DART ZOOM

DALLAS AREA RAPID TRANSIT

Transit Choices Report

APRIL 2020

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Table of Contents

Table of Contents

1 Executive Summary

What is the New Bus Network?

The DARTzoom New Bus Network project will update and redesign the DART bus network in all 13 of the DART cities. This bus network redesign is a collaborative planning effort to decide where bus lines should go, when they should run, and how frequent the service should be, starting from a clean slate.

At the end of this process, DART will have a New Bus Network Plan which includes two networks:

- A network that could be implemented without any additional funding for bus service, as early as 2022.
- A higher-funding network that could be implemented in the future if additional funding became available for bus service.

The members of the DART Board of Directors will direct DART staff in how to balance competing goals in a redesigned network. Input gathered from the groups of people described above will inform their decision about this difficult trade-off.

Why is DART doing a bus network redesign?

Bus service is much less expensive to operate than rail, bus vehicles are easier to purchase and maintain than rail vehicles, and bus service does not require lengthy and costly construction projects. Nearly every city with a high-ridership rail network has a high-ridership bus network.

People who use DART are more likely to use a bus as part of their trip than light rail. As of 2014, 71% of transit trips included at least one bus ride.

An outdated system

Some DART bus routes have been running the same paths since World War II, and most of the network was designed in the 1980s. Since then, the urban area has grown enormously and the places people go for work, recreation, socializing and other purposes have changed. The rail and bus network was originally designed to focus on downtown Dallas, but more of the region's activity happens far outside of that center today than in the past.

Decline in transit ridership

In the past twenty years, DART's transit ridership grew and then declined. Most U.S. transit agencies have seen declining transit ridership over the past decade. The exceptions are those cities where transit service has been increased or redesigned.

One of the biggest drivers of ridership gains or losses is how much service is provided: when more buses and trains are provided, more people tend to ride. When service is cut and fewer buses and trains are running, fewer people tend to ride.

Looking at total ridership over the years (in the graph at right) shows ups and downs that are mostly related to how much service DART was able to fund in those years. Yet when we hold the amount of service constant, as in the graph at right below, we see that ridership relative to service (productivity) has slowly declined for buses since 1994, and for light rail productivity since 2009.

Declining productivity means that DART has been attracting fewer riders for every unit of service that it provides. For various reasons, DART service is less useful to people today than it used to be, compared to peoples' other transportation options.

Transit values and goals

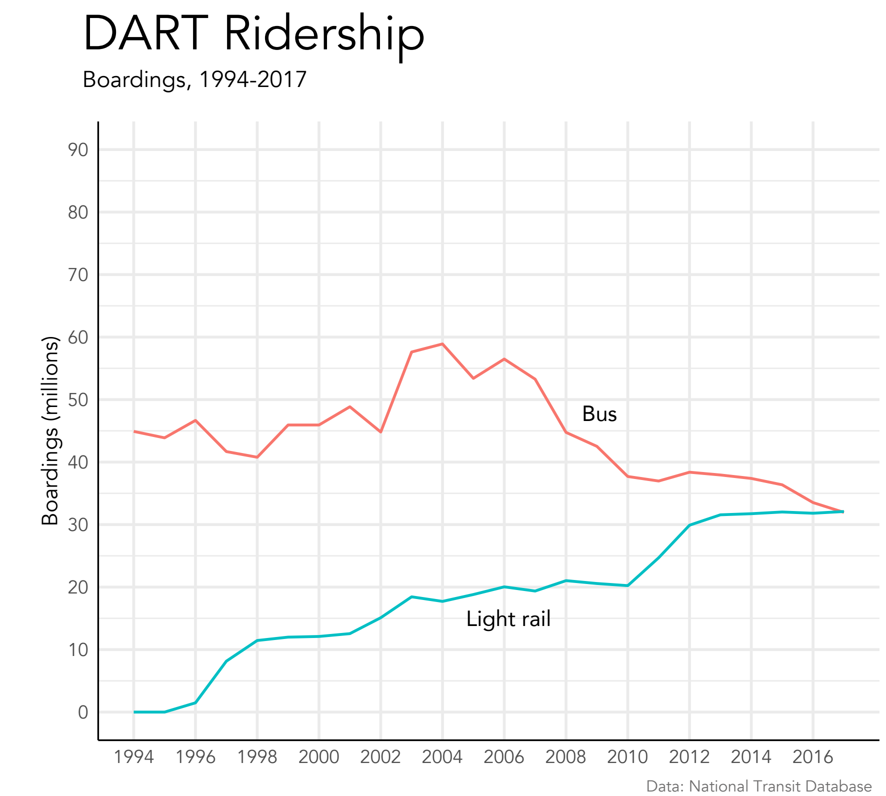
High ridership is just one value that a transit network can serve, and increasing ridership is one potential goal for this network redesign. However, transit serves other values besides high ridership which can lead to economic, environmental, social, health and personal liberty goals.

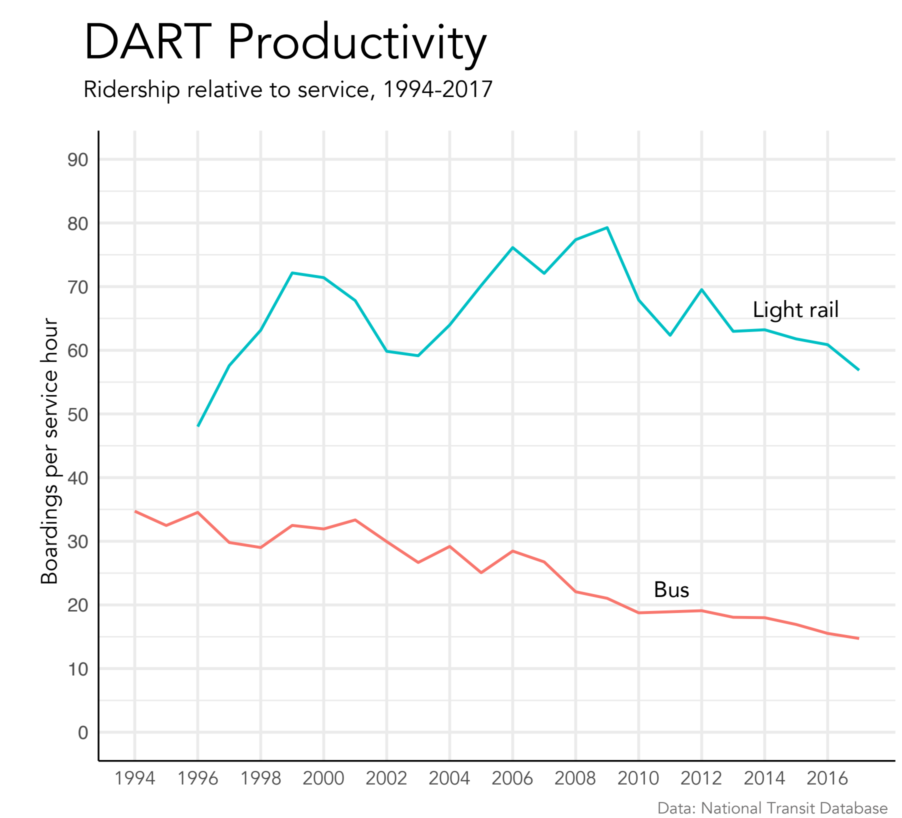
A complete, blank-slate redesign allows DART to ask the public: *How can the transit network best serve peoples' values today?*

Much of the current network is designed to get a little bit of service close to people in many places, even where there are not many people. Is that still the right design?

Starting from a blank slate

Redesigning the DART bus network does not mean every route or stop would change. It does mean, however, that everyone involved in this plan can think beyond the existing network. If there are routes or schedules that are meeting the region's goals today, they are likely to be retained in the New Bus Network. If there are routes or schedules that are artifacts of history and no longer make sense, they can be revised.





Bus ridership has gone up and down since 1994; light rail ridership has grown steadily as new lines have opened (as shown at top). However, once we control for the amount of service supplied, a concerning downward trend appears, especially on the bus network (as shown at bottom).

Useful terms

Frequency

For the DART network, we describe service coming every 20 minutes or better as "frequent."[1] Frequency has a big impact on peoples' travel time. Speed matters too, especially in DART's large service area, where so many trips are many miles long. But frequency is invisible, and hard to imagine for those of us who mostly drive, cycle or walk. More frequent service means people are able to travel when they want to, without arriving at their destination earlier than they wanted to. High frequency also makes transfers quick and reliable. Higher frequency service tends to attract higher ridership, even relative to its costs.

Hours of service, or span

The span of a transit service is the number of hours it operates during the day, e.g. a service that runs from 6:00 am to 11:30 pm would have a 17.5 hour span. For riders who depend on transit service for all aspects of their life, it is important that the span is long enough for their weekday and weekend trips, whether it is an early morning work shift or a late night out with friends.

Ridership and coverage goals

Ridership and coverage goals, both laudable, compete with one another.

An agency seeking to maximize ridership would focus service where there are large numbers of people, where walking to transit stops is easy, and where the linear routes feel direct and fast to customers. Because service would be concentrated onto fewer routes, frequency would be high and a bus would always be coming soon. Transit trips would be easy and quick, and as a result many people would choose to rely on transit.

An agency seeking to maximize coverage would spread out services so that every street had a bus route. As a result, all routes would be infrequent, even those on the main roads where lots of people need to travel. Transit travel would require a lot of time, mostly time spent waiting somewhere, and as a result few people would choose transit.

On a fixed budget, designing transit for both ridership and coverage is a zero-sum game. Concentrating more of the budget into frequent routes means less of the budget is available to spread service out to get close to many places.

1 For many agencies the standard is 15 minutes or better. In the biggest cities, the standard may be even higher, with only services coming every 5 or 10 minutes described as "frequent."

Productivity

Ridership responds to the amount of service provided on a route. To control for this, a route's productivity can be measured – the total ridership divided by the quantity of service provided. Routes with low levels of service but high productivity probably have potential to attract even more ridership, if their service levels are increased. Routes with high levels of service but middling or low productivity probably just don't have enough people nearby to make them efficient, even with all the service invested in them.

Rush hours, middays, nights and weekends

Many transit systems, like DART, focus service during rush hours when automobile travel peaks. Providing high frequencies during these times makes transit an attractive option for commuters. However, this often results in poor frequencies at other times when many people still need to get around.

For example, many people travel at midday during the week for non-office commutes as well as for shopping, medical and school trips. Similarly, weekend transit service is essential for the retail and service workers who are required to take at least one weekend shift per week. Night service typically doesn't attract as many riders as daytime service, but it allows people to rely on transit: it helps the service worker travel home from work, lets people socialize, and provides a "just-in-case" option for 8-to-5 commuters.

Providing an all-day all-week service is part of a high ridership strategy. Cities that have increased or maintained their transit ridership in the past decade are cities that invested in all-day, all-week services.

Rush hour peaking

DART runs some special routes only during rush hours. Many DART routes also have increased frequencies during rush hours. This additional rush hour service comes with some hidden costs. For example, extra buses have to be purchased, maintained and stored just for rush hours, and then sit idle the rest of the day and week. In the DART network, 46% of the fleet is used only during rush hours.

Deadhead and one-way services

Deadhead is the time a bus and driver spend traveling between a route and the bus garage, or returning to the start for a "one-way" route. Extra deadheading is one of the hidden costs of rush-hour only services, because buses have to come into and out of service from the garage twice per day. One-way routes have even more deadhead because the bus has to travel back to the starting point without passengers for each trip.

Flexible transit

Flexible transit is any transit service in which the route varies depending on who requests it. In contrast, fixed routes serve fixed stops, in a certain sequence, at scheduled times. Flexible service is appealing because it responds to people's desire to travel when they want (rather than only when service is scheduled) and to avoid walking to and waiting at bus stops. In very low-density, flexible service can serve demand at a lower cost than fixed routes, which can be particularly valuable for people with severe needs. DART's general public flexible service is called GoLink, and the flexible service for seniors and people with disabilities is called DART Rides.

Transit networks

Individual routes should connect to create a larger network, allowing people to get to many places by transferring between lines. Well-designed transit networks are broadly useful to people making many different trips.

In a network, transferring is a crucial part of creating efficient trips for residents to access many different opportunities. However, if riders have to wait a long time to make a transfer, it greatly increases their total travel time. Transfers between frequent routes allow for reliably short waits. In places where infrequent routes converge, a timed connection can create the same short transfer time. However, if a rider happens to miss the timed connection, they have a much longer wait until the next bus or train arrives.

In these ways, well-connected networks can be built out of either frequent or infrequent lines. The existing DART network is a well-connected but infrequent network.

For more detailed descriptions of these and other transit related terms, see *page 23*.

Existing Network

DART is somewhat unusual among large U.S. transit agencies for having:

- A very large service area, with continuous low-density development throughout the service area (rather than large rural gaps)
- A large service area population
- A large light rail network but without much all day high-frequency light rail service

Productive, high-ridership routes: DART's more frequent, all-day routes are, on average, more productive than the less frequent routes. Additionally, rush hours are not actually the most productive time – buses are most full on weekdays at midday.

Prioritizing rush-hours over other times: The DART network is designed around rush hour commutes, with 46% of the bus fleet used only during rush hours. But work trips make up a small fraction of peoples' total travel; 1/3 of work commutes don't even happen at rush hour.

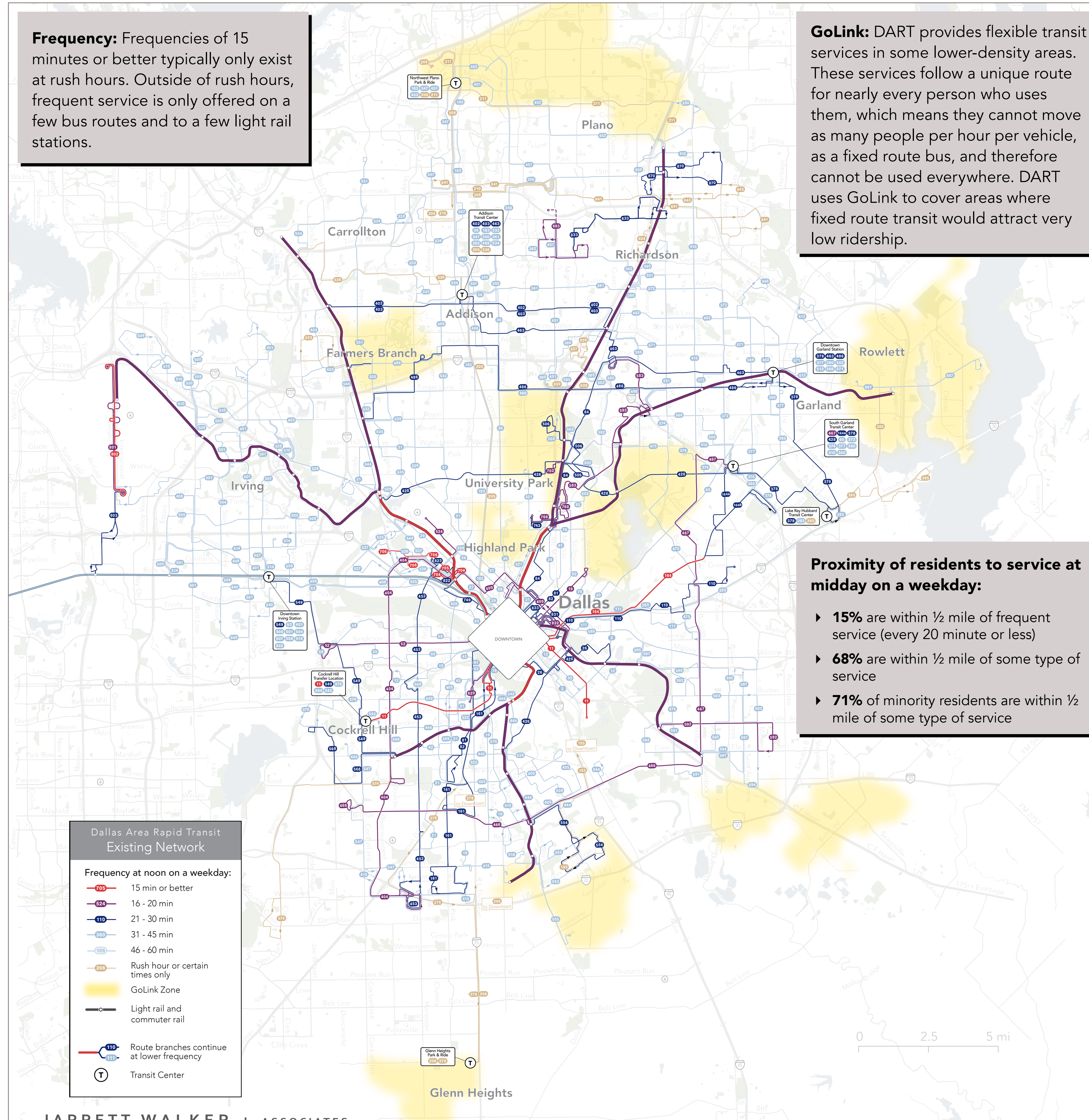
Timed connections reduce transfer wait times: Most bus routes are infrequent, but the poor frequency is mitigated somewhat by reliable timed connections that some routes make with light rail.

High speeds for long trips: Dallas area trips are longer than in most other cities. The high speeds that DART offers on light rail and express buses help people make long trips at a decent speed.

Speed: Most bus routes run on surface roads where buses can stop and large numbers of people can access stops. But buses in mixed traffic are terribly slowed by congestion. Without protection from congestion, the DART bus network will not deliver the high speeds that make long-distance regional transit travel compelling and competitive.

Reliability: The reliability and speed of a route are related to one another. The reliability of DART's existing services is quite good, in part due to staff's work over the past five years to rewrite schedules and add time on the most problematic routes. However, this improved reliability has come at the cost of reduced speeds. The average weekday speed has declined by about 7% at rush hours and 5% at midday over the past seven years.

For more detailed analysis of the existing network, see *page 38*.



Market and need assessments

When designing a transit network, a planner will ask:

- *Where are the strongest markets for transit, with potential for high ridership and low operating costs? This is the transit "market."*
- *Where are there moderate or severe needs for transit, where coverage services may be important even if they do not attract high ridership? These are transit "needs."*

A strong transit market is mostly defined by **where people are**, and **how many of them are there**. Peoples' incomes can also affect ridership potential. Residential and job density, the density of lower-income residents, and walkability can all be mapped to help planners visualize high transit ridership potential.

We learn about transit needs by examining **who people are** and **what life situation they are in**. When planning to meet needs, we consider the locations of lower-income residents; lower-wage jobs; schools; medical centers; and places where seniors, youth or people with disabilities live. Designing a transit network to focus on these places is not generally the highest-ridership strategy, because there are often too few people in all of these places to fill buses. But such a network serves other values for transit, such as being there for people with severe needs for transportation.

Another important factor is **where minority residents live**. A person's race or ethnicity does not tell us if they need transit, or if they have a propensity to use transit. However, we know that race and ethnicity are correlated with income.

In addition, providing equitable and supportive levels of service to minority people, even in areas that are costly to serve or that do not generate much transit ridership, can be an important element of a coverage goal. Transit agency policies that protect minority people from negative impacts are one type of coverage goal, because they pursue an outcome that is highly valuable regardless of ridership.

This page summarizes how each of these factors affect the DART service area. For further information and detailed maps, see *page 29.*

Residential and job density

- In the Existing Network, at least some transit service is provided close to the areas with the most density of housing and jobs, but local street patterns and other physical barriers may create long walks to homes and workplaces.
- People travel in both directions on transit corridors with a mix of residential, commercial and other uses, so buses are full in both directions. In contrast, routes that serve purely residential areas tend to be used in only one direction each morning and evening rush hour.

Walkability

- Walkability is of existential importance to transit ridership: *Only 5% of transit trips on DART bus or rail start with the parking of a car. The vast majority of trips (83%) involve walking at both ends of the trip.*
- A connected street network is essential to easy walking. The most widespread and continuous areas of well-connected streets are those that developed before World War II, when nearly all transportation was done on foot, by bicycle or by transit. These areas are mostly in Dallas. Smaller contiguous areas of high connectivity also exist in Plano, Garland, Richardson and Farmer's Branch.
- Many parts of the DART area are very difficult to walk in, due to a lack of street connections; developments that use cul-de-sacs or walled subdivisions; freeways that divide neighborhoods; rail lines; and a lack of sidewalks, safe crossings or lighting.

Poverty density

- Dense areas of low-income residents are spread out around the DART service area, in nearly every city.
- In some areas, such as southern and eastern Dallas, lower-income residents live at low densities, far from one another and far from dense job and commercial centers. This makes it more costly for DART to reach these residents with service, because buses have to traverse long distances. This is why the "suburbanization of poverty" is an enormous challenge for transit agencies – the farther away low-income people must live, the more it costs to connect them to opportunities.

Minority residential density

- The DART service area is very diverse, with large populations from many different racial and ethnic groups. However, it is more segregated by neighborhood than most U.S. cities. This means that when DART makes decisions about where to provide service, down which streets and in which neighborhoods, those choices have a racial impact, and changes in transit access by people of different races will need to be measured and considered.

Challenges

Not much service

DART has a modest supply of bus service with which it covers a huge area. All of the trade-offs presented in this report become more agonizing when the budget is small, especially in a big city with many urban centers, high standards and global aspirations.

Travel distances are long

The average commute distance in the DFW area has been longer than most peer cities. Transit can be effective over long distances and over a large area using three different strategies, ideally in combination: 1) Bus Rapid Transit or Light Rail Transit in exclusive right-of-way, 2) intercity or express buses on freeways, and 3) creating a frequent grid network. To date, DART has pursued light rail and express buses. The costs of operating a frequent grid far exceed what the existing bus budget could handle.

But shorter trips demand higher frequencies

The shorter someone's trip, the more sensitive they are to time spent waiting. The DART network is currently designed for long trips, and in particular for long trips on light rail due to its high speed and its protection from congestion. This makes it harder for DART to provide high-frequency, local bus routes that make it easy to take short transit trips within your community.

Crosstown trips are hard

DART's light rail network design makes trips to and from downtown fast. However, in a larger urban area with multiple centers, having to transfer at the center for "crosstown" trips can make them very long. The Silver Line is being built in part to address this crosstown problem. However, it can only be in a fraction of places and the train will only come once per hour all week (and every 30 minutes during rush hours). Crosstown travel on the north side will still be the bus network's job.

Freeway-oriented development

Some of the densest development in the DART service area is oriented to freeways. For transit, freeways are barriers, not corridors. This results in two major consequences: 1) people have to walk in unsafe and unpleasant conditions to access transit service near freeway exits and entrances and 2) DART sometimes has to run two routes instead of one to make sure that neighborhoods on both sides of the freeway have access to transit.

The cost of using buses to fix walkability problems near light rail stations

Some light rail stations lack sidewalks and crossings that would make it easy to walk to nearby jobs and housing. To make up for this, DART runs bus routes for very short trips to these stations. Along with the operating expense, this means the bus might need to deviate from an otherwise direct path, making the route more time-consuming for anyone who is riding *through* to other places.

Rather than making the one-time capital investments in sidewalks, crossings and street connections at existing rail stations to address this issue, DART shoulders the perpetual operating costs for these circuitous routes.

Wide light rail station spacing requires a bus supplement

To make the light rail system fast, there are long distances between stations. This is not bad, but it has consequences for the bus network: if someone is located halfway between two stations, the distance is probably too far for them to walk. As a result, *light rail lines have not relieved DART of running parallel local bus routes on the same corridors*.

No "inefficiency" in the network today

One of the biggest challenges for this network redesign is that the existing DART network is fairly well-designed. Every route has a purpose, though reasonable people can disagree about the relative importance of different purposes. Making service better in a certain place, or at a certain time, would require making service worse somewhere else for someone else.

Opportunities

All-day all-week service

If DART wants to increase ridership on its bus network, providing more consistent seven-day-a-week service on the highest ridership routes has proven to be a good strategy by peer cities and by DART's own experience with the addition of weekend service in the past few years.

On average, DART bus routes are less productive at rush hours than at midday, which means that some rush hour service could be shifted to other times (like weekends) in pursuit of higher ridership.

Creating a few frequent crosstown connections

Although a complete frequent grid network for the entire DART service area is currently unaffordable, some frequent crosstown connections may be possible. However, even that would require a major shift in investment away from low-ridership coverage services.

Close route-spacing

There are some parts of DART's service area in which the transit network currently offers short walks to multiple parallel routes. This is an opportunity to ask bus riders and the public whether short walks are more important than short waits. Consolidating parallel service into fewer routes is a way that DART could improve frequencies within its existing budget.

For more details about these challenges and opportunities in redesigning the network, see *page 55*.

Key choices

1. Longer walks for shorter waits?

In places with many parallel routes, consolidating service onto fewer streets can allow an agency to offer riders higher frequencies. This could make peoples' trips faster, but it would mean a longer walk to service.

2. How important are rush-hours relative to all-day, all-week frequency?

DART transit ridership is somewhat higher during weekday rush hours than at middays, nights or on weekends. However, providing extra service during rush hours comes with extra costs. What is more important: fully-serving rush hour demands, and avoiding crowding on rush-hour buses, or providing more useful frequencies all day, everyday?

3. Are declining speeds tolerable?

DART's service has been slowing down in the past decade, with average bus speeds dropping by 5-7% during weekdays since 2012. The slower DART's buses run, the less frequency DART can provide within the same budget, and the less useful transit is to people in a hurry.

DART has no control over the operation of the roads, and therefore has no control over how congestion affects bus speeds. Municipalities raise sales tax revenue for DART bus service, and they have the power to protect their investment by changing the way streets are managed for transit. Some of DART's cities are testing transit priority measures that speed up buses, but more work will need to be done if declining speeds (and the increase in costs they cause) are not tolerable.

4. How should ridership and coverage goals be balanced?

In every transit system's limited budget, a basic trade-off is made between:

- Services and decisions that increase ridership relative to cost (such as concentrating service into more frequent routes where the greatest number of people are), and
- Services and decisions that cover important places but do not yield high ridership relative to their costs.

About 55% of the existing DART bus budget is spent pursuing high ridership, and 45% is spent covering important places where ridership is low.

How should DART balance ridership and coverage goals in a redesigned network? Is the appropriate balance-point the same if, in the future, additional funding is available for more bus service, or does it change?

For further discussion of these choices, see *Chapter 8*.

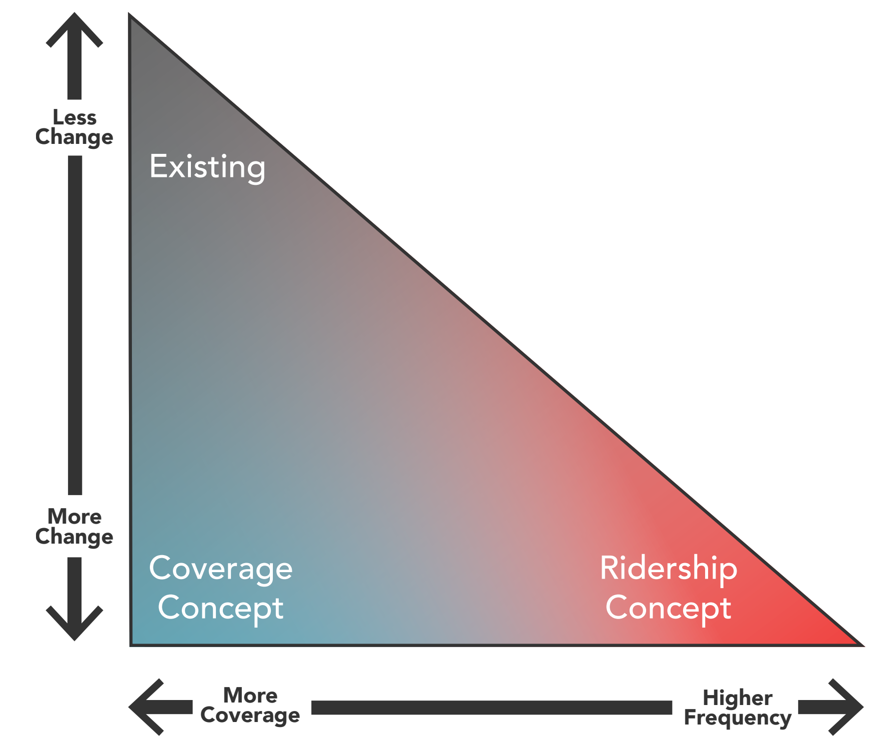
Future Network Concepts illustrating choices

Some of the key choices described at left are illustrated in a pair of Concepts. These Concepts were designed collaboratively by DART staff, the consultant team and staff from each of the 13 DART cities.

The two Concepts are intentionally very different from one another and are meant to help people develop their preferences and priorities for the New Bus Network plan:

- **The High Coverage Concept** spreads service widely across the DART service area. A few areas that are not covered today would become covered, while some areas would get worse frequencies than they do now. Short walks are maintained in many places, even though it means frequencies can't be improved.
- **The High Ridership Concept** concentrates frequent service in areas with the largest number of people and jobs. Most existing transit riders would see improvements in their service, and the network would become more useful to large numbers of people, but some people in low-density areas would lose all access to service.

Spectrum of Choices for the Dallas Area Rapid Transit Network



Neither of these concepts is a proposal. Rather, they illustrate how much the network could change, and how different the network could be, depending on whether DART shifts away from providing coverage and towards higher ridership potential.

These Concepts mark the ends of a spectrum between high coverage and high ridership potential. DART can decide to pick a balance point somewhere on that spectrum.

Design Principles and Assumptions

- **Same budget:** Both Concepts are limited by the same budget.
- **Same resources in each city:** Both Concepts were designed to avoid shifting much bus service among the 13 DART cities.
- **Same speeds:** Both Concepts assume that buses travel at the same average speeds as in the existing network.
- **More consistent service all week:** Both Concepts would shift some service away from rush hours, to midday, night and weekends. However, the High Ridership Concept would make a greater shift in this way.
- **Blank slate:** Both Concepts were designed from a "blank slate."
- **The Silver Line:** Since this study is rethinking the network for 2022, the Concepts assume that the Silver Line has begun operating, with service every 60 minutes at midday and 30 minutes at rush hour.

The following two pages provide a brief summary of each of the Concepts, but for full details and analysis, see *Chapter 7*.

High Coverage Concept

Design

Maintain some transit service close to nearly every existing rider, and cover a few new places if possible.

- 60% of the budget would be spent toward Ridership goals and 40% toward Coverage goals.
- Small increases to daytime and weekend coverage of residents and jobs would be paid for by reducing some rush hour and nighttime service, and by replacing some extremely low-ridership daytime routes with GoLink.

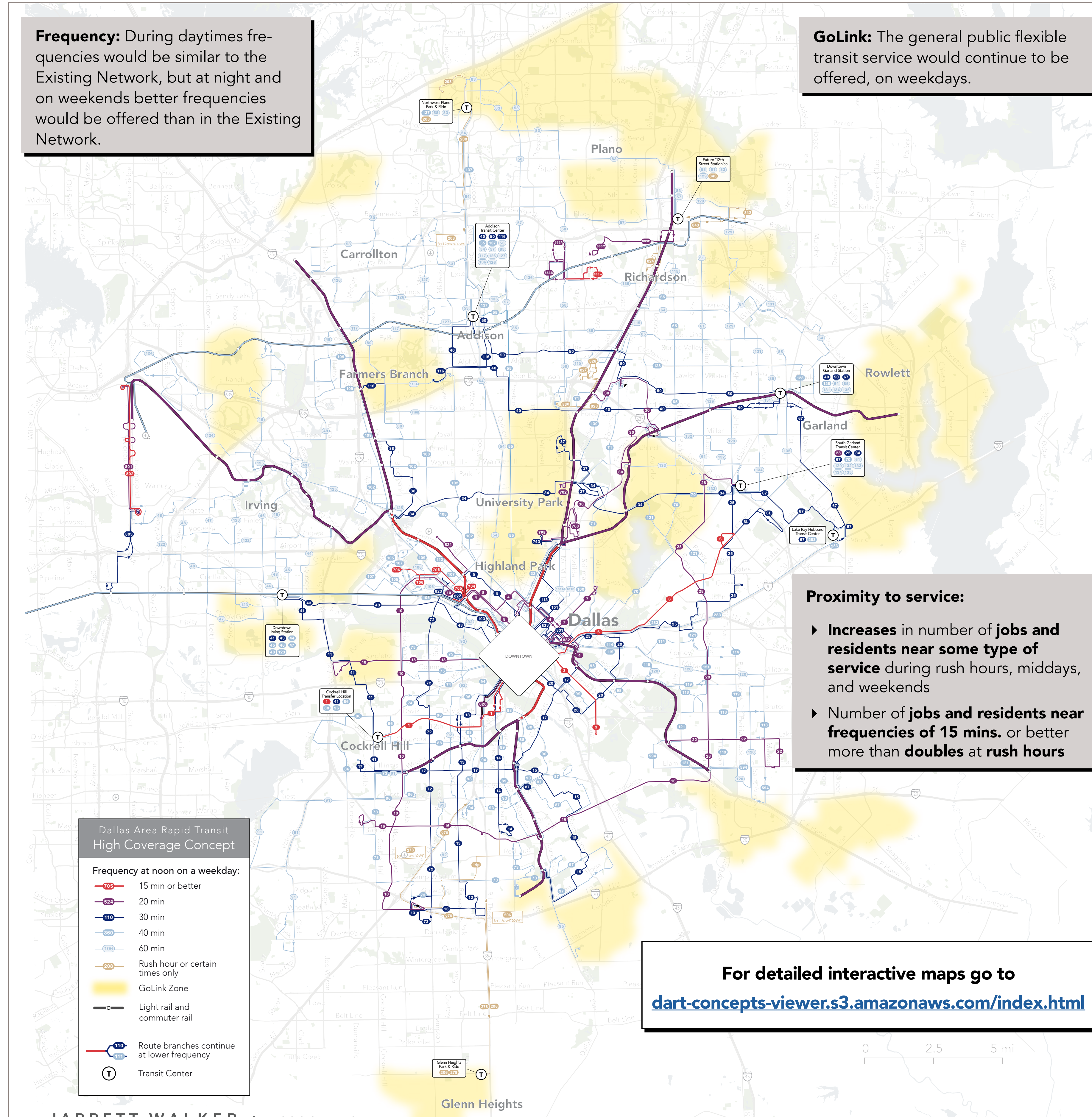
Outcomes

Coverage: Existing riders would continue to have access to service, and more people would be within walking distance of service at night and on weekends.

- Nearly every existing rider would continue to have access to service.
- There would be service within a ½ mile walk of 99.8% of all existing boardings (on fixed routes, light rail and GoLink). Only a few bus stops with less than 1 daily average boarding would lose coverage.
- Modest increase in the number of residents (including low-income residents and residents of color) and jobs near any service during weekday rush hours and middays, as well as on weekends.
- Fewer residents and jobs would have service nearby late on weekday nights.

Total Travel Time: On average, most travel times on transit would not improve.

- Of 66 example trips between high-demand locations, 50% of the trips could be made faster, 40% would remain the same, and 10% would take longer.



High Ridership Concept

Design

Concentrate frequent service in areas with the largest number of people and jobs. Some low-density areas would have no transit service.

- 85% of the budget would be spent toward Ridership goals and 15% toward Coverage goals.
- Routes would offer good frequencies later into the evenings and on weekends; this would be paid for by reducing some rush-hour frequencies.
- In denser and more walkable neighborhoods, even higher frequencies would be provided by consolidating nearby parallel routes into fewer, more frequent routes.

