation for future growth was needed
- The community asked for improvements to the local bus system

The concise language of these points provided a call to action that would be echoed by board members and elected officials for the duration of the project. A strong board champion and a supportive mayor were key to the successful implementation of the new bus network.

The details regarding declining bus ridership amidst a growing region are worth noting. Despite the rapid growth experienced by the region in the early 2000s, fewer people were utilizing Houston METRO's transit service. The situation was exacerbated following the Great Recession of the late 2000s when system ridership failed to return to pre-recession levels. Despite declining ridership, Houston METRO was committed to improving public transportation in the region. In 2004 after system ridership had already begun to decline, Houston METRO opened a new light rail line, the red line. The 2013 red line expansion and the debut of two new lines (Purple and Green) in 2015 further confirmed the region's commitment to investing in public transportation.

Public Outreach

Two lessons learned regarding public outreach emerged from Houston METRO's bus network redesign efforts: 1) the importance of *engaging diverse stakeholders at many levels*, and 2) the need to *educate as well as listen*. In order to develop a transit network that would better serve the region, Houston METRO was dedicated to conducting a robust engagement and outreach effort. This is evidenced by the fact that the project timeline was extended by an additional year to allow time for more thorough engagement and feedback to be incorporated.

Houston METRO's bus network redesign team understood that successful implementation would be contingent on support from stakeholders, boards, and the public. Their outreach method involved engaging diverse stakeholders at many levels and tailoring their approach to each group. At each project stage, the team determined how they should inform, involve, or consult each group. For instance, at a particular project stage elected officials needed to be *informed*, but members of the public needed to be *involved* and providing input. Part of Houston METRO's engagement effort included establishing and *consulting* with a 120-member stakeholder task force through a series of meetings and workshops. The task force included a diverse cross-section of representatives from government agencies, social service providers, schools and colleges, developers, bus riders, Houston METRO bus drivers, community advocates, and others with an interest in transit.

Through the outreach process, the team took steps to *educate as well as listen* to stakeholders, boards, and the public. During the goal-setting phase of the project, the team invited its stakeholder task force to an all-day workshop where they participated in an exercise designed to provide them with an understanding of the challenges involved in making trade-offs when planning transit service with fixed resources. Input from stakeholders regarding how resources should be allocated gave the team grounds to recommend service changes and face political pushback from re-allocated services.

Part of the general public's involvement in the bus network redesign included public surveys. An initial survey asked the general public to answer questions regarding project goals and their preferences on trade-offs that must be made when redesigning the network with a fixed budget and multiple goals. The survey asked respondents to weigh which aspects of service were most significant. For example, was it more important that the network provide improved peak service or all-day service? The public's response towards these issues helped the redesign team determine how to structure service and devote resources.

Implementation

The core project management team and working group worked together to develop and revise a Master Schedule for implementation that both guided the staff and provided the board with confidence in the process. Another key element of project management for implementation was the establishment of a working group that included senior leadership from finance and administration; government and public affairs; press office; operations, public safety, and customer ridership services; planning, engineering, and construction. Houston METRO's implementation phase spanned from February to August 2015 and involved five key elements: Board Approval, Field and Facilities Activities, Developing and Delivering the Message, Finalizing the Details and Managing Change, and Unveiling.

Board approval was made possible thanks to a well-structured project management team that included project leaders, project managers, and a single executive leader who championed the project. Within this structure, duties were divided with select members working on field coordination and others focused on project messaging.

The Master Schedule proved especially useful in coordinating **field and facilities** efforts across departments and ensuring that critical path items were accomplished. Critical path items included hiring and training activities as well as testing and verifying routes. The latter required input from many departments, including planning, public safety, operations, and Houston METRO police.

Houston METRO devoted a considerable amount of effort to **developing and delivering messaging**. The team went so far as to develop individualized material for each public official (city council members, United States representatives and senators) that included information regarding their specific geography. The materials gave officials an understanding of how the bus network redesign would impact their constituents thus preparing them to respond to potential complaints. The team also utilized educational meetings, emails, newsletters and luncheons to educate public-facing groups about the redesign. These groups included local housing authorities, chambers of commerce, civic and community groups.

Following the public hearing and board approval, the team devoted its effort to **finalizing details and managing change.** The Master Schedule played an essential role in coordinating activities that required effort from multiple departments. Time spent assembling and refining the Master Schedule was attributed to the team's ability to navigate change during implementation.

The operations team assisted riders during the system **unveiling**. Significant resources were devoted to help ease the transition for operators and orient riders with the new system. During the transition, implementation staff was stationed at transit centers to field concerns from customers and operators alike. Alternate service vehicles provided hourly service along discontinued route segments and yellow cabs were made available to transport lost or stranded passengers. A command field center staffed with members of the service planning team was set up to coordinate the unveiling effort.

Following final implementation, the core project management team was able to identify strengths and lessons learned concerning each of these areas. While there were certainly bumps in the road, Houston

METRO's very deliberate and comprehensive approach to implementation resulted in a smooth transition that has resulted in increased public support of public transit and in fact led to a successful voter referendum in November 2019 for a significant increase in transit funding that will help support many future efforts.

IndyGo

Overview

The IndyGo is the transit agency that provides service in the city of Indianapolis and Marion County. After passing an income tax to support the Marion County Transit Plan in 2016, the transit agency has dedicated several years to creating implementation-ready plans for BRT and a supporting bus network redesign. The first BRT line, the Red Line, opened in September 2019, and further BRT lines are planned.

Originally, the entire bus network redesign was supposed to be implemented in 2019, but IndyGo ultimately decided to hold on major local route changes and instead began slowing adding more service to routes in need of frequency increase. When the Red Line opened for service, IndyGo also began operating every local route every day of the week (Figure 16). Due to a driver shortage, IndyGo decided to hold on the rest of the bus network redesign changes--those that were not directly impacted by the Red Line—until June 2020; these changes have been postponed as of April 2020 due to the COVID-19 pandemic.

Source: IndyGo

Figure 16. Red Line Service, Opening Day

Long Term Planning

The Bus Network Redesign initiatives that IndyGo is rolling out are part of a long, sustained planning process going back over a decade, which shows how persistent, diverse groups working together can develop a vision for change. As far back as 2009, a group of government and business leaders formed as the Central Indiana Transit Task Force (CITTF) and identified improving transit as a key goal to make the region economically competitive. This, along with IndyGo's self-assessment that the transit agency had an aging fleet and declining ridership, spurred a decade of thinking big about transit improvements (Indy Connect 2016).

Indy Connect, formed in 2010is an intergovernmental planning initiative to develop forward-looking transit planning for the entire central Indiana region. This year also saw the first of several planning efforts building on CITTF planning efforts, including bringing in public engagement. During this time, Indy Connect started developing plans for several BRT corridors which would shape future bus network redesign plans (Indy Connect 2016).

By 2014, there was a broader political consensus to complete a more forward-thinking process and conducted the *IndyGo Forward* Comprehensive Operations Analysis and alternatives analysis, (IndyGo 2015) which sought to move beyond looking at individual routes and instead prompt the community to think about transit more holistically (Indy Connect 2016).

In parallel with these planning efforts, proponents were investigating how to finance transit improvements. The business leaders involved in CITTF spearheaded the development of state enabling legislation. This included conversations with high ranking state officials such as the State Senate Finance Committee Chair and looking at every possibility to raise funding. While a sales tax was investigated, an income tax increase ended up being the avenue state and local officials got behind. In 2014, the State passed legislation allowing county-wide non-binding referenda to fund transit (Indy Connect 2016).

In 2016, in support of these referenda, IndyGo, the Indianapolis Metropolitan Planning Organization (MPO), and the Central Indiana Regional Transportation Authority (CIRTA), partnering with officials from area counties, developed the Central Indiana Transit Plan. This effort, which benefited from the previous seven years of thinking about transit, laid out an ambitious set of initiatives to improve local transit, including fully electric rapid transit proposals and improving local transit in Marion and Hamilton Counties (Indy Connect 2016).

Later in 2016, over 59 percent of Marion County voters approved a non-binding proposal for an income tax increase of not more than 0.25 percent. This approval rate proved key in encouraging City-County Councilmembers to approve the income tax increase in 2017, leading to the implementation-oriented planning of the bus network redesign and introduction of BRT (Indy Connect n.d.).

Public Engagement

IndyGo and its Indy Connect partners pride themselves on the extensive public engagement involved in developing the Central Indiana Transit Plan in the run up to the 2016 transit referendum. Between IndyGo, the MPO, and other agencies, there were over 75 public meetings hosting over 2,500 individuals; over 250 stakeholder group presentations; 150,000 engagements with local residents through festivals and fairs; and over 110,000 webpage visits and 300,000 webpage views (Indy Connect 2016). IndyGo staff reported that while they still had people who were against the referendum and/or the bus network redesign, as well as people who did not get engaged until construction work started, public sentiment overall viewed the outreach as robust.

IndyGo staff were particularly pleased to see that their messaging was effective; people from the community frequently mentioned that spending was lower than peer systems, which was an IndyGo talking point. This broad-based community support was critical in bridging the gap between two mayoral administrations in demonstrating the importance of transit investment.

Trade-offs

There are many trade-offs that a transit agency and community weigh when considering their transit and transportation system. Three that were highlighted by IndyGo were how to pay for transit, weighing the needs of high- and low-density areas, and transfers vs. frequency.

As described above, IndyGo and the Indy Connect initiative, along with a diverse set of local stakeholders, needed to find a way to finance their ambitious transportation goals. The Central Indiana Transit Plan was a key exercise in developing the case for a tax increase to pay for improved transit. It included sections on funding, such as "*I doubt I'll ever use transit – why should I help pay for it?*" which lays out reasons such as the fact that people who do not use transit still interact and depend on people who do, and that there was forecasted to be an economic payback from every dollar spent on transit. These sections, and attending conversations in public meetings and in the halls of governance, were key in weighing the trade-offs of investing in transit (Indy Connect 2016).

Transit planning in Central Indiana also weighed the needs of high- and low-density areas. IndyGo generally adhered to the strategy of maintaining service—anything new would go into ridership-oriented service, but existing coverage-oriented service would generally stay in place if it was serving an important need. The transit agency looked at this through the lens of "what can we achieve without causing a whole lot of pain." IndyGo acknowledged that not every transit agency may have this option, but that in Indianapolis the planning was conducted with the anticipation of increased funding; this limited the degree to which difficult trade-offs were necessary.

Nevertheless, the bus network redesign is centered on the provision of BRT. There are some trips that will no longer be "one-seat rides," but the most-used corridors will be more frequent. Some passengers will have to transfer, and some may have a longer walk to their stop, but the frequency on those routes will increase and therefore negate some of the downsides of having to transfer.

Coordination with Capital Elements (BRT)

IndyGo's BRT investments have involved significant capital investments, including the design and construction of large, comfortable stations; level-boarding platforms; physically separated dedicated bus lanes; and the purchasing of some ROW, while other aspects of IndyGo's bus network redesign did not involve any additional purchasing of ROW.

As part of the bus network redesign, IndyGo also has budget for several "mobility hubs," areas that would bring together several transportation modes and/or service providers, such as bikeshare, rideshare, dockless scooters, and on-demand transit services,, though the transit agency is still considering how to best develop these.

Role of External Partner Support

External partners are key to developing and winning support for BRT and bus network redesigns. In Indianapolis, many local interest groups—including the AARP, faith-based community groups, transit

advocates, public health advocates, and development and real estate groups—were involved and supportive, successfully working with the City-County Council to place the transit referendum on the ballot.

IndyGo, an otherwise independent municipal corporation, has to work closely with city government, which can sometimes lead to blurred lines between various roles and responsibilities. Many people outside city government do not realize that IndyGo is separate from, but also reliant upon, city government. The Mayor of the City of Indianapolis-Marion County and City-County Council appoint members of the IndyGo Board of Directors, and the IndyGo Board of Directors hires the CEO/President of the transit agency. The sometimes-unclear roles between the transit agency and the City-County led to many conversations and negotiations to set the bus network redesign and BRT up for success.

While the COVID-19 pandemic has delayed some of IndyGo's bus network redesign work, the years of planning and goodwill developed through their comprehensive public and stakeholder engagement, extensive planning, and internal buy-in leave the transit agency confident in rolling out an improved transit system.

LA Metro

Overview

The LA Metro is the regional transit service provider for Los Angeles County. In recent years, the transit agency has explored a number of ways to improve transit service for riders. In 2018 the transit agency's Board adopted its strategic plan, Metro Vision 2028, of which the first goal is to provide high quality mobility options that enable people to spend less time travelling. To meet this goal, the transit agency is undergoing a bus network redesign titled NextGen.

Within LA Metro, NextGen is being led by the Service Development and Scheduling department. LA Metro's Transit Service Policy, which is updated annually, establishes criteria and guidelines for evaluating, designing, and implementing service changes (LA Metro 2020b). The NextGen planning effort began in winter 2018; the service plan was intended to go through public hearings in June 2020 with the first phase implemented in December 2020, but that schedule was put on hold as a result of the COVID-19 outbreak. As of spring 2020, the revised schedule has the plan going through a virtual public hearing in August 2020.

NextGen is being planned alongside two pilots: a first-mile/last-mile partnership with a microtransit company to link riders to transit stations, and a microtransit pilot to provide point to point service in underserved communities. About one third of the transit service in Los Angeles County is provided by municipal operators and Metrolink, the regional commuter rail service, so any service changes require the transit agency coordinating not only within its own departments but also with neighboring jurisdictions.

Coordination with Microtransit

As of April 2020, LA Metro had two pilots underway for on-demand services, both of which have potential implications for service planning. Funded through the FTA MOD Sandbox Program, the first pilot was a partnership with a TNC to provide shared first-mile/last-mile service to select transit stations near disadvantaged communities. The private company provided turnkey solutions, including drivers, vehicles, a mobile app, and consulting services for this pilot. Service operation began in January 2019 and was extended for a second year in January 2020 (Grossman and Lewis 2019).

In 2017, the LA Metro announced plans for a different microtransit service pilot. This pilot would make use of a mixed vehicle fleet to provide shared, on-demand point-to-point service up to 20 minutes in length in underserved communities and areas of Los Angeles County with less frequent or no fixed route transit. This microtransit pilot was intended to be a companion rather than a duplication of its existing fixed route services. The pilot would allow the transit agency to test the feasibility of microtransit to complement fixed route services in different parts of the County before deploying microtransit more widely throughout the system.

In April 2018, the LA Metro awarded contracts to several microtransit operators to plan and design the transit agency's microtransit pilot, with a focus on mobile technology, user experience/user interface design, and using big data and analytics to make decisions (Narula-Woods 2018). One company was awarded the ultimate operations contract, which totaled $29 million, to partner with LA Metro to operate the service. In addition, the LA Metro Board approved of $8 million for additional operating expenses associated with the pilot, including the addition of 80 new LA Metro employees to operate the vehicles (LA Metro 2020a). These operators will receive special safety training, such as incident prevention (LA Metro 2019b).

As of spring 2020, the transit agency completed planning for the microtransit pilot. While they began with a list of 30 potential zones, the list was narrowed down to six zones in the Los Angeles County region where fixed route transit is not the most effective option for many riders but there is still a mobility need. The six zones chosen to represent a range of destinations, such as major employment centers, educational institutions, medical centers, and the airport. Some of the zones also represent areas where existing LA Metro service is in high demand. (LA Metro 2019b). Three of the zones were selected as candidates for replacing fixed route services entirely, though fixed route services will likely remain in place during implementation of the pilot. If the pilot is deemed successful, the transit agency will then consider phasing out those less-used fixed route services; depending on timing these decisions may be incorporated into the NextGen system redesign planning. The pilot is expected to launch in fall 2020 but may be delayed due to the COVID-19 outbreak.

Inter- and Intra-Agency Coordination

In addition to partnering with the private sector to pilot new services, LA Metro has coordinated with other regional transit operators and within its own departments to support its system redesign. Changes in service for any of the region's public transit providers, including LA Metro and the 17 municipal operators in the region, present opportunities to collaborate in order to provide coordinated services to customers. (LA Metro 2020b). For example, LA Metro does not operate bus service in Culver City or Santa Monica but coordinated closely with the municipal operators in those places to work on things like developing transfer locations and coordinating on service duplication while conducting its NextGen study. Additionally, as of February 2020 the Culver City transit operator had plans underway to test microtransit.

Focus on Equity

Based on the guidance of LA Metro's Equity Platform Framework, the 2020 Transit Service Policy stated that service improvements should be prioritized for equity-focused areas. The Equity Platform Framework builds on the standard Title VI Equity Analysis by going beyond minority-status and income to improve service in communities with the greatest mobility needs, as determined by market research, surveys, and public opinion (Figure 17). According to the NextGen project website, zero car households, the population aged 10-19 and 55+, single mothers, and people with disabilities were considered as communities with the greatest mobility needs (LA Metro 2020c).

These criteria were averaged to create an equity score, with low-income households and zero car households weighted twice as important to achieve consistency with the LA Metro Long Range Transportation Plan's definition of Equity Focused Communities. This equity analysis was used as an important input to the planning conducted as part of NextGen.

Source: LA Metro

Figure 17. NextGen ADA-Focused Workshop

Bus Service Planning: Travel Flow Analysis

One interesting approach that the NextGen planning team took to support their service plans was the use of travel flow data to identify common travel patterns. The transit agency used purchased location-based cell phone data and Transit Access Pass (TAP) fare card usage information to determine high volume origin-destination pairs for all modes. The planners also compared transit time to drive time for these high-volume pairs and used this information to better plan transit service that aimed for no more than 2.5 times longer via transit in order to maximize transit mode share.

Bus Network Redesign Priorities and Capital Elements

A three-phased approach to achieving what LA Metro refers to as a "World Class Bus System" was presented to the transit agency's board:

a. **Reconnect**: improve bus levels of service—within the current operating budget—by redesigning routes and schedules to attract trips where there is the greatest market potential;
b. **Transit First**: invest in a large capital program to support the service plan developed in the "Reconnect" phase; and

c. **Future Funding**: once existing levels of service are performing better through a redesigned network and investments in priority, determine the amount and locations of additional service to meet demand.

As stated in the transit agency's 2020 Transit Service Policy, additional services could potentially be funded by future congestion pricing, for which a feasibility study is underway as of spring 2020 (LA Metro 2020b).

Transit First is directly related to capital improvements in support of the bus network redesign. LA Metro could spend up to $1 billion over the entire course of implementation by making the following improvements:

- **Invest in speed and reliability infrastructure**, including strategies such as optimizing stop spacing, all door boarding, and headway-based service management. Other strategies, including some of the more impactful ones—such as implementing transit priority treatments, bus bulb outs, and bus-only lanes—must be achieved through collaboration with other jurisdictions.
- **Create safe and comfortable waiting environments for passengers** by investing to implement the recommendations from the 2018 Transfer Design Guideline, including making the information available to riders more clear and easy to find, making it easier and safer for riders to move around at and near transfer stations, and improving safety, comfort, and convenience at rider waiting areas (LA Metro 2018).
- **Improve the boarding and riding experience** through strategies like level boarding at key stops and improved on-board information.
- **Establish facilities to improve layovers** by investing in off-street layover terminals. This is expected to save the transit agency several million dollars each year, which is currently spent extending routes to layover locations due to limited curb space.

As of spring 2020, LA Metro has identified the specific capital needs and corridors slated for improvement, but the fieldwork needed to create the speed and reliability programs for each corridor had not yet been completed.

