

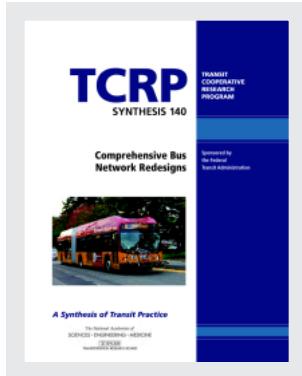
This PDF is available at <http://nap.edu/25487>

SHARE

f

t

in



## Comprehensive Bus Network Redesigns (2019)

### DETAILS

202 pages | 8.5 x 11 | PAPERBACK

ISBN 978-0-309-48024-6 | DOI 10.17226/25487

### CONTRIBUTORS

Lora B. Byala, Katie Filardo, Oren Hirsch, Michael J. Walk, James P. Cardenas, and Jinuk Hwang; Transit Cooperative Research Program; Transportation Research Board; National Academies of Sciences, Engineering, and Medicine

GET THIS BOOK

FIND RELATED TITLES

### SUGGESTED CITATION

National Academies of Sciences, Engineering, and Medicine 2019. *Comprehensive Bus Network Redesigns*. Washington, DC: The National Academies Press.  
<https://doi.org/10.17226/25487>.

Visit the National Academies Press at [NAP.edu](#) and login or register to get:

- Access to free PDF downloads of thousands of scientific reports
- 10% off the price of print titles
- Email or social media notifications of new titles related to your interests
- Special offers and discounts



Distribution, posting, or copying of this PDF is strictly prohibited without written permission of the National Academies Press.  
(Request Permission) Unless otherwise indicated, all materials in this PDF are copyrighted by the National Academy of Sciences.

Copyright © National Academy of Sciences. All rights reserved.

TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP SYNTHESIS 140

**Comprehensive Bus  
Network Redesigns**

***A Synthesis of Transit Practice***

Lora B. Byala  
Katie Filardo  
Oren Hirsch

FOURSQUARE INTEGRATED TRANSPORTATION PLANNING, INC.  
Rockville, MD

AND

Michael J. Walk  
James P. Cardenas  
Jinuk Hwang

TEXAS A&M TRANSPORTATION INSTITUTE  
Austin, TX

*Subject Areas*

Administration and Management • Planning and Forecasting • Public Transportation

---

Research sponsored by the Federal Transit Administration in cooperation with the Transit Development Corporation

---

The National Academies of  
SCIENCES • ENGINEERING • MEDICINE



2019

## TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, adapt appropriate new technologies from other industries, and introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions*, published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the successful National Cooperative Highway Research Program (NCHRP), undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes various transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA; the National Academies of Sciences, Engineering, and Medicine, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel appointed by TRB. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired effect if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

TCRP provides a forum where transit agencies can cooperatively address common operational problems. TCRP results support and complement other ongoing transit research and training programs.

## TCRP SYNTHESIS 140

Project J-7, Topic SA-44

ISSN 1073-4880

ISBN 978-0-309-48024-6

© 2019 National Academy of Sciences. All rights reserved.

### COPYRIGHT INFORMATION

Authors herein are responsible for the authenticity of their materials and for obtaining written permissions from publishers or persons who own the copyright to any previously published or copyrighted material used herein.

Cooperative Research Programs (CRP) grants permission to reproduce material in this publication for classroom and not-for-profit purposes. Permission is given with the understanding that none of the material will be used to imply TRB, AASHTO, FAA, FHWA, FMCSA, FRA, FTA, Office of the Assistant Secretary for Research and Technology, PHMSA, or TDC endorsement of a particular product, method, or practice. It is expected that those reproducing the material in this document for educational and not-for-profit uses will give appropriate acknowledgment of the source of any reprinted or reproduced material. For other uses of the material, request permission from CRP.

Cover photo credit: “[B] Crossroads” by Oran Viriyincy is licensed under CC BY 2.0

### NOTICE

The report was reviewed by the technical panel and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the National Academies of Sciences, Engineering, and Medicine.

The opinions and conclusions expressed or implied in this report are those of the researchers who performed the research and are not necessarily those of the Transportation Research Board; the National Academies of Sciences, Engineering, and Medicine; or the program sponsors.

The Transportation Research Board; the National Academies of Sciences, Engineering, and Medicine; and the sponsors of the Transit Cooperative Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of the report.

*Published reports of the*

### TRANSIT COOPERATIVE RESEARCH PROGRAM

*are available from*

Transportation Research Board  
Business Office  
500 Fifth Street, NW  
Washington, DC 20001

*and can be ordered through the Internet by going to*

<http://www.national-academies.org>

*and then searching for TRB*

Printed in the United States of America

*The National Academies of*  
**SCIENCES • ENGINEERING • MEDICINE**

The **National Academy of Sciences** was established in 1863 by an Act of Congress, signed by President Lincoln, as a private, non-governmental institution to advise the nation on issues related to science and technology. Members are elected by their peers for outstanding contributions to research. Dr. Marcia McNutt is president.

The **National Academy of Engineering** was established in 1964 under the charter of the National Academy of Sciences to bring the practices of engineering to advising the nation. Members are elected by their peers for extraordinary contributions to engineering. Dr. C. D. Mote, Jr., is president.

The **National Academy of Medicine** (formerly the Institute of Medicine) was established in 1970 under the charter of the National Academy of Sciences to advise the nation on medical and health issues. Members are elected by their peers for distinguished contributions to medicine and health. Dr. Victor J. Dzau is president.

The three Academies work together as the **National Academies of Sciences, Engineering, and Medicine** to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine.

Learn more about the National Academies of Sciences, Engineering, and Medicine at [www.national-academies.org](http://www.national-academies.org).

---

The **Transportation Research Board** is one of seven major programs of the National Academies of Sciences, Engineering, and Medicine. The mission of the Transportation Research Board is to increase the benefits that transportation contributes to society by providing leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied committees, task forces, and panels annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

Learn more about the Transportation Research Board at [www.TRB.org](http://www.TRB.org).

# COOPERATIVE RESEARCH PROGRAMS

## CRP STAFF FOR TCRP SYNTHESIS 140

*Christopher J. Hedges, Director, Cooperative Research Programs  
Lori L. Sundstrom, Deputy Director, Cooperative Research Programs  
Gwen Chisholm Smith, Manager, Transit Cooperative Research Program  
Mariela Garcia-Colberg, Senior Program Officer  
Demisha Williams, Senior Program Assistant  
Eileen P. Delaney, Director of Publications  
Natalie Barnes, Associate Director of Publications  
Hilary Freer, Senior Editor*

## TCRP PROJECT J-7 PANEL

*Brad J. Miller, Pinellas Suncoast Transit Authority, St. Petersburg, FL (Chair)  
Donna DeMartino, San Joaquin Regional Transit District, Stockton, CA  
Michael Ford, Camas, WA  
Bobby J. Griffin, Griffin and Associates, Flower Mound, TX  
Ronald Kilcoyne, North County Transit District, Oceanside, CA  
Jeanne Krieg, Eastern Contra Costa Transit Authority, Antioch, CA  
Paul J. Larrousse, Rutgers, The State University of New Jersey, New Brunswick  
David A. Lee, Connecticut Transit, Hartford  
Elizabeth Presutti, Des Moines Area Regional Transit Authority, IA  
Robert H. Prince, Jr., FOOT PRINCE, Jacksonville, FL  
Jarrett W. Stoltzfus, Foothill Transit, West Covina, CA  
Faith Hall, FTA Liaison*

## TOPIC SA-44 PANEL

*Zak C. Acciardi, TransitCenter, New York, NY  
Matthew A. Ciborowski, ARUP, Boston, MA  
Lawrence Deeter, Capital Metro, Austin, TX  
Sybil J. Derrible, University of Illinois—Chicago, Chicago, IL  
Jeanne Krieg, Eastern Contra Costa Transit Authority, Antioch, CA  
Becca Nagorsky, Metrolinx, Toronto, ON  
Daniel Nemiroff, SEPTA, Philadelphia, PA  
Raymond A. Santiago, Golden Gate Bridge, Highway, and Transportation District, San Rafael, CA  
Brian Jackson, FTA Liaison  
Jeffrey Roux, FTA Liaison  
Stephen J. Andrle, TRB Liaison*

## ABOUT THE TCRP SYNTHESIS PROGRAM

Transit administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to the transit industry. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire transit community, the Transit Cooperative Research Program Oversight and Project Selection (TOPS) Committee authorized the Transportation Research Board to undertake a continuing study. This study, TCRP Project J-7, “Synthesis of Information Related to Transit Problems,” searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute a TCRP report series, *Synthesis of Transit Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

## FOREWORD

By Mariela Garcia-Colberg

Staff Officer

Transportation Research Board

This synthesis provides an overview of the current state of practice regarding comprehensive bus network redesign. The study (prepared by Lora B. Byala and her team from Foursquare Integrated Transportation Planning, Inc., and Texas A&M Transportation Institute) captures the state of the practice among agencies of different sizes, geographic locations, and modes.

The study presents a literature review and results of a survey of transit agencies having current or prior experience with considering, planning, and/or implementing a bus system redesign. Thirty-eight completed responses were received from the 49 agencies in the survey sample—a response rate of 78%. Case examples of five transit systems are provided; these present an in-depth analysis of the processes and considerations, challenges, lessons learned, and keys to success.

This synthesis will assist those transit agencies considering redesigning their bus networks. Because the report presents the reality and complexity of conducting a bus network redesign, agencies who use it will be able to make better decisions about the process.

The members of the topic panel are acknowledged on page iv. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.





## CONTENTS

### 1 Summary

### 5 Chapter 1 Introduction: Overview and Key Issues

- 5 1.1 Motivation, Background, and Project Objectives
- 6 1.2 Methodology, Approach, and Report Organization
- 6 1.3 Dimensions and Elements of Bus Service Planning
- 7 1.4 Distinctive Aspects of Redesigns

### 9 Chapter 2 Overall Framework: A Review of Existing Research

- 9 2.1 Overview
- 9 2.2 History of Bus Network Redesigns
- 11 2.3 Key Objectives and Motivations
- 12 2.4 Approaches to Network Redesigns
- 20 2.5 Common Practices and Lessons Learned
- 22 2.6 Summary

### 24 Chapter 3 Survey of Agency Practice

- 24 3.1 Overview
- 24 3.2 Transit Agency Context
- 27 3.3 System Redesign Definition
- 28 3.4 Goals of System Redesign
- 33 3.5 Agency Organization
- 35 3.6 Decision-Making
- 36 3.7 Redesign Components
- 41 3.8 Funding
- 43 3.9 Implementation
- 45 3.10 Post-Launch Adjustments and Performance
- 46 3.11 Group 3 Results – Contemplating Redesign
- 49 3.12 Summary

### 51 Chapter 4 Case Examples

- 51 4.1 Introduction
- 51 4.2 Bloomington-Normal Public Transit System (Connect Transit)
  - Comprehensive Operational Analysis
- 56 4.3 Central Ohio Transit Authority (COTA) Transit System Redesign
- 61 4.4 MDOT Maryland Transit Administration (MTA) BaltimoreLink
- 64 4.5 King County Metro Transit (Metro Transit) METRO CONNECTS
- 68 4.6 Dallas Area Rapid Transit (DART) Comprehensive Operational Analysis
- 72 4.7 Summary

### 73 Chapter 5 Conclusions

- 73 5.1 Motivation for and Objectives of Transit Network Redesigns
- 73 5.2 Key Findings
- 77 5.3 Evolving and Continued Issues and Challenges
- 77 5.4 Future Research

<b>78</b>	<b>Glossary of Terms and Abbreviations</b>
78	Transit Agencies
80	Terminology
<b>81</b>	<b>References</b>
<b>83</b>	<b>Appendix A</b> Reviews of National Reports
<b>88</b>	<b>Appendix B</b> Survey Questionnaire
<b>129</b>	<b>Appendix C</b> Survey Results



## SUMMARY

# Comprehensive Bus Network Redesigns

Comprehensive bus network redesigns, in which transit agencies fundamentally alter the structure and organization of their bus networks, are not completely novel in transit. However, redesigns have become seemingly more common in recent years and have even been called the “Hottest Trend in Transit” (Vock 2017). The motivations for embarking on network redesigns vary across transit agencies, but, given the prevalence of redesigns in recent history and with more redesigns likely to come, the transit industry will benefit from improved documentation of network redesign rationales, outcomes, best practices, and challenges.

This synthesis captures the many components that are needed to successfully plan and implement a redesign and carefully considers the goals and objectives that agencies set forth when they began that process, helping them determine whether a redesign even made sense for the agency at that point in time. For example, even if it appears that system restructuring is needed, depending on the resources and political will, it sometimes makes more sense to do a full restructuring in batches or continue with small tweaks over time.

There is no industry-accepted definition of *network redesign*, so the first step in this synthesis research was to establish an acceptable definition. For purposes of this synthesis report, a network redesign refers to the planning and implementation of significant changes to a transit agency’s network of bus routes, informed by an evaluation of the network structure as a whole rather than solely as a collection of routes. Network redesigns can take a “blank slate” approach, in which transit agencies design the bus network without being tied to previous bus routes or network structures. The “blank slate” approach is more about the process than how it is implemented; even in this approach agencies still take into account the need to keep routes when it makes sense and make small changes to others. Alternatively, some network redesigns use an approach in which the new network design and routes are as similar as possible to current structures while still making significant changes across the entire network. Which approach an agency takes is not black and white – in practice, the approach is a process difference with gradations between a blank slate and tweaks. This synthesis reviews a variety of redesigns that took varying approaches and used various terminology – some agencies called their projects redesigns and some called them comprehensive operational analysis – but the common thread was their willingness to look holistically at their bus networks and make large scale improvements.

This synthesis report is structured to help transit agency and local government leadership, staff, and governing boards – and even transit advocates – better understand the purpose and business case, or the why and how, for conducting a redesign. The information is designed to assist agencies in conducting various components of the planning process, the critical public and stakeholder engagement components, and implementation. It highlights lessons learned from agencies that have gone through or are currently in the midst of the redesign

## 2 Comprehensive Bus Network Redesigns

process that should be helpful to other agencies or jurisdictions that are already conducting or are considering a bus network redesign.

The report includes (1) a review of 13 reports and industry resource publications pertaining to bus network redesigns and bus planning and a review of 10 self-published agency documents about bus network redesigns; (2) a survey of transit agencies that had current or past experience with considering, planning, and/or implementing a bus system redesign (the survey was completed by 38 agencies out of 49 eligible agencies); and (3) detailed case studies for five of the agencies that completed surveys that provide greater insight into the process and considerations for these five examples. The synthesis is by no means exhaustive, but it is comprehensive; there are other systems that have conducted or are conducting system redesigns that have neither been captured in the literature review nor included in the survey results, either because they did not respond or because a survey was not sent to them.

Unlike traditional literature reviews that include only true publications, this synthesis includes review of agency-published documents and other non-peer-reviewed documents. As the field of transit system redesign is so new and still evolving, constraining the research to traditional publications would have limited the timeliness of the information and the breadth of work that is ongoing in this area in 2018.

Thirty-eight agencies representing 22 states and one Canadian province responded to the survey conducted as part of this synthesis; two of these 38 indicated that they had neither conducted a redesign nor were they considering one, resulting in 36 usable surveys. Of these, 21 (58%) operate as independent, 11 (31%) are arms of local or state government, while the remaining four (11%) have a different relationship with the area they serve. Learning about network redesigns from a wide variety of agencies that responded to the survey – 17 that have implemented bus network redesigns, 16 that are in the planning process, and three that are considering one – proved extremely valuable. These 36 agencies spanned North America and included a wide variety of agency sizes and modes operated – 15 of the systems operate in environments with no regular heavy rail, light rail, or commuter rail service and 21 of the systems operate in environments with commuter rail, heavy rail, and/or light rail service.

Five case examples of a range of survey respondents are included in this synthesis. Case examples from three agencies that have completely implemented bus network redesigns (Connect Transit in Bloomington-Normal, IL; Central Ohio Transit Authority in Columbus; and MDOT MTA Maryland in Baltimore, MD) are reviewed, along with one partially implemented redesign (Dallas Area Rapid Transit in Dallas, TX) and one agency still in the planning process (King County Metro in Seattle, WA). These detailed case examples provide deeper insight into each agency's vision and goals for the redesign, the system design parameters, public and stakeholder engagement, implementation, and next steps. The case examples demonstrate that agencies had common visions and goals for improving the system comprehensively, from operational efficiency to providing service that would meet the needs of the riders. They also indicate the extensive amount of public and internal agency communication and coordination that must occur during the planning process and prior to implementation; the all-at-once approach versus the phased implementation approach also proved to result in slight differences in the approach and levels of engagement at implementation time.

The literature review, survey, and case examples yielded many conclusions, common strategies, and lessons learned from across North America. Highlights include the following.

### *Vision, Goals, and Objectives*

- 1. Bus network redesigns are usually conducted to focus on the needs of the riders and potential riders and on the agencies' need to operate efficiently.** Redesigns are geared toward improving the quality and utility of transit service by better meeting the current

and future travel patterns and needs of both current and potential riders. Some of the primary objectives cited in the survey for conducting a redesign include simplifying the system for ease of public use, improving rider satisfaction, increasing ridership (or counteracting ridership losses), improving on-time performance and reliability, reevaluating the “big picture” structure of the bus network, and increasing operational efficiency and effectiveness.

2. **Curbing or controlling operating costs was a key motivator for many bus network redesigns.** Many redesigns were planned with a cost-neutral operating plan, with limited resources being redeployed to other parts of the network. The plethora of good data on bus performance that was not widely available before the early 2010s (and even later for many agencies) has provided a way to really tighten up service, focus on performance, and keep operating costs in-check.
3. **There is significant consistency in goals, approach, and service design in redesigns across agencies.** Peer-to-peer knowledge sharing is prevalent in the industry, ensuring that best practices and lessons learned are passed along from one agency to the next. Through conferences, workshops such as the TransitCenter workshop on transit system redesigns in July 2017, and informal discussion and site visits, agencies are learning from each other. Additionally, there are fewer than 10 consulting firms that are doing this type of work, so the consultants working with the agencies also bring along consistency in approach from one system to the next.

#### *Planning Process*

4. **The quality of a network design plan is contingent on good data.** Having good data is critical to developing a good bus network plan. Most agencies that are planning or have planned a redesign relied on onboard surveys, census data, and automated vehicle location (AVL) and automated passenger counter (APC) data, along with extensive input from the public.
5. **Measurement and quantification of anticipated and actual improvements from bus network redesigns can be key tools in obtaining buy-in for the plan and making decisions between different network scenarios.** Some of the most commonly considered metrics are service area and coverage, impact on cost, equity implications, ridership, travel time, and transit accessibility.
6. **Agencies rely on consultants to conduct a lot of the heavy lifting on planning transit network redesigns.** Planning a redesign is a very time intensive effort for which most agencies do not have internal staff capacity for. Consultants are used to provide planning expertise, technical expertise for data analysis and market assessment, and strategic communications. The consultants often conduct the majority of the planning work for agencies but do so in close coordination with agency staff and with significant input from stakeholders and the public.

#### *Service Design Elements*

7. **Network redesigns were seen as an opportunity to introduce new service philosophies, performance standards, and/or design standards.** In many cases it was an opportunity to create or focus on a high frequency/priority bus network. Agencies also were able to redefine – and better enforce – their service standards and design guidelines as part of opening up the entire network for changes. (The definition of a high frequency network varies among agencies but is generally defined as one with a frequency better than 15 minutes, with some smaller agencies aiming for 20 minutes. *Priority bus* refers to a series of priority treatments, such as limited stops, transit signal priority [TSP], queue jumps, and/or bus only lanes to speed up the travel time of the buses.)
8. **The majority of agencies planning or implementing bus network redesigns combine capital improvements with the operating changes to improve and leverage changes**

## 4 Comprehensive Bus Network Redesigns

**to the network structure.** In many cases these investments tie in with the agencies' objectives of improving efficiency by providing priority for buses and with customer needs by providing improved passenger amenities. Capital improvements may also relate to new needs that are necessitated by the new network structure, such as an increase in walk distances to routes requiring investments in pedestrian infrastructure. In some cases, plans for capital improvements came later in the process to support the operational recommendations, and in others the bus network redesign grew out of wider reaching agency capital plans.

### *Internal Agency Impacts*

9. **There are many ancillary benefits of conducting system redesigns for agencies.** This includes the reduction of split shifts with more all-day frequency and improved communications between departments as the whole agency comes together to plan and implement such a wide-reaching program. In the course of conducting redesigns, agencies find that they end up making policy changes that are long overdue, such as changes to operations practice, organizational structure, fare policy, and rebranding.
10. **Keeping internal communications channels open and gaining buy-in from all parts of the agency is a key component to plan adoption and smooth implementation.** Involving, in a truly meaningful way, the bus operations departments – especially bus operators and unions – provides key input to the planning process from those on the front lines, and results in support during public education and rollout of the redesign.

### *Outreach and Education*

11. **A redesign “champion” who can advocate for the project with the public, funding partners, and other partners required for implementation can be the difference between a plan that gets implemented and one that lies dormant.** Agencies with a strong, respected leader as the redesign champion found it easier to move the redesign process along and garner support.
12. **Engaging the public at project inception and during network planning was extremely useful for agencies to gain qualitative input on service performance and potential recommendations to supplement the data analysis and gain public trust.** Early engagement of the public can help reduce – but certainly will not eliminate – negative perceptions and beliefs within the community that the plan will not improve their transit service. Working with the public throughout the service area and with all types and demographics of riders helps them feel they are a part of the process and not an afterthought. In fact, one agency that failed to include the public during the planning process was unable to implement the redesign because of the public’s lack of support and a feeling like the changes were being forced on them.
13. **Involving boards and other key decisionmakers up front is needed to help the agency as they deal with challenges to the plan or its recommendations.** If the board and other elected officials are not invested in the plan and its objectives, they can get in the way of fully realizing the results; lack of buy-in to the service concept and plan goals can result in the undermining of recommendations that are in line with the plan, such as reducing service in low-productivity areas.
14. **Extensive public education is needed prior to, during, and immediately after launch.** Agencies that have implemented their redesigns – either all at once or in phases – have found that extensive public information campaigns are necessary to make the most people aware of the changes so that no one is surprised or confused. When agencies do not involve the public early or often enough, riders frequently feel like the new network is being forced on them.



## CHAPTER 1

# Introduction: Overview and Key Issues

## 1.1 Motivation, Background, and Project Objectives

The national trend toward redesigns has been influenced in large part by three motivations:

- First, in many places the bus network has been disregarded over time, with small changes made over the years as new rail lines have been introduced or new developments opened. Agencies have recognized that the route structure they have does not necessarily align with today's travel patterns and rider expectations, and agencies need to review what has been going well first and then make route-by-route changes;
- Second, transit agencies are looking for ways to make the most effective use of their limited resources – in fact many network redesigns were efforts to curb or control operating costs; and
- Third, transit ridership, especially bus, has been declining and agencies are looking at new ways to reverse the trend. Transit ridership across the United States has been declining in recent years. Bus ridership has fallen each year since 2013, a total of more than 11% between 2012 and 2017. At the same time, transit ridership overall has declined by about 4% (APTA Ridership by Mode and Quarter, Year End Totals, 2012–2017).

These three motivations, along with national attention by the press and advocacy groups – and generally more awareness of the transportation conversation in general communication – have provided a confluence of events that have made redesigning transit networks a hotly discussed topic. Transit system redesigns have become popularized through many high-profile agencies developing updated system concepts and implementing sweeping, systemwide changes overnight. There are many practical reasons to make all of the changes at once. The transit system is a network, and a tweak in one place has ripple effects that can be avoided by making changes simultaneously; the agency has long suffered from poor public trust and image and wishes to reinvigorate ridership and support by the public, stakeholders, and elected officials; and/or the agency has additional or reduced funds which necessitates a reimaging of the system.

Despite the prominence of full redesigns in the popular press, the data collected in this synthesis suggest that there are also many agencies conducting redesigns and implementing them in phases. Regardless of whether the changes are implemented overnight or phased in over time, transit system redesigns present the agency and the community with many challenges. A full redesign needs top-level support and an agency where departments and the state and local jurisdiction(s) it serves are in lock-step, because there is no department that is untouched – from planning, to operations, to communications, to engineering. Full redesigns require not only support but also significant resources in terms of agency staff time, consultant support, capital funds, and operating funds.

Because bus network redesigns usually involve studying all parts of a bus network, they are quite involved and complex projects that may take years from initial discussions to actual implementations of service changes. Transit agencies reading this report may find themselves in any

## 6 Synthesis on Comprehensive Bus Network Redesigns

one of the many stages of the redesign process. This synthesis report presents an overview of the current state of the practice across the many phases and stages of bus network redesign, including insights into

- The decision-making process for whether to begin a redesign project.
- The planning policies, practices, and tools used during network planning.
- How network redesign scenarios are evaluated and selected.
- How transit agencies engage stakeholders.
- The steps taken during service change implementation.
- Challenges encountered and lessons learned.

### **1.2 Methodology, Approach, and Report Organization**

The research for this synthesis has three main components: a review of existing research, an industry survey, and in-depth case examples. The literature review is broad, relying not only on published reports and articles but on agency self-published materials; while bus network redesigns under various names have been happening at some level for a long time, the renaissance of them over the past 5 or so years means that a lot of the available literature is directly from the agency. To that end, there is some overlap in the three main research components of the study.

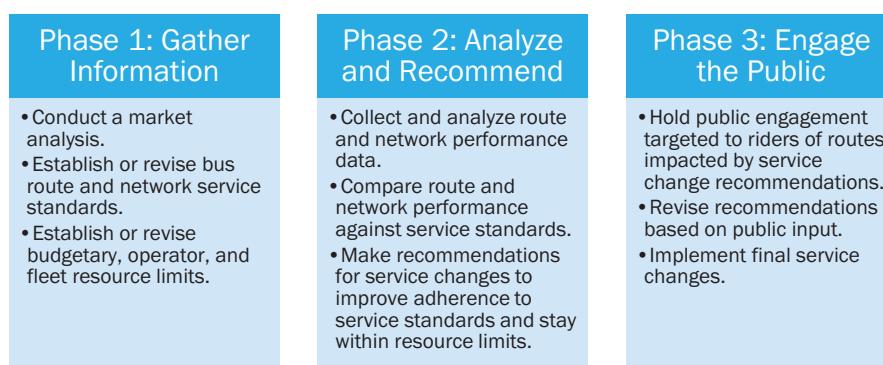
This synthesis is organized as follows: after an overall summary of the results and this overview section, the results of the existing research review, survey analysis, and case examples will be presented in turn. Finally, some key findings and suggestions for further research are identified in the conclusions section. There are also three appendices that contain short summaries of each existing report reviewed (Appendix A), the survey instrument (Appendix B), and the raw survey results (Appendix C).

### **1.3 Dimensions and Elements of Bus Service Planning**

Traditionally, bus service planning usually progresses through a series of basic steps, shown in Figure 1.

Each of these steps may be iterative and performed in different sequences; however, the basic process is largely the same across most bus route planning exercises.

Bus service planning, in its most traditional sense, usually involves an in-depth look at route- or corridor-level performance and service characteristics. Current industry guidance on transit



*Figure 1. Bus service planning process.*

planning is mainly limited to transit route and corridor planning, not system-level planning. For example, the *Transit Capacity and Quality of Service Manual*, 3rd ed., arguably the U.S. transit industry's most robust and comprehensive guide to analyzing transit quality, discusses transit planning at the route- or corridor-level and does not attempt to develop principles that could be applied to networkwide decision making (TCQSM 2013). And, although Chapter 10 – Bus Routing and Coverage of *TCRP Report 95: Traveler Response to Transportation System Changes Handbook* (3rd ed.) addresses different types of bus network structures and some examples of past network redesigns, very little guidance is given in how transit agencies should embark on a network planning exercise, how to implement a networkwide service change, or what to expect when they do (Pratt and Evans 2004).

Despite the lack of published guidance, agencies and their consultants across the country have been applying similar processes to conduct bus service planning at a system level. They are placing more emphasis on the demand and travel flow analysis than was typically done in the past, and are more firmly establishing objectives that the system should meet as part of the redesign – from clearer definitions of service and network standards to identifying where and what types of service should be the new focus of their system. For example, many agencies that are planning or have already planned a network redesign have centered their efforts on establishing or enhancing a high-frequency/priority bus network supported by additional crosstown service to serve the many trips that do not need to access the city or region's traditional "core." Agencies are also rethinking their role by considering tradeoffs such as coverage vs. frequency.

## 1.4 Distinctive Aspects of Redesigns

The steps taken during a comprehensive bus network redesign are quite similar to and are grounded in traditional bus service planning processes; however, the analysis, planning, and public engagement is about evaluating the overall network of routes and how the service would work if things were done differently and is a much more integrated process among analysis, planning, and public engagement. This makes network redesigns distinct from route-level service planning in many ways:

- In addition to detailed corridor, route, and trip level analysis, a redesign typically incorporates a detailed market and travel flow assessment to determine demand and service gaps.
- Network-level planning objectives and design approaches are often defined at the outset. For example, the transit agency may go into the process knowing that it wants to move from a radial system to a grid network, or it may be focused on bigger picture objectives such as maximizing network coverage, increasing system ridership, or connecting more people to more jobs and opportunity.
- Public engagement is often longer and more robust with multiple, iterative phases in which the public may help define the redesign's goals and provide feedback on service options.
- Internal transit agency engagement may also be significant—employees may have multiple opportunities to help define the redesign's goals and refine recommendations.
- Existing conditions data analysis is often more extensive, because the goal is not only to improve route performance but also to improve the connectivity and performance of the entire bus network. Data collection and analysis might include detailed examination of origin-destination (OD) data, passenger transfers, land-use and demographic information, and even networkwide ridership and travel demand modeling.
- If implemented, public education of service changes may be significantly longer and more extensive, because the changes affect a much larger portion (if not all) of the ridership and community.

## 8 Synthesis on Comprehensive Bus Network Redesigns

- Implementation is much more complex. Bus operators, bus supervisors and dispatchers, bus operations control center staff, and customer service agents need to be trained on the significant changes. Bus stop signs may be completely replaced, and completely new sets of system and route maps and route schedules may have to be created.

Regardless of the language used to describe the plan – whether the agency calls the plan a comprehensive operational analysis (COA), a transit development plan (TDP), or something else entirely – a redesign is a plan that consists of a collaborative planning process that can be implemented to change the overall structure of the network.



## CHAPTER 2

# Overall Framework: A Review of Existing Research

## 2.1 Overview

A national and international literature review was conducted using articles and documents to assess the current state of the industry regarding comprehensive bus network redesigns. The literature review focused on both peer-reviewed and self-published articles in the following topic areas:

- Case study research about bus network redesigns, including studies of ridership impacts, customer perceptions, and approaches to network planning.
- Industry resources and current overviews of industry trends, including Transit Cooperative Research Program (TCRP) reports and reviews of multiple transit agency redesigns.
- Self-published documents from transit agencies that describe their comprehensive bus network redesign projects.

A full listing of reviewed documents and a brief description of each is provided in Appendix A. Several previous TCRP reports have touched on the concept of comprehensive bus redesign—*TCRP Synthesis 10: Bus Route Evaluation Standards* (Benn 1995), which discusses the prevalence and contents of documented bus route standards by transit agencies, including standards for route and bus stop spacing, route deviations and branches, and requirements for population and employment density. These factors—along with others regarding network connectivity, limitations on the number of passenger transfers, and service area coverage—are all key components of the current era of comprehensive bus network redesigns. Later, *TCRP Report 95: Traveler Response to Transportation System Changes Handbook* (3rd ed.), *Chapter 10, Bus Routing and Coverage* (Pratt and Evans 2004), provides an overview of how riders tend to react, on average, to different types of bus routing and coverage changes. The authors discuss many different types of service changes, including “service restructuring,” which is the closest type of change to what this report considers a comprehensive bus network redesign.

This synthesis report builds upon these previous ones, adding information from other literature and case studies, adding current relevance to the subject as comprehensive bus network redesigns become ever more common as a way to refresh older bus networks.

## 2.2 History of Bus Network Redesigns

Although there is no definitive history of bus network redesigns, some evidence of them can be found in the literature. For example, *TCRP Report 95* (Pratt and Evans 2004) gives many examples of previous bus network “restructurings.” Some of these

## 10 Synthesis on Comprehensive Bus Network Redesigns

restructurings would likely constitute network redesigns under this study. The following are examples:

- In the late 1970s, Boston, Massachusetts, made significant changes to its bus network by providing more direct service to the Downtown Crossing area and to new rapid transit stations instead of running into downtown.
- In 1977, the radial routes serving southeast Portland, Oregon, underwent a major realignment, with more continuous north-south and east-west routes and new crosstown service. The changes helped to increase ridership.
- In 1992, HARTline in Tampa, Florida, implemented a bus network reorganization resulting in increased ridership.
- In 1994, Sacramento Regional Transit District in California executed a significant network restructuring by reinvesting resources from low-productivity routes into higher-performing areas and routes; the changes helped increase ridership.
- Between 1994 and 1996, C-TRAN in Vancouver, Washington, transitioned from a low-frequency timed-transfer system to a grid system with improved headways. These changes (along with other factors like improvements in the local economy) helped increase ridership.
- In 1995, the Orange County Transportation Authority implemented a network restructuring by eliminating unproductive routes, improving headways and headway consistency, and adding neighborhood shuttles and rail feeders. This network redesign broke ridership records while reducing operating costs.
- In 1995, SunTran in Albuquerque, New Mexico, restructured its bus system into a grid-like network, increasing ridership.
- In 1996, Boise, Idaho, restructured its network into a hybrid hub-and-spoke and grid system, with mixed results.
- Also in 1996, King County Metro in Seattle, Washington, implemented an extensive restructuring of its bus network. The changes included a hub-and-spoke network emphasis, improvements to core routes, and improved off-peak headways, resulting in increased ridership.

Although many of the above-described network redesigns were associated with ridership increases, Pratt and Evans (2004) point out that ridership increases were sometimes likely also related to local factors (e.g., improvements in the economy) and other transit changes (e.g., fare reductions or service expansions). In addition, Pratt and Evans point out that several network structurings resulted in ridership losses—again likely due partly to the restructuring itself and partly to other factors; it is very hard to attribute ridership changes directly to the redesign with many other factors always at play.

Stanley's (1998) review of successful ridership-growing initiatives found that service redesigns (not necessarily complete network redesigns) were part of a package of changes that often resulted in ridership growth. Stanley also found that transit agencies were equipped with detailed marketing and survey data to aid service structurings, likely contributing to the prevalence of network structurings in his sample of transit agencies.

Between 1996 and 2011, other bus network redesigns were likely implemented; however, there appears to be no definitive source of information that cataloged these efforts. The first signs of the recent “resurgence” of bus network redesigns came in 2011, when StarMetro in Tallahassee, Florida, implemented all route changes for its bus network redesign in one day (Bhattacharya et al. 2014). In 2014, the Jacksonville Transportation Authority (JTA) implemented their network redesign, known as the Route Optimization Initiative also enacting all network changes in one day (Jacksonville Transportation Authority 2016).

Then, in 2015, Houston METRO followed Jacksonville's model and implemented all service changes recommended by its System Reimagining Plan in one day (Houston METRO n.d.). Houston METRO's *Reimagined 5-Year Transit Service Plan*, which supported the opening of

three new rail lines in 2013 and 2014, was one of the largest one-day service changes ever enacted by a transit agency in the United States (Houston METRO 2014).

Many additional network redesigns were implemented by various transit agencies between 2015 and today, including the following:

- In 2015, Omaha Metro implemented the first phase of network changes from its Network Evolution Plan (Jaffe 2015).
- Between 2015 and 2017, the Central Ohio Transit Authority (COTA) in Columbus, Ohio, implemented minor changes from its Transit System Redesign, a study that started in 2013. COTA implemented the first phase of major network changes in 2017 (Central Ohio Transit Authority 2016).
- In 2017, Halifax Transit in Halifax, Nova Scotia, Canada, implemented initial network changes from its Moving Forward Together Plan, which commenced in 2014 and was approved in 2016 (Halifax Transit 2016a and 2016b). Halifax Transit plans additional, ongoing changes in subsequent phases.
- In 2017, Cherriots in Salem, Oregon implemented a redesigned regional bus network, including rebranding the regional bus network from CARTS to Cherriots Regional (Cherriots 2016).
- In 2017, the Maryland Transit Administration (MTA) in Baltimore, Maryland, implemented a bus network redesign branded as BaltimoreLink, changing over 60 bus routes in one day (Maryland Transit Administration 2017, 2018).
- In early 2018, Dallas Area Rapid Transit (DART) implemented the first service changes that are part of its COA, which includes several network-level changes (DART 2016 and 2017).
- In June 2018, the Capital Metropolitan Transit Authority (Capital Metro) in Austin, Texas, implemented changes to more than half of its bus routes and added eight routes as a part of its Connections2025 plan (Capital Metro n.d.).

Recently, bus network redesigns were described as the hottest trend in transit (Vock 2017). Vock suggests that transit agencies are making significant changes to their bus networks in response to dropping ridership and to changes in the land-use, demographics, and density of cities. The increase in bus network redesigns may also be partly fueled by the increasing availability of data and geospatial processing tools that allow for relatively easy analysis and visualization of demographic, land-use, and ridership data.

The next sections provide more detail about the results of the literature review, including information about the key objectives and motivations, planning approaches, outcome measures, and engagement strategies used by transit agencies during their bus network redesigns.

## 2.3 Key Objectives and Motivations

There are many possible reasons a transit agency may want to embark on a bus network redesign and just as many ways these motivations could be translated into talking points or slogans. According to the literature, the key objective for most bus network redesigns is to **improve the transit service for both current and potential riders**. For example, the network redesigns in Tallahassee, Halifax, and Columbus all explicitly sought to improve the system's appeal or "attractiveness" to infrequent and discretionary riders (Bhattacharya et al. 2014, Central Ohio Transit Authority 2016, Halifax Transit 2016a) and to make transit more competitive with private vehicles (Halifax Transit 2016b). The Halifax and Columbus redesigns also explicitly sought to improve the experience of existing riders in abstract terms (Central Ohio Transit Authority 2016, Halifax Transit 2016b), while the Staten Island express bus redesign was specifically implemented to help improve system reliability—a much more measurable concept (NYCT MTA 2017a).

## 12 Synthesis on Comprehensive Bus Network Redesigns

Several redesigns sought to improve riders' experiences by **better matching the transit network to both current and forecasted travel patterns** being changed by shifting land-use and development (Bhattacharya et al. 2014, Dallas Area Rapid Transit 2016, Houston METRO 2014, Jacksonville Transportation Authority 2016, NYCT MTA 2017a, Vock 2017). Changes in transit networks themselves, for example adding high-capacity transit such as light rail, also led transit agencies to take a comprehensive look at their overall bus network structure. Both Dallas and Houston cited changes in their rail networks as part of the justification for their bus network redesigns (Dallas Area Rapid Transit 2016, Houston METRO 2014).

Changes in land-use and development patterns, particularly in re-emerging urban areas, may lead cities to seek improvements in the bus network as a way to **support urban sustainability and to reduce congestion** (Kalantari et al. 2014, Vock 2017). For example, Omaha's bus network redesign aimed to support sustainable, active transportation lifestyles in Omaha (Transportation Management & Design 2013), and Currie and Tivendale's (2010) work in Melbourne, Australia aimed to build the community and political buy-in needed for funding service expansions to increase ridership.

Ridership increases—or **counteracting ridership losses**—was also part of the motivation behind the bus network redesigns in Houston, Dallas, and Jacksonville (Dallas Area Rapid Transit 2016, Houston METRO 2014, Jacksonville Transportation Authority 2016).

Although several bus network redesigns' first phases were implemented as operating-cost neutral changes (i.e., there was no substantive change in vehicle hours), many bus network redesigns were efforts to **curb or control operating costs**. For example, the main point of the bus network redesign study in Greensboro, North Carolina, was to improve network efficiency, saving resources to allow for expanding transit coverage without additional cost; due to Board sensitivity to public opposition the proposal was tabled (Boyle and Rey 2012). (Public opposition stemmed from a lack of input early in the planning process, making the public feel like the plan was being “forced” on them.) Other redesigns can be prompted by financial hardship in the transit agency, and redesigning the network is seen as the best way to save resources while still providing the maximum level of service for as many riders as possible, e.g., in Lleida, Spain (Trapote-Barreria et al. 2016).

Overall, most bus network redesigns sought to improve the quality and utility of the transit network for the most possible riders—both current and potential. However, the approaches taken by transit agencies to make their networks better were often quite different.

## 2.4 Approaches to Network Redesigns

Although most transit agencies started their bus network redesigns to improve the quality and utility of their transit systems, transit agencies exhibited significant variability in how they undertook their redesigns. This section discusses strategies and tactics across four topics related to undertaking a network redesign:

- Planning approaches and network design policies;
- Outcome metrics used to evaluate or promote the changed network;
- Implementation of the service changes associated with the network redesign; and
- Engagement before, during, and after implementation.

### Planning Approaches and Network Design Policies

There are many possible bus network designs for local bus networks, but most can be classified as centralized and radial, hub-and-spoke, grid, or combinations of one or more of these

types. In addition to the network design, bus networks can also have tiers of bus services, for example, high-frequency core routes, low-frequency coverage routes, express routes, circulators, feeders, and even peak-period commuter routes. When transit agencies begin their bus network redesigns, they must decide on the best network design and the most appropriate types of service. Even more foundationally, transit agencies should decide *how* to approach developing the best network scenario. Is it best to start with a “blank map” and begin redrawing the bus network? Or, is it most important to try to preserve the existing route network to the extent possible? Or should a computer algorithm find the optimal network design? In reality, most agencies end up somewhere on the spectrum between a blank slate and keeping the network as close to the current network and also use a combination of quantitatively driven and qualitatively driven approaches to developing the new service plan.

The use of computer algorithms to design optimal transit networks appears to be quite rare within the United States. None of the bus network redesigns at U.S. transit agencies used pure computational approaches to lay out their network designs. However, research in transit network optimization through computational models continues to grow and seek application to real-world transit networks. For example, Trapote-Barreira et al. (2016) applied a model developed by Badia et al. (2014) to design the optimal bus network for Lleida, Spain during its economic downturn. The optimal network was then tweaked and revised based on operational and public feedback. Kalantari et al. (2014) developed an analytical approach to optimize a transit network while keeping the network as similar as possible to the original network, and they propose that this approach is often more palatable to riders and more likely to result in actual implementation of the network changes because the changes are less drastic than would occur if the transit agency started with a blank map. In 2017, Viggiano proposed a new approach to network-level public transportation planning that combines OD-level analysis with new spatial aggregation methodologies to develop a framework for identifying corridors for new bus service.

The challenge of making big changes has not deterred many transit agencies from taking a blank-map approach to planning their networks or from entertaining complete conversions of their network designs from one type to another. For example, Boyle and Rey (2012) supported Greensboro, North Carolina’s blank-map network redesign in which the network would have been converted from a centralized radial system to a multiple hub-and-spoke network (although the changes were not implemented). Jacksonville, Florida’s bus network redesign also touted its “from scratch” approach (Jacksonville Transportation Authority 2016). Bus network redesigns in Tallahassee, Florida; Jacksonville, Florida; Omaha, Nebraska; and Houston, Texas all involved a conversion from one network type to another. Tallahassee’s centralized radial network was converted to a decentralized, grid-like network to better match Tallahassee’s decentralized pattern of development (Bhattacharya et al. 2014). Omaha switched from a complex, interlined radial crosstown network to a grid network geared toward supporting easy movement around the urban core (Transportation Management & Design 2013). Barcelona, Spain’s complicated set of low-frequency lines was converted to a high-frequency transfer-based grid system (Badia et al. 2017). In fact, the creation of high-frequency networks (grid or otherwise) was an emerging theme among many bus network redesigns. Examples include Jacksonville, Houston, Baltimore, and Dallas (Jacksonville Transportation Authority 2016, Houston METRO 2014, Maryland Transit Administration 2017 and 2018, Dallas Area Rapid Transit 2016).

However, the choice of network design and service types all depend on the network redesign’s goals and objectives. Houston, Halifax, and Columbus all embarked on their redesigns by establishing a governing-body-adopted goal that determined how much of the transit agency’s resources should be focused on high-frequency services and areas and how much should be used to provide coverage to areas with less ridership potential. Although the goal to increase the

## 14 Synthesis on Comprehensive Bus Network Redesigns

proportion of resources allocated toward high-ridership services in Halifax was vague (Halifax Transit 2016a), Houston set its goal at 80% of resources devoted to high ridership routes and 20% for coverage (Houston METRO 2014), and Columbus set its goal at 70% for ridership and 30% for coverage (Central Ohio Transit Authority 2016). These explicit goals helped to guide the design of the bus networks and to prioritize the use of operating and capital resources.

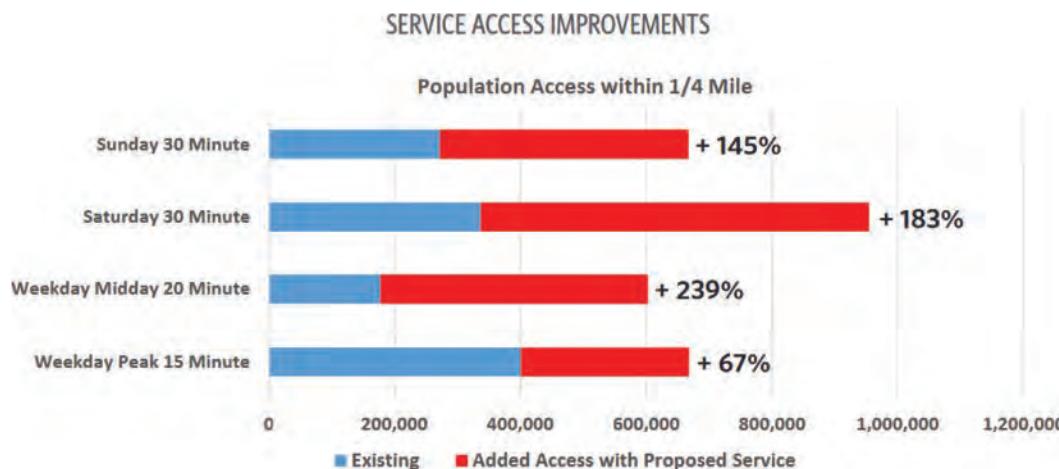
Another difference among bus network redesigns was whether or not the service changes were accompanied by other initiatives, for example, bus stop optimizations (i.e., consolidation or balancing), new passenger bus stop amenities and transfer facilities, or improvements in technology and passenger information. Most of the network redesigns had some form of accompanying initiative, however, the breadth and promotion of these initiatives varied greatly across transit agencies. Bus stop optimizations were part of the network redesigns in Tallahassee, Jacksonville, Baltimore, and Staten Island (Bhattacharya et al. 2014, Jacksonville Transportation Authority 2016, Maryland Transit Administration 2017 and 2018, NYCT MTA 2017b). In Jacksonville, 30% of bus stops, or approximately 1,200 stops, were removed as part of their optimization in an effort to speed up their bus routes. Although many of the redesigns likely had one or more accompanying initiatives, Jacksonville, Halifax, and Baltimore's (Maryland DOT Maryland Transit Administration [MDOT MTA]) redesigns included the most detail. The following are examples:

- Jacksonville increased route supervision and security and safety.
- Jacksonville and the MTA both replaced all the bus stop signs in their networks.
- Jacksonville launched an improved real-time passenger information system during implementation.
- MDOT MTA built new transfer hubs and worked with the local municipality to implement transit signal prioritization and bus-only lanes in key corridors.
- MDOT MTA rebranded the entire system with a new name and color scheme, including completely new bus stop signs and vehicle paint scheme.
- Halifax Transit also implemented queue jumps, transit lanes, and transit signal prioritization along with other initiatives.

### Network Scenario Outcome Measures

No matter how transit agencies approached their network redesign projects, in order to promote and gain approval for the new networks, transit agencies needed to demonstrate to the public and stakeholders whether the new network was better than the old. For example, in Lleida, Spain, the transit agency developed a balanced scorecard with key performance indicators that allowed transit planners and the public to see how different network scenarios performed (Trapote-Barreira et al. 2016). Transit agencies also often enacted follow-up studies to see whether the changes resulted in the intended improvements. The following examples highlight some of the outcome measures commonly used by transit agencies before and after implementation of their bus network redesigns.

- Transit accessibility scores, which calculate how many *places* (usually jobs) are accessible by transit and walking within a given period of time (e.g., 45 minutes), were used by Tallahassee, Houston METRO, and Baltimore (Bhattacharya et al. 2014, Houston METRO 2014, Maryland Transit Administration 2017 and 2018).
- Rider travel times along a corridor (including walk time to stops) was used by Tallahassee to show that, even with route and stop consolidation, most riders' trips were faster under the new network (Bhattacharya et al. 2014). A similar analysis was performed by Houston METRO (Houston METRO 2014) and in Baltimore (Maryland Transit Administration 2018).
- Boyle and Rey (2012) analyzed the changes in walking distance to transit and the changes in direct transit access to major retailers and to downtown Greensboro, North Carolina.



**Figure 2.** Example measurement of access to high-frequency transit (DART), graphic courtesy of DART.

- A unique example of a network measure is found in the Staten Island express bus redesign, in which NYCT calculated the reduction in on-street mileage of bus routes, the reduction in turns at intersections, and the increase in non-stop running time as positive outcomes to help improve bus reliability (NYCT 2017).
- A unique example of a postimplementation evaluation can be found in Badia et al.'s (2017) analysis of the network change in Barcelona, Spain. They examined ridership trends and transfer rates and saw evidence of increased ridership across the network of routes that outpaced ridership growth related to the addition of or improvements to individual routes. This led them to believe that the network design was successful in accomplishing easier anywhere-to-anywhere travel in the city.

## The Network: High-frequency Transit

**Frequent Transit Network (FTN):** Any route that has service at least every 15 minutes between the hours of 7am and 7pm on weekdays



### More People with Access to Frequent Transit

Under BaltimoreLink, an estimated 130,000 additional people – a 32% increase over the pre-BaltimoreLink system – is within 1/4 mile of the frequent transit network.



### Better Access to Services in the Region

BaltimoreLink provides more frequent transit to educational institutions and health services that people need the most. Four hospitals, 10 pharmacies, 13 supermarkets, 22 public schools, and 5 libraries were added to the frequent transit network.