Outcomes

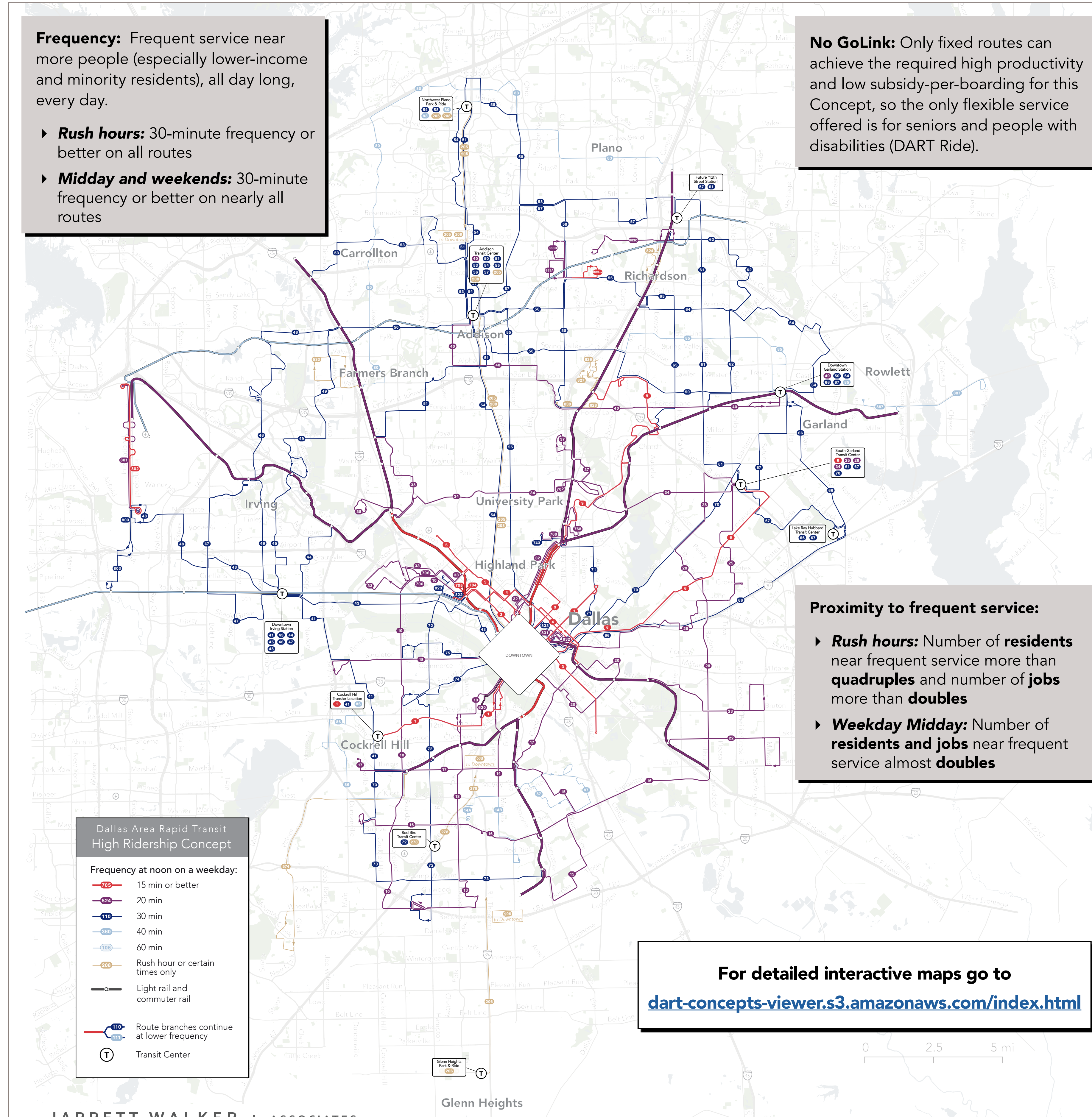
Coverage: Some existing DART riders would lose all transit access. (However, flexible service for seniors and people with disabilities would still be available.) Transit would be provided within a ½ mile walk of 91.7% of all existing boardings.

Ridership: Offers higher ridership potential than the Existing Network or the High Coverage Concept.

- Would dramatically increase the average resident's access to many more useful destinations in a given amount of time.
  - It would particularly increase access for lower-income and minority residents, and access to lower-wage jobs and activity centers outside of downtown.
- The number of jobs and residents within a ½ mile walk of frequent service would greatly increase.
  - However, the number of jobs and residents within a ½ mile walk of any service would decrease.
- The number of jobs and residents near service at night would increase, because all routes in this Concept offer such long schedules all-day and all-week.

Total Travel Time: Most existing riders would spend less time waiting for a bus, giving them access to more opportunities within a reasonable travel time.

- Of 66 example trips between high-demand locations, 78% could be made faster, thanks to shorter wait times and less circuitous routes.



Frequency: Frequent service near more people (especially lower-income and minority residents), all day long, every day.

- ***Rush hours:*** 30-minute frequency or better on all routes
- ***Midday and weekends:*** 30-minute frequency or better on nearly all routes

No GoLink: Only fixed routes can achieve the required high productivity and low subsidy-per-boarding for this Concept, so the only flexible service offered is for seniors and people with disabilities (DART Ride).

Proximity to frequent service:

- ***Rush hours:*** Number of **residents** near frequent service more than **quadruples** and number of **jobs** more than **doubles**
- ***Weekday Midday:*** Number of **residents and jobs** near frequent service almost **doubles**

For detailed interactive maps go to
dart-concepts-viewer.s3.amazonaws.com/index.html

Next steps

By showing the public, stakeholders, and decision-makers the range of possibilities, DART is asking:

"Now that you see what it would be like to prioritize one goal over another, how do you want us to balance these goals? In other words, if you want better service, what is your definition of better?"

Outreach

The actual New Bus Network plan will depend on what we hear from the community. The community's comments will guide the study team and decision-makers in developing the Draft Plan with the right balance between these competing goals. It may be similar to one of these Concepts, or somewhere in between.

The consultant team and DART will be conducting surveys and other outreach efforts from April through early June, and may continue longer depending on the length of the COVID-19 epidemic.

Designing a draft plan

Responses from the public and stakeholders will guide the DART Board in determining the balance of goals for the Draft New Bus Network Plan. With direction from the Board, the study team will design the Draft Plan in late 2020. The Draft Plan will be presented for public and stakeholder review in early 2021.

Who will be consulted?

Many different people will be involved in guiding this plan:

- Transit riders
- People living on low incomes
- People of color and non-English speakers
- Civic and neighborhood leaders
- Employers and businesses
- Municipal staff
- Local elected officials
- Members of the DART Board of Directors

How to get involved

For more information and to stay involved in the project, go to dartzoom.dart.org and:

Learn More

- View the network Concepts in an online, searchable map
- See scheduled events
- Sign up for project emails

Give Input

- Take the online survey
- Join an online webinar
- Call in to a telephone town hall

Share with Others

- Find videos, articles and reports to share
- Request a community presentation

PHASE 1

Network Concepts

Spring and Summer 2020

After evaluating the existing transit network, DART staff, municipal partners and the consulting team have designed a pair of contrasting Network Concepts to illustrate key choices.

Transit riders, stakeholders, employers, workers and community leaders will be consulted on how DART should make these choices.

PHASE 2

Draft New Bus Network

Late 2020 and Early 2021

A Draft New Bus Network Plan, including transit networks at existing and higher funding levels, will be designed by DART staff, municipal partners and the consulting team.

The Draft Plan will be shown to stakeholders and input will be gathered in many ways during Late 2020 and Early 2021.

PHASE 3

Final New Bus Network

Spring 2021

Based on input from the public in Phase 2, a Final New Bus Network Plan will be created for Board consideration in Spring 2021.

If the Board decides to adopt and implement the New Bus Network Plan, the soonest service changes would occur is January 2022.

Anyone who wants additional information, has questions or wishes to make a comment should contact the project team at **serviceplanning@dart.org**

2 Introduction

What is the New Bus Network?

A bus network redesign is a collaborative planning effort to decide where bus lines should go, when they should run, and how frequent the service should be, starting from a clean slate. The DARTzoom New Bus Network project will examine the DART bus network in all 13 of the cities that belong to the DART Service Area and collect sales taxes to fund service.

Transit networks naturally become more complex over time. They do not naturally get simpler. Some DART bus routes have been running the same paths since World War II, and major parts of the network were designed in the 1980s. Since then, the urban area has grown enormously and the places people go for work, recreation, socializing and other purposes have changed. The rail and bus network was originally designed to focus on downtown Dallas, but more of the region's activity happens far outside of that center today than in the past.

A complete, blank-slate redesign allows DART to ask the public: *How can the transit network best serve peoples' values today?* Much of the current network is designed to get a little bit of service close to people in many places, even where there are not many people. Is that still the right design?

Redesigning the DART bus network does not mean every route or stop would change. It does mean, however, that everyone involved in this plan need not be constrained by the existing network. If there are routes and service patterns that are meeting the region's goals today, they are likely to be retained in the New Bus Network. If there are routes and patterns that are artifacts of history and no longer make sense, they can be revised.[1]

At the end of this process, DART will have a New Bus Network Plan which includes two networks:

- A budget-neutral network that could be implemented without any additional funding for bus service, as early as 2022.
- A higher-funding network that could be implemented in the future if additional funding became available for bus service.

1 This is not to say that bus service patterns are *temporary*. Sometimes, in advocating for the use of rail, people argue that bus service is temporary, whereas rail is *permanent*. This is obviously not true, since for a few decades in the late 19th and early 20th centuries U.S. cities were full of trolleys and streetcars running on rails, nearly all of which were ripped out, proving their impermanence. Bus service isn't permanent either, in that sense.

What is very permanent, however, is a *high ridership transit market* and the *transit service patterns* that arise to serve it. The most frequent and high-ridership bus lines in the center of any U.S. city are likely to have been served by horse-drawn bus in the 1800's, streetcars in the early 1900's, and diesel or electric buses since then. Transit technologies come and go, but ***a high-ridership transit market is permanent.***

The most difficult trade-offs will arise as we design the budget-neutral network, because the existing DART bus network is stretched so thin. There is no "inefficiency" in the network today. Every route has a purpose, though reasonable people can disagree about the relative importance of different purposes. Making service better in a certain place, or at a certain time, would require making service worse somewhere else for someone else.

What is a Choices Report?

DART is preparing to redesign its bus network, and thinking about whether the resulting New Bus Network should be designed for higher ridership. The answer to this question is not obvious, as this Report will explain. Transit serves other goals besides high ridership, and some of those goals trade-off against high ridership.

No public service that is working with a limited budget, whether we are talking about schools, parks, emergency response or transit, can maximize its performance towards every goal simultaneously. Limited budgets require us to make trade-offs among the outcomes we value.

In transit, certain outcomes trade-off against one another. We will refer to these as "trade-offs," or "competing goals" or even "conflicting goals." These trade-offs are difficult because reasonable people can and do disagree about how to make them.

Every transit agency balances competing goals, making those trade-offs, in particular ways. There is no objectively-better way to make such trade-offs, and different agencies in different urban areas will make different choices.

The next step in this process will be to gather your input on how DART should make those choices, balancing competing goals within its limited budget. The timeline for this project and the ways that public input will be gathered are described starting on page 22.

Why focus on the bus network?

Most transit riders use the bus

People who use DART are a bit more likely to use a bus as part of their trip than light rail. As of 2014, 71% of transit trips included at least one bus ride. This is true despite the generally worse frequencies, slower speeds and shorter hours of service on bus lines than on light rail lines.

Even in major world cities with huge rail and subway networks, enormous numbers of people travel by bus. Bus service is much less expensive to operate than rail, bus vehicles are easier to purchase and maintain than rail vehicles, and bus service does not require lengthy and costly construction projects. Nearly every city with a high-ridership rail network has a high-ridership bus network.

U.S. regions with growing ridership have updated their bus networks

Most U.S. transit agencies have seen declining transit ridership over the past decade. The exceptions are those cities where transit service has been increased or redesigned. Cities and counties like Seattle, Palm Beach, Houston, Columbus and Richmond redesigned their bus networks with the expressed intention of increasing ridership, and as a result their ridership has grown or remained steady.

Buses break through the limits imposed by physical space

Urban areas are by definition places where people come together to do business, socialize, education themselves, live in families, share knowledge and access all of the other opportunities that come from being close to other people. Every successful urban place bumps up against physical limitations on how many people can move if they all move in small vehicles:

- **Severe road space limitations.** The width of most roads and freeways in the DFW area is fixed, and they will not get any wider.
- **Parking limitations.** Places to store private cars and hired cars when they are not in use are costly, compared to the other ways such real estate could be used in a growing city.
- **Intensification of land use.** The DART Service Area is growing, and growing more dense, thus these space limitations are only going to get more severe.

These factors mean that more and more people are competing for a fixed amount of road space. If they are all in cars, they simply do not fit in the space available. The result is congestion, which cuts people off from opportunity and stifles economic growth.

The photo below illustrates how buses and bikes use exponentially less space than cars. Even autonomous cars cannot change this basic geometric challenge, as they take up almost the same amount of space as today's cars. Carpools that carry three to four persons per car are marginally helpful but still do not approach the space efficiency of people walking, cycling or riding transit.

The way to reduce congestion in cities is to either cease economic growth, or to get a larger share of people using transit and other space-efficient modes.

Transit ridership has declined

In the past twenty years, DART's bus ridership has grown and then declined. The graph at right shows total bus and rail ridership since 1994.

Sometimes bus ridership falls when new light rail lines are opened that replace high-ridership bus lines. This has happened only modestly for DART and for other agencies that invested heavily in light rail in the 1990s and 00s, because most light rail lines of that era were sited alongside freeways or freight rail lines, where no bus routes ran before. In addition, the DART light rail lines were designed for faster long-distance travel, so stations are far from one another, and bus service is still needed to cover areas between stations. As a result, DART light rail lines have not entirely replaced many bus routes.

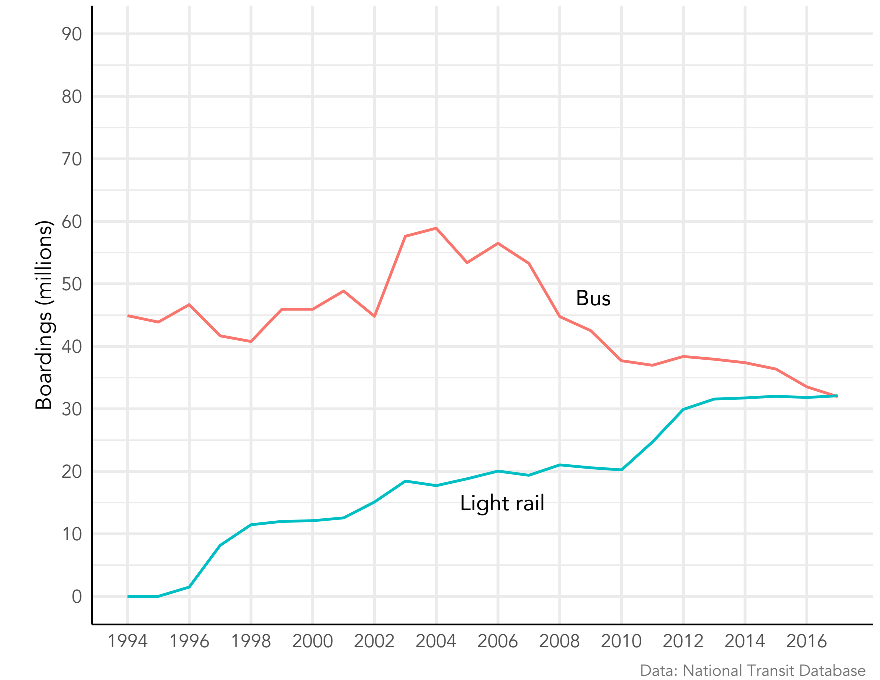
Total bus and rail ridership naturally rises and falls as the amount of service provided rises and falls. To control for the rise and fall of service levels that accompanies economic cycles, we can divide total ridership by the amount of service provided. This is the "productivity" of a network or a route – its ridership relative to service or cost. In the graph at right, total bus and rail ridership are divided by the amount of service provided on each network over the past twenty years.

Much of the drop in light rail productivity is a function of the Orange Line expansion combined with the recession. Bus ridership decline is reflecting the number of downtown workers who live outside of the DART Service Area.

A portion of bus ridership decline is due to deteriorating counting technology on the bus fleet resulting in under counting. In 2018 when new counting technology was put in place, counted boardings increased by 35%, and more on weekends. The counting equipment was believed to be declining over time, so the under-counting was increasing over the years and at its worst in 2017.

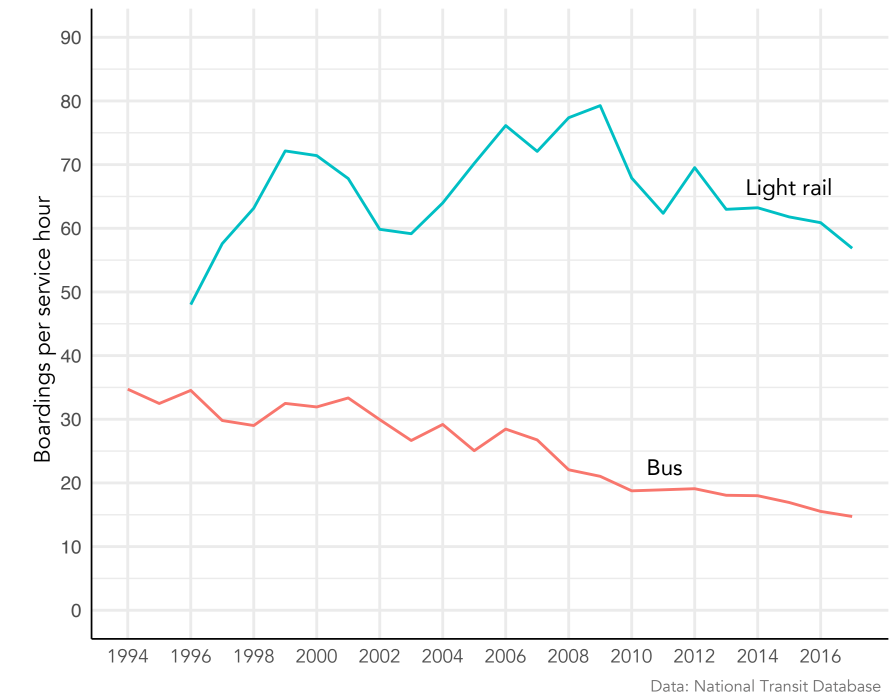
DART Ridership

Boardings, 1994-2017



DART Productivity

Ridership relative to service, 1994-2017



Bus ridership has gone up and down since 1994; light rail ridership has grown steadily as new lines have opened (as shown at top). However, once we control for the amount of service supplied, a concerning downward trend appears, especially on the bus network (as shown at bottom).

What can transit do?

Transit can serve many different goals. Different people and communities value these goals differently. It is not usually possible to excel towards all of these goals at the same time, and certainly not within a limited budget.

Understanding which goals matter most in the DART Service Area is a key step in redesigning the transit network.

Possible goals for transit include:

- **Economic**: transit can give businesses access to more workers, and workers access to more jobs, and give students more access to education and training. Transit can also allow for continued economic growth beyond what congestion would prevent.
- **Environmental**: increased transit use can reduce air pollution and greenhouse gas emissions. Transit can also support more compact development and help conserve land.
- **Social**: transit can help meet the needs of people who are in situations of disadvantage, providing lifeline access to services and jobs.
- **Health**: transit can be a tool to support physical activity by walking. This is partly because most riders walk to their bus stop, but also because riders will tend to walk more in between their transit trips.
- **Personal Liberty**: By providing people the ability to reach more places than they otherwise would, a transit system can be a tool for personal liberty, empowering people to make choices and fulfill their individual goals.

Some of these goals are served by high transit ridership. For example, transit can only support continued economic growth without congestion if many people ride the bus rather than drive. The environmental benefits of transit also only arise from ridership. Subsidy per rider is lower when ridership is high. We call such goals "ridership goals" because they are achieved through high ridership.

Other goals are served by the simple presence of transit. A bus route through a neighborhood provides residents insurance against isolation, even if the route is infrequent and few people ride it. A route may fulfill political or social obligations, for example by getting service close to every taxpayer or into every municipality. We call these types of goals "coverage goals" because they are achieved in part by covering geographic areas with service, rather than by high ridership.

High ridership is not transit's only goal

If DART wanted to maximize transit ridership, it would focus service where and when it could be useful to the most potential riders. DART would be thinking like a business, focusing on places where its service is competitive for a large number of people.

Businesses are under no obligation to operate where they would spend a lot of money to reach few customers.

For example, Whataburger is under no obligation to provide a store within one mile of everyone in the DART Service Area. If it were, then the company would have to add hundreds of additional locations, some serving just a handful of homes, and most operating at a loss because of the few customers nearby.

People understand that rural and suburban areas will naturally have fewer Whataburger locations than urban areas. We don't describe this as Whataburger being *unfair* to rural or suburban areas; they are just acting like a private business. Whataburger has no obligation to cover all areas with its restaurants.

Transit agencies are not private businesses, and most transit agencies decide that they do have some obligation to cover their service area. The elected and appointed officials who make public transit decisions hear their constituents say things like "We pay taxes too" and "If you cut this bus line, I will be stranded" and they decide that coverage, even in low-ridership places, is an important transit outcome.

Transit agencies are often accused of failing to maximize ridership, as if that were their only goal. In fact, they are intentionally operating "coverage services" that are not expected to generate high ridership. Such coverage services are sometimes visible to the public as mostly-empty buses or trains.

Agencies must balance the competing goals of high ridership and coverage. The smaller an agency's budget relative to its service area, the harder the trade-off between those competing goals.

Is an empty bus a sign of failure? That depends on why you're running it in the first place.

Introducing the network

The maps on this and the following pages introduce a style used throughout this report, in which **route colors represent frequency**.

Red lines are frequent service, with a bus coming every 15 minutes or better, in the midday on weekdays. Purple lines run about every 20 minutes. Dark blue lines run about every 21-30 minutes and light blue lines are the least frequent, with more than 30 minutes between buses. Some bus routes offer better frequency than indicated on this map during weekday rush hours, and some offer poorer frequency at night and on weekends.

Rail lines are shown in gray. DART's light rail lines come every 20 minutes at midday. The commuter rail line to Fort Worth comes once per hour at midday on weekdays but does not run on most Sundays.

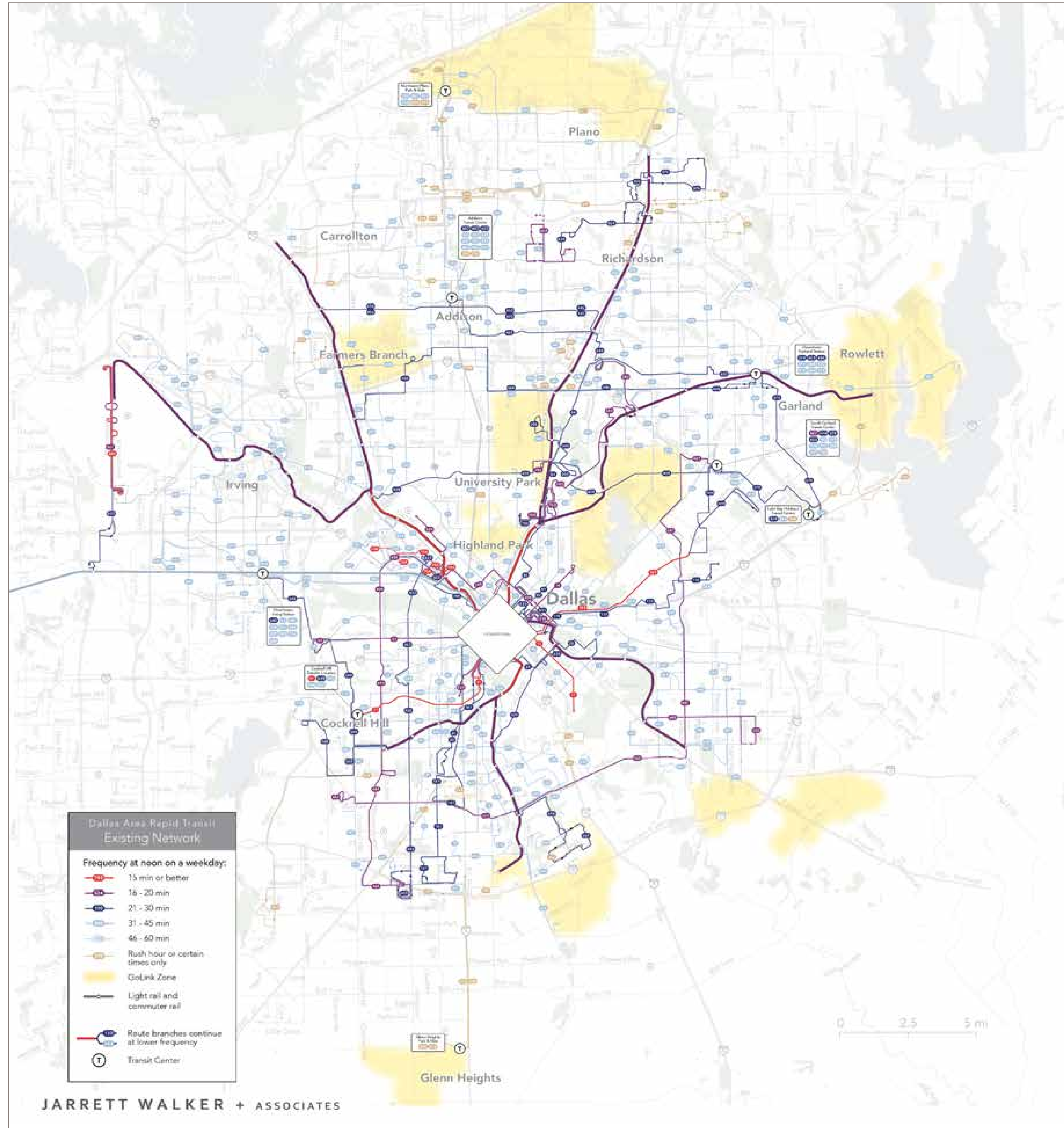
This map makes obvious just how little of the DART network offers high-frequency service. Standard practice in the U.S. transit industry is to describe a service with 15 minutes or fewer between arriving vehicles as "frequent." By that definition, outside of rush hours only one of DART's rail lines is frequent, and very few bus lines are frequent.

DART is somewhat unusual among large U.S. transit agencies for having:

- A very large service area, with continuous low-density development throughout the service area (rather than large rural gaps).
- A large service area population.
- A large light rail network but without much all day high-frequency light rail service.

Because the service area is so large, travel distances are long and transit speed is important as well as transit frequency. The light rail system was designed with speed in mind, which is why many light rail stations are spaced far apart and have bus service covering the areas in between them.

Bus networks are much less expensive to provide than trains, which carry a high capital cost, and can therefore be provided in many more places than trains. Most DART bus routes run on surface roads where, unlike on freeways, buses can stop and large numbers of people can access bus stops. But buses in mixed traffic are terribly slowed by congestion. Without protection from congestion, the DART bus network will not deliver the high speeds that make long-distance regional transit travel compelling and competitive.



How frequent is frequent enough?

In transit conversations, there is always a great focus on *where* transit is provided, but sometimes not enough attention paid to *when* it is provided.

The "when" of transit service can be described as "frequency" or "headway" (how many minutes between each bus) and "span" (how many hours per day, and days per week, it runs). This determines whether service is there when the customer wants to travel.

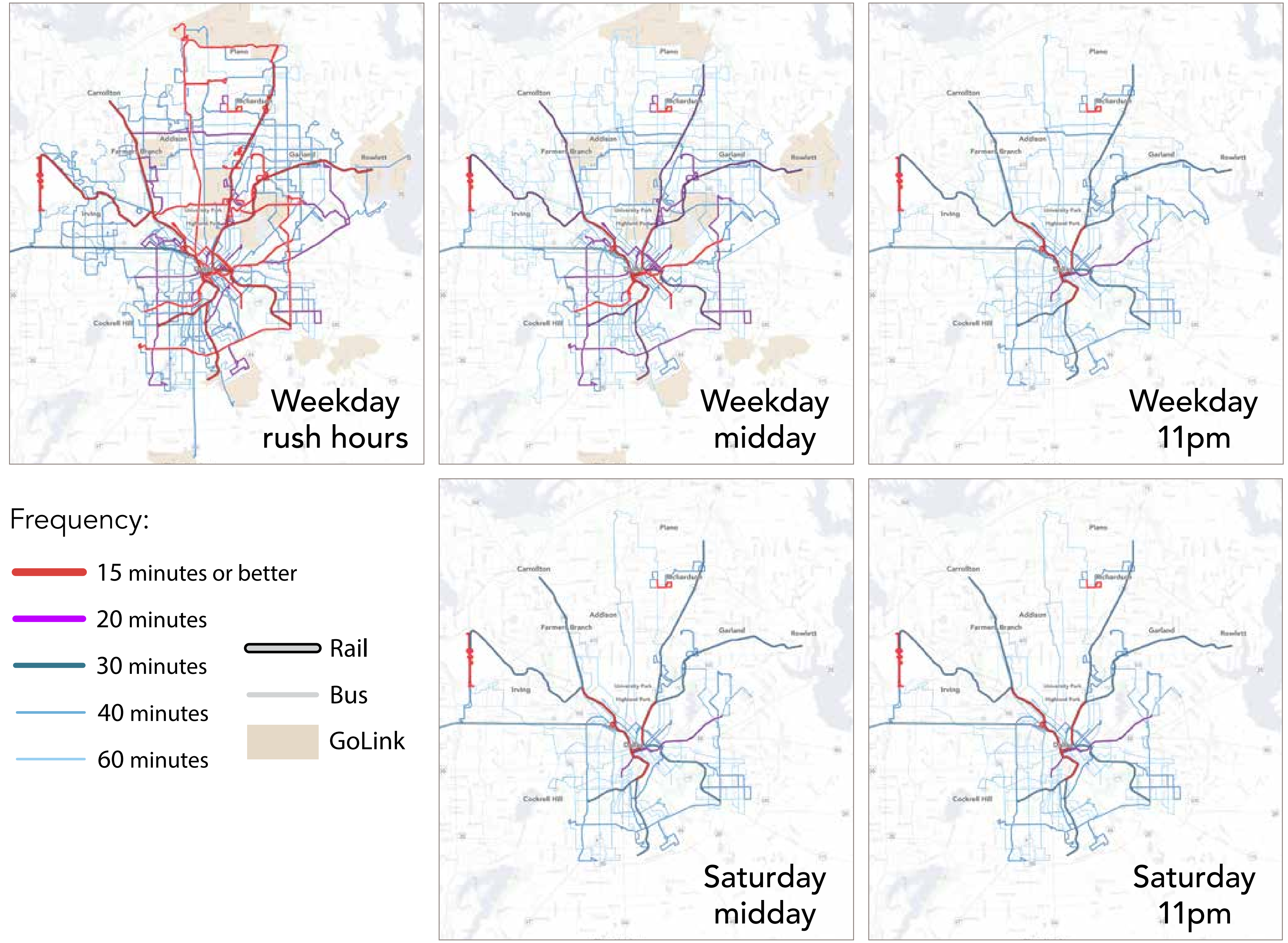
The small maps at right show how rail and bus frequencies change over the course of a weekday and the weekend in the DART network. The highest frequencies are offered during weekday rush-hours (top left). With capital investments, the combined rail corridors have the potential to offer frequencies as often as every 7.5 minutes. There are numerous places where transfers between frequent bus and rail lines are possible, involving only a short wait. On evenings and weekends, only combined rail corridors and select shuttles are coming every 15 minutes.

Frequent service:

- Reduces waiting time (and thus overall travel time).
- Improves reliability for the customer, because if something happens to your bus, another one is always coming soon.
- Makes transit service more legible, by reducing the need to consult a schedule.
- Makes transferring (between two frequent services) fast and reliable.

In order to think about whether any frequency is "frequent enough," imagine waiting one-half of the frequency, on average (since statistically, you will) and ask yourself whether you could tolerate waiting that long as part of an everyday trip.

Many people assume that today, when so many transit systems offer real-time arrival information, nobody needs to wait for a bus anymore, and frequency therefore doesn't matter. If a bus only comes once an hour, that's fine, because your phone will tell you when it is a few minutes away and you should walk to the stop.



The frequency of DART rail lines and bus routes falls off outside of rush hours.

Despite all these new technologies, frequency still matters enormously, because:

- Waiting doesn't just happen at the start of your ride, it also happens at the end. You may not need to leave the house long before your departure, but if your bus is infrequent, you have to choose between being very early or too late. If you start work at 8:00 am but the hourly bus passes your workplace at 8:10 am, you can be 50 minutes early or 10 minutes late.
- Many of the places we go don't let us hang out until our bus's arrival is imminent. We can easily do this when leaving home, but it is more awkward when leaving a restaurant or a workplace that is closing.

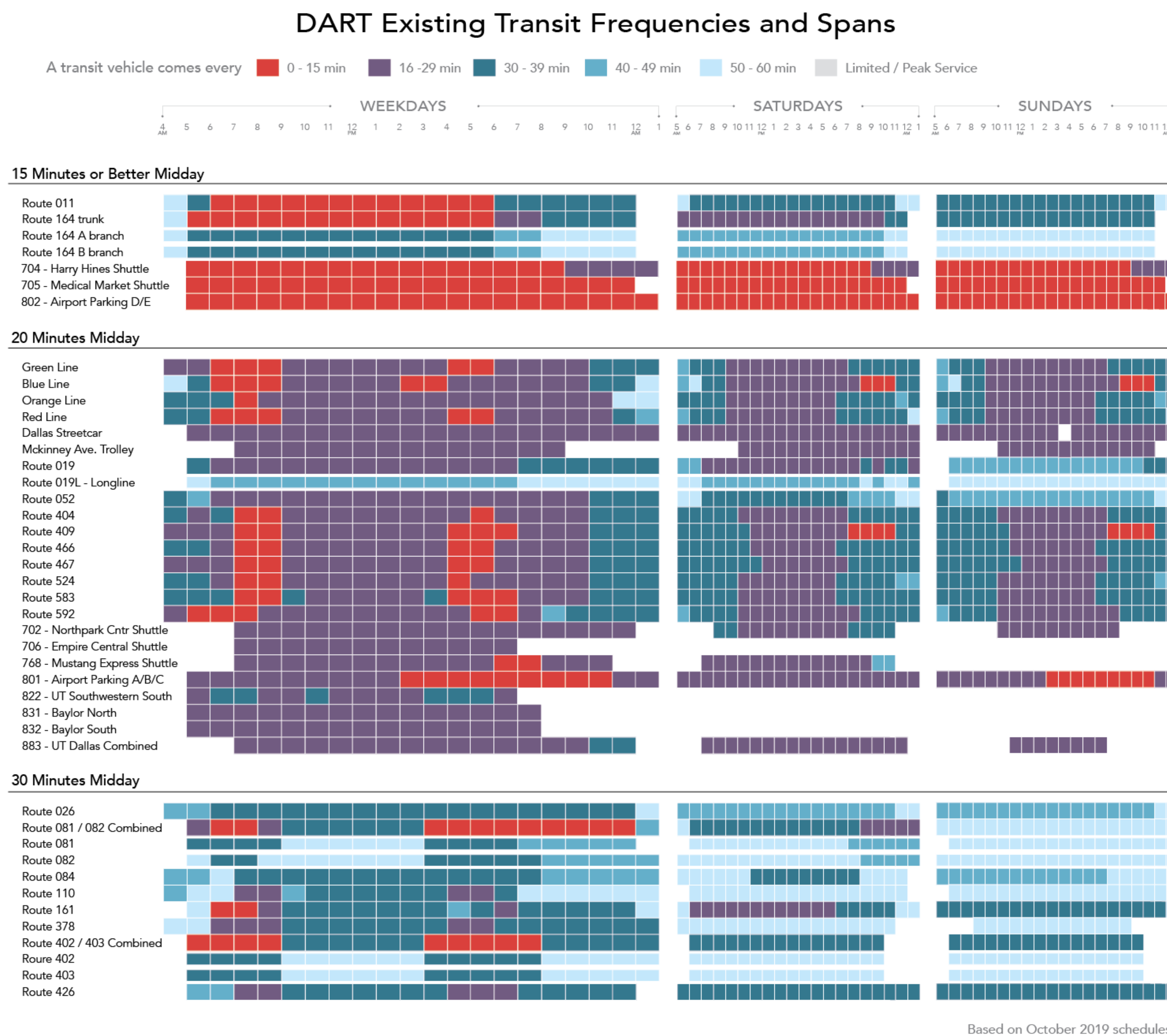
Real-time arrival information doesn't make the bus more reliable, but frequency does.[1] Your phone can tell you when your bus is arriving, but it cannot prevent your bus from having a problem and being severely delayed, or not showing up at all. Only frequency—which means that another bus is always coming soon—can offer this kind of reliability.

The table at right describes DART's most frequent light rail and bus lines. It shows their frequency during each hour of the day (using color), across a weekday, Saturday and Sunday.

Frequencies of 15-minutes or better are rush hours are visible in the two rough bands of red running vertically through the chart. The most frequent routes and lines offer 20-minute service until about 10 pm on weeknights. On weekends, some 20-minute frequencies are offered during midday, when transit becomes busy with people running errands or socializing, and when service workers change shifts. Few routes offer frequencies as high as every 20 minutes on weekends – most routes come every 40 minutes or worse, if at all, on weekends.

Offering long spans of service throughout the day and week, in places where large numbers of people can use transit, is key to attracting high ridership over time. This allows many people to choose to rely on transit, forgoing an owned or hired car and choosing to live or work in places where they can take advantage of transit. If the transit network is only there during certain hours or certain days, few people will make the choices and build the habits that turn them into consistent transit riders.

All four pages of this table, showing all routes operated or funded by DART, are shown starting on page 91.



1 Real time information is also compiled and reviewed by staff order to improve schedules and reliability, but cannot make the same impact on reliability as increasing frequency.