CHAPTER 8

Toolkits

Toolkit #1: Bus Network Redesign

This toolkit is focused on, at a high level, the key topic areas that transit agencies seeking to conduct a bus network redesign should consider. A phasing timeline has been developed to help transit agencies understand how key topic areas fit into each phase of the planning and implementation process.

Overview

When to Consider a Bus Network Redesign

Transit agencies are motivated to conduct bus network redesigns for a broad spectrum of issues, ranging from specific operational and route alignment difficulties to larger-scale problems involving the transit system's relationship to the built environment. The impetus cited for conducting a redesign generally fell into one of four categories:

1. Systemwide bus service analysis and planning have long been put on the back burner.
2. The transit system has changed, such as with the introduction or expansion of fixed-guideway transit.
3. Ridership has decreased and operating costs are high.
4. The economy or demographic makeup has been changing.

Checklist: Whether to Conduct a Bus Network Redesign

When determining whether to conduct a bus network redesign, transit agencies should consider the following questions, answering yes to at least one in any category as a reason to potentially conduct a redesign.

Systemwide bus service analysis and planning have long been put on the back burner.	☐ Do you view "bus network redesign" efforts as a form of "system maintenance" that should be undertaken regularly? ☐ Has it been many years since you have looked holistically at your system? ☐ Has it been more than five years since you have completed a "Comprehensive Operational Analysis" or "Transit Development Plan"?
Changes to the transit system, such as introduction of or expansion of fixed-guideway transit.	☐ Have fixed-guideway services recently been expanded? Is there a desire to better align the transit network with this new infrastructure addition?
Decreasing ridership and high operating costs.	☐ Do you hope to reallocate resources to those services that would provide the best value for the money? For example, you may be suffering from financial, labor, or facility constraints.
Changing economy or demographic makeup.	☐ Have your activity and employment centers changed significantly? This might include new activity and employment centers, changing residential areas, or the decline of older generators. ☐ Have changing demographics impacted paratransit demand?

Key Components of a Bus Network Redesign

The following bus network redesign components will be covered as sections of this toolkit:

1. **Developing goals and objectives.**
   Goals and objectives guide the planning process and influence the final result of a bus network redesign. The role internal and external stakeholders play in determining goals, as well as considerations that should be made in order to balance potentially contradictory goals, should also be noted.

2. **Identifying performance metrics and their relation to goals.**
   When attached to specific goals, performance metrics can be used to evaluate a transit agency's progress. To this end, metrics can also be used to help a transit agency understand existing conditions and establish bus network redesign goals.

3. **Framing trade-offs, plan parameters, and service types.**
   To determine where a particular service should exist, trade-offs need to be understood to frame the parameters of the bus network redesign in terms of changes to operating costs, focusing service on frequency versus coverage, and the overall planned route structure. Special considerations also need to be made for additional factors that impact service, including budget constraints, neighboring transit

agencies, and coordination between multiple operators. Finally, service types being considered in the plan need to be identified and defined.

4. **Involving Boards and elected officials.**
   It is important to engage the transit agency board and elected officials in the bus network redesign process. These leaders can be advocates for a redesign; strategically involving them in the service planning process can contribute to a smoother redesign.

5. **Coordinating and managing within the transit agency.**
   Best practices should be used to ensure internal coordination and project management of a bus network redesign. This is particularly important for larger transit agencies with numerous internal departments involved in a redesign process.

6. **Planning transit service.**
   At the heart of a bus network redesign, the service planning process is paramount to a redesign's success. The redesign team must consider many factors such as equity; trade-offs in how service is allocated; non-financial limitations (such as facility capacity); bus service integration with fixed-guideway transit; urban morphology of the areas being served; travel patterns of current riders and travelers in general; performance of the current transit system; population and employment densities; "walkability" and pedestrian infrastructure; and the transit-supportive nature (or lack thereof) of their overall urban form and built environment. Based on all of these considerations, the redesign team can plan the appropriate types of service for different areas and needs, including both fixed route and new mobility.

7. **Determining fare policies and fare interoperability between modes.**
   Bus network redesigns need to incorporate limitations imposed by a system's current fare structure, policies, and fare collection system. In addition, when re-thinking fares, transit agencies need to consider how new mobility options and transfers will be accommodated.

8. **Conducting public and stakeholder engagement.**
   Public engagement is an integral part of the bus network redesign process. Feedback is needed from a range of stakeholders and demographic groups. When and how engagement activities are conducted impact the feedback the transit agency receives and the level of support from the community.

9. **Addressing the capital elements of a bus network redesign.**
   Capital elements required as part of a bus network redesign will warrant special considerations during the planning process. Such elements include buses for service expansion; new bus types (e.g., size, new propulsion systems); bus priority treatments (e.g., bus lanes, TSP, and queue jumps); bus stop facilities; transfer facilities; and bus maintenance/storage facilities (if needed to accommodate a larger or different fleet or different vehicles and propulsion types).

10. **Planning for Implementation.**
    Staging and implementing of new and modified services requires determining a timeframe for new services and service types (e.g., all at once vs. phased) and coordinating operational details (e.g., scheduling; bus stop signage; marketing; education; maps; GTFS creation; as well as public education). In addition, project elements that are dependent on prior alternations (i.e., critical path elements) need to be identified and given special considerations.

Subsequent sections of this toolkit include briefs covering these key components of planning for a bus network redesign. The purpose of these sections is not to provide a comprehensive review of all materials

on each component, but rather to summarize the topic and explain its role in redesign; the stage(s) of the redesign at which the considerations are best addressed; key questions for the transit agency to consider during that component; and references to places in the report or other resources where more detailed information the topic can be found.

Bus Network Redesign Phases and Timeline

Each of the ten components of bus network redesigns that will be covered in this toolkit fit within the seven phases of planning and implementation listed below. Figure 18 illustrates where each of the component areas fit into each phase of the planning process. The phases are:

A. Initiate Study
B. Market and Service Assessment
C. Preliminary Engagement
D. Regional Service Concepts
E. Iterative Engagement & Service Planning
F. Implementation
G. Evaluation

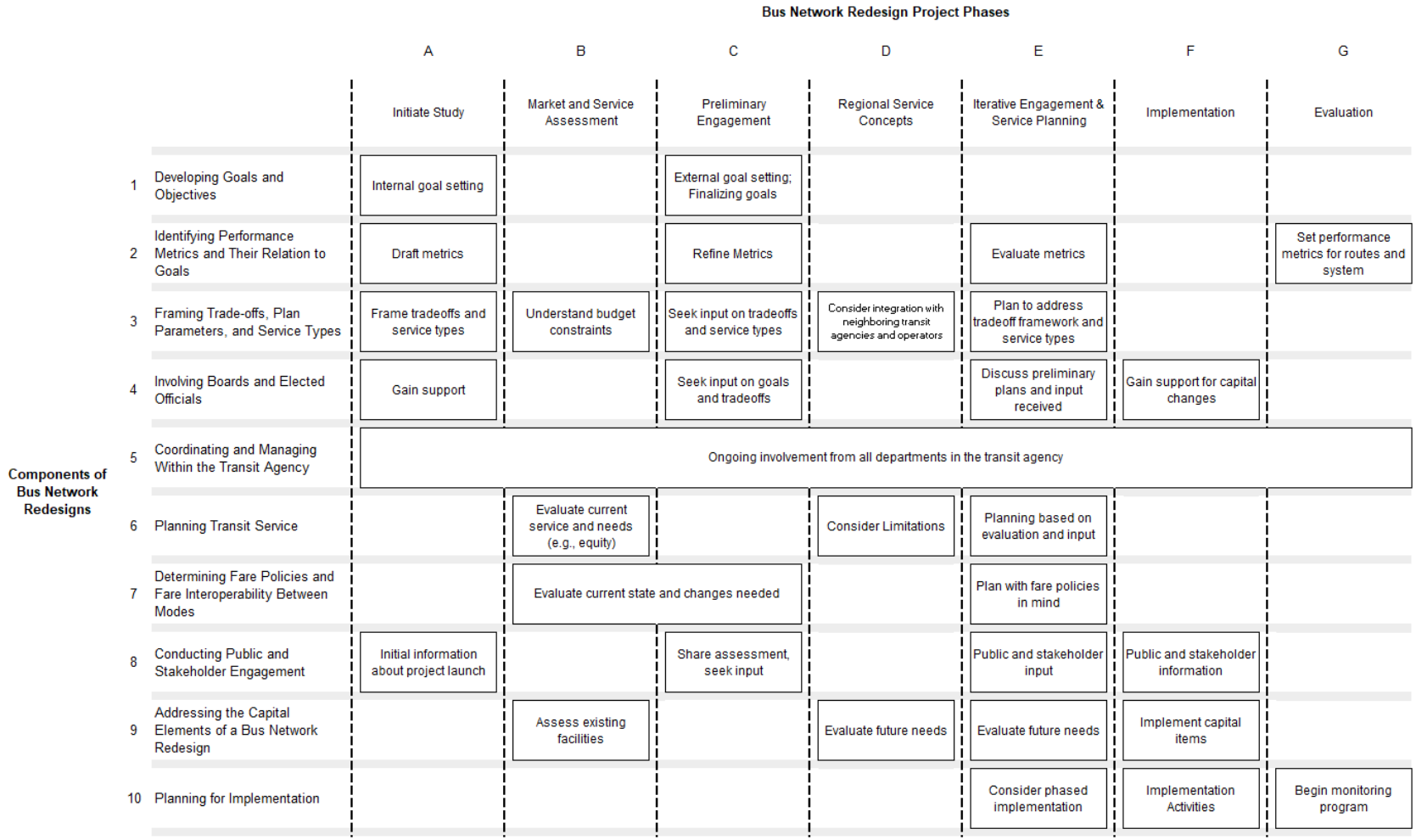


Figure 18. Bus Network Redesign Project Phasing Timeline

Developing Goals and Objectives

Goals and objectives are a critical aspect of bus network redesigns; they influence both the planning process and the outcome of the redesigned bus network. While goals are generally high level, more specific—and measurable--objectives can be associated with particular goals, as shown in the example in Figure 19.

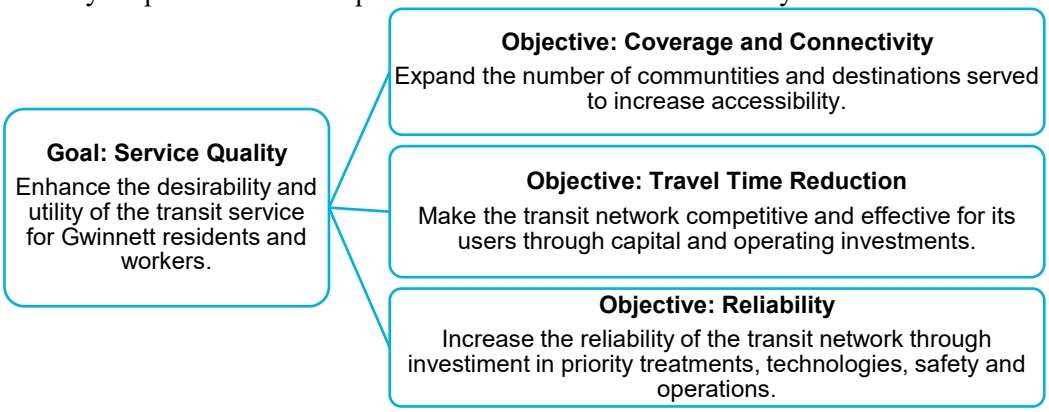
Transit agencies sometimes develop their goals and objectives in-house (sometimes with Board involvement and sometimes without), and sometimes seek input from other local policymakers, stakeholders, and the public.

While the interests of external groups are expected to vary, the potential for divergent interests among internal departments should not be overlooked. For example, a transit agency's civil rights office may prioritize system coverage to adequately serve low-income and minority communities, the planning office may want to maximize ridership and overall accessibility, and the bus operations department may be most interested in ensuring that routes are spread across parallel roadways to avoid too many buses competing for roadway and curb space. When intra-departmental goals conflict during the goal-setting process, trade-offs should be acknowledged and discussed internally so that the transit agency develops shared, clearly defined goals to help navigate the bus network redesign process.

Transit agencies often seek to achieve one or more overarching goals through a bus network redesign. Examples of such goals include but are not limited to:

- Improving transit service for current and potential riders
- Better matching the bus network with current and potential future ridership demand
- Increasing operational efficiency and effectiveness and/or reduce overall operating cost

Reducing dependency on personal cars and promote environmental sustainability



Source: Based on the Connect Gwinnett Transit Plan

Figure 19. Connect Gwinnett Goals and Priorities

Checklist: Goals and Objectives

When establishing goals and objectives for the bus network redesign, the redesign team should consider the following:

Internal Goal Setting	☐ Have all department representatives been brought to the table to establish goals? ☐ Do goals vary across the organization?
External Goal Setting	☐ How will local policymakers play a role in determining the goals and objectives of a bus network redesign? ☐ How will stakeholders play a role in determining the goals and objectives of a bus network redesign? ☐ How will the public play a role in determining the goals and objectives of a bus network redesign?
Finalizing Goals	☐ Have all the goals been clearly defined? ☐ Are any of the citied goals contradictory to each other?

Further Reading

Places in the report or other resources where detailed information the topic can be found.

- **Chapter 3: Components of Bus Network Redesign Planning, Goals and Objectives**
- Byala L., Filardo, K. Hirsch, O., Walk, M., Cardenas, J., and J. Hwang. 2019. National Academies of Sciences, Engineering, and Medicine. Transit Cooperative Research Program (TCRP) Synthesis 140: Comprehensive Bus Network Redesigns. The National Academies Press: Washington, DC.

Identifying Performance Metrics and their Relation to Goals

Various performance metrics are used by transit agencies to compare the planned system to the current system. These metrics are distinct from the metrics used by transit agencies to evaluate bus service on an ongoing basis.

Performance metrics used to evaluate the planned and current systems include but are not limited to:

- **Number of planned revenue hours and miles** and ratio of revenue to non-revenue miles.
- **Number of routes** in the current and proposed networks that provide high frequency service, as defined by the transit agency.
- **Number of people, jobs and current riders** with access to transit and high frequency transit, as defined by the transit agency, potentially defining high frequency based on combined frequencies of multiple routes along the same corridor.

- **Proportion of the population with access to transit** and the proportion of the population with access to frequent service, as defined by the transit agency. This if often measured by people living within one quarter mile of a transit stop.
- **Coverage provided** to particular demographic groups, such as transit access for low-income and zero-car households.
- **Modeled changes** to ridership changes, travel time changes, and transfer rates.

When bus network redesign performance metrics are paired with redesign goals, they explain how the new system will be able to achieve redesign goals. Table 4 in Chapter 3 provides an example of goals and associated performance metrics from Baltimore's redesign.

Checklist: Metrics

To establish metrics, the transit agency needs to have a means of collecting relevant data. The checklist below includes considerations intended to make the process easy to conduct.

☐ Which objectives does each of the metrics measure?

☐ Does the transit agency have good data to support each of the suggested metrics?

☐ Does the transit agency have the capability to easily measure the metrics over potentially several service scenarios or iterations, such as through automated calculators/scripts and/or GIS-based tools?

☐ Are there duplicative metrics that seem different but are essentially measuring the same thing?

Further Reading

Places in the report or other resources where detailed information the topic can be found.

- **Chapter 3: Components of Bus Network Redesign Planning, Metrics**
- National Association of City Transportation Officials. 2017. *City Data Sharing Principles: Integrating New Technology into City Streets*. National Association of City Transportation Officials, New York, NY.
- Kittelson & Associates, Inc., Inc. LKC Consulting Services, Inc. Morpace International, and Queensland University of Technology. 2003. *A Guidebook for Developing a Transit Performance-Measurement System*. Transportation Research Board of the National Academies, Washington, D.C.

Framing Trade-Offs, Plan Parameters, and Service Types

Evaluating the balance of different types of service is inherent in any bus network redesign effort. This process requires considering redesign goals, weighing trade-offs, and determining the parameters of the plan. Trade-offs faced by transit agencies conducting redesigns include, for example, whether to provide coverage over more area vs. concentrating frequency on high-demand routes; whether to provide direct connections between many origin and destination pairs or to require more transfers; and whether to provide more routes and stops or whether to provide faster and frequent service but require longer walks to access it.

The parameters of a bus network redesign include not only decisions about the plan approach based on how the transit agency chooses to weigh different trade-offs but also budget limitations (e.g., cost-neutral planning), the types of service to include (e.g., whether to include DRT, BRT service, etc.), and whether and how to incorporate service being provided by neighboring or overlapping transit agencies.

Understanding Trade-Offs

Determining **how much area the service covers and how frequent the buses are on high-demand routes** is a trade-off of "coverage vs frequency:" should service be provided to maximize the geographic coverage of the service area, or should the focus be on improving service along high ridership routes? With a fixed budget, transit agencies must choose where to invest their resources to maximize achievement of the bus network redesign goals and objectives, which may be in conflict with one another. For example, a transit agency may have an objective of increasing accessibility while also improving service effectiveness, two objectives that, if planned for separately, would yield different results.

Deciding **not to provide direct connections between many origin and destination pairs and instead require transfers** can result in improved frequency on high-ridership routes and the elimination of longer and more circuitous routes. More transfers can also be a natural progression for transit agencies that are multi-modal and are seeking to maximize return on their capital investments in fixed-guideway service, or that are restructuring their bus networks to respond to new fixed guideway services, which, by design, require more transfers (i.e., multi-seat rides). In these cases, some customers are either forced to walk longer distances to reach a transit stop or are required to transfer routes—sometimes between modes—to complete their journey. While this approach can increase overall accessibility by providing service that can get people to more places within a given amount of time, as well as result in more cost-effective service, this approach can be problematic for seniors and people with disabilities who may have difficulty walking or navigating transfers. These user groups may require additional accommodations, such as revised paratransit services or additional bus stops at key-trip generators.

When to provide more service and when to reduce service. is not exclusively a question of ridership demand. The amount of service that can be offered is also limited by the size of the fleet; transit agencies may not be able to add service during peak periods due to limits in funding to purchase expansion buses and expand bus operating and maintenance facilities. Additionally, given a fixed operating budget, transit agencies may decide based on need that service hours should be shifted from the weekday to weekend or to the midday; as job days and hours are no longer traditional "9 to 5," transit agencies are using their bus network redesigns to better match service to the current or projected travel demand by the time of day and day of week.

Budget Constraints

One-third of transit agency respondents to the survey conducted as part of *TCRP Synthesis 140: Bus Network Redesigns* plan their bus network redesign to be operating cost-neutral, with most of the remainder increasing the bus network operating costs (just a couple of transit agencies were seeking to reduce operating costs through their redesign process). The service proposed by the redesign must be reflective of the operating budget the transit agency can provide—even for transit agencies increasing their operating costs there is certainly a limit placed on that increase. If cost-neutrality, or just minor costs increases, is an objective of the redesign, the transit agency needs to be more willing to make drastic changes in order to reallocate existing resources. Since transit agencies rely on operating funding from local and state jurisdictions within their service area to some extent, what those jurisdictions are willing to provide can impact the level of service planned for each of those jurisdictions during a redesign.