Hospitals  
+4



Pharmacies  
+10



Supermarkets  
+13



Public Schools  
+22

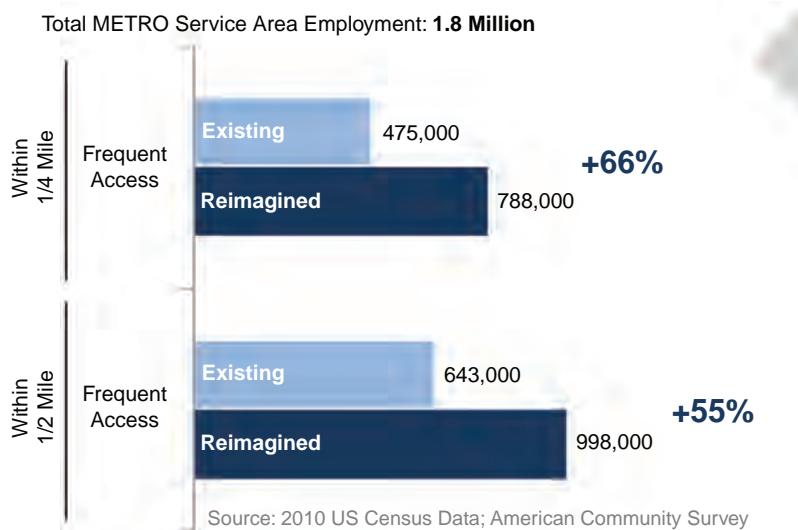


Libraries  
+5

**Figure 3.** Example measurement of access to high-frequency transit, graphic courtesy of MDOT MTA.

## 16 Synthesis on Comprehensive Bus Network Redesigns

### Frequent Access: Jobs

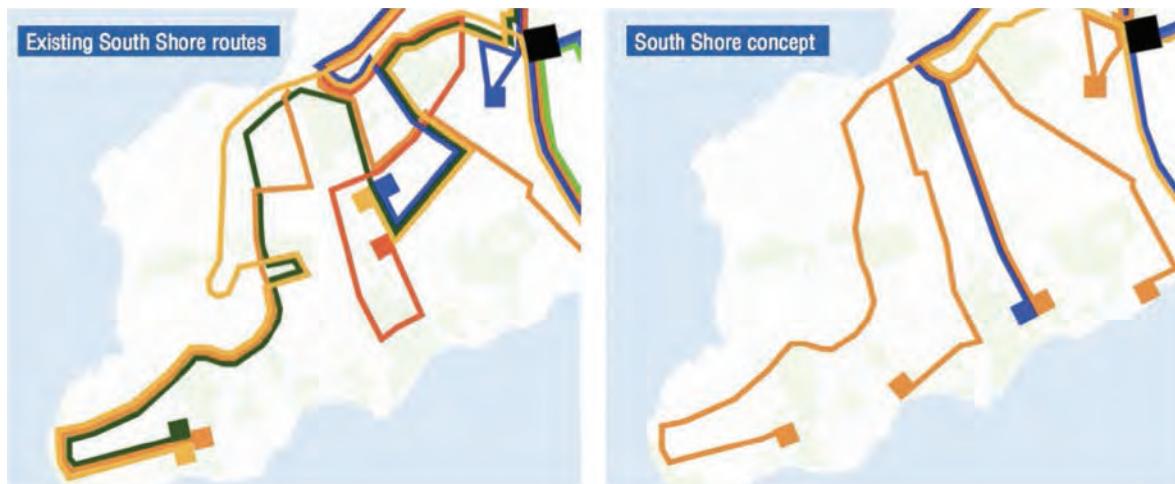


**Figure 4.** Example measure of access to high-frequency transit, graphic courtesy of Houston METRO.

Lastly, for those bus network redesigns that implemented high-frequency bus networks, transit agencies typically measured the number of people and destinations (e.g., jobs, hospitals, or schools) that had access to frequent transit routes before and after the network redesign (Central Ohio Transit Authority 2016, Houston METRO 2014, and Maryland Transit Administration 2017 and 2018). See Figures 2 through 5 for examples.

### Implementation

Although redesigning a bus network requires a lot of careful study, analysis, and customer engagement, actually implementing the changes recommended takes at least the same if not more effort. Transit agencies that have implemented their bus network redesigns usually fall into two categories: (1) implementing all the changes at once (usually on one day) or (2) implementing the changes in phases.



**Figure 5.** Example map of extent of high-frequency transit service, graphic courtesy of NYCT.

Transit agencies identified in the literature that have implemented their service changes in one day are listed in Table 1.

The remaining transit agencies that took a phased implementation approach are listed in Table 2.

Whether the implementation of planned changes was done in one day or over multiple phases, transit agencies often found the need to implement additional changes or revisions that were not in the original service plan (e.g., Brown et al. 2013, Maryland Transit Administration 2017). In fact, Lleida performed a 3,000-person phone-based survey one year after the initial network change implementation to help understand riders' concerns about the new network (Trapote-Barreira et al. 2016). Feedback from the survey was used in the "final fine-tuning analysis that could lead to the final changes."

## Engagement

Transit agencies that embark on bus network redesigns all follow different engagement protocols and timelines and use different tools, depending on their local needs and the stage in the redesign process. However, network redesign projects require extensive engagement, before the project begins, during network planning, and when educating the public on the final, approved

**Table 1. Transit agencies that implemented their bus network redesigns in a single day.**

Transit Agency	City	Date	Source
<b>Metro Transit</b>	Madison, WI	One day in 1998	Brown et al. (2013)
<b>StarMetro</b>	Tallahassee, FL	July 11, 2011	Brown et al. (2013)
<b>Lleida Area Territorial Transport Authority<sup>a</sup></b>	Lleida, Spain	April 2013	Trapote-Barreira et al. (2016)
<b>Jacksonville Transportation Authority</b>	Jacksonville, FL	December 1, 2014	Jacksonville Transportation Authority (2016)
<b>Houston METRO</b>	Houston, TX	August 16, 2015	Houston METRO (n.d.)
<b>Cherriots</b>	Salem, OR	One day in Spring 2017	Cherriots (2016)
<b>Central Ohio Transit Authority<sup>b</sup></b>	Columbus, OH	May 1, 2017	Central Ohio Transit Authority (2016)
<b>Maryland Transit Administration</b>	Baltimore, MD	June 18, 2017	Maryland Transit Administration (2017 and 2018)

Notes:

<sup>a</sup>The changes in Lleida, Spain were very fast and implemented over a "short period of time;" however, the authors are unsure whether the changes were implemented in exactly one day.

<sup>b</sup>Columbus phased in minor changes over three years; however, they implemented all of the major changes at one time.

## 18 Synthesis on Comprehensive Bus Network Redesigns

**Table 2. Transit agencies that implemented their bus network redesigns in phases.**

Transit Agency	City	Phasing Approach	Source
<b>Fresno Area Express</b>	Fresno, CA	Continually added decentralized routes to network	Brown et al. (2013)
<b>Tompkins Consolidated Area Transit</b>	Ithaca, NY	Gradual consolidation of three separate transit systems	Brown et al. (2013)
<b>Spokane Transit Authority</b>	Spokane, WA	Phased improvements, including creating new, crosstown services	Brown et al. (2013)
<b>Sun Tran</b>	Tucson, AZ	Added suburban transfer centers and created decentralized routes	Brown et al. (2013)
<b>Transportes Metropolitanos de Barcelona</b>	Barcelona, Spain	Changes were phased in once a year and completed in the fall of 2018	Badia et al. (2017)
<b>Halifax Transit</b>	Halifax, Nova Scotia, Canada	5-year phased changes	Halifax Transit (2016a)
<b>Omaha Metro</b>	Omaha, NE	3 phases; first phase cost neutral, remaining phases require additional investment	Transportation Management & Design (2013)
<b>Dallas Area Rapid Transit</b>	Dallas, TX	Will be phased over an uncertain number of years and prioritized as part of the long-range plan	Dallas Area Rapid Transit (2016)

changes. The sheer number of changes—sometimes involving every single route in the system—means that engagement is more complex and more important.

This section discusses some highlights from engagement strategies used by transit agencies during network redesigns or recommended by research. The highlights are categorized into three groups: public meetings and focused public engagement, public online engagement, and transit agency in-reach (i.e., engaging transit agency staff).

### *Public Meetings and Focused Public Engagement*

All bus network redesigns had one engagement strategy in common: all involved the public at least at the point when the network design was finalized for public comments. However, in the case of Greensboro, North Carolina, waiting to engage the public until the network design was done ultimately undermined the implementation of the changes (Boyle and Rey 2012). In most redesigns, transit agencies engaged the public when the study launched, during the transit planning, and finally prior to service change implementation. Here are a few examples:

- In Tallahassee, StarMetro held around 100 public meetings during the 2 years leading up to the service changes (Bhattacharya et al. 2014).
- Several transit agencies reported creating and holding regular working sessions with a specialized stakeholder committee of local leaders and representatives of key constituent groups (e.g., Central Ohio Transit Authority 2016, Halifax Transit 2016a).
- Meetings with community organizations, civic associations, groups representing seniors or people with disabilities, and other special-interest groups were also very common methods for engaging the public (Central Ohio Transit Authority 2016, NYCT 2017, Maryland Transit Administration 2017 and 2018).
- Several transit agencies also conducted surveys of riders prior to forming bus network recommendations (Central Ohio Transit Authority 2016, Halifax Transit 2016a, Jacksonville Transportation Authority 2016). Some surveys were conducted at bus stops (NYCT 2017) and onboard buses or at transit facilities (Halifax Transit 2016a, NYCT 2017), while other surveys were conducted online (Halifax Transit 2016a).
- Another common type of engagement was to meet customers where they were. These events, sometimes called “pop-up” events were used in Halifax, Omaha, Jacksonville, Baltimore, and Salem (Halifax Transit 2016a, Transportation Management & Design 2013, Jacksonville Transportation Authority 2016, Maryland Transit Administration 2017 and 2018, Cherriots 2016).
  - The Maryland Transit Administration used a retired articulated bus as an “InfoBus,” which it stationed at various locations throughout the city as a traveling public meeting during the planning phases. The bus was also used in-service on a variety of current routes and was staffed by people knowledgeable in the new network, and offered free rides in addition to important redesign information.
  - Representatives from Cherriots in Salem, Oregon attended community events like markets and fairs in addition to holding traditional public meetings and staffing an information table at a downtown transit center.
- NYCT also had a unique example of public engagement, in which it co-hosted, along with a local university and non-governmental organization, a hackathon for its Staten Island express bus reimagining (NYCT 2017a). The hackathon had 150 attendees who worked with NYCT archived GPS data, passenger origin-destination tables, passenger boarding and alighting data, and NYCT’s general transit feed specification (GTFS) data.
- Due to the large number of Baltimore City school students that utilize public transit to travel to and from school, the Maryland Transit Administration developed a specialized outreach campaign for students and their families (Maryland Transit Administration 2017 and 2018).
- Lastly, Currie and Tivendale (2010) describe in detail the inclusive design process used during a bus network review in Melbourne, Australia. The process used both data analysis and community and operator views to inform network option development and avoided extensive bus network demand modeling.

### *Online Engagement*

In addition to in-person, face-to-face engagement, transit agencies also used online and web-based tools. Many transit agencies likely used standard tools like a webpage on the transit agency’s

## 20 Synthesis on Comprehensive Bus Network Redesigns

website; however, only a few transit agencies specifically featured their online engagement in the available literature. For example, NYCT accepted public feedback through its regular online customer feedback system and through a special email address set up for the study (NYCT 2017). Halifax Transit used an online engagement tool at MakeTransitBetter.ca and also held Twitter town halls at which people could ask transit agency staff questions or submit comments about the network redesign (Halifax Transit 2016a).

Dallas Area Rapid Transit used an online platform specifically designed for public engagement in local government projects called MindMixer (now MySidewalk) (Dallas Area Rapid Transit 2016). Social media was also generally used by most transit agencies (Central Ohio Transit Authority 2016 and Maryland Transit Administration 2017 and 2018).

### *Transit Agency In-Reach*

Because bus network redesigns impact almost all parts of a transit agency's internal staff, transit agencies may also need to develop strategies to educate staff and to generate buy-in. One of the key practices highlighted in TransitCenter's Redesign Workshop proceedings is to make the most of drivers' expertise and daily contact with riders through focus groups and ride-alongs. Although most transit agencies likely had some form of in-reach, only a few transit agencies highlighted their in-reach efforts in the available documentation.

Staff who have significant involvement in daily operations and customer interactions may often glean important insights about what needs to be changed in a bus network and also have ideas about how customers may react to proposed changes. The network redesigns in Jacksonville, Columbus, and Dallas all used feedback from bus operators, supervisors, or customer service representatives obtained through town halls, interviews, or other types of forums (Central Ohio Transit Authority 2016, Dallas Area Rapid Transit 2016, Jacksonville Transportation Authority 2016, Maryland Transit Administration 2017 and 2018). The Maryland Transit Administration took very explicit steps for bus operator in-reach, developing and implementing a detailed and robust input process at the bus divisions for the year before network implementation and surveying bus operators after implementation to understand their experiences and the public perception of the service changes.

## **2.5 Common Practices and Lessons Learned**

Transit agencies offered many insights and lessons learned that would benefit other transit agencies during their contemplation of, planning for, and implementation of a bus network redesign. The lessons learned are grouped into three areas: engagement, network design, and implementation.

### **Engagement Lessons Learned**

Transit agencies offered many lessons learned regarding engagement and working with the public during bus network redesigns. From the TransitCenters *Untangling Transit: Bus Network Redesign Workshop Proceedings*, comprising input from more than 30 agencies, key suggestions are to frame the problem and case for redesign from the outset and to ask for input before coming to riders with a proposed plan (2017). These approaches make the process transparent and engender trust and engagement by the public. The agencies also suggested using data and metrics to support recommendations and counter anecdotes, as well as using advocates and local stakeholders who support the plan as voices for the agency to leverage the trust already established by these other parties.

Two very interesting studies on the bus network change in Tallahassee, Florida, found that riders from different communities impacted by the network changes did not perceive the

network changes the same way (Bhattacharya et al. 2014, Brown et al. 2013). The studies examined the perceptions of the network changes of riders in two different communities (a student community and a low-income community). Riders' perceptions of the network changes did not match the analyzed results of the network changes. For example, although both communities actually had higher levels of transit accessibility (i.e., access to more destinations in fewer minutes) and lower bus travel times, riders in the low-income community perceived the network changes as negative, while riders in the student community viewed them as positive. The negative perceptions in the low-income community actually exhibited themselves in reduced transit use. Bhattacharya et al. (2014) reported that the perception in the low-income community was that their concerns were not addressed or that the outreach had been inadequate. These studies lend evidence to the mantra that perception is reality when it comes to network changes and suggest that transit agencies should enact strategies for meaningful public engagement in order to make sure that concerns are being heard, acknowledged, and addressed, either by modifications to the proposed plans or by a clear explanation as to why plans are not modified, to ensure that trust is earned in the planning process and ridership is not negatively impacted.

Brown et al. (2013) recommend early and frequent engagement with people with disabilities and seniors and their related advocacy and special interest groups in order to actively work to address their concerns. Brown et al. reminds readers that engagement needs to be early, comprehensive, and exhaustive and that public participation has to be actively encouraged. In fact, Boyle and Rey (2012) cite a lack of early public engagement as a significant obstacle to implementing the bus network redesign in Greensboro, North Carolina. In their case, the public did not know the agency was working on a network redesign until the agency shared the proposed network design at public meetings. The public felt that the network was being forced on them, and riders did not understand the need for a "blank slate" approach—why erase everything and start all over when the network seems to be working for many riders' trips (Boyle and Rey 2012)?

On the other hand, Currie and Tivendale's (2010) inclusive planning process helped to increase stakeholder buy-in and even resulted in positive upward pressure through the local political structures for increased funding to support the transit improvements recommended by the planning process. Currie and Tivendale recommend that leaders organize bus network qualities and service characteristics into an easy-to-understand hierarchy to facilitate discussions with the public.

Trapote-Barreira et al. (2016) recommend that transit agencies apply best practices and the principles of change management to a network redesign. Stakeholders must possess a sense of urgency and understand why change is needed. The transit agency should clearly communicate the change and work to produce small wins to generate confidence among stakeholders.

Trapote-Barreira et al. (2016) and Jacksonville Transportation Authority (2016) recommend using performance measures and well-defined goals and objectives during the planning and implementation phases of a bus network redesign. Emphasizing goals, objectives, and measures can help to focus conversation, maintain support and understanding from public officials, and reduce the likelihood that pushback will result in substantive changes to the optimal network design. Jacksonville also encourages transit agencies to clearly define the goals and objectives and what their service implications are at the outset of the project—being completely transparent about the objectives and their likely real-world impacts on riders will help ensure the continued support of governing boards and public officials.

## Network Structure Lessons Learned

The proceedings from TransitCenter's 2017 Bus Network Redesign Workshop suggest that a key element to designing the right network structure is to establish why the agency is doing a

## 22 Synthesis on Comprehensive Bus Network Redesigns

redesign before they start—such as whether such a huge undertaking is needed, or whether the goal is to reduce costs or increase ridership. Although many of the transit agencies that converted their centralized radial systems into grid or hub-and-spoke networks saw ridership increases after implementation (Pratt and Evans 2004), not all transit systems did see increases in ridership. Decentralized bus networks may work in some cases, but not in all, depending largely on local population and land-use patterns. Thompson and Matoff (2003) found that decentralized regions with multiple strong origins and destinations were better served by multi-destinational (i.e., decentralized) transit networks rather than by radial, centralized networks. Brown et al. (2013) also caution that grid networks only work well when the routes in the grid have high-frequencies to facilitate easy transfer between routes. Additionally, transit agencies implementing network restructurings that might force passenger transfers or longer walks to bus stops may also need to carefully consider the infrastructure required to facilitate a high-quality pedestrian experience (e.g., sidewalks, shelters, cross-walks, and protected street crossing signals) (Brown et al. 2013).

### **Implementation Lessons Learned**

There are many lessons learned from transit agencies that have implemented bus network redesigns. The agencies that participated in TransitCenter’s Bus Network Redesign Workshop (Transit Center 2017) suggested

- Organizing a task force to coordinate all internal and external communications.
- Providing the public, stakeholders, and bus operators with clear messaging about why the redesign is happening.
- Arming ambassadors, bus operators, and the public with information to make the transition as painless as possible.
- Providing free rides during an initial period to ease the pain of the transition.
- Preparing tactical teams to address the inevitable issues that will crop up with new bus routes and stops.

The only document reviewed that provided pointers and lessons learned about implementing a transit network redesign came from the Jacksonville Transportation Authority (Jacksonville Transportation Authority 2016). Selected recommendations include

- Implementing all the changes at once is important to project success—multiple phases may delay implementation and create additional rider confusion.
- Including a full portfolio of improvements to wrap around and augment the service changes—replace bus stop signs, add shelters, improve customer service, implement new technologies, etc.
- Holding post-launch operator workshops to help develop system refinements quickly and address safety issues and customer concerns.

Later chapters in this report will provide a much more extensive discussion of lessons learned based on results from the transit agency surveys and case examples and address implementation ideas on a variety of topics.

### **2.6 Summary**

The literature review covers bus network redesign case studies, articles on theories of network redesign approaches, bus route and network planning industry resources, and self-published network redesign documents from transit agencies. Although bus network redesigns are not solely a recent phenomenon, they certainly have become more prevalent and more publicized

within the last decade, likely a result of increased access to data and a broader approach to communication and information sharing than ever before.

Bus network redesigns can range in scale from small to large; they can be implemented in stages or all at once; and they may require fewer, the same, or more operating and capital resources. However, several themes emerged as constants from the literature review:

- Bus network redesigns are usually conducted to improve the quality and utility of transit service by better meeting the travel needs of both current and potential riders. They are a mix of moving from one type of service provision to another and taking a blank-map approach to developing a new network.
- Measurement and quantification of anticipated and actual improvements from bus network redesigns can be a key tool in obtaining buy-in for the plan and making decisions between different network scenarios.
- Bus network redesigns require extensive public and external outreach at project inception, during network planning, and prior to implementation. Continued outreach after implementation was also highly recommended.
- Bus network redesigns can experience significant public pushback, but this can be mitigated by involving stakeholders early; having a strong public champion; setting clear goals, objectives, and measures; and clearly communicating the need for the change in terms stakeholders can identify with.
- In-reach to transit agency staff is just as important as outreach to the public. Generating input, excitement, and buy-in among staff, especially those on the front-line, is critical to success.



## CHAPTER 3

# Survey of Agency Practice

### 3.1 Overview

Based on the literature review and online searches, the authors developed a list of transit agencies that may have completed or started a system design. While the potential transit agencies to be surveyed were limited to those that were believed to have conducted or were in the process of conducting a system redesign, the distribution carefully considered the inclusion of a range of agencies in terms of size, geographic location, modes provided, and stage within the redesign process.

The survey was sent to 49 transit agencies in North America; 38 (78%) responded, and 36 completed surveys were used for the data analysis (two respondents, Tri-Met and Cleveland RTA, each indicated that their agency had neither engaged in nor were considering a system redesign). The survey was conducted using skip logic based on where the agency is in the system redesign process to ensure that the agency received questions applicable to them; therefore, certain questions were only asked of a subset of agencies, and the results outline how many respondents are included in the results from each question. The results are grouped based on the status of the redesign: Group 1: Implemented or Partially Implemented; Group 2: Currently Planning or Planned but Not Implemented; and Group 3: Contemplating a Redesign. Note that, except for the Transit Agency Context and System Redesign Definition sections, Group 3 results (only three agencies) are analyzed separately.

The motivation for and process of planning and implementing a system redesign can take many forms. They also cover a host of aspects, from goal development to service planning to operational considerations, that transit agencies must consider and prepare for. The survey instrument was designed to obtain many data points over a wide variety of components that compose the system redesign process. Through the survey, data were gathered from agencies that completed or are in the process of planning and implementing a system redesign that paints a high-level picture of the state of the practice. This includes context behind the early planning phases, different components of what is entailed in a system redesign, and cost considerations. Several surveys were also collected from agencies that are contemplating a system redesign.

This chapter discusses the findings of the data analysis from the survey. The reader should be aware that while every attempt was made to ensure that the questions had only one interpretation, as with any survey it is possible that agencies may have responded with varying levels of understanding of the question at hand.

### 3.2 Transit Agency Context

The agencies completing surveys have been divided by size in terms of their service area population in the tables that follow. Agencies classified as large have a service area population of 1.5 million people or more (Table 3). Those classified as medium have a service area

population from 500,000 up to 1.5 million (Table 4), and small agencies have a service area population of less than 500,000 (Table 5). The agencies that serve large populations provide upward of one million hours of bus revenue service annually, with some providing many millions of hours. The agencies serving medium sized areas provide between 200,000 and 1.2 million hours annually, and the agencies that serve smaller populations provide between about 40,000 and 160,000 hours of annual bus service. The tables show some of the operating characteristics of each agency, including annual revenue hours from the 2014 National Transit Database (NYCT MTA 2017b), the most recent year these data were available (data have subsequently been added for 2015–2017). The modes listed are in addition to fixed-route bus.

The surveys reviewed are from 36 agencies representing 22 states and one Canadian province responded to the survey conducted as part of this synthesis. Twenty-one (58%) operate as independent agencies, 11 (31%) are arms of local or state government, while the remaining four (11%) agencies have a different relationship with the area they serve. Learning about network redesigns from a wide variety of agencies that responded to the survey – 17 that have implemented bus network redesigns, 16 that are in the planning process, and three that are considering one – proved extremely valuable. These 36 agencies spanned North America and included a wide variety of agency sizes and modes operated – 15 of the systems operate in environments with no regular heavy rail, light rail, or commuter rail service and 21 of the systems operate in environments with commuter rail, heavy rail, and/or light rail service. Of the 21 agencies operating in an area with rail service, 19 of them have commuter rail and 16 systems have either heavy rail or light rail.

**Table 3. Large transit agency respondents.**

Agency Name	City	State	Region*	Governance**	Operations***	Annual Bus Revenue Hours	Service Area Population	Heavy Rail	Light Rail	Streetcar	Commuter Rail	Paratransit	Flex/On-Demand	Ferry	Group for Survey Analysis
<b>DART</b>	Dallas	TX	SW	I	M	2,077,637	2,380,530	•	•	•	•	•	•	1	
<b>Houston Metro</b>	Houston	TX	SW	I	M	2,537,329	4,298,000	•			•	•		1	
<b>King County Metro****</b>	Seattle	WA	NW	G	D	2,759,035	2,177,125	•	•	•	•	•	•	2	
<b>LACMTA</b>	Los Angeles	CA	W	I	M	6,946,779	8,626,817	•	•		•	•	•	2	
<b>LYNX</b>	Orlando	FL	SE	I	D	1,105,050	2,134,411			•	•	•		2	
<b>MBTA</b>	Boston	MA	NE	G	M	2,375,894	3,109,308	•	•	•	•	•		2	
<b>MDOT MTA</b>	Baltimore	MD	MA	G	D	1,738,160	7,888,145	•	•		•	•	•	1	
<b>NYCT</b>	New York (Staten Island)	NY	NE	I	M	12,502,318*****	8,550,405	•			•	•		2	
<b>OCTA</b>	Orange	CA	W	I	M	1,577,713	3,077,903			•	•	•		1	
<b>Denver RTD</b>	Denver	CO	W	I	M	2,674,604	2,902,000		•		•	•	•	1	
<b>SEPTA</b>	Philadelphia	PA	MA	G	D	3,971,387	3,816,641	•	•	•	•			3	
<b>VIA Metro Transit</b>	San Antonio	TX	SW	I	D	1,538,539	1,825,502				•			2	
<b>VTA</b>	San Jose	CA	W	G	D	1,263,254	1,927,888	•	•	•				2	

\* NE (northeast), MA (mid-Atlantic), SE (southeast), M (Midwest), SW (southwest), W (west), NW (northwest)

\*\* (I)Independent Agency or part of local or state (G)overnment (as reported by survey respondents)

\*\*\* Bus service is (D)irectly Operated, (C)ontracted, (M)ix of directly operated and contracted

\*\*\*\* In addition to the modes noted, King County Metro also operates monorail service

\*\*\*\*\* This represents all NYCT Metrobus service, not just Staten Island where the redesign is planned.

**Table 4. Medium transit agency respondents.**

<b>Agency Name</b>	<b>City</b>	<b>State</b>	<b>Region*</b>	<b>Governance**</b>	<b>Operations***</b>	<b>Annual Bus Revenue Hours</b>	<b>Service Area Population</b>	<b>Heavy Rail</b>	<b>Light Rail</b>	<b>Streetcar</b>	<b>Commuter Rail</b>	<b>Paratransit</b>	<b>Flex/On-Demand</b>	<b>Ferry</b>	<b>Group for Survey Analysis</b>
<b>Capital Metro</b>	Austin	TX	SW	I	C	1,065,774	1,163,204				•	•			1
<b>CARTA</b>	Charleston	SC	S	I	C	205,833	543,209				•	•			1
<b>COTA</b>	Columbus	OH	M	I	D	879,037	1,059,314				•				1
<b>Hampton Roads Transit</b>	Norfolk	VA	MA	I	D	778,904	1,143,932	•			•		•		2
<b>IndyGo</b>	Indianapolis	IN	M	G	D	494,489	928,281				•	•			1
<b>JTA</b>	Jacksonville	FL	S	I	D	609,595	1,021,375				•	•			1
<b>Milwaukee County Transit System</b>	Milwaukee	WI	M	G	D	1,258,386	957,735		•		•				3
<b>Nashville MTA</b>	Nashville	TN	SE	I	D	434,710	655,900				•	•			2
<b>Omaha Metro</b>	Omaha	NE	M	G	D	280,616	561,920				•				1
<b>RIPTA</b>	Providence	RI	NE	I	D	633,454	1,048,319				•	•	•		2
<b>Sacramento Regional Transit District</b>	Sacramento	CA	W	I	D	548,446	1,031,946	•			•	•	•		2
<b>SORTA</b>	Cincinnati	OH	M	I	D	736,720	845,303		•		•				2

\* NE (northeast), MA (mid-Atlantic), S (south), M (Midwest), SW (southwest), W (west), NW (northwest)

\*\* (I)Independent Agency or part of local or state (G)overnment (as reported by survey respondents)

\*\*\* Bus service is (D)irectly Operated, (C)ontracted, (M)ix of directly operated and contracted

**Table 5. Small transit agency respondents.**

<b>Agency Name</b>	<b>City</b>	<b>State</b>	<b>Region*</b>	<b>Governance**</b>	<b>Operations***</b>	<b>Annual Bus Revenue Hours</b>	<b>Service Area Population</b>	<b>Heavy Rail</b>	<b>Light Rail</b>	<b>Streetcar</b>	<b>Commuter Rail</b>	<b>Paratransit</b>	<b>Flex/On-Demand</b>	<b>Ferry</b>	<b>Group for Survey Analysis</b>
<b>Clemson Area Transit</b>	Clemson	SC	SE	G	D	42,495	27,883				•				1
<b>Connect Transit</b>	Bloomington-Normal	IL	M	G	D	90,579	129,107				•	•			1
<b>DASH</b>	Alexandria	VA	MA	G	D	179,684	139,966	•			•	•			2
<b>EMTA</b>	Erie	PA	NE	G	D	163,615	189,872				•				2
<b>Halifax Transit</b>	Halifax	NS	CN	G	D	792,904	290,376				•	•	•		1
<b>LAVTA</b>	Livermore Valley	CA	W	I	C	125,826	220,469	•			•	•	•		1
<b>Metro McAllen</b>	McAllen	TX	SW	G	D	35,209	129,877				•				3
<b>Salem Transit (Cherriots)</b>	Salem	OR	NW	I	D	156,860	236,632				•				1
<b>Tri Delta Transit</b>	Antioch	CA	W	G	C	149,444	306,000	•			•	•			2
<b>Valley Regional Transit</b>	Boise	ID	NW	I	C	98,000	338,759				•	•			2
<b>Wave Transit</b>	Wilmington	NC	SE	I	C	86,268	216,479				•				2

\* NE (northeast), MA (mid-Atlantic), S (south), M (Midwest), SW (southwest), W (west), NW (northwest), CN (Canada)

\*\* (I)Independent Agency or part of local or state (G)overnment (as reported by survey respondents)

\*\*\* Bus service is (D)irectly Operated, (C)ontracted, (M)ix of directly operated and contracted

## Agency Population and Redesign Status

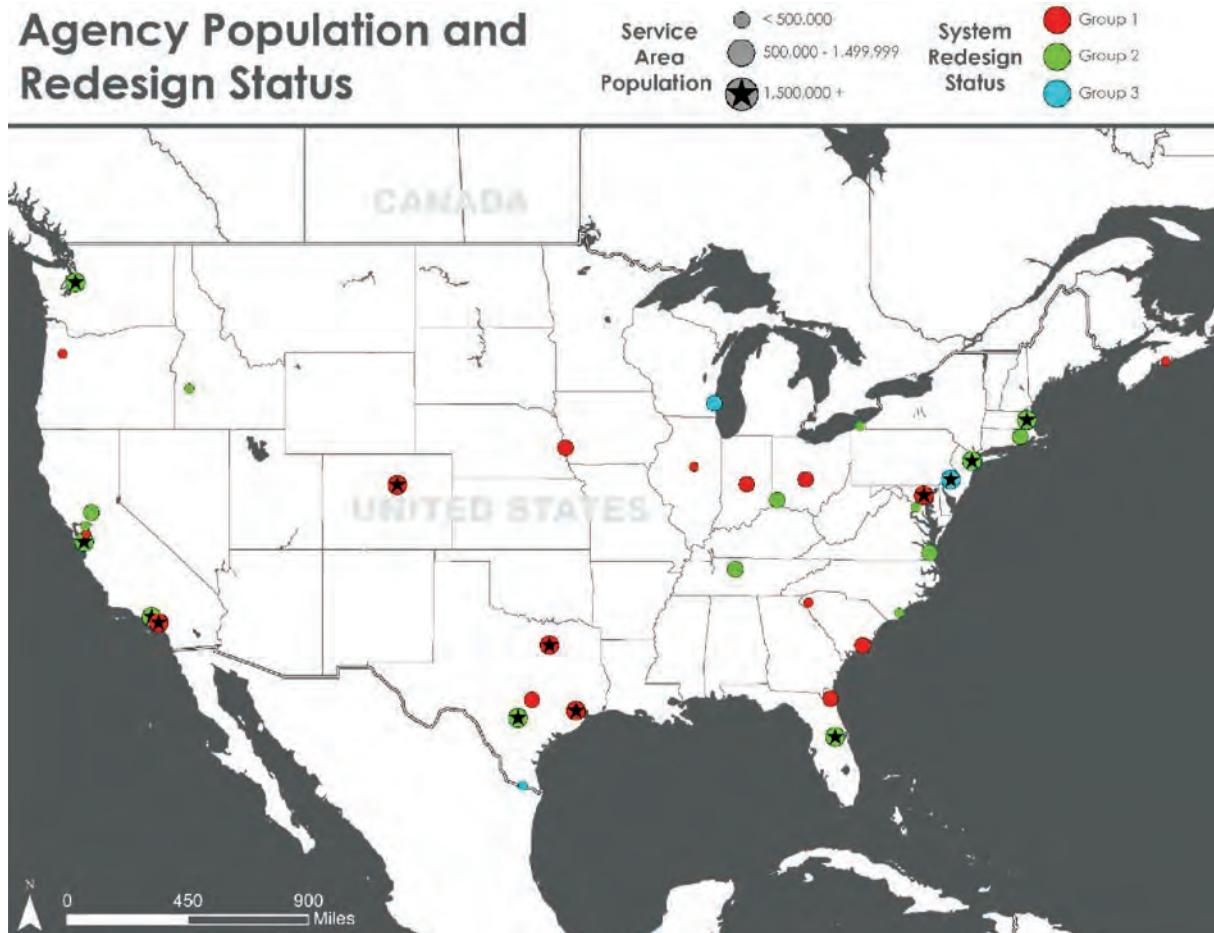


Figure 6. Responding agencies by service area population and redesign status.

Figure 6 shows the geographic distribution of participating transit agencies along with their redesign status. The agency with the smallest service population is Clemson Area Transit in South Carolina (27,883), while the agency with the largest service population belongs to New York City Transit (8,550,405). (While the responses provided in this survey by NYCT refer to the redesign of their Staten Island bus service, in April 2018 the agency announced plans to reimagine their bus system (MTA 2018). <http://www.mta.info/news/2018/04/23/nyc-transit-unveils-plan-reimagine-bus-system-deliver-world-class-bus-service.>)

### 3.3 System Redesign Definition

There is currently no industry-accepted definition of what a “network redesign” entails or consists of. Some agencies have conducted bus network planning studies that take a “blank slate” approach and develop entirely new networks, while others consider very detailed comprehensive operational analyses with significant service change recommendations. The survey asked transit agencies whether or not their agency had considered or conducted a systemwide network redesign and, if they had, they were asked where in the process they were at the time.

The results that follow in this section are largely grouped by the stage at which the agency is in their planning and implementation process: Group 1: Implemented or Partially Implemented; Group 2: Currently Planning or Planned but Not Implemented; and Group 3: Contemplating a Redesign.

Table 6 shows the first group of agencies and the years that their system redesigns were implemented or partially implemented. The second group of agencies indicated that their agency has planned or is currently planning a system redesign, but has not started implementation (Table 7). The last group of respondents (Table 8) includes agencies that are contemplating a system redesign, but have not starting the planning process.

Although most of the agencies conducted a redesign or planning study for their entire systems, several focused on parts of their networks. Of the 17 agencies with complete plans (Group 1), only two, California's Orange County Transportation Authority (OCTA) and Colorado's Regional Transportation District (RTD), conducted partial system redesigns. Group 1 agencies favored calling their plans branded system redesigns; ten called their plans branded system redesigns while seven classified their plans as a Comprehensive Operational Analysis (COA). In Group 2, 2 of the 16 agencies that are in the planning process are conducting partial redesigns. These agencies are evenly split between calling their plan a COA or TDP, a branded system redesign, or something else. Finally, two of the three agencies contemplating a redesign (Group 3) are planning to conduct one for the full system and the last is still deciding.

The agencies surveyed also differ in terms of their approach to planning the new network, whether it was more focused on making modifications to the existing system, be they large or small, or whether the planning process took a "blank slate" approach to developing the new network. Figure 7 shows the breakdown between the approaches by where the agencies are in their planning process; the division between approaches is fairly evenly split.

The remainder of this chapter will focus on data relating to the first two groups—that is, the 33 agencies that have implemented or partially implemented their system redesign or agencies that have planned or are in the process of planning their redesign. Group 3 will be discussed further in Section 3.11 of this chapter.

### **3.4 Goals of System Redesign**

The survey also captured details relating to "big picture goals" and specific service planning objectives that the agencies had in initiating or contemplating a system redesign. As shown in Figure 8, which shows some of the more commonly cited goals, the five most important overall goals that the agencies that have planned or are planning (Groups 1 and 2) were hoping to achieve were improving rider satisfaction, increasing ridership, simplifying the system for ease of public use, better serving transit-dependent populations, and improving on-time performance and reliability. The goals that the survey offered as an option for selection deemed the five least important were: adapt to changes resulting from new types of transportation options (e.g., TNCs, bike share); long-term operating cost savings; use new operating funding strategically; shift ridership to other modes; and increase or decrease service area (i.e., provide service in new/reduced jurisdictions).

The three agencies considering a redesign all agreed that their very important overall goals were to re-evaluate the big-picture structure of the system and increase operational efficiency and effectiveness. The service planning objectives were likely a bit farther off in their minds, but the following were selected as either very or somewhat important by all three agencies were to increase the opportunities for transfer, increase the span of service, and increase frequency.

In addition to asking agencies about their big-picture goals the survey asked them to weigh in on their primary service planning objectives. The service planning objectives that rose to the top for Groups 1 and 2 were decreasing the peak vehicle need, selected by 31 of the 33 (94%) agencies as very or somewhat important; reducing travel times, selected by 26 of the 33 (79%) agencies;

**Table 6. Group 1 – Agencies that have implemented or are currently implementing a system redesign.**

Agency	City	State	Agency Size	Name of Plan (Self-Identified)	Implementation Status	Year of Initial Implementation
JTA	Jacksonville	FL	Medium	Branded System Redesign	Full	2014
RIPTA	Providence	RI	Medium	Comprehensive Operational Analysis	Full	2014
Houston Metro	Houston	TX	Large	Branded System Redesign	Full	2015
Omaha Metro	Omaha	NE	Medium	Branded System Redesign	Full	2015
Salem Transit	Salem	OR	Small	Comprehensive Operational Analysis	Full	2015
CARTA	Charleston	SC	Medium	Comprehensive Operational Analysis	Full	2016
Connect Transit	Bloomington -Normal	IL	Small	Comprehensive Operational Analysis	Full	2016
LAVTA	Livermore Valley	CA	Small	Comprehensive Operational Analysis	Full	2016
OCTA	Orange	CA	Large	Branded System Redesign	Full	2016
COTA	Columbus	OH	Medium	Transit System Redesign	Full	2017
MDOT MTA	Baltimore	MD	Large	Branded System Redesign	Full	2017
Denver RTD	Denver	CO	Large	Branded System Redesign	Full	2017
Halifax Transit	Halifax	NS	Small	Branded System Redesign	Partial	2016
Capital Metro	Austin	TX	Medium	Branded System Redesign	Partial	2018
Clemson Area Transit	Clemson	SC	Small	Branded System Redesign	Partial	2018
IndyGo	Indianapolis	IN	Medium	Comprehensive Operational Analysis	Partial	2018
DART	Dallas	TX	Large	Comprehensive Operational Analysis	Partial	2018

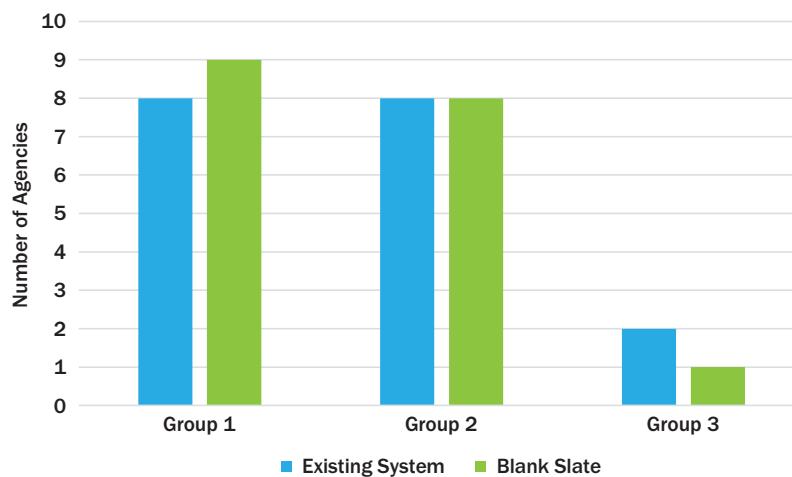
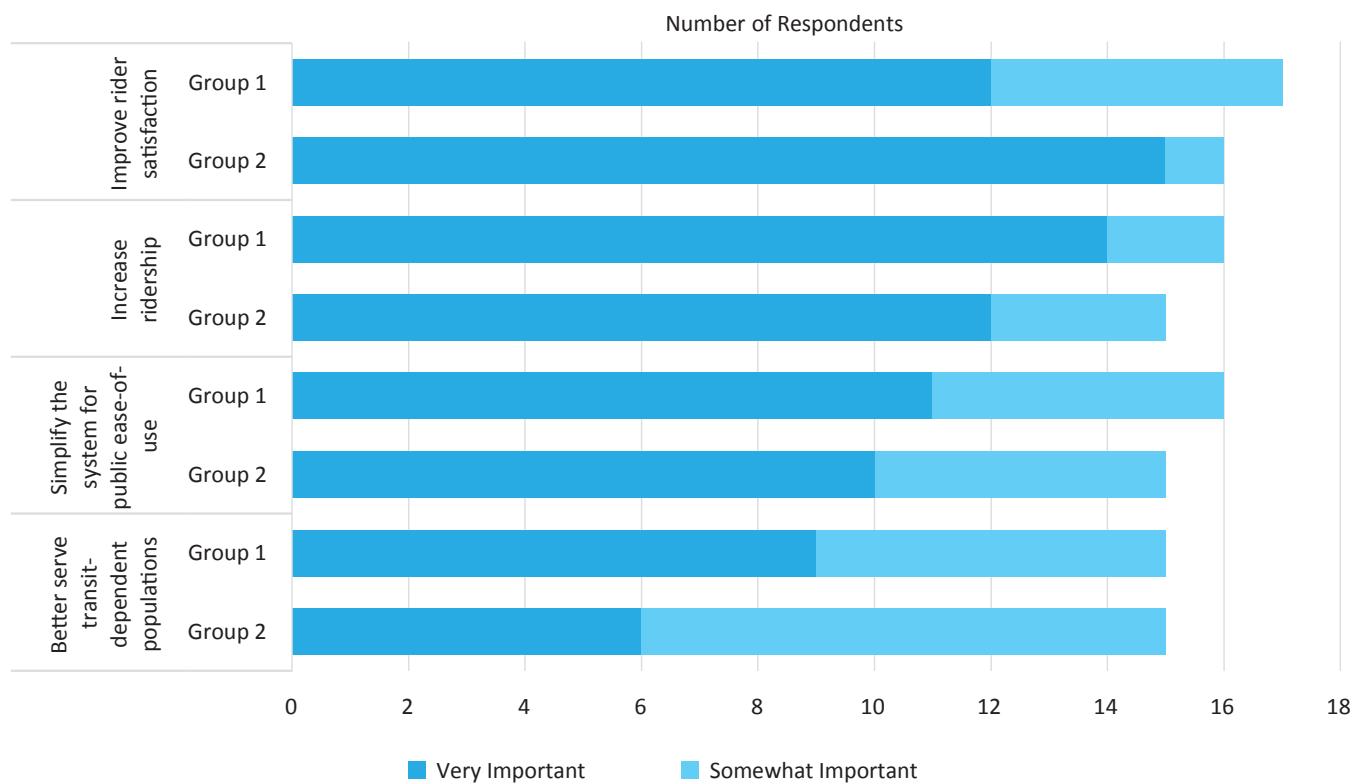
## 30 Synthesis on Comprehensive Bus Network Redesigns

**Table 7. Group 2 – Agencies with a complete plan or in the process of planning a system redesign.**

Agency	City	State	Agency Size	Name of Plan (Self-Identified)
<b>DASH</b>	Alexandria	VA	Small	Transit Vision Plan
<b>EMTA</b>	Erie	PA	Small	Transit Development Plan
<b>HRT</b>	Norfolk	VA	Medium	Transit Development Plan
<b>King County Metro</b>	Seattle	WA	Large	Transit Vision Plan
<b>LACMTA</b>	Los Angeles	CA	Large	Branded System Redesign
<b>LYNX</b>	Orlando	FL	Large	Branded System Redesign
<b>MBTA</b>	Boston	MA	Large	Branded System Redesign
<b>Nashville MTA</b>	Nashville	TN	Medium	Comprehensive Operational Analysis
<b>NYCT</b>	Staten Island	NY	Large	Branded System Redesign
<b>Sacramento RTD</b>	Sacramento	CA	Medium	Branded System Redesign
<b>SORTA</b>	Cincinnati	OH	Medium	Branded System Redesign
<b>Tri Delta Transit</b>	Antioch	CA	Small	Comprehensive Operational Analysis
<b>VRT</b>	Boise	ID	Small	Transit Vision Plan
<b>VIA Metropolitan Transit</b>	San Antonio	TX	Large	Comprehensive Operational Analysis
<b>VTA</b>	San Jose	CA	Large	Branded System Redesign
<b>Wave Transit</b>	Wilmington	NC	Small	Transit Development Plan

**Table 8.** Group 3 – Agencies contemplating a system redesign.

Agency	City	State	Agency Size	Type of Plan	Scope
Metro McAllen	McAllen	TX	Small	Short Range Plan	Full System
Milwaukee County Transit	Milwaukee	WI	Medium	Branded System Redesign	Contemplating Full or Partial System
SEPTA	Philadelphia	PA	Large	Transit System Redesign	Full System

**Figure 7.** Planning approaches to system redesigns.**Figure 8.** Commonly cited big picture goals – Groups 1 and 2.  
(continued on next page)

## 32 Synthesis on Comprehensive Bus Network Redesigns

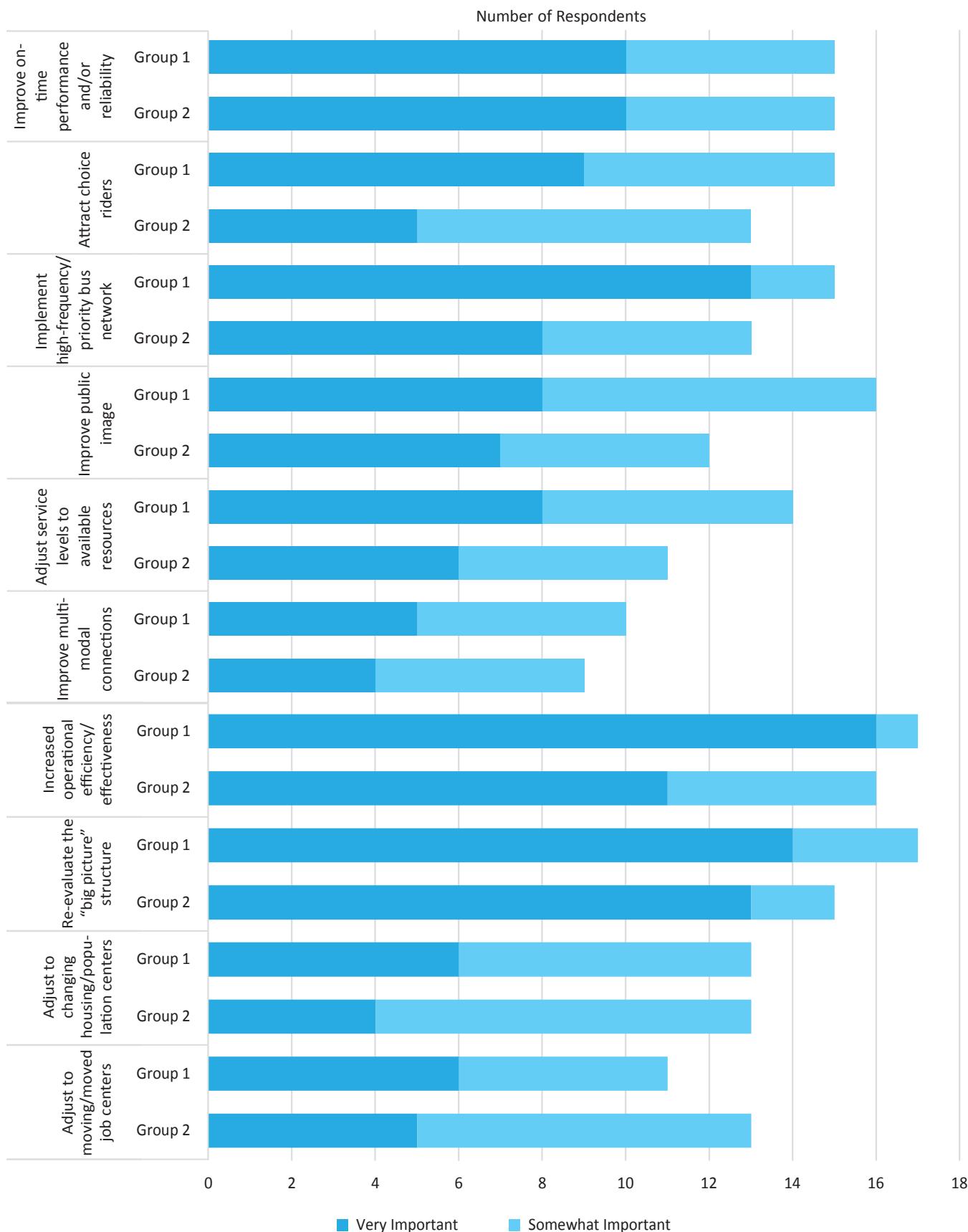
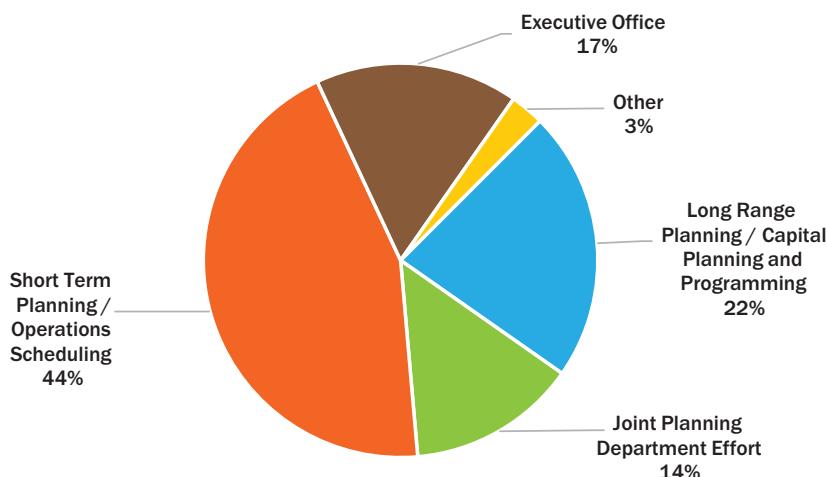


Figure 8. (Continued).