Municipal leadership is essential

DART's 13 member cities do far more than raise the sales tax revenue needed to fund transit service. They also shape the transit environment. In doing so they are as responsible for transit outcomes as is DART. The two biggest transit-ridership factors that local leaders control or influence:

- **Land use:** Cities decide whether more people and jobs will locate in places where they can be served by transit that is both cost-effective and useful.
- **Street design:** Streets and signals can protect transit from congestion, allow people to easily walk to and from transit stops, and offer direct transit paths through dense development.

The impact of these factors on transit's usefulness, transit's cost and how many people choose to ride is described starting on page 24.

Much can be learned from the success of the City of Seattle, which in 2004 became the first city to publish its own Transit Master Plan, even though it did not operate any transit itself. The City of Seattle has taken a leadership position on transit planning and transit-oriented development. Seattle recently began to raise funds locally in order to "buy-up" higher levels of service provided by its regional provider within the City. The original Transit Master Plan (since updated), and the on-going municipal leadership, are probably the biggest reasons that Seattle has had the most growth in transit ridership of any U.S. region in recent years.

Key choices

In the last chapters of this report, we lay out some key choices that DART is likely to face in redesigning its bus network.

Longer walks for shorter waits?

In places with many parallel routes, consolidating service onto fewer streets can allow an agency to offer riders higher frequencies. This could make peoples' trips faster, but it would mean a longer walk to service.

How important are rush-hours relative to all-day, all-week frequency?

The urban transportation industry has traditionally focused on rush hour travel, rather than all-day and all-week travel. The reasons for this focus are partly historic (U.S. workers used to commute more at rush hours) and partly cultural (rush hour commuters are more affluent and influential).

DART transit ridership is somewhat higher during weekday rush hours than at midday, at night or on weekends. Providing extra service during rush hours comes with extra costs.

What is more important: Fully-serving rush hour demands, or providing more useful frequencies all day, everyday?

Are declining speeds tolerable?

Similar to many agencies, DART's service has been slowing down in the past decade, with average bus speeds dropping by 5-7% during weekdays since 2012. The slower buses run, the less frequency routes can provide within the same budget, and the less useful transit is to people in a hurry.

Transit agencies have no control over the operation of the roads, and therefore no control over how congestion affects bus speeds. Municipalities raise sales tax revenue for DART bus service, and they hold the power over street management. DART has been working with many of these Municipalities on solutions including bus only lanes, signal priority, and bus stop optimization, but ultimately it's up to Municipalities to protect their investment by changing the way streets are managed for transit.

How should ridership and coverage goals be balanced?

In every transit system's limited budget, a basic trade-off is made between:

- Services and decisions that increase ridership relative to cost (such as concentrating service into more frequent routes where the greatest number of people are), and
- Services and decisions that cover important places but do not yield high ridership relative to their costs.

About 55% of the existing DART bus budget is spent pursuing high ridership, and 45% is spent covering important places where ridership is low.

How should DART balance ridership and coverage goals in a redesigned network?

Is the appropriate balance-point the same if, in the future, additional funding is available for more bus service, or does it change?

Who will be consulted?

Many different people will be involved in guiding this plan:

Transit riders will be engaged through surveys, outreach at bus stops and stations, and a stakeholder advisory group.

People living on low incomes are particularly important stakeholders in this process. They will be reached in their own communities, and will be invited to participate in the stakeholder advisory group.

People of color and non-English speakers are also important to this process, and will be asked for their opinion directly as well as represented by community leaders at the stakeholder advisory group. DART staff and the consultant team will conduct surveying and outreach in Spanish as well as English.

Civic and neighborhood leaders will be invited to take and distribute surveys and to participate in the stakeholder advisory group.

Employers and businesses will be engaged individually and through the region's many Chambers of Commerce, and will be invited to participate in the stakeholder advisory group.

Municipal staff will work with DART staff and the consulting team to design the New Bus Network.

Local elected officials will receive briefings from DART staff and will be invited to participate in or send delegates to the stakeholder advisory group.

The members of the DART Board of Directors will direct DART staff in how to balance competing goals in a redesigned network. Input gathered from the groups of people described above will inform their decision about this difficult trade-off.

How will input be gathered?

This project has three phases, and this Choices Report begins the first phase.

In Phases 1 and 2 of this project, input will be gathered through:

- Online surveys, presented in English and Spanish
- In-person surveying or events may take place if possible given social distancing requirements
- Pop-up events at busy locations around the region
- Online webinars and videos
- A regional Transit Summit of community leaders

Anyone who wants additional information, has questions or wishes to make a comment should contact the project team, at any time, at **serviceplanning@dart.org**

Your voice matters! Contact the project team and take the survey at dartzoom.dart.org.

PHASE 1

Network Concepts

Spring and Summer 2020

After evaluating the existing transit network, DART staff, municipal partners and the consulting team have designed a pair of contrasting Network Concepts to illustrate key choices.

Transit riders, stakeholders, employers, workers and community leaders will be consulted on how DART should make these choices.

PHASE 2

Draft New Bus Network

Late 2020 and Early 2021

A Draft New Bus Network Plan, including transit networks at existing and higher funding levels, will be designed by DART staff, municipal partners and the consulting team.

The Draft Plan will be shown to stakeholders and input will be gathered in many ways during Late 2020 and Early 2021.

PHASE 3

Final New Bus Network

Spring 2021

Based on input from the public in Phase 2, a Final New Bus Network Plan will be created for Board consideration in Spring 2021.

If the Board decides to adopt and implement the New Bus Network Plan, the soonest service changes would occur is January 2022.

3 How Transit Works

Development patterns affect ridership

Achieving high ridership requires more than good transit service. Many factors outside the control of DART – land use, development, urban design, street networks – affect transit's usefulness. This is why land use planning by cities and counties is such an essential part of transit's success.

If DART wants to achieve higher ridership, then service must be focused on areas where high ridership is likely and operating costs are low. Land use decisions, can arrange development in patterns that DART can reach with useful, frequent transit, for a reasonable operating cost.

The way that DART could attract higher ridership, within a fixed budget, is by targeting places where the "Ridership Recipe" is in effect:[1]

Density: Demand for transit is higher when there are more people, jobs and activities near each transit stop.

Walkability: Service is only useful to people who can safely and comfortably walk to the transit stop.

Linearity: Direct paths among destinations are faster, cheaper for DART to operate, easier to understand and more appealing.

Proximity: Shorter distances between destinations attract more riders per hour and are cheaper for DART to operate.

These are geometric facts of an urban area and its design. They are not a matter of opinion or personal values, unlike the Key Choices presented in this report.

For example, some people react strongly to the term "density" and infer a value or judgment that must come with it. Yet density is a simple geometric fact: the number of people close to any given transit stop.

All of these factors affect both the costs of providing transit in a particular place and how many people will find the service useful.

Density and walkability tell us about the overall ridership potential: "Are there are a lot of people around, and can they get to the transit stop?"

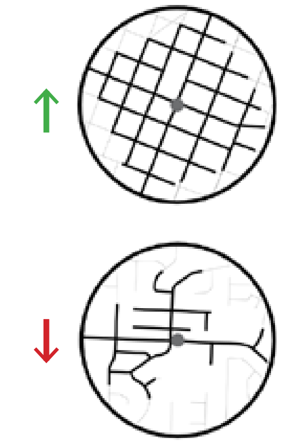
Linearity and proximity tell us about both ridership potential and

1 Research describing the relationships among transit ridership, transit cost, and land use and street design factors is abundant. For an introduction, see *Travel Demand and the 3Ds: Density, Diversity and Design*, by Cervero and Kockelman and *Travel and the Built Environment: A Synthesis*, by Ewing and Cervero.

The Ridership Recipe: Higher Ridership, Lower Costs

Density *How many people, jobs, and activities are near each transit stop?*

Walkability *Can people walk to and from the stop?*

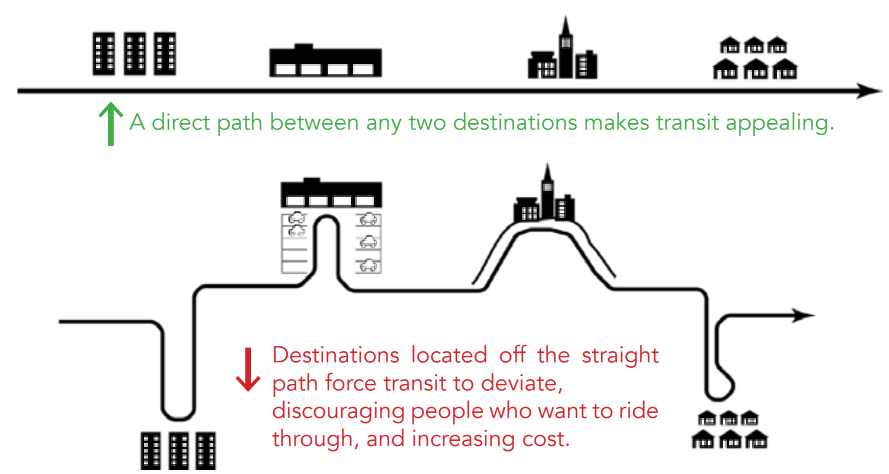


The dot at the center of these circles is a transit stop, while the circle is a 1/4-mile radius.

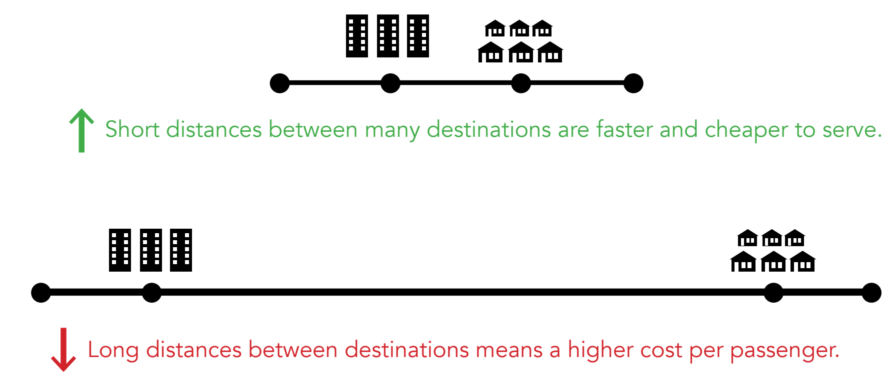
The whole area is within 1/4 mile, but only the black-shaded streets are within a 1/4-mile *walk*.

It must also be safe to cross the street at a stop. You usually need the stops on both sides for two-way travel!

Linearity *Can transit run in reasonably straight lines?*



Proximity *Does transit have to traverse long gaps?*



Land use and street design affect how many people can use transit, how much it costs to operate and therefore the level of service that can be provided.

cost: "Are we going to be able to serve the market with fast, direct lines, or will we have to run indirect or long routes, which cost more to operate (and cost riders time)?"

The mix of uses along a corridor also affects how much ridership transit can achieve, relative to cost. This is because a mix of uses tends to generate demand for transit in both directions, at many times of day.

Transit lines serving purely residential areas tend to be used in mostly one direction and mostly during rush hours – away from the residential neighborhood, towards jobs and services. Transit serving a mix of uses can be full in both directions, all day and all week, which results in higher ridership relative to costs. For example, DART's bus lines between Addison and Dallas tend to fill up in both directions during the morning, while buses into downtown Dallas from areas with many residences but few jobs are full only in-bound, and go back out empty. DART bears the costs of running empty buses back to the start of the route, without ridership to show for it.

Demographics also affect transit ridership. Lower-income people have a big incentive to choose transit rather than owning or hiring a car. People who are young or old are less likely to drive, and also have a big incentive to choose transit. If the Ridership Recipe is not enforced, peoples' incomes or age alone won't generate high ridership relative to costs, but income, age, disability and race can be compelling reasons to provide service without an expectation of high ridership.

Ridership and coverage goals conflict

Ridership and coverage goals are both laudable, but they lead us in opposite directions. Within a fixed budget, if a transit agency wants to do more of one, it must do less of the other.

Here is an illustration of how ridership and coverage goals conflict with one another, due to geometry and geography.

In the fictional city at right, the little dots indicate dwellings and commercial buildings and other land uses. The lines indicate roads. Most of the activity in the city is concentrated around a few roads, as in most cities.

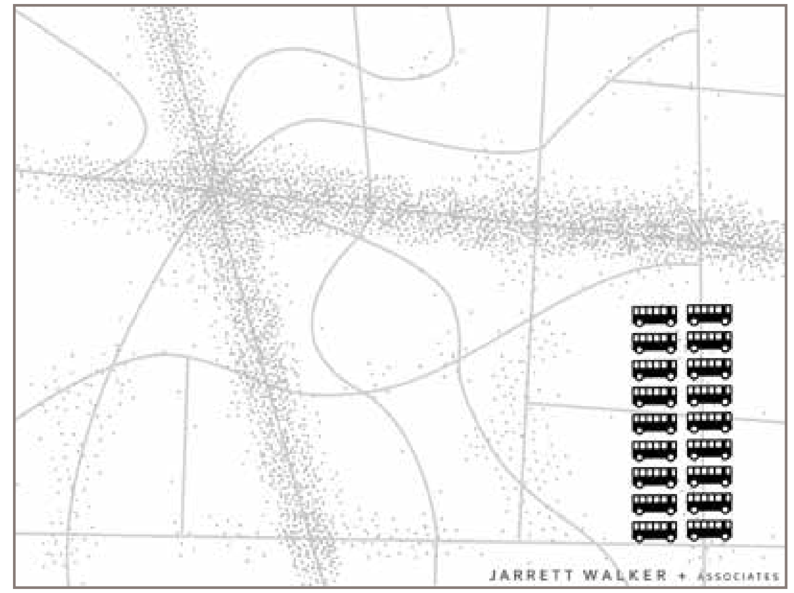
A transit provider pursuing only a ridership goal would focus service on the streets where there are large numbers of people, where walking to transit stops is easy, and where the linear routes feel direct and fast to customers. Because service is concentrated onto fewer routes, frequency is high and a bus is always coming soon. This would result in a network like the one at bottom-left.

If the city were pursuing only a coverage goal, on the other hand, it would spread out services so that every street had a bus route, as in the network at bottom-right. As a result, all routes would be infrequent, even those on the main roads.

On a fixed budget, designing transit for both ridership and coverage is a zero-sum game. In the networks at right, each bus that the transit provider runs down a main road, to provide more frequent and competitive service in that market, is not running on the neighborhood streets, providing coverage. While an agency can pursue ridership and provide coverage within the same budget, it cannot do both with the same dollar. The more it does of one, the less it does of the other.

These illustrations also show a relationship between coverage and complexity. Networks offering high coverage are naturally more complex. In high coverage networks, riders are more likely to use just one or two routes regularly. In high frequency networks, more riders use many routes regularly, because transferring among routes is easier and more reliable thanks to the high frequencies.

In this imaginary city, any person could keep the very simple high frequency network in their head, since it consists of just two routes, running in straight lines. They would not need to consult a schedule to catch a bus because a bus would always be coming soon. The coverage network would be harder to memorize, requiring people to consult a map (to understand the routing) and a schedule (to catch these infrequent services).



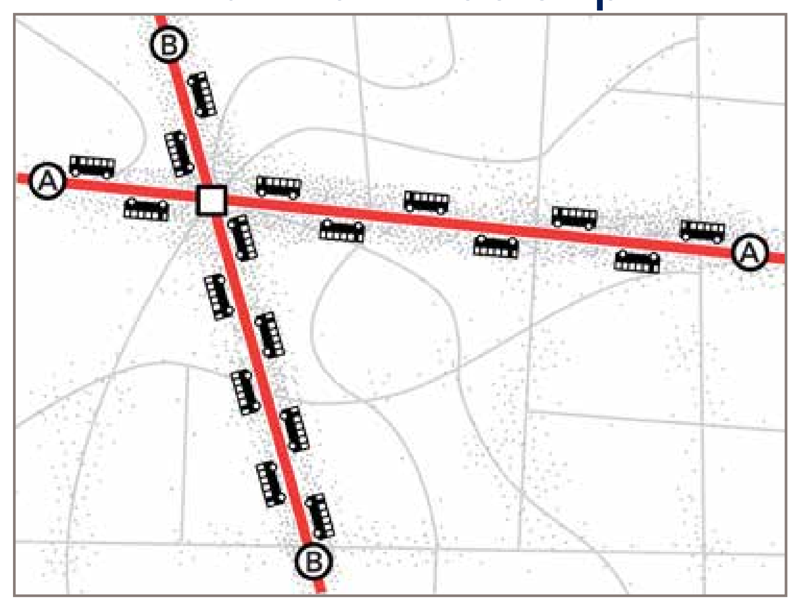
Imagine you are the transit planner for this small imaginary city.

The dots scattered around the map are people and jobs.

The 18 buses are the resources the city has to run transit.

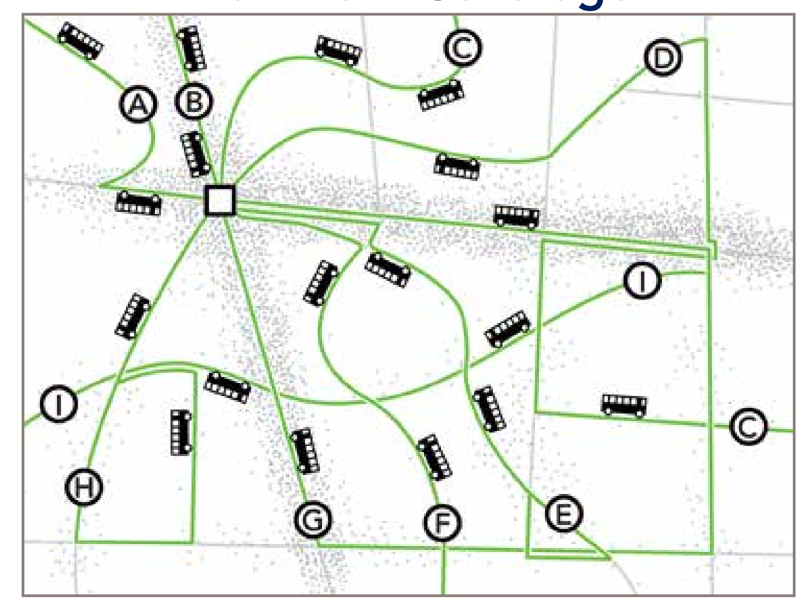
Before you can plan transit routes, you must first decide: What is the purpose of your transit system?

Maximum Ridership



You can focus your 18 buses on the busiest areas. Waits for service will be short but walks to service will be longer for people in less populated areas. Frequency and ridership will be high, but some places will have no service.

Maximum Coverage



You can spread your 18 buses around so that there is a route on every street. Everyone lives near a stop, but every route is infrequent and waits for service are long. Only a few people can bear to wait so long, so ridership is low.

Ridership and coverage goals, both laudable, come into conflict within a fixed budget. Few transit providers design their networks to be 100% Maximizing Ridership (as at left). Most urban transit networks are somewhere on the spectrum between these two extreme examples: some of the budget is spent concentrated into routes that attract high ridership relative to cost, and the rest of the budget is used to provide coverage.

Productivity

Some transit agencies and cities have adopted a goal of "maximizing ridership." Implicit in this statement, however, is a constraint: there is a limit to how much funding is available to increase ridership. The transit agency cannot spend infinite amounts of money pursuing each additional rider.

People who value the economic or environmental benefits of transit will talk about ridership as the key to meeting their goals. However, because their transit agency is operating under a fixed budget, the measure they should be tracking is not sheer ridership but ridership relative to cost. They would not be satisfied simply by a big ridership number until they knew what it cost to achieve that large dot.

Ridership relative to cost is called "productivity." There are two ways to measure productivity. The most broadly-useful measure is the number of people boarding each bus per hour that the bus and its driver are in service:

Boardings ÷ Vehicle service hours provided on the route

This measure gives a sense of how many people are using transit, how many lives it touches. The costs of transit are more affected by the time that a bus and driver are on the road than the miles driven or the size of the bus, which is why a service hour is a decent proxy for operating cost.[1]

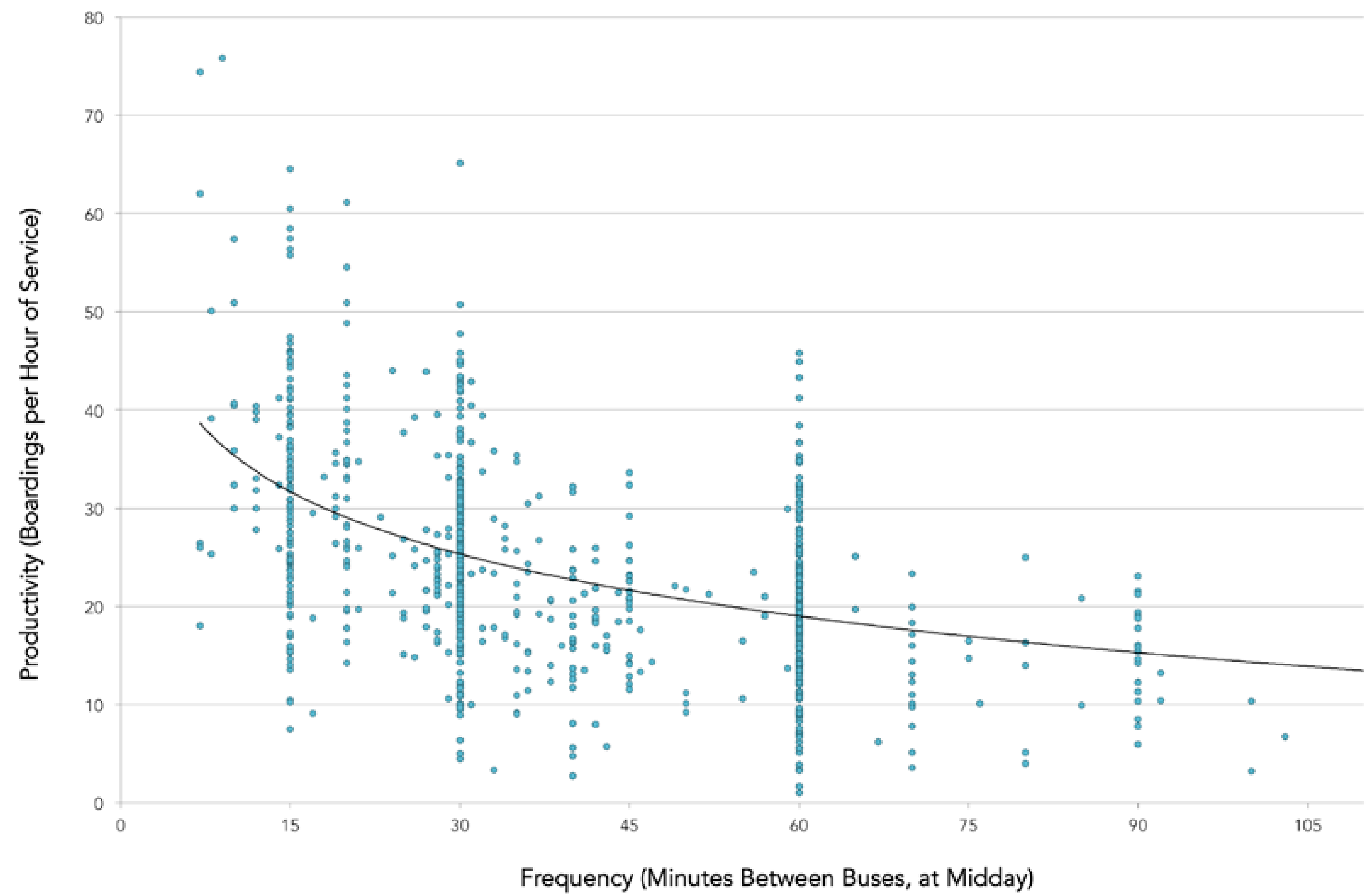
The other way to measure productivity is to count the number of passengers on a bus for every mile that it travels.

Passenger miles ÷ Vehicle service miles provided on the route

This measure gives us a sense of how many miles are avoided that passengers might have otherwise driven a car, relative to the miles driven by buses. This is a more appropriate measure for longer-distance expresses buses, which get all their boardings at one end of a long route and can't take more boardings than the number of seats in the bus, but then drive those people a long distance.

Productivity is strictly a measure of achievement towards a ridership goal. Services that are designed for coverage goals will likely have low productivity. This does not mean that these services are failing or that the transit agency should cut them. It just means that their funding is not being spent to maximize ridership.

1 Service hours include time the bus and driver are on the route, serving customers, as well as the extra "recovery time" built into schedules to protect against delay and to allow for connections with other trains and buses. Recovery time is an essential part of the service offering on each route, because it can support connections with other routes and it supports reliability. However, it also reduces the effective speed of a route for passengers, if it is scheduled to take place mid-route rather than at the ends, and it often must be.



More frequent routes are likely to be more productive, even though higher frequencies cost more to provide.

Frequency and productivity relate

The service hours provided on any particular route, and to any particular stop, will depend on a few factors:

- The length of the route.
- The operating speed of the bus (since a slower operating speed means that covering the same distance takes more time).
- The frequency of service along the route (since higher frequency is created by more buses and drivers working the route simultaneously).
- The span of service along the route each day and each week.

Changing any of these factors will affect the denominator of the productivity ratio. For example, doubling the frequency of service on a route will double the number of service hours being supplied. This means the denominator of the productivity ratio has been doubled. We might therefore expect that productivity of the route would be cut in half – unless the numerator of the productivity ratio, boardings, were to also increase.

The scatter plot above shows every bus route in 24 mid-sized U.S. transit system, each plotted according to its frequency (on the horizontal axis) and its productivity (on the vertical axis). The data points form a diagonal cloud, up and to the left. More frequent services are more likely to have high productivity (ridership per service hour), even though providing high frequency requires spending more service hours.

However, we can not simply increase the frequency of any route and expect productivity to increase as well. In pursuit of higher system wide ridership, experienced transit planners tend to increase frequency on routes that are already highly productive, or routes serving areas with the Ridership Recipe (density, linearity, walkability and proximity) in force.

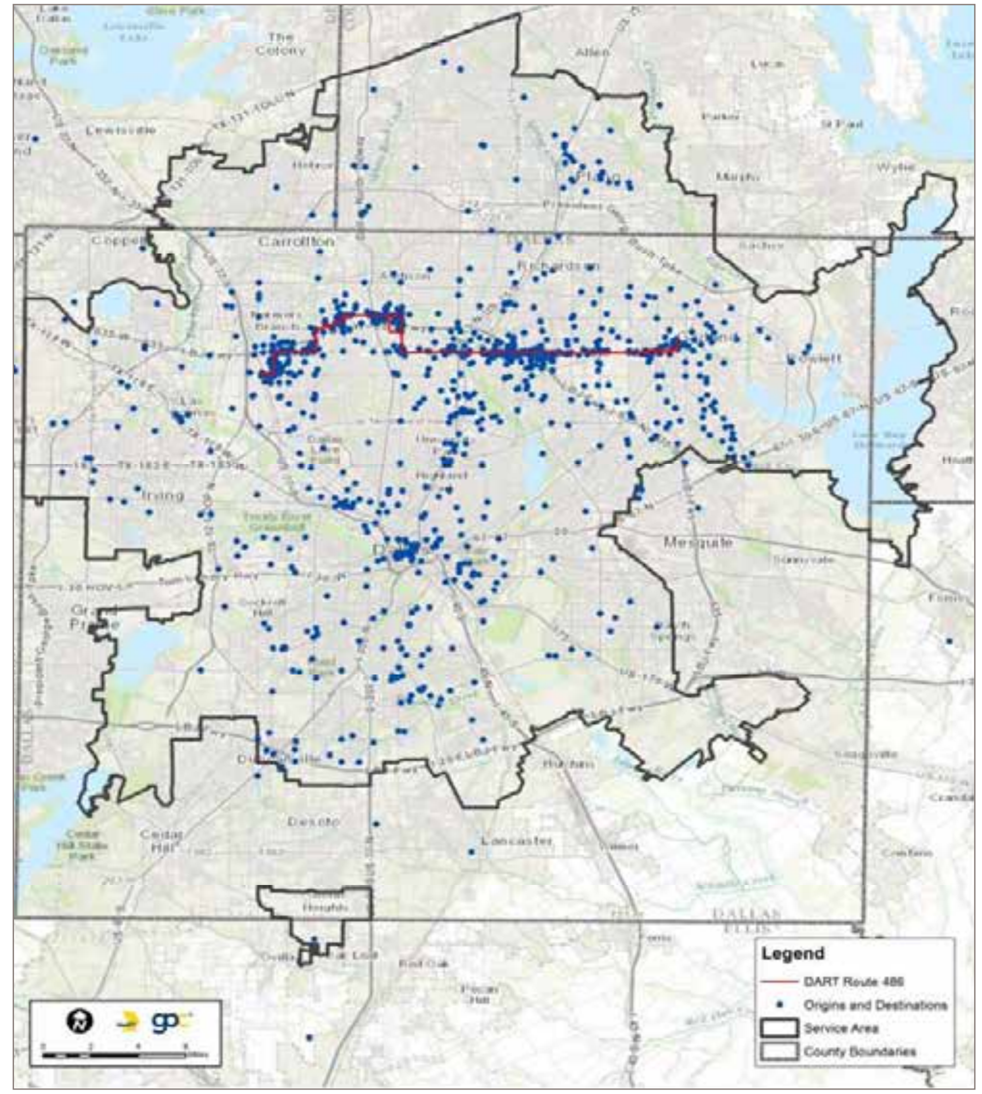
How lines can form a network

DART's bus routes and light rail lines are designed to form a network. Because they connect with one another in useful ways, people can use more than route or line to make a trip, and many people make trips far across the region using multiple lines. As a result, **a route that appears to be in one city is actually relevant for many cities**.

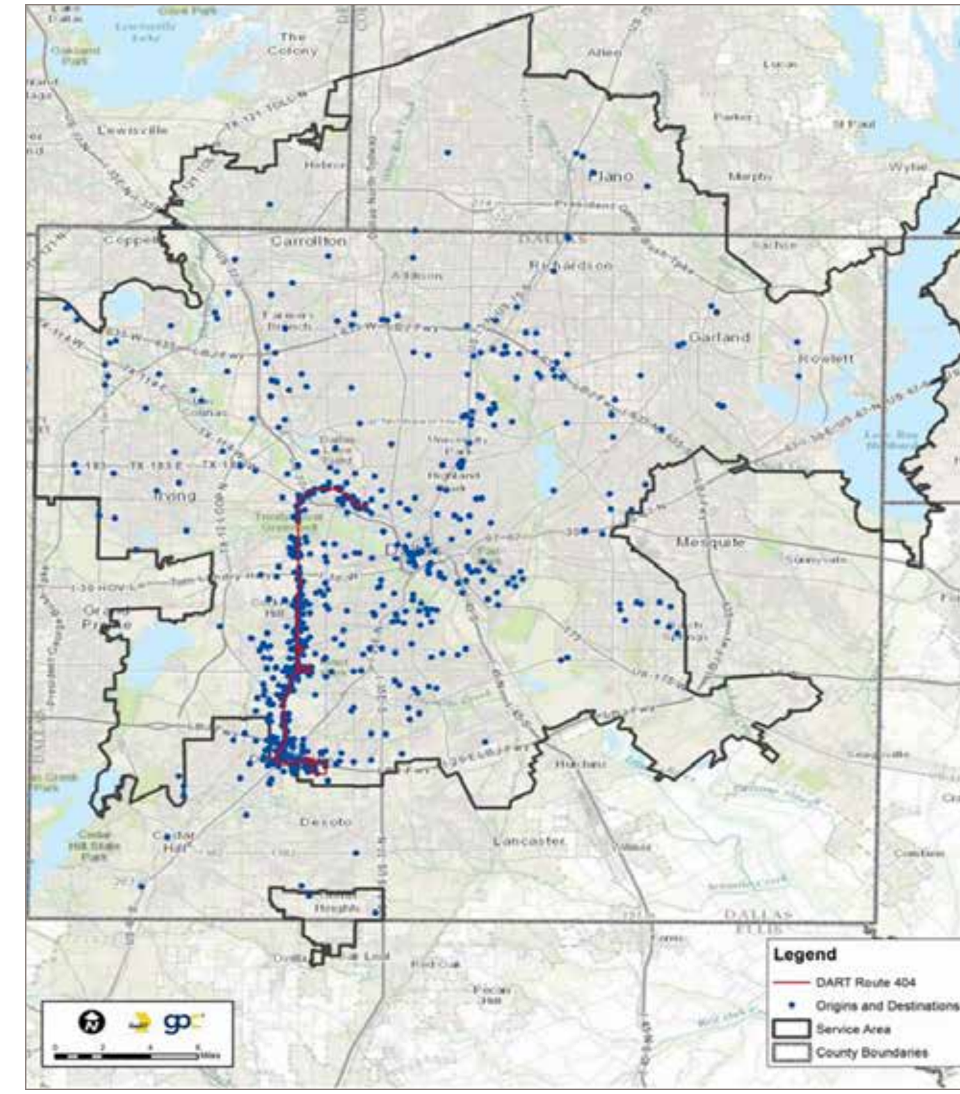
Route 486 is a crosstown route. It runs across the northern part of the DART area, between Downtown Garland Station in the east and Royal Lane Station in the west. Route 404 is a north-south radial route connecting Parkland Station (west of downtown) to Wheatland in the south.

Both routes, shown in the maps at right, work with the rest of the network to help people make trips to and from every one of DART's member cities. In a well-designed transit network, the network is broadly useful to people making many different trips. In a high-ridership transit network, more routes are like these: part of a connected network that is broadly useful to many different people, making many different types of trips at different times of the day and week.

Route 486 Riders' Trip Start and End Locations (2014)



Route 404 Riders' Trip Start and End Locations (2014)



A 2014 survey of DART riders' trip origins and destinations revealed how people from all over the region use most routes in the system. In the maps above, the start and end of each trip on Route 486 (from Downtown Garland Station to Royal Lane Station) and Route 404 (from Parkland Station to Wheatland) are marked by blue dots. These maps help reveal how both routes are relevant to people in all 13 of DART's member cities, even when they only passes through a few of them.

Basic Network Shapes

There are two basic network shapes that can be found in most transit systems, illustrated at right.

"Radial" networks have a central point, and nearly all routes go to that point. A radial network design ensures that anyone looking to travel downtown can make their trip without the need to transfer. Anyone going to another outlying place can get there with a single transfer at the center. Radial networks arose naturally in pre-car cities because so much commerce and culture was centralized.

As a city grows larger, radial networks become less practical because the out-of-direction travel required to get between two non-downtown points gets so much longer. In addition, since the invention of the car and freeways, most U.S. cities have developed many more "centers." A radial system struggles to serve multiple centers or sprawling and scattered development.

The DART light rail lines are built in a radial pattern. There is also a small radial bus network serving downtown Dallas, from neighborhoods that are too close to downtown to ask people to transfer to a light rail line.[1] There are small radial bus networks designed around light rail stations and Transit Centers in dense areas, such as the Addison Transit Center.

"Grid" networks also offer people a way to travel from anywhere to anywhere with a single transfer. But unlike in a radial network, the transfers in a grid network happen wherever two routes intersect.

In cities with many centers (such as LA, Chicago or Houston) a large frequent grid requires much less out-of-direction travel than a radial network would. A frequent grid offers the simplicity and reliability of a street network. It's easy to keep the map in your head.

The necessary precursors to a successful frequent grid, however, are high frequency bus routes, all day and all week. Radial networks can offer timed connections at their central point, so that most transfers from one route to another are quick and easy. Grid transfers happen at so many different places that they cannot be timed. Peoples' waiting time to make a grid transfer is random. The only way to offer a short random waiting time is to offer high-frequency on both connecting routes.

If two routes intersect, and each offers service every 40 minutes, the average wait to connect from one to the other will be 20 minutes. The worst possible wait will be 39 minutes! Very few people are willing to build their lives around such waiting times.

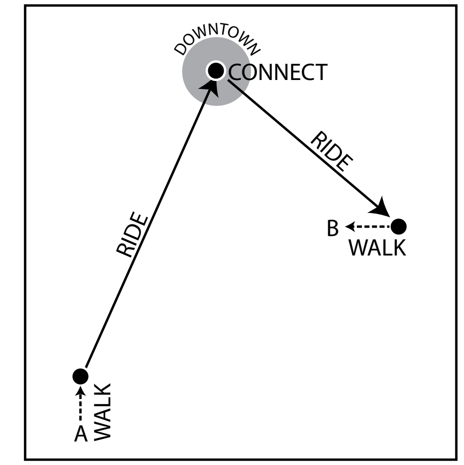
When two frequent routes cross, if each comes every 15 minutes, the average wait to transfer between them will be 7.5 minutes. The worst wait will be 14 minutes. Many more people are willing to build their lives around such short waiting times. High all-day and all-week frequencies make grid networks possible.

DART faces an additional challenge in creating a frequent grid due to the service area's discontinuous arterial street network. Gaps in the arterial street network results in additional complexities in the network as routes deviate to overcome these gaps, the resulting network sees reduced speeds and unintuitive routings.