Service Types and Design Standards

Another key element of bus network redesigns is often the reexamination or creation of updated service standards for different types of service, such as high-frequency service, local service, circulator, coverage service. Before a transit agency plans the new service, it can reexamine these definitions in terms of the design parameters, including frequency, span, directness, stop spacing, route spacing, and levels of density and ridership for which each service type if applicable. By setting these guidelines up front, the transit agency can better design service to appropriately meet customer needs as well as have a ready explanation for why certain types of services were placed where they were. This gives the transit agency backup for explaining why a certain route is recommended at a given frequency, or why the route cannot deviate into a neighborhood.

In the Washington, D.C. region, in addition to regional bus operator the Washington Metropolitan Area Transit Authority (WMATA), there are eight local bus operators in WMATA's service area. As the transit agency prepared to initiate a bus network redesign, it initially spearheaded a regional bus strategic plan, the Bus Transformation Project, that offers recommendations for coordinated planning between the many transit agencies and operators. These include establishing regional standards, collecting and sharing standardized bus operations and performance data, and obtaining regional commitments for bus priority.

Neighboring and Overlapping Transit Agencies and Operators

When multiple transit agencies and operators serve the same metropolitan area there may be opportunities for integration. Such integration could vary from coordinated schedules at transfer locations to interlining route alignments. Though bus network redesign efforts are often focused on a single transit agency, efforts to include neighboring entities in the redesign can capitalize on regional transit opportunities.

Most transit agencies that have conducted bus network redesigns to-date do not operate in a multi-operator environment. When this is the case, the redesign should take into account neighboring jurisdictions and transit agencies by evaluating transit market needs not only within the transit agency's service area but to and from nearby areas. This information will provide the transit agency with an understanding of needs that the bus network redesign could help address by offering service to locations just outside the service area or to a transfer point that connects to another transit provider's service. For transit agencies that do not overlap with others, but where several transit agencies operate within the same region, considerations for more consistency across transit agencies

can be incorporated into redesign planning, such as integrated fare payment and/or transfer policies that could improve ridership and mobility between parts of the region.

LA Metro is one of only a few transit agencies that have conducted bus network redesigns and operate in an environment with overlapping bus providers. Los Angeles County includes 17 major municipal transit operators, and nearly one-third of bus service is municipally operated. This structure required the redesign team from LA Metro to work closely with municipal operators to coordinate transfer locations and prevent service duplication. Since each entity receives operating assistance, coordinating service also had budgetary implications; if more routes were allocated to a municipal operator, that operator would be allocated more operating assistance. Transit funding is transferred to LA Metro before being allocated to other transit agencies using a "miles and fare unit-driven" formula; one concern raised by municipal transit operators during the redesign process was that increasing LA Metro's bus speeds would result in more money being allocated to LA Metro (the assumption being that increased speeds would translate to an increase in miles driven).

Checklist: Services and Service Area

When considering the services and defining the service area, the bus network redesign team should consider the following:

Understanding Trade-Offs	☐ What areas can support fixed route service and at what levels? ☐ Will changes to service (such as an increase in necessary transfers) impact transit access for seniors and people with disabilities? Should additional accommodations be made? How will these changes impact paratransit coverage and eligibility? ☐ Beyond population density and equity considerations, are there any other reasons the transit agency might opt not to provide fixed route service in certain areas?
Budget Constraints	☐ Is the bus network redesign intended to be a cost-neutral planning effort? ☐ Do municipalities contribute different levels of funding and will this impact the coverage they are afforded?
Neighboring Transit Agencies and Multiple Operators	☐ What services are provided by neighboring transit agencies? ☐ Do any of the neighboring transit agencies serve locations also served by your transit agency's existing service? ☐ Within the transit agency's jurisdiction, which services are being provided by which operator? How should the bus network redesign plan account for planning service from different transit agencies?

Further Reading

Places in the report or other resources where detailed information the topic can be found.

- **Chapter 3: Components of Bus Network Redesign Planning, Trade-offs**
- Kittelson & Associates, Inc., Parsons Brinkerhoff, KFH Group, Inc., Texas A&M Transportation Institute, and Arup. 2013. *TCRP Report 165: Transit Capacity and Quality of Service Manual*. Transportation Research Board of the National Academies, Washington, D.C.

Involving Boards and Elected Officials

Through the bus network redesign process, the redesign team will, to a varying degree, be required to interact with boards and elected officials (Figure 20). When and how the redesign team engages these groups can impact the success of the planning process and implementation. Many transit agencies also benefit from their boards and other elected officials serving as advocates for the redesign.

Boards and Elected Officials

Most transit agencies are presided over by a Board of Directors, State Parent Agency, or similar oversight body; Board Support and involvement in bus network redesigns is considered common practice (Byala, et al. 2019, 129). Survey data suggests that among transit agencies that have completed or are currently undergoing a redesign, boards were most often included in "final approval for route recommendations", "policy guidance for bus network redesign visions" and "final approval for operating budgets" (Byala, et al. 2019, 149).

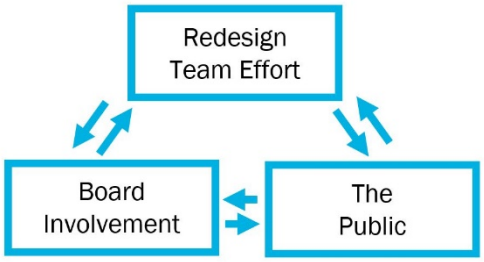


Figure 20. Board Involvement

Boards and elected officials play a key role in bus network redesign visioning and decision-making (Byala, et al. 2019, 79). Managing this relationship can afford the redesign team a smoother planning and implementation process. When working with their board, the redesign team should consider the interests of particular board members; the level of connection between the board and its constituents (i.e., whether the board members can remain impartial or whether they are apt to react to relatively minor constituent complaints); and board turn-over. Understanding these factors can optimize efforts made by the redesign team and contribute to successful outcomes. For board members to be convinced that the redesign will have a positive outcome they need to be "brought along" throughout the process. This requires communication during various phases of the process including study initiation, public and stakeholder engagement, finalizing the plan, and final implementation.

Buy-in from political leaders can also make it easier to gain support from the general public, allowing for a smoother bus network redesign process. One transit agency explained how the mayor and president of council look to their business community for support. Data and visualizations prepared by the redesign team can be useful for political leaders. If officials are educated and armed with supporting information including visualizations, they will have an easier time explaining project benefits to the business community and other key stakeholders.

Houston METRO
One Board member was integrally involved in the planning efforts and led advocacy for the bus network redesign there, providing legitimacy and support to the effort.

Checklist: Boards and Elected Officials

When working with boards and elected officials, the bus network redesign team should consider the following at various stages of the planning process:

Study Initiation	☐ What are the interest and motivations of particular board members? ☐ How objective are the board members? ☐ Will the board experience any personnel turnover during the bus network redesign process? If so, what are the potential consequences? ☐ How will the redesign team collect policy guidance on bus network redesign visioning, including budget parameters?
Preliminary Engagement	☐ How can board members' community connections be leveraged to develop strong community and stakeholder connections?
Iterative Engagement	☐ Can board members assist with public outreach, messaging, or other aspects of public and stakeholder engagement?
Service Planning	☐ How will the bus network redesign team obtain final approval for route recommendations and operating budget?
Implementation	☐ How can the board and elected officials support the education process? ☐ How can the board and elected officials support capital facilities changes, such as associated bus stop optimization and bus priority treatments?

Further Reading

Places in the report or other resources where detailed information the topic can be found.

- **Chapter 4: Support and Collaboration, Boards and Elected Officials**
- Ballam-Schwan, J, K. Hovenkotter, and H. Richardson, 2017. "Untangling Transit: Bus Network Redesign Workshop Proceedings." TransitCenter, New York City.

Coordination and Managing within the Transit Agency

Bus network redesigns by their very nature involve numerous transit agency departments, which requires effective internal coordination and project management. Transit agencies that have successfully planned and implemented redesigns appoint a strong project manager (or multiple managers) to oversee the process and proactively coordinate with other departments. Navigating the redesign process can be helped by internal champions who strongly believe in the positive impact of a redesign and can play a key role in rallying internal support and creating change.

Since service planning is the core of a bus network redesign project, intra-transit agency collaboration needs to revolve around this process, which typically is conducted with significant

consultant support. One transit agency explained that although the redesign was a transit agency-wide initiative, it mostly impacted planning, operations and finance staff. While transit agencies differ in their departmental structure and roles, Figure 21. provides an example of how the redesign planning and implementation might be structured. If transit agency departments are not used to working together, the level of collaboration required for a redesign can be a challenging. Departments may have differing goals for service; for example, while one department may be focused on improving operational efficiency, another may be focused on improving system equity.

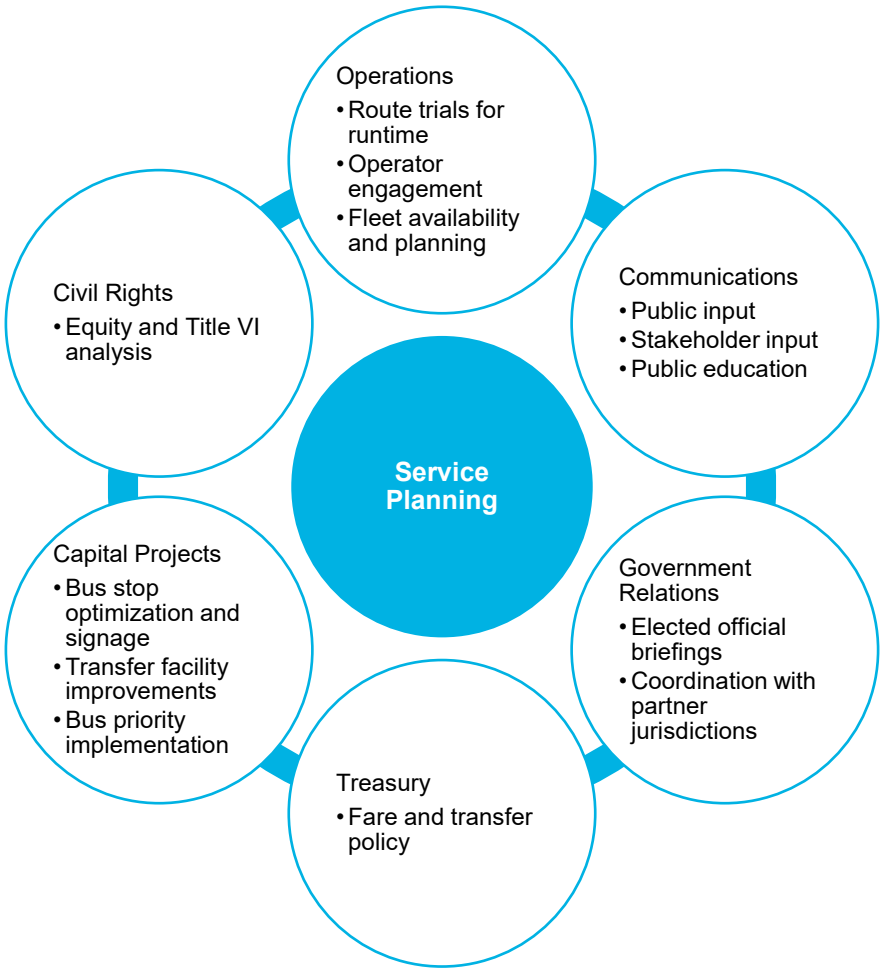


Figure 21. Example Department Functions for Network Redesign Service Planning

Involving Operators and Unions

Bus operators and street supervisors, as well as the organized labor groups that represent them, should be included early in the bus network redesign process. Operators have valuable real-world insight to contribute to planning implementation; depending on how the project is structured there are various ways they can be included in the redesign process. In one instance, the transit agency's operations team that led the redesign process was in contact with supervisors and drivers to coordinate on scheduling. In another transit agency, the consultants leading the redesign met with operators in the divisions (i.e., the bus garages) monthly for nearly a year, following an organized syllabus and seeking input on various facets of the redesign. Additionally, each division nominated

one operator to attend the service planning workshops during all phases of the planning process; this input proved invaluable in terms of providing insight on route safety issues and travel patterns not apparent in the data. Having bus operators on-board with the plans is also crucial from a public perspective – customers need to know that the operators support the plan, and operators that have been brought along respectfully along the way can be the strongest advocates – and educators – of the new system with the riding public. As one transit agency planner explained, there is an opportunity for operators to be ambassadors for the redesigned system.

Union leadership, while they represent the operators and supervisors, must be separately engaged. Buy-in from union leadership is absolutely critical to the successful implementation of a bus network redesign. If the transit agency is planning a cost-neutral redesign or one that will result in additional service, the union leadership needs to understand this in order to avoid concerns that the redesign will result in less work for its members. One transit agency sent staff to the Union Hall to listen to the concerns of union leadership. This particular transit agency also involved the union in testing and piloting aspects of the redesigned system. Especially in larger transit agencies, it can be difficult to schedule meetings with very busy union leadership, but it is worth the effort to ensure that the union is on-board. One transit agency that struggled to gain the attention of the union leadership during the planning process was able to obtain needed input by going through the union's outside legal counsel, who arranged a meeting between the two parties with their participation.

Checklist: Internal Coordination and Project Management

When considering internal coordination and project management, the bus network redesign team should consider the following:

Project Management	☐ Has a strong project manager(s) been identified to lead the transit agency's bus network redesign effort? ☐ Is there an internal champion who has broad respect throughout the organization to advocate for the project internally (and externally)?
Operators and Unions	☐ How will bus operators be involved in the bus network redesign? Have you considered ways to involve them in all phases of the process, from input on planning to public education? ☐ How will union leadership be involved in the bus network redesign? Have you involved them from the beginning as the project was being initiated? ☐ Initially, how do you plan to connect with Union leadership?

Further Reading

Places in the report where detailed information the topic can be found.

- **Chapter 4: Support and Collaboration, Internal Agency Collaboration**

Planning Transit Service

The service planning process is at the heart of a bus network redesign. Regardless of a redesign's scale (e.g., system-wide or just a part of a larger system) the basic principles and considerations remain the same. As with any transit service planning effort, planning transit service for a redesign must include an analysis of current system performance, travel patterns, densities, demographics, and the built environment. Based on all of these considerations, the redesign team can plan the appropriate types of service for different areas and needs, including both fixed route and new mobility.

While there is much more to planning transit service in a bus network redesign, the considerations outlined in this section are areas that are most different than in traditional service planning. These considerations include but are not limited to equity, financial and non-financial limitations, integration with fixed guideway transit, and integration of new mobility.

Equity

Beyond meeting Title VI requirements, the bus network redesign team should consider the needs of low-income and minority communities, people with limited English proficiency, people with disabilities, and seniors. For instance, if the redesign includes limiting stops along high-density corridors, customers may need to walk further to reach transit stops. This may be problematic for groups with limited mobility, and additional transit stops may be warranted to serve locations frequented by people with disabilities or seniors. Likewise, reduction in service coverage requiring longer walks to bus routes can be more efficient and allow the transit agency to provide better service in high demand areas, but the transit agency may need to provide alternative service delivery models for seniors and people with disabilities who cannot walk farther distances.

Low-income communities should be considered outside of Title VI. First, the planning process should account for the needs of low-income, minority, and limited English proficient populations due to their higher propensity to use transit. Second, for many transit agencies, the low-income threshold in their Title VI program is very low, and many households above that threshold are still highly reliant on public transit to meet their mobility needs.

A best practice followed by transit agencies that have conducted bus network redesigns is to conduct a draft Title VI service equity analysis to accompany each iteration of the draft network plan. This ensures that changes that may result in a potential disparate impact or disproportionate burden are addressed throughout the planning process. This avoids the need to make last minute changes and conduct further public participation required by Title VI regulations should potential disparate impacts or disproportionate burdens be found in the final redesign plan, as this may ultimately impact the ability to implement the redesign on schedule.

Non-Financial Limitations

A bus network redesign may be limited by factors that include but are not limited to:

- **Union Contracts**: The presence of unions may bring additional complexities to operations. One transit agency explained how their unionized labor force raised issue with the scale of runtime changes and changes in recovery time. In some transit agencies different unions operate different bus divisions, resulting in limitations on moving routes between garages. Union rules related to shift length and split shifts, among others, should also be accounted for in the

planning process—at a high level—so that the plans can be scheduled without having to make significant changes to the planned service.

- **Capacity**: The size of existing maintenance and storage facilities will impact the size of fleet and types of vehicles able to be accommodated. This could impact the ability to increase peak period service even if capital funds for vehicles and operating budgets are sufficient. Capacity at a given garage can also impact costs once the routes are scheduled; routes may have to operate out of a non-optimal garage due to space constraints, causing increased deadhead time and higher costs.
- **Operators**: Transit agencies are struggling to fill the positions they have open, and many transit agencies have large extraboards that they rely on to put service on the street—and even then, transit agencies across the country still struggle to avoid missed trips. Even a great bus network redesign plan will not work without buses operating as planned.
- **Transit Centers**: Bus network redesigns often result in big changes in the number of buses converging on a transfer location. Some transit agencies plan without regard for location and capacity of existing transfer locations, while some, especially if there is no capital funding associated with the plan, will plan to tie in with their existing transfer locations. One way or the other, location and size of current transfer centers can impact bus routing decisions and/or the need for new or expanded transfer facilities.

Integration with Fixed Guideway Transit

The opening or expansion of fixed guideway transit can be the impetus for a bus network redesign, or in some cases part of the redesign planning process. Some transit agencies have planned redesigns around future or recently implemented fixed-guideway transit, including BRT and rail. For example, one transit agency used a bus-rail interface plan to provide adequate service during rail construction and scaled back bus service over time once the rail opened. Other transit agencies have stated that redesigns serve as an impetus to future BRT service by planning for high-frequency corridors that would be best suited to additional bus priority treatments that would eventually become BRT. Regardless of the order in which the planning occurs, transit agencies should consider how the bus network feeds into and leverages fixed-guideway transit, regardless of mode.

Incorporation of New Mobility

Several approaches to incorporating new mobility in the context of bus network redesigns have been identified, including using new mobility to maintain or enhance coverage and service quality and leveraging new mobility to enhance system access. Transit agencies that have directly or indirectly incorporated new mobility into their redesigns have done so by defining zones that can be served by new mobility to either replace fixed route service that would be removed in the redesign or to enhance coverage over what it was before. Transit agencies have also been planning new mobility around not just coverage for point-to-point service but as a new means of accessing fixed route service, particularly high-frequency fixed route service that is often the outcome of bus network redesigns.

Microtransit zones or potential stops can be identified based on a combination of current transit performance or demonstrated desire for or use of transit service, as well as understanding the propensity for transit use in areas that cannot necessarily support effective fixed route bus service. Transit agencies have planned these zones by looking at data about travel patterns, demographics, and densities—often alongside assistance from new mobility providers to account for operating realities—alongside their planning for redesigning the fixed route bus network.

Checklist: Service Planning

In addition to the typical service planning considerations, when conducting service planning, the bus network redesign team should also account for the following:

Equity	☐ Where are low-income and minority populations located? ☐ What are destinations that attract people with disabilities and senior riders that need to be served?
Non-Financial Limitations: Union Contracts	☐ If unions are involved with operations and maintenance, what work rules must be accounted for in planning? ☐ Do different unions operate out of different garages?
Non-Financial Limitations: Garage and Transit Center Capacity	☐ If you are planning to add to the fleet can the current operations and maintenance facilities accommodate more vehicles? ☐ Do the garages near areas of increased service have sufficient capacity? If not, have you accounted for the potential of increased operating costs? ☐ Are there new locations that will need transfer centers, or current transfer centers that will need to be expanded? Is there sufficient space to accommodate these needs?
Non-Financial Limitations: Operators	☐ Are you able to operate the scheduled service now? If not, do you have plans to improve upon this? ☐ Will the bus network redesign call for more operators? If so, will you be able to provide the staff to fully operate the schedule?
Fixed Guideway	☐ How will you consider current and planned fixed guideway services in the bus network redesign process? Will bus service be planned to feed the fixed guideway or might there be parallel high-capacity bus service?
New Mobility	☐ Are you open to considering new mobility as a “service type” in the planning process? If so, how will you determine where this service makes sense and what guidelines might it follow?