**Figure 9. Lead role on system redesign.**

and increasing the span of service, selected by 24 of the 33 (73%). Other service planning objectives that the agencies planned for were: consolidating or modifying service into new/moved transfer hubs/centers and decreasing coverage within the service area, both of which were considered “very” or “somewhat” important by 21 of 33 agencies (64%).

### 3.5 Agency Organization

System redesigns are born of different motivations and have different goals, and each agency has different areas of strength and influence within their organization. As a result, the agency champion, lead department, and participation from other offices can vary.

#### Lead and Major Support Departments

Overall, the responses indicated that a majority of system redesigns were housed in the short-term planning/operations scheduling department. Figure 9 shows the breakdown of which departments led the system redesign effort, while Table 9 indicates the other departments that

**Table 9. Other departments that played/are playing a significant role in the redesign.**

	Long Range Planning	Short Term Planning/Operations	Executive Office	Finance	Marketing	Operations	Procurement	Customer Relations	Other
<b>Group 1: Implemented or Partially Implemented</b>	65%	65%	82%	53%	88%	82%	24%	65%	29%
<b>Group 2: Planning a Redesign</b>	63%	69%	75%	44%	69%	69%	0%	44%	13%
<b>Total</b>	64%	67%	79%	48%	79%	76%	12%	55%	21%

played significant roles. The most common departments with significant roles were the executive office, marketing, and operations; more departments played significant roles in agencies that have already completed or begun the implementation of their redesigns.

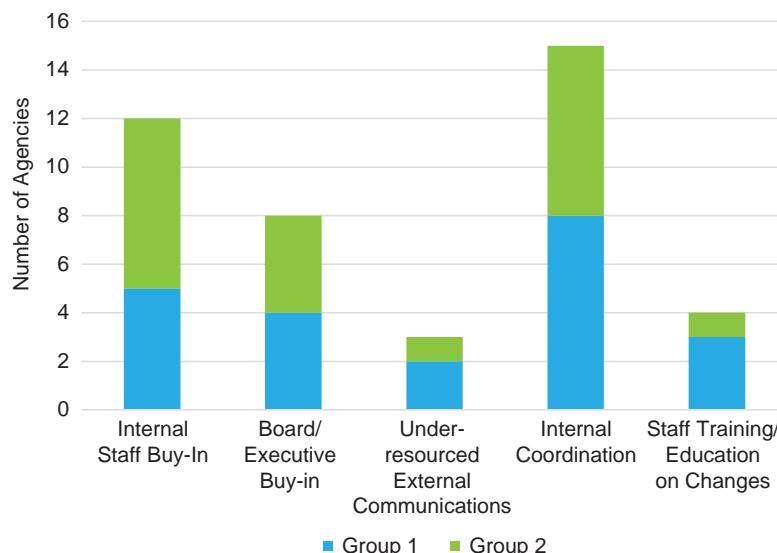
## Redesign Champions

In addition to board support and involvement, large projects often require champions to help advocate for the project. Sixty-seven percent, or 22 of the 33 agencies, indicated that there was a project champion within the agency, the most common being the agency head or CEO. Other common champions included board members, local politicians, and other agency staff members. The role of the champion included developing the vision for the project, leading internal coordination, and/or promoting the project to internal and external stakeholders. LACMTA noted that their CEO championed the redesign effort by “*Educat[ing] the Board of Directors on the need to re-baseline the system to be more relevant to today’s travel markets and demand, and to set a foundation from which to grow with funding from Measure M.*” A few agencies had more than one champion, promoting the redesign work in different ways. For example, VRT responded “[Executive Director] *Kelli Badesheim really saw the need for a unified plan for Valley Regional Transit and saw the network restructure as a critical piece of that. She has shopped the plan and network around to board members, stakeholders and the business community. Jim Hansen [Board Chair] has been focusing on keeping the VRT board focused on delivering on the unified vision and restructured network, specifically working out funding issues and working through key relationships/potential conflict points with highway districts and local road jurisdictions.*”

## Internal Communications Challenges and Strategies

With many departments interacting with such a large-scale project, it is no surprise that the respondents experienced challenges in their planning and implementation of system redesigns. The most common challenge indicated by agencies was generating buy-in for the project within their own agency; for example, Omaha Metro found that “*Some staff members felt that major changes were not necessary, and feared we would lose our ridership base. Strong leadership from the Executive Director made it clear that change was necessary, and would happen.*” LAVTA responded that their biggest communication challenge was “*getting all internal stakeholders onboard with a system redesign. We are a small agency and if one person isn’t onboard with a plan, it can be disruptive.*” Larger agencies were concerned about internal buy-in, but also highlighted the need to overcome information silos; for example, Houston Metro noted that “*bringing disparate groups of employees together who have/had significant experience and recognition based upon independent operation and results to work collectively on an organization-wide effort proved incredibly challenging. Weekly meetings were held where individual tasks and deadlines were reviewed collectively to ensure that everyone was operating on the same page toward the same time deadline with the same goal.*” With so many departments impacted and involved when an agency conducts a redesign, these communication efforts have proven in several cases to help break down the walls between silos and improve interdepartmental communication. Figure 10 shows the results of all challenges indicated by agencies during the planning and decision-making process.

Twenty-nine of 33 agencies (88%), including all Group 1 agencies and 75% of Group 2 agencies, responded that they involved bus operators in the system redesign planning process. Respondents who indicated that they involved operators received an open-ended follow-up question, asking in what way the operators were involved. The most common method used to collect information from bus operators was through meeting with them in the operator break room and conducting focus groups. Some agencies also indicated the type of information they collected from operators, such as comments on the draft recommendations, having operators



**Figure 10. Internal communication or coordination challenges experienced.**

involved in route planning, and gaining operator input on the system vision and existing conditions. HRT, which has planned but not implemented a redesign, noted that they held stakeholder meetings with operators to gain insights from them on what worked best on the existing routes and what, from their perspectives, were low passenger productivity areas of the routes. Additionally, some agencies indicated that operator input was specifically sought for operational details such as turns, safety, layovers, restrooms and other operational details. JTA worked closely with operators during the launch of their system to identify operational issues; they noted “we sought input on route changes and held table top exercise on launch week to identify quick fixes.”

Involving bus operator union leadership was also common among the surveyed agencies. Twenty-three of the 33 agencies (70%) reported involving union leadership. Seventeen of 33 agencies (52%) indicated that they approached union leadership occasionally regarding specific topics while seven of the agencies (21%) responded that they held regular briefing meetings. Regular engagement with the union is also critical for a smooth implementation. OCTA, one of the agencies that has implemented its redesign, noted that union leadership provided feedback about relief points, routing options, and other route-specific insights. When it came time to post the new bid/pick, the union was helpful in selling the changes to the drivers as an improvement in overall work hours.

### 3.6 Decision-Making

Agencies varied in who was responsible for decision-making, in some cases based on whether the agency was an independent agency or an arm of the local or state government. Overall, boards played a key role in both supporting redesign and serving as champions as well as being opposed to the redesign. In some cases, board members were not supportive of the overall goals of the redesign—not because of theory or concepts but because of concern about a particular route.

#### Role of Board and/or Parent Agency

Agency board involvement and support is an integral yet varied part of the decision-making process. According to the survey results, most commonly the board gives policy guidance and

**Table 10. Board involvement in system redesigns.**

Type of Board Involvement	Group 1	Group 2	Total
<b>Policy Guidance: Route recommendations</b>	75%	31%	49%
<b>Final Approval: Route recommendations</b>	88%	63%	71%
<b>Policy Guidance: System redesign vision</b>	94%	63%	74%
<b>Final Approval: System redesign vision</b>	56%	56%	51%
<b>Policy Guidance: Operational restructuring</b>	50%	0%	47%
<b>Policy Guidance: Operating budgets</b>	56%	25%	37%
<b>Final Approval: Operating budgets</b>	81%	69%	71%
<b>Policy Guidance: Stakeholder involvement</b>	69%	44%	54%
<b>Final Approval: Capital Improvements</b>	63%	50%	54%
<b>Final Approval: Capital budgets</b>	75%	56%	63%
<b>Policy Guidance: Equity considerations</b>	63%	63%	60%
<b>Final Approval: Equity considerations</b>	69%	38%	49%
<b>Policy Guidance: Community outreach</b>	63%	38%	49%

final approval of the system redesign vision and route recommendations, along with policy guidance on stakeholder involvement and final approval of operating and capital budget impacts. Some of the most common elements of board participation are shown in Table 10.

An agency board can also play a role in advocating for the system redesign; answers from 65% of Group 1 agencies indicate that boards may conduct political advocacy on behalf of the project, and 53% conduct public outreach among the community to garner support. Group 2 agencies that have not started the implementation process similarly answered that their boards have or are likely to conduct public and political advocacy for their respective system redesigns.

### **Role of the Jurisdiction in Which the Agency Operates**

State, city, and county departments of transportation may also play a large role, depending on the context of the local service environment. Twenty-four of 33 agencies (73%) including every “large” agency except VIA Metro Transit, reported that their state or municipal DOT was involved at the stakeholder level for review and feedback. Forty-five percent of the 33 responses indicated that the DOT had a small part in the planning and implementation process, and only 33% had a very close working relationship with the transit agency on the planning; interestingly 40 to 45% of the small and medium agencies had a strong involvement and only 17% of the large agencies had strong collaboration on planning with the cities in which they operate.

### **3.7 Redesign Components**

The agencies that either have implemented/partially implemented a system redesign (Group 1) or are in the process of planning for one (Group 2) were directed to a set of survey questions designed to gather information related to the detailed components of a system redesign. This

includes service planning, outreach to stakeholders, operating and capital costs, planning and implementation costs and post-launch performance. The following section discusses these results.

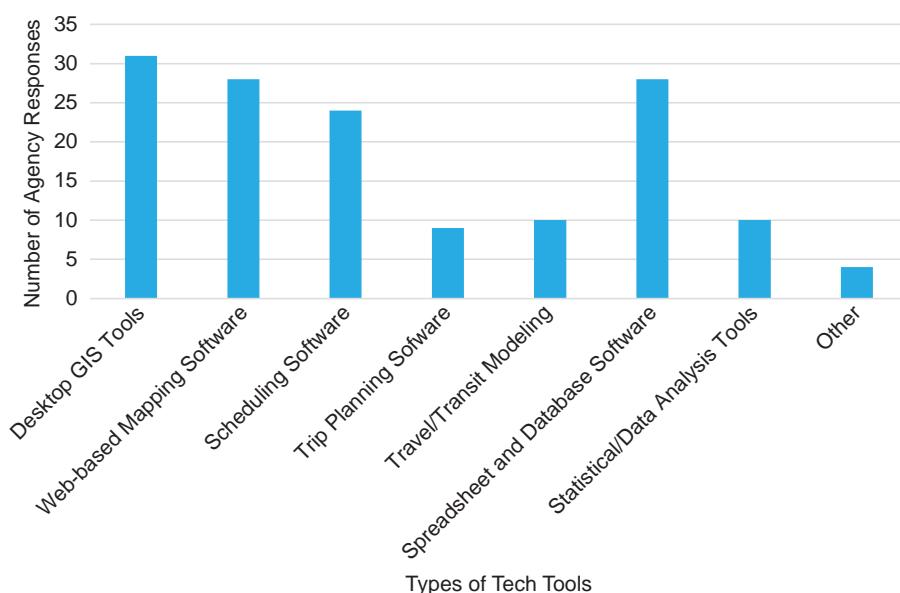
## Service Plans

The service planning process conducted by the agencies varied. They used a variety of approaches to planning, different tools, and varying levels of involvement by stakeholders. All agencies began the process by defining key goals that they were trying to address in the redesign (as shown in Figure 8). They also all focused on a variety of service planning objectives to guide the service planning process – from moving toward a grid network to focusing service on high-frequency corridors. As discussed in Section 3.3, the agencies were about evenly split in how they approached their redesign in terms of beginning with their current network or taking a blank-slate approach. Most agencies surveyed used metrics to evaluate their plans during the process to evaluate how well the plan was aligning with their stated goals and objectives, and all agencies with completed plans reported the anticipated impact of the plans on operations.

## Tools and Data

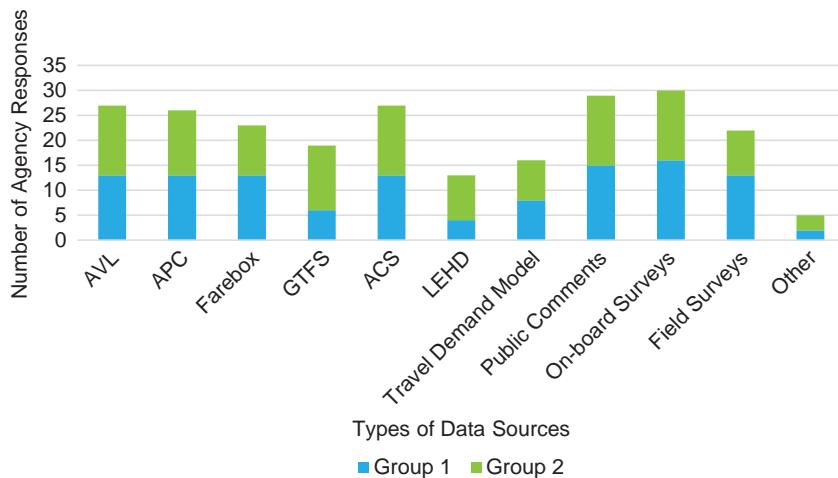
Agencies also responded on what technical tools were used in the planning process. Desktop geographic information system (GIS) mapping tools were the most common, with 31 agencies (94%) indicating that they used such software. The two agencies that did not use desktop GIS tools were EMTA and LAVTA. The next most common tools used were web-based mapping software, and spreadsheet and database software, both with 28 agencies (85%) using each. Least used were trip planning, travel demand modeling, and statistical data analysis tools—no agency that implemented or was working on a partial system redesign used travel demand modeling tools, likely because they are not calibrated for this type of work. Agencies that indicated “Other” specified specialized in-house or proprietary tools that they used. Figure 11 shows the full list of tech tools along with the number of responses out of 33 agencies.

In addition to tech tools, agencies provided which data sources were or would be relevant during the planning process (Figure 12). The most common data source was passenger provided



**Figure 11. Tech tools used for system redesign.**

### 38 Synthesis on Comprehensive Bus Network Redesigns



**Figure 12. Data used for service planning.**

information, with all but two agencies indicating that they used public comments and/or onboard passenger surveys to inform their planning. It is worth noting that later in the survey both of the agencies that did not use passenger-provided information, EMTA and LAVTA, indicated that they planned to use various public engagement strategies and that they consulted the public. Automated passenger counters (APCs), automated vehicle location (AVL) systems, and American Community Survey/Decennial Census were also commonly used – by more than 79% of respondents each – in planning their redesigned systems. Least commonly used were regional and national datasets that provide information on travel patterns generally. The agencies that answered “other” used data sources such as aerial photography, location based data provided by cell phones and social media tools, prior agency studies, and other resources available to the consultant team.

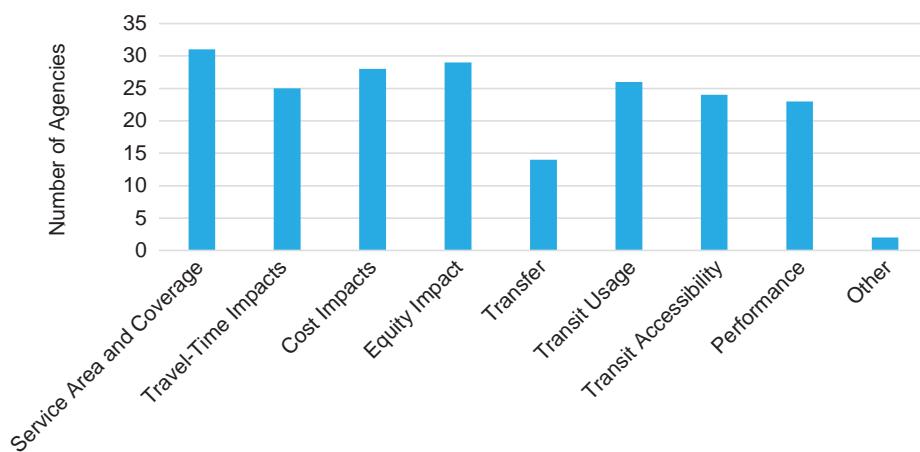
#### Evaluation Criteria

Agencies were asked what types of evaluation criteria they used to assess possible impacts during the planning process. The options provided to the respondents were

- Service area and coverage, e.g., transit walkshed, service to key trip generators/facilities/places, service availability for different demographics;
- Travel time impacts, e.g., systemwide average transit travel time, number of trips by trip duration, average transit travel time by zone/district/neighborhood;
- Cost impacts;
- Equity impacts;
- Transfers, e.g., systemwide average transfer rate, number of trips by number of transfers;
- Transit usage, e.g., ridership, mode share;
- Transit accessibility, e.g., regional transit accessibility, jobs accessible within a specified time-frame; and
- Performance, e.g., predicted changes in on-time performance and average systemwide speed.

Thirty-one agencies selected service area and coverage criteria as the most common metric type used in the planning process. This was followed by equity impacts and cost impacts criteria. Houston Metro and LA Metro both indicated that they used other evaluation criteria: Houston Metro used specific criteria that showed “*Employment/Population relative to frequent network*” and LA Metro used criteria based on “*User Experience and other Customer focused KPIs and measures of success based on what service characteristics and attributes are important to [customers]*.”

Figure 13 shows the frequency of responses for all evaluation criteria listed.



**Figure 13. Evaluation criteria used during system redesign planning process.**

### Impact of Emerging Modes

The survey requested input on the topic of newer modes of transportation—such as transportation network companies (TNCs), bike share, and automated vehicles (AVs)—and 12 of 33 agencies (36%) indicated that these did have an impact or an anticipated impact to the system redesign; most of those agencies fell in Group 2, indicating that considering these impacts is a newer trend in redesigns. Only 4 of 33 agencies (12%) indicated that bike share impacted or will impact their redesign efforts, and just one agency (VRT) indicated that autonomous vehicles may have an impact. VRT noted that they are very interested in identifying use cases for autonomous transit services and would envision using them either for access to large business parks and/or to improve service frequencies at a lower cost. When the 12 agencies that indicated that TNCs had or might have an impact on system redesign efforts were asked to explain the impacts further, 8 agencies (67%) indicated through partnerships that provide service, for example LYNX responded that “*We have already created a Mobility Management Call Center and recently began diverting some paratransit trips to Taxis and soon TNCs*” and two (17%), Nashville MTA and VRT indicated through assistance in filling first/last mile gaps.

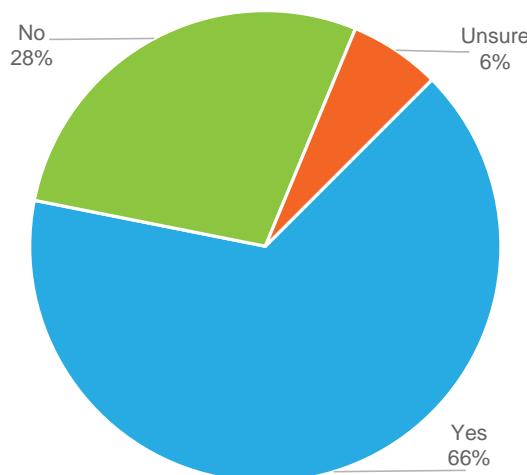
### Capital Improvements

The survey found that capital improvements are often associated with a system redesign. Shown in Figure 14, 21 agencies (66%) answered yes to whether or not capital costs were associated with their system redesign. Of those 21 agencies, 17 of them (81%) said that they improved or expected to improve passenger facilities, and 16 of them (76%) said that they had or expected to install new bus stop signage systemwide. Eleven agencies said they purchased or would purchase new rolling stock in conjunction with their redesign. The percentage of Group 1 and Group 2 agencies did not differ in the types of capital expenditures with the exception of bus support facilities such as improving a garage or layover spaces – only one Group 1 agency (COTA) said they had done this, but five Group 2 agencies are planning such expenditures.

### Outreach

Agencies indicated that outreach was a large part of the system redesign process; all agencies either consulted or plan to consult the public during the redesign process. For Group 1 agencies that have already implemented their plans, the points in the redesign process where most agencies consulted the public were after draft and final scenarios were developed (88% each). Fewer

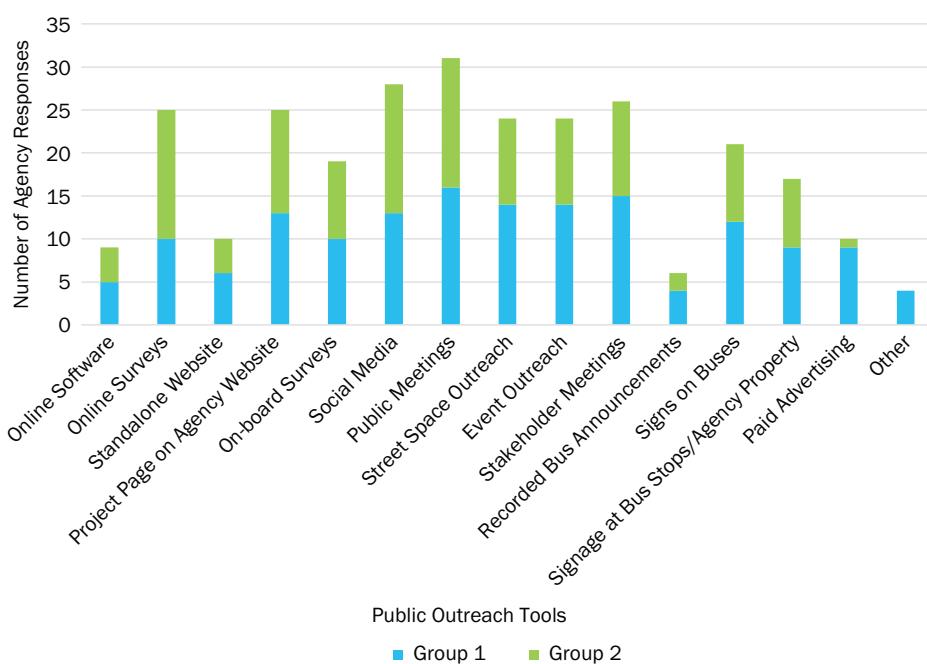
## 40 Synthesis on Comprehensive Bus Network Redesigns



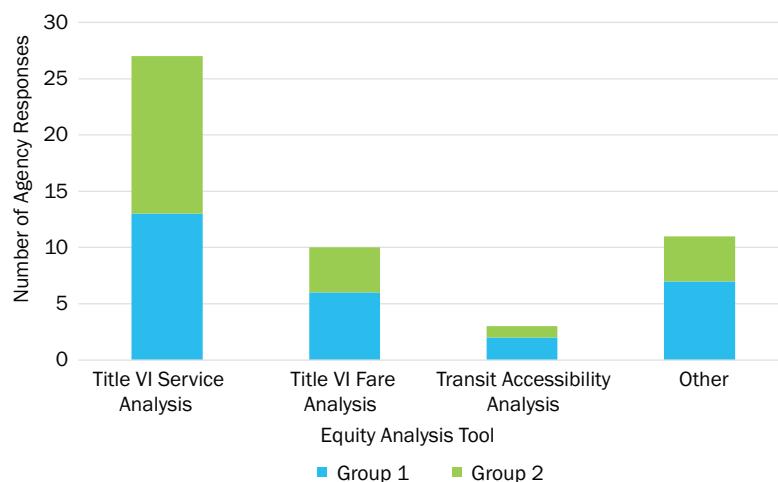
**Figure 14. Were capital costs associated with the system redesign?**

agencies, although still a majority, began seeking public input on the plan during the visioning stage (71%). Group 2 agencies, currently planning or planned but not implemented, indicated a stronger inclination to consult the public after final scenarios were developed (94%), although still a majority indicated that input would be or was sought after draft scenarios were developed (81%) and during the visioning stage (63%).

The survey asked agencies about the types of outreach tools used or would be used. Figure 15 shows the frequencies of responses. All but one agency indicated public meetings as a tool for public outreach (This agency did not select any public outreach tools, but later in the survey did indicate that public input would be sought, suggesting that this question was skipped). Social



**Figure 15. What community engagement strategies did you employ/will you be employing?**



**Figure 16. How did you or how are you planning to gauge the redesign impacts on equity considerations?**

media (85%) was the next most prevalent outreach tool, followed by other person-to-person engagement strategies such as stakeholder meetings (79%) and engagement in public spaces at events or on the street (73%). The outreach tools that were used the least were paid advertising, recorded announcements on buses, standalone project websites, and online crowdsourcing software. In addition, four respondents responded with descriptions of other strategies they employed or would employ for community engagement. These included media interviews, meetings with all local elected officials, sending mailings throughout the community, and using a trolley at outreach events.

## Equity Considerations

Agencies were asked how they gauged or planned to gauge the equity impacts of their redesigns. All but two agencies indicated a method for assessing equity impacts, and over half (54%) indicated that they used or planned to use two or more approaches to assess equity impacts. All but four US agencies indicated the use of a Title VI analysis tool; the four agencies that did not all had service area populations of below 200,000 people. Eleven agencies wrote in other tools they used which included assessing the impact on riders who would fall under the Americans with Disabilities Act (ADA), job access analysis, watershed analysis, and other specific measures tied to equity. Figure 16 shows the number of responses regarding the types of equity analyses performed or planned to be performed. Based on the number of agencies that are still in the planning process, the high level of Title VI service equity analysis indicates that agencies are conducting these analyses earlier than is required to check for and address any potential impacts. Agencies found that addressing impacts on ADA paratransit early can help assuage concerns about impact to existing paratransit users; anecdotally most agencies grandfather in existing users even if the ADA paratransit service area will change under the redesign.

## 3.8 Funding

### Planning Costs and Process

The survey sought to reveal what resources agencies used during the planning and implementation processes. The majority of respondents, 85%, indicated that planning work was done through a mix of agency staff and consultants. Two agencies, EMTA and LYNX, have so far used



**Figure 17. Estimate of planning costs.**

consultant staff exclusively, while two agencies, NYCT and Halifax Transit, used only agency staff. Of the 27 agencies that indicated that a mix of agency staff and consultants conducted the planning work, the majority (85%) indicated that the consultants did most of the work. Two agencies, JTA and VIA Metro Transit, indicated that it was an even split, and VRT indicated that agency staff did most of the work. In general, consultants were used to conduct market assessments, service valuations, and to craft recommendations for agency and public input.

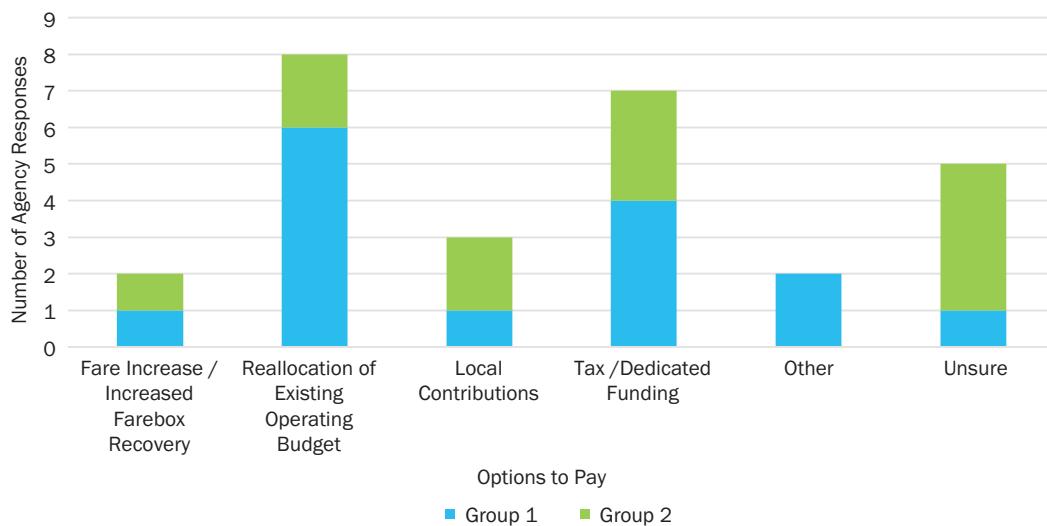
The survey also addressed the implementation planning process. Sixteen agencies responded to a question regarding who did the planning work around implementation, of which the majority of respondents, 94%, indicated that a mix of agency staff and consultants conducted implementation planning work. Only one agency, LAVTA, indicated that consultants did all implementation planning work.

Agencies were asked how much the overall planning process cost. Thirty agencies responded, and the majority indicated that their planning costs were between \$100,000 and \$500,000 (Figure 17). The agencies that spent the most, or anticipate spending the most on their planning are Houston Metro, JTA, LA Metro, VIA Metro Transit, MDOT MTA, and MBTA.

## Operating Costs

Survey participants were asked about the impact of the redesign on agency operating costs; of the 33 agencies that saw the question, 30 responded. A third of agencies indicated that they did not experience or did not anticipate experiencing operating cost impacts. Two-thirds of the respondents indicated that there had been or would be an annual operating impact. Respondents who indicated there would be an impact were asked a follow-up question to find out if it increased or decreased operating costs; 18 agencies responded, and the majority (16 agencies) indicated an increase, while two agencies, Halifax Transit and CARTA indicated a decrease. Halifax Transit and CARTA both indicated that a very important goal in their redesign was to increase operational efficiency and effectiveness, however service planning goals were largely different. Halifax Transit indicated a focus on increasing transfer opportunities and increasing service frequency as its top two service planning priorities. CARTA's top service planning goals were to strategically apply service cuts through decreasing frequency and thus decreasing revenue hours.

The Group 1 agencies that indicated an operating cost increase were also asked to quantify the percent increase; half of respondents indicated at most an increase of less than 5% of annual operating costs. Three respondents indicated that annual operating costs had increased between 5% and 10%, and five agencies indicated an increase of greater than 10%. Of those with the



**Figure 18. Options to pay for increased operating costs.**

greatest percent increase in annual operating costs only two had implemented their redesign, Connect Transit and Clemson Area Transit; both agencies have small service areas and operate less than 100,000 annual revenue hours. These agencies responded that they would cover increased operating costs with local contributions and reallocation of the existing operating budget, respectively. The Group 2 agencies whose plans call for increasing annual operating costs by more than 10% are HRT, SORTA, and VRT; both HRT and SORTA anticipate using additional tax revenue or another dedicated funding source to pay for the increase while SORTA also anticipates raising fares. VRT is at the stage in their planning where they are unsure how they will pay for the increase. Overall, the most frequent response to how the agencies paid for or planned to pay for increased operating costs was through reallocating existing operating budgets, followed by taxes/dedicated funding sources (Figure 18).

## Capital Costs

The capital cost that was most frequently expended/planned to be spent by agencies was rolling stock, followed by passenger facilities (e.g., transit hubs), and bus stop signage. All but three of the 21 agencies that indicated that capital costs were associated with their redesign invested in more than two types of capital improvements, including in bus priority treatments and support facilities (e.g., bus garage or layover facility). Table 11 shows which capital investments were selected by responding agencies as part of their system redesigns.

## 3.9 Implementation

Agencies were asked how they implemented or planned to implement the redesign from a timing perspective. Thirty-one percent of the agencies stated that they had/would implement all at once, with another 25% stating it would be mostly all at once with minor additional phases. Only 36% had implemented or planned to implement in phases; the remaining 8% cited that they did not yet know. For those agencies using phasing, the agencies that responded were evenly split in whether they were phasing by geographic service area or by service type, and the span of time for the phasing ranged anywhere from less than 2 years to 10 years or more.

Group 1 agencies were asked what the agency did to prepare for the launch of their redesigned system; 15 out of the 17 Group 1 agencies responded (Table 12). Most used multiple methods to

**Table 11. Capital investments.**

Agency	Rolling Stock	Passenger Facilities	Priority Treatments	Bus Stop Signage	Support Facilities (e.g., bus garage, layover facility)	Other
<b>MDOT MTA</b>	•	•	•	•		
<b>Houston Metro</b>		•		•		
<b>JTA</b>		•		•		•**
<b>LA Metro</b>		•	•	•		
<b>VIA Metro Transit</b>	•	•		•		
<b>CARTA</b>		•		•		
<b>Clemson Area Transit</b>	•					
<b>Connect Transit</b>	•					
<b>COTA</b>		•		•	•	•*
<b>DART</b>	•	•		•		
<b>HRT</b>	•	•		•	•	
<b>IndyGo</b>	•	•	•	•		
<b>LYNX</b>	•	•		•		
<b>Sacramento RTD</b>		•		•		
<b>Salem Transit</b>				•		
<b>SORTA</b>	•	•	•		•	
<b>Tri Delta Transit</b>		•		•		
<b>VRT</b>	•	•	•	•	•	
<b>Nashville MTA</b>		•	•	•	•	
<b>Halifax Transit</b>	•	•	•			
<b>King County Metro</b>	•	•	•	•	•	

\* Respondent wrote that network redesign related capital costs were associated with a transit center renovation.

\*\* Respondent wrote that network redesign related capital costs were associated with “bus branding.”

prepare for launch, the most common being launch preparing meetings and print materials. Two agencies, CARTA and IndyGo, restructured their organizations as part of the redesign; CARTA consolidated its leadership and IndyGo added more staff and created a new Planning and Capital Projects Division for long and short-term planning and construction. JTA indicated that in addition to the preparation options listed they also held a pep rally in preparation for launch. Finally, most agencies provided free fares on the new system for some length of time, typically for 1 to 2 weeks, to ease the financial burden on riders who were getting used to the new system.

Agencies were asked to describe their launch preparation selections in more detail; for example, Omaha Metro explained that their launch meeting preparations included, *“several training meetings for all operators to review route-by-route changes. Marketing staff met to plan for launch day media, paid advertisements, etc. We also enlisted about 25 volunteer ‘transit ambassadors’ to pass out information during the first few days, so we held training sessions for them as well.”* Analysis of write-in responses showed that most agencies held meetings to train staff and to ensure effective interagency coordination.

Ten agencies specified that they created externally facing print material such as handouts, flyers, and brochures; most of those agencies (seven) also created posters and signs such as bus cards. For example, RIPTA wrote that *“Our marketing department developed materials for installation at bus stops, on-board buses, and via the internet.”* Internal print materials were detailed route level information for staff as well as key contact information for further information about the launch within the agency. For example, COTA wrote *“Printed materials*

**Table 12. Launch preparations.**

Agency	Organizational Restructuring	Launch Preparation Meetings	Launch Preparation Print Materials	Temporary Staff	Other
<b>COTA</b>		•	•	•	
<b>CARTA</b>	•		•		
<b>Denver RTD</b>		•	•	•	
<b>Salem Transit</b>		•	•		
<b>Connect Transit</b>		•	•		
<b>Houston Metro</b>		•	•	•	
<b>JTA</b>		•	•	•	•*
<b>MDOT MTA</b>		•	•		
<b>Omaha Metro</b>		•	•		
<b>OCTA</b>		•	•		
<b>RIPTA</b>		•	•		
<b>Capital Metro</b>		•	•		
<b>Clemson Area Transit</b>		•			
<b>Halifax Transit</b>			•		
<b>IndyGo</b>	•	•	•		

\* Respondent held a pep rally prior to the launch of the redesigned network.

were developed for both internal staff and the public. Internal: Staff were given talking points with key leader phone numbers, system maps, Downtown maps with key transfer locations, and a table that described pre-change lines, by unique segment, and what lines riders would board in the new network.”

Four agencies hired temporary staff in preparation for launch, and all four indicated that temporary staff were used for outreach purposes. COTA and MDOT MTA specified the use of street teams for outreach and additional call center staff, while JTA referred to their temporary staff as customer outreach specialists, and Denver RTD called their staff public relations staff for outreach.

### 3.10 Post-Launch Adjustments and Performance

The oldest redesigns in this survey are from 2014 (JTA and RIPTA), and most are from the past 2 years, which is a short timeframe to observe the performance impacts of a bus system redesign. In fact, none of the responding agencies provided a full quantification of the impacts of the redesign, possibly due to how recently the changes were implemented. Additionally, parsing out impacts of the redesign vis-à-vis other externalities can be difficult, such as overall transit ridership decline nationwide.

Agencies that had fully implemented or partially implemented their redesign (Group 1) were asked what additional changes were necessary after the redesign was first implemented and how the performance of the system had changed. While most agencies are continually making updates to their routes, the big difference with making updates after a redesign is the volume and pace with which they must be made. When so many routes are changing at once, the likelihood of needing tweaks is higher than usual, and agencies need to be ready to process the large number of modifications – some of which can be quite urgent in nature if, for example, on-time performance is poor.

Twelve of the seventeen Group 1 agencies responded to the question about what types of post-launch adjustments were needed. The most common change that was made post-launch was to adjust the run time of routes (35%), followed by updating stops (24%), adjusting alignments (18%), and lastly upgrades to street infrastructure (e.g., stop bars) (12%). For example, Cherriots (Salem Transit) noted that “*On time performance required significant changes to routes. We had created many crosstown routes that had to be taken apart to help with bus bunching and the routes being on time*” and MDOT MTA wrote, “*Some routes were adjusted immediately (within days) after launch for safety reasons. Other routes were adjusted at the next service change 3 months later. We implemented run time adjustments on 40+ routes at the service change 8 months after launch.*”

Of the five agencies that had not done any post-launch adjustments, four implemented or are implementing their redesigns this year, while the fifth agency, Halifax Transit, is implementing its redesign in phases over a 4- to 5-year period, began implementing in 2016 and plans on completing the implementation of its plan in 2020/2021. In both cases, these agencies may still be in the process of evaluating and executing potential post-launch adjustments.

Regarding system performance post-launch, all agencies expressed positive results from their system redesign. Although CARTA noted that ridership decreased more than expected, the agency noted that their goals were met, which were to make the system more efficient and to strategically implement service cuts. Other agencies that are experiencing or experienced ridership decline also see the performance of their system as better after implementation; RIPTA, Omaha Metro, COTA, and JTA all noted ridership decreases, however they credited their redesigns for reducing those decreases, which would have been larger without the redesigns. For example, Omaha Metro noted, “*Ridership declined, although it happened at the same time as a significant drop in gas prices . . . Even still, our goals were met. We wanted to strengthen the network structure, redistribute coverage/frequency, improve the customer experience, and build financial sustainability. . . .*” Connect Transit saw ridership decrease initially and then begin to increase, and LAVTA, OCTA, and Houston Metro noted ridership increases. For example, OCTA wrote “*The changes appear to have stemmed the declining ridership trend we were experiencing. Routes which saw service improvement have seen ridership increase by over 10%.*” MDOT MTA noted that on-time performance of their system improved by 5%, an important goal of the agency’s redesign.

### **3.11 Group 3 Results – Contemplating Redesign**

Out of the 36 agencies that completed the survey, three of them responded that they were contemplating the decision to plan a system redesign. These agencies were Metro McAllen, Milwaukee County Transit, and SEPTA. This section explores some context behind the decision-making process for agencies still deciding.

#### **Redesign Goals and Objectives**

As was the case with the Group 1 and Group 2 agencies, all three Group 3 agencies indicated that if they elect to embark on a system redesign, re-evaluating the big picture structure of

the transit system and increasing operational efficiency and effectiveness are very important goals for their redesigns. Table 13 shows Group 3 agencies' responses relative to the importance of each to the question "What is your agency hoping to achieve through your bus system redesign?"

Group 3 agencies are quite varied in terms of their potential service planning goals (Table 14). SEPTA indicated that only one objective would be very important: to increase opportunity for transfers. Of the 14 objectives to choose from, SEPTA ranked six of them as "neutral" and said that four of them were "not applicable." Metro McAllen (Texas) said that reducing travel times, increasing transfer opportunities, reducing the need for transfers, expanding coverage throughout the service area, and increasing frequencies would all likely be very important service planning objectives. Milwaukee County Transit had only two very important service planning objectives, which were to increase overall frequency and strategically apply service cuts to decrease frequency in specific areas.

**Table 13. Group 3 big picture objectives by level of importance.**

Big Picture Objectives	Rating
<b>Re-evaluate the "big picture" structure</b>	High
<b>Increased operational efficiency/effectiveness</b>	High
<b>Adjust service levels to available resources</b>	High
<b>Adapt to new types of transportation options</b>	High
<b>Implement high-frequency/priority bus network</b>	High
<b>Improve public image</b>	High
<b>Simplify the system for public ease-of-use</b>	High
<b>Improve rider satisfaction</b>	High
<b>Improve on-time performance and/or reliability</b>	High
<b>Better serve transit-dependent populations</b>	High
<b>Adjust to changing housing/population centers</b>	High
<b>Attract choice riders</b>	Medium
<b>Adjust to moving/moved job centers</b>	Medium
<b>Increase ridership</b>	Medium
<b>Improve multi-modal connections</b>	Medium
<b>Long-term operating cost savings</b>	Medium
<b>Use new operating funding strategically</b>	Medium
<b>Increase service area</b>	Medium
<b>Shift ridership to other modes</b>	Low
<b>Decrease service area</b>	Low
<b>Provide alternatives to heavily congested automobile corridors</b>	Low
<b>Adjust to other public transit investments</b>	Low

**Table 14. Service planning goals by level of importance.**

Service Planning Goals	Rating
<b>Reduce travel times</b>	High
<b>Increase opportunity for transfers</b>	High
<b>Increase span of service</b>	High
<b>Increase frequency</b>	High
<b>Reduce need for transfers</b>	Medium
<b>Expand coverage within service area</b>	Medium
<b>Decrease coverage within service area</b>	Medium
<b>Increase weekend service</b>	Medium
<b>Increase revenue hours</b>	Medium
<b>Decrease revenue hours</b>	Medium
<b>Increase peak vehicle need</b>	Medium
<b>Decrease peak vehicle need</b>	Medium
<b>Consolidate or modify service into new/moved transfer hubs/centers</b>	Low
<b>Strategically apply service cuts (reduce frequency)</b>	Low

### Agency Organization and Decision Making

The organization and decision-making process mirrors agencies that have already begun the planning or implementation stages. Some interesting deviations are in the agency department that is leading the system redesign consideration. Two of the three agencies marked that the executive office is leading the charge. The other agency marked that the long-range planning department housed the effort. Like the Group 1 and Group 2 agencies, two of the three agencies indicated that the board would be involved at either the approval of the final plan or in the policy recommendations stage.

### Service Planning Considerations

Though Group 3 agencies have not begun the planning process for a system redesign, some questions asking respondents to “foresee” what their agency would do shed some light on agency considerations. One example is that all three agencies answered that they would involve bus operator union leadership in the planning process. With regard to tech tools for planning, two of the three agencies estimate that their agency would use desktop and online mapping tools, scheduling software, and spreadsheet software for planning purposes. For data sources, all three agencies responded that field surveys, farebox data, automated passenger counters, and automated vehicle location data would be used for planning purposes.

### Outreach Considerations

Group 3 agencies indicated that outreach considerations have been a part of the decision-making process. All three agencies indicated that after the scenarios were developed would be a

point where general public comment would be sought. For equity concerns, all three agencies agreed that a Title VI service analysis would be conducted during the planning process.

## **Capital, Planning Process, and Costs Considerations**

Metro McAllen and SEPTA anticipate that there will be capital costs associated with their redesigns. Metro McAllen foresees investing in rolling stock and bus stop signage, while SEPTA anticipates investing in passenger facilities, bus stop signage, and bus priority treatments. Regarding who will be doing the planning work, Milwaukee County Transit anticipates it will be agency staff only, SEPTA anticipates a mix of staff and consultants, and Metro McAllen is undecided. Only SEPTA indicated how much they think the planning for the system redesign would cost, they estimated between \$1 million and \$5 million, however they also noted that no final decision to move forward has been made and that the cost and scope of the project are being discussed.

### **3.12 Summary**

The survey respondents represented a wide variety of agencies from the perspectives of geography, system size, and status of their redesigns. Yet, they had many commonalities, including the overall goals of the system redesigns – most were hoping to improve rider satisfaction, increasing ridership, simplifying the system for ease of public use, better serving transit-dependent populations, and improving on-time performance and reliability. The agencies also largely agreed on their objectives relating to service planning, including decreasing the peak vehicle need (but often increasing service at other times of day); reducing travel times; and increasing the span of service.

Agencies consistently cited the need for board support and involvement as well as for the outside influence of a project champion to help advocate for the project; the most common champion was usually the agency head or CEO. One of the key challenges cited in terms of engagement was generating buy-in for the project within their own agencies across many departments, and a common thread was the need for union engagement and support as a critical component of successfully completing and implementing a plan. Another challenge that agencies sought to address was ensuring collaboration with the cities and jurisdictions in which they operate, particularly from the perspective of coordination on bus priority treatments and other aspects related to street and curb space that the agencies do not have direct control over. In terms of outreach to the public and key stakeholders, all agencies indicated that outreach was a large part of the redesign process, especially during the development of draft and final scenarios, though the majority also sought input earlier during the visioning stage.

Transit agencies surveyed unanimously approached their planning with equity considerations at the forefront. Most agencies applied a methodology for assessing equity impacts, and all agencies with service area populations of greater than 200,000 used a Title VI analysis tool despite it not being required at the planning phase. This indicates an emphasis across the board on providing service in an equitable manner.

Most agencies used consultants for all or part of the work, and agencies that used a mix of consultants and agency staff indicated that the consultants did the majority of the work. As the pool of consulting firms conducting network redesigns is relatively small, this may help explain the common themes and approaches between the bus network redesigns surveyed.

**50** Synthesis on Comprehensive Bus Network Redesigns

About one-third of the agencies had conducted or were currently planning redesigns to have no net change in operating costs, while the remainder were planning toward a change, most of them an increase. The survey did not ask about the level of capital investments, but most agencies invested in some capital items related to the redesign, primarily rolling stock, passenger facilities, and bus stop signage, although a reasonable number of agencies also invested in bus priority treatments.

Overall, the survey responses provided great insight into current practice of how agencies plan and implement bus network redesigns, showing many similarities but also a lot of unique ideas and approaches that provide rich lessons for other agencies considering a similar endeavor.



## CHAPTER 4

# Case Examples

### 4.1 Introduction

This synthesis report includes case examples from five agencies whose responses to the survey suggested that there was a lot to be learned and that they represented a diversity of agencies by redesign status, geographic location, agency type, and agency size (Figure 19). The five agencies for which case studies were conducted are shown in Table 15. Annual revenue hours noted in the table as well as other data on service provided and service area size are all sourced from the NTD 2016 Transit Agency Profiles. These detailed case examples provide deeper insight into each agency's vision and goals for the redesign, the system design parameters, public and stakeholder engagement, implementation, and next steps.

In addition to selecting case examples with a mix of agency characteristics, the agencies were selected to provide depth in the following areas: service planning detail (Connect Transit); long range focus (King County Metro); implementation aspects (COTA); budget constrained and visionary planning (DART); and operator in-reach and capital investments (MDOT MTA).

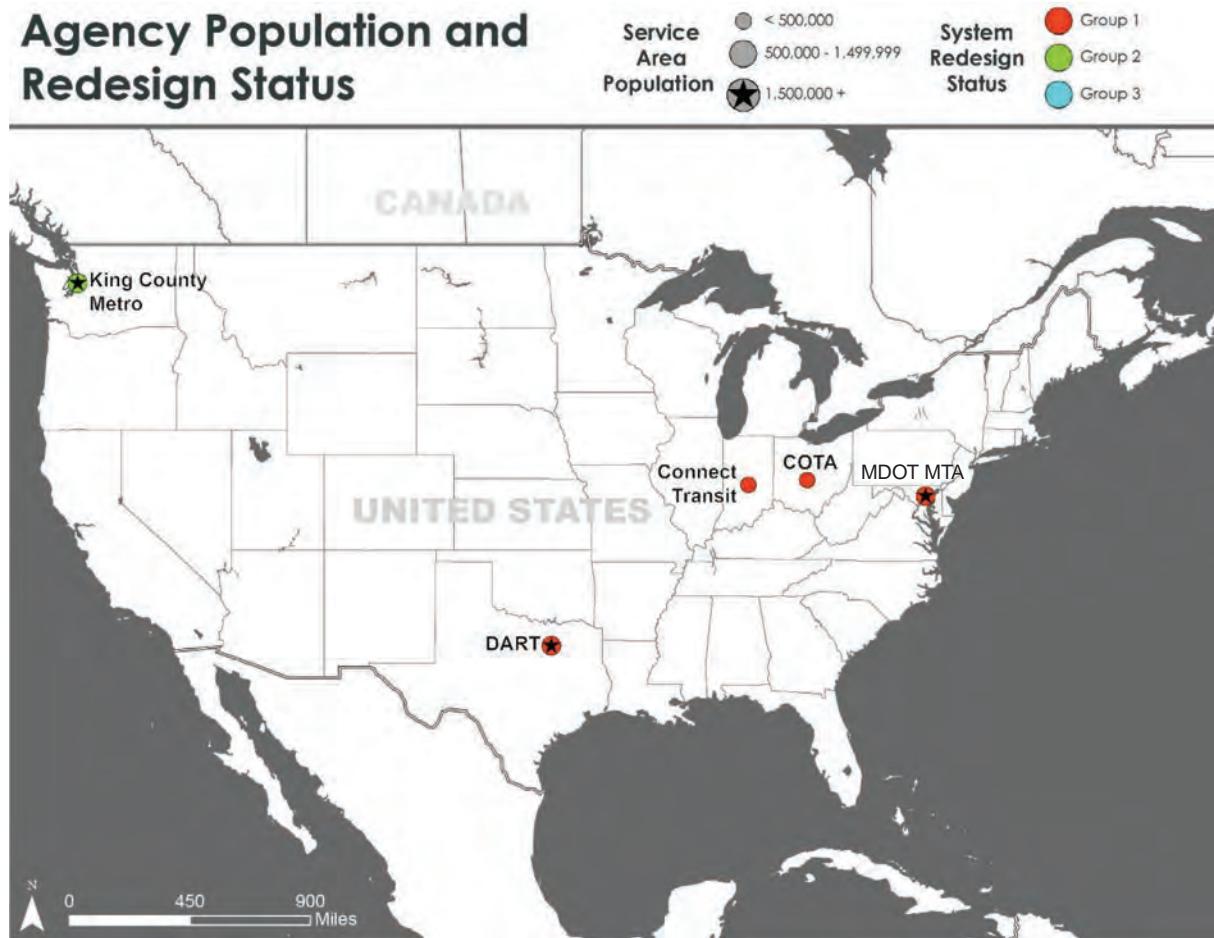
### 4.2 Bloomington-Normal Public Transit System (Connect Transit) Comprehensive Operational Analysis

*Interviewees: Isaac Thorne, General Manager, and Martin Glaze, Transit Operations Manager*

The Bloomington-Normal Public Transit System, known as Connect Transit, provides bus transportation and demand response paratransit services within the City of Bloomington and Town of Normal, Illinois, home to the 20,000+ student Illinois State University. The bus system service area is 46 square miles with a service area population of 129,000. Connect Transit provides an average of 8,600 trips per weekday (see Figures 20 and 21 for further information). In 2015, prior to the launch of their redesigned system, Connect Transit received the American Public Transportation Association (APTA) award for Outstanding Public Transportation System (for agencies in North America providing fewer than 4 million passenger trips annually) for improvements in ridership thanks to investments in branding, improved technology, and customer service (Metropolitan Transit Authority 2015). (<http://www.metro-magazine.com/management-operations/news/295042/connect-transit-named-best-public-transit-system-in-north-america.>)

#### Vision and Goals

Connect Transit initiated a comprehensive operational analysis (COA) in 2015 to assess existing service and to develop options for a new, more frequent and efficient network. Leading



*Figure 19. Map of agencies included in case study.*

**Table 15. Main features of case study agencies.**

Agency	Location	Region	Status	Agency Type	Annual Revenue Hours
<b>Connect Transit</b>	Bloomington-Normal, IL	Midwest	Implemented	Government Agency	90,579 (small)
<b>King County Metro</b>	Seattle, WA	West	Planned, not implemented	Government Agency	2,759,035 (large)
<b>COTA</b>	Columbus, OH	Midwest	Implemented	Independent Agency	879,037 (medium)
<b>DART</b>	Dallas, TX	South	Planned, partially implemented	Independent Agency	2,077,633 (large)
<b>MDOT MTA</b>	Baltimore, MD	East	Implemented	Government Agency	1,738,160 (large)

up to the COA, Connect Transit had been investing in technology, such as adding automated passenger counters (APC), mobile bus tracking, and trip planning software on the agency website, and was focused on improving internal and external customer service. These investments, along with observations of the day-to-day operations of the bus service, supported the understanding within the agency that the way the service was designed was causing inefficiencies, unnecessary stress on bus operators, and was not meeting the needs of the public. The goal of the COA was to improve operational efficiency while meeting the needs of transit riders in Bloomington-Normal. This included planning service that would be more attractive to riders and non-riders by increasing frequency and adding Sunday service.