These issues are exacerbated by the overall service area size, producing long-distance commutes for many workers. These long distances mean that high speeds will be critical, whether they be for radial trips (which DART has already invested in, using light rail) or non-radial trips. For a high-frequency arterial grid network to work well, buses will have to be protected from congestion and from delays so that crosstown rides are nearly as fast as radial rides.

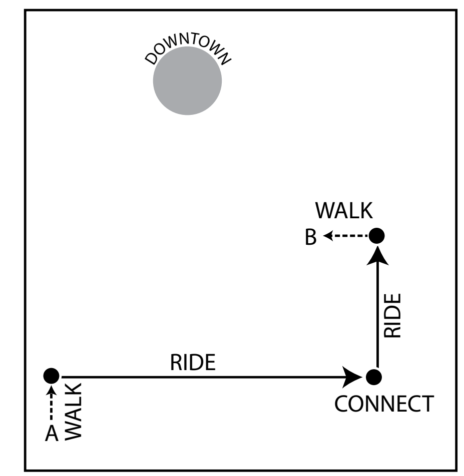
DART staff has estimated that offering a frequent grid network across its entire service area, during weekdays only, would cost at least $72 million per year (on top of the existing bus operating budget of about $110 million per year).[2] Especially once we consider the cost of providing frequent service on the weekends, a frequent grid across the entire service area is currently far out of reach.

Basic Network Shapes



Radial
Most routes lead to and from the center. Anyone wishing to travel from one non-central location to another must pass through downtown and transfer there.

A radial structure makes sense when one part of a city (typically the downtown) is a dominant destination. In a radial network many routes can be scheduled to converge at a set time (called a "pulse") to reduce the waiting time needed to transfer.



Grid
Parallel routes and intersect all across the city, not only in a downtown, and people transfer in those places.

Grid networks are only effective when the intersecting routes offer high frequencies so that connections between routes do not require long, discouraging waits. A grid structure is most suited to a city with multiple activity centers and corridors, where people are traveling among many different destinations.

Two basic shapes underlie most transit networks. Both allow for travel from anywhere to anywhere, with a single transfer. A radial network brings all routes together in a central place, whereas a grid network asks people to transfer wherever two grid routes intersect. Grid networks require high frequencies in order to work. Radial networks can offer civilized connections even without high frequencies.

1 The shorter peoples' trips, the more waiting time discourages ridership, and a transfer represents a second wait in a trip. This is why close-in neighborhoods are rarely asked to transfer to another line to reach a downtown.

2 2019 DART COA Update Existing Conditions Assessment.

4 Market and Need Assessments

In this chapter, we present and discuss data that inform two different types of considerations in transit planning:

- Where are the strongest markets for transit, with potential for high ridership and low operating costs?
- Where are there moderate or severe needs for transit, where coverage services may be important even if they do not attract high ridership?

The maps in this chapter are based on data from the U.S. Census Bureau.[1] Note that Census data is collected based on residential address, not based on workplace or shopping place or place of worship. This data shows us where people *live*, but not where they wish to *go*. Information about where people want to go will come from other data sources, from the knowledge of local planners and stakeholders, and from the public.

Market and need assessments

A "strong transit market" is mostly defined by *where* people are, and *how many* of them are there, rather than by *who* people are.

We learn about transit needs by examining *who* people are and what life situation they are in.

On the following pages, these maps and diagrams help us visualize potential transit markets and potential needs:

- Activity density map (combined **residential** and **job density**)
- Maps of **walkability**
- **Poverty** density map
- Diagram of **estimated travel** within and among cities

None of these data alone tell us that a place has high ridership potential and is therefore a strong transit market. Rather, we must consider them in combination.

If you asked a transit planner to draw you a very high-ridership bus route, that planner would look mostly at densities of all residents and jobs; at the walkability of streets and neighborhoods; and at the cost of running a bus route long enough to reach them. Only secondarily would that planner look into the income or age of those residents or workers.

However, the "who" attribute that has the strongest influence on transit ridership potential is income. Low income people are, as individuals, more likely to choose transit than higher-income people. This is especially true in suburban areas where driving and parking cars is so easy.

This is not to say that who people are is not important. It is extremely important, especially when contemplating whether and how to cover areas that do not generate high ridership.

If you asked a transit planner to draw you a route that helped as many people with severe needs as possible, they would look at where low income people, seniors, youth and people with disabilities live and where they need to go. The densities at which these people live matters, because at higher densities a single bus stop can be useful to more people in need. However, the transit planner might also try to get the route close to small numbers of people. In fact, the more distant and scattered people are, the more isolated they can be and the more badly they might need access to transit.

Civil rights assessment

Another important set of maps in this chapter is not strictly related to *need* but rather to civil rights, and that is maps showing **where minority residents live**. Unequal treatment on the basis of race or ethnicity is prohibited by Civil Rights Act of 1964. (Unequal treatment on the basis of other characteristics, including income and age, is also prohibited by law.)

A person's race or ethnicity does not tell us if they need transit, or if they have a propensity to use transit. However, we know that race and ethnicity are correlated with income. Providing equitable and supportive levels of service to minority people, even in areas that are costly to serve or that do not generate much transit ridership, can be an important element of a coverage goal.

The data shown in the maps in this chapter were used to evaluate the two Network Concepts and how they would affect access to service and mobility for low-income residents and minority residents.

1 The 2010 full Census and the 2017 American Community Survey.

Activity density map

The map at right shows many different types of activity: homes, workplaces, shopping, industry, entertainment and more. This map uses a three-color scale: residential density is shown in shades of blue, job density is shown in shades of yellow, and places where residents and jobs are both present are shown in shades of red. The darker the color, the greater the number of jobs or residents in the area.

Note that some busy places like malls and hospitals are underrepresented on these maps, because only the workers are counted, not the numerous visitors. In addition, data from schools and universities counts only employees, not students, even though many students commute every day.

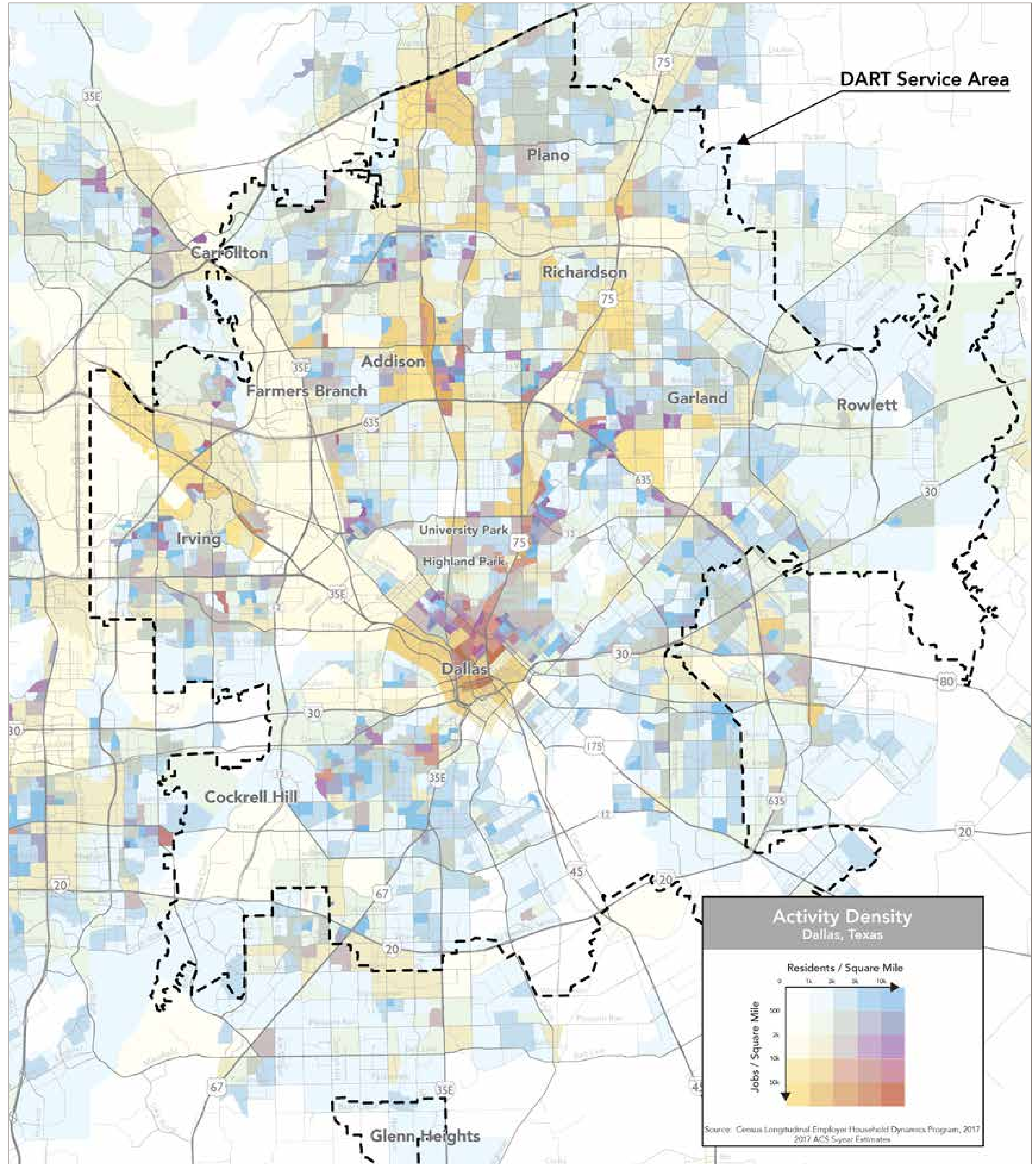
Separate maps of residential and job density are shown in the Appendix starting on page 95.

By comparing this map to the map of the existing network on page 18, we can see that at least some transit service is provided close to the densest places. However, "close to" is a relative statement. In some developments the local street pattern puts homes and workplaces a long walk away from the nearest through-street. In other places, freeways and freight rail lines keep places that are close "as the crow flies" from being close on foot. Both of these factors make it hard for DART to get close to important places without driving in looping patterns and down cul-de-sacs. This walkability problem is illustrated further starting on the next page.

The map at right allows us to see not only high density, but also the mix of activities in an area, which contributes to ridership potential. Transit routes serving purely residential neighborhoods tend to be used in only one direction each morning and evening rush hour. In contrast, on corridors where residential, commercial and other uses are mixed, people are traveling in both directions so buses can be full in both directions. Travel demand also goes beyond the weekday rush hours, and is high throughout the midday, evening and weekends, as people move in all directions for work, socializing, shopping and other activities.

This Activity Density map allows us to see three ingredients in the Ridership Recipe: high **density**, arranged in **linear** patterns, and **proximate** to other dense places. However, there is a catch! Some of the seemingly-linear and dense corridors on this map are actually arranged around *freeways*. The transit consequences of freeway-oriented development are described on page 57.

This map shows where people live and work at higher densities. Areas that are red have a particularly high mix of uses, which suggests that many people travel to and from those places at different times of day and all week long.



Walkability examples

Walkability is the second ingredient in the Ridership Recipe because it governs whether the people nearby can actually reach the transit stop. *How many potential riders nearby can actually reach a transit stop?*

Walkability is of existential importance to transit ridership:

Only 5% of transit trips on DART bus or rail start with the parking of a car. The vast majority of trips (83%) involve walking at both ends of the trip.[1]

Given how much parking has been provided next to transit stations, that those parking lots are served by some of the most frequent and long-running services in the system, and how hard it is to walk on many streets in the DART Service Area, its surprising that so few trips involve a parked car.

Street connectivity is fundamental to walkability – it governs whether a walking trip is possible at all, and how long it is. It also has influence over how safe and comfortable a walking trip is, because poor street connectivity causes arterial roads to be wider and safe crossings of those roads to be farther apart.

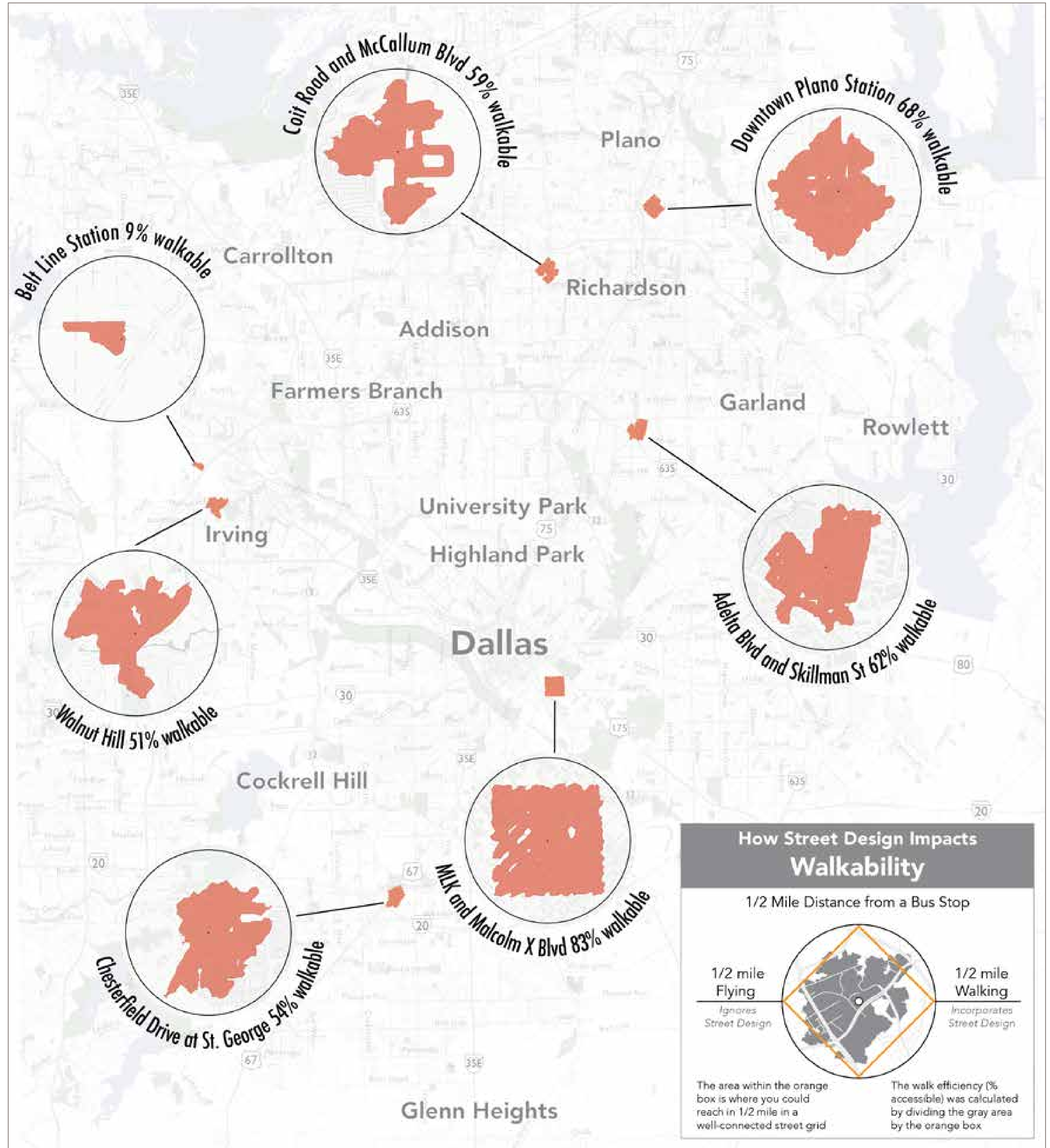
The diagrams at right illustrate how walkability on the street network varies around the region. Only the street network is considered, meaning that areas lacking in sidewalks, lighting, or safe crossings are less walkable then they appear.

In historic neighborhoods that were laid out before the private car was dominant, nearly all transportation was done on foot, by bicycle or by transit. A walkable and well-connected street network was therefore of existential importance to the usefulness and value of land, and so neighborhoods build in those times have very high street connectivity.

South Dallas epitomizes this urban form, and as a result most of the space that is 1/2 mile flying distance from the intersection of MLK and Malcolm X Boulevards is also within 1/2 mile walking distance. In contrast, the area around Belt Line Station is mostly inaccessible by foot, due to a lack of street connections and sidewalks. This situation, and the costs it imposes on the DART bus network, is described in greater detail on page 58.

1 Like much of our data on DART riders' behaviors and DART trip characteristics, this information comes from the very large and statistically rigorous on-board origin-and-destination survey performed by NCTCOG in 2014. The next survey will occur in the spring of 2020.

The shapes at right show how much of the area within 1/2 mile flying distance of each place is within a 1/2 mile walk. In many places, walking is limited by a lack of street connections, safe road crossings or sidewalks. Less walkability means fewer people can reach a transit stop.



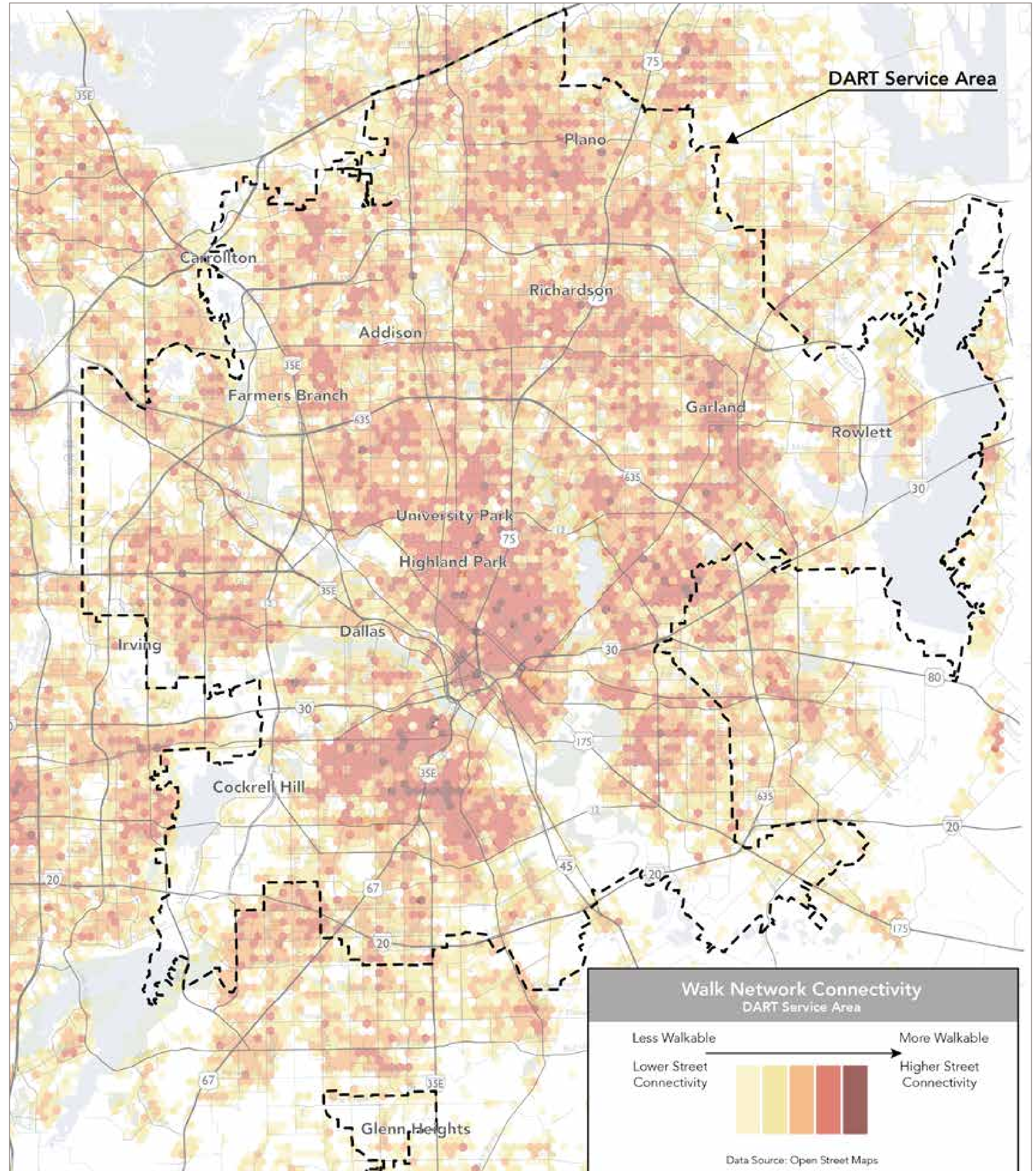
Walkability map

The measure of street connectivity shown in the map at right describes how likely streets are to offer people reasonable-length walks to destinations nearby. This map summarizes the results of measuring the walkable area from each point, as was done for the seven examples on the previous page.

The most widespread and continuous areas of high connectivity are those that developed before World War II and are mostly in Dallas. Smaller contiguous areas of high connectivity also exist in Plano, Garland, Richardson and Farmers Branch.

Newer developments can have high street connectivity, even without a traditional grid of streets. However, many newer developments are designed to minimize car traffic past the most valuable real estate. This is done in part with intentionally poor street connectivity. If streets don't go through, only residents will drive down them. Anyone who wants to go anywhere will have to use the main arterial (this is why poor street connectivity and wide arterials go together). In most cul-de-sac developments, walking routes are long and circuitous, making it hard for people to reach transit if the bus routes stick to the major, linear roads.

Undeveloped land and waterways, having no streets or sidewalks, appear in light shades. The areas near to freeways and freight rail lines appear in light shades because those barriers reduce the area someone can reach within a given walking distance.



The map at right summarizes walkability across the entire DART Service Area. Freeways, rivers and freight rail lines tend to appear in light colors because there are few streets or paths that allow people to cross them, limiting peoples' access to transit stops (and more) just on the other side.

Poverty density map

People who are living on limited incomes can represent a strong market for transit or a need for coverage service (regardless of ridership), depending on the built environment around them.

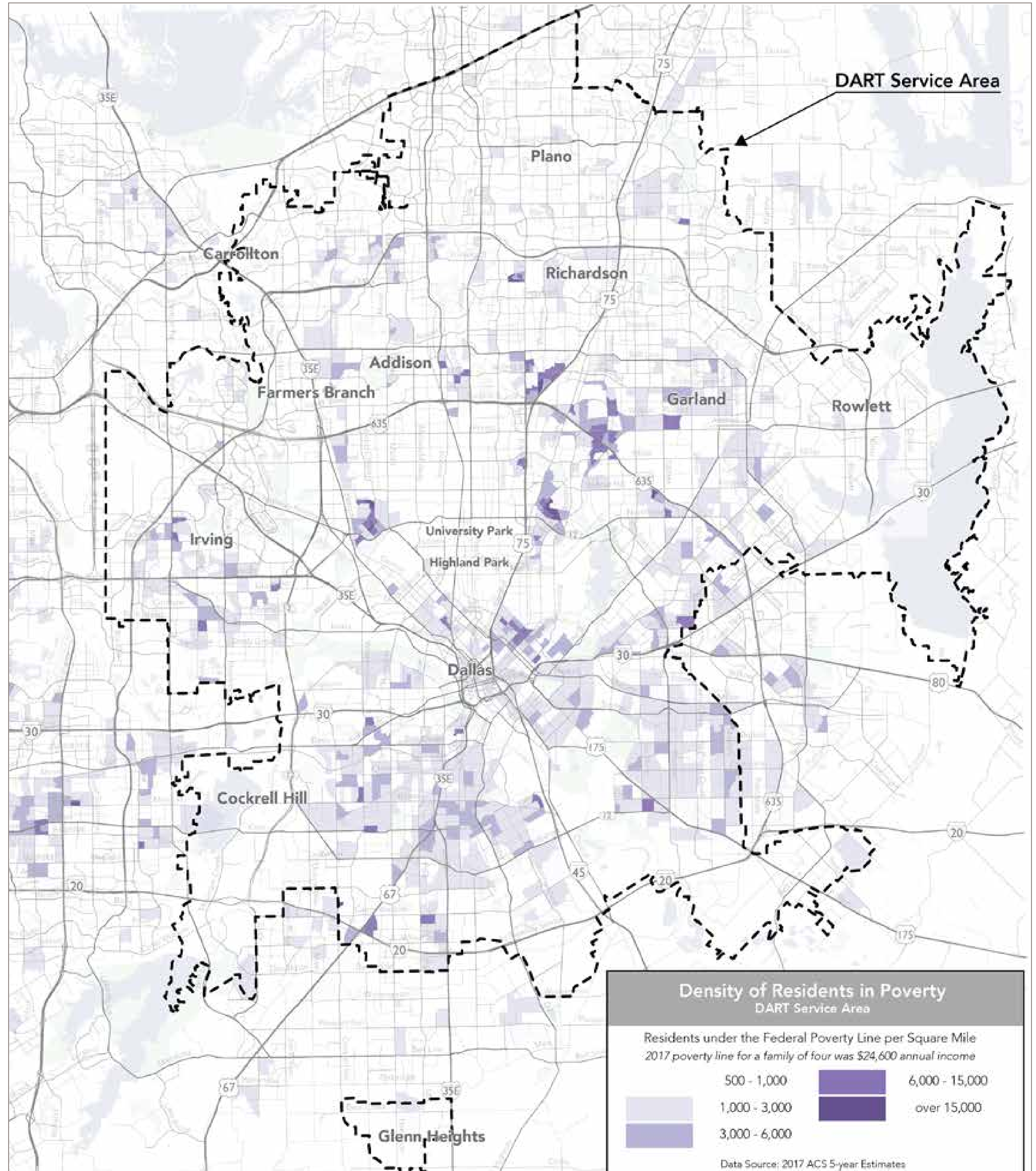
The more carefully a person must manage their money, the more attractive transit's value proposition may be. This doesn't mean that lower-income people will automatically choose transit because it's the cheapest option. Transit service must be useful and reliable for the kinds of trips they need to make, to compete for their ridership. For a long time the transit industry has described lower-income people as "dependent" riders and higher-income people as "choice" riders. Yet the drop in ridership over the past decade demonstrates that lower-income people have some choices too!

The map to the right shows the density of people in poverty in the DART Service Area. While there are more areas in south and east of downtown Dallas with residents living in poverty, there are also dense pockets of poverty in the north. Areas that are dense with low-income residents but are not near other dense places, and are not arranged in linear patterns, are more costly for DART to serve because of the long distances with low demand that DART buses have to traverse. Where low-income people live close to other dense places, it is much less costly to provide them with high levels of service.

Density alone, as discussed earlier in this report, is not enough to support high transit ridership relative to cost. If a place is dense but is far away from other dense places, and is difficult to walk in, and requires transit routes to deviate or follow circuitous paths, then those factors will increase the transit operating costs, which reduces the quality of service that can be provided, which in turn decreases the ridership potential.

This makes the "suburbanization of poverty" an enormous challenge for transit agencies. More and more people with severe needs for transit are in a geographic situation that makes it hard to reach them with cost-effective service. Without intervention by local municipal governments and private sector stakeholders, if urban growth causes rents to increase in transit-oriented places, low-income people may be pushed to more distant and scattered developments where they lose access to the most useful transit service and are forced to travel increasing distances to reach job opportunities. This pattern of spatial mismatch can be seen by many residents of living in Oak Cliff that need to travel long distance into northern cities to reach jobs, due to the imbalance of job densities between north and south of downtown.

This map shows where people are living in poverty at moderate and high densities.



Estimated weekday travel

The chart at right shows how much people travel (by car or transit) for all types of trips during all hours of the average weekday, among the cities in the DART Service Area. (The smallest cities are included at top but are hard to see and label.) This chart shows that a great deal of travel is within individual cities, even smaller cities like Irving, Garland and Richardson.

Rush hour travel patterns (not shown) are similar, but with more trips from the smaller cities to Dallas, and fewer trips that stay within each city (except within Dallas). This is consistent with other sources of information showing that work commutes are, on average, longer than other types of trips. (People will travel across the region to a job but probably not to a grocery store.) Other sources also suggest that rush-hour commutes tend to be longer than non-rush-hour commutes, perhaps because 8-to-5 jobs are more likely than other jobs to be specialized, with only one possible job site. Still, even during rush hours, most of the trips in the biggest cities (Dallas, Plano and Irving) begin and end within those cities.

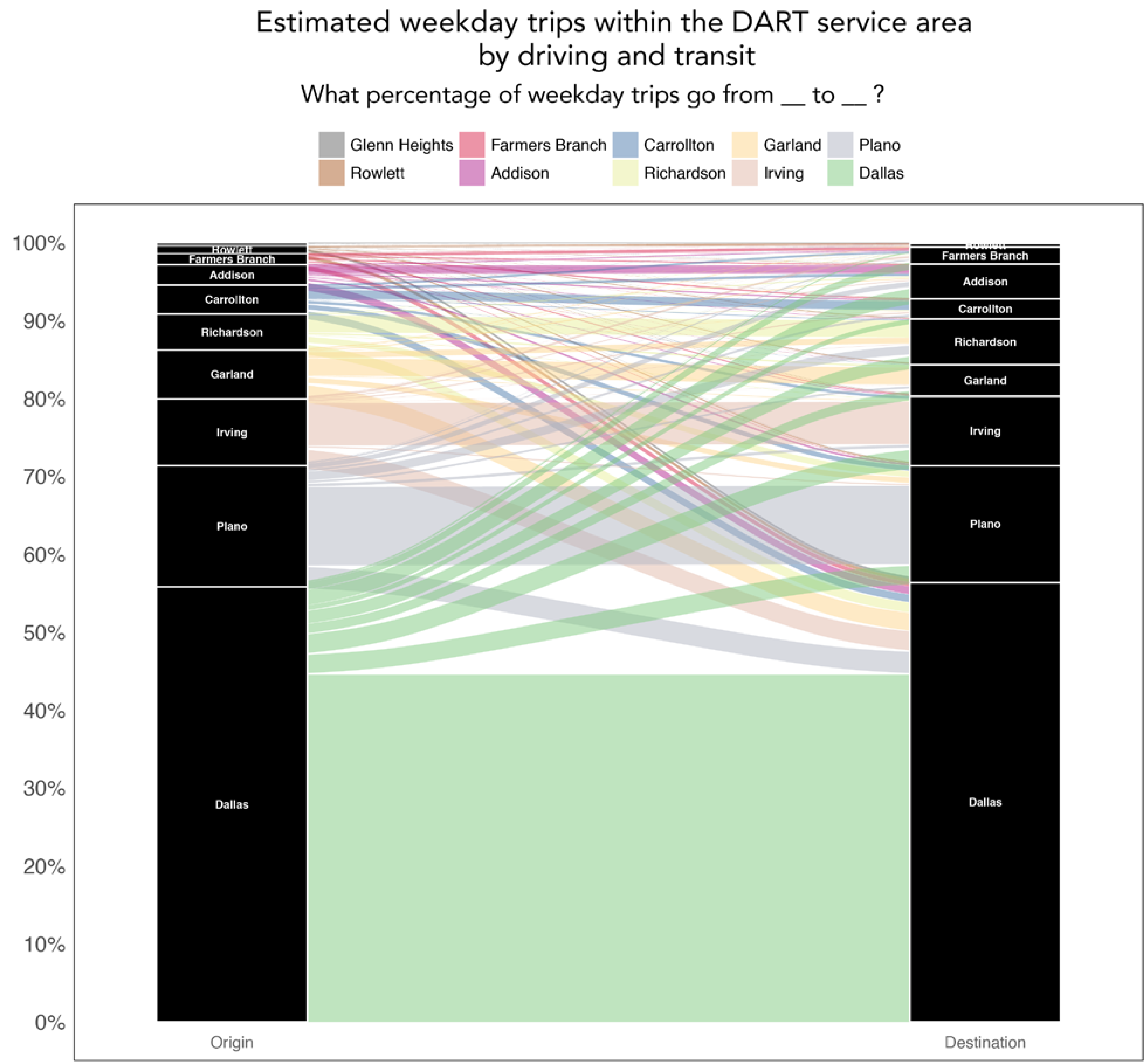
This within-city travel demand presents a challenge for DART. The shorter someone's trip, the more sensitive they are to time spent waiting. The DART network is currently designed for long trips, and in particular for long trips on light rail due to its high speed and its protection from congestion.

Most of the routes offering local service within cities are infrequent, but the poor frequency is mitigated somewhat by the reliable timed connections that many local routes make. People have to bear a long wait at some point during their trip (whether at the bus stop or at their destination, as explained on page 19), but they don't have to bear it *a second time* at the transfer point, thanks to the timed connection.

This network design prioritizes longer-distance travel and rail travel over shorter-distance travel. In doing so, it slightly prioritizes work commutes over other kinds of trips, because work commutes tend to be longer. Nationally, only 16% of all trips are to or from work. In 2014, 48% of trips on DART were part of a commute.

Many people will build their lives around a transit trip that involves a long wait but takes them 20 miles across the region. Fewer people will build their lives around a trip requiring the same long wait to go just 3 miles. Whenever they have another option for that short trip – perhaps a ride from a friend, a hired car or a bicycle – they will probably choose it.

The chart at right shows the estimated number of trips, by driving or transit, that happen on the average weekday within the DART Service Area in 2018. A great deal of travel happens within each city.



Notes: University Park, Highland Park and Cockrell Hill are included in Dallas.
Rowlett and Glenn Heights are shown but generate a very small quantity of trips relative to the other data.
Total number of trips: 7,685,232. (Data from 2018)

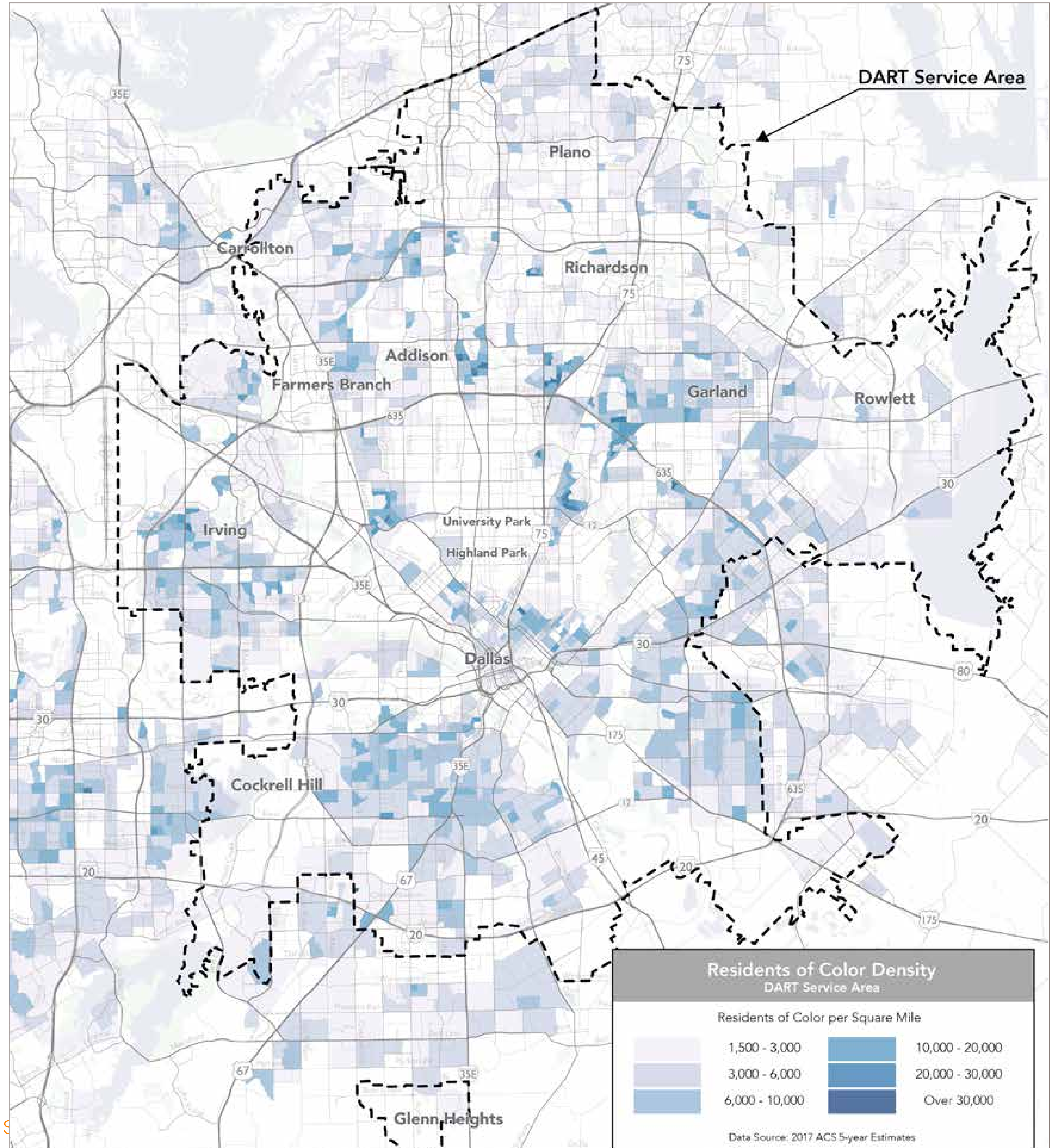
Map of minority residential density

The map at right shows where people of racial and ethnic minorities live at moderate and high densities. Just like the map of poverty density, this map shows us where people *live,* but not where they want to *go.*

The DART Service Area is very diverse, with large populations from many different racial and ethnic groups. However, it is more segregated by neighborhood than most U.S. cities.[1] This means that, for an average resident, the percentage of people in their residential neighborhood who belong to a different ethnic or racial group is lower than is true for the average resident in other U.S. cities.