Further Reading

Places in the report or other resources where detailed information the topic can be found.

- **Chapter 3: Components of Bus Network Redesign Planning, Equity**
- **Chapter 3: Components of Bus Network Redesign Planning, Incorporation of Fixed Guideway Services**

Determining Fare Policies and Fare Interoperability Between Modes

Bus network redesigns should consider existing fare policies and collection systems, as well as limitations imposed by the system’s current fare structure. Fare policies dictate fares and pass products for each mode as well as transfers between modes or routes, while fare collection systems support fare policy.

Ideally, fare policy and the fare collection technology facilitate "seamless" travel for transit users. The redesign team needs to consider how fare policy will integrate modes and transfers, as bus network redesigns often result in changes to transfer patterns. For instance, when transit networks are designed around high-frequency corridors, as is common in redesigns, many riders may require a transfer to feeder bus service or another mode to reach their final destination. If riders are charged for transfers, this can have equity implications. To support the high-frequency, grid network implemented by one transit agency as part of its redesign, the transit agency began offering free transfers to all smart card users (Figure 22); free smart cards were widely distributed to support this change.

The presence of multiple transit agencies in the service area can present additional complexities, including considering the impact of transfer fees or lack of fare integration between transit agencies in customers' travel choices between multiple transit options or even if the complexity of multiple payments is just too much of a barrier to entry. As transit agencies begin to include new mobility and on-demand solutions as part of their bus network redesigns, future fare policy and collection should consider how new mobility can effectively complement fixed route transit networks. Some transit agencies aspire to have a single web-based platform that allows riders to plan and pay for their entire trip (i.e., MaaS. For example, a user could purchase a transit pass and then book a shared bike to complete their last-mile connection through one app.

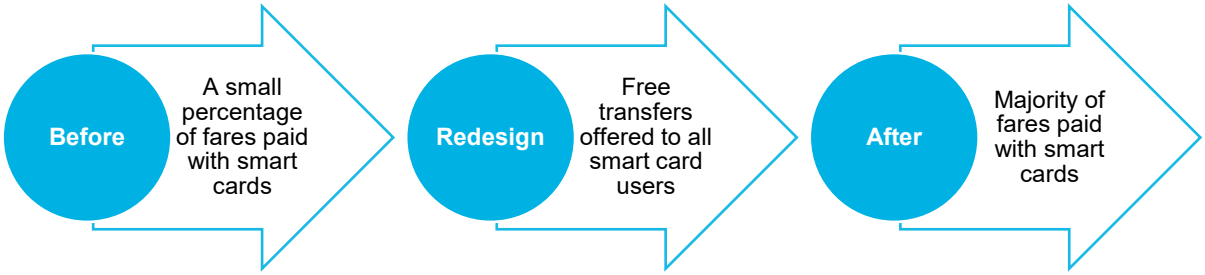


Figure 22. Example Fare Policy Change in Conjunction with Bus Network Redesign

Checklist: Fare Policy and Interoperability

As transit agencies consider how and whether to adjust fare policy and/or fare interoperability, the following should be considered:

Fare Policies	☐ Will the bus network redesign require fare policy or collection to be modified? ☐ Does the fare policy consider integration with social services and universities?
Fare Collection	☐ Will the bus network redesign encourage the use of smart cards and account-based fare collection? ☐ Have locations for cash fare payments been considered?
Transfers	☐ Will free or discounted transfers be offered between transit modes? ☐ Will free or discounted transfers be offered for first-mile/last-mile connections completed via micromobility (e.g., bikeshare and scooters)?
New Mobility Providers	☐ How will the fixed route fare collection system integrate with new mobility providers?

Further Reading

Places in the report or other resources where detailed information the topic can be found.

- **Chapter 3: Components of Bus Network Redesign Planning, Fares**
- Canadian Urban Transit Association. 2017. *Integrated Mobility Implementation Toolkit*, Toronto, Canada.

Conducting Public and Stakeholder Engagement

In order to gain public input and support, public and stakeholder engagement should happen early and often, a variety of strategies should be employed, and an effective feedback loop should be generated. Throughout the engagement process, the bus network redesign team should be mindful of the fact that traditional meetings tend to have less participation and particularly low representation by low-income and minority groups; people need to be met in spaces they frequent. Transit agencies should refer to their Title VI Public Participation Plans for guidance on ensuring that reach these communities.

People with disabilities and organizations representing them should also be involved in the bus network redesign process. One transit agency explained how they included these representatives in working groups, conducted individual briefs, and held outreach events at senior independent living centers. Paratransit providers that operate in the transit agency's coverage area should also be included in the engagement process, as they have direct insights into the needs of these communities.

Bus network redesigns involve at least two rounds of public engagement, in addition to ongoing maintenance of communications through website updates and other means.

- **Visioning stage.** The objective of the first round is to identify issues, establish goals, and set priorities ("visioning" stage).
- **Planning stage.** The objective of the second round (and perhaps subsequent rounds) is to present the public and stakeholders possible service alternatives ("planning" stage). The engagement conducted during the "planning" phase should be used to both identify whether further modifications to the plans are desired, to educate the public and stakeholders on how the improvements will benefit them, and to obtain stakeholder buy-in (see Figure 8 in Chapter 3).

Some transit agencies also opt to engage the public after the Final Plan is released, typically as part of the public education process. While there are certainly discrete outreach phases where the transit agency makes large efforts to reach the public and stakeholder groups, it is key that the transit agency have an ongoing outreach program to keep interested parties engaged and up to date on the process. This can be done through website updates, social media, earned and paid media, on-board advertisements, and continued meetings with key stakeholder groups.

In addition to public engagement, stakeholder engagement is critical to obtaining input and also reaching the general public. For example, reaching out to community groups, advocacy groups, senior centers, healthcare providers, and faith-based groups provides the transit agency with access to a broader group of riders and potential riders through a single point of contact.

For transit agencies that move to implement their bus network redesign, the public needs to be educated on the new network so that people are prepared for how to get around once the changes are implemented; these outreach efforts do not replace public hearings which most likely will also be required for implementation. The need for an extensive public education process – using every tool at a transit agency's disposal – cannot be understated. Online resources, earned and paid media, information at every bus stop, information on-board buses and other modes, and opportunities to engage with transit agency staff or representatives for personalized assistance are just a few of the tactics that transit agencies take to inform as many people as possible about the upcoming changes.

Checklist: Public and Stakeholder Engagement

When planning the public engagement for the bus network redesign process, the redesign team should consider the following:

Visioning	Engage the public at the visioning stage to identify…	☐ Issues and Needs ☐ Priorities ☐ Goals
	What methods of engagement will be used during implementation?	☐ Public Meetings ☐ Stakeholder Meetings ☐ Social Media ☐ On-Board and Bus Stop Announcements ☐ Online Comment Forum/Survey ☐ Project Website Updates ☐ Other_____
	Where will outreach efforts be conducted?	☐ Transfer Centers ☐ Community Events ☐ Retail Centers ☐ Houses of Worship ☐ Community Centers ☐ Senior Centers / Independent Living ☐ Other_____
	Which stakeholders will be solicited? Groups should represent a variety of perspectives and follow the transit agency's Title VI Public Participation Plan requirements.	☐ Transit bus operators and supervisors ☐ Transit agency staff (all other departments) ☐ Transit agency board members ☐ Paratransit Operators ☐ Riders ☐ Non-riders ☐ Elected officials ☐ Funding partner agencies/MPO/department of transportation ☐ People with disabilities / Organizations representing them ☐ Social/human service agencies ☐ Faith-based organizations ☐ School district, colleges, universities ☐ Chamber of commerce/business community ☐ Major Employers ☐ Hospitals ☐ Civic/homeowner organizations ☐ Local Advocacy organizations ☐ Other_____

Draft Plans	Engage the public at the planning stage(s) to identify…	☐ Desired Plan Modifications ☐ How stakeholder buy-in can be achieved
	What methods of engagement will be used during implementation?	☐ Public Meetings ☐ Stakeholder Meetings ☐ Social Media ☐ On-Board and Bus Stop Announcements ☐ Online Comment Forum/Survey ☐ Project Website Updates ☐ Other_____
	Where will outreach efforts be conducted?	☐ Transfer Centers ☐ Community Events ☐ Retail Centers ☐ Houses of Worship ☐ Community Centers ☐ Senior Centers / Independent Living ☐ Other_____
Final Plan / Implementation Education	What methods of engagement will be used during implementation?	☐ Public Meetings ☐ Stakeholder Meetings ☐ Social Media ☐ On-Board and Bus Stop Announcements ☐ Project Website Updates ☐ Other_____
	Where will implementation outreach efforts be conducted?	☐ Transfer Centers ☐ Community Events ☐ Retail Centers ☐ Houses of Worship ☐ Community Centers ☐ Senior Centers / Independent Living ☐ Other_____
	How will the impact of system improvements be relayed to the public?	☐ Published Documents (e.g., impact report) ☐ Project Website ☐ Trip Planner to compare current to proposed future trips ☐ Personalized trip planning in-person and virtually ☐ Other_____

Further Reading

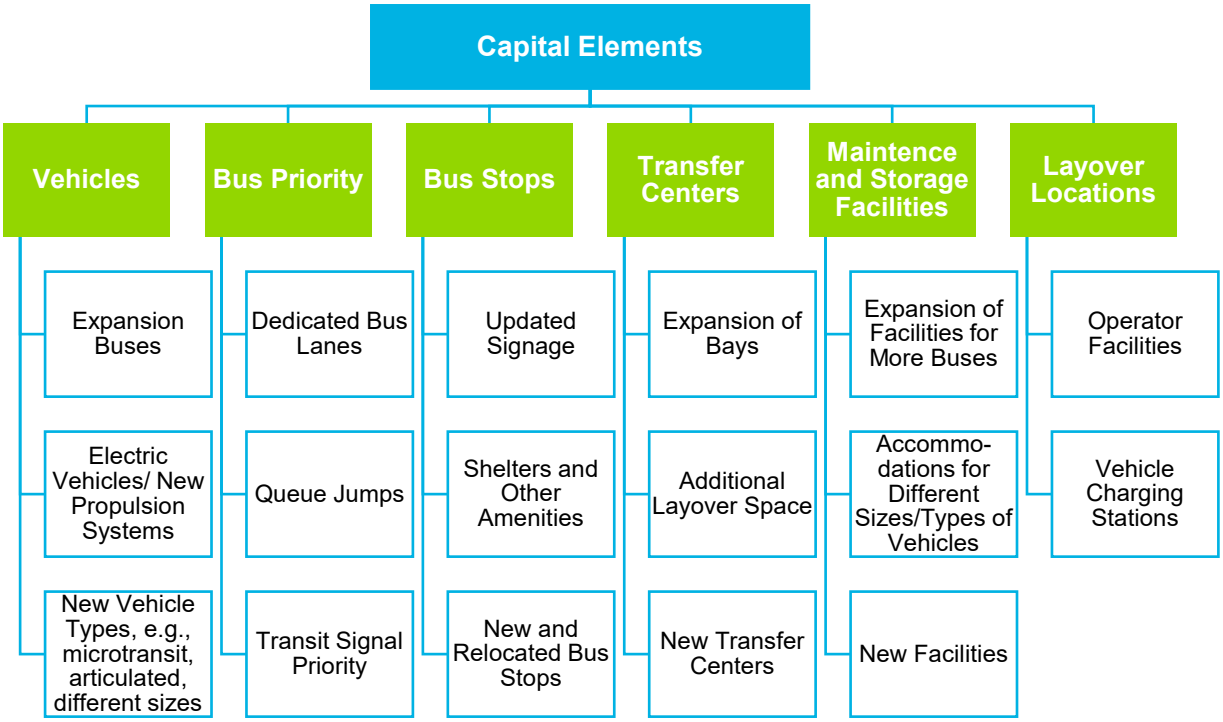
Places in the report or other resources where detailed information the topic can be found.

- **Chapter 3: Components of Bus Network Redesign Planning, Public and Stakeholder Involvement**
- Ballam-Schwan, J, K. Hovenkotter, and H. Richardson, 2017. "Untangling Transit: Bus Network Redesign Workshop Proceedings." TransitCenter, New York City.

Addressing the Capital Elements of a Bus Network Redesign

Capital elements (Figure 23) may be required—or desired—to support a bus network redesign and should be worked into the planning process at the outset. Such elements include new buses and new bus types (i.e., size, new propulsion systems), as well as capital items related to speed and reliability, such as bus priority treatments (e.g., bus lanes, queue jumps, TSP); capital items to improve the attractiveness of the service (e.g., real-time information, safe waiting environments, and improved transfer facilities); and capital investments to improve operating efficiencies (e.g., new or expanded maintenance and storage facilities and layover locations.

Capital improvements need to support the service plan. First, improvements need to be coordinated with route planning. Along potential routes, turn locations, roads not previously served by transit, and layover locations need to be examined for safety and accessibility. For instance, a potential routing may require a vehicle to serve a stop and then merge lanes to make a left-hand turn a short distance up the road, which can be a safety concern; a layover location may also require the availability of operator relief facilities or charging facilities for electric buses; and accessibility checks include confirming whether sidewalks exist along roadways that will have transit service that did not before.



Coordination between the transit agency and the jurisdictions in which it operates is required to construct physical infrastructure that will enhance service quality. Transit agencies have worked with their jurisdictions on several aspects of bus network redesigns, including changing bus stop locations and implementing bus priority. Any bus priority that a transit agency wants to implement to support service speed and reliability will need support and likely funding from the jurisdiction. Involving staff and leaders from the jurisdictions in the redesign—not just planners but also engineers and capital planning and programming—is a best practice to make sure that long-lead capital items can be started early.

Checklist: Capital Elements

As the bus network redesign team considers capital investments, they should consult the following checklist.

Figure 23. Sample Capital Elements of Bus Network Redesigns

Vehicles	☐ Have electric vehicles been considered? If so… ☐ Have charging facility locations been considered? ☐ Has the battery duration (in different weather/elevation grades) and re-charge time been considered? ☐ Will smaller buses or vehicles be needed to expand microtransit service?
Bus Priority	☐ Where should bus lanes be added? ☐ Have locations for queue jumps been identified? ☐ Have locations for TSP been identified?
Bus Stops	☐ Will new stops be added as part of the bus network redesign? ☐ What infrastructure will be required at these locations (e.g., shelters, benches, etc.)? ☐ Will existing stops be servable by new patterns (e.g., the bus might still operate along the same roadway segment, but because it needs to now make a left ahead, it can no longer serve the current bus stop)?
Transfer Centers	☐ Are there enough bays to accommodate the bus network redesign service serving the location? ☐ Is there adequate space to accommodate all the redesigned service vehicles?
Maintenance and Storage Facilities	☐ Will the new or modified fleet be able to be accommodated?
Layover Locations	☐ Have you evaluated each route's layover facilities? ☐ Will any layovers need to occur outside of transfer stations and maintenance storage facilities? ☐ Do all layover facilities have a safe space for the bus to park (e.g., out of traffic, in a well-lit area)? ☐ Will you need to build a loop or add a traffic signal for the bus to turn around? ☐ Do all layover facilities have restroom facilities for the operators?

Further Reading

Places in the report or other resources where detailed information the topic can be found.

- **Chapter 3: Components of Bus Network Redesign Planning, Capital Elements to Support Redesigned Bus Service**
- TransitCenter. 2018. The Path to Partnership: How Cities and Transit Systems Can Stop Worrying and Join Forces Street Design. TransitCenter, New York, NY.
- National Association of City Transportation Officials. n.d. *Transit Street Design Guide*.

Planning for Implementation

Staging and implementing new and modified services—especially at the scale of a bus network redesign—can be a challenge. Approaches to implementing a redesign vary, with some transit agencies opting to make changes all at once and others taking a phased approach, implementing changes over a period of time. Among transit agencies surveyed in TCRP Synthesis 140, some that took a phased approach structured phasing by "geographic service area" and others "service type" (Byala, et al. 2019, 140). Figure 24 can be used to determine whether the redesign team should take a phased approach to implementation.

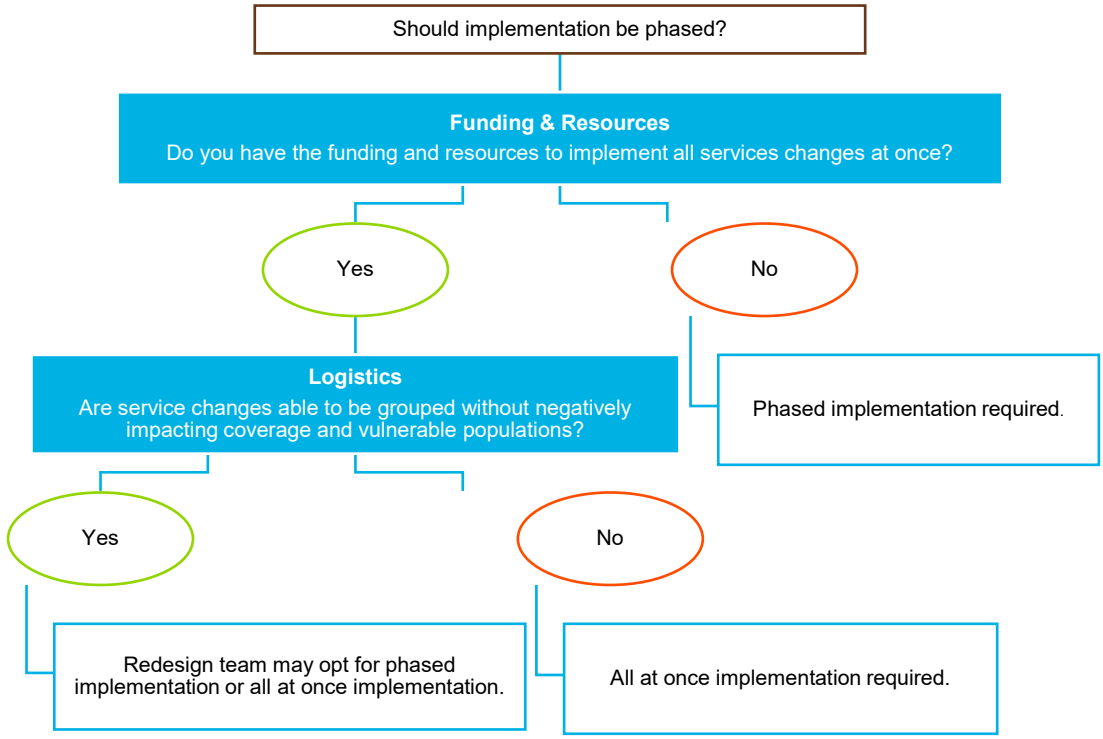


Figure 24. Phasing Considerations for Bus Network Redesigns

Alongside service changes, many operational details need to be coordinated and online and print materials developed during implementation, including but not limited to schedules, bus stop signage, print timetables and maps, GTFS creation, and operations and frontline staff training (e.g., customer

service representatives). The public facing materials ensure that transit riders have the resources they need to navigate upcoming service changes.