## System Design

Service planners conducted a comprehensive assessment of the bus network. From an operational perspective the routes were extremely tight, meaning run times left little room for error or delay and buses and bus operators were fully committed with minimal back-up options. Routes were long and circuitous, winding through residential streets and parking lots; this made improving frequencies difficult because to achieve significant headway improvement required the addition of multiple buses along a single long route. Service was not provided on Sunday, and Saturday service was infrequent.

Connect Transit wanted to be able to provide bus service 7 days a week and provide high frequency peak period service – 15 minutes where possible or 30 minutes when 15-minute headways were not feasible. However, the design of the existing service did not make that possible within operating budget constraints. Connect Transit's planners did not consider partially modifying the bus network because it was understood that to achieve efficiency gains the whole network needed to be redesigned. This vision was supported by Connect Transit's Board of Directors, who had an active role in the COA process from visioning to implementation.

The redesign process included a market analysis where planners looked at population and employment density, socioeconomic characteristics, the location of major activity centers, and origin-destination (OD) data. As a part of the COA, Connect Transit conducted an OD survey to better understand travel patterns; the agency also used existing ridership information to inform their understanding of travel patterns. With this information in hand Connect Transit began to draw out a new system following five guiding network design principles:

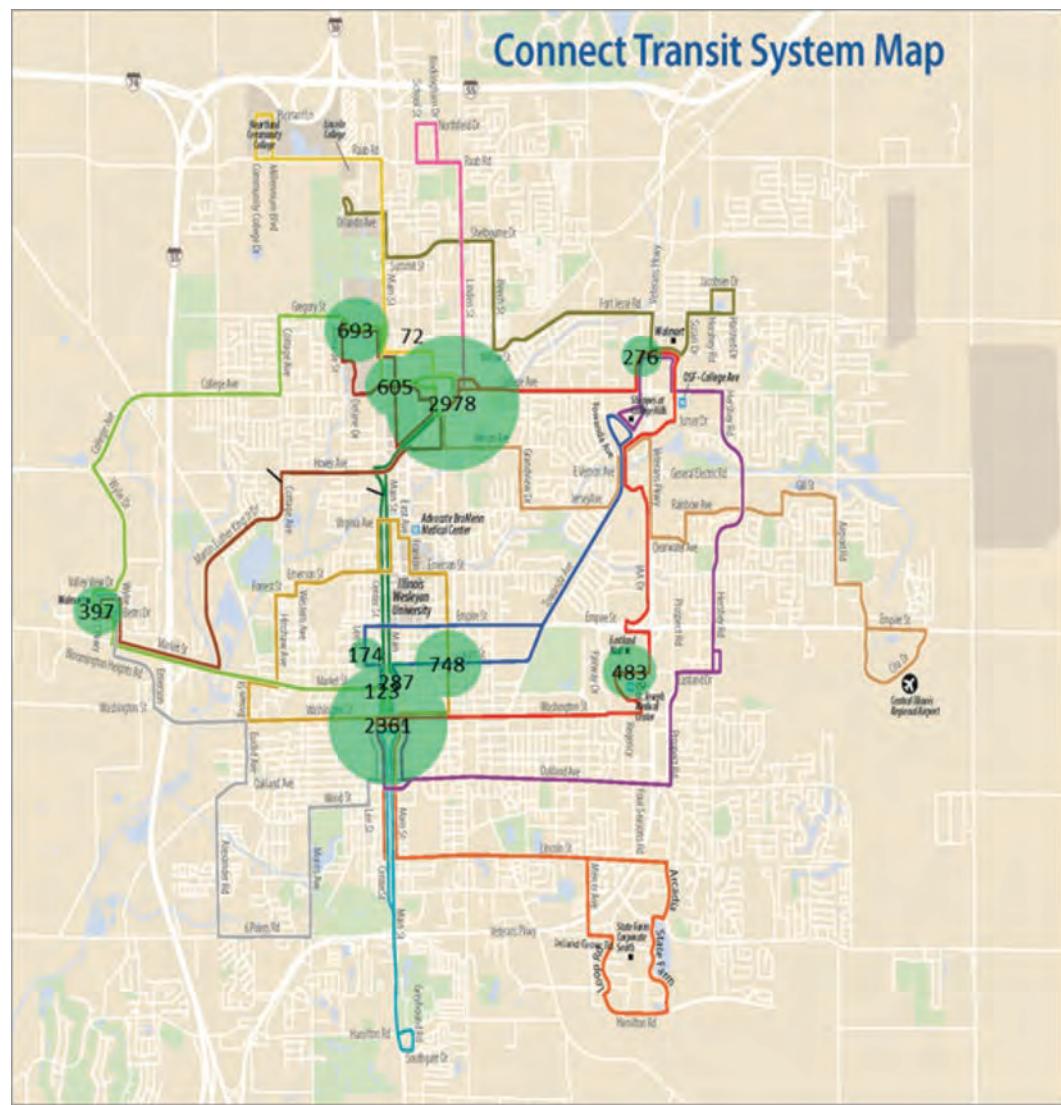
- Service should operate at regular intervals
- Routes should operate along a direct path
- Routes should be symmetrical (alignment should be the same in both directions for ease of understanding and consistency of access)
- Routes should serve well defined markets
- Service should be well-coordinated

Proposed route alignments were designed for a Core Network and Neighborhood Network of routes. Routes were moved off small residential streets and out of all parking lots; these new alignments on major corridors and main streets provided benefits in terms of travel time for riders, and allowed the buses to operate on streets that were better maintained, plowed in the winter, and had easier-to-maneuver turns. With these alignments, two service level scenarios were developed: one focused on maximizing weekday service frequency and span and the second proposed adding Sunday service by reducing the frequency and span of select neighborhood routes.

## Public and Stakeholder Engagement

The first draft of the plan was taken to the public in October 2015 for input. Connect Transit held public meetings in Bloomington and Normal, held two events at busy transit locations, and

## 54 Synthesis on Comprehensive Bus Network Redesigns



**Figure 20.** Top stops in Connect Transit System, graphic courtesy of Connect Transit.

had a COA website where the public could review material and provide comments. Bus operator input was also collected around alignment options and run times. The public was asked to weigh in on their preference between the two scenarios and to provide any other comments regarding alignment, frequency, and span.

The second draft plan was sent to the Board of Directors in April 2016. Political stakeholder input impacted the second draft of the network design; two routes were added to the network to accommodate concerns about the reduction in network coverage/longer walk to proposed service in the proposed plan. Although the proposed network would have met Title VI requirements as originally designed, the additional routes also served low-income areas, which at the time outweighed other indicators that there would not be enough demand for the additional level of service the two routes provided. The final plan was approved in June 2016 and was implemented 2 months later, on August 15, 2016.

Public education around the concept of the network redesign began in October 2015, however public education around the final plan did not start until June 2016. Public education was



**Figure 21. Connect Transit Map For Downtown Bloomington, graphic courtesy of Connect Transit.**

provided through rider guides handed out by staff at public engagement sessions at busy locations such as libraries and the United Way. Connect Transit's customer service hotline provided riders with new trip plans; this was particularly important for the first few weeks since Connect Transit's online trip planning software was temporarily unavailable due to the switch over of AVL companies. It was free to ride the bus for the first 2 weeks after service was launched.

Public education efforts continued through October 2016 to ensure that the Bloomington-Normal communities knew how to use the new service. Although the original system comprised 15 routes and the proposed new system comprised 16 routes, one point of confusion for the public was that while the bus system was very different, the names of the old routes were recycled and reapplied to the new network. For example, in the previous network the Orange route served Bloomington and Normal residents, but under the new network the Orange route only serves Bloomington residents and largely follows a different alignment from the original Orange. (The final system comprised 15 routes, because the Teal route was later eliminated.)

## Implementation

To finalize the routes for scheduling and implementation, Connect Transit service planners developed the details on where the start and end of the routes would be and the start and end times for the peak periods. Connect Transit then scheduled all routes and ironed out the details of each run, supported by the hiring of a new scheduler. The new design also introduced new service planning applications, such as interlining routes and using scheduling software to produce schedules. The schedule information was then captured in rider guides and maps for the public as well as training materials for operators for new alignments and time points. Layover times

**56** Synthesis on Comprehensive Bus Network Redesigns

were added to each route, which had not been in practice before. Additionally, Connect Transit was switching AVL companies and decided to time the switch to coincide with the system launch to make a clean data break between the old and new system and the AVL data. Finally, where needed, new bus stops were placed and old bus stops were removed; the process was not overly complicated since bus stop flags along old alignments that were being used for a newly named route could stay, since Connect Transit's bus stops do not include route information. Connect Transit planners tried to get as much input as possible from a diverse array of agency staff on the details of the service plan and other support materials. Multiple reviews by staff across the agency helped ensure that the detailed work required to operationalize the plan was well vetted.

To be able to deliver additional service hours 18 new bus operators were hired and trained. Existing operators were trained on the new routes and although these operators were quick studies, it did take them a little while to grasp the full system to the point where they knew how to help riders navigate.

Operational preparations were conducted within a tight timeframe—from April through August 2016—and included modifications that were made up until June 2016. The agency's external communications department had to produce, print, and deliver the final materials in an even tighter timeframe since operational preparations informed final material production; communications was under-resourced given the short timeframe.

### **Post-Implementation and Next Steps**

The new network increased operating costs overall but provides significantly more frequent service as well as Sunday service. All gains from operational efficiency were delivered back to riders—efficiency savings on one route were reinvested for increased service on another. The new system's on-time performance improved, however layover times for bus operators were reduced on longer routes where the total layover time was greater than 5 minutes, which proved not to be necessary. For the first 8 months after launch ridership decreased, but it began to increase after the initial adjustment period. Ridership has continued to increase on routes that have 30 minutes or better headways, but it has begun to decline on less frequent routes. Since the launch, operating cost savings resulting from elimination of the Teal route and two temporary trips were rolled back into the network to improve frequencies on other routes.

Although there is not stable funding for Connect Transit to expand right now, the agency continues to look at possible ways to increase frequencies on core network routes in the future. Like many transit agencies, Connect Transit's capital needs are continuing to grow and pose additional funding challenges. There may be opportunities to revisit continued operation of the two routes that were added to the final plan without sufficient demand projections; one of those routes is Connect Transit's least productive route. However, agency service planners note that it is extremely difficult to cut service once it has been provided.

### **4.3 Central Ohio Transit Authority (COTA) Transit System Redesign**

*Interviewee: Josh Sikich, Former Transit System Redesign Project Manager*

The Central Ohio Transit Authority is the regional public transit provider for greater Columbus and central Ohio. With a service area of 323 square miles and over one million residents, COTA provides an average of 62,000 rides per weekday. Columbus is home to Ohio State University, with more than 65,000 registered students. The Columbus region has experienced population and employment growth over the past decades and the region's growth trend is

projected to continue. For a period leading up to 2006, COTA struggled with troubled finances, service cuts, and aging equipment in the face of regional growth. In 2006 residents in the region approved an additional sales tax to provide financial support for the agency, allowing COTA to invest in additional service and maintenance.

## Vision and Goals

In the lead up to COTA's system redesign, the agency had been growing, adding ridership and service hours to meet growing demand for transit in greater Columbus. The CEO at the time saw the need for continued growth, but growth guided by a plan. Although COTA began operations in 1974, the bus network in 2013 largely followed the same structure, but with piecemeal additions. To grow effectively and efficiently, COTA set out to review and evaluate its entire bus network. The Transit System Review process began in 2013 and led to the creation of four key priorities that guided the plan:

- Expand the frequent service network
- Better reach suburban job centers
- Make the network more efficient and useful to a larger portion of the population
- Increase ridership

The review process also allowed COTA to set agreed upon parameters for service design work from the outset: to allocate 70% of the bus operating budget to service that would increase ridership in dense corridors and 30% to coverage of geographic areas with less density. With these parameters and priorities in mind COTA set out to design a new network, unencumbered by the old design, that would provide better and more bus service in Central Ohio.

## System Design

The previous bus network radiated out of downtown Columbus in a hub-and-spoke design (Figure 22). This design forced many riders who wanted to travel across town to travel downtown first and then back out. Greater Columbus had experienced job growth in suburban centers, which were inefficiently served by this kind of network. Additionally, the previous network provided its highest levels of service during standard weekday business hours, with lower frequencies on Saturday and even lower frequencies on Sunday. However, local job hours had not remained static at typical 9:00 to 5:00 hours.

The new network was designed to be more evenly distributed across downtown Columbus, with more high frequency—15 minutes or better—service (Figure 23). This design supported easier transfers to allow riders to get crosstown either directly on a new route or by transferring from one frequent route to another. This was also supported by investing in improvements to existing transit center infrastructure. The new network more than doubled the number of high frequency routes, increased Saturday service by 50%, and increased Sunday service even more. By making Saturday and Sunday service levels more consistent with weekday service schedules it became easier for riders to understand how to use weekend service. COTA's service area shrunk slightly with the system redesign and also shifted geographically, impacting the agency's paratransit service area as well. To mitigate the impact of the change to the system on existing paratransit riders, COTA identified the few individuals who might be negatively impacted and grandfathered them into the new system; in other words, existing paratransit users can still receive paratransit service to their homes even if those areas are no longer areas officially served by paratransit. On the other hand, the shift in frequency of service actually increased paratransit options for many riders, particularly during off-peak times and on weekends.

## 58 Synthesis on Comprehensive Bus Network Redesigns

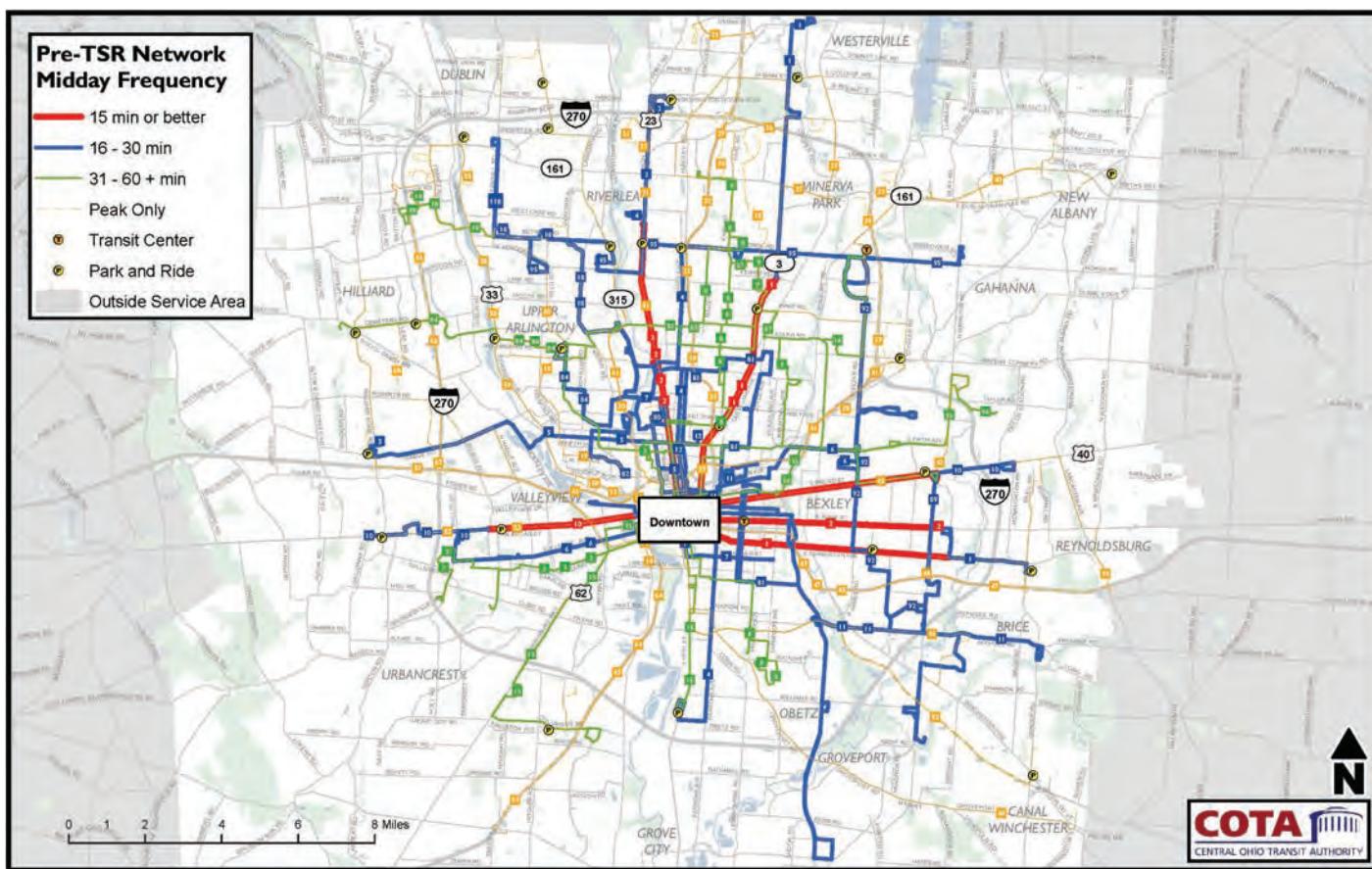


Figure 22. COTA Pre-TRS network, graphic courtesy of COTA.

### Public and Stakeholder Engagement

COTA's public engagement around its system redesign was extensive and prolonged. Initial public outreach began in 2014. Public input informed the key priorities, parameters, and overall vision and direction of the plan. The public provided input on draft versions of the bus network through public meetings, focus groups, and online surveys. Bus operators were engaged in the bus operating day rooms, with staff on hand to talk about and collect feedback on the plan. By

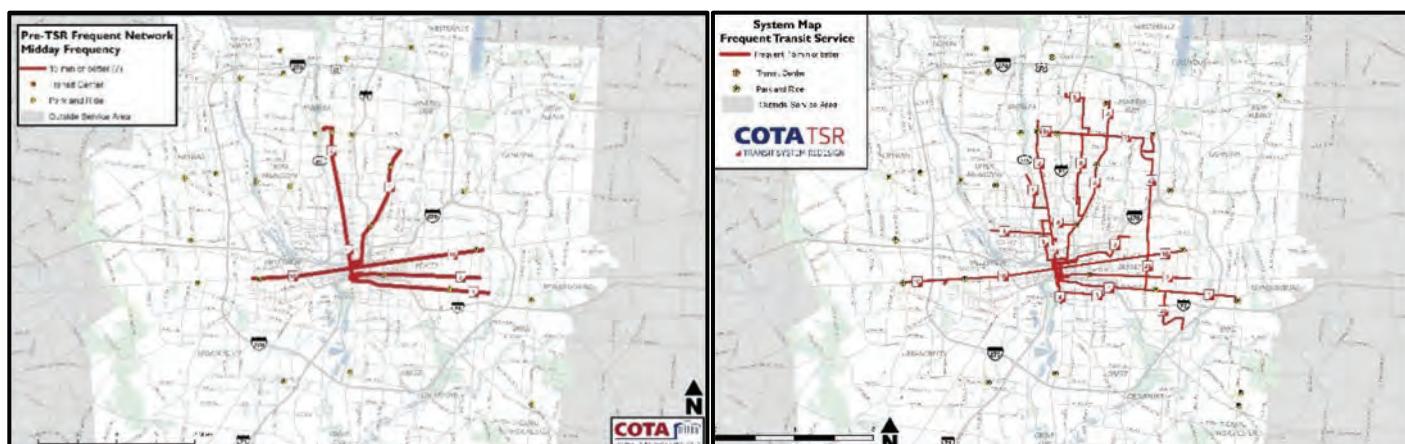


Figure 23. COTA before and after high frequency service, graphic courtesy of COTA.

the end of 2014 the COTA Board of Trustees adopted the new system framework along with the addition of more service in downtown.

In 2015, the service plan went out for public hearings and approval. Meanwhile, new routes identified in the service plan and approved by the COTA Board were implemented, with public education to support the start of these new routes. After various board meetings and public meetings, the plan was finalized at the end of 2015 with the plan to launch on May 1, 2017.

## Implementation

COTA developed a secondary organizational structure within the existing structure to support the work that needed to go into the system redesign, while the day to day work of running the transit agency continued. Following the completion of the transit system review, COTA hired a transit system redesign (TSR) project manager who reported to the Vice President of Planning. The TSR project manager established six working groups made up of roughly 45 staff from across the agency that were responsible for leading specific tasks. These groups were:

- Bus Stops, Passenger Shelters, and License Agreements
- TSR Plan Alignments, Schedules, and Maps
- Marketing, Communication Plan, and Public Involvement
- Operations, Human Resources, Training, and Coordination
- Budget
- Government and Community Relations

Each working group was made up of subject matter experts from across the agency. For example, the bus stop working group included staff from facilities, operations, and the legal department and the operations working group included bus operations supervisors and IT staff. Support from the TSR project manager and leadership from COTA's CEO made it possible for working group staff to collaborate, coordinate, and delegate around the redesign, even though these additional duties were challenging and needed to be executed while staff were still providing their normal day-to-day functions within the agency.

From January 2016 to May 2017, COTA implemented public education around the new system. Public education efforts intensified from January to May 2017 and even more in the 2 weeks prior to launch. Public education focused first and foremost on riders. COTA staff discussed the merits of educating potential riders who would benefit from the new system; however, it was decided that public education leading up to the launch would be directed at existing riders and, after the launch, new riders could be taught how to ride the new system and encouraged to do so. The system was free to ride the first week of implementation.

COTA public education took a three-pronged approach to reach riders: individualized engagement, stakeholder engagement and public meetings, and mass marketing. The individualized engagement strategy included street teams at bus stops and the website dual trip planner that showed the riders the old trip and the new trip. This strategy was characterized by one-on-one interactions focused on providing individuals with the specific information that they would need to use the system. The stakeholder engagement and public meeting strategy included meetings with municipal mayors, public works staff, neighborhood leaders, and other groups that represented larger networks of people, as well as meetings open to the general public. This strategy ensured community leaders and decisionmakers understood the overall plan and how to get access to individualized information for their own benefit and so that they could support educating their constituents and friends. The mass marketing strategy included using billboards, radio ads, and posters on buses to provide critical information to as many people as possible. In addition to these strategies, which were carried out at different levels of intensity over the year

## 60 Synthesis on Comprehensive Bus Network Redesigns

and a half before the launch, COTA also had agency staff out on the streets with the street teams the two days preceding and the day of launch not only to provide extra on-the-ground support, but also as a demonstration of the agency's investment in the redesign and its impact on riders.

In addition to the TSR project manager position, COTA added an additional communications position. Temporary positions were planned for around the launch to add capacity, including street teams, a travel trainer (for providing training to riders on how to use the new system and bus service in general), and additional call center staff. For temporary street team positions, COTA set out to have reliable people representing the agency out on the street. COTA's approach to finding high quality street team staff was to over hire with the understanding that there would be attrition due to the challenges of the job; in the end COTA received positive feedback from bus operators and riders on the quality of street team staff.

Contractors and consultants were used on a temporary basis as well. Two key contractors were the bus stop changeover and wayfinding contractors, who were responsible for designing, printing and installing the new bus stop signs. The changing of all bus stops in the system and overall reduction of bus stops was a huge push, one identified early on as a critical component of implementing the plan. COTA understood that it would be easy to fail at transitioning bus stops, because this requires intensive attention to detail as well as manual heavy labor. Information needed to be clearly communicated, correctly printed, and placed on temporary hoods over the bus stop signs. The installation and removal of temporary hoods and signs needed to be well-coordinated and executed. Bus display headers were updated and new stop announcements were recorded for every stop, using a single style and voice for improved consistency over the old system.

An additional critical component of successful implementation was ensuring that the agency had enough bus operators to deliver the additional service hours in the plan. Management knew that without enough bus operators it would not be possible to deliver the service promised. COTA identified the key constraints to meeting the target of hiring 100 additional operators – the capacity of the human resources department and marketing department. The Operations, Human Resources, Training, and Coordination Working Group set out to overcome those limitations well in advance. The addition of a communications position was partly to support this work. COTA started doubling the operator training class size and was able to hire the target number of operators to provide the additional service hours and replace operators that were retiring.

In concert with hiring new operators, another key challenge to successful implementation was the internal education of all COTA employees. This was a multifaceted effort that included producing YouTube videos, weekly email blasts, and in-depth training for bus operators. This effort was supported by COTA's IT staff, who created, for the first time, email addresses for every COTA employee, including bus operators and maintenance staff. The Operations, Human Resources, Training, and Coordination Working Group developed and delivered a training schedule and materials. In December of 2016, after a few minor adjustments to the plan were made from Title VI analysis, training began. Every operator took an 8-hour class to learn the new routes and system elements, and also received customer service training. COTA's redesign involved renaming routes with different numbers; as such one aspect of training focused on the names and the numbering of the routes, which helped to demystify the service changes. The training process helped make skeptical staff supportive of the system redesign.

### Infrastructure

COTA invested in improving passenger facilities, such as their bus stops, shelters, and expansion of the capacity of one of their transit centers. The expansion of the Easton Transit Center was their largest capital project conducted as part of the redesign. These capital projects in general, but particularly the transit center, had long lead times. Additional capital projects included

end of the line layovers, turnarounds, and intersection improvements. These projects were supported by strong communication with municipalities since much of this work was in public rights of way or in some cases on private property. The Bus Stops, Passenger Shelters, and License Agreements Working Group led these initiatives.

### **Post-Launch and Next Steps**

Following the launch of the new system, COTA made adjustments and refinements to service during the September 2017 service change. Bus operator feedback was critical to identifying these changes since many had to do with turn restrictions and temporary construction obstacles.

Regarding the performance of the system, COTA anticipated a temporary decline in ridership, which has occurred. However, the rate of declining ridership is slowing, in contrast to the national trend toward ridership loss. Although it is too soon to know when ridership will increase, COTA believes the agency will see that growth. The agency's Short Range Transit Plan 2017-2021 (<https://www.cota.com/wp-content/uploads/2016/04/S RTP.pdf> Accessed April 25, 2018) envisions continuing to increase service by 11% in the plan timeframe. The additional service hours projected would be supported by the existing 0.5% sales tax in Franklin County. (COTA funding is supported by two quarter-cent sales taxes in Franklin County. One tax is permanent and the second one is approved on a 10-year basis, which was renewed by ballot measure in 2016.) Additionally, COTA is currently investigating how to leverage transportation network companies where fixed route service is inefficient and ineffective. COTA also recently completed long-range vision plan, branded NextGen, that defines the region's transit future and will guide planning going forward (COTA 2017). (<https://www.cota.com/initiatives/nextgen/> Accessed April 25, 2018.)

## **4.4 MDOT Maryland Transit Administration (MTA) BaltimoreLink**

*Interviewees: The authors of this synthesis were the primary consultants on the BaltimoreLink bus network redesign and compiled this case study for review by Holly Arnold, MDOT MTA's Director of Planning and Programming*

Maryland Department of Transportation's Maryland Transit Administration (MDOT MTA) is a statewide agency that provides and funds transit service throughout the state. The bus network redesign focused on the Baltimore area, specifically the City of Baltimore and its suburbs. The agency provides several transit options across the Baltimore region, including Core Bus service in the City of Baltimore and its suburbs, Light Rail and Metro Subway, and other services that connect the Baltimore region with other state communities and beyond via commuter bus services and the Maryland Area Regional Commuter (MARC) rail system. MDOT MTA's service area covers 1,795 square miles and serves over 2.2 million people. ("Core Bus" is used instead of "Local Bus" to emphasize that there are gradations of service offered that are not exclusively local bus but have some express elements to them.)

### **Vision and Goals**

BaltimoreLink is a complete overhaul and rebranding of the core bus system operating within the City of Baltimore and throughout the greater Baltimore region. MDOT MTA's first attempt at adjusting and rationalizing the core bus service was conducted by the Office of Service Development through the Bus Network Improvement Project (BNIP) from 2013-2014, which included an extensive review of existing conditions, outreach to the public on their riding

## 62 Synthesis on Comprehensive Bus Network Redesigns

preferences, and outreach to the public and bus operators on proposed solutions. Recommendations under BNIP were ultimately put on hold; however, an opportunity to revive it allowed the data to be processed and analyzed, and the opinions collected and assessed, to form the basis of the BaltimoreLink vision and the service planning efforts throughout the BaltimoreLink project.

The pre-BaltimoreLink network, while it moved hundreds of thousands of people every weekday, was unreliable and inefficient and had not adjusted to shifting employment centers or worsening traffic conditions. To design and build a better bus network, MDOT MTA set out to design routes through inclusive service planning, improved infrastructure, and better supported operations. MDOT MTA assessed the impact and tested the merit of these plans during the planning process through technical impact analyses and by involving the public and internal stakeholders into the design process.

### System Design

The pre-BaltimoreLink bus network was characterized by antiquated routes that did not align with today's job centers and were too long to manage reliably, especially those that traversed downtown Baltimore. BaltimoreLink was developed to deliver a more efficient and reliable bus network for the region by spreading out routes across the downtown core and creating a grid of high-frequency routes. To achieve this, the Maryland Department of Transportation Maryland Transit Administration (MDOT MTA) took a fresh look at all core bus routes, assessed the operational resources and infrastructure needed to support those routes, and reimagined how core transit services, including one light rail line and one Metro subway line, would be branded and communicated to the public.

The BaltimoreLink network redesign was approached as a complete redesign of the system to be supported by robust analysis, but it was constrained by firm operational parameters. The resulting system keeps revenue hours the same as before, though the agency was able to add additional operators that were needed to work the revised schedules. The network redesign process produced three draft service design plans based on the following goals:

- Improve service quality and reliability;
- Maximize access to high-frequency transit;
- Strengthen connections between MTA's bus and rail routes;
- Align the network with existing and emerging job centers; and
- Involve riders, employees, communities, and elected officials in the planning process.

The network design focused on a high-frequency grid network in downtown Baltimore, composed of 12 new, high-frequency bus routes and the existing Metro subway and light rail line, which was supported by a new crosstown network and a feeder service to the grid. Other key design changes included shortening routes to improve reliability and better spacing out bus routes on more downtown streets to avoid bus congestion. The final system consisted of 12 color-coded high-frequency routes called CityLink that form a grid network in the downtown and radiate out in all directions; the other core bus service was branded as LocalLink.

### Public, Stakeholder, and Operator Engagement

The redesign plan was shaped and tested against real world input provided by the public, bus operators, and other MDOT MTA departments involved with the planning and provision of bus services. Public outreach and education were a major component of BaltimoreLink and shaped service planning decisions from initial planning to implementation. Public outreach results had a major effect on the network design in Draft 2 of the BaltimoreLink Plan. Plan 2 was released to the public on July 5, 2016: while the first draft plan emphasized high frequency service over

coverage, Plan 2 maximized coverage and avoided the need for transfers where possible, resulting in less frequent routes. High frequency service was preserved on the CityLink routes, but not beyond those. Plan 2 was well received by the public and stakeholders. A third and final plan was produced for implementation and reflected more minor public feedback as well as some more detailed operational analysis.

Bus operator in-reach was similarly robust and raised important service planning and operational issues that were addressed due to the inclusion of bus operator knowledge. The purpose of the in-reach program was to inform, engage, and gather input from bus operators to ensure that the system redesign and implementation planning reflected their knowledge and experience and took into account their concerns.

MDOT MTA also had a strong program for internal departmental collaboration. Weekly technical team meetings, led by the Office of Planning and attended by MDOT MTA staff and their consultants from Service Development, Marketing, Communications, Engineering, and occasionally Operations, were held to ensure that all tasks were proceeding according to plan and schedule. These meetings provided an opportunity for collaboration between departments so that all aspects of the task, beyond the primary owner, could be coordinated. Additionally, in the year leading up to launch, a bi-weekly communications meeting was held with participation from Marketing, Communications, Community Relations, and others to keep the public involvement and public education components of the process coordinated and moving forward, such as public outreach, informational materials, and other areas of public communication. Finally, MDOT MTA held retreats, known as “advances,” about four times in the year and a half of planning and implementation. These large workshops of between 80 and 100 staff afforded many more people the opportunity to be informed about all the aspects of BaltimoreLink that may impact their jobs (and may require their help), discuss key strategic decisions, and get people excited about the upcoming changes.

MDOT MTA created and implemented a detailed public education plan to help riders and the public learn the new transit network throughout the spring of 2017. The public education plan included strategies for direct rider contact, marketing and communications, government affairs outreach, community based organization outreach, school outreach, and a coordinated June 2017 BaltimoreLink implementation plan. The education plan included a website, social media, print material, advertisements throughout the system, pop-up tents at transit centers, and an information bus that was deployed on different routes each day and contained a lot of information and provided free rides. The education program was implemented with major staff involvement and by using public outreach street teams equipped with thoughtfully designed informational materials. Another critical component of public education was ensuring that MDOT MTA bus operators had informational materials and could let their riders know what was coming.

## **Implementation**

On June 14, 2017, a “launch event” for elected officials, MDOT staff, and the media was held at the West Baltimore MARC Station to ceremonially mark the start of BaltimoreLink in advance of the June 18th implementation date. Prior to implementation, all bus operators participated in training, which began in January 2017 to ensure that all operators could be taken out of service for 3 days while the pre-BaltimoreLink system could continue with regular operations. Right before the June 18th launch, operators were given the opportunity to retrain on routes of their choosing. Every bus operator was provided with a binder that contained the right and left turns for every BaltimoreLink route to support operator understanding of the full network (not just the routes out of their division), and made it possible for operators from different divisions to work runs outside of their specific home division.

## 64 Synthesis on Comprehensive Bus Network Redesigns

The days of and surrounding the launch required an all-hands-on-deck approach to be able to address any issues in real-time and provide as much information to the public as possible. For the first 2 weeks following the launch of the new system fares were free not only on the bus network but the subway and light rail as well. This grace period was provided to allow riders to learn the system without the stress of having to pay for any mistakes. It also took one responsibility off bus operators while they were educating the public and executing new routes.

Every Core Bus service stop was replaced with a new BaltimoreLink bus stop sign. As all MDOT MTA bus stop signs could not be taken down and reinstalled overnight, the process had to occur gradually while still providing riders with the existing system stop information they needed. The solution to this challenge was to take down old stop signs, replace them with BaltimoreLink signs, and then cover those new signs with a temporary vinyl cover with existing route information on it.

### Infrastructure

The BaltimoreLink network, with its new route alignments, frequencies, and spans, was accompanied by \$65 million in critical capital infrastructure upgrades to support the service design and rebranding of core services. To support service reliability and to increase roadway capacity for buses, MDOT MTA worked with the City of Baltimore to design and implement dedicated bus lanes on downtown streets that are served by CityLink routes and carry the greatest number of bus trips per day. By the time of the system launch, about 5 miles of dedicated bus lanes had been installed along corridors in downtown Baltimore. MDOT MTA also partnered with the City of Baltimore to implement transit signal priority (TSP) on two pilot corridors in time for launch that comprised 22 intersections. Another key capital investment was the improvements of a number of bus transfer centers—the largest BaltimoreLink capital project was the creation of a new bus transfer facility at the West Baltimore MARC commuter rail station.

### Post Implementation

While ridership has not increased in the year since launch, the BaltimoreLink process has left MDOT MTA in a better position to continuously assess and improve its core bus service. Critical service planning data including a new bus stop database and the General Transit Feed Specification (GTFS) data files are up-to-date, and new real-time data on all routes will enable more accurate reporting of operating statistics. The processes for maintaining bus stop information, GTFS feeds, and runtimes has been improved. MDOT MTA is also continuing to implement more TSP and bus only lanes to support the CityLink network.

## 4.5 King County Metro Transit (Metro Transit) METRO CONNECTS

*Interviewees: Graydon Newman, Transportation Planner; Katie Chalmers, Service Planning Supervisor; and Tristan Cook, Community Relations Planner.*

King County Metro Transit provides comprehensive bus service, vanpools, paratransit services, and community shuttles to residents and visitors of King County, Washington. Metro Transit also operates Sound Transit's regional Express bus service, Link light rail, and the Seattle Streetcar. Additional transit options in the region, not operated by Metro Transit, are ferry, commuter rail, and monorail service. Metro Transit serves the county's 39 cities and towns, including Seattle, with a service area of 2,134 square miles and a population of 2.1 million. Metro Transit provides over 400,000 rides each weekday and has been increasing its ridership significantly, nearly 12% between 2014 and 2016 at a time when national trends in public transit use have seen decreasing ridership.

## Vision and Goals

The King County Council adopted the METRO CONNECTS long-range vision on January 23, 2017. The 25-year long-range plan was an opportunity for Metro Transit and its partners to address the large growth that is occurring and projected to occur in the region and to define a transit future that supports the day-to-day transit needs of the community. Supported by extensive public outreach and stakeholder engagement, the plan provides a vision of “frequent, reliable and fast service—all day, every day.” Key elements of the plan are a build-out of Metro Transit’s RapidRide service and restructuring bus service around Sound Transit Link light rail (operated by Metro Transit), which is anticipated to add 33 miles over four extensions by 2025. Metro’s RapidRide service is a bus rapid transit (BRT) type service with frequent service on major corridors with queue jumps, transit signal priority, and other priority roadway treatments where possible and stations at high ridership stops that allow for pre-paid and all-door boarding.

To achieve the vision laid out in METRO CONNECTS, Metro Transit has created a development program, led by the office of long-range planning and staffed with a mix of long-range and service planners, that is focused on implementing the 2025 service network as it is outlined in the plan.

Metro Transit is not new to restructuring their bus routes; they bring to their current effort both experience and a tested methodology of planning, public engagement, and implementation. In the past 10 years the agency has restructured around two light rail stations and six RapidRide lines. What differentiates this effort from past restructuring work is the network design guidelines provided by METRO CONNECTS, the partner support and buy-in that was fostered through the METRO CONNECTS process, and the pace and breadth of the work that is planned until 2025. The METRO CONNECTS plan was a comprehensive look at the transit needs of the county, particularly focused on the high capacity and high frequency corridors needed to serve transit riders and the community at large.

## System Design

While METRO CONNECTS is a long-range, 25-year plan, the changes to the bus network are more defined over the period leading up to 2025, during which significant additions will be made to the region’s light rail network. The 2025 plan involves more than tripling Metro Transit’s current six RapidRide lines by adding 13 new lines by 2025; the aim is to upgrade all lines to the international BRT standard of bronze or better by 2040. Sound Transit Link light rail is expanding north, east, and south of downtown Seattle; projects slated to be completed by 2025 (contingent on federal funding) are the East, Federal Way, Redmond, and Lynnwood Link extensions, with 33 miles of new light rail and 19 new Link stations. These investments, along with others detailed in METRO CONNECTS, will be the backbone of a network of high frequency and high capacity corridors provided by RapidRide BRT and light rail that are supported by feeder routes and overlaid express routes between urban centers in the county, including downtown Seattle.

The restructuring work gets into the details of the exact routing and station and stop siting of expanded RapidRide lines and how all-day service, peak-only express, and school routes, as well as Demand Area Response Transit (DART) and Community Shuttle service will feed into or complement the new high frequency corridor or light rail station (Figure 24). This service planning work has been divided into 20 projects based on the geographies and routes impacted by new high frequency investments. The first of these 20 phases is focused on the Northeast side of the county, slated to reorient service around a light rail station opened in 2016 and restructure service ahead of new RapidRide service in a future project. The planning phase will begin with public outreach, and in conjunction planners will assess how to reduce duplication, increase frequency, feed riders into light rail or RapidRide where feasible, bring in other

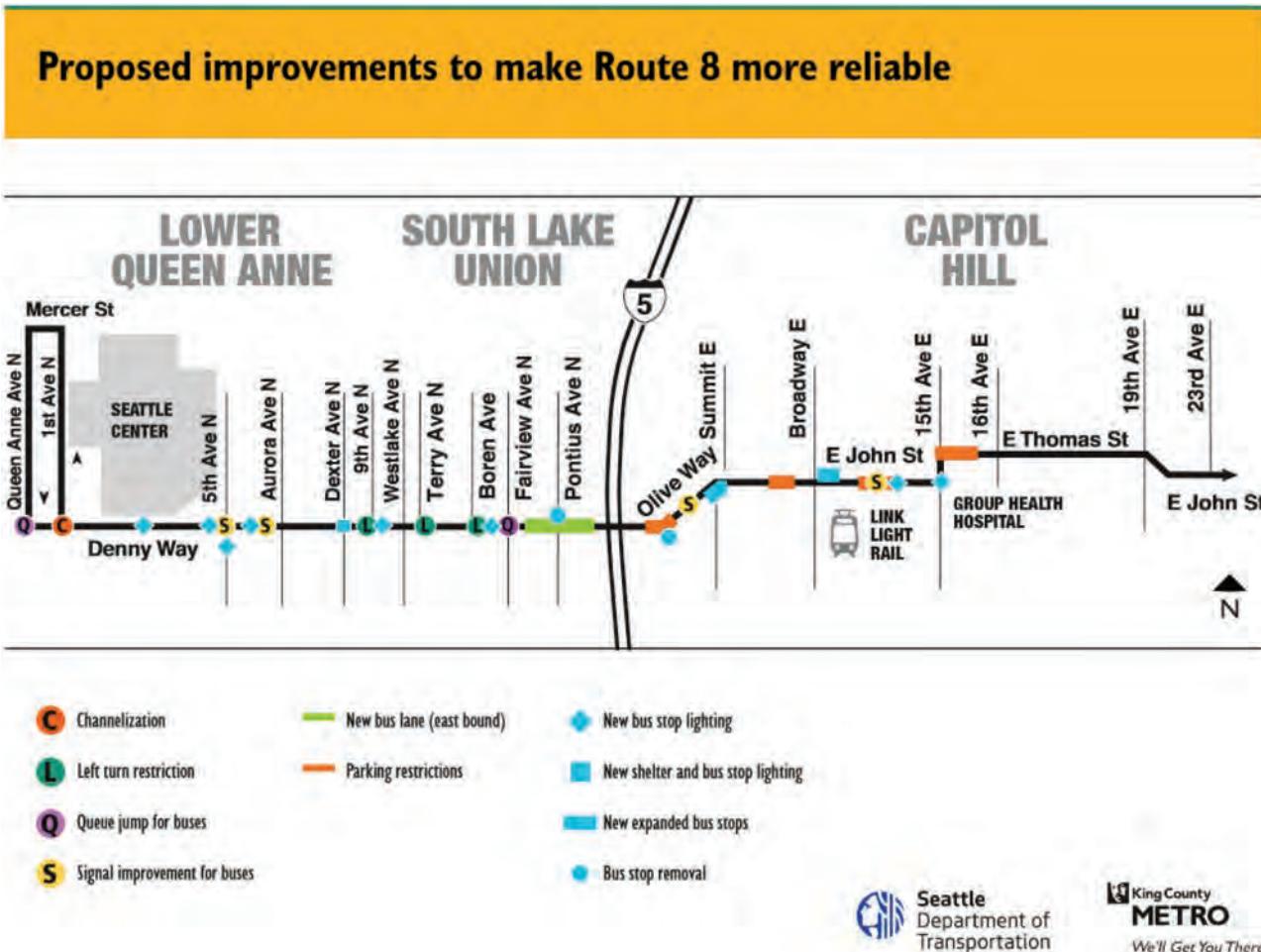


Figure 24. King County Metro Transit, Route 8 improvement diagram, graphic courtesy of King County Metro.

modes (shuttles, vans, and rideshare), and provide highly usable services without necessarily increasing the overall bus service hours in that area. Detailed service planning considerations are available in the Restructuring Service section of Metro Transit's Service Guidelines document. (<https://metro.kingcounty.gov/planning/pdf/2011-21/2015/metro-service-guidelines-042816.pdf> Accessed April 20, 2018.)

### Public and Stakeholder Engagement

Metro Transit conducted extensive public outreach for the creation of the METRO CONNECTS plan. The outreach was guided by a strategic engagement plan which aimed to engage the general public, ensuring participation of traditionally underserved and transit-dependent communities, as well as jurisdictions and key stakeholders. The agency established a community advisory group to provide diverse rider viewpoints over the course of the plan and a technical advisory committee that represented King County jurisdictions and regional transportation partners. Outreach for the plan lasted for nearly a year and a half and included visioning, alternatives, and draft plan phases. Details of METRO CONNECTS community engagement can be found in the *Public Engagement Report*. (King County Metro 2016)

Going forward, for each restructure project additional public outreach will be conducted to inform service planning work. Similar to the METRO CONNECTS public engagement process,

restructuring outreach is made up of three phases: a needs assessment, an assessment of alternatives, and the review of the draft service changes. Restructuring outreach will focus heavily on reaching the riders of the service that is being restructured and less on the general public. It is also Metro Transit's practice and policy (Planning and Community Engagement section of <https://metro.kingcounty.gov/planning/pdf/2011-21/2015/metro-service-guidelines-042816.pdf> Accessed April 20, 2018) to recruit and convene a community-based sounding board composed of people who would be affected by significant service changes, which these restructurings will largely be. Metro Transit's 18-month planning timeline is driven by their public outreach efforts. Metro Transit's strategies to reach the public include posting information at bus stops, holding public meetings, disseminating and collecting surveys/questionnaires, convening meetings with community or stakeholder groups, sharing information through online/social media outlets, and participating in conversations with riders at bus stops and community events.

The agency sees its ability to deliver on public outreach as a significant component to being able to reach the 2025 goal and is working to ensure that outreach is properly resourced. The information gleaned from the community helps service planners do their work effectively and develop usable transit solutions with community buy-in.

## Phased Implementation

Metro Transit has identified 20 phases for planning and implementing bus network restructuring projects in the next 8 years. There are many variables that have impacted the decision to implement in 20 phases, but the key driver of these phases is the planned capital projects that will support RapidRide service expansion and Link light rail expansion. Many of the capital investments are planned to be made in partnership with jurisdictions, and as such the agency does not have direct control over their timing. Metro Transit staff are acutely aware that the METRO CONNECTS vision will be achieved by working closely with local jurisdictions and regional transportation partners.

Metro Transit worked with the technical advisory committee (established during METRO CONNECTS public engagement) to identify a regional project schedule that provides a comprehensive list of planned service projects and corridors for capital investment that are related to delivering transit per METRO CONNECTS plan, and highlights the partnerships that could be leveraged to align capital projects needed to support transit. Additionally, Metro Transit worked with the City of Seattle's Department of Transportation (SDOT) to develop the RapidRide Expansion Program, which details the timing of the expansion of seven RapidRide lines serving Seattle by 2024. (Seattle Department of Transportation 2018)

Although funding for capital improvements comes from multiple and at times unreliable sources, SDOT's RapidRide Expansion Program has the benefit of funding from the "Levy to Move Seattle," a ballot initiative passed in 2015, which provides \$930 million over nine-years to "improve safety for all travelers, maintain streets and bridges, and invest in reliable and affordable transit options for a growing city." (Seattle Department of Transportation 2018)

The regional project schedule and the SDOT RapidRide Expansion Program provide time-frame markers for the next 8 years. Additionally, the restructure projects were packaged geographically so they made sense from a holistic network perspective and took into consideration groups of routes that were interconnected. Part of that holistic view included considering if the phases were being distributed equitably so that improvements within Metro Transit's control would not leave behind traditionally underserved populations. In addition to equity considerations, Metro Transit also looked at the geographic spread of projects to make sure the 39 jurisdictions the agency serves were represented as their needs dictated.

Lastly, but importantly, phasing was impacted by Metro Transit's planning and public outreach timeline. Metro Transit typically plans service 18 month prior to implementation. This allows

time for three phases of public outreach and the service planning that informs outreach and is informed by it. Twenty phases, each with 18-month planning timeframes, require overlap and/or concurrent execution of phases to implement in an 8-year timeframe. Metro Transit is working to ensure that it has sufficient community relations and government relations specialists to conduct this extensive level of outreach.

## Next Steps

Metro Transit will be assessing the timing of the 20 phases of planning on a regular basis, understanding that project timelines shift, particularly large capital projects. Metro Transit also intends to revisit the full 25-year METRO CONNECTS plan every 6 years to evaluate whether the projections that informed the vision and service design have shifted and, if necessary, to adjust the vision and service design accordingly. Metro Transit has planned for increased service revenue hours, miles, additional buses, new infrastructure, and bus operators to achieve the 2025 service network defined in METRO CONNECTS. The agency is able to support some of these additional operating and capital costs thanks to funding from the City of Seattle, increased sales tax revenue resulting from the stronger local economy, and other resources. (Funding from the City of Seattle comes from Proposition 1: Seattle passed a ballot measure to impose a \$60-a-year car-tab fee and to increase sales by 0.1 percent. Revenue goes to Metro Transit and supports regional bus service that begins or ends in Seattle and better access to transit for low-income riders. Additionally, Seattle residents passed the Transportation Levy to Move Seattle, a 9-year funding package paid for through property taxes, which supports capital infrastructure investments in transit and transportation.) Despite all of this funding, there is still a significant projected funding gap that will need to be resourced in order to achieve the full 2025 vision for service and infrastructure identified in METRO CONNECTS.