This means that when DART makes decisions about where to provide service, down which streets and in which neighborhoods, those choices have a racial dimension. DART cannot (and does not) assume that any bus route going down a road serves people of all different races, just because Dallas is a "diverse" region.

The map on the next page shows more precise information about where people of different races and ethnicities live.



1 On a "Segregation Index" scale of -19 to +11, on which zero represents the average degree of integration in U.S. cities, Dallas received a -7. Chicago, with -19, is the most segregated city in the U.S., despite being one of the most diverse. Irvine and Sacramento, CA, are the most integrated, with scores of +10 and +11. This Index is explained, and a table of major U.S. cities is provided, at fivethirtyeight.com/features/the-most-diverse-cities-are-often-the-most-segregated/.

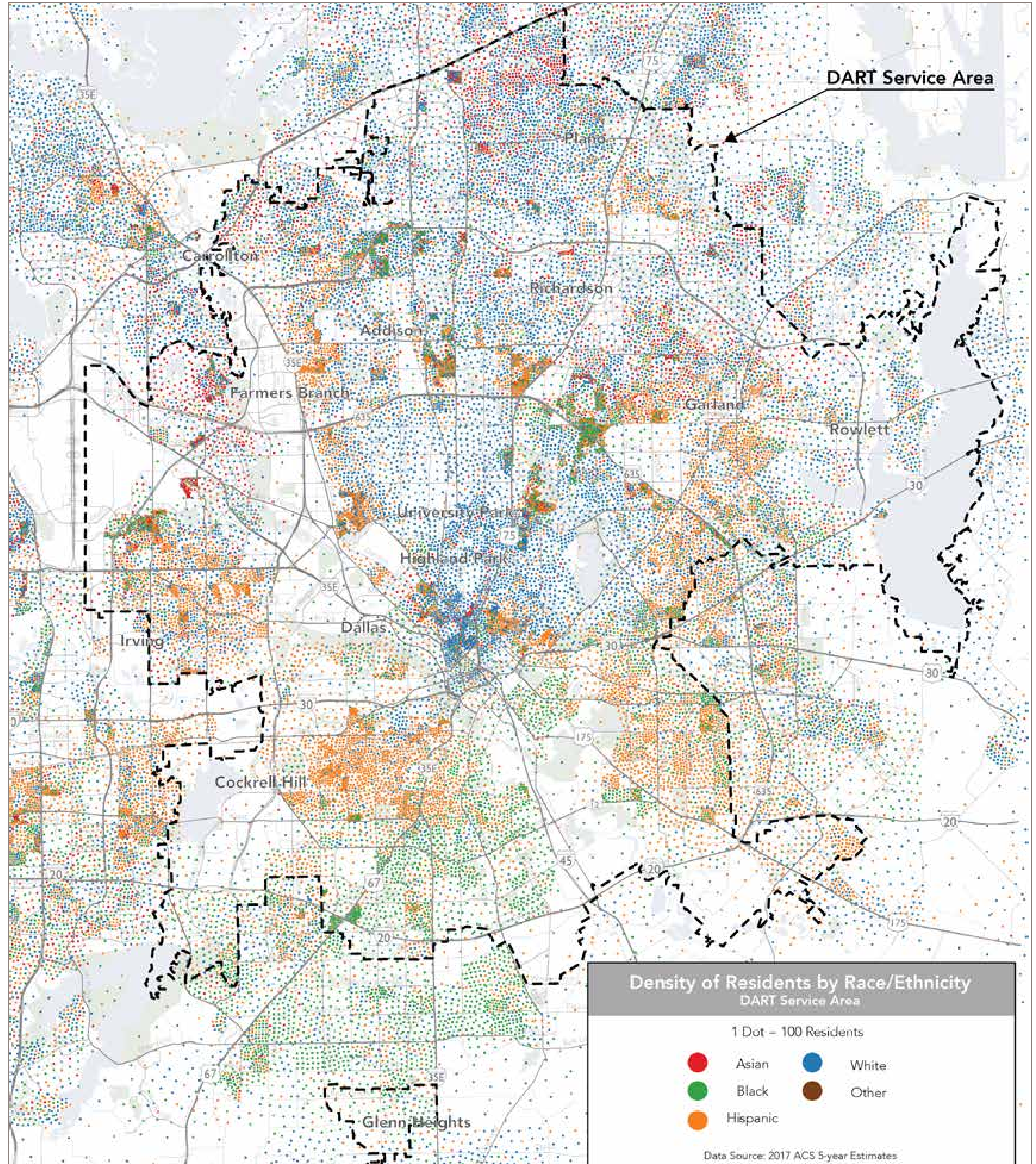
Map of residential density by race or ethnicity

The map at right shows where people of different races and ethnicities live in the DART Service Area. Each dot represents 100 residents. Where many dots are very close together, the overall density of residents is higher. Where dots of a single color predominate, people of a particular race or ethnicity make up most of that area's residents.

While information about people's income tells us something about their potential interest in or need for transit, information about ethnicity or race do not alone tell us how likely someone is to use transit. However, avoiding placing disproportionate burdens on minority people, through transportation decisions, is essential to the transit planning process.

Transit agency policies that protect minority people from negative impacts are one type of coverage goal, because they pursue an outcome that is valuable regardless of ridership. Such policies might state, for example, that service to high-density and high-minority neighborhoods should be prioritized even if such service would not maximize ridership.

It is important to understand where large numbers of non-white people live, so that public outreach during this project can be sensitive to language and cultural barriers, and so that service changes can be evaluated in light of impacts to protected people.



The map at right shows where people of different races and ethnicities live in the DART Service Area. While Dallas-Fort Worth is a very diverse region, it is not a very integrated region, and so there are many neighborhoods where most residents are of one race or ethnic group.

5 Transit Outcomes

Ridership

Ridership is one measure of transit performance. It can be visualized by mapping boardings at transit stops, as shown at right. Boardings on buses are shown in red and boardings on light rail trains are shown in black. When a stop is served by multiple routes, the boardings for all routes are summed for that stop.

The largest red dots on this map are at light rail stations and bus transit centers, where many routes come together and many people transfer among them.

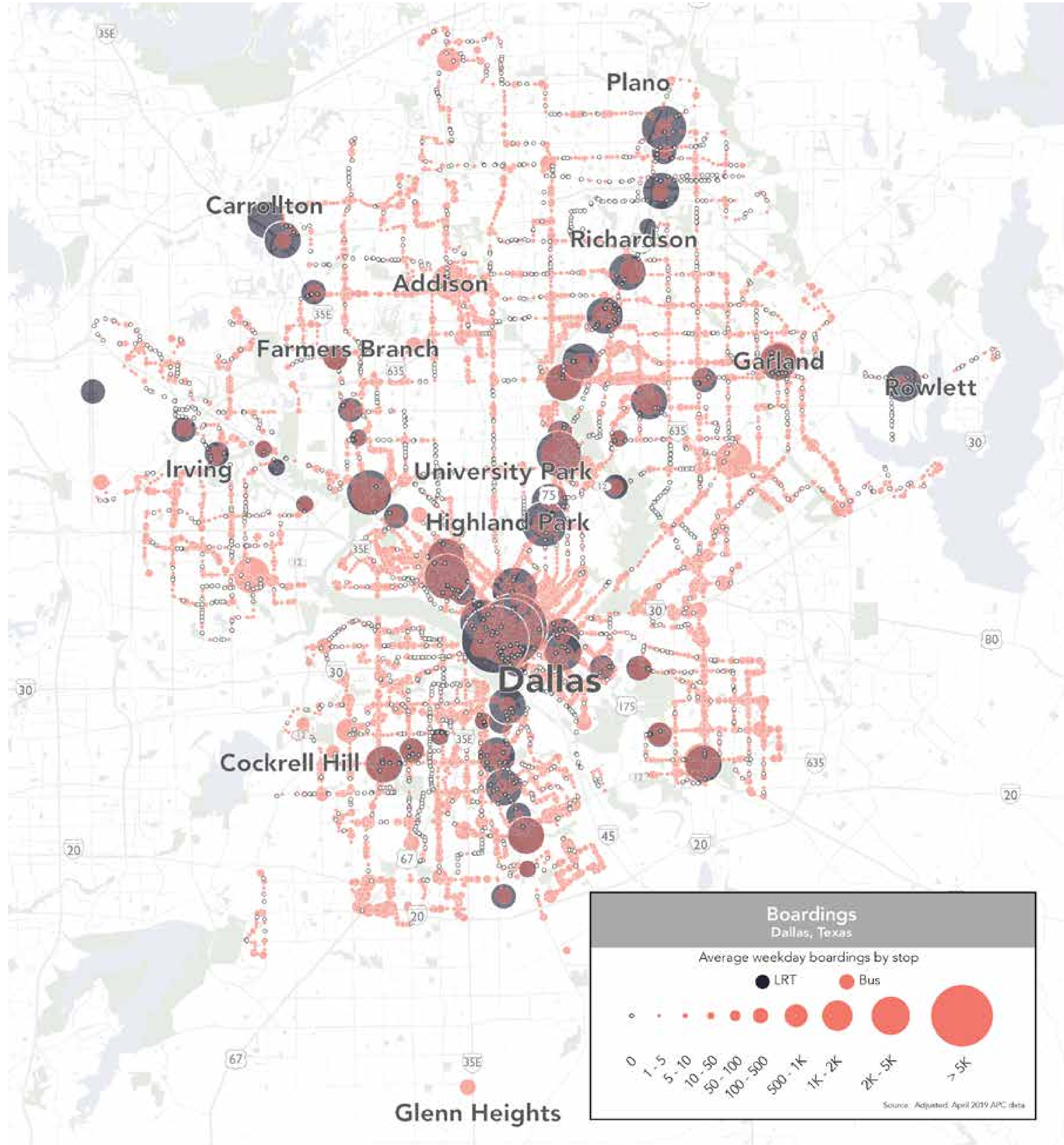
Some of these transit centers are in high-density areas, and many people are traveling to and from the area, such as the Addison Transit Center on Arapaho Road or LBJ/Skillman Station, which is surrounded by commercial and residential development. Some are not, such as the South Garland Transit Center next to I-635 Freeport / Amazon in Irving, which are surrounded by low-density industrial and freeway ramps. For transit centers like the latter two, it is likely that most of the boardings recorded there are transfers between two bus routes, or between bus and rail, and are therefore the result of network planning decisions by DART rather than a reflection of nearby demand.

Long corridors with high boardings at many stops can be seen along some of DART's most frequent bus routes, such as along Buckner Blvd. in East Dallas; Forest Lane in North Dallas; and around UT Dallas in North Dallas and Richardson.

Looking at this map, however, we must keep in mind that not every stop is offering the same level of service. Some of these stops are served just a few times a day. Some are served every 15 minutes.

A small dot on a low-frequency route may simply reflect the low level of service. A small dot on a more frequent route, on the other hand, suggests other problems.

Conversely, a large dot on an infrequent route means that ridership is high despite a low level of service, which suggests that underlying transit demand may be high.



The map at right shows boardings at every stop in the DART system. The largest dots on this map are at light rail stations or transit centers, where many people transfer among buses and trains. Continuous strings of smaller dots show high-ridership corridors, though this map alone doesn't tell us what DART spends to attract that ridership.

Route productivity

Boardings per service hour

By controlling for the amount of service provided on a route, we can understand not just the total boardings on a route but what level of service all of those people are responding to.

The scatter plot on page 26 showed a relationship between frequency and productivity among all of the routes in many systems. The scatter plot at right shows only DART routes with their frequencies and productivities as of April 2019.[1]

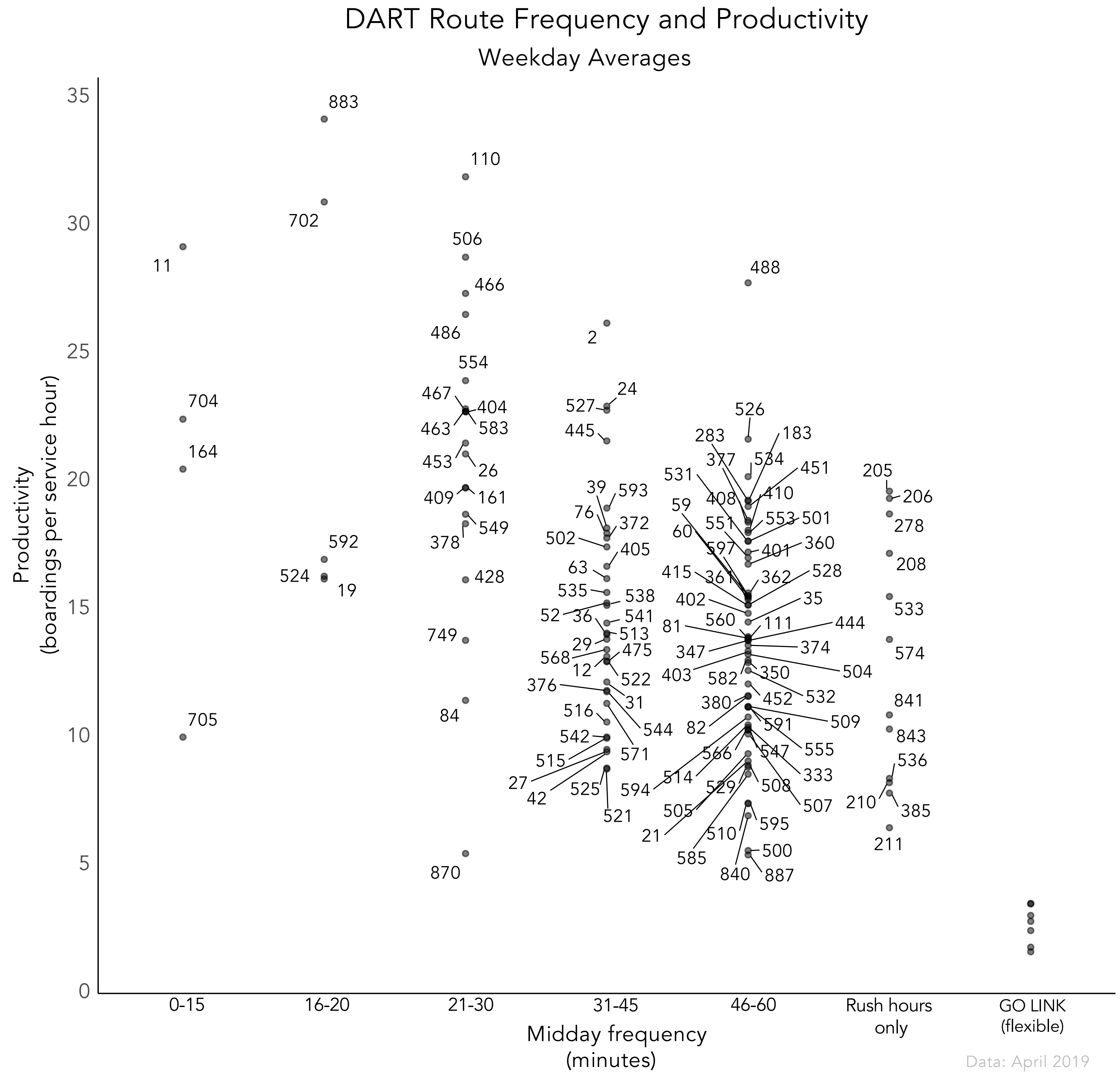
DART's more frequent, all-day routes are, on average, more productive than the less-frequent routes. DART's rush-hour-only routes (shown far to the right) have the same range of productivities as do routes that come every 46-60 minutes all day, despite being focused on the highest-ridership hours of the day and in many cases offering decent frequencies during rush hours. A number of forces combine to limit the productivity of rush-hour-only routes. Some rush-hour-only routes also have hidden costs that aren't accounted for in this productivity measure. These limitations and costs are described on page 51.

DART's flexible services, called "GoLink," are shown at the far right. Flexible services follow a unique route for nearly every person who uses them and therefore cannot move more than a few people per hour, per vehicle.

The productivity measure shown in this scatter plot is one way of expressing the "efficiency" of a service: How many people find one of these transit vehicles useful, per hour that DART pays to operate it?

Productivity can help us see how much use a route gets, but it does not show us where a different network or route design would provide even more access to more people. This is partly because productivity counts *boardings,* which are not the same thing as *trips.*

Imagine a person makes a one-way trip today with three boardings on three transit lines. In a redesigned network, their trip might become possible using two transit lines. The number of boardings they make has declined by 50%, but the number of trips they make has not. Without data about *trips*, rather than *boardings*, it is hard to evaluate service changes that change people's transfers but help more of them get where they are going.



More frequent DART routes – to the left in this scatter plot – are likely to be more productive than less frequent routes – to the right. This is true even though higher frequency routes use more vehicles and therefore more service hours.

1 Note that the service hours shown here for each route include both driving time and recovery time. Recovery time is built into schedules to protect buses against unexpected delays and to wait for connections with other buses or trains, and an essential part of the service offering on each route. The productivities shown here are lower than what DART usually reports, because DART does not normally include recovery time in the count of service hours.

Passenger miles per service mile

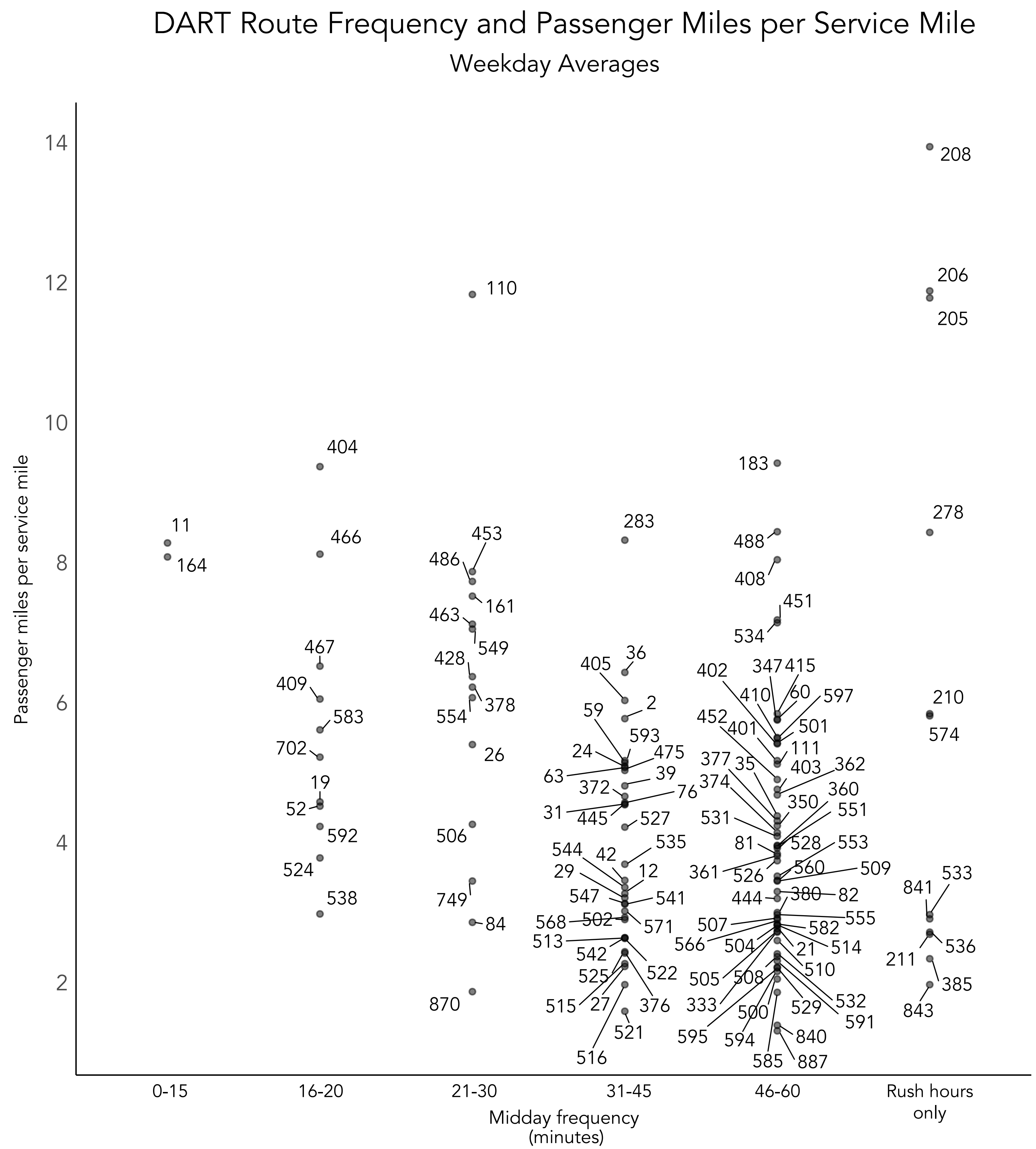
Passenger miles per service mile is a way to evaluate services that take people long distances, like DART's expresses. The scatter plot at right shows passenger miles per service mile for all routes, plotted according to their midday frequency.[2] Rush-hour-only routes are shown at far right, and all but one of the expresses (routes named in the 200s) are in this category.

Some of the rush-hour-only routes are very productive by this measure, such as Routes 208, 206, 205 and 278, which all account for more than 8 passenger miles for each mile driven by a bus. Routes 208 and 205 both provide additional rush-hour service along the Dallas North Tollway corridor, which is also served all day by Route 183.

Other all-day routes are also highly productive by this measure, such as Route 110, which is a bit like an express, connecting East Dallas and Downtown Dallas via the I-30 HOV lanes. Route 183 is also a bit like an express, connecting Plano and Dallas via local roads but with a long non-stop segment on the DNT.

Many local, non-express, all-day routes appear productive by both of these measures, on both scatter plots. The same relationship between frequency and productivity is visible in both plots.

All but three of the rush-hour-only routes in these scatter plots have deadhead costs that are not accounted for by these measures, spending more than 25% of their driving time out of service. If this cost were included, they would appear about 20% less productive.



Data: August 2019 schedules and 3Q19 Bus Route Performance Report

We can also measure a route's productivity by summing all of the passenger miles traveled on it and dividing by the number of service miles the buses drive. Routes that cover long distances with full loads of passengers do well by this measure.

2 This scatter plot is made from a different data source and a different time period than the plot on the previous page. Not all routes are present in both. Contracted services such as the frequent Parkland shuttles 704 and 705 are not included on this page. This plot shows data from after August 2019 service changes that increased frequencies, cut deviations and lengthened hours of service on some West Dallas routes. The costs (in service miles) of these changes are present in the data at right, but the likely benefits (increased passengers) will take time to accrue and are therefore not yet present in the data at right. For example, Route 52 now requires more service miles (because frequency and span were increased), but did not instantly attract more passengers in August when its service was increased. It is therefore probably lower on this scatter plot than it will be a year from now, once more people have encountered the higher frequency and chosen to ride it.

Subsidy per boarding

The productivity scatter plot on page 26 uses service hours as a proxy for operating cost, but DART actually spends a different amount on service provided by different parties. Some contracted services have a lower operating cost, and GoLink flexible services have a very low operating cost. DART also splits the costs of some shuttles with other organizations.

In order to account for service operating cost, we can examine cost per boarding. We can also take into account how much passengers are contributing towards the cost of their ride through fares, and examine subsidy per boarding. This is the data shown in the scatter plot at right.[1] The math works like this:

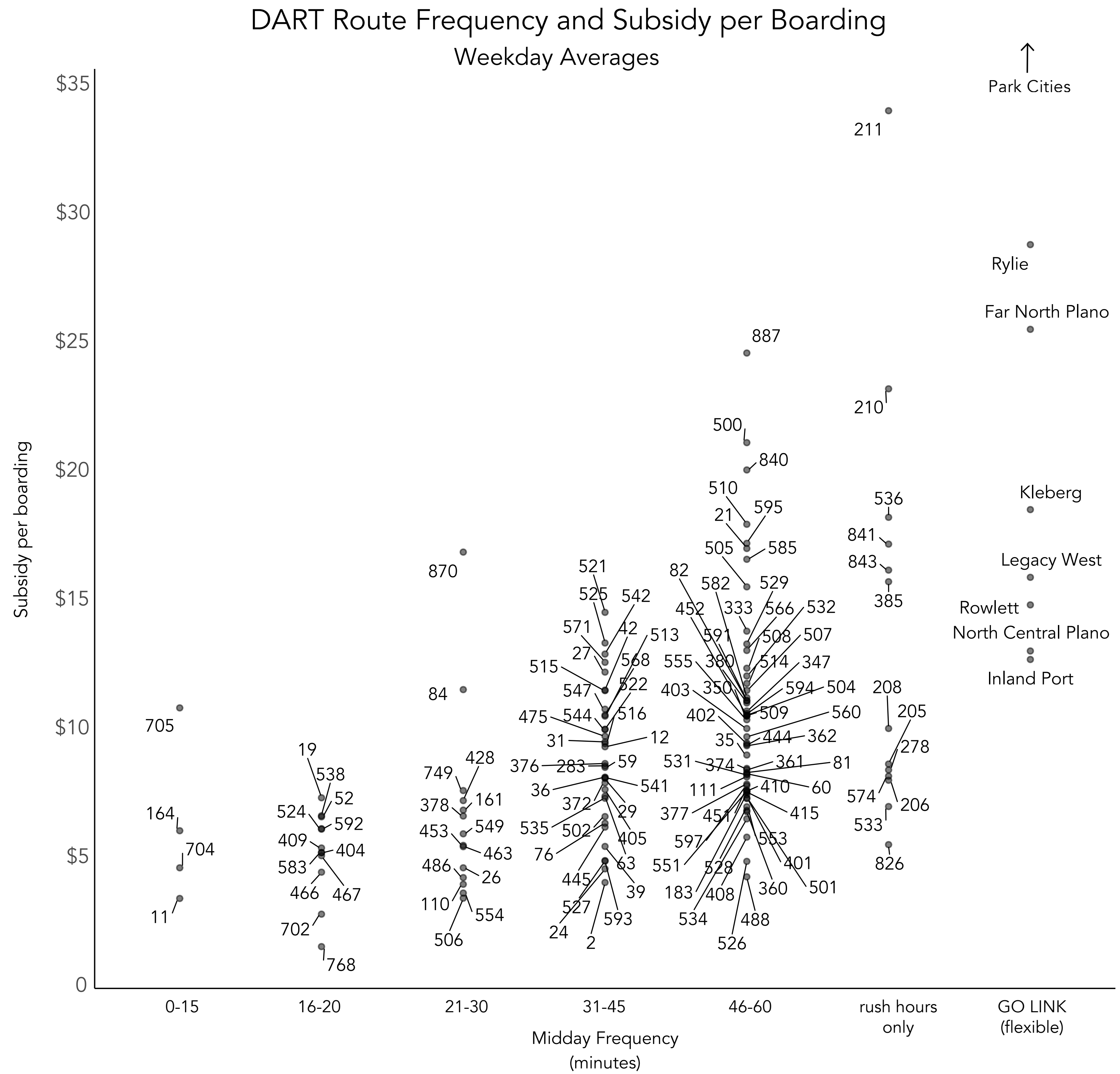
Operating Cost per Service Hour ÷ Boardings per Service Hour
=
Operating Cost per Boarding

Operating Cost per Boarding – Fares Collected
=
Subsidy per Boarding

Cost per boarding and subsidy per boarding are strongly related to productivity: the more people use each bus, the more the operating cost is divided across all those people, and the lower subsidy per person. This is why it is so hard to get subsidy per boarding on flexible services as low as it is for most fixed routes. Because flexible service vehicles struggle to handle more than 3 people per hour, whatever the operating cost of that vehicle, it is divided over a tiny number of people.

If a transit agency wants to increase ridership within a limited budget, it will do more things that have a low subsidy per passenger, and fewer things that have a high subsidy per passenger.

Coverage services have lower productivity and higher subsidy per boarding than services that are intended to attract high ridership. A coverage service is designed to meet a need or an expectation that has a particularly high value to the transit agency, a value that justifies its higher subsidy per boarding.



Data: August 2019 schedules and 3Q19 Bus Route Performance report

Subsidy per boarding takes into account the quantity of service provided, the cost to DART of providing that service, and the fares collected from passengers. With very few exceptions, low-productivity services have high subsidy per boarding.

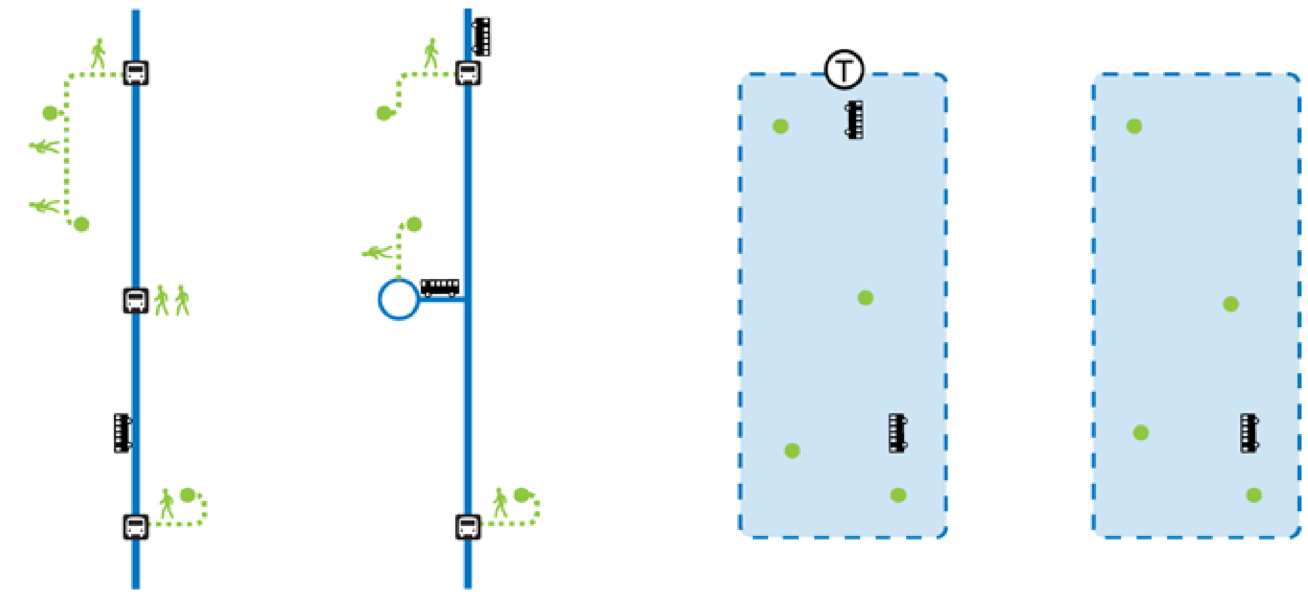
1 As in the scatter plot on the previous page, this data is from after the August 2019 service changes. Some routes have had their service levels increased, but the likely increase in ridership will take time to occur, and as a result their subsidy per boarding is higher now than it was before August, and than it will likely be in the future. Routes towards which DART contributes no funding are not shown on this scatter plot, even if they are operated by DART.

Flexible transit: GoLink

"Flexible transit" is any transit service on which the route varies depending on who requests it. In contrast, "fixed route" transit serves fixed stops, in a certain sequence, at scheduled times. Whereas fixed routes can be used by simply going to the stop, flexible service requires the customer to contact the agency in advance, to request that the bus come to a certain place at a certain time. The customer experience of flexible service is thus more like that of a taxi, Uber, or Lyft ride, except that other customers may be picked up or dropped off along the way and the ride may therefore not always be direct.

Flexible service is attractive to customers because it responds to peoples' desire to travel when they want (rather than only when service is scheduled), and to avoid walking to and waiting at bus stops. It is attractive to transit agencies if it can provide lifeline access to a greater area at a lower cost than fixed routes can, or if it can provide a socially-valuable service to vulnerable people and people with severe needs.

Many US public transit agencies are currently experimenting with flexible services, in this historical moment of excitement about what apps can do for the efficiency of various services such as transit.



Transit agencies have long offered a range of flexible services, understanding that productivity falls and costs grow as the service becomes less rigid.

DART's flexible services

DART has implemented new flexible services in places where the density, street design, or poor walkability mean that fixed routes are likely to be very inefficient. These services are now called GoLink. In some cases, these have replaced inefficient fixed routes. In other cases, these have been established in an area where no fixed routes existed before and where covering a large area with fixed routes would be costly. DART has also recently replaced an older flexible service called OnCall with GoLink.

Flexible transit service is an old idea. Paratransit for disabled persons has always worked this way and many agencies have provided flexible services for the general public in low-demand areas. Those services were summoned by making a phone call, and had to be booked in advance, typically the previous day, for a customer to be guaranteed a pick-up. (DART's old OnCall service required reservations one hour in advance.)

GoLink and similar products introduce three changes to this model:

- Customer reservations, communication and fare payment can all be done in real-time, especially for those users who use a smartphone app.
- Trips can be summoned on short notice, rather than requiring an advanced reservation.
- By using companies like Lyft or Uber to provide some of the service, lower costs are achieved.

GoLink combines both the traditional and new ways of providing flexible service, along the lines described above:

1. People can choose between arranging a GoLink ride using the app or calling a phone dispatcher. The availability of a traditional phone interface is important to ensure that the service is accessible to people without smartphones (or without data remaining on their plan) and to people who struggle to use a smartphone due to age or disability.
2. DART works to keep pick-up times to 10 minutes or less after a customer requests a ride using the app. Trips booked using the phone must be made at least 30 minutes in advance.
3. GoLink provides the customer with a choice among kinds of service, and a company handles the brokering and dispatching of trips in each zone to match customers with the right service. One type of service provides wheelchair-accessible vans and drivers, driven by contract operators with dedicated vehicles in the zone. Some trips can also be handled by taxis, some of which are wheelchair-accessible. Other trips in the zone are handled by Uber drivers who use their own personal vehicles.

The Uber-driven trips are much less costly to DART, averaging just $7 per ride. Yet the other services must be offered as part of each GoLink zone to ensure that GoLink is accessible to people using mobility devices and that customers can choose a service provided by drivers who have been drug tested. The FTA[1] allows DART to use Uber as a service contractor only if customers have a choice between using Uber or using one of the dedicated-vehicle or taxi services.

DART's ability to reduce the cost per rider of GoLink depends on greater use of lower-cost contracted service currently provided by Uber. The more GoLink customers choose Uber, the lower the average cost per rider will be for DART. At present, about 35% of GoLink rides are, by customer choice, provided in Uber vehicles, and the balance are in dedicated vehicles or taxis.

1 Federal Transit Administration, which regulates many aspects of transit service in the U.S.

GoLink in the Concepts

GoLink has an important role to play in the High Coverage Concept, which was designed to provide at least some service to all people who have access to DART service today. There are places in the DART Service Area where densities of people, jobs and activities are so low, street connections are so poor, and it is so hard to walk that a flexible service can be as cost effective (or more cost effective) as a fixed route at providing coverage where ridership will be low.

The Concepts are designed with the year 2022 in mind. In deciding where to deploy GoLink rather than a fixed route, while being accountable to DART's limited budget, we had to assume a certain subsidy per boarding for GoLink services. DART staff set $14.50 per boarding as the conservative assumption for average subsidy per boarding on GoLink services in 2022. While staff hopes to achieve a lower subsidy than that, progress in lowering costs will depend largely on private contractors and their willingness to continue charging the same introductory rate, or an even lower rate, in the future.

In the High Coverage Concept, GoLink zones are drawn only where they exist today, or where DART staff believes that a subsidy per boarding of $14.50 or less could be achieved in 2022. If fixed routes are covering those areas today, and achieving a lower subsidy per boarding than $14.50 today, then those areas have been shown as covered by fixed routes, not by GoLink, in the High Coverage Concept.

Highly productive routes

What can we learn by looking at the patterns of boardings on some of DART's highest-ridership routes?

Route 466: Buckner Station[1]

Route 466 runs east-west between South Oak Cliff and Pleasant Grove on Ledbetter Drive. It is designed to be part of a nearly-frequent grid, offering (since August) 20 minute frequency during daytimes all week, and 15 minute frequency at rush hours. As a grid route, it is designed not just to serve demand along the route itself, but also for connections with north-south running grid elements: Blue and Green Line light rail, Route 467 in East Dallas and Route 404 on Westmoreland Road.