During planning for implementation transit agencies also need to determine "critical path" items and stage modifications that are dependent on prior alterations. Figure 25 outlines activities involved in the implementation process. One transit agency noted driver training as a critical path item, and another stated the importance of holistic training so that the operators know enough to serve as ambassadors to the public who will undoubtedly have a lot of questions. The role of operators in the implementation process should not be understated. Transit agencies expressed difficulty in hiring and maintaining the number of operators needed to staff the redesigned system; one transit agency even had to delay implementation of their bus network redesign due to their inability to hire enough drivers.

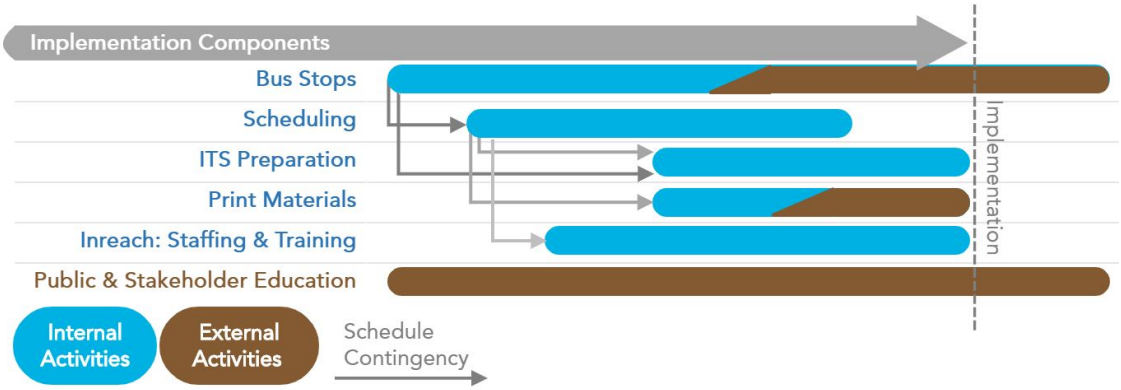


Figure 25. Detailed Components of Bus Network Redesign Implementation

Once the new system has been launched, transit agencies can monitor and continue to make improvements to the system. Using performance metrics developed earlier in the process—such as ridership, schedule adherence, and crowding—transit agencies can set up more formal performance monitoring programs to ensure that all the effort that went into planning and implementing the bus network redesign is followed up on. Despite the best planning efforts, bus transit is dynamic and ongoing performance monitoring, using easily collected data, is key to keeping the service at peak performance.

Checklist: Bus Network Redesign Implementation

This checklist will help transit agencies plan the details of implementing their bus network redesign.

Bus Stops	☐ Evaluate the bus stop sequencing for new and modified routes for safe operations and transfer convenience ☐ Determine which stops and infrastructure is critical path for operations, and which can be built or installed incrementally after implementation ☐ Follow internal policies and procedures for public notice and comment on bus stop removal ☐ Fabricate and install new bus stop signage where applicable
Scheduling	☐ Develop Route Naming/Numbering Conventions along with timepoint naming conventions ☐ Create timetable spacing standards and identify timepoints for new/modified routes ☐ Estimate segment runtimes for all new/modified routes based on existing data or other methods ☐ Build route timetables and perform quality assurance/quality control (QA/QC) ☐ Block, Cut, and Roster timetables ☐ Identify and vet new operator field relief points, if applicable ☐ Gather operator and/or union feedback on proposed schedules as well as new time points, layovers, and relief locations.
Intelligent Transportation Systems (ITS) Data Preparation	☐ Review bus stop location data for accuracy and completeness ☐ Determine bus stop sequencing for new/modified routes and identify stops which will need to be moved, discontinued, added for service changes ☐ Work with ITS vendors to prepare for data updates to software and hardware such as AVL, APCs, and Automated Fare Collection (AFC) systems, onboard annunciator systems, headsigns, real-time feeds, and dispatch systems ☐ Publish GTFS feeds for third party applications
Print and Online Materials	☐ Prepare new print- and web-ready timetables and maps ☐ Update system maps ☐ Identify locations for the dissemination of print material such as shelters, bus stop info stations, transit centers, rail stations, and local resource centers which may regularly stock print timetables or system maps
Staffing and Training	☐ Evaluate existing staffing levels for operators, street supervisors, dispatch and maintenance staff ☐ Estimate staffing needs based on planned changes ☐ If plan requires additional staff, develop a hiring and training plan to meet needs prior to launch ☐ Develop a training program to train operators, dispatch, street supervisors, customer service representatives and other frontline staff on new/modified routes and new policies

Educational Outreach	☐ Develop a comprehensive public education plan designed to reach current and potential riders to communicate coming changes. Education plan should include events, pop-ups, speaking engagements, and other efforts to disseminate information ☐ Develop a comprehensive marketing plan to raise awareness of service changes through paid and earned media, print and online marketing, and through existing alter systems such as transit vehicle onboard announcement and service alert systems ☐ Develop a comprehensive website which covers important information about service changes ☐ Deploy "Transit Ambassadors" to transit centers leading up to launch and during first few days of initial operations to answer questions and provide print materials ☐ Develop a mechanism for public to ask questions and receive answers on service changes
Ongoing Monitoring	☐ Review metrics developed earlier in the planning process, determine what data and information can be easily collected and processed on a regular (weekly/monthly/quarterly) basis, and finalize ongoing metrics for analysis ☐ Set targets for each metric for evaluation, e.g., riders per hour by service type ☐ Develop replicable data processing and route/system rating program and review results on ongoing basis ☐ Develop and follow procedures for updating service at set intervals based on results of monitoring program and continued service planning

Further Reading

Places in the report or other resources where detailed information the topic can be found.

- **Chapter 5: Bus Network Redesign Implementation**
- Karlin-Resnick, J., R.R. Weinberger, and B. Whitaker. 2014. *How Planning and Implementation Affect the Success of Transit System Redesign*. Transportation Research Board of the National Academies, Washington, D.C.

Toolkit #2: Leveraging Partnerships for a Better Bus System

This toolkit provides brief profiles highlighting how as part of bus network redesigns, transit agencies have effectively engaged with and leveraged intra-agency, inter-agency, and private-sector partnerships to successfully adopt new strategies or implement infrastructure and other projects that increase the attractiveness of riding the bus. Working with internal and external partners can help generate the cross-institutional and political support needed to overcome barriers and implement strategies and projects, or may be a necessity due to the limits of the transit agency's role in operating transit service while other agencies control ROW or have jurisdiction over other elements required to bring a new strategy to fruition. These partners may include other groups within the transit agency, individuals from other government agencies or institutions, and political leaders.

Strategies for Making the Bus the Mode of Choice

Strategies that improve transit operations and service delivery necessitate working closely with a variety of internal and external partners. Table 6 below outlines strategies, highlights key partners, and lists the transit agencies profiled in this toolkit. It should be noted that some of the transit agency experiences profiled have occurred as part of a bus network redesign, and some as a separate but contemporaneous or follow-on effort. Information in this table reflects the status of each transit agency's implementation through May 2020.

Table 6. Transit Agency Experiences Highlighted for Making Bus the Mode of Choice

Strategy	Description	Key Partners	Transit Agency Highlighted Below
Bus Priority	Transit agencies have employed various strategies to prioritize bus travel, including dedicated bus lanes (peak-only or all-day), TSP, queue jumps, and all-door boarding policies. Reducing travel time and increasing travel time reliability contribute to enhancing the passenger experience.	ROW Owners, Law Enforcement, Elected Officials, Public Health Community	COTA (Columbus, OH)
Microtransit	Microtransit, also known as DRT or flex service, enables real-time, on-demand transit trip scheduling using an app or over the phone. Vehicles pick-up passengers at individual addresses or central pick-up locations, typically operating within a designated zone. Microtransit is often used to provide greater coverage of a service area and to connect otherwise underserved or unserved communities to the broader transit system.	Vehicle Operators, Mobility Companies	Gwinnett County Transit Division (suburban Atlanta, GA)

Strategy	Description	Key Partners	Transit Agency Highlighted Below
Account-Based Fare Systems and App-Based Transit Platforms	Implementing account-based fare systems and smartphone or web-based platforms that facilitate integration among multiple service providers can facilitate transit agencies becoming leaders in the transition to a MaaS environment. Services represented on the platform might include transit, bikeshare, carshare, and new mobility options, and ideally could integrate both fare payment and trip planning.	New Mobility Providers, Transit Agency Customer Service, Technology, and Budget/Financial Staff	IndyGo (Indianapolis, IN)
Real-time Passenger Information	Real-time passenger information provides riders with accurate arrival and departure times for an individual bus. This information may be delivered via passenger information screens at stops or stations, via smartphone or web applications, or via telephone.	Transit Agency Operations, Customer Service and Technology Departments; New Mobility Providers	Lehigh and Northampton Transportation Authority (LANTA) (Allentown, PA)

The following sections provide an overview of how each of these transit agencies implemented the strategy outlined in the table above. These examples and the identified benefits of each provide guidance on each strategy in terms of why the transit agency implemented it along with how it specifically played out at the transit agency profiled.

Bus Priority (Dedicated Bus Lanes): COTA

Transit agencies have employed various strategies to prioritize bus travel, including dedicated bus lanes, TSP, queue jumps, and all-door boarding policies. Reducing travel time and increasing travel time reliability contribute to enhancing the passenger experience.

In 2017, COTA implemented its Transit System Redesign. The CMAX Cleveland Avenue bus BRT, planned as a part of the Transit System Redesign, launched in 2018. High Street, one of the main corridors served by CMAX, has peak hour dedicated bus lanes. The dedicated bus lanes along this corridor which pre-date the 2017 bus network redesign, provided the right infrastructure for BRT service, preventing vehicles from piling up and keeping buses moving during peak hours.

Results from the Mid-Ohio Regional Planning Commission's insight2050 Corridor Concepts study, in conjunction with feedback received from community members at the Purple Aisle Transportation Innovation Weekend in November 2018, led the city to subsequently consider additional dedicated bus lanes. In 2019, the authority conducted two tests for new "mobility lanes." These lanes are dedicated to buses but also allow bike and scooter traffic.

Selected Benefits
Buses no longer need to merge into traffic or contend with congestion, allowing for improved travel speeds and increased travel time reliability.
Provides a premium bus service experience, including limited stops and all new CMAX bus stations that are adorned with public artwork.
The Cleveland Avenue corridor was selected to enhance access to specific healthcare facilities, thereby reducing health access disparities and enhancing access to downtown employment centers.

Source: https://www.cota.com/ (As of May 20, 2020).

Figure 26. Central Ohio's First Bus Rapid Transit Line

Working with Key Partners, Lessons Learned from COTA

- **City of Columbus (Roadway ROW Owner):** COTA began working with the City of Columbus on their desire to implement BRT in downtown in 2015. These discussions led to

broader coordination with the City of Columbus regarding the role of transit on specific corridors and the location of on-street parking.

- **Developers and the Business Community**: Engagement and support from both the business community at-large and private sector property owners along the CMAX was critical to the project's success. Several private property owners along the CMAX route provided new bus stops, enhanced access from their site to the stops, and were active in discussions around stop locations.
- **Downtown Improvement District**: The Capital Crossroads Special Improvement District, which champions development and economic vitality in downtown Columbus, helped to champion the bus lanes within the civic and business communities.
- **Elected Officials**: The Mayor of Columbus and the President of Council were essential champions of implementing dedicated bus lanes. The broad support from community members, including the businesses and downtown improvement district, helped to demonstrate to elected officials the value that dedicated bus lanes provide to the community.
- **Metropolitan Planning Organization**: The Mid-Ohio Regional Planning Commission was very supportive of the bus lane implementation and actively convened key stakeholders to build support for the project across the community.
- **Law Enforcement:** More parking meters were added along High Street following the bus network redesign to improve bus lane enforcement. The transit agencies also hires off-duty police officers to provide additional enforcement for the bus lane. Ohio law requires that law enforcement officials be viewing a live feed at the time of the incident to issue a ticket.
- **Public Health Community:** The CMAX Cleveland Avenue BRT connects socio-economically disadvantaged neighborhoods to key health care facilities. One of the goals of the CMAX BRT was to reduce high infant mortality in neighborhoods served by the BRT by enabling time-efficient and convenient access to health care.

When and Why COTA Implemented Bus Priority
Congested roadways inhibited efficient bus operations
The transit agency had developed a bus priority plan in close coordination with the City and key partners
A coalescence of support from key stakeholders including the business community, the MPO, and public health community

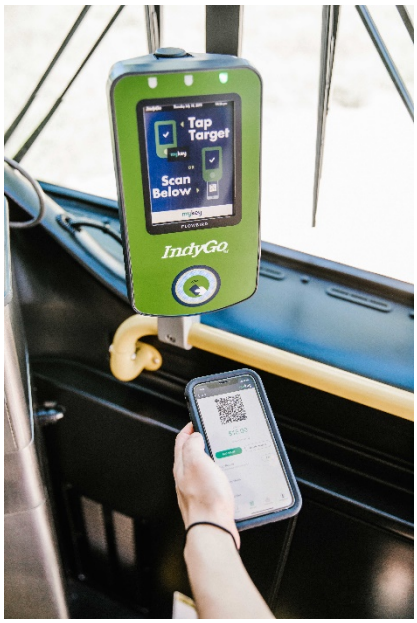
Account-Based Fare Systems and App-Based Transit Platforms: IndyGo

Implementing account-based fare systems and smartphone or web-based platforms that facilitate integration among multiple service providers can facilitate transit agencies becoming leaders in the transition to a MaaS environment. Services represented on the platform might include transit, bikeshare, carshare, and new mobility options, and ideally could integrate both fare payment and trip planning.

IndyGo will soon be implementing an account-based fare system called "MyKey." A new BRT network with off-board fare payment based on the honor system, was planned as part of the transit agency's bus network redesign and was the impetus for the new fare system, which includes a mobile application and reloadable fare cards (Figure 27).

Since "MyKey" provides a framework for financial integration, it is also viewed by the transit agency as a steppingstone toward the development of an app-based transit platform that could be implemented in the future. This would be a single application that would enable the purchase of multi-modal, multi-provider, trip planning or booking and fare value purchases. With the IndyGo bus network as the backbone, the platform could integrate a larger network of mobility providers.

Selected Benefits
The implementation of account-based fare systems provides a framework for future integration with new mobility providers and or other service providers.
By leading on the development of an app-based transit platform, IndyGo hopes to position the transit agency's services as the backbone of a larger network of mobility options available through one app.



Source: IndyGo

Figure 27. IndyGo's payment system accepts payment from reloadable cards or smartphones

Working with Key Partners, Lessons Learned from IndyGo

- **Other Transit Agencies:** Depending on the provider, various political or legal considerations impact the ability or desire of individual providers to participate in a future app-based transit platform. As a result, IndyGo has started the process of working to implement an app-based transit platform by working with public transit providers in the central Indiana region.
- **Transit Agency Staff**:
  - Customer Service: Staff are responsible for educating current and prospective transit riders about changes to the fare payment system. They also market new applications and services as they become available.
  - Technology: Staff worked with external vendors to develop applications per their specifications. The team confronted a number of novel challenges during development. Technical specifications for the transit app deliverable evolved throughout the project as transit agency staff gained a greater understanding of the technical complexities that had not been anticipated during the scoping of the project.
  - Financial and Budget Team: During beta-testing of the app, the finance and budget team identified issues related to accounting that required time-consuming changes to the app. IndyGo staff believe that involving the finance and budget team at an earlier point in select conversations could have avoided these late changes.

When and Why IndyGo Implemented Account-Based Fare Systems
There was internal buy-in for the project among transit agency staff.
A new BRT network with off-board fare payment based on the honor system, was impetus for re-thinking fare collection. The transit agency wanted to insure seamless transfers between new and existing services. Combining multiple modes into one place for payment made sense.
Fare collection system was antiquated and ready to be replaced.

Microtransit: Gwinnett County Transit Division

Microtransit, also known as DRT or flex service, enables real-time, on-demand transit trip scheduling using an app or over the phone. Vehicles pick-up passengers at individual addresses or central pick-up locations, typically operating within a designated zone. Microtransit is often used to provide greater coverage of a service area and to connect otherwise underserved or unserved communities to the broader transit system.

From September 2018 to April 2019, Gwinnett County Transit Division in suburban Atlanta, Georgia piloted a door-to-door on-demand bus service. The pilot which operated over a six-month period was conducted as part of a Comprehensive Operational Analysis and Transit Development Plan that functioned as a bus network redesign called Connect Gwinnett. For the pilot, seven 12-passenger buses were used to serve a 16-square-mile area of the county which had a low population density and no existing fixed-route service (Figure 28). Customers used an app to request rides that were offered free of charge during the pilot. The service operated weekdays (6:00 a.m. to 8:30 p.m.) and Saturdays (7:00 a.m. to 7:00 p.m.) with a 20-25 minute average wait time.

The Gwinnett County Transit Division credits the pilot with starting a conversation about alternate transportation in the community. In 2020, the division hopes to expand and renew the on-demand

service. The success of the pilot led to the transit agency to the realization that microtransit should be part of the transit solution in their county.

Selected Benefits
Serve low-density areas that cannot support fixed-route service.
Serve key trip generators in low-density areas.
Provide first-mile/last-mile connections; anchoring zones to fixed-route service

Source: https://www.gwinnettcounty.com/ (As of May 20, 2020).

Figure 28. One of the 12-Passenger Buses used for the on-demand service

Working with Key Partners, Lessons Learned from Gwinnett County Transit Division

- **Vehicle Operators:** There are various models for how vehicles and labor can be provided. Gwinnett County Transit Division owned the vehicles used for on-demand service but had a third-party contractor provide drivers. The division already had a contractor running its paratransit service and was able to utilize the same provider for the pilot.
- **Mobility Companies:** Transit Division staff work with mobility companies in order to deliver service. Gwinnett county partnered with a third party who provided their app and training for the operators. Moving forward, the transit division hopes the private company will run the app alongside a private operator. Conducting a pilot prior to installing permanent service allowed the division to become comfortable with the technology.

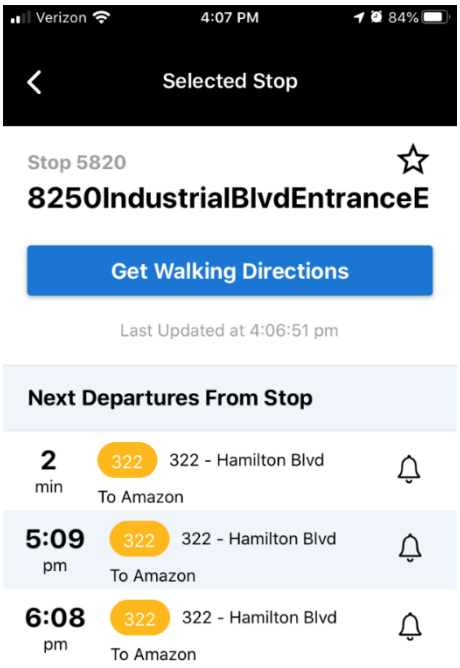
When and Why Gwinnett County Implemented Microtransit
Trip generators exist in the zone but cannot support fixed-route service. In Gwinnett County, this included three Walmarts, a Hospital, Senior Center, Library, Extended Stay Hotel, a High School, and a Junior High School.
The built environment lacks sidewalk connectivity.