Metro Transit planners are in the process of embarking on the detailed work associated with delivering what is envisioned in the 2025 service network. An element that they are still ironing out is developing enough project details to support resource estimation and having a comprehensive understanding of current capacity constraints (service, capital delivery, facility, workforce, etc.) in a fast-paced environment with multiple partners and many moving parts.

## 4.6 Dallas Area Rapid Transit (DART) Comprehensive Operational Analysis

*Interviewee: Rob Smith, Assistant VP, Service Planning and Scheduling*

Dallas Area Rapid Transit (DART) provides comprehensive bus service, flexible service, and paratransit in the Dallas Metro area. DART operates the longest light rail network in North America (90 miles) as well as streetcar. DART also partners with the Fort Worth Transportation Authority to operate a commuter rail line between the two cities. DART operates most of its bus service directly, with one major route operated by a contractor and others operated by third-parties through funding partnerships. DART provides service to 13 member cities with a service area of 698 square miles, comprising a population of 2.4 million. DART provided approximately 113,000 bus rides each weekday in 2016, down from 123,000 in 2015.

### Vision and Goals

DART's Comprehensive Operations Analysis (COA) was developed as part of a new 2040 System Plan and was originally motivated by a desire to look at what should be done with the bus system between 2015 and 2040 (General Planning Consultant Team 2016). While called a

COA, the plan was a comprehensive evaluation of the bus system at a route and system level with the intention of making sweeping changes to redefine the overall bus network structure for the first time in more than 20 years. Since then there had been a lot of changes in the operating environment, the city and region's development patterns and density, and the completion of the rail network. Additionally, over the previous decades, DART had reduced bus service over time; increased rail options had eliminated the need for some bus lines and shrinking sales tax revenues reduced the available operating funds. DART wanted to go back and look at how changes to travel patterns and development and the prospect of growing sales tax revenue should impact changes to the bus network and how the bus service should be structured in a way that was not so focused on providing feeder service to the rail network.

The planning began in 2014, at which time DART had finished the originally planned rail expansion and had recently made extensive changes to the bus routes to provide access to the rail lines. When the agency began the 2040 plan, they were starting to investigate the next steps after completing the rail system, which had been a large focus of the agency for many years. Through this planning process, the agency developed a Draft System Plan that was completed in 2016. Since that time, DART's Board of Directors was almost entirely replaced. The new Board, which is very much focused on bus service, will oversee the finalization of the System Plan in 2018.

## System Design

Right now, DART's bus system design is based on how routes can complement the rail network. Over time, the service transitioned from traditional radial routes to a combination of rail feeder routes and crosstown routes, but even those were designed largely to provide connections to the rail network, resulting in a high transfer rate and very long, indirect trips. The system design developed in the COA was focused on straightening and simplifying the routes and increasing the frequency and speed of the buses (Figure 25). A revised crosstown network was also developed to address the mismatch between where riders live and work that makes for excessively long trips, especially for lower-income communities.

Initially DART thought they would take more of a blank slate approach to the system redesign and developed several scenarios for service that varied in the degree of change required. Ultimately, they changed course on that approach due to concern by the Board and elected officials about the disruption that would be caused by wholesale changes; the Draft System Plan that resulted preserves a greater percentage of the existing network.

DART expects that a large focus of the Final System Plan will be on increased frequency as well as the continued development of a grid network that provides more crosstown service (both east-west and north-south) than before; one of the key recommendations of the Draft Service Plan is seven Rapid Ride corridors – high frequency service along with introduction of Transit Signal Priority (TSP). However, there has been some discussion with the new Board in place about doing something more drastic like the Houston redesign, including creation of a high-frequency, low-transfer time grid, which has the potential to increase operating costs by 70%. What ultimately is decided will be determined later in 2018.

## Public and Stakeholder Engagement

The 2040 System Plan and COA marked a significant change and improvement in how DART engaged the public and stakeholders and how their input was incorporated into the recommendations. DART conducted significant engagement with key stakeholders (including bus operators and supervisors, customer service representatives, and business and community organizations, etc.) and the general public through focus groups, public workshops, online

## CORE FREQUENT ROUTES - EXISTING VS. PROPOSED

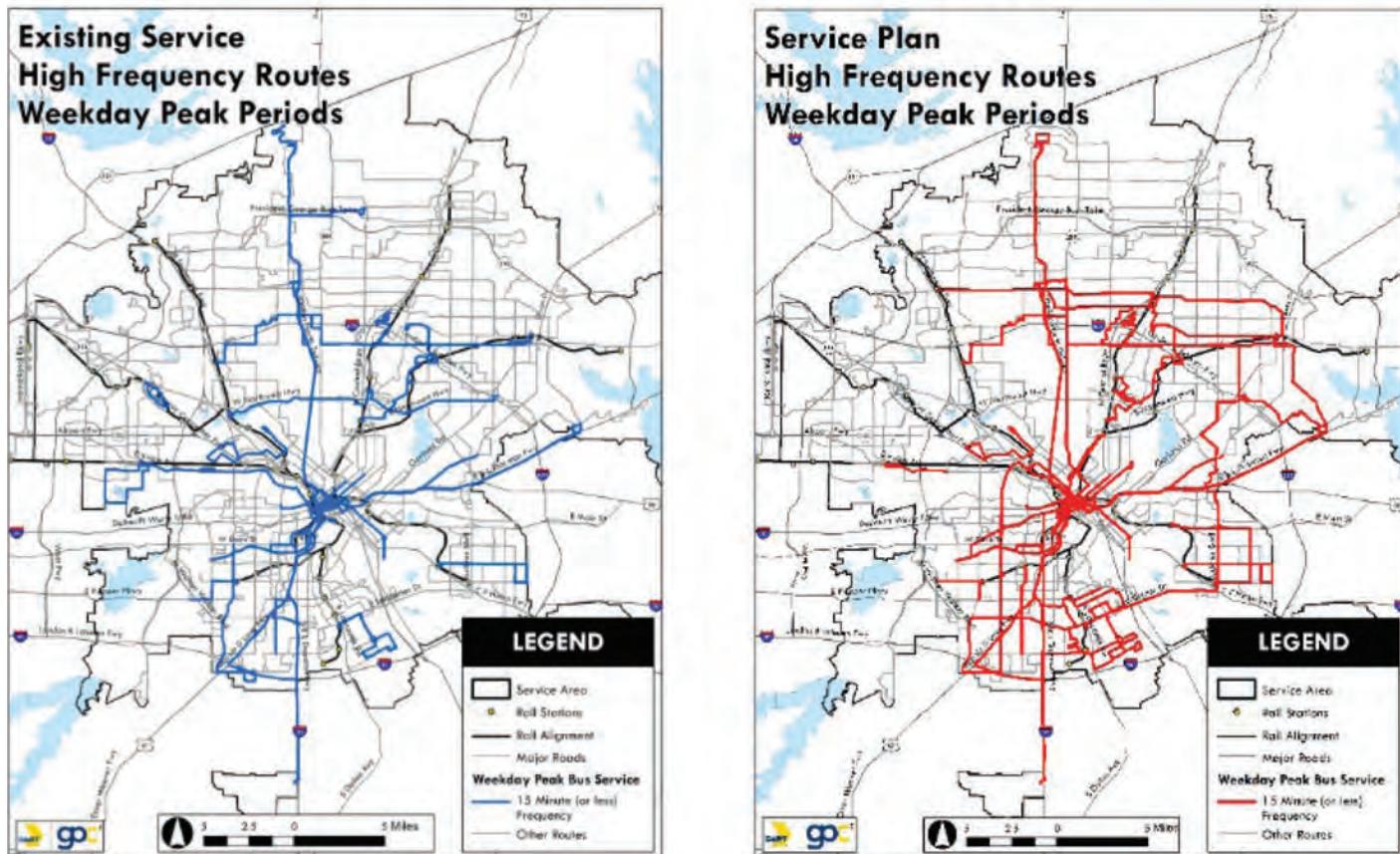


Figure 25. DART existing versus proposed high-frequency network, graphic courtesy of DART.

engagement through mySidewalk and social media, and pop-up meetings at rail stations. At the study outset, people were asked what they would like to see in terms of changes to bus service, and later in the study they were asked to weigh in on draft recommendations to see if the plans would meet their needs. The impact of this input was critical to the recommendations developed in the COA, especially because input from all parties followed the same themes, whether they were riders, non-riders, stakeholders, and others. The general concerns expressed were that the bus system was too complex and difficult to follow and understand; it was not frequent enough; and the long headways—60-minutes off-peak in many cases—made it very inconvenient.

### Non-Fixed Route Services and TNCs

DART has been providing on-call zone service in low density areas that are not supportive of traditional fixed route service for the past 20 years. There are currently eight on-call zones that are each served by one or two dedicated vehicles. The Draft System Plan recommends expanding to 14 on-call zones as part of the plan to focus and simplify the system. The agency is currently running pilot service in the new zones that use live-request (through an app or call-in). If the pilot is successful, DART expects to roll out the live-request system to the current eight zones that currently require advance reservations.

The growth of Transportation Network Companies (TNCs) did not play a role in the COA other than acknowledging that they had to play a role in areas with low demand, and the COA

envisioned moving to TNCs instead of the on-call zones for zones that currently have extremely low ridership, on the order of about 10 riders per day. The System Plan also took into consideration a hypothesis that TNCs are hurting ridership on certain routes—largely those that run through areas with higher density, a younger demographic, and where there are lots of apartments. The acknowledgment of this competition played a role in defining how fixed route services need to be improved—in frequency and speed—to remain viable.

## **Capital Improvements**

In the ongoing work to finalize the 2040 System Plan, DART is looking at more aggressive treatments on new BRT corridors (some but not all of which overlap with Rapid Ride). The Draft Plan also recommends two new bus transfer facilities in areas where there are none, as well as upgrades to bus facilities at rail stations. Finally, implementing recommendations will also require growth in the bus fleet.

## **Costs and Funding**

As part of the planning process for the COA, the agency looked at several scenarios of varying levels of changes and investment. While the Draft System Plan includes many recommendations that together would increase operating costs by as much as 60%, based on DART's 25-year financial plan (updated annually), the agency determined that a 5% to 10% increase (about \$12.5 million) in annual operating costs was the greatest investment feasible for the redesigned bus network at the time, absent new revenue sources.

To pay for the increased operating costs, DART is expecting to receive additional farebox revenue beginning in late 2018, with the first fare increase in about 6 years. However, the bulk of the funding that allows for this growth in operating costs is through sales tax revenues. The economy in the Dallas-Fort Worth area has been doing extremely well and sales tax revenues, some of which are dedicated to DART, have been growing for some time. It was determined that the agency could take some of that revenue and invest in bus service; this is a big change for the agency, which previously cut service during a decade of lagging sales tax revenue.

DART will also be using increased sales tax revenue to fund the fleet expansion buses and TSP on three pilot corridors, most likely on the Rapid Ride network. The funding for the new transfer centers that are part of the Draft System Plan has not yet been identified.

## **Phased Implementation**

DART has begun to implement the recommendations of the COA and is still prioritizing what changes should go through with the remaining funds. In March 2018 the agency implemented service changes focused on off-peak frequency (recommendations that could be implemented without additional vehicles, which are not due to arrive until the middle of 2019); these changes accounted for about one-third of the operating budget increase available for implementation. In parallel with the finalization of the System Plan, DART is developing the plans for the second phase, a very large change that will include more frequency increases and route changes. This is anticipated to be implemented in August 2019 in conjunction with the arrival of fleet expansion buses. The final phase is expected to follow that and will focus on operating changes, such as addressing scheduling issues and recovery time.

## **Operating and Implementation Challenges**

One challenge that DART has been trying to address is the speed with which it can hire additional operators. This is not a new challenge, but one that gets in the way of fully implementing

## 72 Synthesis on Comprehensive Bus Network Redesigns

the recommended service; while this has not held back the implementation of service changes, it is costing the agency additional overtime pay and occasional missed runs. The agency is not sure if the cause of the challenges is a function of the labor market or one of the labor agreements; in Texas no collective bargaining agreements are allowed, so the contract with the operators is not a union contract.

### Next Steps

In parallel with finalizing the Draft System Plan in 2018, DART is currently updating its service standards; these will be incorporated into the Final System Plan. Whatever is finalized in the System Plan, DART plans to revisit it in 5 years as the region continues to grow and change. In the intervening years, staff plans to conduct more detailed service reviews on a geographic basis.

### 4.7 Summary

The case examples covered five agencies across the country at various stages of bus network redesign, from a small agency that provides 91,000 revenue hours of service a year to one that provides 2.8 million. Some of the key similarities and differences discovered in the case studies are:

- Agencies had common visions and goals for improving the system comprehensively, from operational efficiency, to providing service that would meet the needs of the riders.
- All case example agencies structured their system redesigns on a network of high-frequency bus routes.
- All case example agencies emphasized the importance of obtaining rider and stakeholder feedback and how the input and feedback received was a critical element to the network design.
- The focus of the system design varied across the case studies, such as DART's which was centered on revising the network away from one that was solely designed to feed the rail network, and COTA, and BaltimoreLink.
- Three of the case studies, COTA, BaltimoreLink, and Connect Transit all implemented their redesigns at once, while DART is phasing its implementation and King County is planning a phased implementation. The agencies with longer implementation timeframes have redesigns centered around longer-term capital investments (King County) and phased availability of increased operating funds (DART).
- Implementation of service changes all at once requires extensive efforts around public education, including all kinds of marketing materials, traditional and social media, and street teams in the field to ensure that the word is spread and that riders know how to get around when the service changes.
- Having a strong collaboration between planning and bus operations is key to being able to operationalize the plans. This includes obtaining personnel numbers and hiring new operators to support the new service, field testing new routes for run times and safety considerations, and making sure that the operators and supervisors are on-board and supportive of the changes.



## CHAPTER 5

# Conclusions

## 5.1 Motivation for and Objectives of Transit Network Redesigns

For many decades, the bus networks in many cities were tweaked around the edges while cities focused on building fixed guideway transit or simply did not concentrate on transit. However, in recent years and actively continuing, many transit agencies and operators have planned, and in many cases implemented, complete redesigns of their bus networks. In about half of the cases the planning approach has been classified by the agencies as a design “from a blank slate,” while others evaluated their systems holistically but describe their approach as comprehensive modifications to the existing system. The research conducted for this synthesis yielded a number of key objectives that the transit operators set out to meet by conducting these redesigns, including:

- To reevaluate the big picture structure of the system and better match the transit network to both current and forecasted travel patterns and development.
- To improve transit service for both current and potential riders and improve the image of the transit agency.
- To support urban sustainability and address congested corridors.
- To increase operational efficiency and effectiveness and match operating costs to available resources.
- To counteract ridership losses and/or increase ridership.
- To adapt to other public transit investments and new technologies.

## 5.2 Key Findings

To meet the objectives of the redesigns, agencies followed certain processes for planning, outreach, and implementation of comprehensive bus network redesigns. Some of the common elements and other informative key findings are as follows:

- Vision, Goals, and Objectives
  - All agencies set out the goals and objectives for their redesigns at the outset in order to frame the approach and recommendations. This was key to ensuring that the strategies and recommendations are focused on achieving those goals.
  - Redesigns focused both on improving operations and system performance.
  - Redesigns carefully consider and incorporate the needs of riders and potential riders, often for the first time in many years to look at this from a network perspective.
  - Agency boards and other elected officials are a key part of the redesign visioning and decision-making process. Many agencies experienced political challenges, but with engagement at strategic points and the acknowledgment that these redesigns are important, compromise was generally reached and the plan could move forward.

**74** Synthesis on Comprehensive Bus Network Redesigns

- Planning Process
  - Because the bus network redesigns are often the first holistic look at changing the bus network in many years, several agencies go beyond the existing service evaluation and conduct detailed market assessments, travel flow data, and origin-destination studies to help support the general structure of the recommendations.
  - With agencies having so much access to data, they utilize a wealth of ridership and travel time data from AVL and APC systems, as well as other sources.
  - Agencies all incorporated equity considerations in the decision-making process, extending beyond the requirements of Title VI (which requires an assessment closer to implementation). Some agencies used the results of this “pre-analysis” to make some changes to the final plans as a result.
- Service Design Elements
  - Many agencies centered their redesigned network structures on grid networks and new crosstown services to provide better connections without forcing riders to ride into the core of the system and back out.
  - Many agencies centered their redesign on a network of high-frequency, priority bus routes to provide a higher quality level of service.
  - Many agencies focused on making the system easier to use, from straightening out route deviations to standardizing frequency and span across service types.
  - Many agencies incorporated longer spans of service during the weekdays – later in the evenings and higher frequencies in the midday – as well as added additional weekend service as part of the redesigns.
  - Many agencies incorporated revised run times, layover time, and capital investments in bus priority to improve on-time performance and reliability.
  - Impacts on the ADA paratransit service area need to be considered; letting existing users know if they will be grandfathered in can help assuage concerns about changes to the fixed-route network and thus the paratransit service area.
- Internal Agency Impacts
  - Redesigns often have ancillary and unintended benefits for transit agencies outside the initial scope of the redesign.
  - Reorganization of departments.
  - Better internal and cross departmental communication.
- Outreach and Education
  - It is important to think strategically about public and stakeholder outreach from the very beginning of the redesign planning process in order to gain support and achieve understanding of what the agency is setting out to do.
  - Outreach to bus operators and front-line employees is critical to success, from gaining valuable input about how the service currently operates to achieving support for when the plan is launched.
  - Developing the outreach strategy often involved the input of senior leadership, communications strategists, and representatives from stakeholder groups and community-based organizations to help make sure that input is sought and received from a diverse audience.
  - Tying the outreach strategy to decision points in the process provides the public with opportunities for meaningful engagement and input.
  - Agencies used a range of types of public engagement, including traditional public workshops and meetings, websites, social media, online surveys, field outreach (i.e., pop-ups), and stakeholder meetings.
  - Agencies use the input received from the public engagement to frame service recommendations and make adjustments to proposed changes.
  - Performance measures are often used to communicate the benefits of the new networks to the public. In many cases this is very effective, but agencies must be careful about the messages and how they may be perceived by different communities; in one case two

communities of differing demographics were receiving better levels of access with the new system, but one group recognized that while the other perceived the changes to be negative. Perception is reality, and agencies must be careful to frame their messaging in a way that is easy for all to understand.

- Public education is critical once the redesign plans have been finalized to inform people of the changes. Education ranged in length by agencies from one year to a few months.
- Implementation and Phasing
  - There is a mix of agencies both implementing their redesigns all at one time or in phases – some over many years. Agencies that have a long-term implementation have indicated that they will revisit the plan over the course of time as needs will continue to evolve.
  - In some cases agencies developed plans for a redesign and then moved the process forward when the time was right from a political and funding perspective.

## **What Makes a Redesign Different than Traditional Service Planning**

Agencies regularly evaluate service at the corridor, route, and trip level to ensure that they are meeting performance targets and remain within the agency's service standards. A redesign incorporates this type of detailed analysis but goes beyond it to incorporate a detailed market and travel flow assessment to determine demand and service gaps. Redesigns also are characterized by setting network-level planning and design objectives are often defined at the outset. For example, the transit agency may want to move from a radial system to a grid network or may want to maximize network coverage, increase system ridership, or connect more people to more jobs and opportunity.

Extensive board and high-level executive involvement is also a feature of redesigns – because of the far-reaching impacts not only in the community but within the agency, redesigns require support and leadership beyond the service or short-range planning department of an agency. They also require greater collaboration with the impacted department of transportation, particularly when the redesign includes roadway and signal bus priority improvements.

Much more in-depth and broad-reaching public, stakeholder, and bus operator engagement is also a key element of redesigns. All agencies who responded to the survey said they consulted or will be consulting the public during the redesign process, and many do so at several intervals throughout the planning process, from visioning, to draft service plans, to implementation. While nearly all agencies continue to use public meetings, the outreach strategies for redesigns go well beyond that, with the majority of agencies using social media, stakeholder meetings, and pop-up events.

## **Common Elements for Conducting Redesigns**

### *Goal Setting and Tradeoff Analysis*

The first element of almost every redesign reviewed through the literature, survey, and case studies was developing a strategic framework around which to structure the plan. This included developing goals and objectives that the agency and the constituents were trying to achieve through the network design process. By establishing goals up front – such as maximizing service efficiency – and answering tough tradeoff questions – such as focusing on coverage or frequency, or less frequent direct service versus more frequent service that requires transfers – the service planning process could be tailored to addressing the agreed upon goals and preferences.

### *Service Planning*

The steps taken during a comprehensive bus network redesign are quite similar to and are grounded in traditional bus service planning processes; however, the analysis, planning, and public engagement is multiplied over the entire network of routes. In addition to detailed

## 76 Synthesis on Comprehensive Bus Network Redesigns

corridor, route, and trip level analysis, a redesign typically incorporates a detailed market and travel flow assessment to determine demand and service gaps. For example, MDOT MTA used travel demand model flows and DART used a purchased cell phone dataset to gain insight into where people were going in the service area – not just by transit, which is typically ascertained by origin-destination studies – but by all modes, an indicator of need.

Existing conditions data analysis is often more extensive, because the goal is not only to improve route performance but also to improve the connectivity and performance of the entire bus network. Data collection and analysis might include detailed examination of origin-destination data, passenger transfers, land-use and demographic information, and even network-wide ridership and travel demand modeling.

Most agencies reported that consultants performed either “all or nearly all of the work” or “most of the work” involved in the planning for redesigns. While agency staff was certainly involved in providing data and feedback, the bulk of the technical analysis is conducted by outside parties.

### *Capital Improvements*

Because so many of the redesigns centered on a high frequency network, capital improvements were a larger component of redesigns than in typical service plans; 66% of the surveyed agencies have capital costs associated with their redesigns. The most common capital costs included rolling stock, passenger facilities (e.g., bus stops and amenities), and bus stop signage, followed by bus priority treatments (e.g., bus only lanes, transit signal priority). Capital improvements are one area where the planning office and engineering and capital planning offices must work hand-in-hand as part of a successful redesign.

### *Communications and Decision-Making*

Communication with the public and key stakeholders was a key element of all redesigns, and all agencies indicated that outreach was a large part of the system redesign process. In addition to the extensive outreach that agencies made in developing their plans, communications prior to implementation were crucial to implementation. The case studies revealed significant amounts of communication around the launch of the redesigns. At least two agencies, MDOT MTA and COTA, developed side-by-side online trip planners using GTFS feeds to allow riders to compare their current trip to their future trip.

One aspect that was common across many agencies that have conducted or are planning a redesign is the use of metrics to communicate the benefits and impacts and to evaluate their plans during the process to evaluate how well the plan was aligning with their stated goals and objectives. Smaller scale changes do not require as widespread buy-in, whereas redesigns require that the agency provide quantitative measurements to gain support. Some of the most commonly considered metrics are changes in service area and coverage, impact on equity, potential ridership, impact on costs, access to key destinations, and softer measurements such as simplicity of system design and consistency in span and level of service.

Agencies varied in who was responsible for decision-making, in some cases based on whether the agency was an independent agency or an arm of the local or state government. Overall, boards played a key role in both supporting redesign and serving as champions as well as being opposed to the redesign. In some cases, board members were not supportive of the overall goals of the redesign not in theory or concepts but because of concern about a particular route.

### *Implementation – All at Once or Phased*

Some agencies, like DART and King County, are implementing their redesign in phases over time, while others have implemented all at once. A majority of agencies stated that they had or

would implement all at once or mostly all at once with minor additional phases. For the agencies using phasing, the span of time for the phasing ranges anywhere from less than two years to 10 years or more. Certainly, for plans with lengthy spans of phasing the agency is likely to do additional planning to update the original plans prior to implementation.

### **5.3 Evolving and Continued Issues and Challenges**

Bus network redesigns continue to evolve as new and better data becomes available and more lessons learned are easily gleaned for agencies to leverage. Many agencies currently conducting or thinking about conducting a redesign are simultaneously dealing with the challenge of decreasing ridership and growth in the use of privately provided services like TNCs. The uncertain future of automated vehicles – both for passenger cars and for transit vehicles – is another challenge that agencies must consider as they proceed with bus network redesigns. Transit agencies moving toward a “mobility-as-a-service” model, where their offerings will continue to change over time, throws another wrinkle and challenge in as more agencies proceed with the redesign process (MaaS Alliance. n.d., Kelly 2018). Communication continues to remain a challenge, though certainly a surmountable one – riders, stakeholders, board members, and elected officials all live in a world of readily accessible information and opportunities to engage – and they expect and deserve to have those legitimately meaningful opportunities with regard to bus network redesigns.

### **5.4 Future Research**

Because most redesign implementations are relatively new, future research should seek to evaluate the success and pitfalls of redesigns and their costs and benefits, along with a comparison of the anticipated outcomes during the planning phase and the actual outcomes after implementation. These evaluations will have to rationalize against other factors that may have also been at play after the redesign launched – from the economy, to congestion, to the performance of the agency. Some of the agencies that have already implemented bus network redesigns are implementing robust performance measurement programs to track their progress. Future research on the results of these evaluations – cross-referenced with how they were planned and implemented – will be useful for agencies that are still earlier in the process.

This research did not attempt to investigate differences in redesign approaches or designs between cities that are in major growth mode in terms of development and population and those that are more stagnant. Understanding those differences could better tailor the understanding of which approaches apply to another place considering a redesign.

Another potential consideration is how redesigns have impacted the location of affordable housing; in other words, did any redesigns have an impact on development and gentrification. While the impact of rail investments is well documented, bus system changes at this broad level have not yet been considered in any substantive way.

Finally, many redesigns focus on achieving efficiency of service and favor high frequency service over traditional routes that may be infrequent but provide some access to nearly every corner of the service areas. While over time some of these changes may be addressed through agencies’ adoption of flexible services and other aspects of providing mobility, the initial impact on seniors and disabled populations – who now may have to walk farther to reach service (or turn to a greater reliance on paratransit) – should be explored.



# Glossary of Terms and Abbreviations

## Transit Agencies

Agency Abbreviation/Short Name (if applicable)	Full Agency Name	City	State/Province
-	<b>Connect Transit</b>	Normal	IL
-	<b>Halifax Transit</b>	Halifax	NS
-	<b>Metro McAllen</b>	McAllen	TX
-	<b>Tri Delta Transit</b>	Antioch	CA
Capital Metro	<b>Capital Metropolitan Transportation Authority</b>	Austin	TX
CAT	<b>Clemson Area Transit</b>	Clemson	SC
CARTA	<b>Charleston Area Regional Transportation Authority</b>	Charleston	SC
Cherriots	<b>Salem Area Mass Transit District</b>	Salem	OR
COTA	<b>Central Ohio Transit Authority</b>	Columbus	OH
DART	<b>Dallas Area Rapid Transit</b>	Dallas	TX
DASH	<b>Driving Alexandria Safely Home</b>	Alexandria	VA
EMTA	<b>Erie Metropolitan Transit Authority</b>	Erie	PA
Houston Metro	<b>Metropolitan Transit Authority of Harris County</b>	Houston	TX
HRT	<b>Hampton Roads Transit</b>	Norfolk	VA
IndyGo	<b>Indianapolis Public Transportation Corporation</b>	Indianapolis	IN
JTA	<b>Jacksonville Transportation Authority</b>	Jacksonville	FL

Agency Abbreviation/Short Name (if applicable)	Full Agency Name	City	State/Province
King County Metro	King County Department of Transportation Metro Transit Division	Seattle	WA
LACMTA	Los Angeles County Metropolitan Transportation Authority	Los Angeles	CA
LYNX	Central Florida Regional Transportation Authority	Orlando	FL
MBTA	Massachusetts Bay Transportation Authority	Boston	MA
MCTS	Milwaukee County Transit System	Milwaukee	WI
MDOT MTA	Maryland Department of Transportation Maryland Transit Administration	Baltimore	MD
Nashville MTA	Nashville Metropolitan Transit Authority	Nashville	TN
NYCT	New York City Transit Authority	Staten Island	NY
OCTA	Orange County Transportation Authority	Orange	CA
Omaha Metro	Metro Transit	Omaha	NE
RIPTA	Rhode Island Public Transit Authority	Providence	RI
Sacramento RTD	Sacramento Regional Transit District	Sacramento	CA
Denver RTD	Regional Transportation District	Denver	CO
SEPTA	Southeastern Pennsylvania Transportation Authority	Philadelphia	PA
SORTA	Southwest Ohio Regional Transit Authority	Cincinnati	OH
ValleyRide	Valley Regional Transit	Boise	ID
VIA	VIA Metropolitan Transit	San Antonio	TX
VTA	Santa Clara Valley Transportation Authority	San Jose	CA
Wave Transit	Cape Fear Public Transportation Authority	Wilmington	NC

## Terminology

Acronym	Definition
ACS	American Community Survey
APC	Automated Passenger Counter
AVL	Automated Vehicle Location
GIS	Geographic Information Systems
GTFS	General Transit Feed Specification
LEHD	Longitudinal Employer-Household Dynamics
NTD	National Transit Database
TSP	Transit Signal Priority



# References

- APTA Ridership by Mode and Quarter. <http://www.apta.com/resources/statistics/Pages/ridershipreport.aspx>. Accessed April 26, 2018.
- Badia, H., Estrada, M., and Robusté, F. (2014). Competitive Transit Network Design in Cities with Radial Street Patterns. *Transportation Research Part B*, 59, pp. 161–181.
- Badia, H., Argote-Cabanero, J., and Daganzo, C. F. (2017). How Network Structure Can Boost and Shape the Demand for Bus Transit. *Transportation Research Part A: Policy and Practice*, 103, pp. 83–94.
- Benn, H. P. (1995). *TCRP Synthesis 10: Bus Route Evaluation Standards*. TRB, National Research Council, Washington, D.C. <http://onlinepubs.trb.org/onlinepubs/tcrp/tsyn10.pdf>. Accessed Nov. 3, 2017.
- Bhattacharya, T., Brown, J., Jaroszynski, M., and Batuhan, T. (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(2), 1.
- Boyle, D. K., and Rey, J. (2012). Redesigning an Existing Transit Network from Scratch. In *TRB 91st Annual Meeting Compendium of Papers*, No. 12-3887, Transportation Research Board of the National Academies, Washington, D.C.
- Brown, J., Batuhan, T., Bhattacharya, T., and Jaroszynski, M. (2013). *Analyzing the Effects of Transit Network Change on Agency Performance and Riders in a Decentralized, Small-to-Mid-sized US Metropolitan Area: A Case Study of Tallahassee, Florida*. Mineta Transportation Institute, Report 12-04.
- Capital Metro. (n.d.). *Connections2025*. <http://connections2025.org/>. Accessed Feb. 6, 2018.
- Central Ohio Transit Authority. (2017). *NextGen: It’s Your Move*. <https://www.cota.com/wp-content/uploads/2016/04/LRTP.pdf>. Accessed April 25, 2018.
- Cherriots. (2016). CARTS Redesign Draft Plan. <http://www.cherriots.org/sites/default/files/files/carts-redesign-draft-plan.pdf>. Accessed November 21, 2017.
- Connect Transit. (2017). Connect Transit System Map. <https://www.connect-transit.com/civicax/filebank/blobdload.aspx?BlobID=23439>. Accessed May 24, 2018.
- Connect Transit. (n.d.). Dashboard | Cyfe. <http://www.connect-transit.org/dashboards/616079/5ad78dad0776a101237789513291>. Accessed May 24, 2018.
- Comfort, P. (2016). Redesigning the Baltimore Transit Network. *APTA Bus and Para-transit Conference, Charlotte, North Carolina*. <https://www.cota.com/wp-content/uploads/2016/04/SRTP.pdf>. Accessed April 25, 2018.
- Currie, G., and Tivendale, K. (2010). Inclusive Planning Process for Citywide Bus Network Restructuring: Experience and Impacts. *Transportation Research Record: Journal of the Transportation Research Board*, No. 2145, pp. 18–29.
- Dallas Area Rapid Transit. (2016). *Comprehensive Operations Analysis (COA): Draft Bus Service Plan Recommendations*. <https://www.dart.org/ShareRoot/about/expansion/tsp/COADraftBusServiceExecutiveSummaryJune2016.pdf>. Accessed on Feb. 6, 2018.
- Dallas Area Rapid Transit. (2017). Public Meeting March 2018 Service Changes. <https://www.dart.org/meetings/2018servicechange/DARTMarch2018ServiceChange.pdf>. Accessed Nov. 21, 2017.
- FTA. (2016). NTD Transit Agency Profiles. <https://www.transit.dot.gov/ntd/transit-agency-profiles>.
- General Planning Consultant Team (GPC5). (2016). Dallas Area Rapid Transit Comprehensive Operations Analysis (COA): Draft Bus Service Plan Recommendations. <https://www.dart.org/ShareRoot/about/expansion/tsp/COADraftBusServiceExecutiveSummaryJune2016.pdf>. Accessed 2018.
- Halifax Transit. (2016a). *Halifax Transit Moving Forward Together Plan*. <http://legacycontent.halifax.ca/boardscom/SCtransp/documents/160324tsc1213.pdf>. Accessed Nov. 21, 2017.
- Halifax Transit. (2016b). *Halifax Transit: Moving Forward Together: About*. <http://maketransitbetter.ca/moving-forward-together/about/>. Accessed Feb. 6, 2018.

## 82 Synthesis on Comprehensive Bus Network Redesigns

- Houston METRO. (2014). *Reimagined 5-Year Transit Service Plan* (Draft). <https://www.ridemetro.org/MetroPDFs/AboutMETRO/CurrentProjects/pdfs/Reimagining/Draft-System-Reimagining-Plan-051014.pdf>. Accessed Nov. 21, 2017.
- Houston METRO. (n.d.). System Reimagining Website Archived. <https://www.ridemetro.org/Pages/Reimagining.aspx>. Accessed Feb. 6, 2018.
- Jacksonville Transportation Authority. (2016). *Route Optimization Initiative: Case Study*. [https://www.jtafla.com/media/Documents/General/Case%20Study/roi\\_casestudy/1022/roi\\_casestudy.pdf](https://www.jtafla.com/media/Documents/General/Case%20Study/roi_casestudy/1022/roi_casestudy.pdf). Accessed Nov. 21, 2017.
- Jaffe, E. (2015). Omaha Just Designed a Way Better Transit System for Zero Cost. *CityLab*. <https://www.citylab.com/solutions/2015/05/omaha-just-designed-a-way-better-transit-system-for-zero-cost/393620/>. Accessed Feb. 6, 2018.
- Kalantari, N., Zamanian, M. H., and Amiripour, S. M. M. (2014). Bus Network Modification Problem: A New Approach to Bus Network Design. In *TRB 93rd Annual Meeting Compendium of Papers*, No. 14-4310, Transportation Research Board of the National Academies, Washington, D.C.
- Kelly, N. (2018). What is Mobility as a Service? Geotab. <https://www.geotab.com/blog/what-is-mobility-as-a-service/>. Accessed November 9, 2018.
- King County Metro. (2016). *Public Engagement Report*. <http://www.kcmetrovision.org/wp-content/uploads/2016/08/Metro-Connects-Public-Engagement-Report.pdf>. Accessed April 20, 2018.
- King County Metro. (n.d.). Proposed Improvements to Make Route 8 More Reliable. Seattle Department of Transportation. <https://kingcounty.gov/~media/depts/transportation/metro/programs-projects/route-8/pdf/route-8-improvements-diagram.ashx?la=en>. Accessed May 24, 2018.
- Maryland Transit Administration. (2017). Launching the Network Redesign. [https://baltometro.org/phocadownload/Committees/Tech\\_Committee/TC171003pres\\_Baltimore\\_Link\\_Redesign.pdf](https://baltometro.org/phocadownload/Committees/Tech_Committee/TC171003pres_Baltimore_Link_Redesign.pdf). Accessed Nov. 21, 2017.
- Maryland Transit Administration. (2018). *BaltimoreLink Final Report* (Draft). Internal document.
- MaaS Alliance. (n.d.). What is MaaS? <https://maas-alliance.eu/homepage/what-is-maas/>. Accessed 2018.
- Metropolitan Transit Authority. (August 11, 2015). Connect Transit Named “Best Public Transit System in North America.” <http://www.metro-magazine.com/management-operations/news/295042/connect-transit-named-best-public-transit-system-in-north-america>. Accessed April 25, 2018.
- Metropolitan Transit Authority. (April 23, 2018). NYC Transit Unveils Plan to Reimagine Bus System and Deliver World-Class Bus Service. <http://www.mta.info/news/2018/04/23/nyc-transit-unveils-plan-reimagine-bus-system-deliver-world-class-bus-service>. Accessed June 28, 2018.
- New York City Transit MTA. (2017a). *Staten Island Bus Study: Reimagining Express Buses*. <http://nymta.civicconnect.com/sites/default/files/Final%20Report%20May%2031%202017.pdf>. Accessed Nov. 21, 2017.
- New York City Transit MTA. (2017b). National Transit Database (NTD) Agency Profiles 2016 from: <https://www.transit.dot.gov/ntd/transit-agency-profiles>. Accessed Nov. 21, 2017.
- Pratt, R., and Evans, IV, J. E. (2004). *TCRP Report 95: Traveler Response to Transportation System Changes Handbook, 3rd ed.: Chapter 10, Bus Routing and Coverage*. Transportation Research Board of the National Academies, Washington, D.C.
- Ryus, P. (2013). *TCRP Report 165: Transit Capacity and Quality of Service Manual*, 3rd ed. Transportation Research Board of the National Academies, Washington, D.C.
- Seattle Department of Transportation. (December 6, 2018). Levy to Move Seattle. <http://www.seattle.gov/transportation/about-sdot/funding/levy-to-move-seattle>. Accessed April 20, 2018.
- Stanley, R. (1998). *TCRP Research Results Digest 29: Continuing Examination of Successful Transit Ridership Initiatives*. TRB, National Research Council, Washington, D.C.
- Thompson, G. L., and Matoff, T. G. (2003). Keeping Up with the Joneses: Radial vs. Multidestinational Transit in Decentralizing Regions. *Journal of the American Planning Association*, 69(3), pp. 296–312.
- TransitCenter. (2016). *TransitCenter Bus Network Redesign Workshop: Participant Briefing Book*. New York, NY.
- TransitCenter. (2017). *Untangling Transit: Bus Network Redesign Workshop Proceedings*. July 13, 2017, New York City, NY.
- Transportation Management & Design, Inc. (2013). Heartland Regional Transit Vision: Metro Fixed-Route Operations Analysis. Network Evolution Plan. [http://www.ometro.com/wp-content/uploads/2015/05/Metro\\_Network\\_Evolution\\_Plan\\_2013.pdf](http://www.ometro.com/wp-content/uploads/2015/05/Metro_Network_Evolution_Plan_2013.pdf). Accessed Nov. 21, 2017.
- Trapote-Barreira, C., Robusté, F., Badia-Rodríguez, H., and Estrada-Romeu, M. A. (2016). Learnings from Urban Bus Network Change. In *TRB 95th Annual Meeting Compendium of Papers*, No. 16-6772, Transportation Research Board, of the National Academies, Washington, D.C.
- Viggiano, C. A. (2017). *Bus Network Sketch Planning with Origin-Destination Travel Data*. PhD dissertation. Massachusetts Institute of Technology, Cambridge, MA.
- Vock, D. C. (Sept. 18, 2017). Bus Network Redesigns Are the “Hottest Trend in Transit.” *GovTech*. <http://www.govtech.com/fs/Bus-Network-Redesigns-are-the-Hottest-Trend-in-Transit.html>. Accessed Jan. 26, 2018.



## APPENDIX A

# Reviews of National Reports

### A.1 Overview

Within each topic area, articles are sorted chronologically. Some secondary, additional sources were added as references in the literature review text because they were needed for the narrative, however these secondary sources are not listed below but are included as references in the body of this report, where appropriate.

### A.2 Case Study Research

*Inclusive Planning Process for Citywide Bus Network Restructuring: Experience and Impacts (Currie and Tivendale 2010)*

This study portrayed the steps behind an inclusive planning and network design process in Melbourne, Australia. Rather than use complex transportation demand modeling, the authors combined route- and stop-level data analysis and visualization tools with public and bus operator feedback using an iterative engagement process to identify the most critical network changes needed and to build consensus on the final network design and areas for transit service growth. The authors report that the process has led to stakeholder buy-in to the degree that additional revenues have come from the government to improve services.

*Redesigning an Existing Transit Network from Scratch (Boyle and Rey 2012)*

In this study, the authors discuss their work redesigning the bus network in Greensboro, North Carolina. The authors guided Greensboro through a bus network redesign study that sought to improve the efficiency and flexibility of the bus network, resulting in a recommendation to convert from a centralized, radial system to a multiple-hub-and-spoke system. They discuss the planning process, the resulting network plan, and the challenges they faced during the project.

*Analyzing the Effects of Transit Network Change on Agency Performance and Riders in a Decentralized, Small-to-Midsized U.S. Metropolitan Area: A Case Study of Tallahassee, Florida (Brown et al. 2013)*

The study investigated the effects of the Tallahassee network redesign, looking for changes in ridership patterns, variations in the use of transit by different populations or geographies, and rider and community perceptions of the network redesign.

*The Effects of Perception vs. “Reality” on Travel Behavior after a Major Transit Service Change: The Case of Tallahassee, Florida (Bhattacharya et al. 2014)*

This study was also based on the network redesign in Tallahassee. The authors investigated the perceptions of riders in a low-income community and a student community regarding the

**84** Synthesis on Comprehensive Bus Network Redesigns

outcomes of the network redesign. The authors compared those perceptions with objective outcome measures of the redesign. The authors found that under the new network both communities had better service; however, low-income riders perceived the service changes as negative while student riders perceived the changes as positive. These differences in perception also generated changes in transit use—student ridership increased while ridership from the low-income community decreased.

*Bus Network Modification Problem: A New Approach to Bus Network Design (Kalantari et al. 2014)*

In this article, the authors present an alternative to the blank slate approach for bus network planning, which they call a *modification* approach. In their approach, the authors aim to improve the overall performance of the network by making minimal changes to the network. The authors developed an algorithm that optimizes transit network performance metrics while keeping the new network as similar as possible to the current network based on a calculated “similarity index.”

*How Network Structure Can Boost and Shape the Demand for Bus Transit (Badia et al. 2017)*

This study examines the transit demand that resulted after a grid-type transfer-based bus network was implemented in Barcelona, Spain. The authors found that the new network has attracted more ridership than the previous network, suggesting that an appropriately-designed grid network can increase ridership.

*Learnings from Urban Bus Network Change (Trapote-Barreira et al. 2016)*

The paper presents the strategies used to improve bus service in Lleida, Spain while also saving resources by implementing a bus network redesign. The authors discuss the objectives of the network redesign, the public engagement process, network evaluation criteria, and the phases of implementation.

*Untangling Transit: Bus Network Redesign Workshop Proceedings (TransitCenter, 2017)*

This workshop proceedings document from the July 13, 2017 workshop shares lessons learned based on the input of more than 30 transit agencies at varying stages of system redesigns, from fully implemented to those considering significant changes to their bus networks. The report summarizes discussions from the event into a guide of best practices for transit agencies and others to use as they consider whether and how to update their bus route networks.

### A.3 Industry Resources and Overviews

*TCRP Synthesis 10: Bus Route Evaluation Standards (Benn 1995)*

This synthesis report discusses the prevalence and contents of documented bus route standards by transit agencies, including standards for route, corridor, and bus stop spacing; limitations on route deviations and branches; route proximity to residences and non-residences, and requirements for population and employment density, among other factors. The research did not specifically address network design standards as a concept; however, transit agencies did have standards for network connectivity, limitations on the number of passenger transfers, and service area coverage—all of which influence a bus network’s overall design.

*Continuing Examination of Successful Transit Ridership Initiatives (Stanley 1998)*

The author held interviews with more than 50 transit agency managers and drew conclusions about factors that contributed to ridership increases between 1994 and 1996. Even in this period

of time, the author found that service restructuring was prevalent and in some cases helped with ridership growth.

*Keeping up with the Joneses: Radial vs. Multidestinational Transit in Decentralizing Regions* (Thompson and Matoff 2003)

The authors examined ridership data from 1983 through 1998 for nine urban regions and compared the service effectiveness, efficiency, and equity of radial (focused on a single central business district) and multi-destinational (serving many regional destinations) transit networks. The authors found that, after controlling for population, multi-destinational networks were more effective and equally efficient as radial networks.

*TCRP Report 95: Traveler Response to Transportation System Changes Handbook* (3rd ed.), Chapter 10, *Bus Routing and Coverage* (Pratt and Evans 2004)

Chapter 10 of *TCRP Report 95* provides an overview of how riders tend to react, on average, to different types of bus routing and coverage changes. The authors discuss many different types of service changes, including “service restructuring,” which is the closest type of change to what this report considers a comprehensive bus network redesign. The handbook provides transit managers some guidance on how riders might react to a service restructuring based on several case studies.

*Bus Network Redesigns are the ‘Hottest Trend in Transit’* (Vock 2017)

This non-academic article from *Governing Magazine* suggests that bus network redesigns have become increasingly popular as a strategy to both counter ridership losses and to realign bus networks with the demographic and land-use changes in cities. The author suggests that typical route changes, new routes, or service level changes are not enough to address the big challenges facing cities and their transit agencies.

## A.4 Self-Published Documents from Transit Agencies

*Heartland Regional Transit Vision: Metro Fixed-Route Operations Analysis—Network Evolution Plan* (Transportation Management & Design 2013)

Omaha Metro in Omaha, Nebraska undertook a network redesign effort entitled the Network Evolution Plan, which resulted in a phased bus network reconfiguration that was implemented in 2015 (Jaffe 2015). The document describes the goals and background for the study, reports on existing conditions, and discusses service change recommendations across three implementation phases.

*Reimagined Five-Year Transit Service Plan* (Houston METRO 2014)

The self-published document is a comprehensive overview which describes the goals, objectives, process, and service recommendations for the Harris County Transit Authority’s (Houston METRO) System Reimaging, which was implemented in August of 2015 (Houston METRO n.d.).

*CARTS Redesign Draft Plan* (Cherriots 2016)

Cherriots, the transit operator in the Salem Area Mass Transit District in Salem, Oregon, launched a network redesign initiative in 2016 to evaluate the eight-route regional bus system, known at the time as CARTS but rebranded as Cherriots Regional when the network changes were implemented in 2017. The draft network redesign document highlights the rationale

**86** Synthesis on Comprehensive Bus Network Redesigns

behind the network redesign, the steps taken (including public outreach), and the proposed recommendations.

*Moving Forward Together Plan (Halifax Transit 2016a)*

Halifax Transit, the transit provider in Halifax, Nova Scotia, Canada, launched its network redesign project by establishing a set of board-approved “principles” in 2014, which, among other things, sought to increase the proportion of resources allocated toward high-ridership services. This self-published document discusses the principles, public outreach, service recommendations, and implementation plan.

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

This document is the executive summary of Dallas Area Rapid Transit’s (DART) COA, which was phase one of developing DART’s 2040 Transit System Plan. The document summarizes the goals and recommendations from DART’s COA, which began in 2014 and was completed in 2016. The service recommendations represent a 42% increase in operating costs and will require a long-term, phased approach that prioritizes implementation of changes as resources allow. Some of the changes are planned for implementation in 2018 (Dallas Area Rapid Transit 2017).

*Route Optimization Initiative: Case Study (Jacksonville Transportation Authority 2016)*

The Jacksonville Transportation Authority implemented its restructuring in December of 2014 under the moniker of the Route Optimization Initiative (or ROI). The document contains the play-by-play account of Jacksonville Transportation Authority’s ROI, including the rationale for the change, the process of data analysis and engagement, strategies for implementation day, and lessons learned.

*2016–2040 Long-Range Transit Plan (Central Ohio Transit Authority 2016)*

The Central Ohio Transit Authority’s (COTA) 2016–2040 Long-Range Transit Plan has contents typical of a long-range transit plan except that it also has the details of COTA’s short-range (through 2019) network redesign project known as the *Transit System Redesign* (TSR), which began in 2013. The document describes steps of the TSR, including the evaluation of the existing transit system, public outreach, service change recommendations, and implementation plans. Like Houston METRO, COTA decided to set an explicit goal for the use of resources: 70% of resources was allocated to high-ridership lines and 30% to coverage lines.

*Launching the Network Redesign (Maryland Transit Administration 2017)*

This document is a presentation to the Baltimore Metropolitan Council by the Maryland Transit Administration (MTA) about its BaltimoreLink bus service redesign project. The presentation highlights the goals of the network redesign and provides an overview of the major changes including service, technology, and infrastructure improvements. The network redesign was implemented in one day in 2017 and MTA continues evaluation and implementation of additional changes as needed.

*BaltimoreLink Final Report (DRAFT) (Maryland Transit Administration 2018)*

This document is a comprehensive summary document that describes the original network and its performance, the redesign goals and parameters, and the methodology followed for planning the redesigned network. It also covers the other key elements of the program including system rebranding, infrastructure investments, public outreach and education, and internal communications. It also discusses key elements of implementation for a systemwide launch conducted in one day.

*Staten Island Bus Study—Reimagining Express Buses (NYCT 2017)*

New York City Transit (NYCT) of the Metropolitan Transportation Authority in New York City launched the Staten Island Bus Study to improve Staten Island bus service, using a network perspective rather than just looking at individual routes. The study resulted in two phases of recommendations of which restructuring the express bus network is the first. The document highlights NYCT's express bus network redesign data analysis, public engagement, and draft recommendations. As of February 2018, the final, approved express bus recommendations had not yet been released. Recommendations for improving local bus service will be released at a later date.



## APPENDIX B

# Survey Questionnaire

## TCRP Synthesis SA-44 Comprehensive Bus Network Redesign

### Introduction

Dear Survey Recipient:

The Transportation Research Board (TRB) is preparing a synthesis of current practices on Comprehensive Bus Network Redesign, also known as network redesigns or re-imaginings. Transit system redesigns have become popularized through many high-profile agencies developing updated system concepts and implementing sweeping, system-wide changes overnight. This synthesis will capture not only the many components that are needed to successfully implement a redesign but whether a redesign makes sense for the agency at the current time. This is being done for the Transit Cooperative Research Program (TCRP) in cooperation with the Federal Transit Administration (FTA) and the American Public Transportation Association (APTA). The synthesis will provide practical information and guidance for transit agencies of all sizes in profiling innovative and successful practices, lessons learned, and gaps in information.

This survey questionnaire is being distributed to 48 transit agencies. If you are not the appropriate person at your agency, to complete this survey, please forward it to the correct person.

Please complete and submit this survey questionnaire by February 21, 2018. If you have any questions, please do not hesitate to contact our principal investigator, Lora Byala at [lbvala@foursquareitp.com](mailto:lbvala@foursquareitp.com).

Thank you very much for participating in this survey!