Route 466 has boardings in both directions along most of its length, and especially where it connects with these other grid routes. The boardings at the intersection of Westmoreland and Ledbetter are particularly noticeable, because the area around that intersection is less dense than around any other large boardings dot – two of the four corners are the edges of low-density residential developments, and one of the corners is the edge of the Dallas Executive Airport which is, from a transit perspective, just empty space. Yet the boardings on Route 466 at this intersection are the third-highest on the route, after the two light rail stations.

Connections with Route 404 are the obvious explanation for why boardings at this point are high. DART, knowing the importance of transfers here, has invested in benches at all four corners, and shelters at the two bus stops where the most people wait.

Route 702: NorthPark Mall / Park Lane Station

Route 702 helps people make very short trips under the Central Expressway between NorthPark Mall and Park Lane Station, where many of them surely transfer to light rail. The bus comes every 20 minutes, all week, though it has a short span of service on the weekends, especially on Sundays. Mall employment surely peaks on weekends, and shifts go beyond the hours when the 702 runs, so perhaps Mall workers walk to and from the Park Lane Station when the bus is not running.

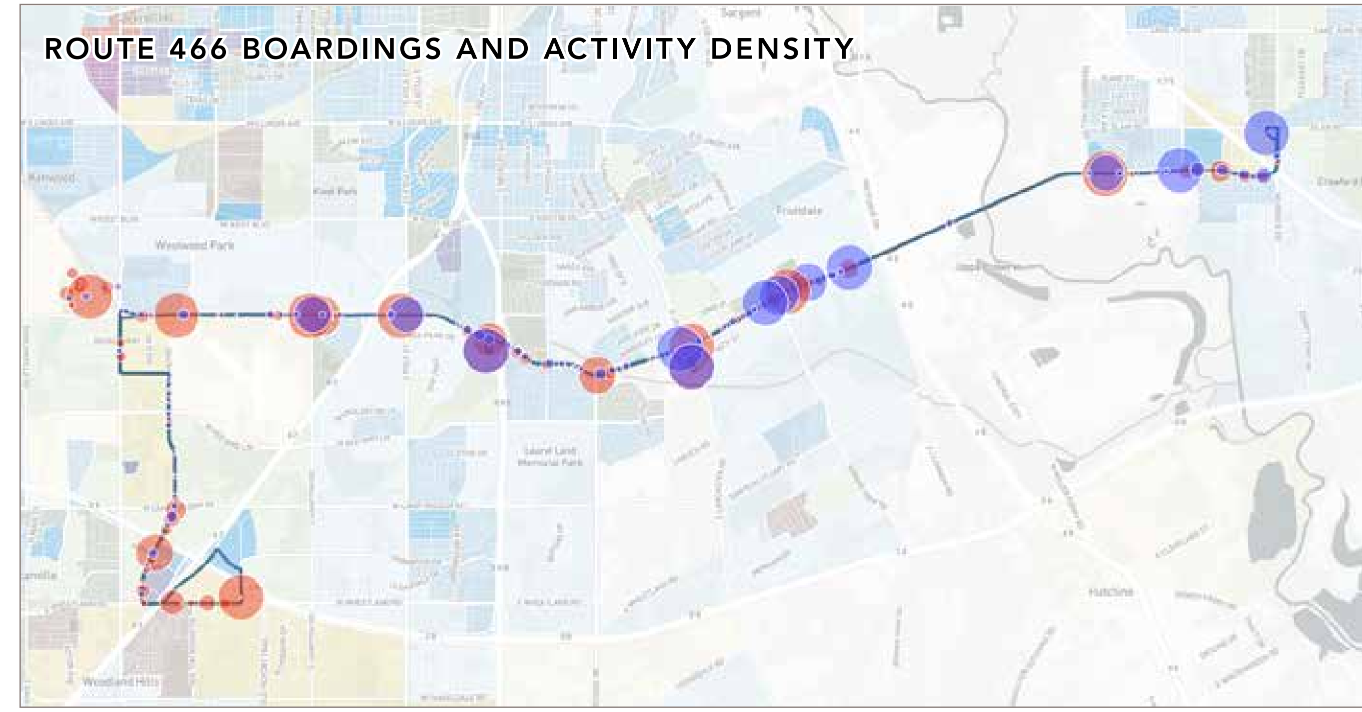
Route 702 is very productive, with 31 boardings per service hour. However, it has middling-to-low passenger miles per service mile among routes with similar frequencies. This reflects the short distances people ride the route. It also reflects how many service hours the route spends waiting at the station in order to make a reliable timed connection with light rail. Route 702 could be incorporated into a longer route, such as the 428, so that it serves trips beyond just the Mall-to-station.

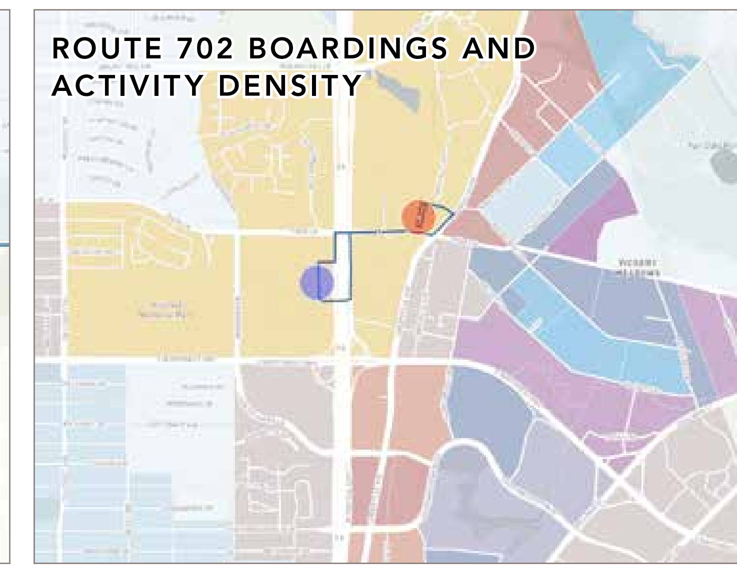
Route 486: Royal Lane / Garland

Route 486 is one of the crosstown routes that DART has been investing in to make non-downtown trips faster. Its boardings pattern, shown in the map at bottom right, demonstrates the strong relationship between boardings at a stop and nearby density. Few of the places without nearby density produce high boardings.

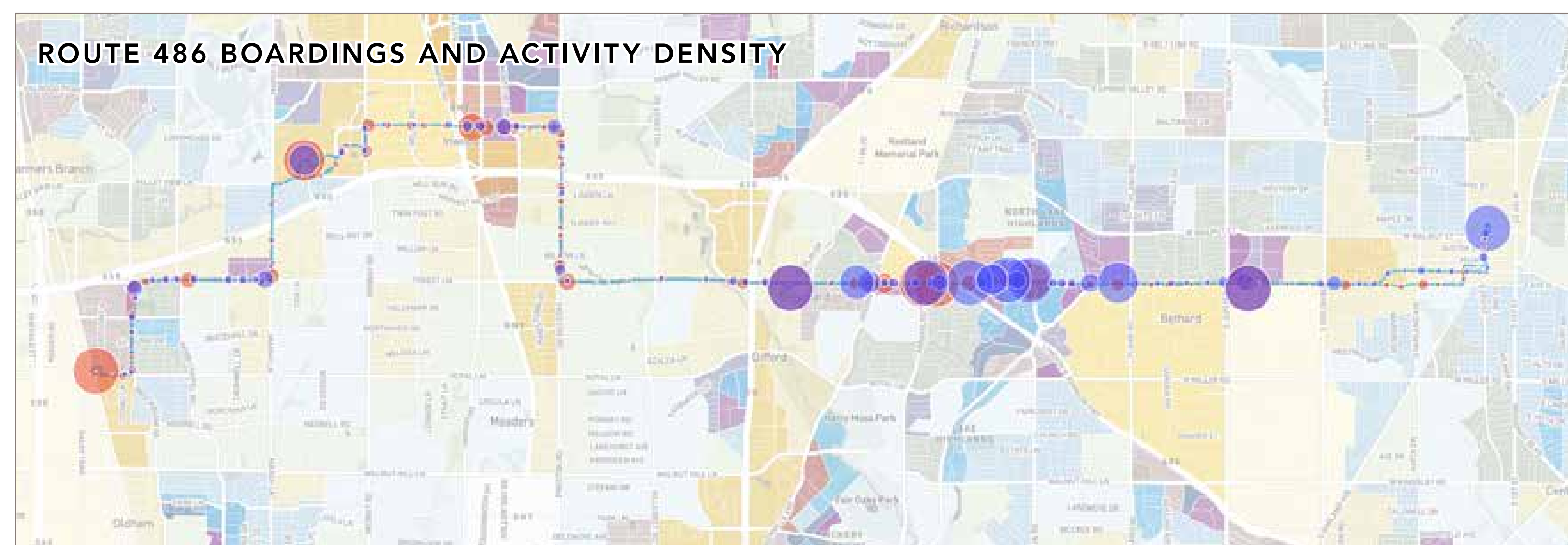
Blue dots indicate boardings on westbound buses, and red dots indicate boardings on eastbound buses. Where they overlap, the dots are purple. Route 486 has ridership in both directions, along the entire route, but especially around apartment zones along Forest Lane. It also runs in pattern with Route 488, meaning that a bus is service this segment midday every 30 minutes. This means that buses are rarely empty.

On page 40, Route 486 shows strong passenger miles per service mile among routes with its frequency, confirming that the buses cover very few miles empty. Recall also that the people surveyed on Route 486 in 2014 came from every city in the service area, as shown in the map on page 27, which results from its good connections and demonstrates its regional relevance.





The dots on these maps represent the average daily boardings at each bus stop. Blue does indicate westbound boardings, red dots indicate eastbound boardings. These maps are not at the same scale, so dot sizes should not be compared among them.



1 This is referring to Route 466 as of April 2019. It has subsequently increased in frequency during daytimes, and changed alignment in an effort to create a stronger East/West connection.

Proximity to service

By counting the number of people and jobs near service, we can estimate how well a transit network serves both coverage and ridership goals.

The charts at right report proximity to services of different frequencies. The distinction is important because frequent service is most liberating for people. Frequent service is also the most likely to attract high ridership relative to cost.

Only 1% of residents are within 1/4 mile of frequent service at midday on a weekday (shown in red), though 7% are that close to service coming every 20 minutes or better (red and purple). A much larger proportion – 50% – are near some kind of service. Residents in poverty are covered, on average, to a greater degree than white residents, as 55% of them are within 1/4 mile of some type of service. Coverage of residents in poverty is very similar to coverage of all residents.

The maps on the next page show the DART 20-minute network (bus and light rail) overlaid on Activity Density and on Poverty Density.

How far will people walk?

The chart at top reports proximity within 1/4 mile of transit, and the chart at bottom reports proximity within 1/2 mile of transit.

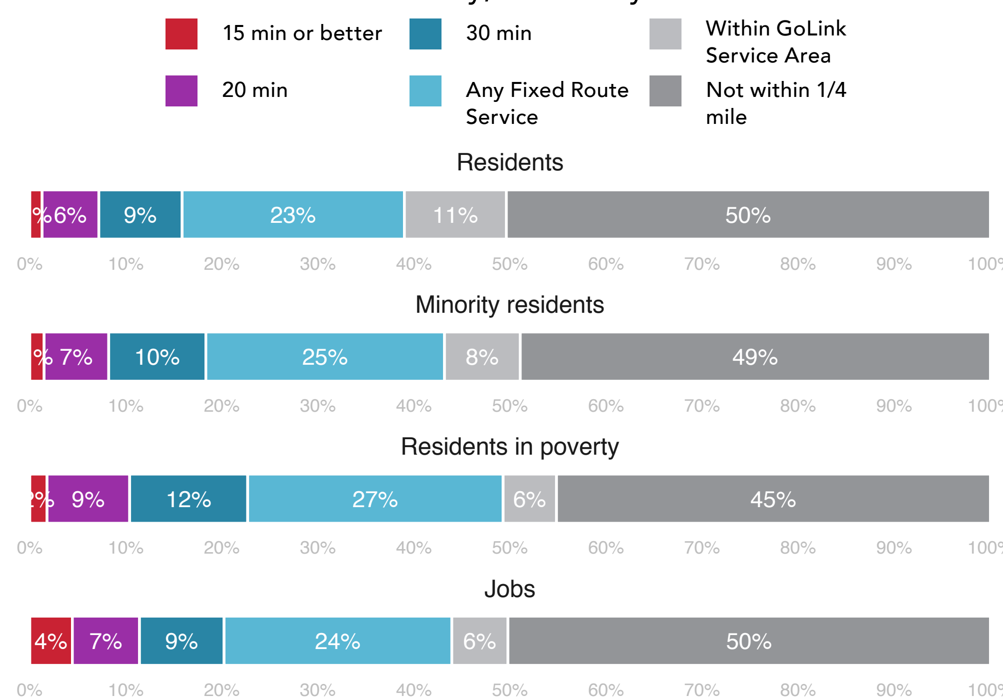
There is no good assumption about how far people will walk to access transit service. Some people like to walk. Some people don't, but they're in a hurry and will walk far if it gets them where they are going soon. Some people cannot walk, or cannot walk very long without needing to sit down.

People's ability and willingness to walk depends on the environment: if they are faced with walking on a highway shoulder or in a ditch, and if there are no safe crossings, or if roads are loud and scary with traffic, they may not be willing to walk. Weather and temperature can change these preferences day to day. People tend to be willing to walk farther to transit is that is more frequent, faster and more reliable.

Because the millions of unique people of the DART Service Area are in millions of unique situations, we will not presume to know how far any of them will walk. Summing how many of them are within 1/4 or 1/2 mile of transit will provide a useful comparison among the existing network and the two Network Concepts. Increasing the percentage of residents and jobs that are within those distances of frequent service would suggest higher ridership potential.

How many residents and jobs are within **1/4 mile** of transit?

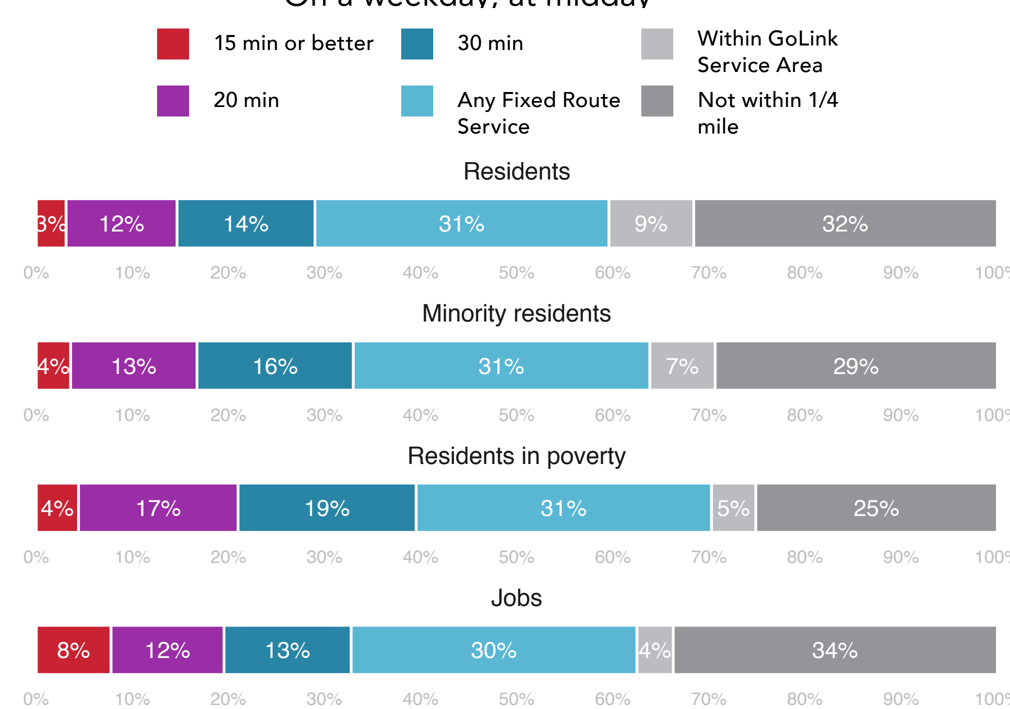
On a weekday, at midday



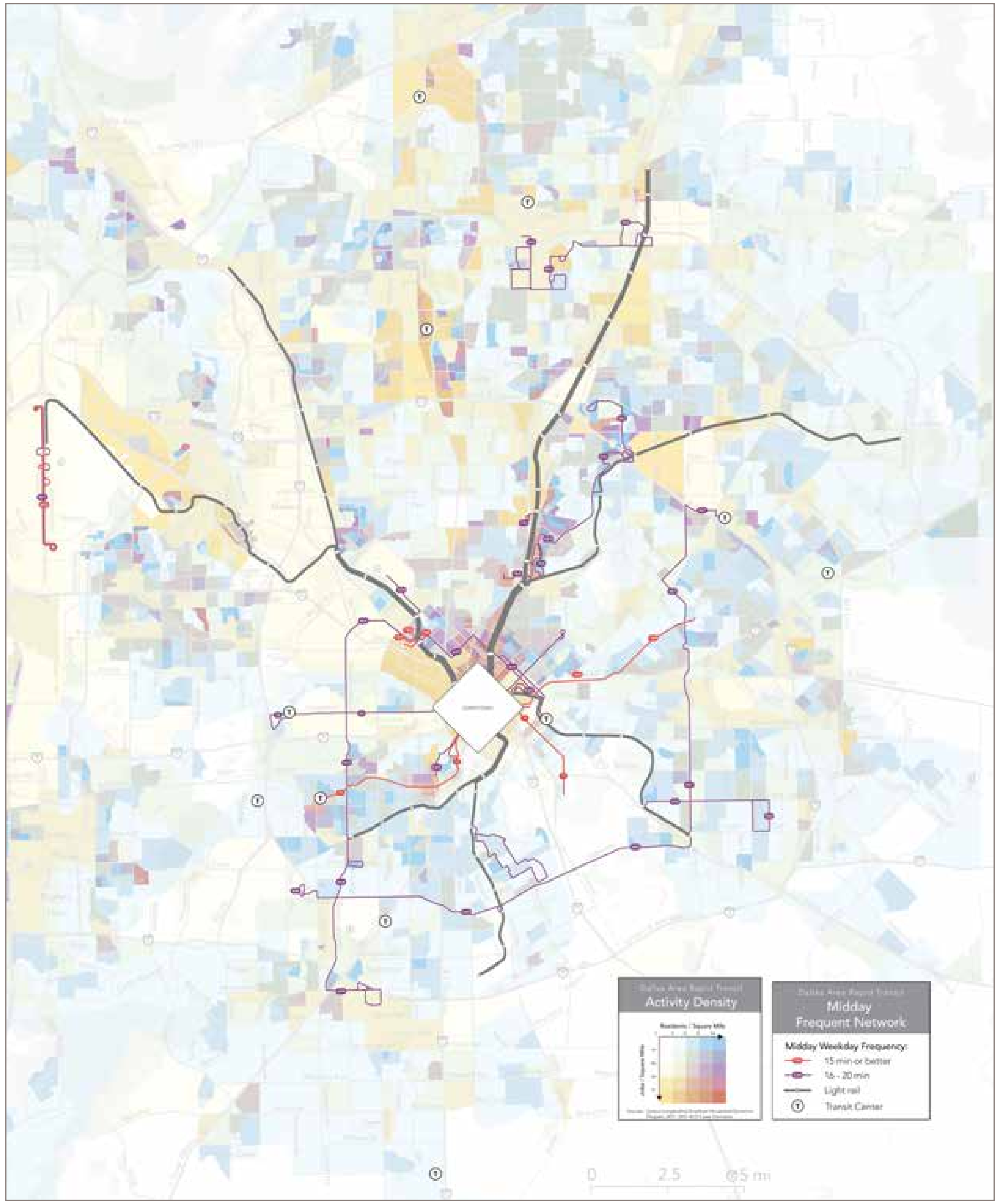
Note: Proximity is measured as being located within 1/4 mile of a bus or rail stop.

How many residents and jobs are within **1/2 mile** of transit?

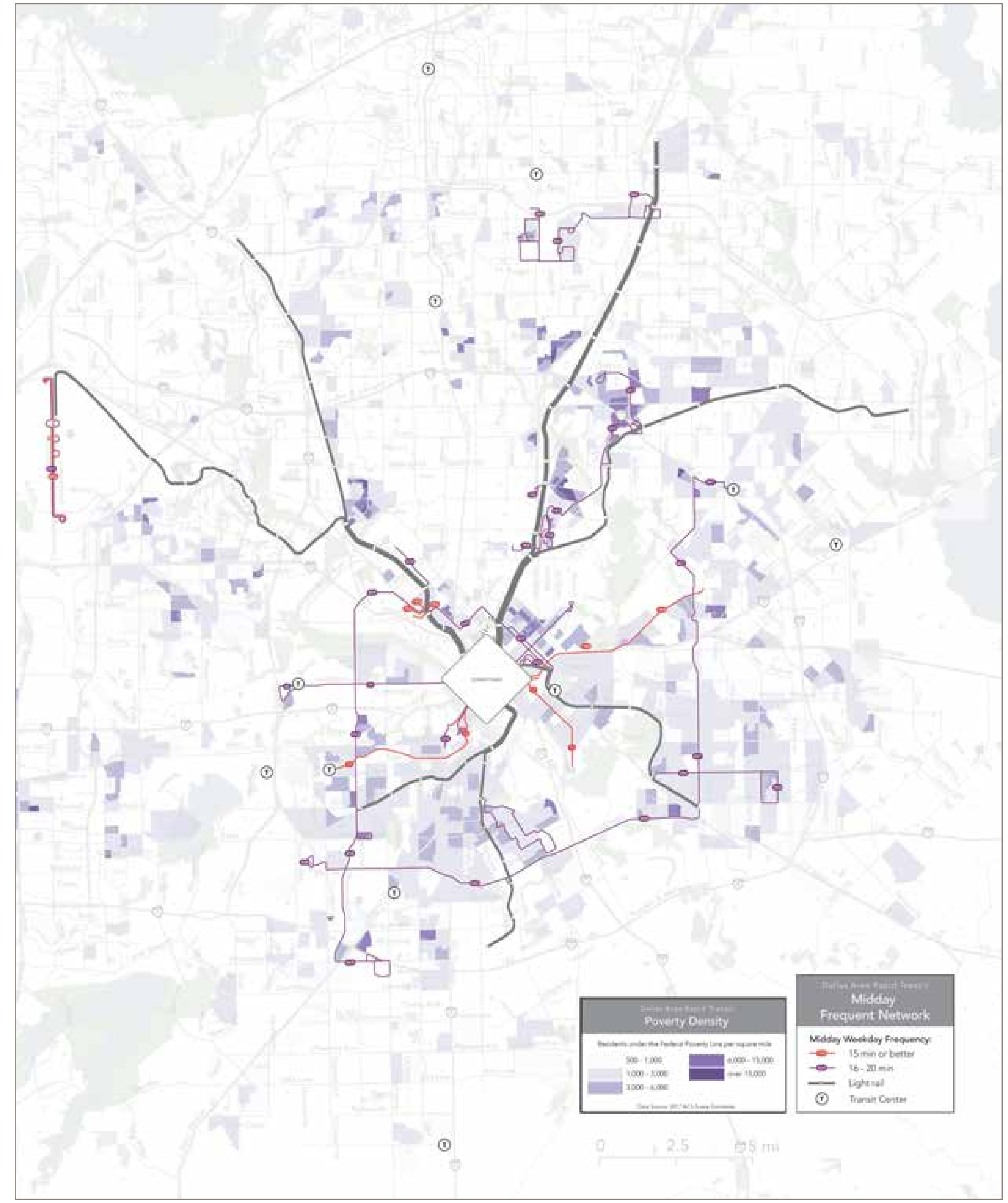
On a weekday, at midday



Note: Proximity is measured as being located within 1/2 mile of a bus or rail stop.



In this map, the 20-minute-frequency network (light rail and bus, coming every 20 minutes or better at midday) is overlaid on Activity Density (as shown in the larger map on page 31). Frequent bus routes have been designed to serve dense, linear development patterns, but many dense places, in nearly every city, have no frequent service at all. This map is about 30 miles across, so the gaps in coverage by frequent lines are enormous. Even if we assume everyone within 1/2 mile on either side of a frequent line has access to it, those 1-mile-wide ribbons cover just a fraction of the dense places in the DART Service Area.



In this map, the 20-minute-frequency network is overlaid on Poverty Density (as shown in the larger map on page 34). All of the frequent bus lines run near residential areas with high or moderate poverty rates, but vast areas with high or moderate poverty rates are unserved by frequent transit. Providing a frequent grid of services across the DART Service Area, just on weekdays, would cost about $72 million more in annual operating budget, on top of the existing $110 million budget. Without an enormous increase in funding, it will not be possible to bring frequent service within reach of the dense, low-income residential areas, to say nothing of the impossibility of covering all dense areas (shown at left).

Transit demand through the day and week

The small maps on page 19 show how frequency falls away on many routes outside of rush hours, at night and on weekends. Weekdays are more productive than weekends, with an average of 17 boardings per bus service hour on weekdays compared to 14 on Saturdays and 11 on Sundays.

Like many large transit agencies, DART concentrates its service on weekday rush hours. Rush hours are the time when the most people are traveling to work, and work is a very important trip. Rush hours are also when the most people try to travel all at the same time, and so congestion is at its worst.

The graph at right shows boardings and service levels by hour of the day on weekdays, as a percent of the daily average level. Boardings are shown in blue, and peak sharply during rush hours. Service levels are shown in green, and peak almost as sharply during rush hours.

There is a third line, in orange, which shows productivity by hour. This line reflects not just how many boardings take place, but how much DART service is on the road. The shape of this line shows us that:

- Productivity is highest not during rush hours, but in the midday. Weekday service productivity peaks during the three-hour period starting at noon.
- Service is slightly more productive from 8-9 pm than from 6-7 pm.
- Service between 4 and 5 am is actually slightly more productive than during the morning rush hour. The number of people riding very early in the morning is high relative to when DART services start running.

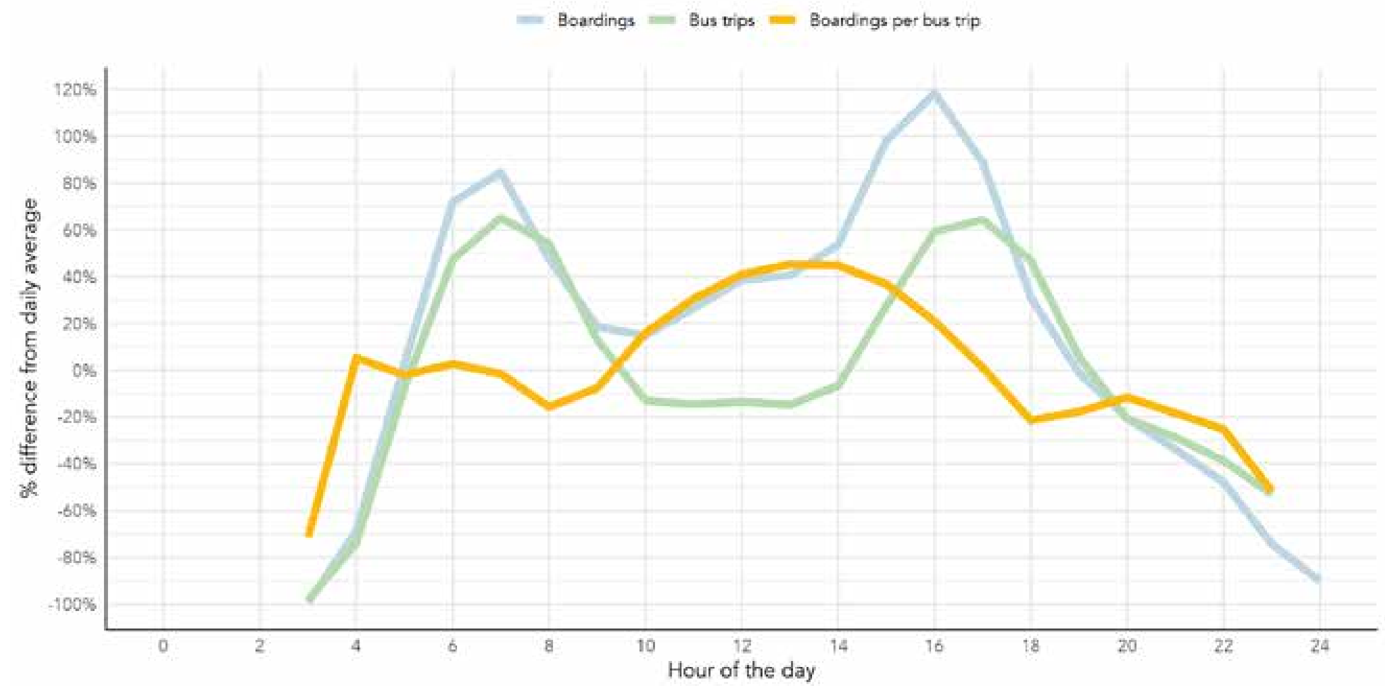
This graph suggests that the ridership potential during midday is over-matched by extra rush hour service. The real-life expression of this math is that midday buses are likely to be more crowded than rush hour buses.

How important are rush hours?

A few statistics from 2017 can give us a sense of proportion about the importance of commutes, and the dominance of rush hour commuting:

- As of 2017, the average American made four trips per day.

DART Bus Service and Ridership: Weekday



Source: DART adjusted boardings data, March - August 2019

The orange line in this graph shows how many bus boardings take place, relative to the amount of bus service provided, within each hour of the weekend. This measure of productivity peaks at midday, not during rush hours.

- Only 15% of Americans' daily trips are made for commuting. The rest are for errands, socializing and other purposes.
- The most trips are made on Fridays, and the fewest on Sundays.
- Looking only at U.S. workers, 62% of them traveled to work between 6 and 9 am. The rest traveled at other times of day.
- More trips are made between noon and 1 pm than are made between 8 and 9 am.
- Less than half of DART's boardings, as of 2014, were made as part of a work commute.

Service at rush hours may have particular importance to DART for a few reasons. More work commutes happen at rush hours than at other times, so if work trips are more important to serve than other trips, rush hour warrants extra focus.

Commutes tend to be longer than other trips. DART has made big investments to optimize transit for longer trips, by focusing on the fastest services (light rail and, to a lesser degree, express buses) while deprioritizing frequency, which is more essential for short trips on transit.

Longer trips, if they happen on full buses, can take more cars off the road (and relieve more people of the costs of cars). However, only a few of the DART routes targeted at rush hours actually exceed all-day routes in passenger miles per service mile.

Rush hours are when roads are most congested, so people have an additional incentive to ride, whether to reduce their stress (if they ride a bus on congested roads) or to get a faster trip (if they have access to light rail or an express route in an HOV lane).

How important are middays, nights and weekends?

The transportation profession has long been focused on the weekday peaks, because those are the times when our road capacity is most-used and congested. There may also be a bias among decision-makers and transit professionals, who themselves work 8-to-5 white collar jobs, that causes us to understand the importance of rush hour service in a personal way while the importance of service at midnight on a Saturday is more abstract.

Yet all kinds of people need to travel at all times of day and week. Arguments for the importance of service at all times of day and week, beyond rush hours, include:

- Service workers tend to work from very early in the morning to midday, or from midday to late at night. This means that large numbers of service workers are changing shifts in the middle of the weekday, when some rush-hour-only routes don't run.
- Most people working in retail or restaurants are only offered a job if they can commit to work on both weekend days. A route that doesn't exist on weekends, and at night, doesn't work for low-income service workers.
- Among rush hour commuters, anyone taking an evening class, pursuing a hobby, going to volunteer, or staying late at work to finish a report wants the flexibility to get home outside of the traditional 8-to-5 workday.

As mentioned above, DART's weekday bus service is more productive than weekend bus service. However, service falls away on the weekends, with 41% of service coming off the street between Friday and Saturday. Service levels compared to weekdays, and average productivity by day, are summarized in the table below.

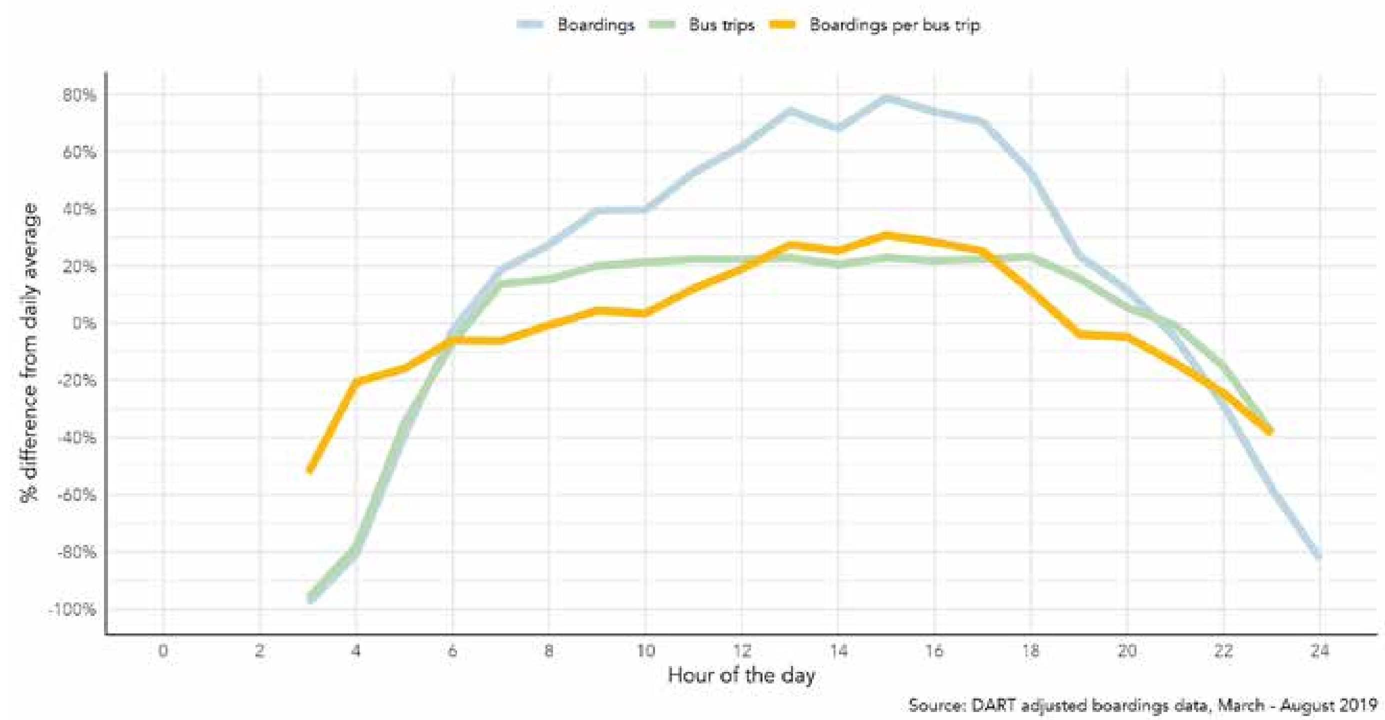
Days	Bus service levels as a % of weekday[1]	Bus boardings as a % of weekday	Average bus route productivity
Weekday	-	-	17
Saturday	59%	49%	14
Sunday	54%	34%	11

The two graphs at right show how boardings, service levels and productivity are better matched throughout the day on Saturdays and Sundays. We can observe that:

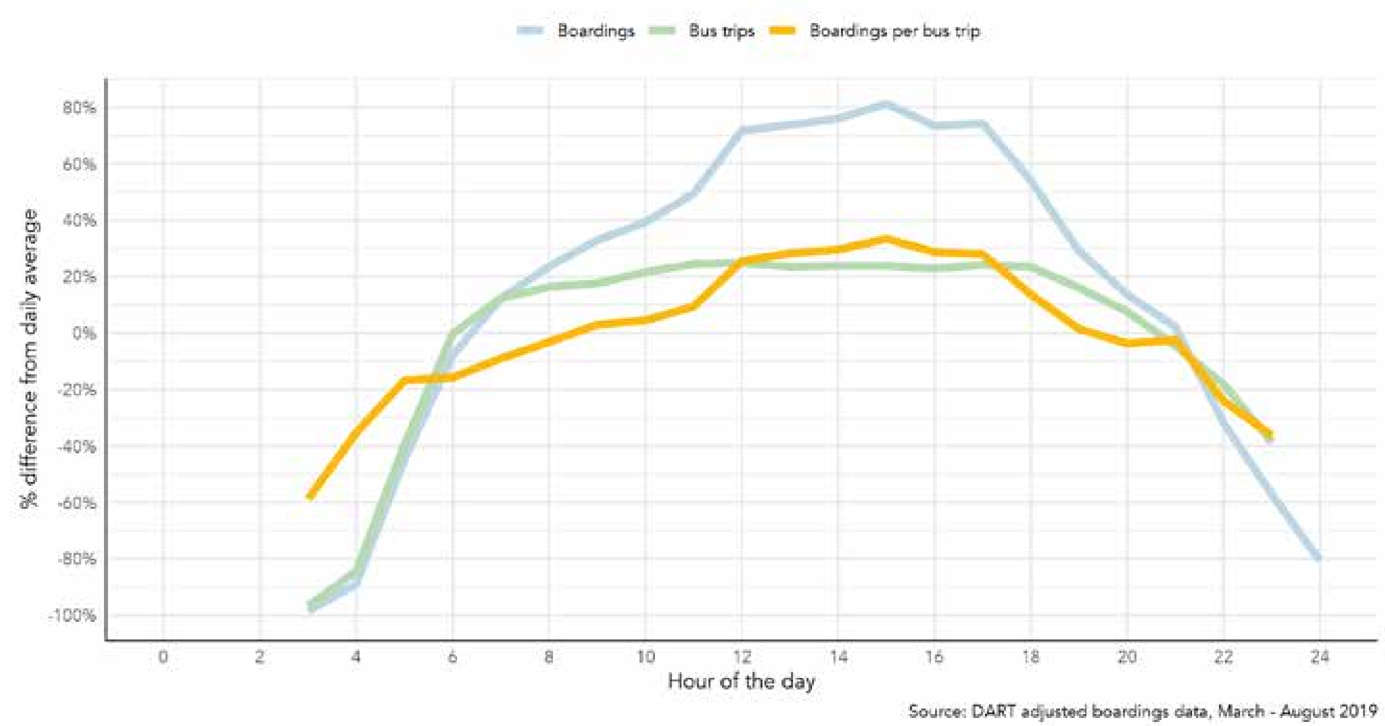
- The number of total boardings (shown in blue) grows steadily through the day until it peaks between noon and 5 pm.
- Service levels are much flatter on weekends, as the mostly-flat green lines from about 5 am to 6 pm show.
- Because service is mostly flat during the day, the shape of the productivity line (in orange) is very similar to the shape of the boardings line (in blue).
- Boardings start to exceed the hourly average (where the blue line crosses over the 0% mark) around 6 am on Saturdays and Sundays, compared to 5 am on weekdays.