Real-time Passenger Information: LANTA

Real-time passenger information provides riders with accurate arrival and departure times for an individual bus. This information may be delivered via passenger information screens at stops or stations, via smartphone or web applications, or via telephone.

LANTA, based in Allentown, PA, integrated real-time passenger information for fixed-route service into their smartphone and web applications. The push for real-time information was separate from the transit agency's 2009 and 2011 comprehensive service planning studies but, was requested during the outreach for these projects. The transit agency's application, which was implemented in 2012, allows riders to track the location and arrival status of buses in real-time using a Computer-aided Dispatch/Automatic Vehicle Location (CAD/AVL) system. Figure 29 shows how the real-time vehicle tracker appears on LANTA's app.

Selected Benefits
Real-time information provides riders with information to enhance their transit experience and make informed travel choices.



Source: Screenshot of LANTA's app (As of May 20, 2020).

Figure 29. LANTA's Real-Time Vehicle Tracker

Working with Key Partners, Lessons Learned from LANTA

- Transit Agency Staff:
  - **Bus Operators:** The operators received a basic tutorial regarding the real-time platform. This was limited to content such as where and how to download the app.
  - **Technology:** The app began as a text message based platform. Customers texted their bus stop to receive time information. When the app interface was first deployed, customers were

checking on their computer prior to leaving the house. Later, there was an uptick in mobile usage.

- **Customer Service:** The app was originally only web-based. It was initially used by the transit agency's customer service department when people called to ask for bus arrival time status.

When and Why LANTA Implemented Real-Time Passenger Information
To meet people's expectations of modern transit service. The addition of real-time information was not seen as a ridership driver.
Enhance rider experience on LANTA's low-frequency routes.

Toolkit #3: Working with the Private Sector

Bus network redesigns may involve planning for and deploying services operated by third-party private-sector partners. These partnerships can take many forms, including leveraging private vendors for operations or maintenance of traditional fixed route transit services, having partners provide on-demand first-mile/last-mile services that link to the transit agency's routes, and using a private company's software or technical expertise to operate traditional or new forms of transit service.

This toolkit focuses on partnerships in the new mobility context, a model that is unprecedented at many transit agencies and thus requires extra consideration. Lessons from contracting for fixed route traditional bus services can help to inform contracting for new mobility services. Several resources already exist to guide transit agencies in implementing more traditional partnerships for fixed route service, and many of those lessons have informed the development of this toolkit.

Working with the private sector can involve financial relationships where transit agencies procure services; part of this relationship can include setting performance-based incentives for the private sector company to ensure that the private provider is working to meet public sector goals. It also means non-financial relationships where transit agencies give space, curb access, advertising, or other public benefit to a private operator for a mutually beneficial outcome. Partnerships may also entail sharing of data and integration with publicly sponsored tools or initiatives.

This toolkit will cover a variety of topics that transit agencies should consider when planning for partnerships with the private sector. It should be noted that this toolkit is not intended to cover an exhaustive list of all aspects of private sector partnerships, only to cover key topics for consideration particularly in the context of private sector partnerships occurring or interacting with bus network redesigns. While some partnerships may be conceived of as a part of a redesign (e.g., introducing new types of service to meet specific gaps identified in the redesign process), transit agencies with contracted service may also need to consider how existing private sector partners or contracts integrate with the redesign process. The following topics are addressed in this toolkit:

- Motivations for Working with the Private Sector
- Regulatory and Legal Considerations
- Identifying Potential Risks in Partnerships

Motivations for Working with the Private Sector

There are many motivations that may lead a transit agency to pursue or continue a partnership with an external partner. In some cases, transit agencies are required to partner, as in the case of the FTA MOD Sandbox program, which provides grants to project teams to integrate transit and new technology solutions. In other cases, the decision to partner is driven by internal limitations or a desire to explore new approaches to service delivery. It is key to identify the motivations for partnering at the outset of the development of any potential partnership to guide the type of partnership and define the goals and desired outcomes for the partnership. The flow chart in Figure 30 will help transit agencies to determine whether to partner with a private sector new mobility partner.

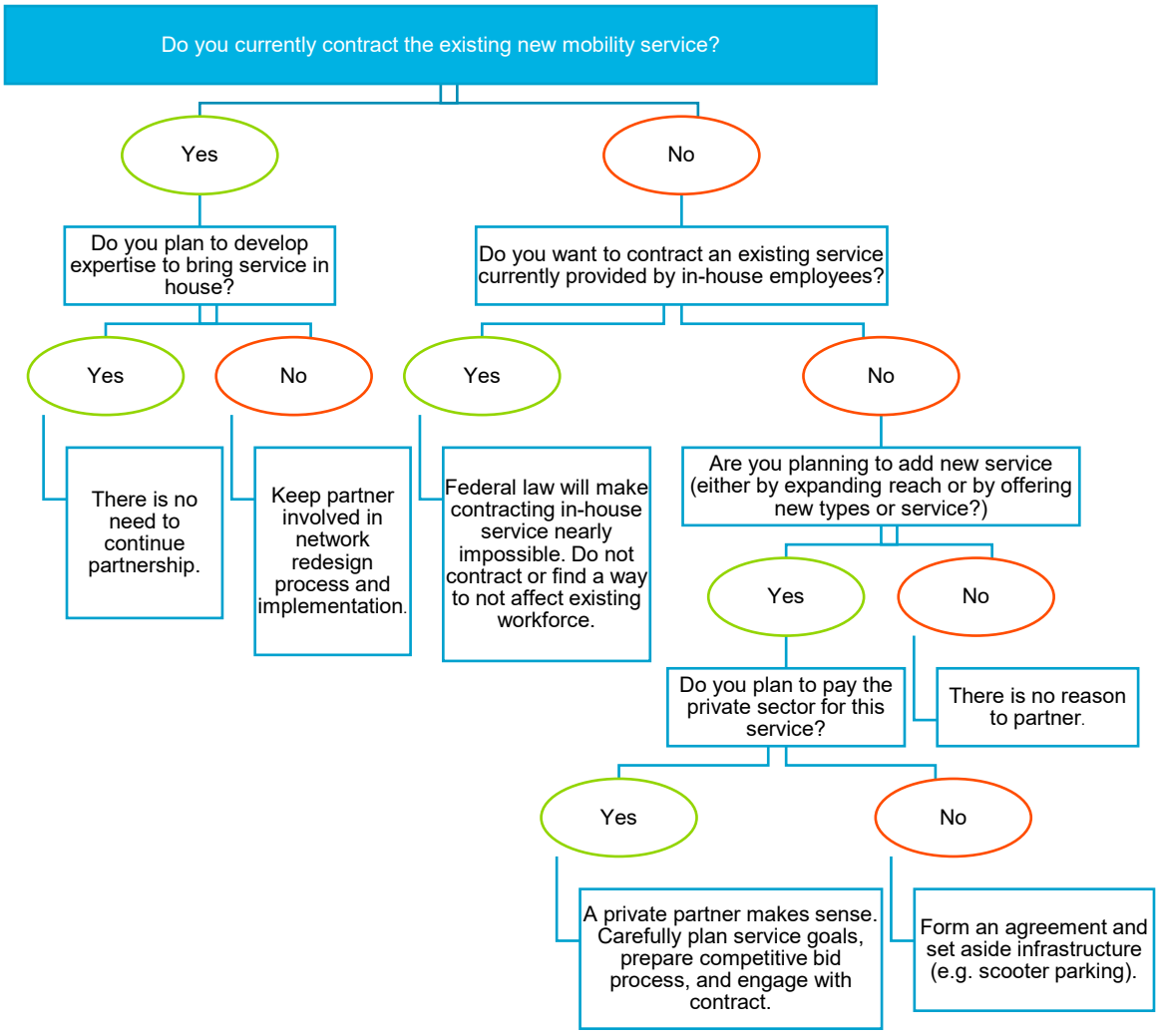


Figure 30. Flow Chart to Help Transit Agencies Determine Whether to Partner with the Private Sector

Sample Motivation 1: The transit agency does not have or decides not to develop in-house capacity to provide a portion or all of its service.

Transit agencies may be limited in their capacity in terms of budget, personnel, or facility space to employ and train the staff needed to carry out services. For example, many transit agencies do not have the technical capacity to implement app-based flexible service or fare payment. This is especially relevant in the new mobility context, in which transit agencies decide to partner with services like transportation network companies (TNCs). Transit agencies may also partner to leverage routing and dispatch technologies developed in the private sector while maintaining direct operations and asset ownership.

Example
The FTA MOD Sandbox Program provides a platform for transit agencies to experiment with new technologies via partnerships. LA Metro and the Puget Sound Regional Transit Authority (Sound Transit) together entered a first-mile/last-mile partnership with Via, an example of transit agencies' exploring dynamic routing and DRT to transit stations. Another example from the FTA MOD Sandbox Program is the DART integration of its GoPass ticketing app into TNC's apps to provide access to multiple transportation options as first-mile/last-mile options. This program used the payment application programming interfaces and software development kits from these partners (FTA 2018).

Sample Motivation 2: Enhance ability to achieve accountability and performance standards.

Partnering can help transit agencies meet pre-defined performance targets that they use to hit benchmarks for funding. Public-sector operators have imperatives to meet public interest goals, including service that is high-quality, affordable, equitable, sustainable, and safe. If structured correctly, competition between private sector bidders compels these companies to meet performance targets with more direct incentives (profit) than public-sector operators. Clearly establishing these metrics in a contract can improve a transit agency's operations while potentially leading to cost savings if coupled with competitive contract tendering (Lotshaw, et al. 2017).

Example
Transport for London uses a quality-incentive contract model in which private sector partners receive financial bonuses for exceeding performance targets and penalties for failing to hit targets. This model has improved reliability, thus boosting ridership on the bus network 69 percent since 2000 (Lotshaw, et al. 2017, 33). While this model is specific to fixed route transit, the notion of performance targets can be adapted to a new mobility context.

Regulatory and Legal Considerations

Transit agencies need to comply with FTA regulations as well as other relevant state, local, or grant-providing agency regulations regardless of whether they directly operate the service or use private sector partners to deliver services. With respect to partnerships between transit organizations and new mobility private sector partners, the legal aspects are still largely unknown. Further, regulations for these partnerships are much less clear and have not been established as they have for more traditional contracts with a third party for traditional bus services (Waite 2018, 111).

As new mobility partnerships evolve, transit agencies should pay attention to how the federal government adapts to accommodate these services. For example, the FTA is in the process of categorizing TNCs and determining whether they must follow the same regulations as traditional mass transit. Currently, they do not have to report data to the NTD. If new mobility is found to be "mass transit" in this sense, they will be required to report, for example, total boardings, vehicle miles, vehicle hours, passenger miles, asset inventory, revenue sources (Curtis, et al. 2019, 5-8, 5-9). However, this would not necessarily meet a transit operator's need for more detailed data sharing for planning purposes nor would it necessarily comply with local data-sharing mandates.

Americans with Disabilities Act (ADA) and Shared Mobility

For services that are under contract, Part 37 of the ADA requires transit agencies to ensure that private sector partners comply with the same requirements that the transit agencies would be required to follow if they were directly operating the service, sometimes referred to as "stand-in-the-shoes" requirements. These requirements do not apply, however, in two cases: when private entities are simply regulated by public entities or receive a permit to operate from public entities; and when public entities provide subsidies to private companies for the services they already operate (FTA C 4710.1). However, private sector partners typically do not have the same capability to provide equivalent service for customers with disabilities (Tsay et al. 2016, 33). For example, partnerships with TNCs or microtransit providers may face difficulties ensuring that the services are wheelchair accessible, as they do not typically have wheelchair accessible vehicles and will engage third-party contractors to provide such vehicles for pilots (Curtis, et al. 2019, S-2). Audible stop announcements are another benefit of fixed route service that is neither required by FTA nor typically provided in shared mobility.

TNCs. FTA guidance on shared mobility states the following about the ADA regulations that apply to TNC services:

- "The service, though not necessarily the ridesourcing [TNC] vehicles themselves, would have to be accessible to and usable by people with disabilities, including those who use wheelchairs…A transit system partnering with a ridesourcing entity to provide service to and from a commuter rail station, for example, could dispatch accessible vehicles from its own paratransit fleet via the ridesourcing entity's smartphone app to accommodate wheelchair users (FTA 2016)."
- In the case of partnerships with TNCs, the transit agency is obligated to meet the equivalent service standard and can do so by using accessible vehicles provided by the TNC operator, another third-party operator, or transit agency vehicles (Graves 2019).

Microtransit. FTA guidance states that providers of demand-responsive service to a new service area ensure that wheelchair-accessible vehicles are available, that fares for riders using wheelchair-accessible vehicles be the same as a rider using vehicle that is not wheelchair-accessible for a similar trip, and that wait times for wheelchair-accessible and non-wheelchair-accessible vehicles be the same (FTA 2016). Often, heavy-duty shuttle vehicles are used to meet ADA paratransit needs for microtransit services a transit agency offers (Shared-Use Mobility Center n.d.).

Checklist: ADA Compliance

The purpose of this checklist is to help transit agencies design contracts for services that comply with ADA laws. It is intended as a guide to help transit agencies ensure the provision of equivalent service but may not be an exhaustive list of all considerations an individual transit agency may need to review.

1. When negotiating contracts, does the contract or transit agency policy address the seven metrics? (All must be checked.)	☐ Response time ☐ Fares ☐ Geographic area of service ☐ Hours and delay of service ☐ Restrictions or priorities based on trip purpose ☐ Availability of information and reservation capability ☐ Constraints on capacity or service availability
2. What methods are used to ensure private sector partner compliance with contract terms? (Check all that apply, but at least one must be checked)	☐ Audits of private sector partner ☐ Unannounced on-site visits to observe operations ☐ Customer surveys ☐ Vehicle/maintenance records inspection ☐ Monthly management performance reports ☐ Other_____
3. What operational model are you using to provide equivalent service? (Any of these can be chosen.)	☐ All private sector partner vehicles comply ☐ Private sector partner has subcontract with ADA-compliant provider ☐ Transit agency has two contracts to comply
4. Have you coordinated with the city department responsible for issuing dockless permits with respect to sidewalk accessibility?	☐ Yes ☐ No

Further Reading

- FTA. November 4, 2015. “Circular 4710.1 Americans with Disabilities Act (ADA): Guidance”, pp.1-5, 1-6.
- Simon, R.M. 1998. Paratransit Contracting and Service Delivery Methods, Transit Cooperative Research Program (TCRP) Synthesis 31. Transportation Research Board, Washington, D.C.
- FTA. 2016. “Shared Mobility FAQs: Americans with Disabilities Act (ADA).”

Title VI of the Civil Rights Act of 1964

Title VI prohibits discrimination based on race, color, or national origin for programs receiving federal funds. FTA Circular 4702.1B describes specific requirements for analyses that must be performed by providers of fixed route transit operating 50 or more vehicles in peak period service that must be addressed when making service or fare changes.

All transit agencies should consult their Title VI Officer and the FTA Region Title VI Officer at the outset of planning for any private-sector partnership to understand how the requirements of FTA C 4702.1B need to be addressed in their planning process.

- If partnerships with ride-sourcing providers (TNCs) are replacing fixed route service for a transit agency that operates 50 or more vehicles in peak period service, then the transit agency may be required to conduct a service equity analysis that documents the potential findings of *disparate impact* to minority communities and *disproportionate burden* to low-income comments due to the fixed route service changes. Transit agencies could consult the *major service change policy* in their Title VI Program to determine if a service equity analysis is required.
- Microtransit is not specifically addressed as a mode in FTA C 4702.1B. Given that microtransit often has characteristics of both fixed route and DRT, the specific characteristics of the service design may impact guidance from your Title VI Officer and FTA Region Title VI Officer on how to analyze the effects of introducing microtransit.
- If microtransit service is classified as DRT, no Title VI service equity analysis is required.
- If a transit agency that operates 50 or more vehicles in peak period service is modifying existing fixed route transit service in concert with the introduction of microtransit service, then the transit agency may be required to conduct a service equity analysis that documents the potential findings of disparate impact to minority communities and disproportionate burden to low-income comments due to the fixed route service changes. Transit agencies could consult the major service change policy in their Title VI Program to determine if a service equity analysis is required.
- If the microtransit service is classified as fixed route, you may or may not need to conduct a Title VI service equity analysis. Transit agencies could consult the major service change policy in their Title VI Program to determine if a service equity analysis is required.

Checklist: Title VI Compliance

The purpose of this checklist is to help transit agencies design contracts for services that comply with Title VI laws. It is intended as a guide to help transit agencies provide access for underserved communities but may not be an exhaustive list of all considerations an individual transit agency may need to review.

Have you consulted with your Title VI Officer and FTA Region Title VI Officer to inquire about the applicability of conducting a Title VI Service Equity Analysis for your specific shared mobility related service change?	☐ Yes ☐ No

Further Reading

- FTA. October 1, 2012. “Circular 4702.1B: Title VI Requirements and Guidelines for Federal Transit Administration Recipients.”
- Oregon Department of Transportation. 2018. “Handbook: Title VI of the Civil Rights Act.”
- Transportation for America. 2018. “Shared Micromobility Playbook.”

Equity Considerations

Among the most pressing issues with respect to new mobility partnerships is ensuring equitable service. Transit agencies should set clear objectives and assess equity broadly to achieve the best

outcomes for a partnership (Peterson, et al. 2019, 2). Transit agencies should consider the spatial, temporal, economic, physiological, and social barriers to achieving equity (Peterson, et al. 2019, 10). Spatial analyses of demographics, access to jobs and critical services, and transportation service should be used to establish baselines of the transportation network, and this analysis can inform performance metrics tied to specific community-driven goals to improve equity in service (Accuardi 2018, 39).

Unbanked Populations

In general, TNC and micromobility riders must have a debit or credit card, a mobile device, and access to mobile data. This can exclude some people from using these services (Westervelt, et al. 2017, 108). Providers typically address this by engaging a third-party (e.g., taxi service) that accommodates dispatching over the phone, or by utilizing a dispatch platform that allows a call-center to make bookings and manage reservations on behalf of the customer (Curtis, et al. 2019, S-2, S-3). Requiring private sector partners to use a cash-based system is one way to ensure that service is available to those who are unbanked.

Low-Income Populations

New mobility services may be less affordable to the user than traditional public transportation services. Service providers should first assess whether the new options are affordable for low-income individuals to regularly use those services or, if bus services are to be cut and replaced by new mobility services, that there are mechanisms in place to ensure that costs do not increase for low-income riders (Cohen and Cabansagan 2017, 8).

Equitable Access

Many cities include a requirement for equity plans in their permitting processes whereby operators must demonstrate how their services increase access for all with a specific emphasis on communities with fewer public transit options. Transit agencies can work with the department in charge of micromobility permits to determine whether equity plans are in place (Transportation for America 2020; National Association of City Transportation Officials 2019).

Checklist: Equity Considerations

This checklist will help transit agencies determine what they should do to ensure they are achieving equitable service when partnering during a bus network redesign.