**QUESTIONNAIRE INSTRUCTIONS**

1. **To view and print the entire questionnaire, Click on the following link and print using "control p"** <https://survegizmolibrary.s3.amazonaws.com/library/64484/TCRPSynthesisSA44Survey.pdf>
2. **To save your partial answers, or to forward a partially completed questionnaire to another party,** click on the "Save and Continue Later" link in the upper right hand corner of your screen. A link to the partially completed questionnaire will be emailed to you from *SurveyGizmo*. To return to the questionnaire later, open the email from *SurveyGizmo* and click on the link. To invite a colleague to complete part of the survey, simply click on the "Save and Continue" link and enter your colleague's email address. Please note that the questionnaire can be saved and passed around multiple times, but respondents must use the link emailed from *SurveyGizmo*. *We suggest using the "Save and Continue Later" feature if there will be more than 15 minutes of inactivity while the survey is opened, as some firewalls may terminate due to inactivity.*
3. **To view and print your answers before submitting the survey, click forward to the page following question 98. Print using "control p".**
4. **To submit the survey, click on "Submit" on the last page.**

---

## Agency Information

**Please enter the date (MM/DD/YYYY).\***

---

**Please enter your contact information.**

First Name\*: \_\_\_\_\_

Last Name\*: \_\_\_\_\_

Title\*: \_\_\_\_\_

Agency/Organization\*: \_\_\_\_\_

Street Address: \_\_\_\_\_

Suite: \_\_\_\_\_

City\*: \_\_\_\_\_

State\*: \_\_\_\_\_

Zip Code\*: \_\_\_\_\_

Country: \_\_\_\_\_

Email Address\*: \_\_\_\_\_

Phone Number\*: \_\_\_\_\_

Fax Number: \_\_\_\_\_

Mobile Phone: \_\_\_\_\_

URL: \_\_\_\_\_

### Additional People Completing the Survey

**Names of Additional People Completing the Survey**

---

---

### **Departments of Additional People Completing the Survey**

---

## Agency Information Part 2

**1) Does your agency have a Board of Directors and/or state parent agency (or similar oversight body)?**

- Yes  
 No

**2) Please specify, e.g., governing board, city council, advisory board, etc.**

---

---

---

**3) What is your transit agency's relationship with the area you serve?**

- Independent agency  
 An arm of the local government  
 An arm of the state government  
 Other - Please Describe: \_\_\_\_\_ \*

## System Demographics

**4) How is your fixed route bus service operated?**

- Directly operated
- Contracted / Third Party Provider
- A mix of directly operated and contracted

**5) Please list and indicate their role(s)**

---

---

---

**6) Are there other public or private agencies that operate fixed route bus service in your service area?**

- Yes
- No

**7) Please list and indicate their involvement, e.g., key partner, passive stakeholder, not involved.**

---

---

---

**94** Synthesis on Comprehensive Bus Network Redesigns

**8) Within your bus network service area, are there other mass transit modes in operation?  
Please select all that apply.**

- Heavy rail
- Light rail
- Streetcar
- Commuter rail
- Paratransit / Demand Response
- Flexible service model(s)
- Other - Please Specify: \_\_\_\_\_

---

## System Redesign Definition and Status

**9) Which of these statements best applies to your agency? In the past five years:\***

- My agency has completed (planned and fully implemented) a bus system redesign.
- My agency has completed planning of a bus system redesign and is in the process of implementing it / has partially implemented it.
- My agency is currently engaging in a bus system redesign plan (or has completed the plan but has yet to begin implementation).
- My agency is contemplating a bus system redesign.
- My agency contemplated a bus system redesign in the past five years, but decided against it.
- None of the above.

**10) What is/was the scope of the bus system redesign?**

- Full system
- Partial system (e.g., by part of service area, garage, corridor)
- Other - Please describe: \_\_\_\_\_ \*

**11) How did you implement/are you planning on implementing the redesigned system?**

- All at once
- Almost all at once, with minor stages
- In Phases
- I don't know yet
- N/A

**96** Synthesis on Comprehensive Bus Network Redesigns

**12) What are the minor stages?**

---

---

---

**13) How many phases?**

---

---

---

**14) Over what period of time?**

---

---

---

**15) What is the name of the process or program under which your bus system redesign was/is being executed or considered?**

- Branded system redesign (e.g., MTA BaltimoreLink)  
 Transit Development Plan (TDP)  
 Comprehensive Operational Analysis (COA)  
 Transit Vision Plan  
 Other - Please Specify: \_\_\_\_\_ \*
- It is not called anything at this time

**16) What are you/were you hoping to achieve through your bus system redesign? Please rate the following Big Picture Objectives in terms of their importance to your agency's system redesign.**

	Very	Somewhat	Neutral	Low	N/A
Re-evaluate the "big picture" structure of the system	( )	( )	( )	( )	( )
Increased operational efficiency and effectiveness	( )	( )	( )	( )	( )
Adjust service levels to available resources	( )	( )	( )	( )	( )
Adjust to other public transit investments (e.g., new rail line)	( )	( )	( )	( )	( )
Adapt to changes resulting from new types of transportation options (e.g., TNCs, bike share)	( )	( )	( )	( )	( )
Implement high-frequency / priority bus network	( )	( )	( )	( )	( )
Improve public image	( )	( )	( )	( )	( )
Simplify the system for public ease-of-use	( )	( )	( )	( )	( )

## 98 Synthesis on Comprehensive Bus Network Redesigns

Improve rider satisfaction	(O)	( )	(O)	(O)	(O)
Improve on-time performance and/or reliability	(O)	( )	(O)	(O)	(O)
Attract choice riders	(O)	( )	(O)	(O)	(O)
Better serve transit-dependent populations	(O)	( )	(O)	(O)	(O)
Shift ridership to other modes	(O)	( )	(O)	(O)	(O)
Increase ridership	(O)	( )	(O)	(O)	(O)
Improve multi-modal connections	(O)	( )	(O)	(O)	(O)
Long-term operating cost savings	(O)	( )	(O)	(O)	(O)
Use new operating funding strategically	(O)	( )	(O)	(O)	(O)
Increase service area (i.e., provide service in new jurisdiction(s))	(O)	( )	(O)	(O)	(O)
Decrease service area (i.e., eliminate service in specific jurisdiction(s))	(O)	( )	(O)	(O)	(O)
Adjust to moving/moved job centers	(O)	( )	(O)	(O)	(O)

Adjust to moving/moved housing/population centers	<input type="radio"/>				
Provide transportation alternatives to heavily congested automobile corridors	<input type="radio"/>				

17) What are you/were you hoping to achieve through your bus system redesign? Please rate the following Service Planning Objectives in terms of their importance to your agency's system redesign.

	Very	Somewhat	Neutral	Low	N/A
Reduce travel times	<input type="radio"/>				
Increase opportunity for transfers (e.g., transition from hub-and-spoke to grid network)	<input type="radio"/>				
Reduce need for transfers	<input type="radio"/>				
Expand coverage within service area	<input type="radio"/>				

## 100 Synthesis on Comprehensive Bus Network Redesigns

Decrease coverage within service area	( )	( )	( )	( )	( )
Consolidate or modify service into new/moved transfer hubs/centers	( )	( )	( )	( )	( )
Increase span of service	( )	( )	( )	( )	( )
Increase weekend service	( )	( )	( )	( )	( )
Increase revenue hours	( )	( )	( )	( )	( )
Decrease revenue hours	( )	( )	( )	( )	( )
Increase peak vehicle need	( )	( )	( )	( )	( )
Decrease peak vehicle need	( )	( )	( )	( )	( )
Increase frequency	( )	( )	( )	( )	( )
Strategically apply service cuts (reduce frequency)	( )	( )	( )	( )	( )

**18) If you decided not to perform a bus system redesign, why? Please select all that apply.**

- No agency or elected champion to push it through
- Did not have broad agency support
- Did not have local public/political support
- Did not have financial resources required for planning
- Did not have financial resources required for implementation
- Did not have the expertise available for redesign planning
- Other - Please Specify (Required):  
\_\_\_\_\_\*

**19) How long did the process for planning the system redesign take/do you anticipate it to take from start (planning kick-off meeting) to completion (ready for scheduling) of the new plan?**

---

---

---

**20) How long did the process take / do you anticipate it to take from plan completion (ready for scheduling) to implementation of redesigned system/routes?**

---

---

---

**102** Synthesis on Comprehensive Bus Network Redesigns

**21) When was the system redesign implemented or when do you plan to implement the system redesign? Please provide a Month and Year or, if an implementation time frame has not been determined, enter "not sure yet."**

---

**22) Did you take / are you taking a "blank slate approach" to the system redesign, i.e., the planning process approach was to develop a bus network and routes from the ground up rather than tweaking existing routes.**

Yes

No, the redesign makes changes that build upon our existing bus network

**23) Are you considering / did you consider a blank slate approach to the system redesign?**

Yes

No, the redesign considered will/would make changes that build upon our existing bus network

## Agency Organization

**24) What agency department or staff is taking / took the lead role on the system redesign or redesign consideration (choose the one that best describes the department or staff)?**

- Long Range Planning / Capital Planning and Programming
- Short Term Planning / Operations Scheduling
- Executive Office
- Finance
- Marketing/Communications
- Other - Please Specify: \_\_\_\_\_ \*

**25) Is there / was there a champion (or champions) of the effort within the agency, government, board, etc.?**

- Yes
- No

**26) What is/was their organization and title?**

---

---

---

**27) In what way(s) did this person champion the redesign?**

---

---

---

**104** Synthesis on Comprehensive Bus Network Redesigns

---

**28) What other transit agency departments are playing / played significant roles, meaning that they were a key part of the effort involved during all or most of the process? Please select all that apply.**

Long Range Planning / Capital Planning and Programming

Short Term Planning / Operations Scheduling

Executive Office

Finance

Marketing/Communications

Operations

Procurement

Customer Relations

Other - Please Specify: \_\_\_\_\_

\*

**29) What internal communication or coordination challenges are you experiencing / did you experience and how are you / did you address them?**

---

---

---

---

**30) Has the system redesign planning and, if applicable, implementation, led to any agency restructuring of departments or a reallocation of duties?**

Yes

No

**31) Briefly describe the restructuring and/or reallocation of duties.**

---

---

---

---

## Decision-making

32) What was the role of your Board or similar oversight body in making decisions about the following aspects of the system redesign? Please select all that apply.

	Policy Guidance	Detailed Input	Final Approval	None	Other
Route recommendations	<input type="checkbox"/>				
System redesign vision	<input type="checkbox"/>				
Operational restructuring	<input type="checkbox"/>				
Operating budgets	<input type="checkbox"/>				
Stakeholder involvement	<input type="checkbox"/>				
Capital improvements	<input type="checkbox"/>				
Capital budgets	<input type="checkbox"/>				
Federal/State compliance	<input type="checkbox"/>				
Equity considerations	<input type="checkbox"/>				
Marketing/branding	<input type="checkbox"/>				
Community Outreach	<input type="checkbox"/>				

**106** Synthesis on Comprehensive Bus Network Redesigns

**33) Did the Board or similar oversight body support the system redesign through: (Please select all that apply.)**

- Political advocacy on behalf of the redesign
- Public outreach for the redesign
- Identifying funding for the redesign
- Providing technical support
- Other - Please Specify: \_\_\_\_\_ \*
- None of the above

**34) What role(s) did the departments of transportation or public works of the jurisdiction(s) in which the agency operates play in the planning and implementation of the system redesign? Please select all that apply.**

- The transit agency and local DOT are in the same organization, so roles were integrated
- Service planning / route recommendations
- Planning and/or engineering for capital improvements (e.g., transit centers, TSP, bus lanes)
- Stakeholder-level review and feedback
- Final approvals
- Very close collaboration with the transit agency
- Small part of the planning and implementation process
- Local DOT was opposed and was therefore not involved
- No involvement

**35) What is the role of your board or similar oversight body in making decisions about the following aspects of the system redesign? Please select all that apply.**

	Policy Guidance	Detailed Input	Final Approval	None	Not Yet Decided
Route recommendations	<input type="checkbox"/>				
System redesign vision	<input type="checkbox"/>				

Operating budgets	<input type="checkbox"/>				
Stakeholder involvement	<input type="checkbox"/>				
Capital improvements	<input type="checkbox"/>				
Capital budgets	<input type="checkbox"/>				
Federal/State compliance	<input type="checkbox"/>				
Equity considerations	<input type="checkbox"/>				
Marketing/branding	<input type="checkbox"/>				
Outreach	<input type="checkbox"/>				

**36) Is your board or similar oversight body actively supporting the system redesign through: (Please select all that apply.)**

- Political negotiations on behalf of the redesign
- Identifying funding for the redesign
- Public and political advocacy on behalf of the redesign
- Other - Please Specify: \_\_\_\_\_ \*
- None of the above

**37) What position/department will have the final say on what changes to bring to the Board or oversight agency for approval?**

---



---



---

**108** Synthesis on Comprehensive Bus Network Redesigns

**38) What role(s) are the departments of transportation or public works of the jurisdiction(s) in which the agency operates playing in the planning and implementation of the system redesign? Please select all that apply.**

- Service planning / route recommendations
- Planning and/or engineering for capital improvements (e.g., transit centers, TSP, bus lanes)
- Stakeholder level review and feedback
- Final approvals
- Very close collaboration with the transit agency
- Small part of the planning and implementation process
- No collaboration

**39) Have you brought your system redesign considerations to your board or similar oversight body?**

- Yes
- No

**40) What do you think is most likely to be the role of the board or oversight body in making decisions about the following aspects of the system redesign? Please select all that apply.**

	Policy Guidance	Detailed Input	Final Approval	None	Not Yet Decided
Route recommendations	<input type="checkbox"/>				
System redesign vision	<input type="checkbox"/>				
Operational restructuring	<input type="checkbox"/>				
Operating budgets	<input type="checkbox"/>				

Stakeholder involvement	<input type="checkbox"/>				
Capital improvements	<input type="checkbox"/>				
Capital budgets	<input type="checkbox"/>				
Federal/State compliance	<input type="checkbox"/>				
Equity considerations	<input type="checkbox"/>				
Marketing/branding	<input type="checkbox"/>				
Outreach	<input type="checkbox"/>				

**41) Is the board or oversight body actively supporting the system redesign considerations through: (Please select all that apply.)**

Holding discussions within the agency on behalf of the redesign

Identifying funding for the redesign

Other - Please Specify: \_\_\_\_\_\*

**42) If a system redesign is implemented, what position/department would be most likely to have the final say on what changes to bring to the Board or oversight agency for approval?**

---



---



---

**110** Synthesis on Comprehensive Bus Network Redesigns

**43) Before deciding not to redesign your bus network, did you bring your considerations to your board and/or state parent agency?**

- Yes  
 No

**44) Did the board and/or state parent agency support the system redesign concept?**

- Yes  
 No

**45) What position/department made the final decision not to proceed with a system redesign?**

---

---

---

**46) What reasons were given?**

---

---

---

---

## Redesign Components

**47) What metrics did you use / are you using during the planning process to assess possible impacts? Please select all that apply.**

- Service Area and Coverage, e.g., transit walkshed, service to key trip generators/facilities/places, service availability for different demographics
- Travel Time impacts, e.g., systemwide average transit travel time, number of trips by trip duration, average transit travel time by zone/district/neighborhood
- Cost Impacts
- Equity Impact
- Transfers, e.g., systemwide average transfer rate, number of trips by number of transfers
- Transit Usage, e.g., ridership, mode share
- Transit Accessibility, e.g., regional transit accessibility, jobs accessible within a specified time-frame
- Performance, e.g., predicted changes in on-time performance, average systemwide speed
- Other - Please Specify: \_\_\_\_\_ \*
- We did not use metrics to assess possible impacts of the plan

**48) Did any of the following impact bus system redesign decision-making? Please select all that apply.**

- Transportation Network Company (TNC) services (e.g. Uber, Lyft, etc.)
- Autonomous Vehicles (AV)
- Bike Share
- Other - Please Specify: \_\_\_\_\_ \*

**112** Synthesis on Comprehensive Bus Network Redesigns

**49) Do you anticipate that any of the following will impact potential bus system redesign decision-making? Please select all that apply.**

Transportation Network Company (TNC) services (e.g. Uber, Lyft, etc.)

Autonomous Vehicles (AV)

Bike Share

Other - Please Specify: \_\_\_\_\_ \*

**50) In what way (for Transportation Network Company (TNC) services)?**

---

---

---

---

**51) In what way (for Autonomous Vehicles (AV))?**

---

---

---

---

**52) In what way (for Bike Share)?**

---

---

---

---

**53) Did you involve/are you currently involving bus operator union leadership in the planning process?**

- Yes
- No
- Not applicable

**54) In what way?**

---

---

---

---

**55) Why not?**

---

---

---

---

**56) Did you directly involve/are you currently directly involving bus operators in the planning process?**

- Yes
- No

**57) In what way?**

---

---

---

---

**58) Why not?**

---

---

---

---

**59) Do you foresee yourself involving the bus operator union and/or bus operators in the planning process?**

- Yes  
 No

**60) At what point(s) in the process was the general public consulted for input? Please select all that apply.**

- At the visioning stage  
 After scenarios were developed (in initial draft form)  
 After scenarios were developed (in final draft form)  
 Immediately before the service change, after the plan was finalized, i.e., public hearing  
 Other - Please Specify: \_\_\_\_\_ \*

**61) At what point(s) in the process has or will the general public be consulted for input? Please select all that apply.**

- At the visioning stage  
 After scenarios were developed (in initial draft form)  
 After scenarios were developed (in final draft form)  
 Immediately before the service change, after the plan was finalized, i.e., public hearing  
 Other - Please Specify: \_\_\_\_\_ \*

**62) If your considerations for a system redesign proceed, at what point(s) in the process do you think the general public will be consulted for input? Please select all that apply.**

- At the visioning stage
- After scenarios were developed (in initial draft form)
- After scenarios were developed (in final draft form)
- Immediately before the service change, after the plan was finalized, i.e., public hearing
- Other - Please Specify: \_\_\_\_\_ \*

**63) What types of key stakeholders were involved and what was their role?**

- Input on visioning
- Input on draft recommendations
- Support publicizing changes
- N/A

**64) What types of key stakeholders will be or do you hope will be involved and what will be their role?**

- Input on visioning
- Input on draft recommendations
- support publicizing changes
- N/A

**65) How did you or how are you planning to gauge the redesign impacts on equity considerations? Please select all that apply.**

- Title VI service analysis during the planning process
- Title VI fare analysis during the planning process
- Other (e.g. access to jobs, walkshed to transit stops, coverage in low-demand but high need areas, etc.) - Please Specify: \_\_\_\_\_ \*

## 116 Synthesis on Comprehensive Bus Network Redesigns

**66) What technical tools were used / are being used / do you (or a consultant) anticipate using during the planning process? Please select all that apply.**

- Desktop geographic information system mapping tools (e.g., ESRI Arc GIS, QGIS)
- Web-based mapping software (e.g., Remix, Google Maps, Google Earth, etc.)
- Scheduling Software (e.g., Trapeze)
- Trip Planning Software
- Travel/Transit Modeling (e.g., Regional travel models, TBEST, Sugar Access, STOPS)
- Spreadsheet and Database software (e.g., Excel, Access, SQL)
- Data Analysis Tools (R, SAS, SPSS)
- Other - Please Specify: \_\_\_\_\_ \*

**67) What data sources were used/ are being used/ do you anticipate using during the planning processes? Please select all that apply.**

- Automatic Vehicle Location (AVL) Data
- Automatic Passenger Count (APC) Data
- Farebox Data
- General Transit Feed Specification (GTFS) Data
- American Community Survey / Decennial Census data
- Longitudinal Employer-Household Dynamics
- Travel Demand Model data / results
- Public comment data
- Passenger Surveys / On-board surveys
- Field surveys / data collection (ride checks, street observations, etc.)
- Other - Please Specify: \_\_\_\_\_ \*

**68) What community engagement strategies did you employ/ will you be employing? Please select all that apply.**

- Online software (e.g., mySidewalk, Ideascale)
- Online surveys (e.g., SurveyMonkey, Survey Gizmo, Google Forms)
- Stand-alone project website
- Project page on existing agency website
- On-board surveys
- Social media
- Community/public meetings
- Street/public space engagement (e.g., talking to riders at bus stops, or in parks)
- Event engagement (e.g., tabling at community or sporting events)
- In-person and/or phone meetings with key community stakeholders
- Recorded Announcements on buses
- Physical signage on buses
- Physical signage at bus stops or other agency property
- Paid Advertising
- Other - Please Specify: \_\_\_\_\_
- None

**69) What measures did your agency take to ready the agency for the redesign launch? Please select all that apply.**

- Organizational restructuring
- Launch preparation meetings
- Launch preparation print materials
- Hiring temporary staff
- Other - Please Specify: \_\_\_\_\_\*

**118** Synthesis on Comprehensive Bus Network Redesigns

**70) Please describe (for Organizational restructuring).**

---

---

---

**71) Please describe (for Launch preparation meetings).**

---

---

---

**72) Please describe (for Launch preparation print materials).**

---

---

---

**73) Please describe (for hiring temporary staff).**

---

---

---

## Operating Impacts

74) What was the impact of the system redesign on?

	Net neutral	More	Less
Service revenue hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Service revenue miles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bus fleet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Operators	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

75) What is the target/desired impact of the system redesign on?

	Net neutral	More	Less
Service revenue hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Service revenue miles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bus fleet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Operators	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**120** Synthesis on Comprehensive Bus Network Redesigns

**76) What additional changes were necessary after the redesign was first implemented? How did your agency identify and make those changes?**

---

---

---

**77) What were the key initiatives associated with implementing the plan and what initiatives were particularly successful (e.g. public education, training, internal communication strategies)? Would you have done anything differently in hindsight?**

---

---

---

---

## Costs and Funding

**78) How did your agency fund its system redesign planning efforts? (Please select all that apply.)**

- FTA funds  
 State formula or discretionary grants  
 Agency general funds  
 Other - Please Specify: \_\_\_\_\_

**79) Please Specify (for FTA funds)**

---

---

---

**80) Who did / is doing / will do the planning work?\***

- Agency staff only  
 Consultants only  
 A mix of consultants and agency staff  
 Undecided

**81) How was the planning work divided between agency staff and consultants?**

---

---

---

## 122 Synthesis on Comprehensive Bus Network Redesigns

**82) Approximately how much did the system redesign planning cost? Includes consultant costs for planning, modeling, data collection, public outreach, etc., up to the point of a final plan.**

- <\$50,000
- \$50,000 - \$100,000
- \$100,000 - \$500,000
- \$1 million to \$5 million
- Over \$5 million
- Unsure

**83) Approximately how many staff hours did the system redesign planning require? Includes time for planning, modeling, data collection, public outreach, etc., up to the point of a final plan. (One FTE for one year averages 2,000 hours)**

- <1,000
- 1,000 - 2,000
- 2,000 - 4,000
- 4,000 - 6,000
- >6,000
- Unsure

**84) Approximately how much did the system redesign implementation planning cost? Includes consultant costs for scheduling, public education, site planning / design for capital improvements, etc, up to the point of launch (excluding infrastructure or fleet investments).**

- <\$100,000
- \$100,000 - \$500,000
- \$500,000 - \$1 million
- \$1 million to \$5 million
- \$5 million to \$10 million
- Over \$10 million
- Unsure

**85) Approximately how many staff hours did the system redesign implementation planning require? Includes time for scheduling, public education, site planning / design for capital improvements, etc. up to the point of launch (excluding infrastructure or fleet investments).**

- <1,000
- 1,000 - 2,000
- 2,000 - 4,000
- 4,000 - 6,000
- >6,000
- Unsure

**86) How much do you anticipate that the system redesign planning will cost? Includes consultant costs for planning, modeling, data collection, public outreach, etc., up to the point of a final plan?**

- <\$50,000
- \$50,000 - \$100,000
- \$100,000 - \$500,000
- \$500,000 - \$1 million
- \$1 million to \$5 million
- Over \$5 million
- Unsure

**124** Synthesis on Comprehensive Bus Network Redesigns

**87) How many staff hours do you anticipate that the system redesign planning will require? Includes time for planning, modeling, data collection, public outreach, etc., up to the point of a final plan?**

- <1,000
- 1,000 - 2,000
- 2,000 - 4,000
- 4,000 - 6,000
- >6,000
- Unsure

**88) Did implementation of the redesign have or is anticipated to have an impact on the agency's annual operating costs?**

- Yes
- No

**89) Has or will the impact result in an increase or decrease in annual operating costs?**

- Increase
- Decrease

**90) Increase in costs by:**

- <5%
- 5%-10%
- >10%

**91) Decrease in costs by:**

- <5%
- 5%-10%
- >10%

**92) What funding sources were used / will be used to pay for the increased operating costs? Please select all that apply.**

- Fare increase / increased farebox recovery
- Reallocation of existing operating budget
- Local contributions
- Tax / dedicated funding source
- Other - Please Specify: \_\_\_\_\_ \*
- Unsure

**93) Were there capital costs associated with the system redesign?**

- Yes
- No

**94) What capital costs were associated with the system redesign? Please select all that apply.**

- Rolling stock/vehicles
- Passenger facilities (e.g., bus stops and amenities)
- Bus priority treatments (e.g., bus only lanes, transit signal-priority, bus bulbs)
- Bus stop signage
- Bus support facilities (e.g., bus garage or layover facility)
- Other - Please Specify: \_\_\_\_\_ \*

**95) Will there be or do you anticipate capital costs associated with the system redesign?**

- Yes
- No
- Unsure

**126** Synthesis on Comprehensive Bus Network Redesigns

**96) What capital costs will there be or that you anticipate with the system redesign? Please select all that apply.**

- Rolling stock/vehicles
- Passenger facilities, e.g., transit hubs
- Bus priority treatments
- Bus stop signage
- Bus support facilities, e.g., bus garage or layover facility
- Other - Please Specify

---

## Final Thoughts

**97) How has the performance of the system changed? Has ridership increased? Were goals and objectives met? (Please limit your response to a maximum of 250 words.)**

---

---

---

**98) Is there anything else you want to share about your system redesign process? Would you do anything differently? Describe the most important lesson learned. Please limit your response to a maximum of 250 words.**

---

---

---

Thank you for taking the survey! On the next page you will be able to review your responses. This survey has various skip logic questions, please do not be alarmed when you review your responses that some questions appear blank or repeated with slightly different language, your responses have been captured under the appropriate questions based on your previous responses.

---

## Thank You!

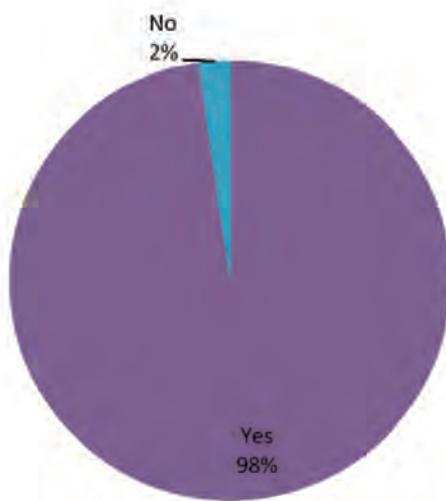
Thank you for taking our survey. Your response is very important to us. If you have any questions or comments, please feel free to contact at:

- E-mail: *Ibyala@foursquareitp.com*
  - Phone: (301) 774-4566
  - Mailing Address: 51 Monroe St #1103, Rockville, MD 20850
-

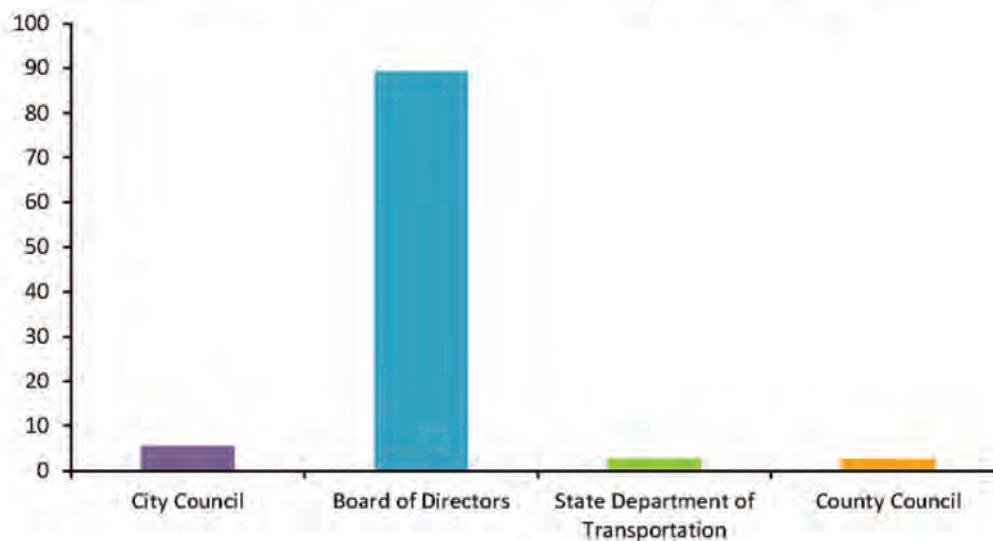
## APPENDIX C

## Survey Results

Does your agency have a Board of Directors and/or state parent agency (or similar oversight body)?

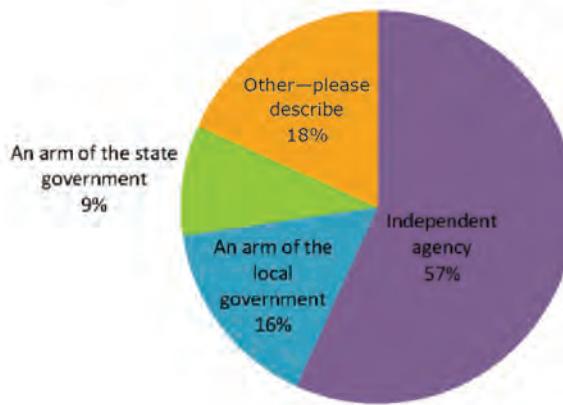


Please specify, e.g., governing board, city council, advisory board, etc.

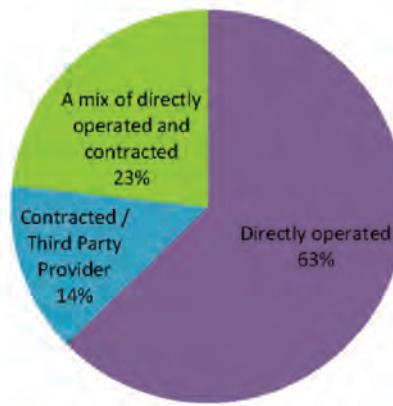


## 130 Synthesis on Comprehensive Bus Network Redesigns

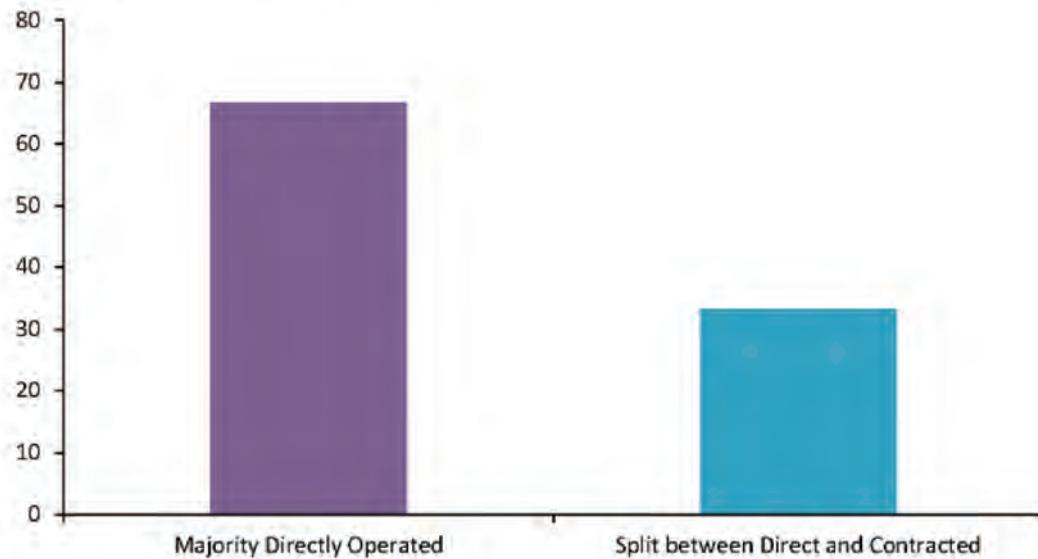
What is your transit agency's relationship with the area you serve?



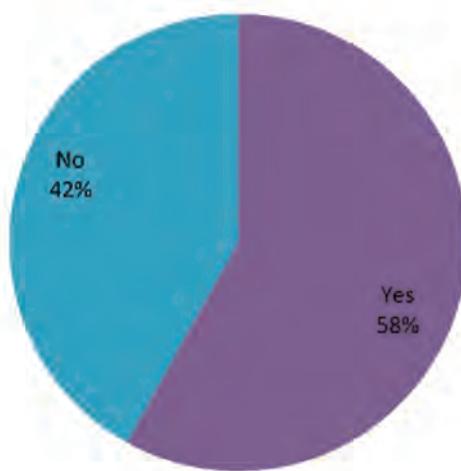
How is your fixed route bus service operated?



Please list and indicate their role(s)

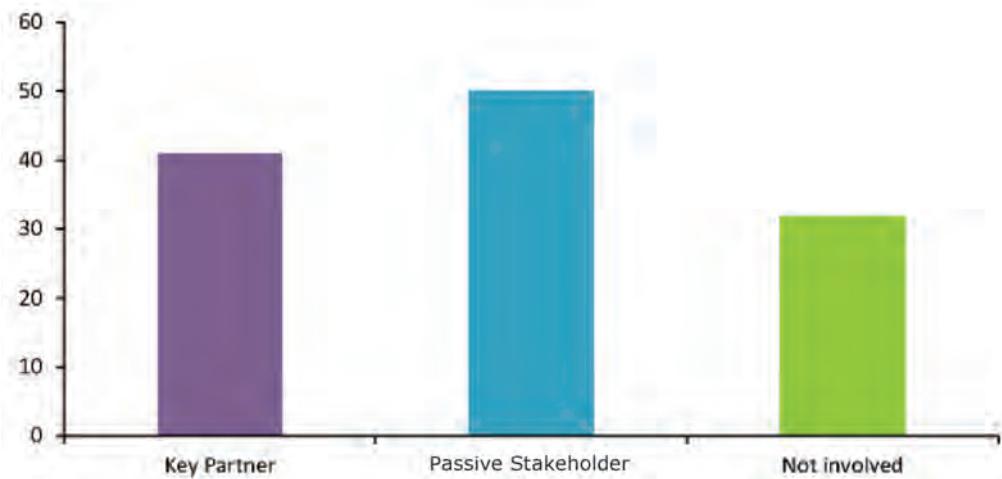


Are there other public or private agencies that operate fixed route bus service in your service area?

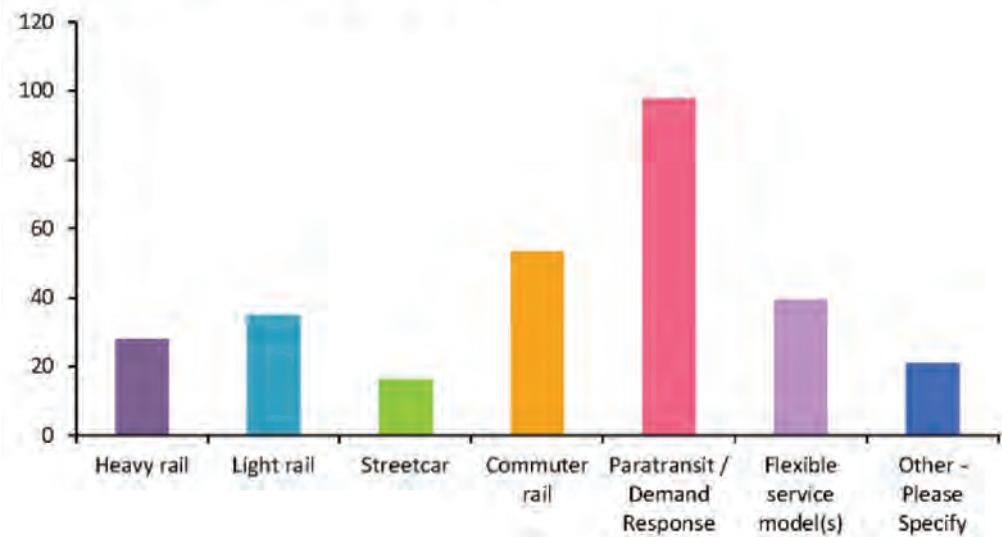


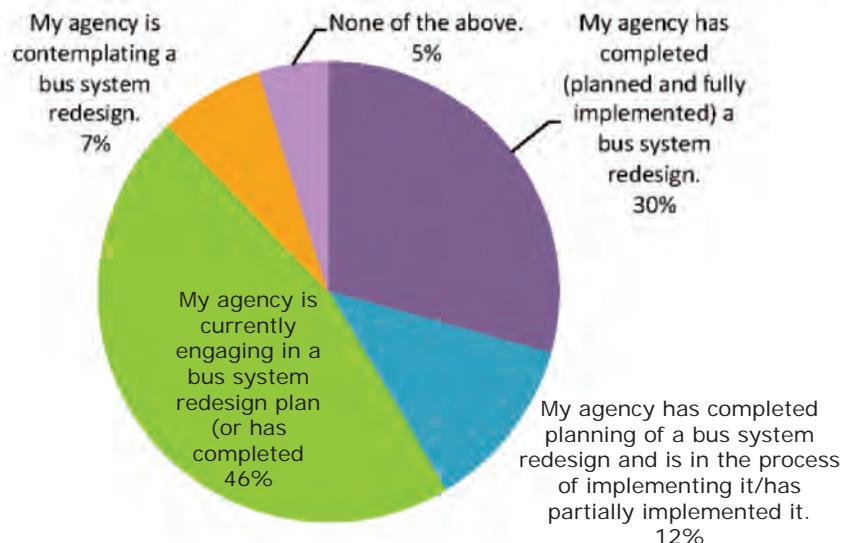
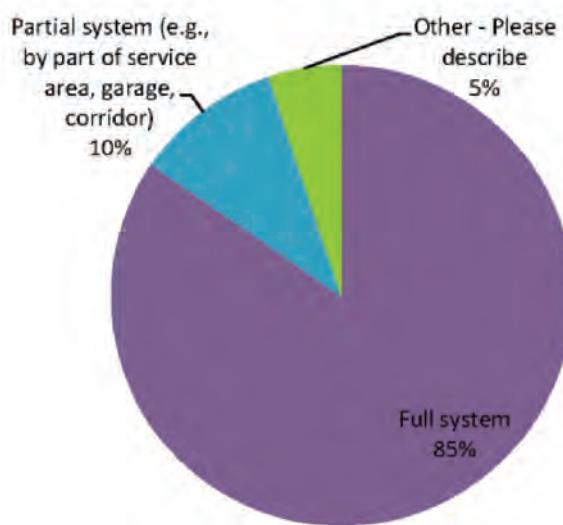
## 132 Synthesis on Comprehensive Bus Network Redesigns

Please list and indicate their involvement, e.g., key partner, passive stakeholder, not involved.



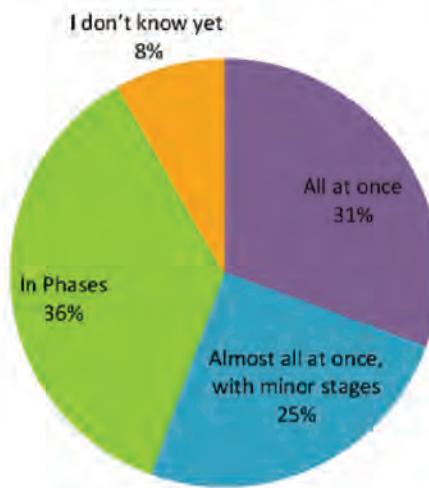
Within your bus network service area, are there other mass transit modes in operation? Please select all that apply.



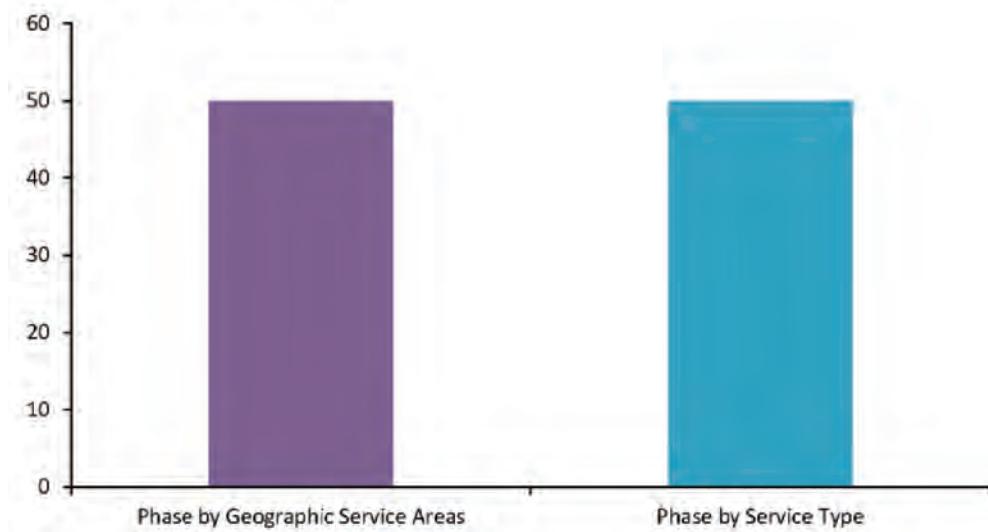
**Which of these statements best applies to your agency? In the past five years:****What is/was the scope of the bus system redesign?**

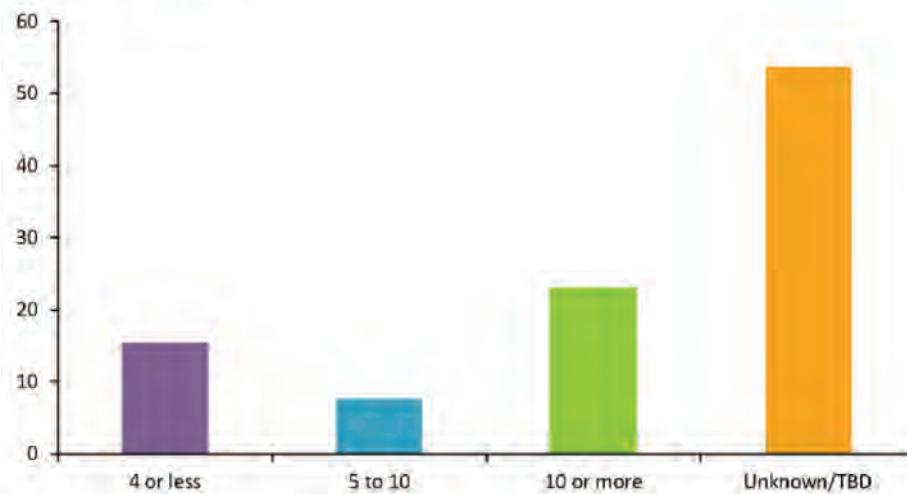
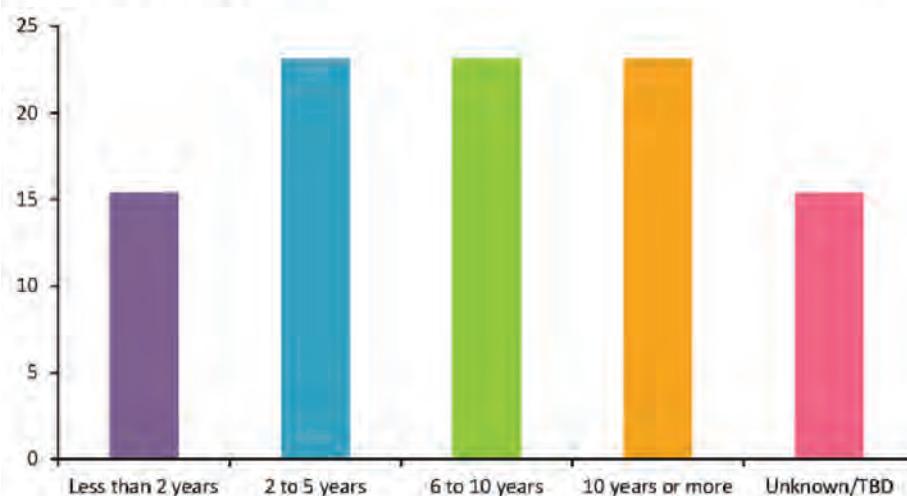
## 134 Synthesis on Comprehensive Bus Network Redesigns

**How did you implement/are you planning on implementing the redesigned system?**



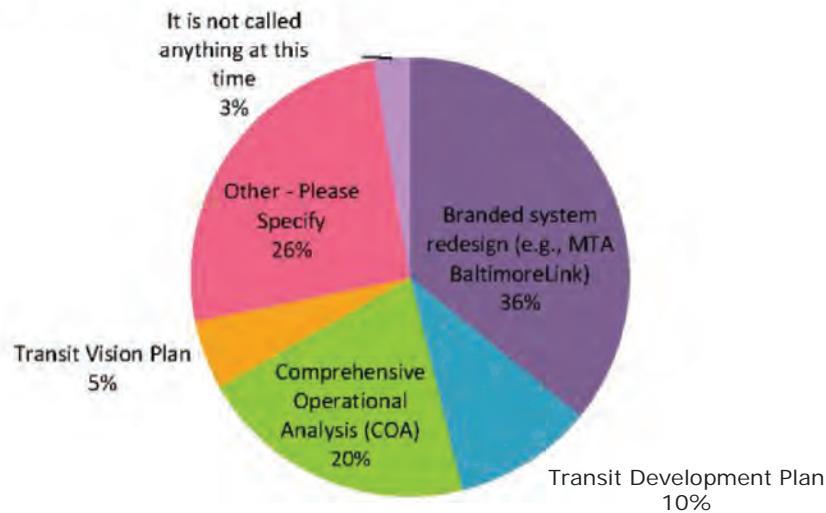
**What are the minor stages?**



**How many phases?****Over what period of time?**

## 136 Synthesis on Comprehensive Bus Network Redesigns

**What is the name of the process or program under which your bus system redesign was/is being executed or considered?**



**What are you/were you hoping to achieve through your bus system redesign?**

**Please rate the following Big Picture Objectives in terms of their importance to your agency's system redesign.**

	Very	Somewhat	Neutral	Low	N/A	Responses
Re-evaluate the "big picture" structure of the system	32	5	0	1	0	38
Increased operational efficiency and effectiveness	32	6	0	0	0	38
Adjust service levels to available resources	17	12	7	1	1	38
Adjust to other public transit investments (e.g., new rail line)	7	9	8	5	9	38
Adapt to changes resulting from new types of transportation options (e.g., TNCs, bike share)	7	12	8	9	2	38
Implement high-frequency / priority bus network	24	7	3	1	3	38

## 138 Synthesis on Comprehensive Bus Network Redesigns

	Very	Somewhat	Neutral	Low	N/A	Responses
Improve public image	18	14	5	1	0	38
Simplify the system for public ease-of-use	25	11	2	0	0	38
Improve rider satisfaction	31	7	0	0	0	38
Improve on-time performance and/or reliability	24	10	2	0	2	38
Attract choice riders	17	15	3	2	1	38
Better serve transit-dependent populations	19	15	1	3	0	38
Shift ridership to other modes	1	5	12	8	8	34
Increase ridership	29	5	2	0	1	37
Improve multi-modal connections	10	11	11	2	2	36
Long-term operating cost savings	5	11	11	6	5	38

	Very	Somewhat	Neutral	Low	N/A	Responses
Use new operating funding strategically	6	9	8	5	10	38
Increase service area (i.e., provide service in new jurisdiction(s))	3	6	6	16	7	38
Decrease service area (i.e., eliminate service in specific jurisdiction(s))	0	6	11	12	9	38
Adjust to moving/moved job centers	12	16	5	4	1	38
Adjust to moving/moved housing/population centers	12	18	6	1	1	38
Provide transportation alternatives to heavily congested automobile corridors	8	10	15	2	3	38
Other: Increase 7-day service	1	0	0	0	0	1
Other: Offer new service to the new BART stations	1	0	0	0	0	1
Other: Redistribute operating funds to capital needs	1	0	0	0	0	1

**140** Synthesis on Comprehensive Bus Network Redesigns

**What are you/were you hoping to achieve through your bus system redesign?**

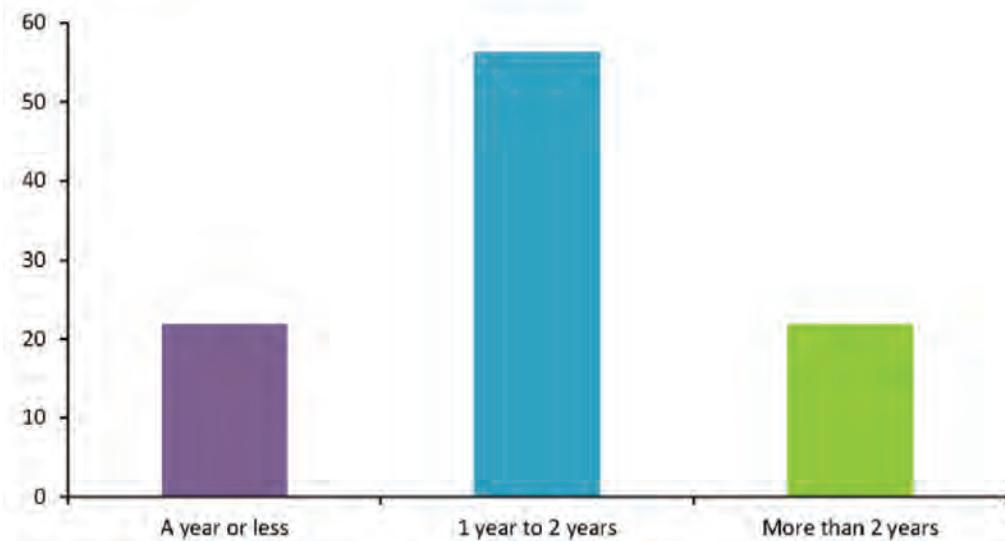
**Please rate the following Service Planning Objectives in terms of their importance to your agency's system redesign.**

	Very	Somewhat	Neutral	Low	N/A	Responses
Reduce travel times	21	15	2	0	0	38
Increase opportunity for transfers (e.g., transition from hub-and-spoke to grid network)	16	15	5	2	0	38
Reduce need for transfers	6	5	15	10	2	38
Expand coverage within service area	7	7	8	14	2	38
Decrease coverage within service area	0	11	15	9	3	38
Consolidate or modify service into new/moved transfer hubs/centers	11	13	8	3	3	38
Increase span of service	11	14	7	6	0	38

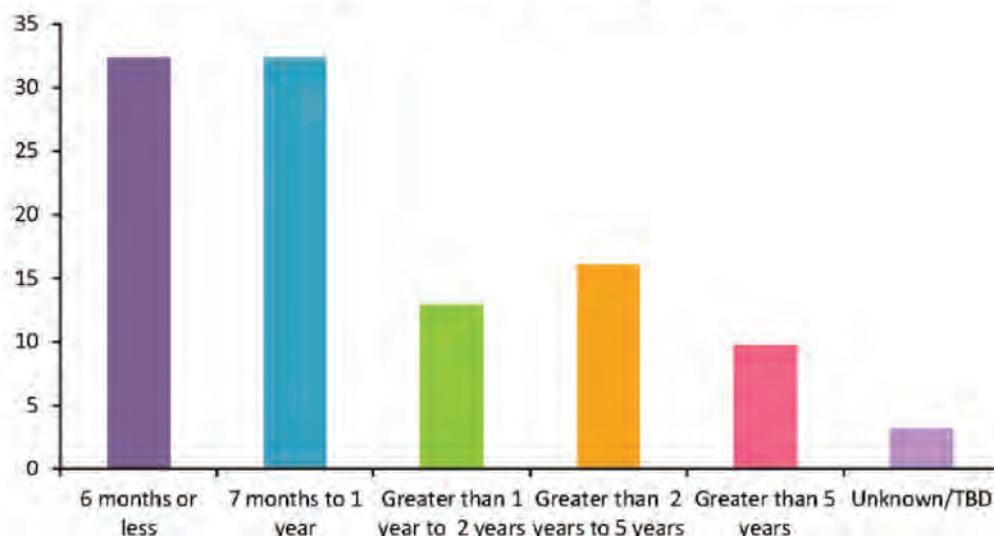
	Very	Somewhat	Neutral	Low	N/A	Responses
Increase weekend service	15	12	5	6	0	38
Increase revenue hours	8	8	17	4	1	38
Decrease revenue hours	1	0	17	12	8	38
Increase peak vehicle need	5	5	17	8	3	38
Decrease peak vehicle need	0	3	19	10	5	37
Increase frequency	30	6	2	0	0	38
Strategically apply service cuts (reduce frequency)	5	7	7	6	12	37

## 142 Synthesis on Comprehensive Bus Network Redesigns

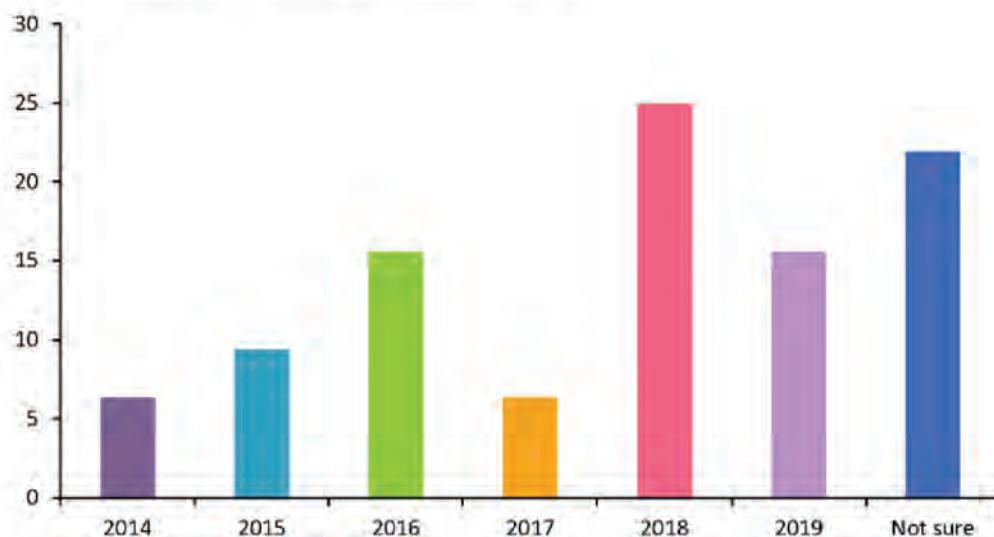
**How long did the process for planning the system redesign take/do you anticipate it to take from start (planning kick-off meeting) to completion (ready for scheduling) of the new plan?**



How long did the process take / do you anticipate it to take from plan completion (ready for scheduling) to implementation of redesigned system/routes?