1 The service hours counted here, and in the chart showing productivity by hour of the day, include recovery time, which is time built into schedules to protect against unexpected delays and to allow for connections among buses and trains. DART does not usually include recovery time in its productivity calculations, and as a result these productivity numbers will appear lower than what DART usually reports. About 18% of the hours DART vehicles and drivers spend on the road providing service to the public is spent in recovery time. This is a normal ratio for an urban transit agency, and recovery time is essential to the reliable transfers among buses and rail that make DART's low-frequency network work.

DART Bus Service and Ridership: Saturday



DART Bus Service and Ridership: Sunday



The two graphs above show total boardings (in blue), service levels (in green) and productivity (in orange), throughout the day on Saturdays and Sundays. Boardings grow about one hour later in the morning on weekends than on weekdays, as do service levels.

These graphs can help us understand the shape of transit demand throughout the day and week, though transit demand here is represented by transit boardings, which are themselves responding to the transit service levels provided. Thus other sources of information about the timing of travel demand, uninfluenced by existing DART service timing, must be considered.

In addition, high ridership transit services will always have times of the day and week when they are unproductive. It is a mistake to measure the productivity of a routes' individual trips, and cut trips that seem unproductive. An essential feature of a high ridership transit network is that it allows people to depend on it for many different trips, at different times of day and week. This is different from an expectation that people must be riding the network to an equal degree at all different times of day and week.

- Nighttime service nearly always looks unproductive when examined on its own, but the people riding at night were very likely also riding at midday. Cutting night service tends to reduce midday productivity.
- The same is true of early morning service, whose riders are also using midday service to get home.
- Weekend service allows households to forgo a car, for themselves or their teenagers, which makes them better all-week customers of transit.
- Early, midday, night and weekend service also allows an agency to attract more ridership using buses it already owns and maintains, rather than having to acquire more buses to add more service to weekday rush hours.

It is valuable to understand the temporal pattern of ridership and productivity throughout the day and week, to identify times when service may be slightly over- or under-supplied. But each DART route and the entire DART network are complete week-long products, and should ultimately be evaluated based on total productivity across all of those times.

The high costs of service peaking

Peaking service at rush hours has some extra costs that are often invisible to the public.

Peak hour services have a slightly higher labor cost than service at other hours. This can be hard to estimate, because it accrues in subtle ways, either to the transit agency or to the operators.

More service at rush hours, relative to midday, means that more bus operators need to be at work during rush hours. This can either be accomplished through split shifts, in which people work two short shifts with a long unpaid break during the day, or by paying operators extra per hour to work only one short shift.

Split shifts can be hard for operators. They have a long "break" during the day, but they may be far from home with little to do. If they have a family, a split shift means leaving home before their kids wake up and barely getting home before bedtime. While some split shifts are unavoidable, due to scheduling, transit agencies go to great lengths to assemble full shifts for most operators. Yet with high rush hour peaking, there is really no avoiding short shifts or split shifts and their negative impacts on workers or costs.

DART must maintain a larger fleet of buses for rush hours, buses that sit idle during the rest of the day and week. Midday service can be delivered with 284 buses, but rush hour service requires 528 buses. This means that 46% of the fleet exists for extra rush-hour service. A small portion of that additional fleet would be necessary at rush hours just to maintain frequencies as service gets slower due to congestion, but most of it is attributable to higher frequencies and special routes running at rush hours only.

For each extra bus, the agency has to purchase the bus, find land to store it on, stock parts for it and pay people to maintain it. The cost of a "peak bus" is attributable to the people who use it over just a few hours of the week, whereas the cost of an "all-week" bus is attributable to the much larger number of people riding during all the non-rush-hour times of the week. Given the "premium" cost of rush-hour peaking, it may be justifiable to ask people traveling at rush hours to bear more crowding than people traveling at other times. Yet the graph on page 48 suggests that buses are actually more crowded at midday.

Peaking and deadhead

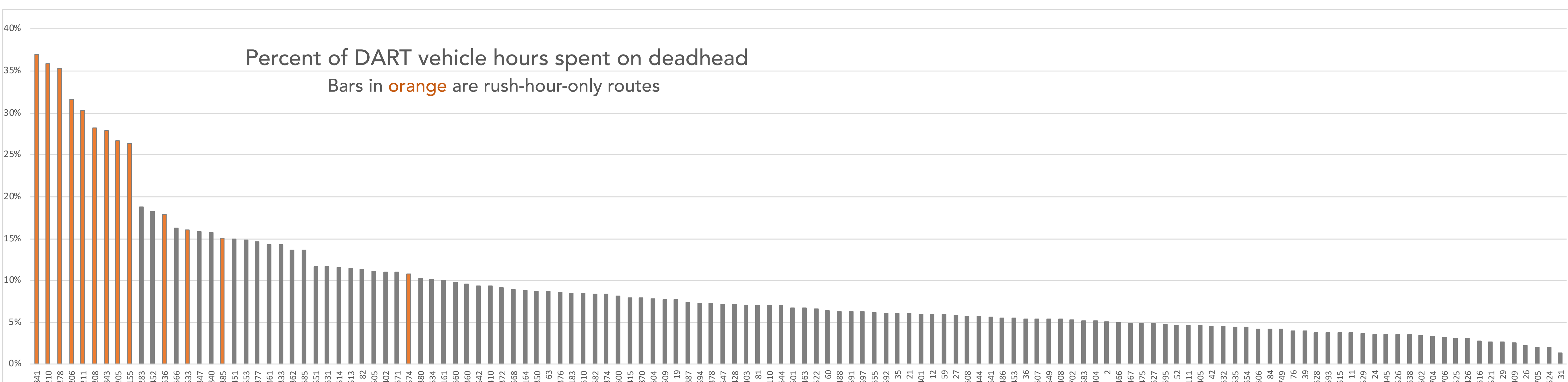
A third type of extra cost that arises for most rush-hour-only services is "deadheading." Deadhead is the time that a bus and driver spend traveling between the route and the bus garage.

The distance between a route and one of DART's three operating garages is a major factor in deadhead, and that distance has nothing to do with the design of the route. Some of this deadhead could be addressed by establishing a northern operating facility, current facilities skew south. However, rush-hour-only routes tend to spend much more time deadheading than other routes for three reasons:

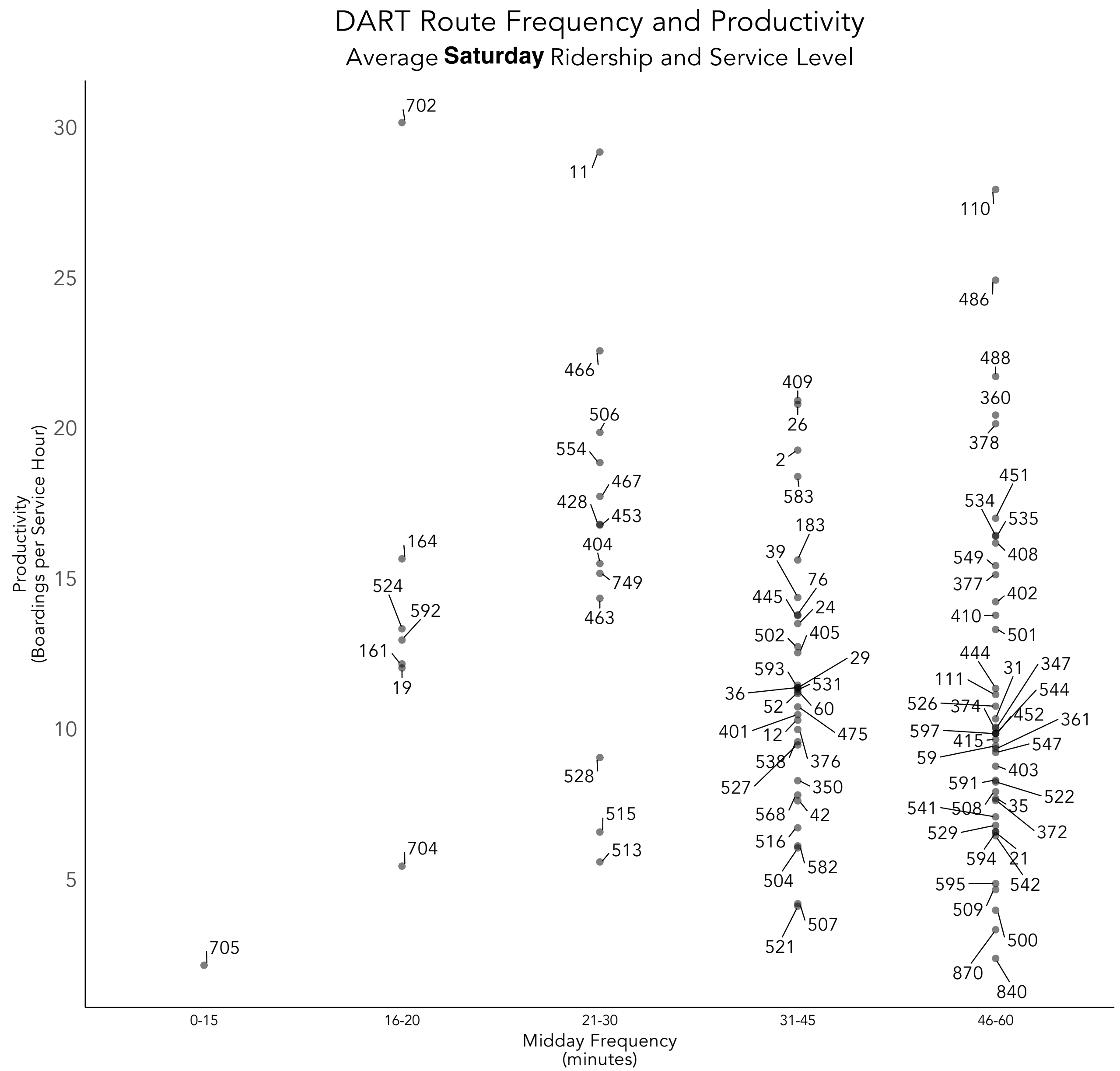
- Rush-hour-only buses come into and out of service twice per day, rather than once, which means twice as many deadhead trips between the route and the garage.
- Rush-hour-only routes tend to be designed to be long, which means that their starting points are often far from a DART garage.
- Five of DART's rush-hour-only routes offer mostly or entirely in one direction, but the buses have to get back to the beginning of the route to start again, which adds to their deadhead.

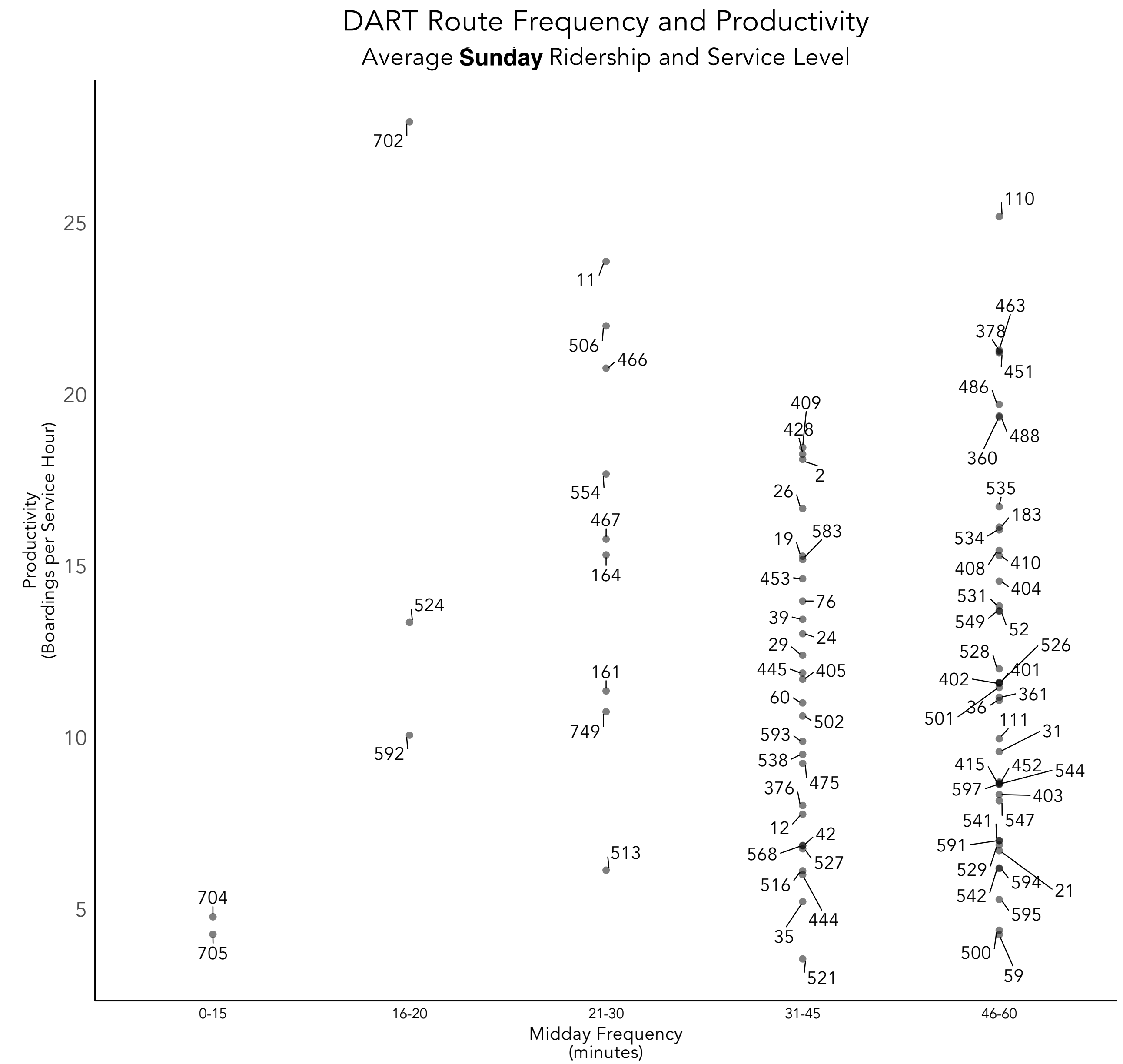
All of the routes that spend more than 25% of their vehicle hours deadheading are rush-hour-only routes, highlighted in orange in the graph below.

There is nothing inherently wrong with high deadhead, but it is a cost that is absent from the productivity measures we presented on earlier pages: neither boardings per service hour nor passenger miles per service mile accounts for deadhead, since deadhead happens when a bus is "out of service." Four of the routes with high deadhead in the graph below are also highly productive: Routes 205, 206, 208 and 278. If the extra mileage they cover deadheading were accounted for, they would appear about 20% less productive than they do, relative to other routes.



Rush-hour-only routes tend to spend much more of their time "deadheading" between the garage and the route, and, if the service is "one-way," driving the other way empty of passengers. (2019)





These scatter plots show weekend routes based on their midday frequencies and their average productivity. Some routes are just as, or more, productive on weekends as on weekdays, despite offering worse frequencies. Other routes are much less productive on weekends. (April 2019)

Weekend productivity by route

The two scatter plots on this page show each route's frequency and productivity at midday on Saturdays (at left) and Sundays (at right) in April 2019.

Unlike the weekday scatter plot on page 40, these scatter plots do not show much of a relationship between frequency and productivity. For some of these routes, frequency is likely under supplied on the weekends, or at least on Saturdays, relative to demand.

For example, Route 11 was just as productive on Saturdays, at a frequency of every 30 minutes, as it was on weekdays at every 15 minutes.

Route 110, between East and Downtown Dallas, is nearly as productive on Saturdays as on weekdays despite serving ample demand to Eastfield College on weekdays.

Route 378, in South Garland, comes every 30 minutes on weekdays and attracts 18 boardings per hour, but on Saturdays and Sundays, with much worse frequency, it attracts 20 boardings per hour.

In contrast, the very frequent Route 704 (a Southwestern Medical District shuttle) is fairly productive on weekdays, with an average of 22 boardings per hour. On Saturdays and Sundays it attracts just five boardings per hour. (The operating cost of Route 704 is covered entirely by other parties.)

Given that:

- Lots of different people travel on the weekends, for many reasons, and
- Retail and service work is an increasing share of the available work in the U.S. economy, and
- Weekends are "all hands on deck" at most service jobs, and
- Retail and service workers are more likely to be living on low incomes, and therefore have a big incentive to choose transit...

...if DART wants to increase ridership on its bus network, providing more consistent seven-day-a-week service on the highest ridership routes may be a good strategy.

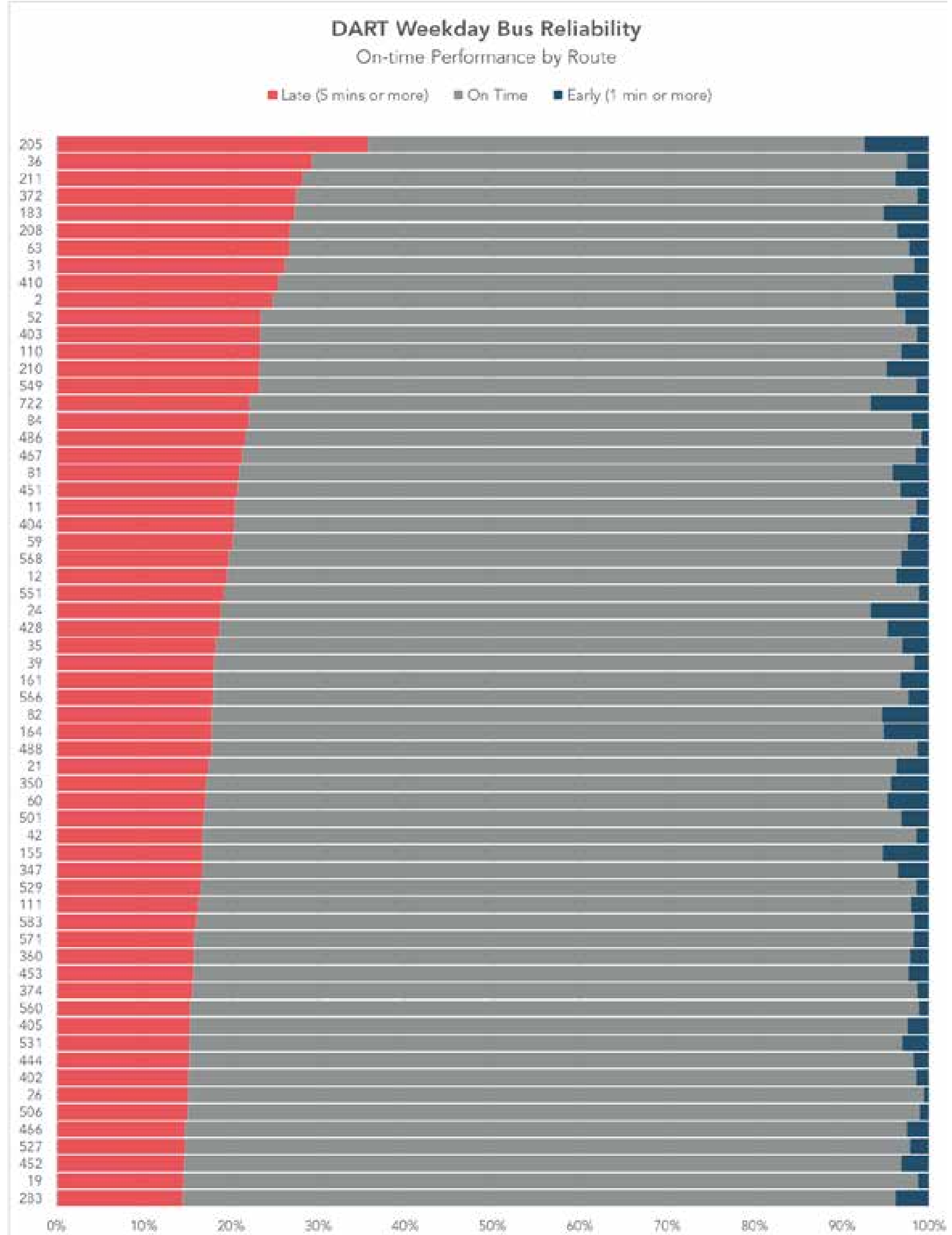
Reliability and speed

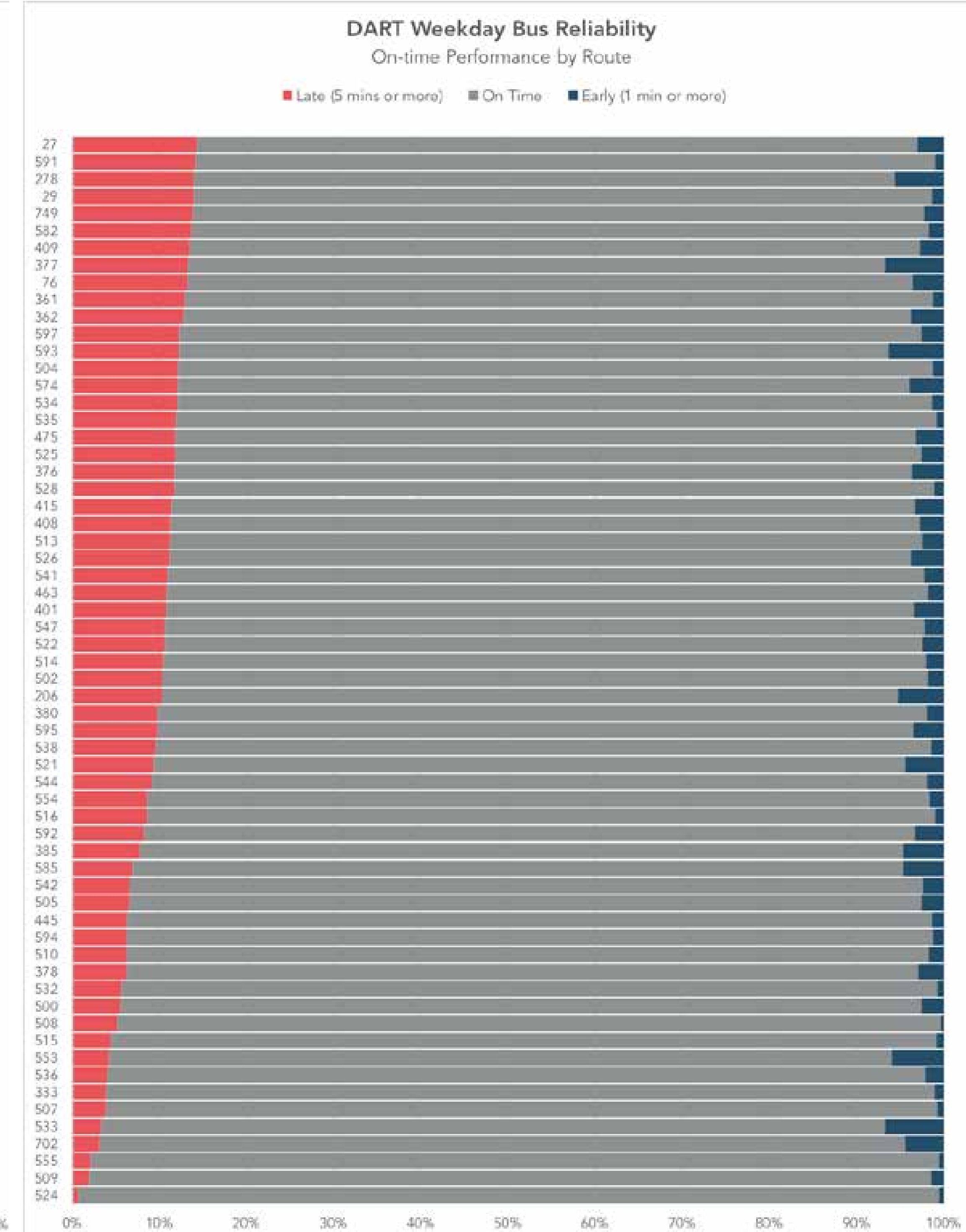
The reliability and speed of a route are related to one another. If a route is consistently running behind or missing connections, additional time can be added to the schedule, and its reliability will improve, but its speed will go down. If a route is scheduled to run faster than is actually possible, it will chronically run behind and miss connections.

The reliability of DART's existing services is quite good, in part due to staff's concerted effort over the past five years to rewrite schedules and add time on the most problematic routes.

Many of DART's routes make timed connections with one another and with light rail. The reliability of those connections is critical: if your bus is late coming into a transit center, you will have *just barely* missed a connection with a different bus that comes every 40 minutes. Now you are facing a 39-minute wait, the worst-case-scenario for that frequency.

The charts at right offer a very simple summary of a route's on-time performance. They do not convey where on a route delay occurs, nor whether the bus is full of people at that point. Delays that affect full buses are of much greater consequence than delays that affect empty buses. When DART staff evaluate on-time performance and decide where to spend additional operating dollars to add time to routes, they look closely at those factors.





The on-time performance of every DART bus route, FY 2019, is illustrated in these graphs. The red portion of each bar represents the percent of scheduled arrivals at stops that were "late" (up to 5 minutes after the scheduled time). The blue portion shows the percent of arrivals that were "early" (1 minute or more before the scheduled time). DART's routes are very reliable, on average, considering that nearly all of them run in mixed traffic, with no protection from congestion. Even driving a personal car in the Dallas area doesn't deliver "on time" arrivals 100% of the time. (April 2019)

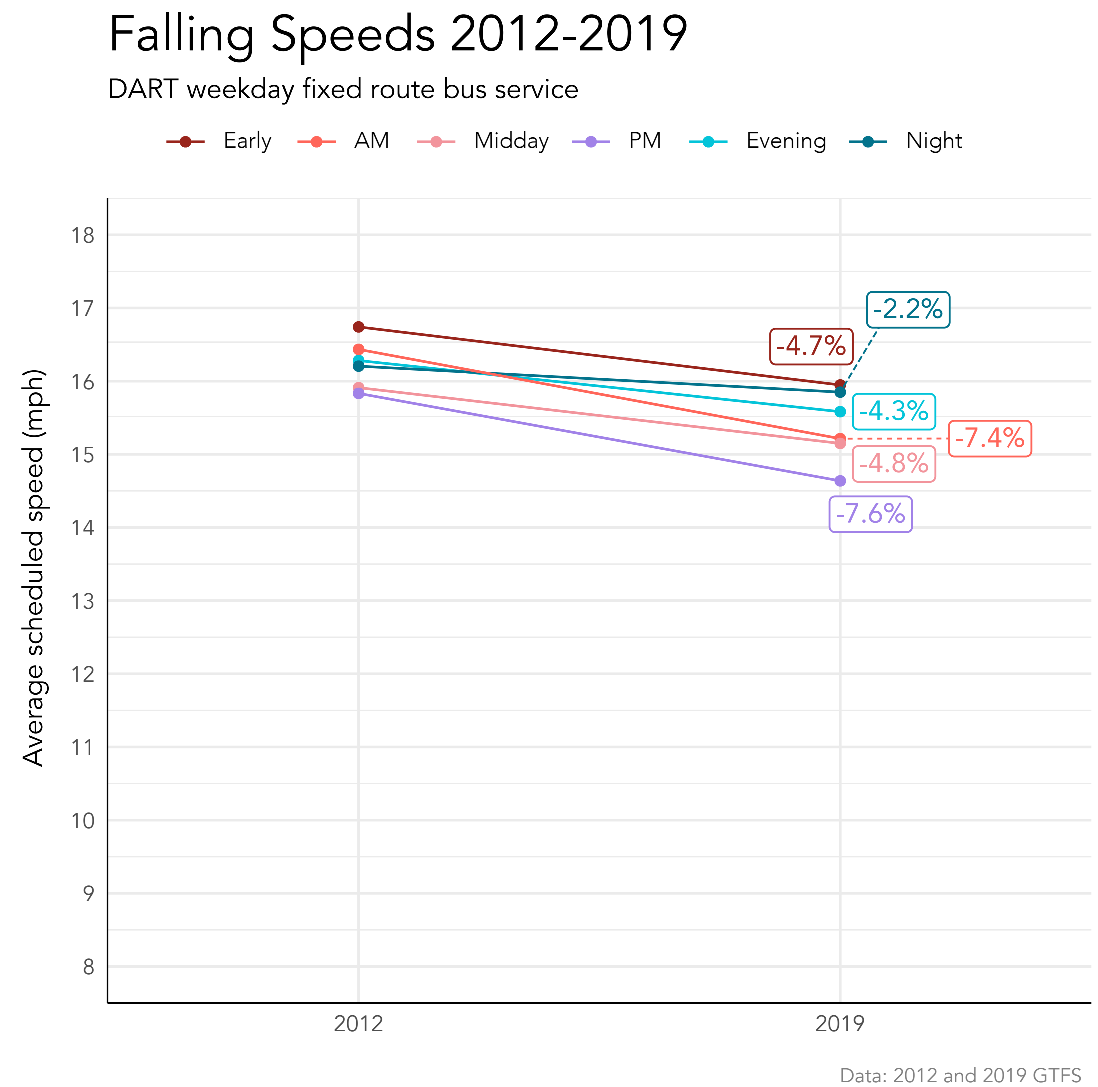
As congestion increases, any transit service that is not protected from congestion faces declining reliability and declining speed.

The speeds of buses on a route affect both the frequency of service and DART's operating costs. If a route is slowing down or becoming unreliable, DART has four choices of what to do about it:

1. Reduce the advertised frequency of the route to avoid incurring any additional operating cost. If the route is advertised at every 30 minutes but runs behind consistently, rewrite the schedules and admit that it only comes every 35 minutes, reliably.
2. Add another bus and driver to the route, to maintain the advertised frequency. This increases operating costs. It is better for customers than Option 1, because they don't spend any more time waiting, but they still have a slower ride once they're on the bus.
3. Change the few speed factors within DART's power: reduce the number of bus stops, eliminate deviations, use faster fare-payment systems or allow all-door boarding. Most of these have a minimal or modest impact on speed.
4. Work with municipal and other government partners to speed up transit on streets and highways. This is by far the most powerful way to make transit faster and more reliable.

DART has been taking all of these actions over recent years, to improve reliability, preserve frequencies and speed up service to the extent that is within the agency's power. Without intervention by local municipal governments and the agencies that control roads and intersections, declining transit speeds will either erode frequencies or consume more of DART's budget, while also making transit riders' trips slower. Municipal intervention is also a factor during periods of construction, when congestion and detours can result in delays. Route 206, serves as an example of municipal actions affect DART services, during construction Route 206 lost HOV Lane access resulting in slower speeds as trip are forced into the resulting congestions.

The graph at right shows how "successful" DART has been at improving reliability since 2012, by reducing the scheduled speeds of routes in order to make them slower (but reliable). The average weekday speed has declined by about 7% at rush hours and 5% at midday over the past seven years.



In order to improve reliability, DART staff has added time to bus schedules. The result is better reliability, but slower speeds. Slower speeds mean passengers get a slower ride, but slower speeds also force DART to either spend more money or cut frequencies.

6 Challenges and Opportunities

Not much service

DART has a modest supply of bus service with which it covers a huge area. All of the trade-offs presented in this report become more agonizing when the budget is small, especially in a big city with many urban centers, high standards and global aspirations.

Canadian cities demonstrate how much more relevant transit can be to the life of a city with more investment. Canadian cities are often built like U.S. cities, with small historic cores dwarfed by sprawling freeway-oriented suburbs. Yet Canada spends about twice as much per capita on transit service, and as a result gets about twice as much transit ridership.

Calgary, Alberta, is a big oil town like Dallas. Calgary Transit can provide about twice as much bus service per capita as DART. Bus ridership relative to population is about three times as high in Calgary, despite its car-oriented development pattern and absolutely frigid weather for half of the year.

Travel distances are long

As of 2015, people living in the DFW region were not commuting for more *minutes* than people living in other similar cities. However, the average commute *distance* in the DFW area has been longer than other similar cities, with the exception of Houston.

Transit can be effective over long distances and over a large area using the three different strategies, ideally in combination, shown in the table to the right.

DART has pursued the first two strategies, building a radial LRT network that offers high speeds (but not very high frequencies) centered on Downtown Dallas. In 2022, a cross-town Silver Line will open between DFW Airport and Plano.

DART has also offered some freeway express service for higher-speed travel between cities.

The idea of creating a frequent grid has been discussed and analyzed by DART staff and consultants for multiple years. The costs far exceed what the existing bus budget could handle, and represent about twice as much budget as is currently spent on *all* coverage services.

A smaller frequent grid may be possible within some parts of the DART Service Area, but even that would require a major shift in investment away from low-ridership coverage services, to free up enough service to provide all-week high frequencies on just a few additional lines.

Long Distance Transit Strategies

Strategy	What is it like?	What makes it work?	What are the downsides?
LRT or BRT	Bus Rapid Transit or Light Rail Transit in exclusive right-of-way.	High speeds allow people to access more opportunity, and also make more frequent operations more affordable. Major development within walking distance of stations is essential if costly feeder networks are to be avoided.	LRT, and to a lesser degree BRT, is capital-expensive and so cannot be provided in very many places at once. They are expensive to operate and therefore are typically only built where ridership will be very high.
Intercity or express buses on freeways	Buses make local stops in an area and then use a freeway for high-speed travel to a distant center.	High-ridership intercity or express buses are typically those that help people avoid congestion (by using HOV lanes or other priority), avoid expensive tolls, avoid high parking costs, or avoid driving for a very long trip.	Buses cannot stop on freeways, and even if they could there would be hardly anything within walking distance of a freeway-edge stop. As a result, bus service down a freeway does not exist for any of the places it passes by. Local service on parallel (transit-operable) roads must also be provided, to serve those areas. In some places, the "coaches" used for freeway-running service have narrow aisles and a single door, which slows the loading and unloading of passengers on high-ridership routes and makes wheelchair boardings difficult.
Frequent grid	A grid of main arterial roads has frequent, all-day and all-week bus routes running along them.	High frequency, all day and all week, is key to the success of a grid. Many trips can be made with a single transfer, but that transfer happens at random times and the only way to make it fast is if both grid routes are coming frequently. A grid is helpful for long-distance urban travel because it reduces out-of-direction travel, but without transit priority it may not be very fast. Many trips can be made by two alternative paths, which provides some resilience in the case of disruptions. Grid networks relieve transit agencies of having to pick a "center" or a single important corridor. The distributed investment also reduces fears that a single capital-intensive line (like BRT or LRT) will cause property speculation and gentrification.	Providing the high frequencies and long spans of service that make a grid network functional, across many miles, is costly and requires a very high level of commitment to funding bus service. High frequencies have to be justified even across low-ridership segments because of the connections that are made at the scale of the entire network. In the face of budget cuts, temptations to reduce frequencies at nights and on weekends are hard to resist, and can result in very long wait times to transfer at arterial intersections. It can be hard to organize social and political support around a distributed investment. With long travel distances, speed is very important and grid services on arterials must therefore be fast in order to replace radial light rail trips without making many peoples' trips longer.