1. What analyses will be conducted to assess baseline public transit equity? (The following are examples of analyses, not an exhaustive list.)
    a. Spatial analyses to identify traditionally disadvantaged populations.
    b. Project-level planning analyses that assess both quantitative and qualitative community data to identify how a partnership may affect a specific route or program.
    c. System-level planning analyses that assess both quantitative and qualitative community data to identify how a partnership may affect the entire transit system.
    d. Mobility equity analysis that assesses whether projects increase access to mobility, reduce air pollution, and enhance economic opportunities for affected communities.
    e. Accessibility-driven performance analysis that measures access to critical destinations like jobs, cultural spaces, healthcare facilities, schools, and groceries.
    f. Community outreach that is inclusive and accessible to all who may be affected by a change in service.
2. How will the selected service performance goals impact baseline equity in terms of the proportion of traditionally disadvantaged populations served and the quality of the service experienced by these populations versus the general population?
3. What strategies will be used to ensure access for the traditionally disadvantaged populations traveling in the selected service area? How will the populations that these strategies are intended to serve been involved in their development or review?
4. If conducting public outreach for the partnership activity, will public outreach be conducted in an equitable fashion and in accordance with your transit agency's Title VI Public Participation Plan?

Further Reading

- Accuardi, Z. 2018. Inclusive Transit: *Advancing Equity Through Improved Access and Opportunity*. TransitCenter, New York, NY.
- City of Oakland. *Equity Dashboard*. http://oakbec.s3.amazonaws.com/MapLanding/maps/Equity_Dashboard_2.html (As of February 18, 2020).
- Creger, H., J. Espino, and A.S. Sanchez. 2018. *Mobility Equity Framework: How to Make Transportation Work for People*. The Greenlining Institute.
- Peterson, S.J., B. Holland, E. Evenhouse, and P. Lauer. 2019. Equity and Shared Mobility Services: Working with the Private Sector to Meet Equity Objectives. Shared-Use Mobility Center, Chicago, IL.

Data Sharing

Data shared by private new mobility providers, including TNCs and microtransit companies, could prove very useful for transit agency planners seeking to determine travel patterns and how people are using these services in areas differently served by transit.

Existing research has identified the inability to reach agreements on data sharing as one of the biggest barriers to pursuing partnerships with the private sector, though a transit agency's access to data will affect its ability to assess service performance and secure public funding (Curtis, et al. 2019, 3-3). TNCs are hesitant to share data due to privacy concerns, and most transit agencies are required to make data available and open to the public under "sunshine laws" or federal Freedom of Information Act (FOIA) laws (Curtis, et al. 2019, ES-2). Specific data collection and sharing requirements can be listed in agreements between the organization and the partnering companies (New York Public Transit Association n.d., 10).

Regulated compulsory data sharing has been effective for organizations, but many municipalities are not permitted by state law to require this information from private partners. Most transit providers that have set up voluntary data sharing agreements have not found them particularly effective. For example, Boston started a voluntary data-sharing agreement with a TNC in 2015. The City has found that the data is aggregated at a ZIP code level, which does not provide enough detail for meaningful analysis. Furthermore, there are strong data protection agreements that prevent the City of Boston from responding to FOIA requests on the data (though the TNC has agreed to be liable for any penalties for violating FOIA) or sharing it with any third parties, including using cloud-based systems (which could be considered third-party) to analyze the data (Tsay, et al. 2016, 38). Another option is to have the private company share through a third party, such as a non-profit or a university, which has potential benefits in terms of data security and privacy (Tsay, et al. 2016, 75).

Data sharing agreements with private companies tend to be most beneficial for public entities with leverage, either through the size of their market or through regulations. New York City has both the market size and the state-granted regulatory power to require data sharing. New York City also requires data from providers that are not new mobility, such as taxis and black cars, which provides more political justification for this requirement (Tsay, et al. 2016, 35-36). The City's data requirements result in information on origins for all trips taken on TNCs. This data is available to the public and utilized for third-party research and analysis (Tsay, et al. 2016, 35-36). While New York City has significantly more leverage to negotiate agreements due to its size, other cities like Seattle have also instituted data sharing requirements. An alternative to negotiating data sharing requirements at the municipal level is to create state-wide requirements (Tsay, et al. 2016, 35).

Before negotiating a contract, a transit agency should define service performance goals and what data it would need to assess progress toward those goals. This can then be written into the contract via a Term Sheet or reporting requirements for the private entity that provides that data (Tsay, et al. 2016, 8)

Checklist: *Data Sharing*

This checklist will help transit agencies understand how to use data in service of achieving performance goals and design a contract that clearly delineates data requirements to private sector partners.

1.	List any existing or pending state, local, or transit agency legal constraints regarding data collection or sharing (e.g., public records request laws).	
2.	Do you currently collect data to measure your service performance goals? If so, what additional data would you need to achieve those goals?	☐ Yes ☐ No
3.	Did you create a Term Sheet early in the process to determine the data points requested?	☐ Yes ☐ No
4.	Who will have access do the data? (Check all that apply)	☐ Transit agency ☐ Private sector partner ☐ Third party (e.g., non-profit or university) ☐ Others
5.	Who will own the data?	☐ Transit agency ☐ Private sector partner
6.	What measures do you take to ensure data privacy?	☐ Removing unique identifiers ☐ Aggregating data ☐ Maintaining secure server and computer access
7.	List any existing or pending state, local, or transit agency legal constraints regarding data collection or sharing (e.g. public records request laws).	

Further Reading

- Grossman, A., and P. Lewis. 2020. *Data on Demand: A Case Study in the Los Angeles and Puget Sound Regions*. Eno Center for Transportation, Washington, DC.
- Tsay, S., Z. Accuardi, and B. Schaller. September 2016. Private Mobility, Public Interest: How Public Agencies Can Work with Emerging Mobility Providers. TransitCenter, New York, NY.
- Gururaja, P., R. Faust, and S. Feigon. 2019. *Objective-Driven Data Sharing for Transit Agencies in Mobility Partnerships*. Shared-Use Mobility Center, Chicago, IL.

Labor and Safety Considerations

Among the considerations when implementing a new mobility partnership or contracting for service delivery is how proposed changes will affect labor relations and safety of both operators and passengers. Table 7 lists several labor laws that relate to new mobility providers

Table 7. Selected Relevant Labor Force Laws

Applicable Law	Description
National Labor Relations Act (29 U.S.C. 151 – 169)	Stipulates that workers classified as employees, but not independent contractors, have the right to form or join unions or participate in collective bargaining.
Federal Transit Act, Section 13(c)	Protects the benefits, collective bargaining rights, and working conditions of incumbent workers both at transit agencies and private companies operating transit service as purchased transportation.
California Assembly Bill 5 (2019)	California is one state among several that now require TNCs and microtransit providers to hire workers as employees, rather than as independent contractors.

Labor laws guide how transit agencies interact with their existing and potential workforces. For new mobility providers, particularly TNCs, workers are not salaried but rather are paid per task, resulting in a lack of clarity in some cases as to how these workers fit into the existing legal context; the employment status and worker protections for these and other "gig economy" workers is a topic of consideration by legislative bodies across the country, such as the New York, New Jersey, Illinois, and California legislatures (Rosenberg 2020). Given that workplace protections for gig economy workers is increasingly a focus at the state level, transit agencies should make clear in contracts how the service partner should support their workforce.

With regard to safety, the differing legal and regulatory requirements for private companies compared to transit agencies may pose risks to drivers and passengers. Public transit drivers undergo extensive background checking and specific training to create a safe environment for passengers, and private sector drivers are not held to the same training standards. Table 8 lists some labor and safety challenges experienced by transit agencies and how they responded.

Table 8. Common New Mobility Partner Labor or Safety Characteristics and Transit Agencies

New Mobility Partner Labor or Safety Characteristic	Challenge for a Transit Agency	Example Transit Agency Response
Employees are independent contractors	In order to provide federally funded services, such as paratransit, the FTA requires drivers to undergo drug and alcohol testing (Shared-Use Mobility Center 2016a, 26). There is a "taxicab" exception, in which these rules do not apply if the customer can choose which company to use. This exception does not apply, however, if the transit provider makes this choice, for example if the transit company provides vouchers for only a single operator (Graves 2019).	The KCATA partnered with its transit union to provide new mobility services, using unionized labor to operate the vehicles. Transit provider and union conversations about the implications of new mobility began early in the development of their contract with a private new mobility partner to provide the service (Tsay, et al. 2016, 30; Westervelt, et al. 2017, 110).
Low level of driver training and vetting	The lack of training and vetting required specifically of TNC drivers compared to other professional drivers poses safety and liability concerns (Waite 2018). Unlike many commercial drivers, TNC drivers are not always required to undergo fingerprinting, drug tests, or sensitivity training (Curtis, et al. 2019, 3-2).	**The California Public Utilities Commission,** while not a transit agency, requires TNCs to provide driver training programs and report on the number of drivers completing the program. However, there is no public data on this program and its effectiveness (San Francisco Transportation Authority 2017, 4).
Concerns that a partnership will result in loss of unionized positions	Many transit agency respondents to one survey indicated that concerns about the impact or perceived impacts to union labor was a key challenge (Curtis, et al. 2019, 121).	**Livermore Amador Valley Transit Authority (LAVTA)**. Prior to piloting on-demand services with two TNC companies and a local cab company, labor unions with LAVTA expressed concern that the partnerships would replace the unionized workforce. However, the union's concerned were allayed after learning that the pilot would not reduce the amount of fixed-route service provided or impact the number of union operators (Curtis, et al. 2019, 38-39).

Checklist: *Labor*

As the bus network redesign team considers working with private providers, they should consult the following checklist to consider labor implications.

1.	Does the service you are trying to contract out represent any loss of in-house workers?	☐ Yes (Agencies wishing to contract out transit services are not prohibited from doing so under federal law, but they must do so in compliance with 13(c)) ☐ No
2.	Are there any current or pending laws in your jurisdiction about worker protections for independent contractors?	☐ Yes ☐ No
3.	Does your transit agency have any of the following policies that support contracted worker protections? If no to any, will you evaluated how to incorporate these policies into your existing contracts?	☐ Compensation parity ☐ Defined benefit retirement plan ☐ Benefits similar or equal to city employees

Further Reading

- Lotshaw, S., P. Lewis, D. Bragdon, and Z. Accuardi. 2017. *A Bid for Better Transit: Improving Service with Contracted Operations*. TransitCenter and Eno Center for Transportation, Washington, DC.

Identifying Risks in Partnerships

Contracting or partnering with the private sector always involves a level of risk. The partner that is chosen—and the service contract agreed upon—can have an impact on the transit agency workforce and the riding public's daily lives. Laws and regulations are constantly changing, implicating labor protections, data sharing, and how, where, and for what cost the systems operate. Understanding and mitigating risks like these is particularly important as transit agencies implement bus network redesigns that include elements of new mobility in their long-term operational plans. This section will cover the types of risk that contracting or partnering with the private sector entails, including how to anticipate and mitigate these risks with an effective contract.

As shown in Figure 31 there are four major elements of risk to which transit agencies may be susceptible when partnering during a bus network redesign.

- **Financial risk**. A transit agency is at financial risk when it funds services provided by an external partner.
- **Operational risk**. Relying on a partner for service puts a transit agency at operational risk**,** because if those services are no longer offered, the transit agency must find another way to provide service.
- **Regulatory risk.** Government actions put a transit agency at regulatory risk**,** as any new mandates or laws may interrupt the transit agency's ability to proceed with a partnership or may impact existing partnerships.
- **Reputational risk.** Partnering can put a transit agency at reputational risk if the partner fails to provide service to the standard or precedent set by the transit agency itself.

These risks are interrelated. Exposure to one type of risk can introduce another type of risk to the transit agency. For example, if the service provision costs increase (i.e., financial risk), the transit agency may initially increase fares to deliver the service, damaging its reputation (i.e., reputational risk), and may eventually cease to provide the service altogether (i.e., operational risk).

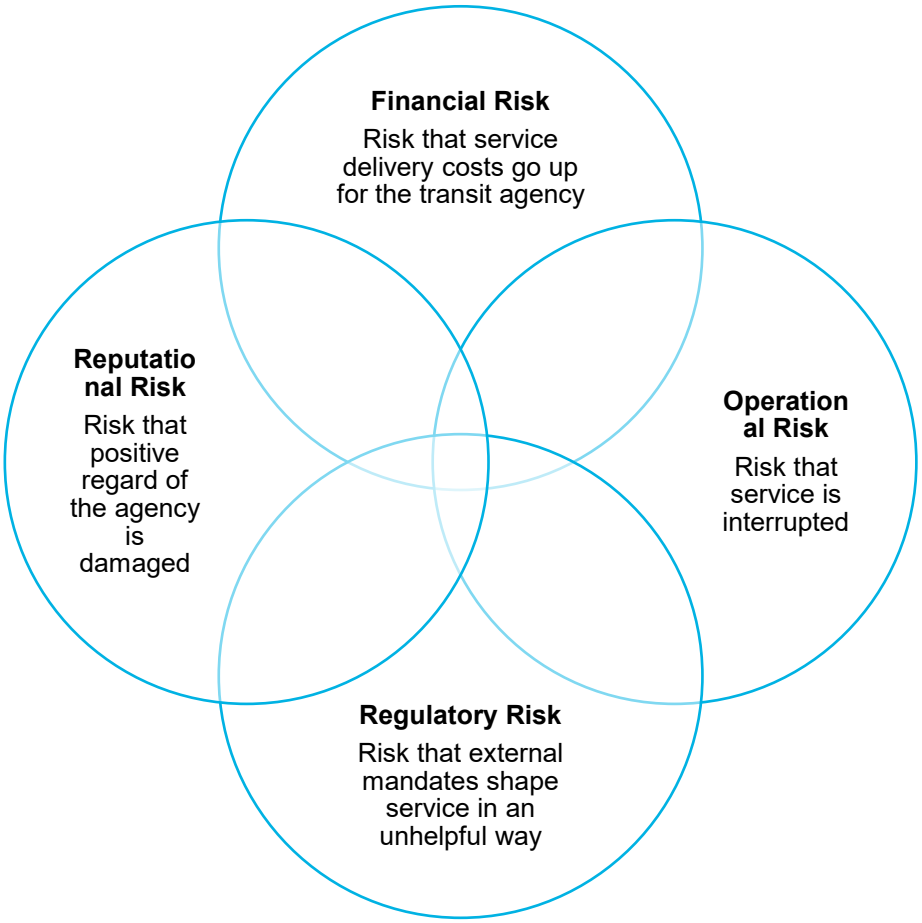


Figure 31. Four Major Elements of Risk in Partnerships Between Transit Agencies and the Private Sector

Financial Risk

Contracting presents an opportunity to transfer risks related to financial costs to the private sector. In some cases, such as when the private sector partner provides assets, they take on capital risks associated with these assets (Reich and Davis 2011, 58). In other cases, such as fare revenue as it relates to ridership, the transit agency maintains the risk and would thus be impacted financially in a way that the private sector would not necessarily be in the event of ridership declines (Lotshaw, et al. 2017, 130). A private sector partner will often price risk and uncertainty into their bids, which is something that a transit agency should learn to identify before entering the contracting phase (Lotshaw, et al. 2017, 130-131).

Potential strategies to anticipate and mitigate financial risk

- Gather information on pilot programs being conducted at other transit agencies
- Monitor the financial trends at new mobility companies
- Identify where a private sector partner has built uncertainty into their bidding price
- Conduct a pilot with a new partner before engaging in full-scale operations

- Create a contingency plan for situations such as for if a private sector partner's prices increase dramatically after a pilot
- Link financial risks to positive incentives for the private sector partner

Operational Risk

If a private sector partner ceases to exist or changes their operational model in any significant way, this can put transit agencies at risk of losing a service that augments their networks and brings users to the system. If a transit agency relies completely on a private company's service without the ability to step in and continue service in the event of a service interruption, it may lose riders over the long-term.

Private companies must achieve financial viability (with revenues meeting or exceeding costs) or they will go out of business. In recent years TNCs, which were initially backed by venture capital, have reported considerable financial losses (King and Newcomer 2018). Many private micromobility providers also report considerable financial losses, and in the late 2010s large scale layoffs at both TNCs and micromobility providers have occurred in an effort to decrease costs at these firms (Wilson 2020). Partnering with firms that have not achieved financial viability can pose a risk for a transit agency as they may not be able to operate indefinitely without raising the cost of their services or scaling back their operations, including potentially ceasing operations in a transit agency's service area.

Potential strategies to anticipate and mitigate operational risk

- Closely evaluate financial performance of private companies
- Incorporate contingency plans for continued service in the event that a private company can no longer provide service

Regulatory Risk

Regulation in a new mobility market tends to happen outside of the transit agency's jurisdiction and affects a transit agency's decision to pursue partnerships as well as the ultimate shape of those partnerships. Following their experience with the arrival of TNCs in markets with little regulation, cities and states are increasingly apt to regulate new services. Strict permitting requirements or regulations like data sharing requirements may discourage companies from seeking to operate in a given place, but it can also pose new challenges to a transit agency that may not have the capacity to oversee that companies comply with new regulations in the context of a contracted partnership.

Determining the appropriate amount of consideration to give to each of these factors when establishing a contract is important. A transit agency should weight the importance of these and any additional factors in relation to one another, then consider how these factors map on to various governance arrangements before determining which is most appropriate.

Insurance is another consideration that plays out differently depending on the partnership type. For new mobility services, transit agencies approach liability requirements in different ways. In a recent survey, 53 percent of transit agency respondents indicated that partners or collaborators are not required to obtain additional liability insurance as part of a partnership, while 29 percent stated that partners must obtain additional coverage (Curtis, et al. 2019, 125). A recent report on the legal considerations of partnerships between transit organizations and TNCs provided guidance on best practices regarding risk management. With respect to insurance, insurance coverage should apply to both vehicles that are hired and owned by drivers. The report also suggests that agreements use broad language regarding compensation for harm or

loss, especially since TNC drivers are not full-time employees of the companies for which they drive (Waite 2018, 108-109).

Potential strategies to anticipate and mitigate regulatory and governance risk

- Create a decision matrix to compare various governance models against decision factors
- Stay informed of state and local regulations with respect to new mobility
- Maintain close contact with officials from your state and local jurisdictions' legislative affairs offices to stay informed about potential legislative changes that may impact your partnerships

Reputational Risk

Choosing to partner means that a transit agency is entrusting its services to a private company. If that company underperforms or in some way violates public trust, both the company and the transit agency may be blamed. An unsuccessful pilot with a new mobility company may also reflect poorly on a transit agency and hinder the potential to introduce and scale the pilot for full service. Vehicle branding for new mobility provider partners—which may be the transit agency's, the private company's, or a mix—is one factor that may influence the assignment of blame in the event of inadequate or unsafe service. Transit agencies should think critically about the public-facing aspects of service operation and how to mitigate or manage any public relations related to service issues.

Potential strategies to anticipate and mitigate reputational risk

- Anticipate the types of challenges that may affect your service when in the hands of a private sector partner
- When piloting a service and providing full-scale service with a new private sector partner, conduct longitudinal assessments of rider opinions of both that operator and your transit agency
- Develop standards and procedures for responding to significant events for both the private sector partner and your transit agency

REFERENCES

Accuardi, Z. 2018. *Inclusive Transit: Advancung Equity Through Improved Access and Opportunity.* TransitCenter, p. 39, New York, NY.

APTA. 2019. *Being Mobility-as-a-Service (MaaS) Ready: APTA International Study Mission.* American Public Transportation Association, Washington, DC.

Arlington County, VA. 2012. *Capital Bikeshare Transit Development Plan*. Arlington County, VA, Arlington, VA.