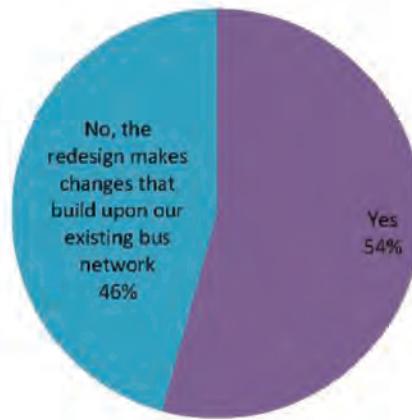


When was the system redesign implemented or when do you plan to implement the system redesign? Please provide a Month and Year or, if an implementation time frame has not been determined, enter not sure.

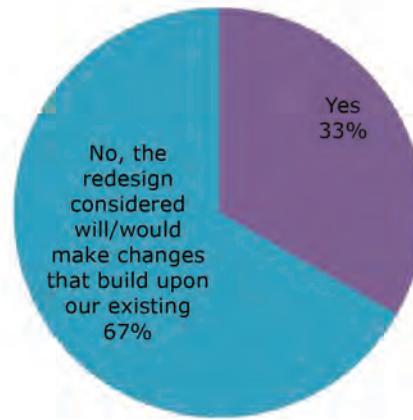


## 144 Synthesis on Comprehensive Bus Network Redesigns

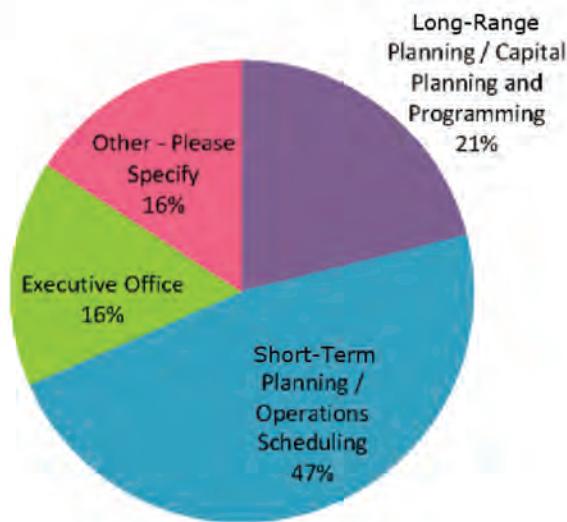
**Did you take / are you taking a "blank slate approach" to the system redesign, i.e., the planning process approach was to develop a bus network and routes from the ground up rather than tweaking existing routes.**



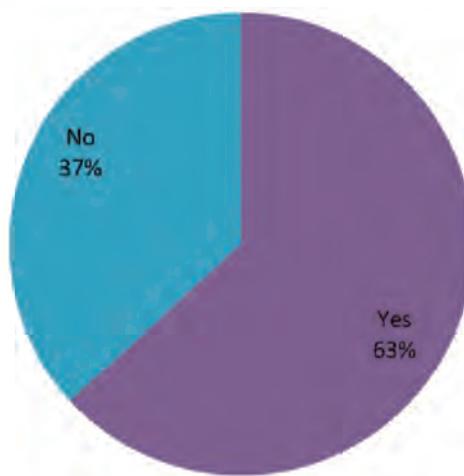
**Are you considering / did you consider a blank slate approach to the system redesign?**



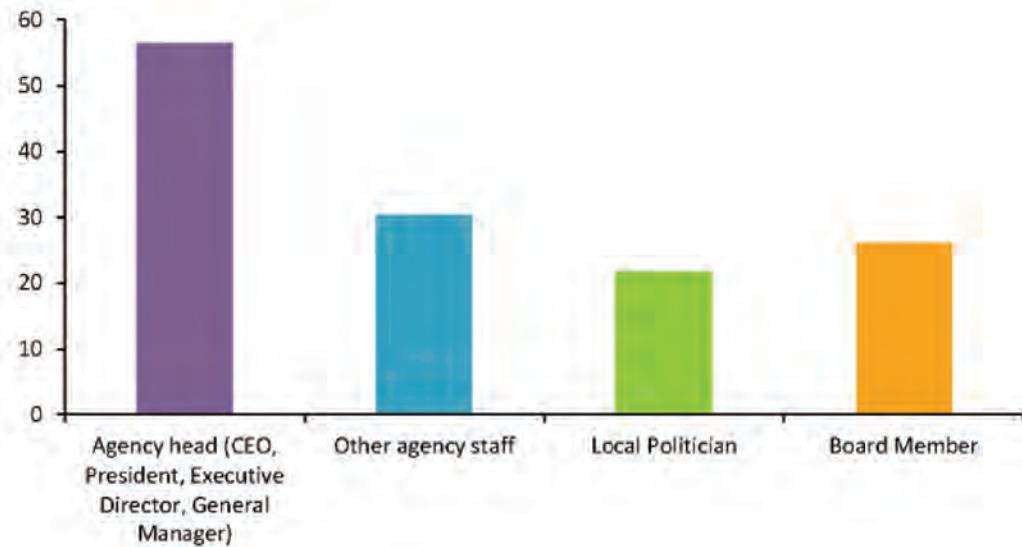
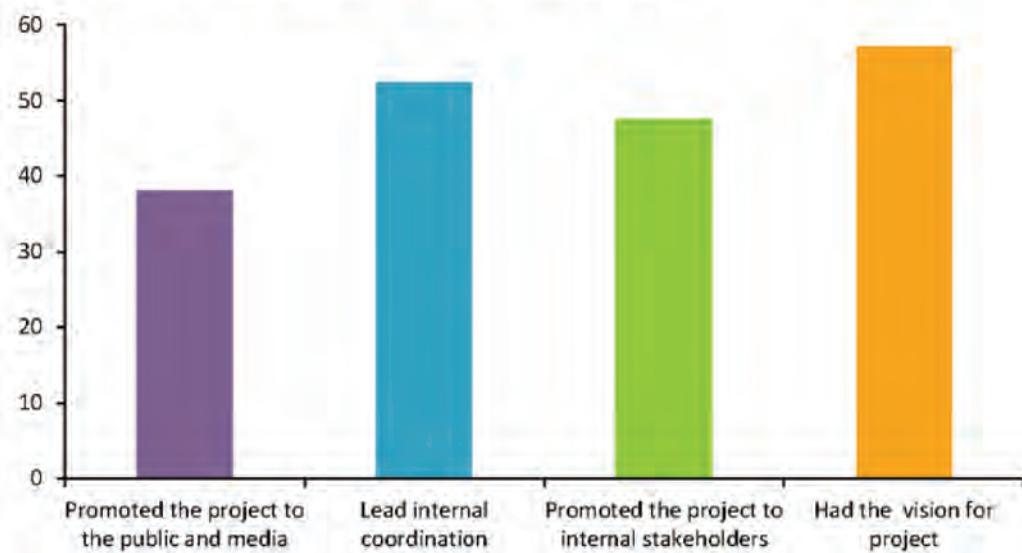
What agency department or staff is taking / took the lead role on the system redesign or redesign consideration (choose the one that best describes the department or staff)?



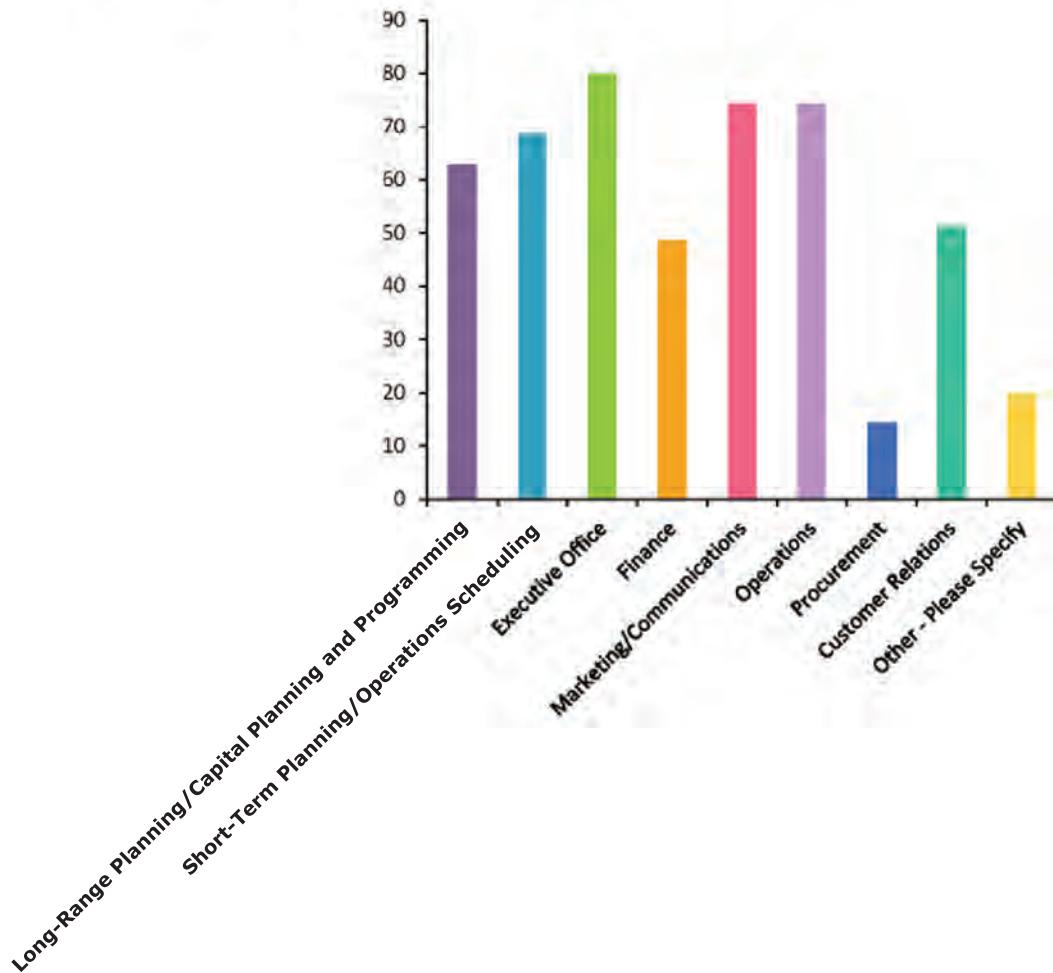
Is there / was there a champion (or champions) of the effort within the agency, government, board, etc.?



## 146 Synthesis on Comprehensive Bus Network Redesigns

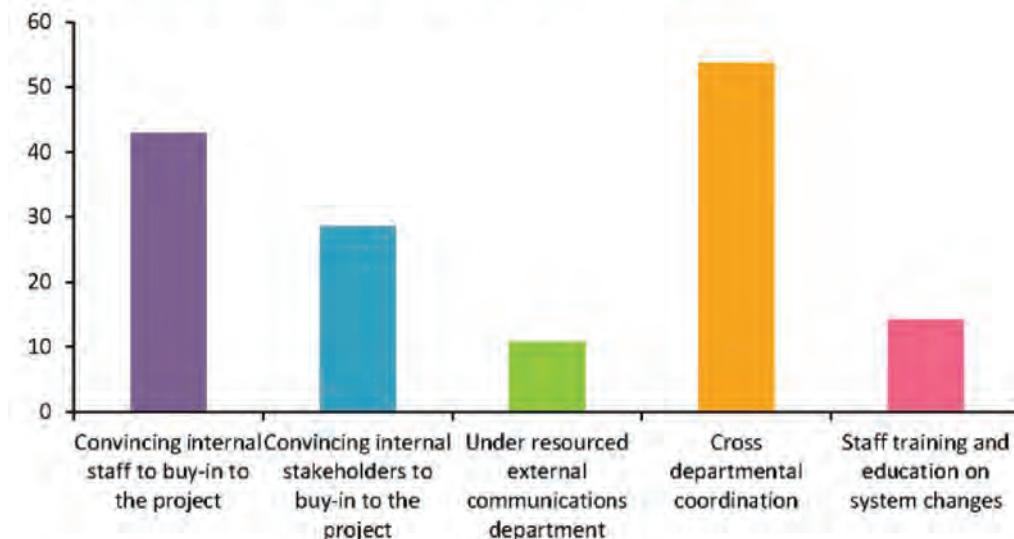
**What is/was their organization and title?****In what way(s) did this person champion the redesign?**

What other transit agency departments are playing / played significant roles, meaning that they were a key part of the effort involved during all or most of the process? Please select all that apply.

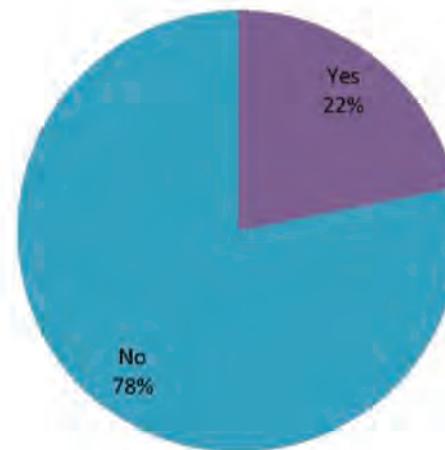


## 148 Synthesis on Comprehensive Bus Network Redesigns

**What internal communication or coordination challenges are you experiencing / did you experience and how are you / did you address them?**



**Has the system redesign planning and, if applicable, implementation, led to any agency restructuring of departments or a reallocation of duties?**

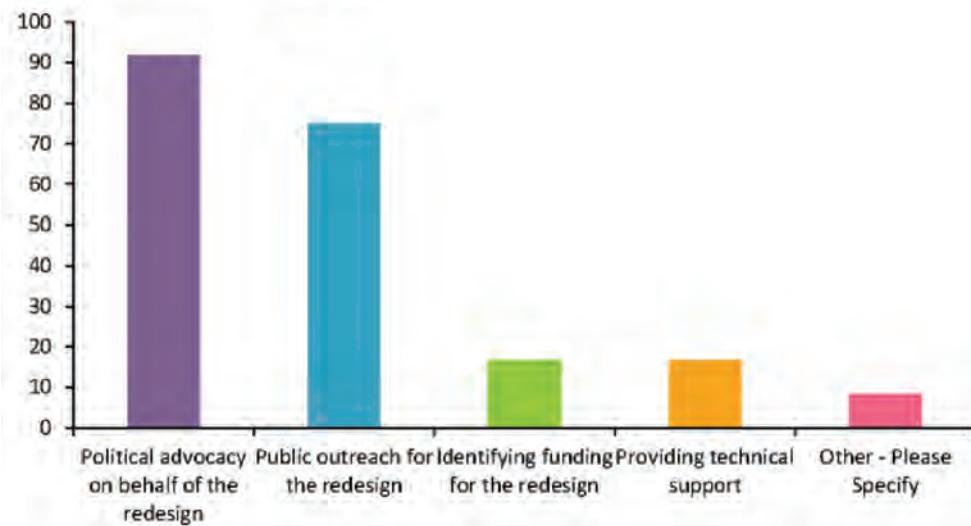


What was the role of your Board or similar oversight body in making decisions about the following aspects of the system redesign? Please select all that apply.

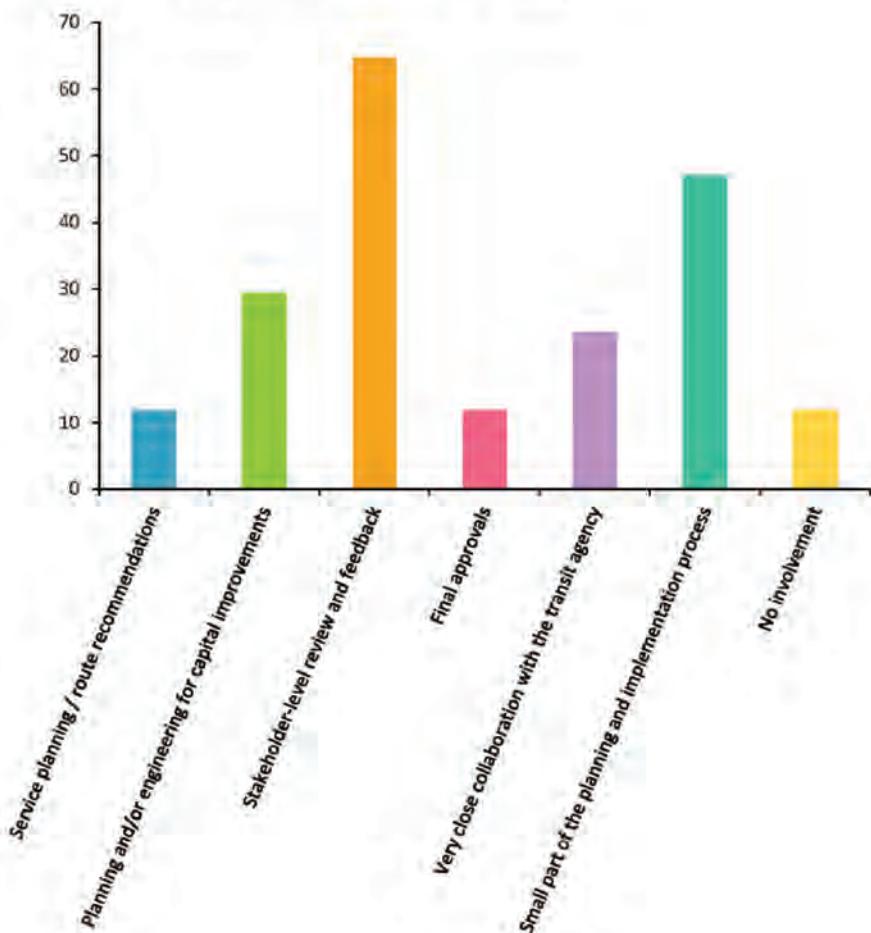
	Policy Guidance	Detailed Input	Final Approval	None	Other	Total Checks
Route recommendations	12	5	14	0	0	31
System redesign vision	15	3	9	1	1	29
Operational restructuring	8	3	5	6	0	22
Operating budgets	9	1	13	0	0	23
Stakeholder involvement	11	6	4	0	2	23
Capital improvements	8	1	10	3	1	23
Capital budgets	7	1	12	2	1	23
Federal/State compliance	7	0	5	7	1	20
Equity considerations	10	3	11	1	0	25
Marketing/branding	4	3	5	7	0	19
Community Outreach	10	5	3	1	2	21
Total Checks	101	31	91	28	8	259

**150** Synthesis on Comprehensive Bus Network Redesigns

**Did the Board or similar oversight body support the system redesign through:**  
**(Please select all that apply.)**



What role(s) did the departments of transportation or public works of the jurisdiction(s) in which the agency operates play in the planning and implementation of the system redesign? Please select all that apply.

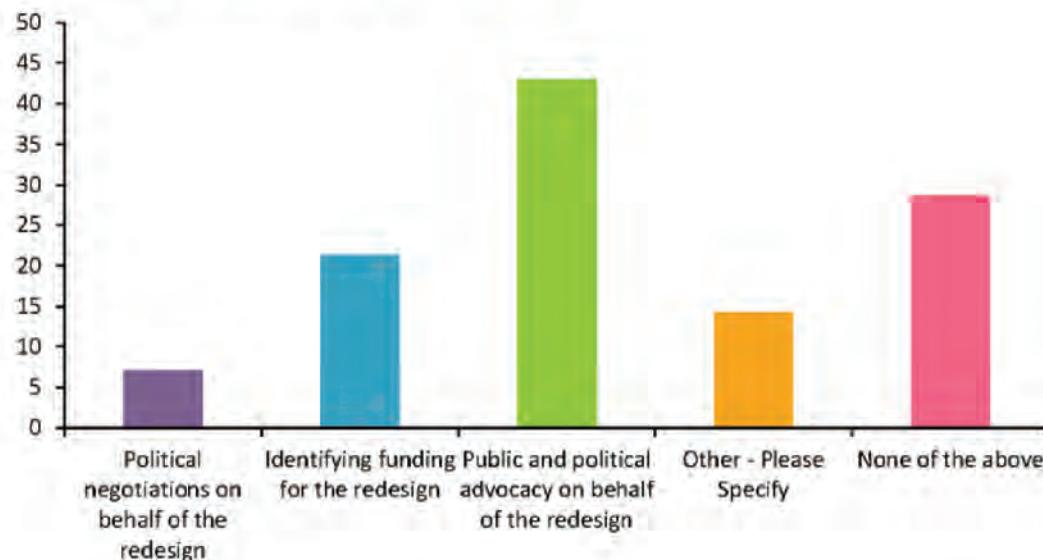


## 152 Synthesis on Comprehensive Bus Network Redesigns

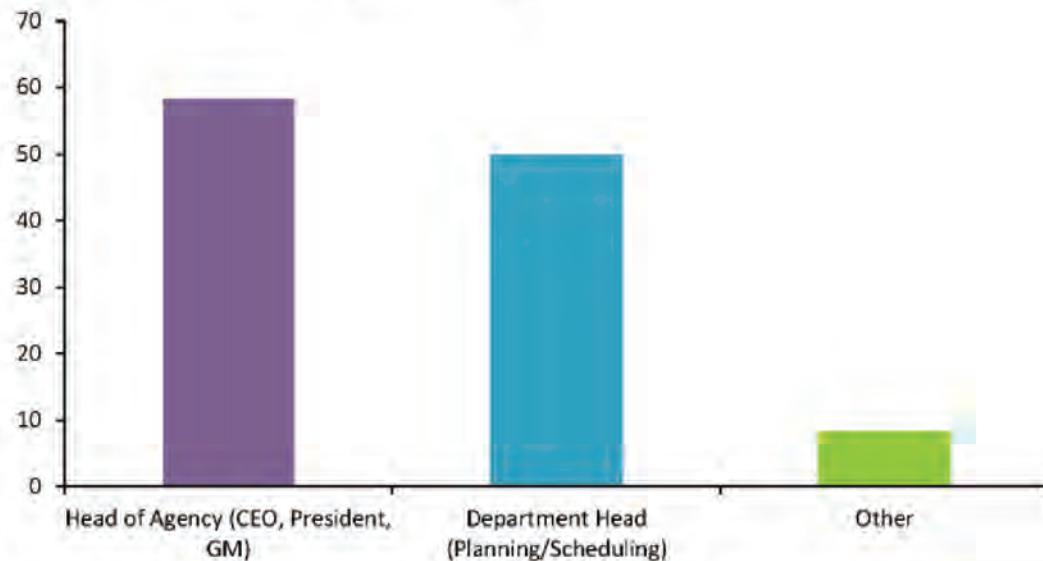
**What is the role of your board or similar oversight body in making decisions about the following aspects of the system redesign? Please select all that apply.**

	Policy Guidance	Detailed Input	Final Approval	None	Not Yet Decided	Total Checks
Route recommendations	5	2	10	3	1	21
System redesign vision	10	2	9	2	2	25
Operating budgets	4	3	11	1	2	21
Stakeholder involvement	7	3	2	3	3	18
Capital improvements	6	0	8	2	3	19
Capital budgets	3	1	9	2	3	18
Federal/State compliance	2	0	5	7	3	17
Equity considerations	10	1	6	2	1	20
Marketing/branding	5	0	3	7	2	17
Outreach	6	1	4	4	2	17
Total Checks	58	13	67	33	22	193

Is your board or similar oversight body actively supporting the system redesign through: (Please select all that apply.)

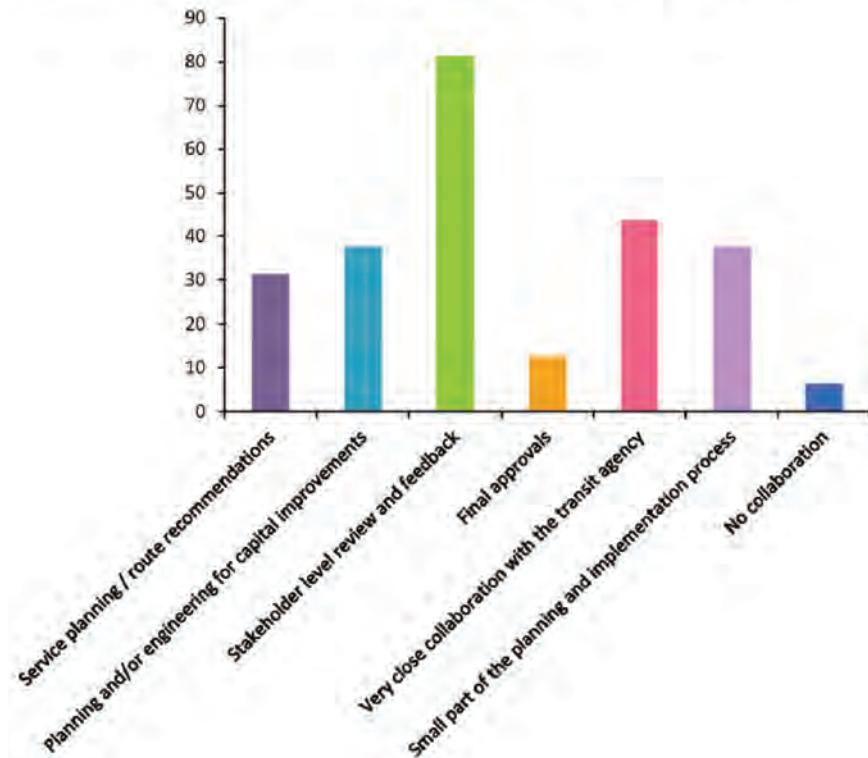


What position/department will have the final say on what changes to bring to the Board or oversight agency for approval?

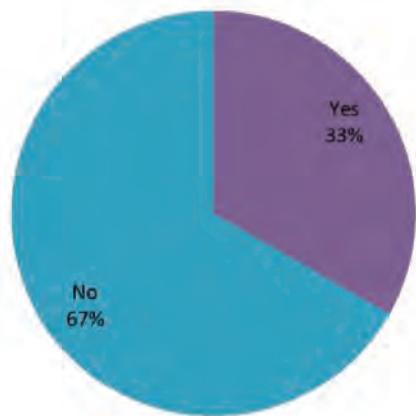


## 154 Synthesis on Comprehensive Bus Network Redesigns

**What role(s) are the departments of transportation or public works of the jurisdiction(s) in which the agency operates playing in the planning and implementation of the system redesign? Please select all that apply.**



Have you brought your system redesign considerations to your board or similar oversight body?

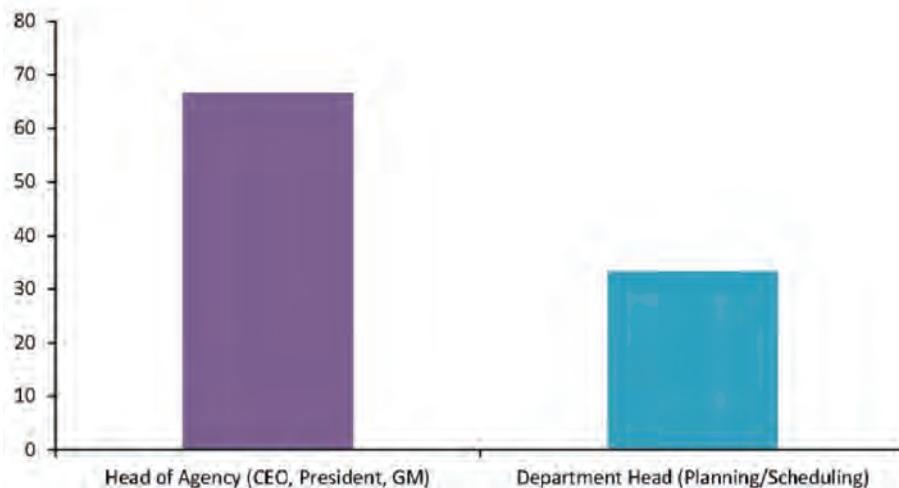


## 156 Synthesis on Comprehensive Bus Network Redesigns

**What do you think is most likely to be the role of the board or oversight body in making decisions about the following aspects of the system redesign? Please select all that apply.**

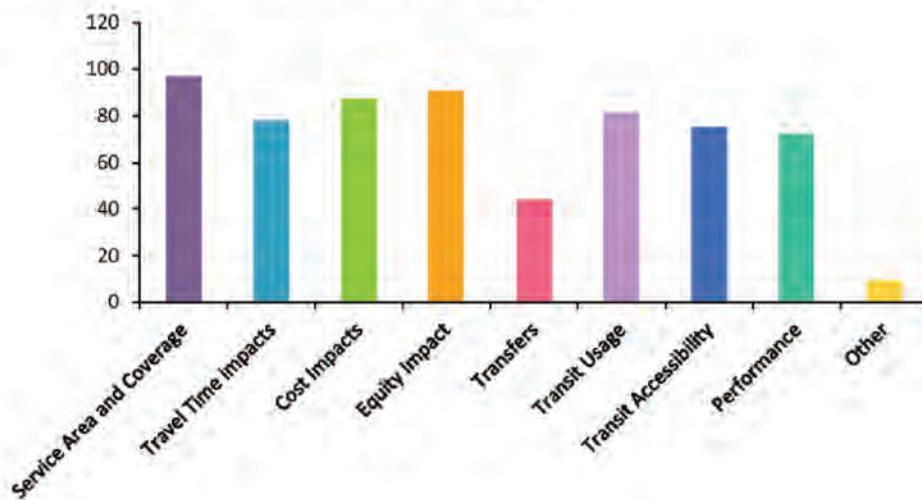
	Policy Guidance	Detailed Input	Final Approval	None	Not Yet Decided	Total Checks
Route recommendations	0	0	1	0	0	1
System redesign vision	1	0	0	0	0	1
Operational restructuring	1	0	0	0	0	1
Operating budgets	0	0	1	0	0	1
Stakeholder involvement	1	0	0	0	0	1
Capital improvements	0	0	1	0	0	1
Capital budgets	0	0	1	0	0	1
Federal/State compliance	0	0	0	0	1	1
Equity considerations	1	0	0	0	0	1
Marketing/branding	1	0	0	0	0	1
Outreach	1	0	0	0	0	1
Total Checks	6	0	4	0	1	11

If a system redesign is implemented, what position/department would be most likely to have the final say on what changes to bring to the Board or oversight agency for approval?

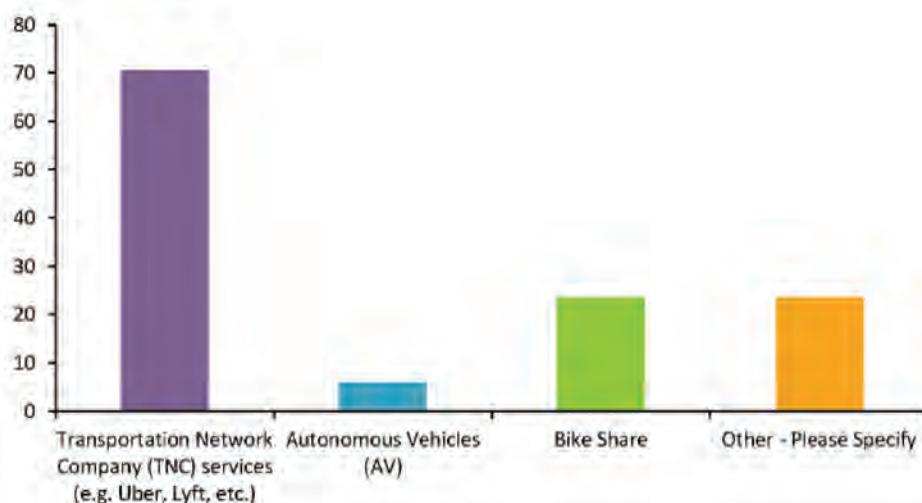


## 158 Synthesis on Comprehensive Bus Network Redesigns

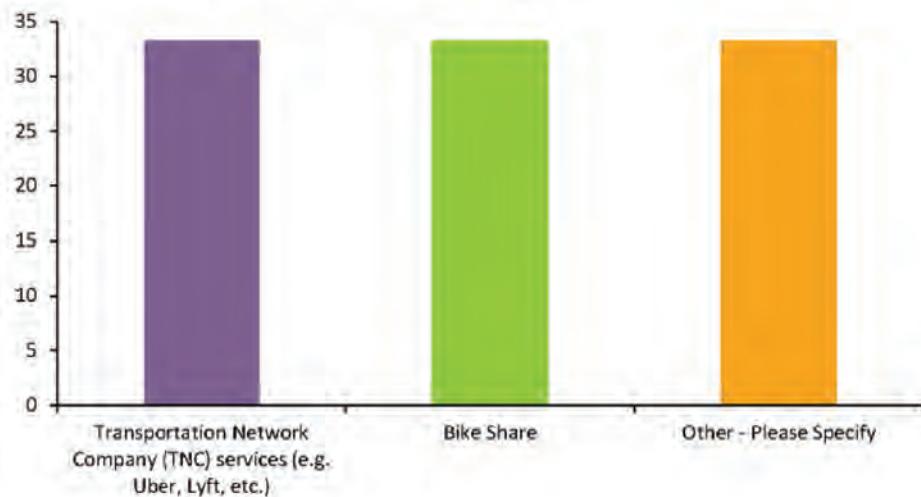
**What metrics did you use / are you using during the planning process to assess possible impacts? Please select all that apply.**



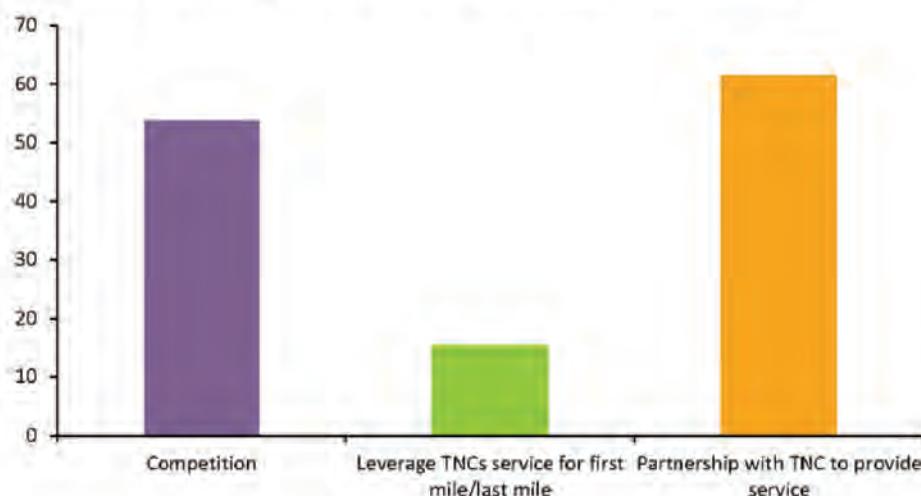
**Did any of the following impact bus system redesign decision-making? Please select all that apply.**



**Do you anticipate that any of the following will impact potential bus system redesign decision-making? Please select all that apply.**

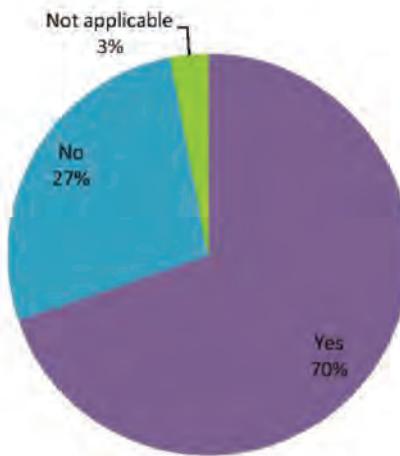


**In what way (for Transportation Network Company (TNC) services)?**

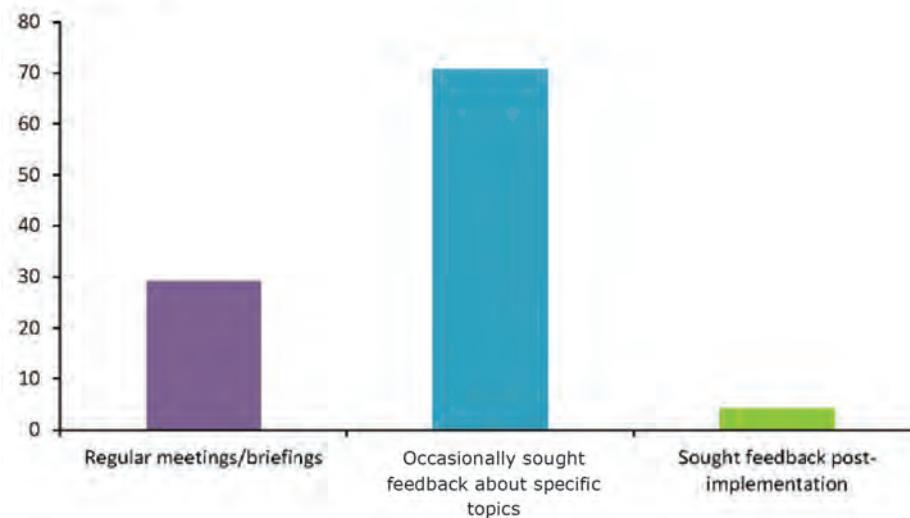


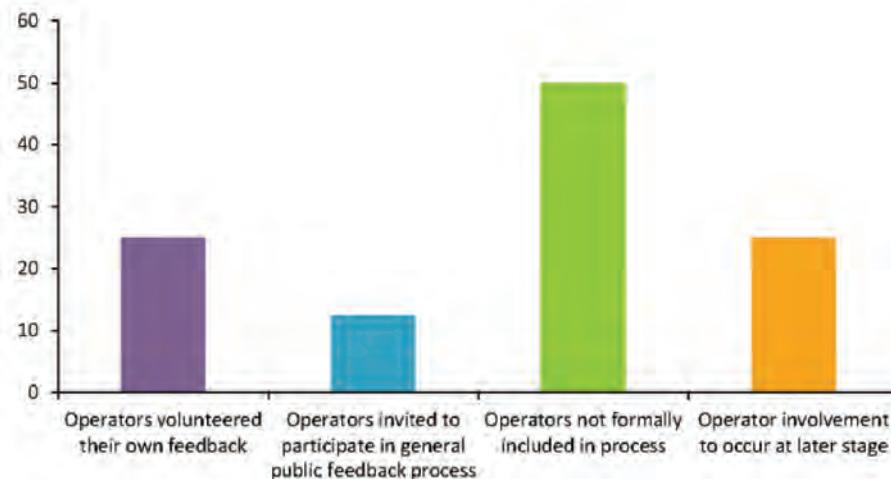
## 160 Synthesis on Comprehensive Bus Network Redesigns

**Did you involve/are you currently involving bus operator union leadership in the planning process?**

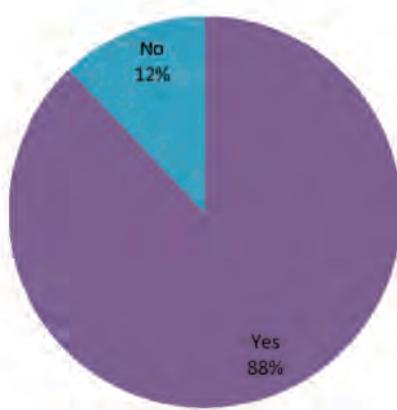


**In what way?**

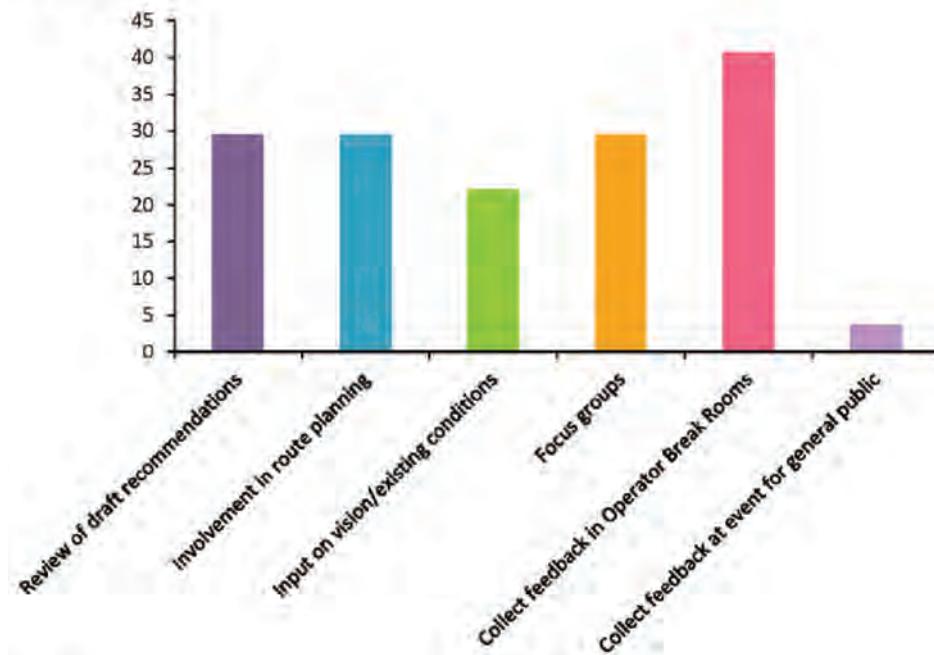
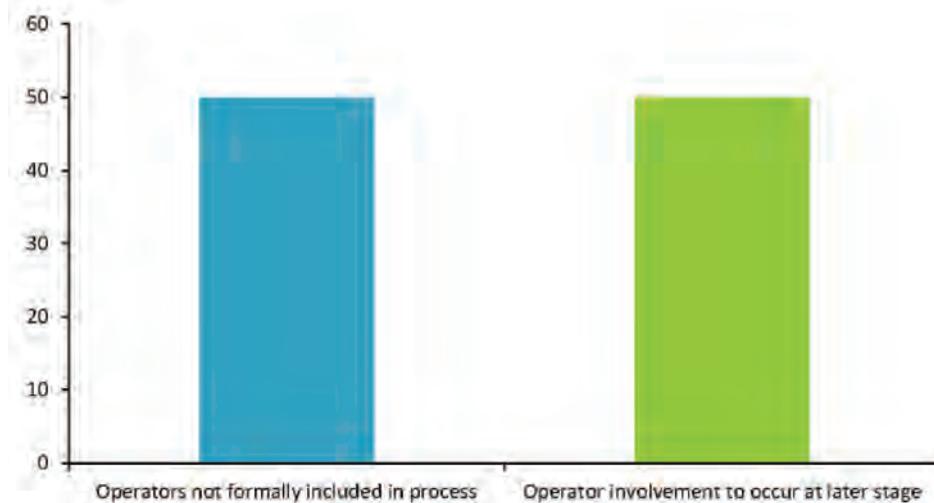


**Why not?**

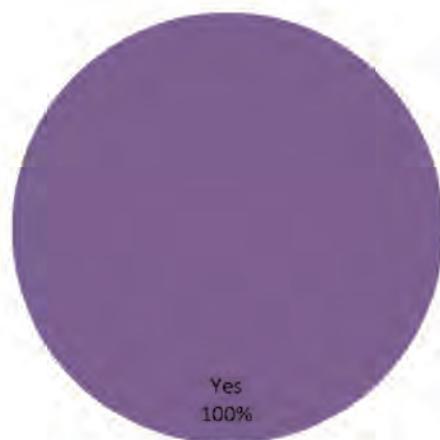
**Did you directly involve/are you currently directly involving bus operators in the planning process?**



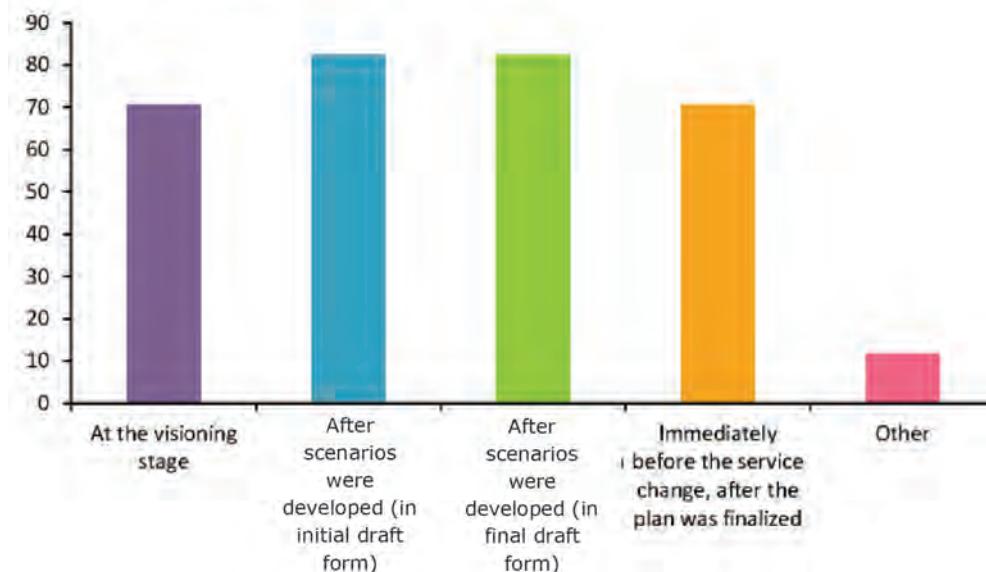
## 162 Synthesis on Comprehensive Bus Network Redesigns

**In what way?****Why not?**

Do you foresee yourself involving the bus operator union and/or bus operators in the planning process?



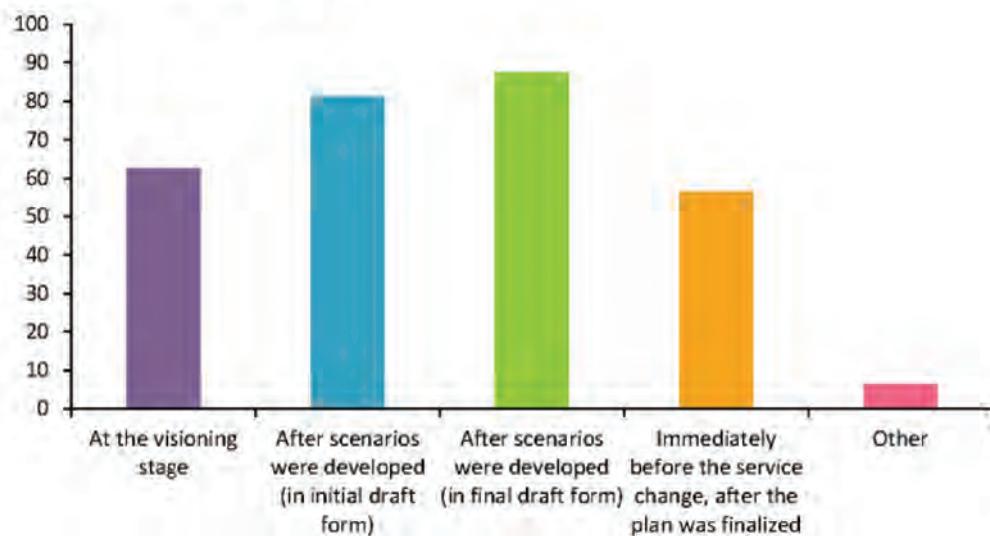
At what point(s) in the process was the general public consulted for input? Please select all that apply.