Badia, H., E. Miquel, and F. Robuste. 2014. "Competitive Transit Network Design in Cities with Radial Street Pattterns." *Transportation Research Part B: Methodological,* pp. 161-181. doi:10.1016/j.trb.2013.11.006.

Bhattacharya, T., J. Brown, M. Jaroszynski, and T. Batuhan. 2014. "The Effects of Perception vs. "Reality" on Travel Behavior after a Major Transit Service Change: The Case of Tallahassee, Florida." *Journal of Public Transportation*, 17 ed.

Boyle, D.K., and J. Rey. 2012. "Redesigning an Existing Transit Network from Scratch." *Transportation Research Board of the National Academies,* No. 12-3887.

Central Ohio Transit Authority. 2016. *Long Range Transit Plan.* Central Ohio Transit Authority.

City of Santa Monica. 2019. *Shared Mobility Pilot Program Summary Report*. City of Santa Monica, Santa Monica, CA.

Cohen, S., and C. Cabansagan. 2017. *A Framework for Equity in New Mobility.* TransForm, Oakland, CA, p. 8.

Dallas Area Rapid Transit. 2016. *Comprehensive Operations Analysis (COA): Draft Bus Service Plan Recommendations.* Dallas Area Rapid Transit, Dallas, TX.

Eno Center for Transportation. 2019. *A Fast-Changing Mobility Landscape: An Analysis of Public Transit Agency Survey Results.* The Eno Center for Transportation.

Federal Transit Administration Office of Budget and Policy. 2019. *National Transit Summaries and Trends: Appendix.* Federal Transit Administration, Washington, DC.

FTA. 2018. *MOD Sandbox Demonstrations Independent Evaluation: DART – The First and Last Mile Solution Evaluation Plan.* Federal Transit Administration,Washington, DC.

FTA. 2016. *Shared Mobility FAQs: Americans with Disabilities Act.* https://www.transit.dot.gov/regulations-and-guidance/shared-mobility-faqs-americans-disabilities-act-ada. (as of May 1, 2020).

Goodall, W., T.D. Fishman, J. Bornstein, and B. Bonthron. 2017. "The Rise of Mobility as a Service: Reshaping How Urbanites get Around." *Deloitte Review*.

Graves, B. 2019. *Shared Mobility and TNCs: Legal Considerations for Public Transit.* Federal Transit Administration.

Grossman, A., and P. Lewis. 2019. *Contracting for Mobility: A Case Study in the Los Angeles and Puget Sound Regions.* Eno Center for Transportation, Washington, DC.

Grossman, A., and P. Lewis. 2020. *Data on Demand: A Case Study in the Los Angeles and Puget Sound Regions.* Eno Center for Transportation, Washington, DC, p.12.

Halifax Transit. 2016. *Moving Forward Together Plan*. Halifax Transit.

Houston METRO. 2016. *Houston METRO New Bus Network (NBN) Planning & Implementation, Lessons Learned Volumes 1 & 2.* Houston METRO, Houston, TX.

Houston METRO. 2014. *Reimagined 5-Year Transit Service Plan.* Houston Metro, Houston, TX.

Houston METRO. n.d. *Houston Metro New Bus Network (NBN) Planning & Implementation.* Metropolitan Transit Authority of Harris County, Houston, TX, pp. 1-3.

Indy Connect. 2016. *The Central Indiana Transit Plan*. Indy Connect.

Indy Connect. n.d. *The Marion County Transit Plan*. Indy Connect.

IndyGo. 2019. *Fare Capping and 2-Hour Transfer: Fare Policy Proposal and Equity Analysis*. IndyGo, Indianapolis, IN, p. 9.

IndyGo. 2015. *IndyGo Forward*. IndyGo, Indianapolis, IN.

Jacksonville Transportation Authority. n.d. *Route Optimization Initiative: Case Study*. Jacksonville Transportation Authority, Jacksonville, FL.

Kalantari, N.Z. 2014. *Bus Network Modification Problem: A New Approch to Bus Network Design*. Transportation Reserach Board, Washington D.C.

King, I., and E. Newcomer. 2018. "Uber Spent $10.7 Billion in Nine Year. Does it Have Enough to Show for it?" *Bloomberg*, March 6.

LA Metro. 2019a. *Board Report: NextGen Regional Service Concept.* LA Metro, Los Angeles, CA, Juy 18. http://media.metro.net/projects_studies/nextgen/images/Ops_Committee_NG_Regional_Service_Concept_2019-0718.pdf (As of May 22, 2020).

LA Metro. 2020a. *LA Metro Board of Directors Approves Creation of Innovative New MicroTransit Pilot Project,.* LA Metro, Los Angeles, CA, February 27. https://www.metro.net/news/simple_pr/la-metro-board-directors-approves-creation-innovat/ (As of May 22, 2020).

LA Metro. 2020b. *LA Metro Transit Service Policy.* LA Metro, Los Angeles, CA.

LA Metro. 2019b. *MicroTransit Pilot.* LA Metro, Los Angeles, CA.

LA Metro. 2020c. *NextGen Bus Plan.* LA Metro, Los Angeles, CA.

LA Metro. 2018. *Transfers Design Guide: Improving Connections for a Seamless Trip.* LA Metro, Los Angeles, CA.

LA Metro. n.d. *Office of Extraordinary Innovation.* https://www.metro.net/projects/oei/ (As of May 20, 2020).

Lotshaw, S., P. Lewis, D. Bragdon, and Z. Accuardi. 2017. *A Bid for Better Transit: Improving Service with Contracted Operations.* TransitCenter and Eno Center for Transportation, Washington,DC.

Madej, P. 2020. "Leslie Richards Has Taken Over as SEPTA's General Manager. She's All Ears." *The Philadephia Inquirer*, January 24.

Martin, E., and S. Shaheen. 2016. *Impacts of car2go on Vehicle Ownership, Modal Shift, Vehicle Miles Traveled, and Greenhouse Gas Emissions: An Analysis of Five North American Cities*. Innovative Mobility Research and Transportation Sustainability Research Center, Berkeley, CA.

MDOT MTA. 2018a. *BaltimoreLink Final Report (Draft).* Maryland Transit Administration, Baltimore, MD.

MDOT MTA. 2018b. n.d. "Project Overview: North Avenue Rising." Open House Meeting Slides. https://northavenuerising.com/ (As of July 21, 2020).

MDOT MTA. 2017. *Launching the Network Redesign.* Maryland Transit Administration, Baltimore, MD.

Meese, A. 2019. "Ovewview of Recent COG/TPB Dockless Shared Mobility Device (SMD) Activities." *Commuter Connections Subcommittee Item #4.*

Narula-Woods, R. 2018. *Three Contracts Awarded to Firms to Design Microtransit Service.* LA Metro, Los Angeles, CA.

National Association of City Transportation Officials. 2018. *Guidelines for the Regulation and Management of Shared Active Transportation.* National Association of City Transportation Officials, New York, NY, pp. 7-8.

National Association of City Transportation Officials. 2019. *Shared Micromobility in the U.S.* National Association of City Transportation Officials, New York, NY.

New York City Transit Authority. 2017. *Staten Island Bus Study: Reimagining Express Buses.* New York City Transit Authority, New York, NY.

New York Public Transit Association. n.d. *NYPTA White Pater on Transportation Network Company (TNC) Issues.* New York Public Transit Association, New York, NY, p. 10.

Peterson, S.J., B. Holland, E. Evenhouse, and P. Lauer. 2019. *Equity and Shared Mobility Services: Working with the Private Sector to Meet Equity Objectives.* Shared-Use Mobility Center, Chicago, IL, pp. 2, 10.

PTSA. 2020. *Catch a Ride Before You Ride*. PTSA https://www.psta.net/riding-psta/direct-connect/ (As of May 22, 2020).

Reich, S.L., and J.L. Davis. 2011. *Analysis of Contracting for Fixed Route Bus Service.* National Center for Transit Reserach, Tampa, FL, p. 58.

Rosenberg, E. 2020. "Can California Rein in Tech's Gig Platforms? A Primer on the Bold State Law that Will Try." *The Washington Post,* January 14.

San Francisco Transportation Authority. 2017. *The TNC Regulartory Landscape: An Overview of Current TNC Regulation in California and Across the Country*. San Francisco Transportation Authority, San Francisco, CA, p. 4.

Schmitt, A. 2018. "The Columbus Bus Network Redesign Boosted Ridership." *Streetsblog USA*, August 14.

Shaheen, S., and A. Cohen. 2020. *Innovative Mobility: Carsharing Outlook Carsharing Market Overview, Analysis, And Trends.* Transportation Sustainability Research Center, Berkeley, CA.

Shaheen, S., and N.D. Chan. 2012. "Ridesharing in North America: Past, Present, and Future". *Transport Reviews*.

Shared Use Mobility Center. 2020. *Mobility on Demand Learning Center.* https://learn.sharedusemobilitycenter.org/ (As of March 22, 2020).

Shared-Use Mobility Center. n.d. *Learning Module: Microtransit.* https://learn.sharedusemobilitycenter.org/learning_module/microtransit/ (As of May 22, 2020).

Shared-Use Mobility Center. 2016a. *Shared Mobility and the Transformation of Public Transit.* Shared-Use Mobility Center.

Shared-Use Mobility Center. 2016b. *Shared-Use Mobility Toolkit for Cities.* Shared-Use Mobility Center.

Short, A. 2017. "Driver Shortages Causing Transit Delays Nationwide." *Streetsblog USA*, August 27. https://usa.streetsblog.org/2019/08/27/driver-shortages-causing-transit-delays-nationwide/ (As of May 22, 2020).

Touhy, J. 2016. "Supporters declare victory for mass transit tax hike in Marion County." *IndyStar*, November 9.

Transportation for America. 2020. *Shared Micromobility Playbook*. Transportation for America. https://playbook.t4america.org/ (As of May 22, 2020).

Tsay, S., Z. Accuardi, and B. Schaller. 2016. *Private Mobility, Public Interest: How Public Agencies Can Work with Emerging Mobility Providers.* TransitCenter, New York, NY.

Union of Concerned Scientists. 2020. *Ride-Hailing's Climate Risks Steering a Growing Industry toward a Clean Transportation Future*. Union of Concerned Scientists, Cambridge, MA.

Vock, D.C. 2017. "Bus Network Redesigns are the 'Hottest Trend in Transit'." *Government Technology.* September 19.

Westervelt, M., J. Schank, and E. Huang. 2017. "Partnerships with Technology-Enabled Companies: Lessons Learned." *Transportation Reserach Record* Vol. 2649, Is. 1, pp. 108,110.

Wilson, K. 2020. "Why Do Micromobility Companies Keep Losing Money?" *Streetsblog*, January 14.

ABBREVIATIONS AND ACRONYMS

AC Transit	Alameda-Contra Costa Transit District
ADA	Americans with Disabilities Act of 1990
AFC	Automated Fare Collection
APC	Automated Passenger Counter
APTA	American Public Transportation Association
AVL	Automatic Vehicle Location
BART	Bay Area Rapid Transit
BRT	Bus Rapid Transit
CAD/AVL	Computer-aided Dispatch/Automatic Vehicle Location
Capital Metro	Capital Metropolitan Transportation Authority
CARTA	Charleston Area Regional Transportation Authority
CEO	chief executive officer
CIRTA	Central Indiana Regional Transportation Authority
CITTF	Central Indiana Transit Task Force
COTA	Central Ohio Transit Authority
COVID-19	Coronavirus Disease 2019
DART	Dallas Area Rapid Transit
DRT	demand response transit
e-bike	Electric Bicycle
FOIA	Freedom of Information Act
FTA	Federal Transit Administration
GIS	geographic information system
GTFS	General Transit Feed Specification
Houston METRO	Metropolitan Transit Authority of Harris County
HRT	Hampton Roads Transit

IndyGo	Indianapolis Public Transportation Corporation
ITDP	Institute for Transportation and Development Policy
ITS	Intelligent Transportation Systems
JTA	Jacksonville Transportation Authority
KCATA	Kansas City Area Transportation Authority
LA Metro	Los Angeles County Metropolitan Transportation Authority
LANTA	The Lehigh and Northampton Transportation Authority
MaaS	Mobility as a Service
MARC	Maryland Area Regional Commuter
MARTA	Metropolitan Atlanta Rapid Transit Authority
MDOT MTA	Maryland Department of Transportation Maryland Transit Administration
MOD	Mobility on Demand
NTD	National Transit Database
PSTA	Pinellas Suncoast Transit Authority
QA/QC	Quality Assurance/Quality Control
QR	Quick Response
RFP	Request for Proposals
ROW	Right-of-Way
RTD	Denver Regional Transportation District
SEPTA	Southeastern Pennsylvania Transportation Authority
TAP	Transit Access Pass
TCRP	Transit Cooperative Research Program
Title VI	Title VI of the Civil Rights Act of 1964
TNC	Transportation Network Company
TSP	Transit Signal Priority
UTA	Utah Transit Authority
VVTA	Victor Valley Transit Authority

WMATA	Washington Metropolitan Area Transit Authority

APPENDIX

Question Bank for Interviews

Questions for each interviewee were selected from a question bank that covered a variety of topics for this research. Not every transit agency or organization was asked the same questions, but rather was asked a subset of the questions listed here.

- Transit Network Redesigns – How and why are transit agencies conducting them and what benefits are resulting?
  - What were the goals of the redesign process (or comprehensive transit plan) and why did the transit agency conduct one – what was the driving force?
    - Were there findings from an existing analysis that lead decisionmakers to pursue a redesign?
    - Who were the stakeholders involved in pursuing a redesign?
    - When was the decision made to pursue a redesign? Was there any relationship with this decision to the arrival of new mobility services?
  - Was there any single overarching philosophy or goal of the redesign (e.g., change balance between frequency and coverage, increase access to job centers, etc.)?
  - What were the major barriers encountered in the redesign process (e.g., political and public support, funding, consideration of trade-offs in various service design approaches such as a frequency vs. coverage) and were they overcome?
  - How were the needs of specific populations (e.g., disability community, Title VI protected populations) were analyzed and incorporated in the process?
  - What process did you utilize to identify any Title VI impacts of the network redesign? How did you analyze the potential Title VI impacts for the use of TNCs or micromobility?
  - Were there any specific considerations given to the potential impacts on affordable housing?
  - How were stakeholders and the public engaged; how did you involve the operator/union in the redesign process and what were there key concerns?
    - How did you create “buy-in” for the process from both internal and external stakeholders?
  - How did the transit agency address other areas such as integration with other regional transit providers and whether the redesign went beyond the bus network?
  - How did the transit agency deal with related capital improvements such as bus priority treatments as part of the redesign?
  - What metrics did you use to describe costs and benefits of the redesign?
  - What were the successes or failures of the redesign, both in terms of the process and expected vs. actual outcomes?

  - How has the public perceived the redesign?

- Transit Network Redesigns and Service Planning – How has transit service planning responded to new mobility options and changing customer expectations and preferences?

  - How were customer expectations and preferences explored during the transit network redesign process?
  - In your redesign, how did you weigh the needs of high- and low-density areas? How did you measure impacts to service in low density areas?
  - If new mobility options such as TNCs, micro-mobility, microtransit, and AVs were incorporated or considered in a redesign, how were the impacts of these options analyzed in terms of current and potential impacts on system ridership and travel patterns?

    - How were the impacts of these options considered in the context of developing transit network redesigns and service planning?

- Transit Agency Partnerships with TNCs, Micro-mobility, On-Demand Microtransit Services, and AV Pilots: How are fixed-route transit providers adapting to and leveraging the technological advances and new services in the marketplace?

  - What has been your experience to-date with current or past partnerships with TNCs, micro-mobility, microtransit, and AVs operators?
  - What service model does the provider you contracted with use (i.e., DRT, deviated fixed route, etc.)?
  - Do you feel the private provider(s) you are working with is best suited to providing a certain trip type, or service in a certain type of area, that transit may not be best suited for?
  - How is the service/partnership integrated with your fixed route service?
  - How have these partnerships been structured in terms of shared goals?
  - How are costs and benefits and overall performance measured in your partnership(s)?
  - Did the outcomes of your partnership differ from what you expected? How was "success" defined?
  - What have been the ridership and reliability results of the service? How (if at all) has it impacted the transit agency's fixed route service ridership, reliability, or other key metrics?
  - How did you engage the public in the development of this partnership, if at all? How was the public informed/marketed the service, and what has been the public response to using your partnership with the private provider?
  - Have you encountered any implications regarding equity and accessibility issues by using private sector partners for the provision of some services? How were the needs of specific communities (e.g., seniors, Title VI protected populations, disability community), considered in the development of the service/partnership?
  - What type of procurement contract did you enter into with TNCs? How does this compare to what are considered industry "best practices" or your transit agency's typical practices?
  - Broadly, in your view, what types of partnerships with TNCs, micro-mobility, on-demand transit services, and/or AV shuttle providers are a value-add for transit agencies?
  - Are there lessons learned for incorporating TNCs, micro-mobility, microtransit, and AV shuttle providers as vendors or partners for transit agencies, including contractual, liability, procurement, labor, regulatory, and other legal and organizational considerations?
  - How may the development of new mobility options and AVs change service delivery/design for transit agencies in the mid- to long-term?
  - How are new mobility options changing customer expectations for public transit?

- Questions for Private Sector Providers

  - What problems have the potential to be solved through partnerships between public transit agencies and private sector partners? What new challenges are created through these partnerships?
  - Describe your experience to date with public transit agency partnerships. Did the outcomes of your partnership differ from what you expected? How was "success" defined?
  - What have been the ridership and reliability results of your experiences partnering with a public transit agency?
  - How have you used or provided data and other information to better inform the decision-making process?
  - How have these partnerships been structured in terms of shared goals?
  - How were the needs of specific communities (e.g., seniors, Title VI protected populations, disability community), considered and addressed in the development of the service/partnership?
  - How were procurement regulations considered and addressed in the development of the service/partnership?
  - Describe your experience in navigating public transit agencies' procurement processes, including suggestions to improve it.

- Questions for Third-party Experts with professional research or practical experience related to public transportation and/or new mobility options

  - What do you consider to be the unique challenges facing transit agencies today? What does transit need to be competitive?
  - What elements should transit agencies evaluate when considering a redesign? How should transit agencies prepare for the start of a system redesign process?
  - What are some of the political challenges associated with bus network redesigns, and how might transit agencies overcome these institutional and political barriers?
  - Are private providers best suited to providing a certain trip type or service that transit agencies may not be best suited for?
  - What are some guidelines for establishing performance-based incentives in contracts with private contractors to achieve public sector goals?
  - What are the legal considerations associated with partnering with the private sector? What are the labor considerations?
  - Which regions offer examples of best practices for partnerships between public transit agencies and private sector partners?
  - How can transit agencies work with other levels of government or governmental departments to create a level playing field with new mobility services?
  - How should the public be engaged in the development of transit agency/private sector partnerships, if at all?
  - How can partnerships with TNCs, micro-mobility, on-demand transit services, and/or AV shuttle providers be a value-add for transit agencies?
  - How might the development of new mobility options and AVs change service delivery/design for transit agencies in the mid- to long-term?

    - We are interested in not just how these services can be utilized by public transit providers but also have their availability may impact transit choice? Do you expect certain types of trips to no longer be taken by transit? Do these services compete or compliment traditional public transit?

- How are new mobility options changing customer expectations? What are the kinds of changes transit agencies should be making to remain competitive?