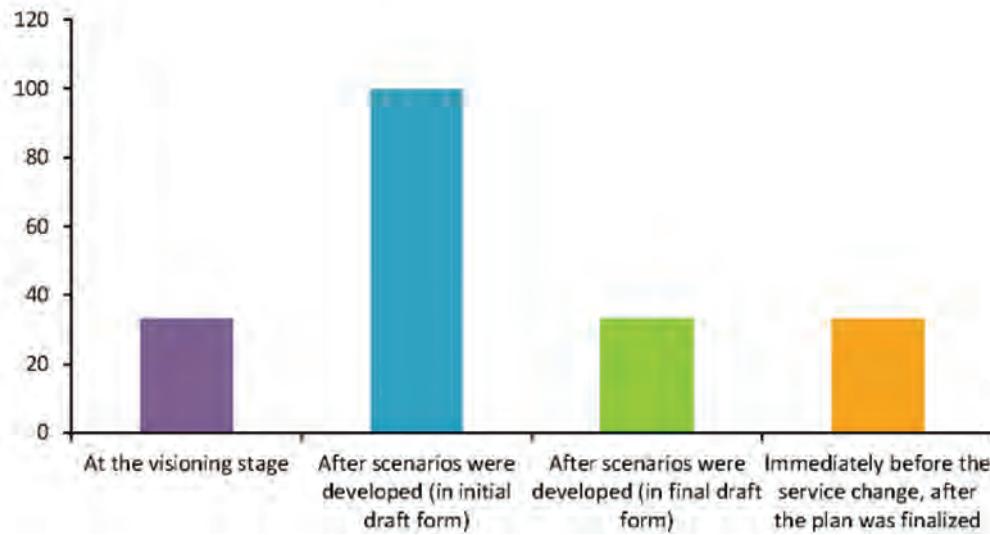
## 164 Synthesis on Comprehensive Bus Network Redesigns

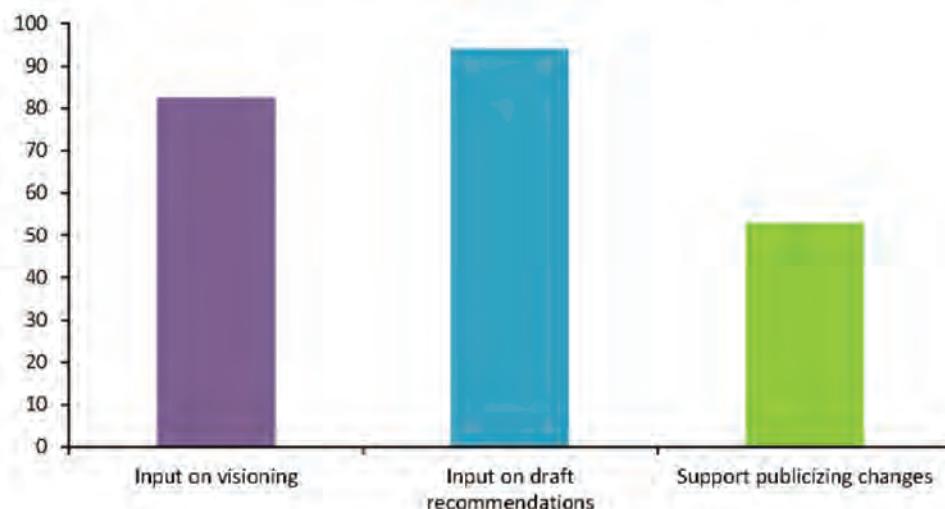
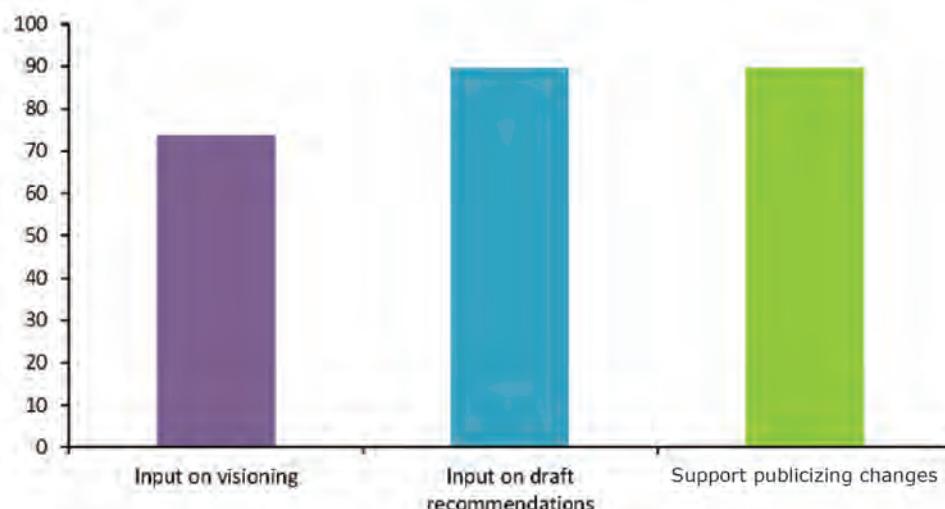
At what point(s) in the process has or will the general public be consulted for input?

Please select all that apply.



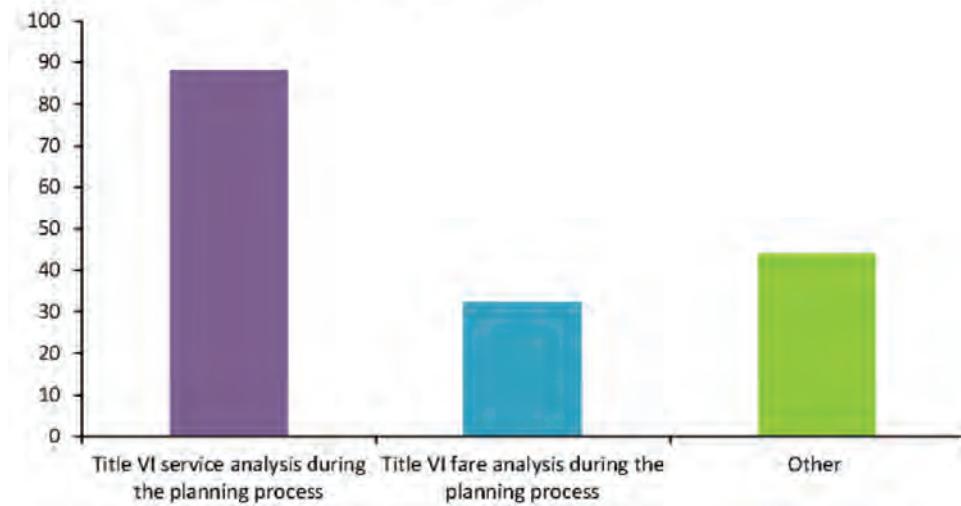
If your considerations for a system redesign proceed, at what point(s) in the process do you think the general public will be consulted for input? Please select all that apply.



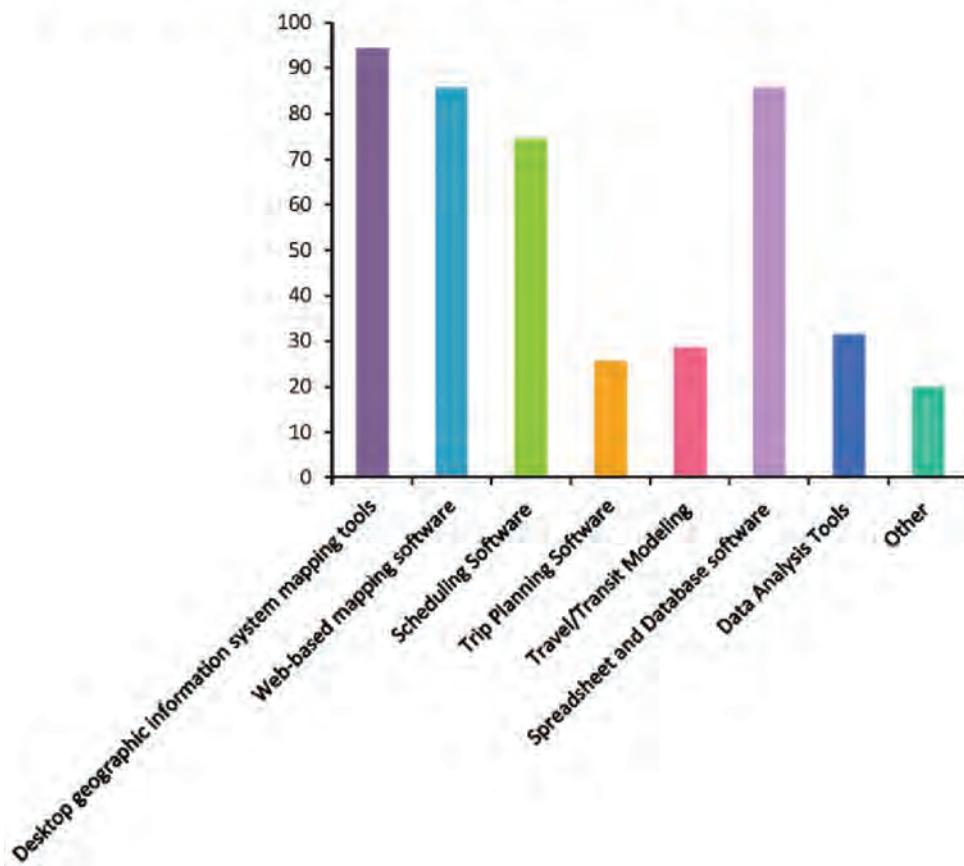
**What types of key stakeholders were involved and what was their role?****What types of key stakeholders will be or do you hope will be involved and what will be their role?**

**166** Synthesis on Comprehensive Bus Network Redesigns

**How did you or how are you planning to gauge the redesign impacts on equity considerations? Please select all that apply.**

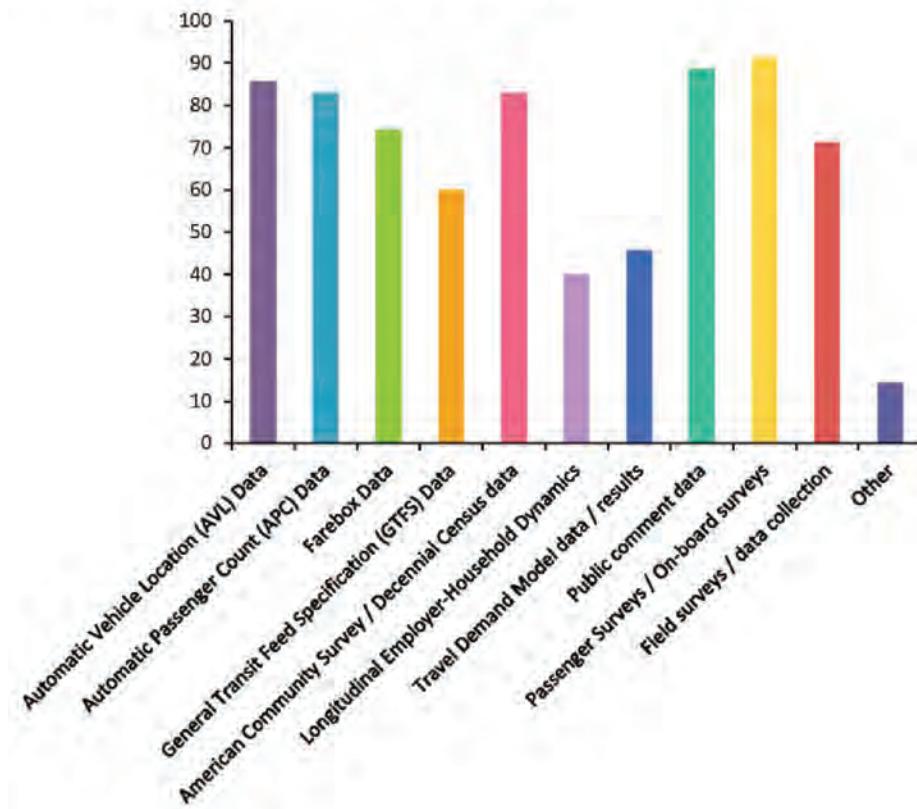


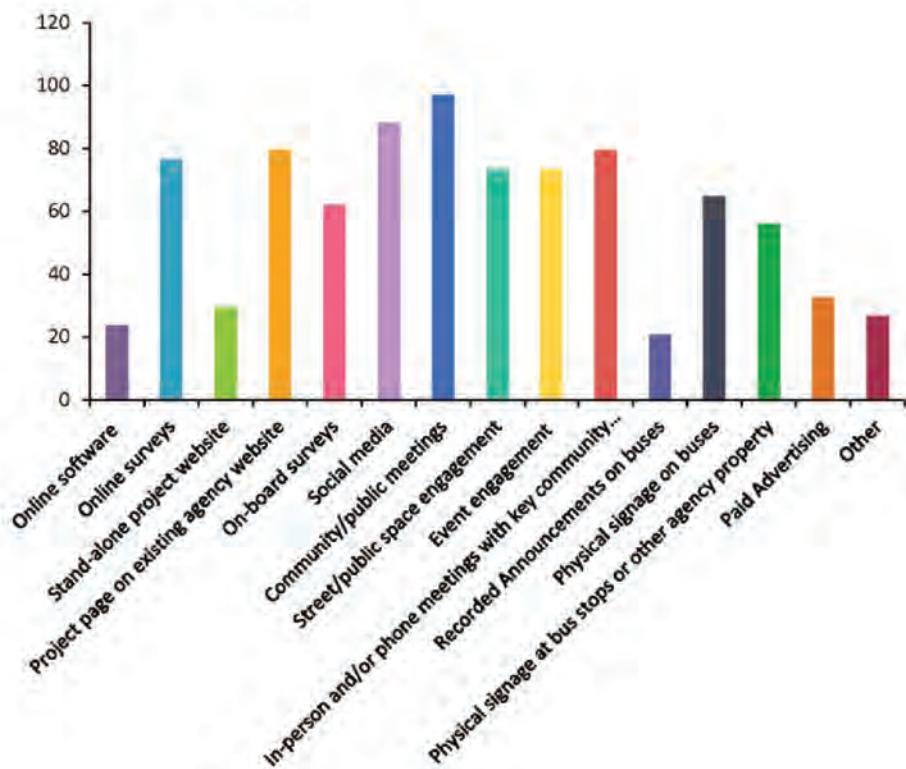
What technical tools were used / are being used / do you (or a consultant) anticipate using during the planning process? Please select all that apply.

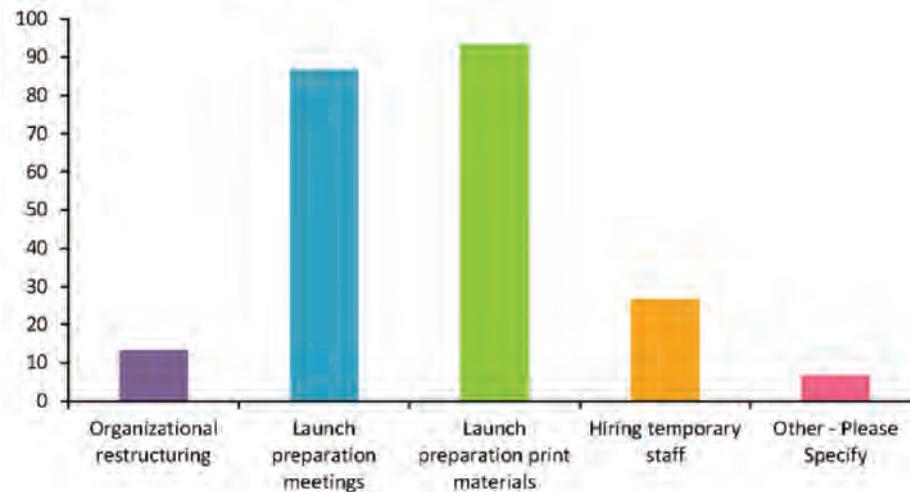
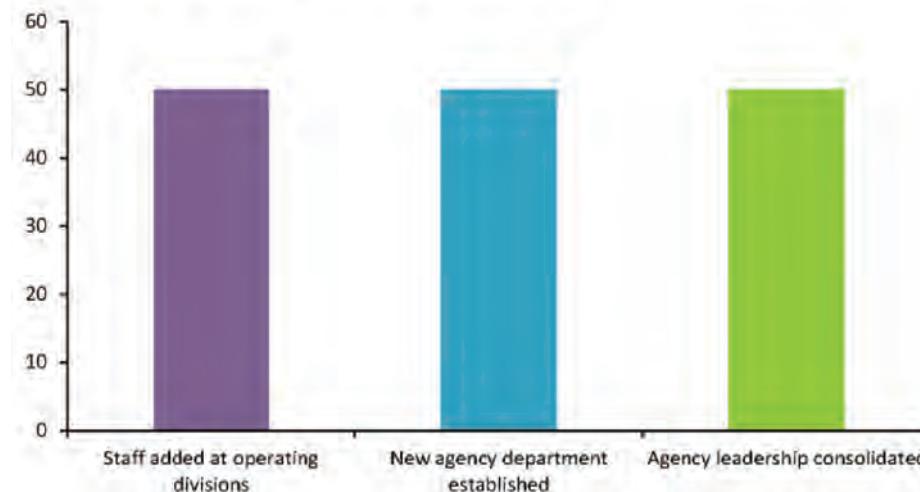


## 168 Synthesis on Comprehensive Bus Network Redesigns

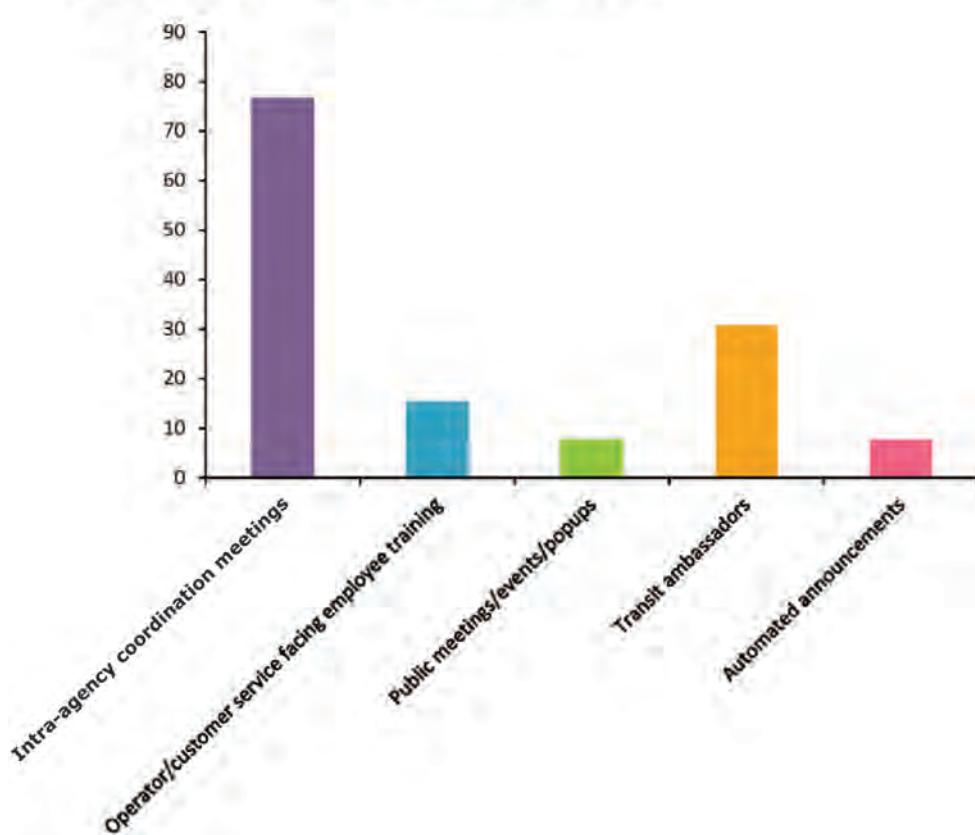
**What data sources were used/ are being used/ do you anticipate using during the planning processes? Please select all that apply.**



**What community engagement strategies did you employ/ will you be employing?****Please select all that apply.**

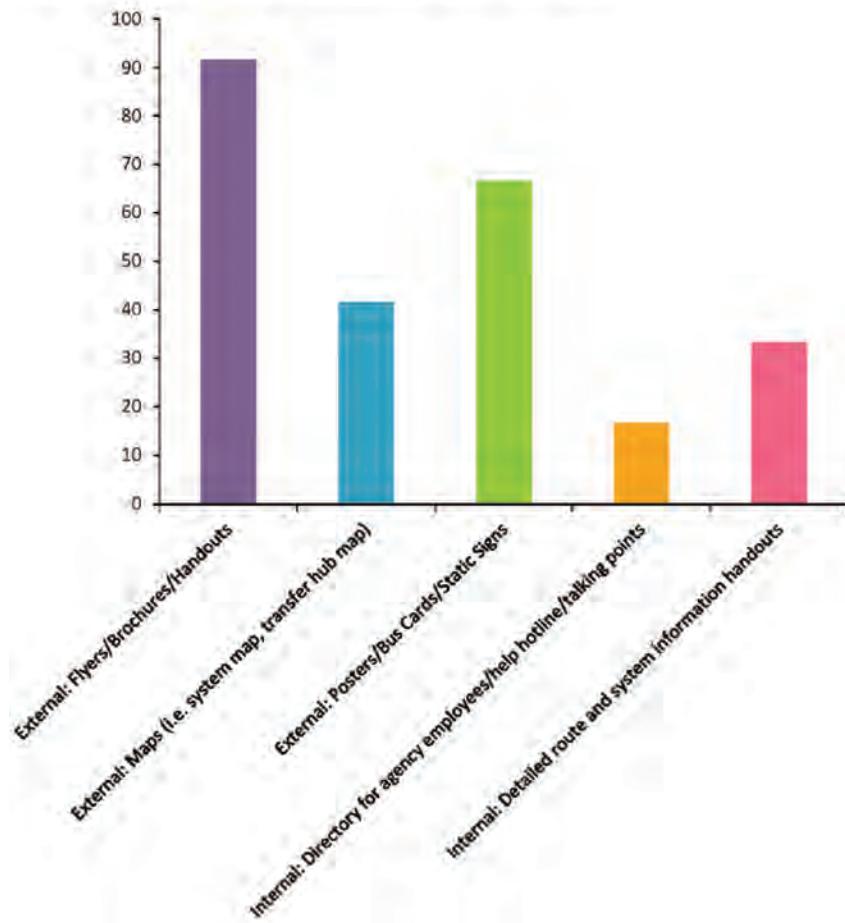
**170** Synthesis on Comprehensive Bus Network Redesigns**What measures did your agency take to ready the agency for the redesign launch?****Please select all that apply.****Please describe (for Organizational restructuring).**

Please describe (for Launch preparation meetings).



## 172 Synthesis on Comprehensive Bus Network Redesigns

Please describe (for Launch preparation print materials).



**What was the impact of the system redesign on?**

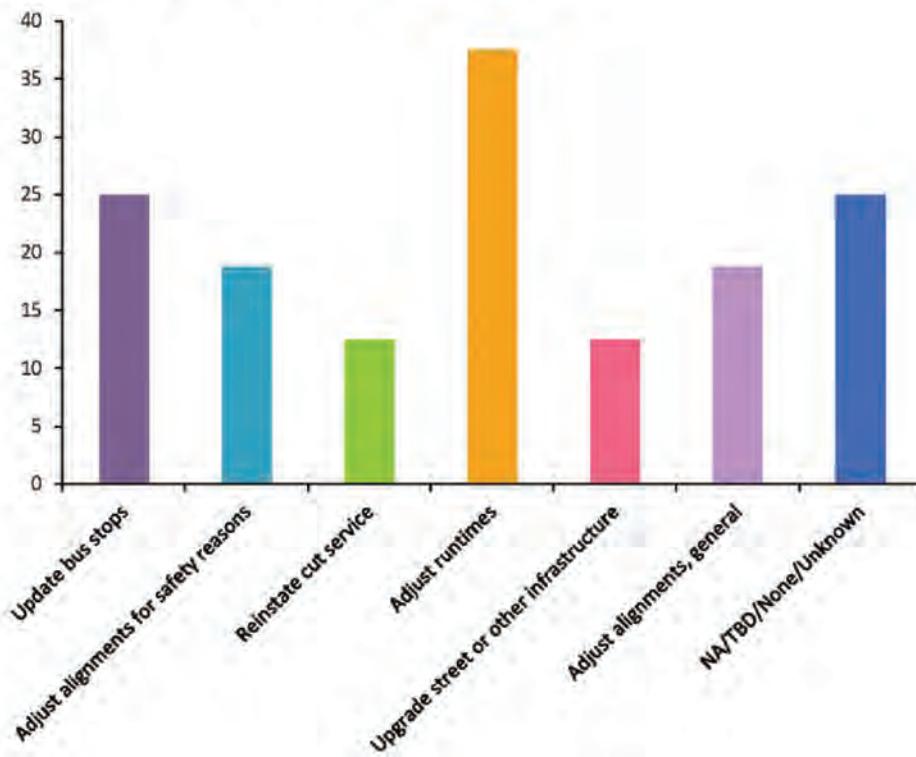
	Net neutral	More	Less	Responses
Service revenue hours	5	11	1	17
Service revenue miles	3	11	3	17
Bus fleet	6	6	5	17
Operators	7	10	0	17

**174** Synthesis on Comprehensive Bus Network Redesigns**What is the target/desired impact of the system redesign on?**

	Net neutral	More	Less	Responses
Service revenue hours	8	8	0	16
Service revenue miles	9	7	0	16
Bus fleet	11	5	0	16
Operators	9	7	0	16

What additional changes were necessary after the redesign was first implemented?

How did your agency identify and make those changes?

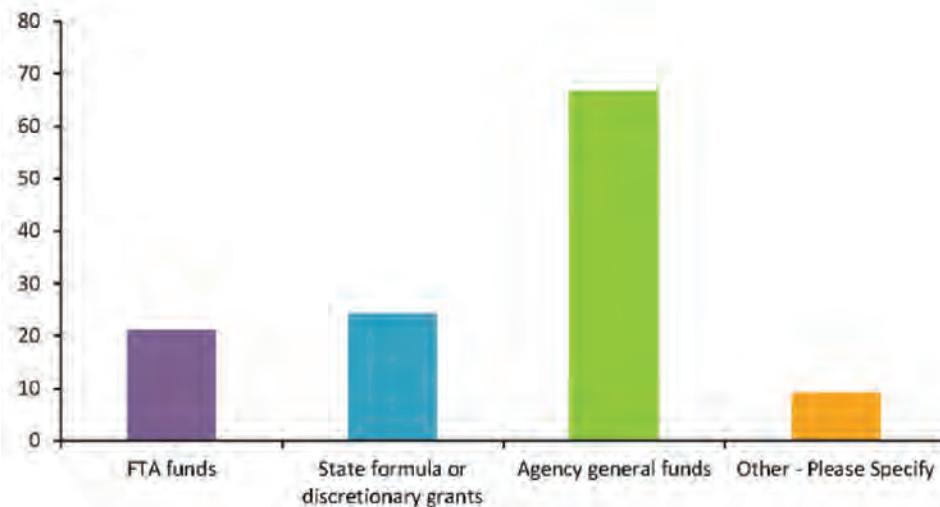


**176** Synthesis on Comprehensive Bus Network Redesigns

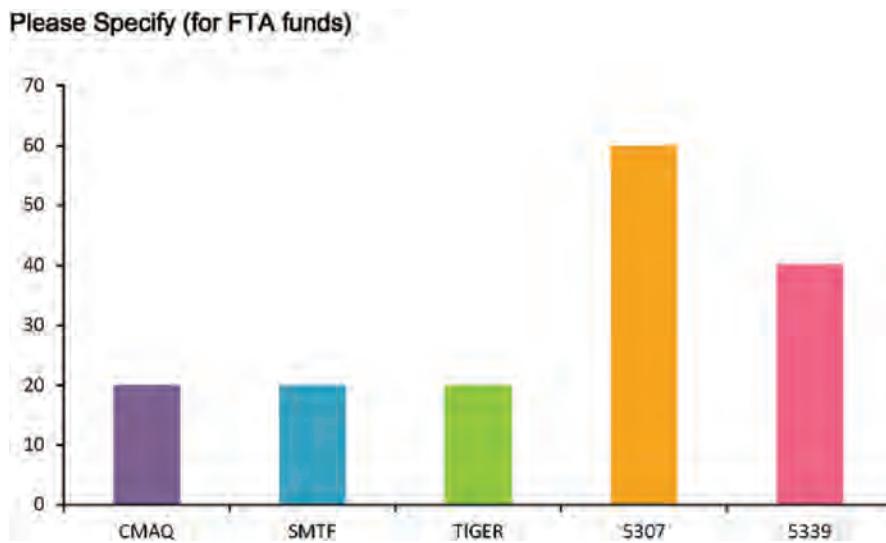
**What were the key initiatives associated with implementing the plan and what initiatives were particularly successful (e.g. public education, training, internal communication strategies)? Would you have done anything differently in hindsight?**

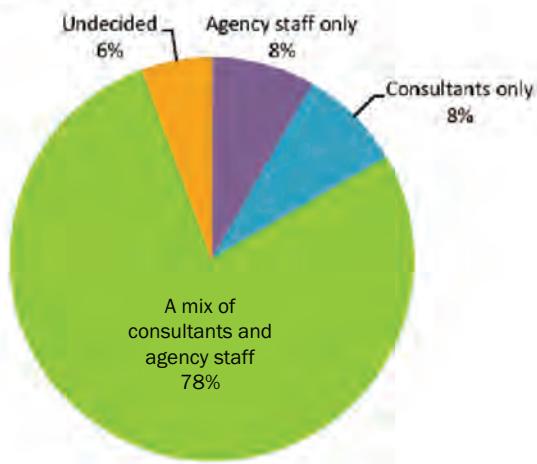
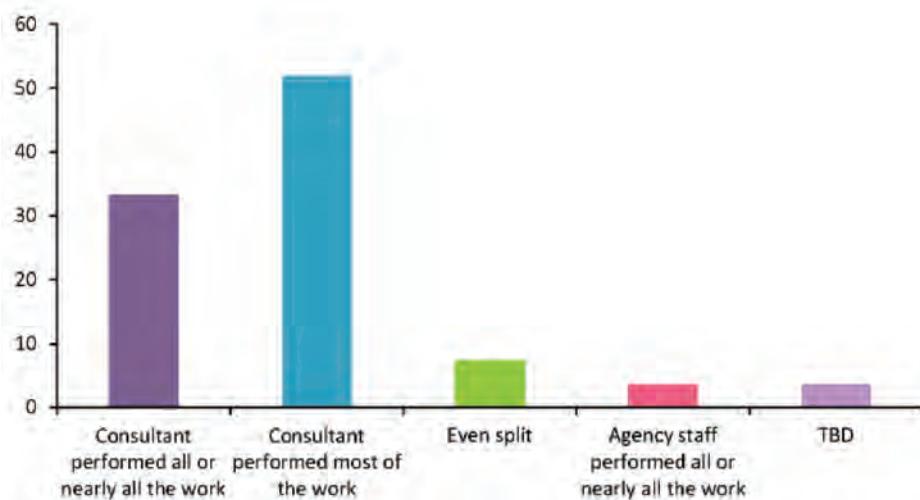


How did your agency fund its system redesign planning efforts? (Please select all that apply.)



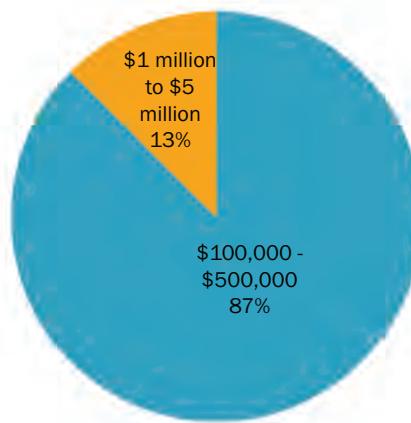
**178** Synthesis on Comprehensive Bus Network Redesigns



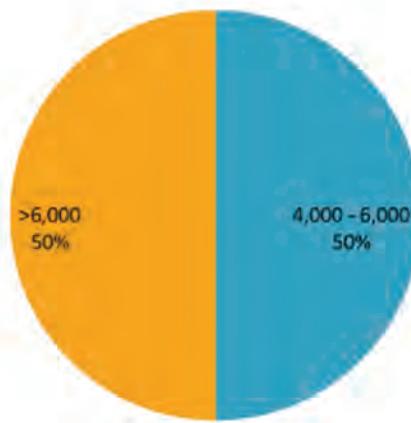
**Who did / is doing / will do the planning work?****How was the planning work divided between agency staff and consultants?**

**180** Synthesis on Comprehensive Bus Network Redesigns

**Approximately how much did the system redesign planning cost? Includes consultant costs for planning, modeling, data collection, public outreach, etc., up to the point of a final plan.**

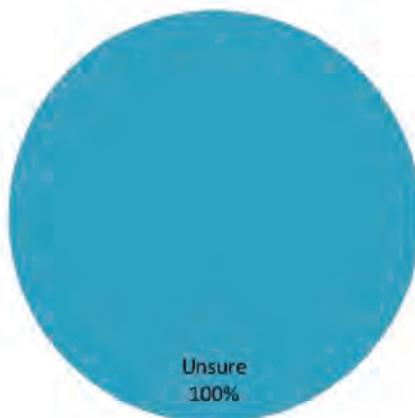


**Approximately how many staff hours did the system redesign planning require? Includes time for planning, modeling, data collection, public outreach, etc., up to the point of a final plan. (One FTE for one year averages 2,000 hours)**

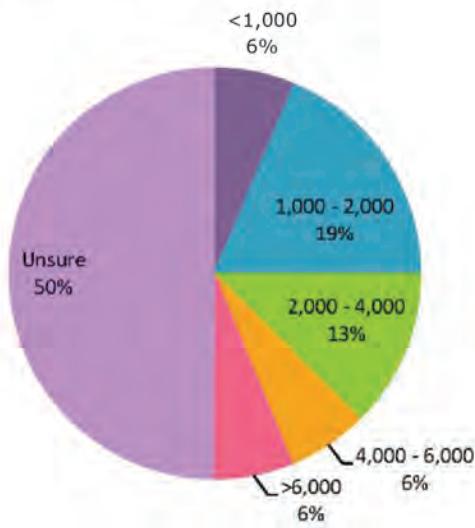


Approximately how much did the system redesign implementation planning cost?

Includes consultant costs for scheduling, public education, site planning / design for capital improvements, etc. up to the point of launch (excluding infrastructure or fleet investments).

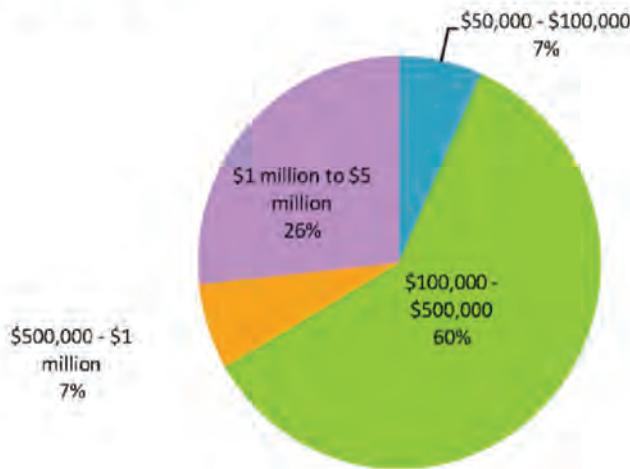


Approximately how many staff hours did the system redesign implementation planning require? Includes time for scheduling, public education, site planning / design for capital improvements, etc. up to the point of launch (excluding infrastructure or fleet investments).

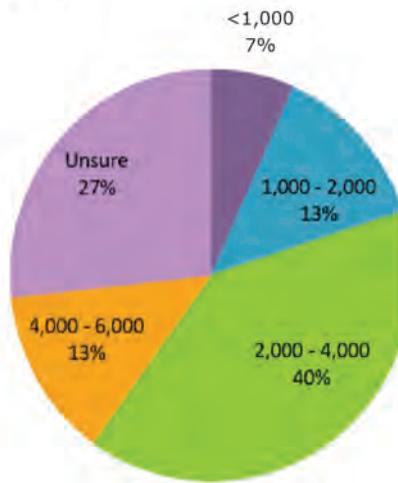


**182** Synthesis on Comprehensive Bus Network Redesigns

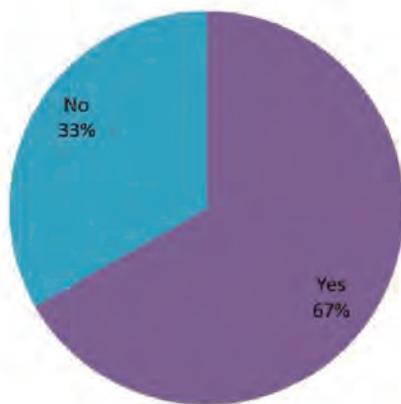
**How much do you anticipate that the system redesign planning will cost? Includes consultant costs for planning, modeling, data collection, public outreach, etc., up to the point of a final plan?**



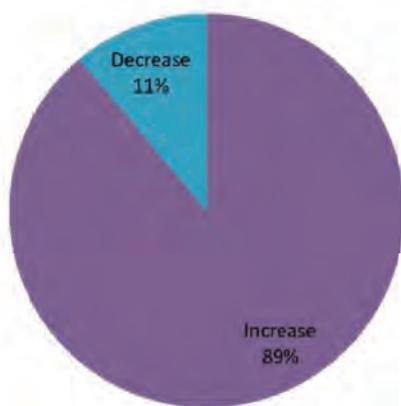
**How many staff hours do you anticipate that the system redesign planning will require? Includes time for planning, modeling, data collection, public outreach, etc., up to the point of a final plan?**



Did implementation of the redesign have or is anticipated to have an impact on the agency's annual operating costs?

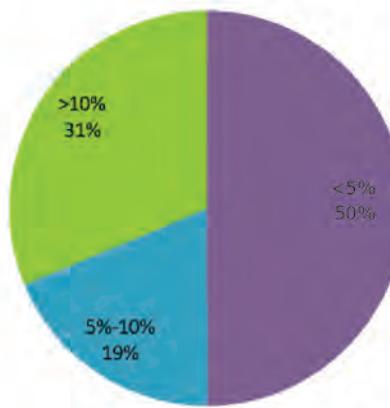


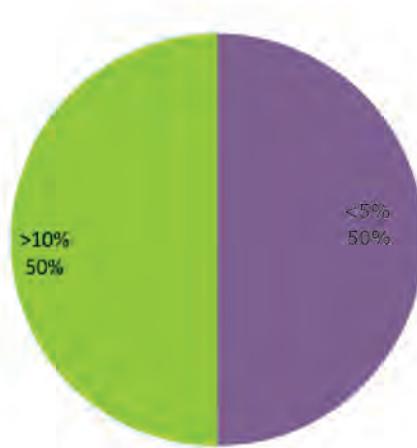
Has the impact resulted in, or will it, an increase or decrease in annual operating costs?



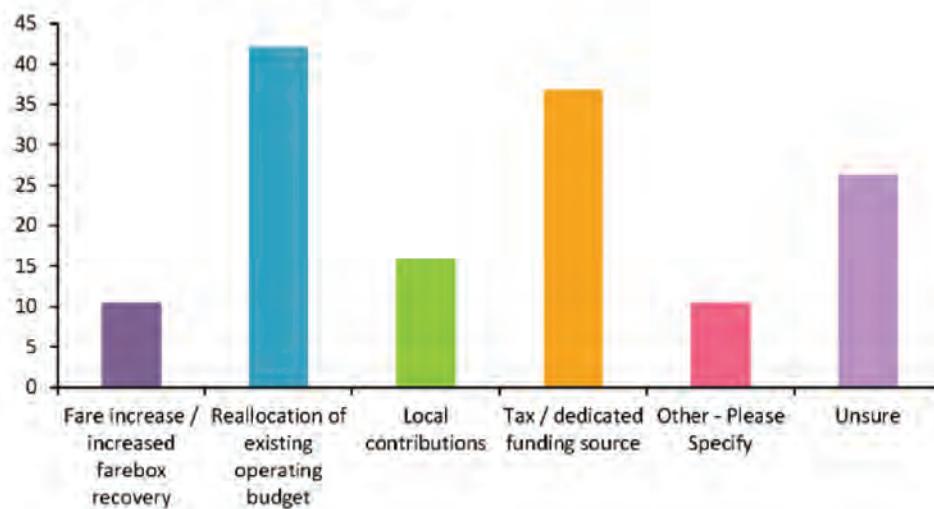
**184** Synthesis on Comprehensive Bus Network Redesigns

**Increase in costs by:**



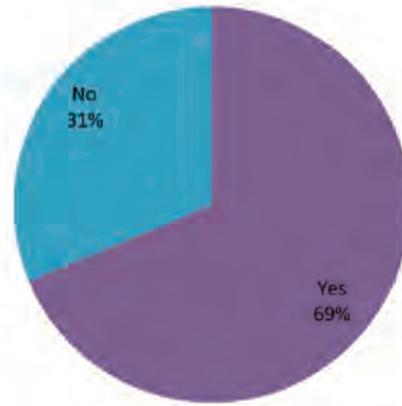
**Decrease in costs by:**

What funding sources were used / will be used to pay for the increased operating costs? Please select all that apply.

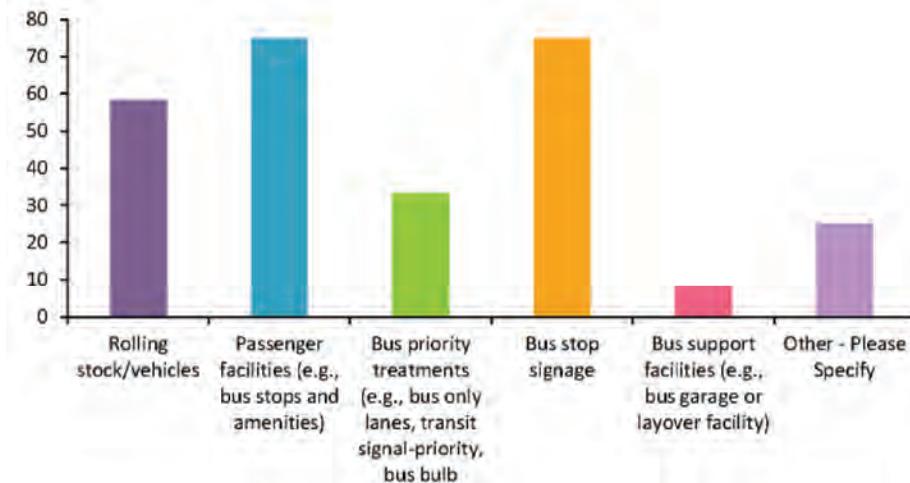


## 186 Synthesis on Comprehensive Bus Network Redesigns

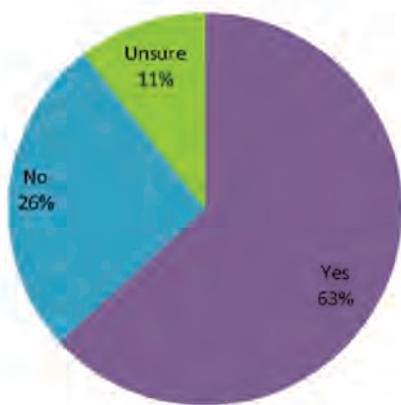
Were there capital costs associated with the system redesign?



What capital costs were associated with the system redesign? Please select all that apply.

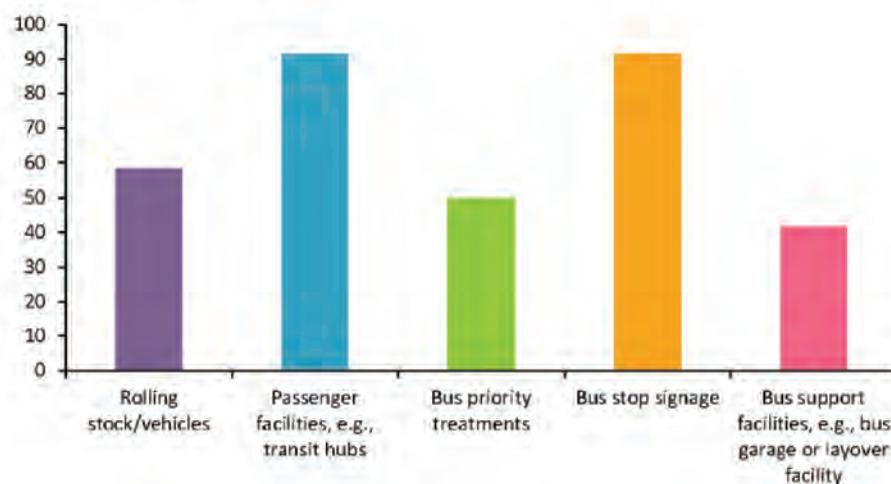


Will there be or do you anticipate capital costs associated with the system redesign?



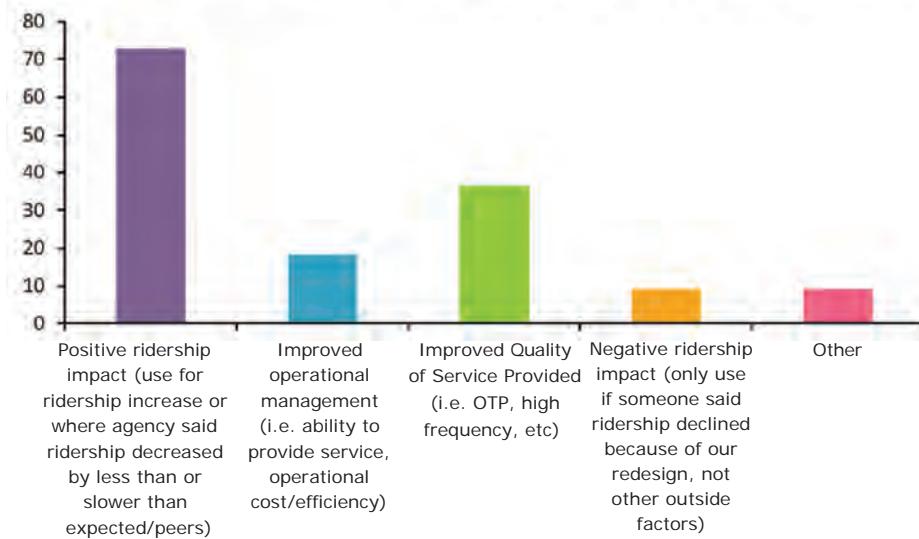
What capital costs will there be or do you anticipate with the system redesign?

Please select all that apply.



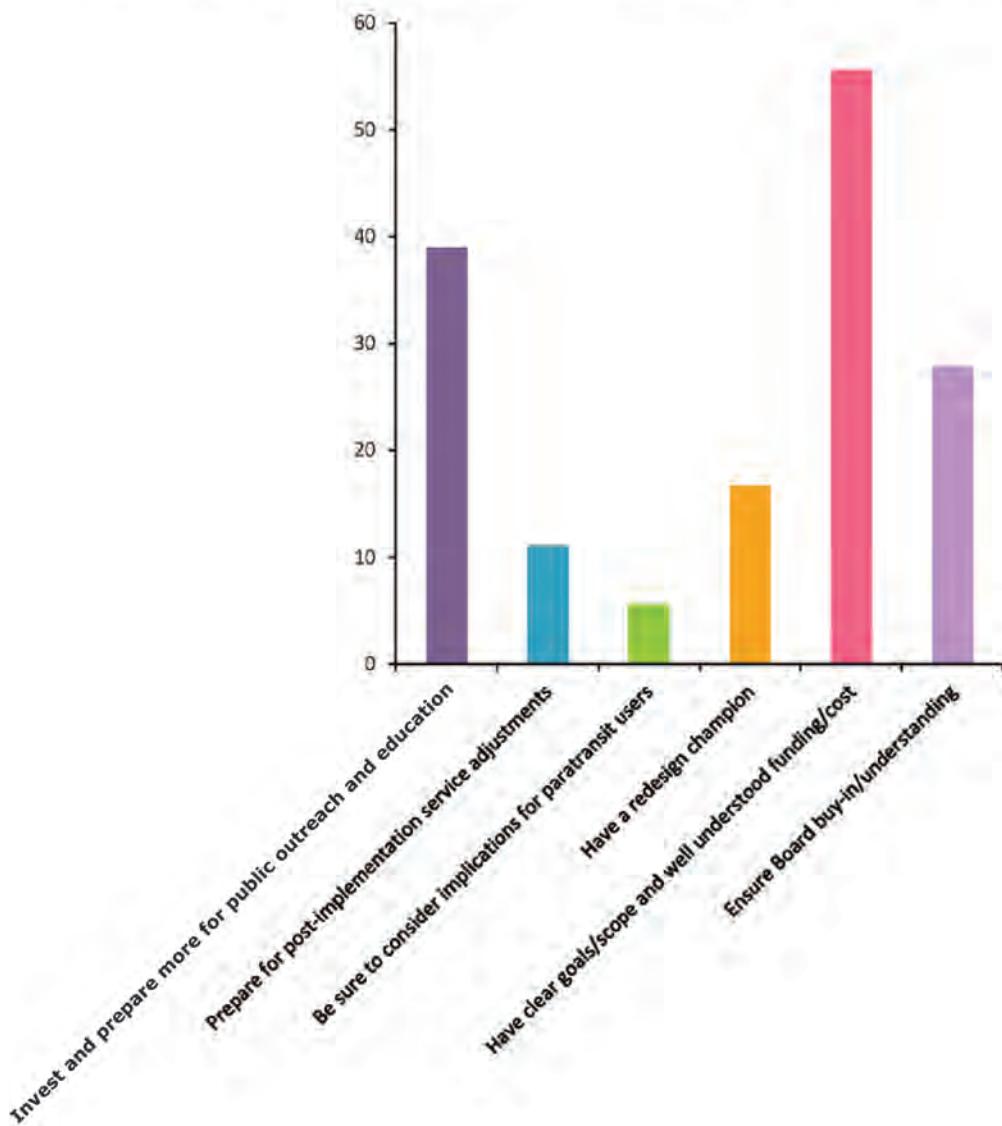
## 188 Synthesis on Comprehensive Bus Network Redesigns

**How has the performance of the system changed? Has ridership increased? Were goals and objectives met? (Please limit your response to a maximum of 250 words.)**



Is there anything else you want to share about your system redesign process?

Would you do anything differently? Describe the most important lesson learned.









*Abbreviations and acronyms used without definitions in TRB publications:*

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI-NA	Airports Council International—North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation Act (2015)
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TDC	Transit Development Corporation
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S. DOT	United States Department of Transportation

**TRANSPORTATION RESEARCH BOARD**

500 Fifth Street, NW  
Washington, DC 20001

---

**ADDRESS SERVICE REQUESTED**

---

*The National Academies of*  
**SCIENCES • ENGINEERING • MEDICINE**

The nation turns to the National Academies of Sciences, Engineering, and Medicine for independent, objective advice on issues that affect people's lives worldwide.

[www.national-academies.org](http://www.national-academies.org)

ISBN 978-0-309-48024-6



9 780309 480246