Freeway-oriented development

Some of the densest development in the DART Service Area is oriented to freeways and frontage roads. This freeway-oriented development strategy reduces DART's ability to provide transit service that is both useful and cost-effective.

This pattern is visible in the map of activity density on page 31. Dense, developed areas seem to be arranged in a linear and proximate pattern – but the line along which they are arranged is a one-way frontage road. One of the ingredients in the Ridership Recipe is linearity, but only if the line being followed is one along which buses can serve stops, and people can access those bus stops. Neither is true of frontage roads – buses running down the freeway are walled off from potential riders, and must exit the freeway and loop around to serve stops. For transit, freeways are barriers, not corridors.

There are two major consequences of this freeway-oriented development pattern. The most obvious consequence is that development concentrated along frontage roads requires people to walk in unsafe and unpleasant conditions to access transit service. This will naturally suppress transit ridership at those bus stops below what it could otherwise be.

There is a second-order consequence, which is just as serious. DART and other transit agencies in this situation respond quite reasonably by making sure that neighborhoods on both sides of the barrier have access to transit. This means running two routes, instead of one.

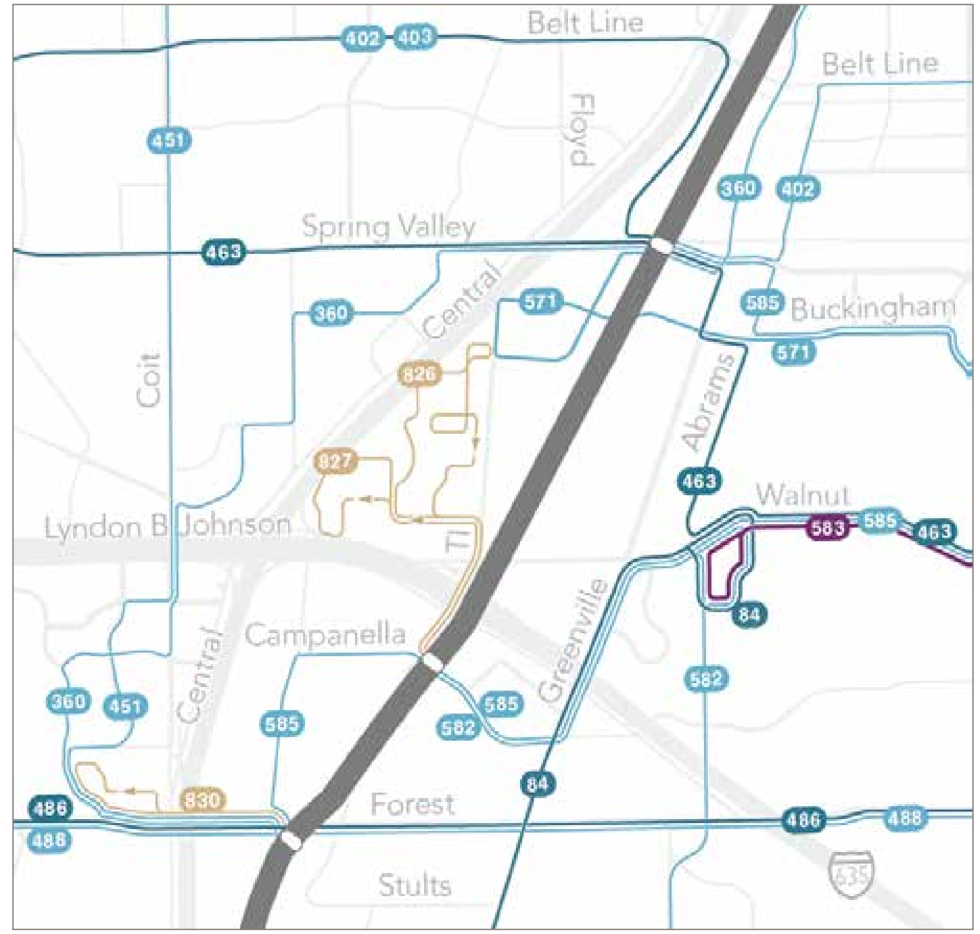
For example, the area around the interchange of the LBJ Freeway and Central Expressway is dense with development. The red line passes about one mile from the interchange, and has three stations in the area (Spring Valley, LBJ/Central and Forest Lane). Some long bus lines also pass through the area, connecting it to other cities.

DART's service pattern is complex. Because dense places just across a freeway from one another are far away by walking, DART has to run bus routes down frontage roads on both sides of both freeway to cover the area. (Local partners share the costs of some of these routes.) For example, Routes 827 and 360, and Routes 571 and 360, are just 1/4 mile apart but in different worlds on either side of the freeway.

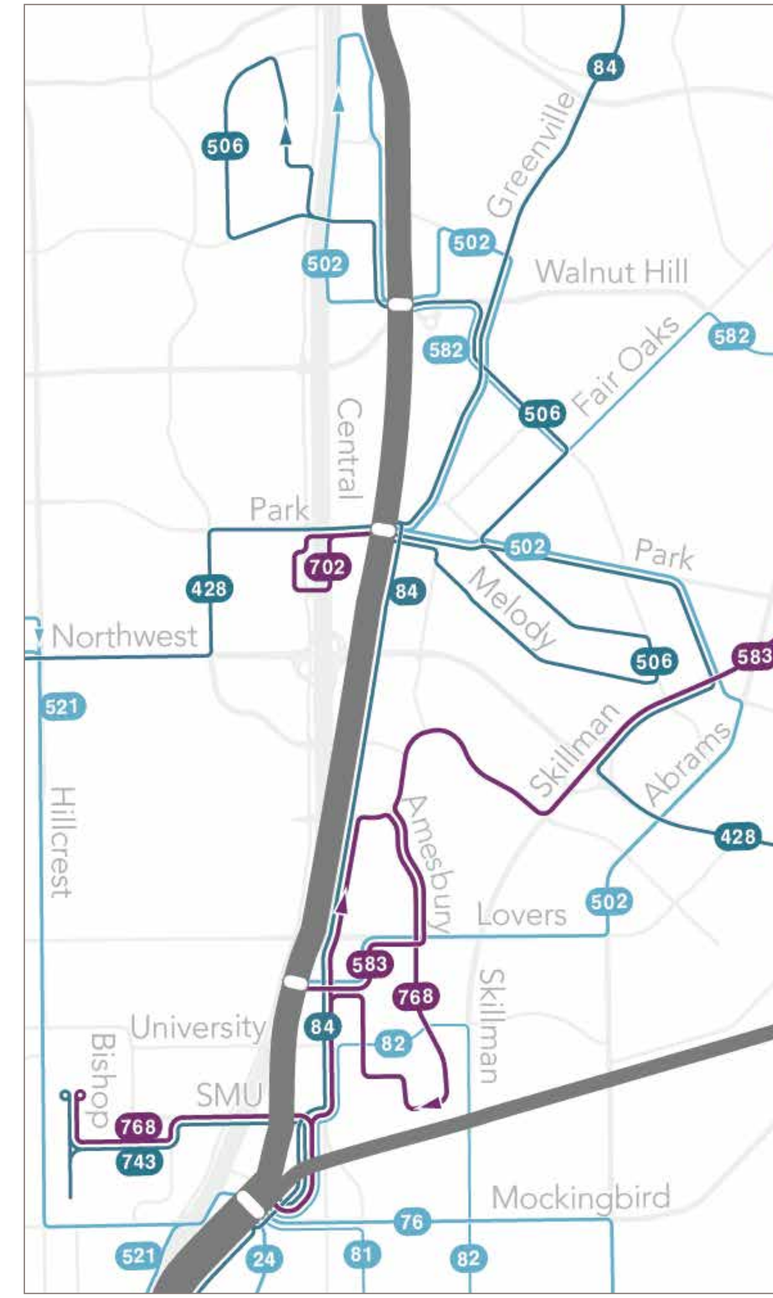
Dividing a limited quantity of service into more routes means that routes have worse frequencies (or shorter spans of service) than they otherwise could.

The same phenomenon is visible in other places, including just to the south, where the red line runs close to and then under the US 75 Central Expressway. NorthPark Center is a little more than 1/2 mile from the Park Lane Station, and there is a Route 84 stop just 1,200 feet from the NorthPark Center entrance...but on the other side of the freeway. Given how unpleasant the walk is (going over the freeway, with long waits to cross wide high-speed roads), DART runs the Route 702 to the mall to connect people across the freeway to the station. (Route 702 gets very high ridership.) Routes 506 and 502 also cover opposite sides of the freeway, within 1/4 mile of one another. To the south, a tangle of routes cover both sides of the freeway, connecting SMU and nearby developments to Mockingbird Station.

Imagine that one-way frontage road developments were instead concentrated to the same degree along arterial roads. Then DART could take many of these squiggly, infrequent lines, combine them, and offer linear service at higher frequencies for improved spans while still passing within walking distance of many peoples' front doors.



For transit, freeways are barriers, not corridors. Serving freeway-oriented development requires dividing service into more routes, each with worse frequencies than would be possible if that development is oriented towards transit-operable roads (for example, Routes 571 and 360).



In many places along the DART light rail network, freeways or freight rail tracks divide the area around a light rail station in half. DART runs bus routes to "feed" light rail so that people can reach stations despite those barriers, covering distances that would otherwise be short enough for most people to walk (for example, see Route 702).

Some people have the idea that light rail is great because it is direct, fast, reliable, and easy to understand, whereas bus routes are confusing and circuitous. There is nothing about steel wheels or rubber tires that causes linearity, or simplicity, or complexity. The source of those differences are our land use patterns, and the jobs that we ask each type of vehicle to do. With linear, transit-oriented development, bus lines can be direct, frequent and simple.

Light rail stations

Buses fix walkability problems

Freeways aren't the only barriers to walking to light rail stations. Some stations are located in places where street connections are simply missing, and where a lack of sidewalks and safe crossings prevent people from using the streets that do exist.

For example, at Belt Line Station (towards the bottom of the aerial image at right), a moderately dense employment area is located just to the north. The center of this development is less than 1/2 mile from the station, less than a 10 minute walk. The photo below right shows the view from the Belt Line Station, towards this job center just to the north. There is no street connection, and no pedestrian connection. There are also no sidewalks on the road just outside of the light rail station.

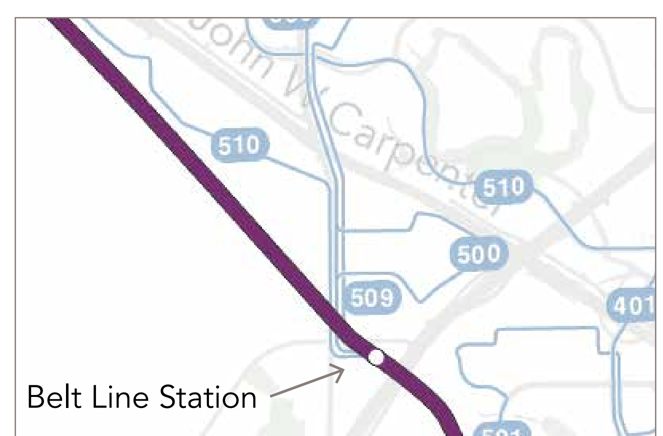
If someone wants to walk into the center of this jobs area, a place less than 1/2 mile to the north as the crow flies, the actual walk is nearly a mile. The walk begins in a ditch or on the shoulder of Valley View Lane for a little ways until the sidewalk begins.

The map at far right, top, shows the area around Belt Line Station that is within a 10 minute walk, circled in red. Shown in yellow is the area with moderately dense jobs and other activities. To provide contrast, the map at far right, bottom, shows the same 10 minute walk from the Farmers Branch Station. While there is less activity around the Farmers Branch Station, there are well-connected roads and sidewalks. The walkshed is so much larger that there are nine times as many jobs within a ten minute walk of Farmers Branch Station as Belt Line Station.

What does this mean for the transit network? First, those jobs are not within an easy or safe walk of Belt Line Station and the enormous capital and operating investment that has been made in the light rail line serving it. A capital investment in sidewalks and a street or a path is preventing people from using light rail service that passes right by them.

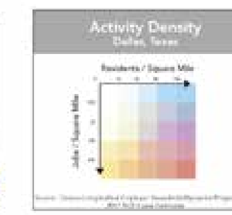
Second, instead of a one-time capital investment, this problem is solved with a bus operating expenditure, year after year. Route 500 deviates from an otherwise direct path to loop through this development, making up for the lack of infrastructure around the rail station. This makes Route 500 more time-consuming for anyone who is riding *through* to other places.

Some light rail stations lack street connections, sidewalks and crossings that would connect them to jobs and housing that are very close by. To make up for this lack, DART runs bus routes to help people make very short trips to light rail stations, trips that under better conditions most people would probably be willing to walk.



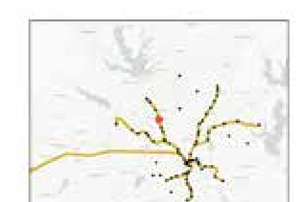
BELT LINE STATION

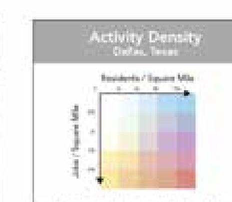
	10 min walk
Jobs Access	122
Resident Access	1



FARMERS BRANCH STATION

	10 min walk
Jobs Access	1075
Resident Access	1043





Because light rail has been designed for speed over long distances, stations are spaced far apart. DART runs local buses to cover the places between stations.

Wide station spacing requires a bus supplement

The DART light rail system was designed to be fast, in order to make it competitive for very long trips. One of the decisions that was therefore made about the system was to have long distances between stations, since decelerating, loading and unloading passengers, and accelerating all slow down a transit vehicle's overall speed.

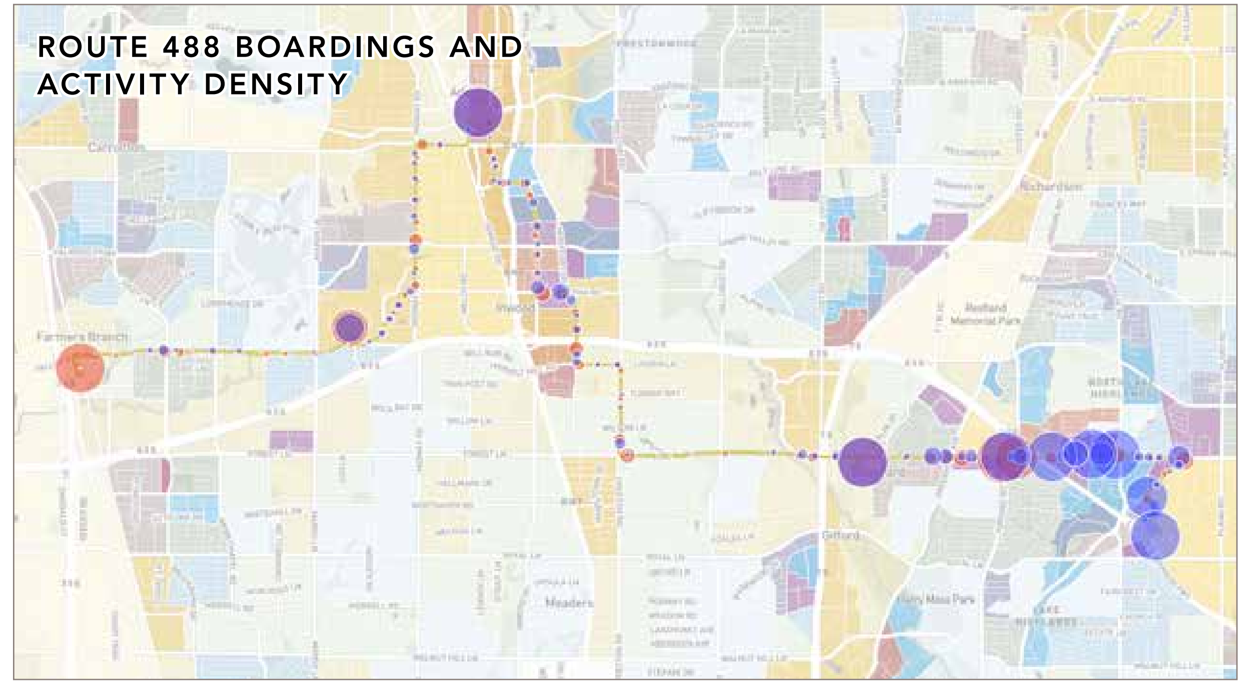
This was not a bad decision, but it has consequences for the bus network which DART understands well.

If someone is located halfway between two stations, the distance is probably too far for them to walk, even if they are in an area with good street connections and sidewalks. As a result, ***light rail lines have not relieved DART of running parallel local bus routes on the same corridors***. The only bus routes that light rail lines replaced, over the years, are long-distance point-to-point express routes.

The map inset at right shows Route 544 running parallel to the Green Line on Harry Hines Blvd., connecting the Farmers Branch, Bachmann and Southwest Med. District/Parkland Stations. Harry Hines Blvd. is a decent transit corridor, with much commercial development along it, dense housing to the east of it, anchored by the huge medical district at its south end.[1] Yet Route 544 is not very productive, probably because it is uniquely useful only for short trips to places between light rail stations. Anyone going farther, or going someplace near a station, would take the Green Line instead. Route 544 exists to provide access to the people and places that are too far from a Green Line Station to walk. A similar local route is provided by Route 84, for the Red/Orange light rail lines, between downtown Dallas and Park Lane Station.

The new Silver Line train from DFW Airport to Plano will likely present a similar challenge for local access. It is planned to have wide station spacing (an average of 2.9 miles), and it will run in existing rail right-of-way rather than on an arterial road. For both of these reasons, it is unlikely to replace any existing segments of DART bus routes.[2] People wanting to walk to Silver Line stations may also encounter disconnected street networks, which are common around freight rail rights-of-way and in suburban areas.

Wide station spacing and high speeds are a sensible feature of a long-distance rail network, but those features imply that there will be decent bus service around and between stations.



Crosstowns in the north part of DART's Service Area can either be direct, or can hit all very dense centers (as Route 488 does), but cannot do both.

Crosstown trips are hard

DART's light rail network is radial, which makes trips to and from downtown fast. Radial networks are the right shape for smaller cities, because they connect everywhere to everywhere with a single (downtown) transfer.

As urban areas get bigger and develop multiple centers, the out-of-direction travel necessary to transfer at the center becomes very long. People want to make "crosstown" trips, for example from Garland to Addison, or Plano to Irving, without going all the way downtown.

A radial shape is more suitable for a low-frequency network, because it allows for timed connections (which DART provides at stations and transit centers), and also because it allows people to pass long waiting times in a civilized place (at a transit center or downtown, rather than on a street corner where two bus lines intersect).

DART has begun to offer more crosstown routes in recent years though the low level of overall bus service makes it challenging. Because crosstown routes are so long, they are costly to provide at high frequencies. They run in mixed traffic, so they get delayed by congestion. There are some crosstown trips that are still much faster by train, despite the out-of-direction travel through downtown.

Dense development is not continuous along east-west roads in the north part of the service area, so crosstown routes have to deviate north and south to connect dense places to one another. Route 488 (shown above) offers crosstown services between N. Lake Highlands and the Green Line rail station in Farmers Branch, a similar route to the one offered by Route 486 (shown on page 45). But Route 488 doesn't cover quite as much east-west distance as Route 486, because it starts at LBJ / Skillman Station rather than Garland. Route 488 is also much less direct than Route 486 because it makes a deviation far to the north to reach the densest parts of Addison and the Addison Transit Center.

Because development is organized around different, far-apart east-west arterial roads in this area, it is hard to draw a small number of linear crosstowns that connect many dense places to one another. Dividing service into more crosstown routes, so that each dense place can be directly connected to each other dense place, results in lower frequencies on every route. Routes 486 and 488 are both quite productive, but neither offers high frequencies, especially not on weekends when they both come just once per hour.

The Silver Line is being built in part to address this crosstown problem, though like all capital-intensive transit it can only be in a fraction of the places people are traveling among. The areas around its 10 stations will have a fast ride east-west, but the train will only come once per hour all week (and every 30 minutes during rush hours), so the wait to use it will be long. Crosstown travel on the north side will still be the bus network's job.

1 It is not a coincidence that Harry Hines Blvd. predates the interstate freeways. Old highways in growing cities are often low-rent and humble, but the pre-WWII development pattern demonstrates the Ridership Recipe nonetheless: Dense, Walkable, Linear and Proximate.

2 The only segment it duplicates is the UT Dallas shuttle between campus and Cityline/Bush Station. But that shuttle comes every 20 minutes, all day, seven days a week, and attracts very high ridership, so it is hard to imagine a train arriving once per hour replacing it.

Close route-spacing

There are some parts of DART's Service Area in which the transit network currently offers short walks to multiple parallel routes. This is an opportunity to ask bus riders and the public whether short walks are more important than short waits.

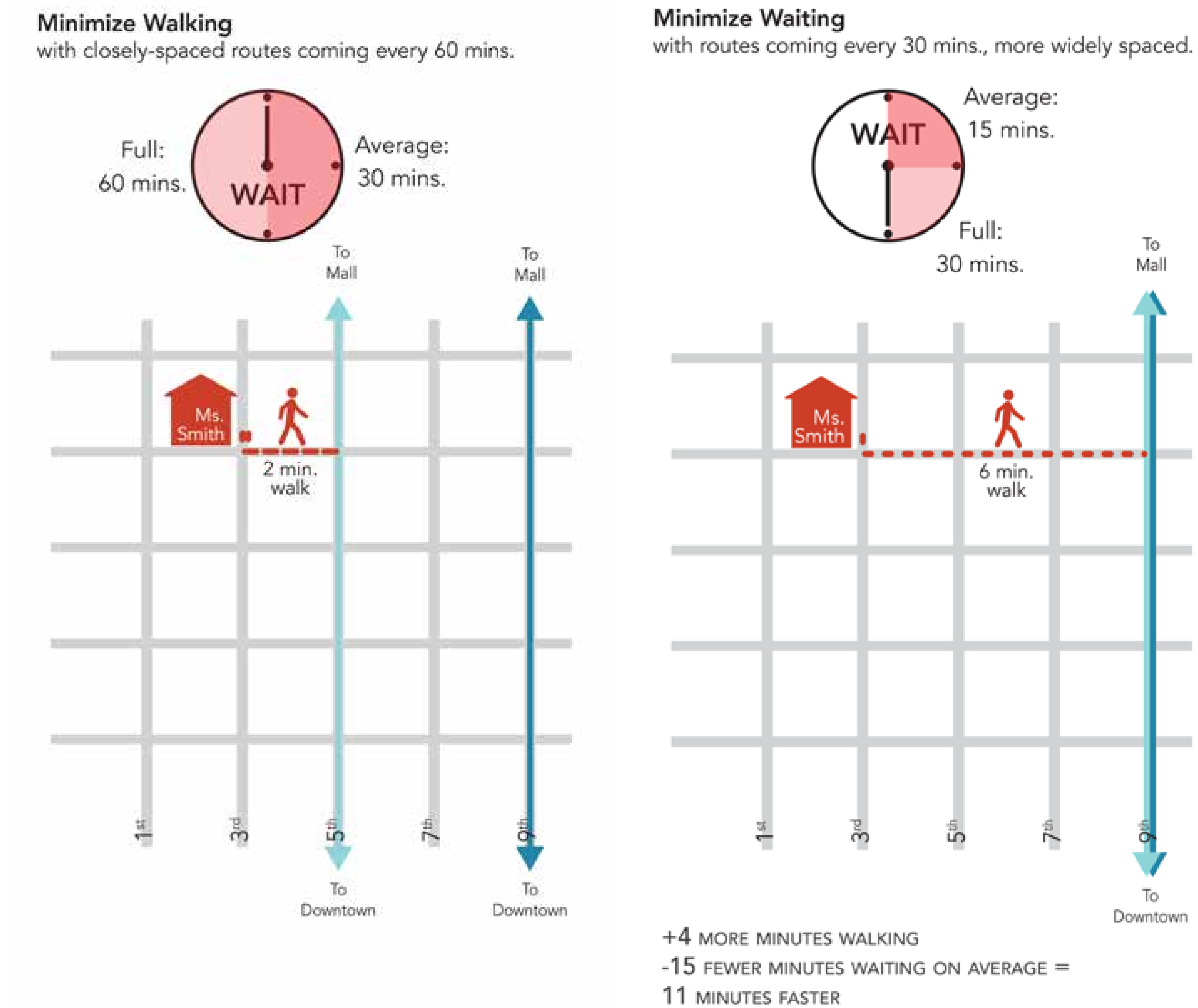
Within a fixed budget, increasing frequency or lengthening spans requires consolidating service into fewer routes. But this increases walking distances. The math that makes this possible is demonstrated for a fictional transit rider, Ms. Smith, in the diagrams at right.

In areas with good street connectivity where walking routes are direct, consolidating routes to make them more frequent can actually make people's trips faster, despite the longer walks. Some people might prefer a longer walk if it means they wait less, and get where they're going sooner. However, local conditions normally affect peoples' willingness to walk: if the walk is noisy, or unsafe, or dark, or if extreme weather is a concern, then people may prefer longer waits at a stop closer to them.

Consolidating parallel service into fewer routes is a way that transit agencies can improve frequencies or lengthen spans of service within their existing budgets.

This choice is particularly relevant in places that were built before World War II and the dominance of private cars, which have well-connected street networks that allow transit to run down multiple parallel streets, such as in South Dallas, Oak Cliff and especially in Old East Dallas.

This is a choice that could also arise in some of the complex networks that DART provides around freeways and around its light rail stations, where asking people to walk farther may allow DART to consolidate services and give them a shorter wait.



In some situations, consolidating parallel routes onto fewer streets can make the average person's trip faster. There may be opportunities to do this in certain parts of the DART Service Area, if people value shorter waits and faster travel more than they value shorter walks.

Using the example of Old East Dallas, five north-south routes run down parallel streets in a band just 1.5 miles wide, for an average spacing of 0.4 miles per route. Many people are walking distance from multiple routes all heading roughly in the same direction. Only one route offers decent frequency (every 20 minutes) on any given day.

For close-in neighborhoods, downtown is an obvious big destination, but transit trips to downtown are short enough that waiting time can exceed riding time. The shorter a trip, the less a person will tolerate a long wait to use transit. This is why, in high-ridership radial bus networks, routes close to downtown are often consolidated into frequent "trunks" 1/2 to 3/4 mile apart, giving everyone a walk of 1/3 mile or less, a shorter wait and a faster trip. DART has done this to a small degree by combining Routes 81 and 82 onto Live Oak Street, where their 50-minute frequencies can combine to offer 25-minute frequency, as shown in the network map at right, top.

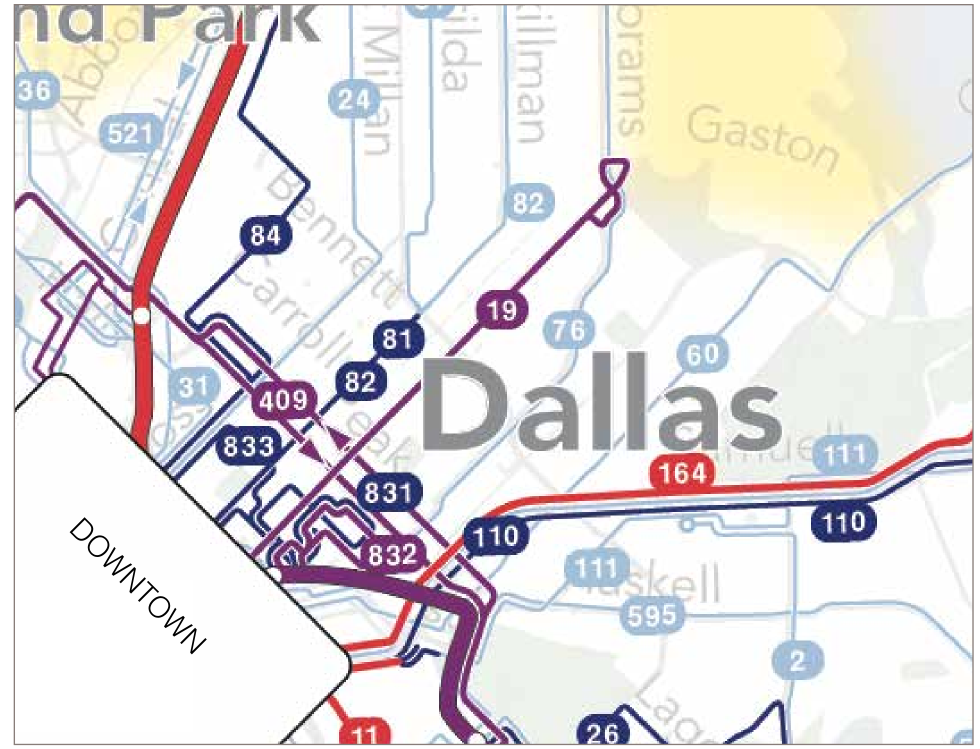
The strongest patterns of boardings on these parallel routes are not what you would expect if you looked only at frequencies and spans. Routes 81/82 and 19 offer good weekday frequencies – every 15 minutes during rush hour and 20 minutes at midday. At night, however, their frequency falls off. Only Route 19 offers 20-minute service on Saturday, and only Routes 81/82 offer 20-minute service on Sundays.

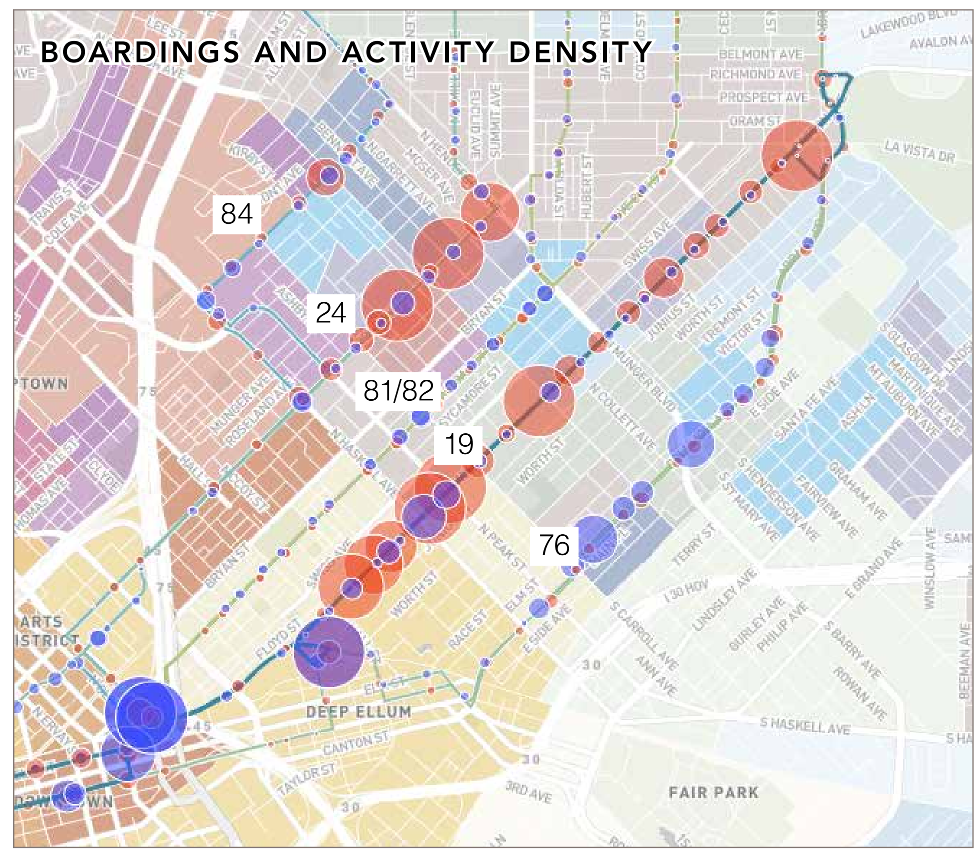
Proximate density and activity certainly affects the ridership on these routes. The map at right, bottom, shows Activity Density in Old East Dallas underneath total boardings at each bus stop. The spacing between the routes with large boardings dots is about 1/2 mile.

Route 19 connects downtown, Baylor and numerous apartments and commercial businesses that are too far apart to walk among, via busy and walkable Gaston Ave. Routes 81/82 are a few blocks away from Baylor, but they get very low boardings, perhaps because they don't get as close to Baylor and they don't serve the entire Gaston Ave. corridor (as Route 19 does).

Route 24 on Ross Ave. attracts modest boardings, but this belies its relatively low service level. Route 24 is one of the most productive of the DART routes that come every 31-45 minutes. This suggests that local demand for transit around Ross Ave. is high.

If, in this planning process, riders and the public express a preference for shorter waits, and a tolerance for longer walks, then there may be an opportunity to increase frequencies in some of these walkable neighborhoods by consolidating routes onto fewer streets.





Old East Dallas provides an example of many parallel routes that offer short walks but mostly long waits. The five routes shown in the network map at top (84, 24, 81/82, 19 and 76) are all within 1.5 miles. Routes 81/82 and 19 offer the highest weekday frequency of the bunch, but boardings on Route 19 are much higher in this area than on Routes 81/82. Boardings on Route 24 are very high considering its poor frequency – it is one of the most productive routes in its frequency class.

7 Alternative Service Concepts

Introduction

This chapter describes two Concepts for how the DART bus network might be redesigned, depending on what priorities the community chooses to emphasize." The Concepts differ from each other in how they emphasize ridership and coverage goals. These Concepts were designed collaboratively by DART staff, the consultant team and staff from each of the 13 DART cities.

Each concept illustrates the full set of service changes that DART could make as early as 2022, if it moved strongly in one direction or the other. DART could also decide to pick a balance point between these two goals that is somewhere on the spectrum between the two Concepts.

The two Concepts are intentionally very different from one another:

- **The High Ridership Concept** concentrates frequent service in areas with the largest number of people and jobs. Some outlying neighborhoods would be farther from service than they are right now.
- **The High Coverage Concept** spreads service to more places, taking the existing network as a starting point. Some areas would get new coverage, but some area would get worse frequencies than they do now.

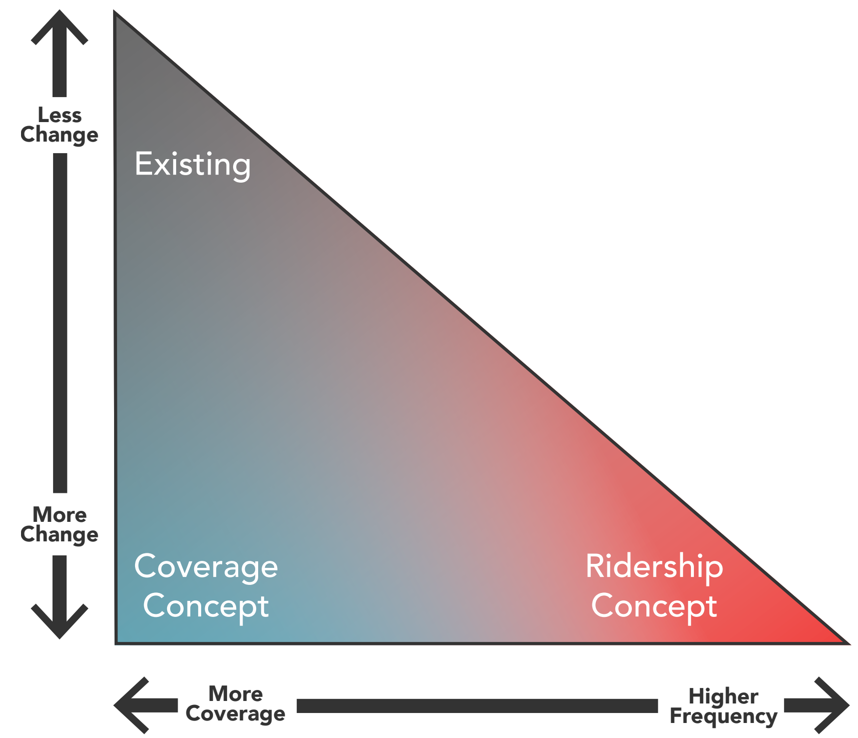
Neither of these concepts is a proposal. Rather, they illustrate the ends of a spectrum of possible changes DART could make.

You can compare these Concepts and their outcomes to help you clarify your preferences and priorities for the New Bus Network plan. By showing the public, stakeholders, and decision-makers the range of possibilities, DART is asking:

> *"Now that you see what it would be like to prioritize one goal over another, how do you wish to balance these goals? In other words, if you want better service, what is your definition of better?"*

The actual New Bus Network Plan will depend on what we hear from the community. The community's comments will guide the study team and decision-makers in developing the Draft Plan with the right balance between these competing goals. It may be similar to one of these Concepts, or somewhere in between.

Spectrum of Choices for the Dallas Area Rapid Transit Network



A range of possibilities

In every public transit system, there is a basic trade-off between:

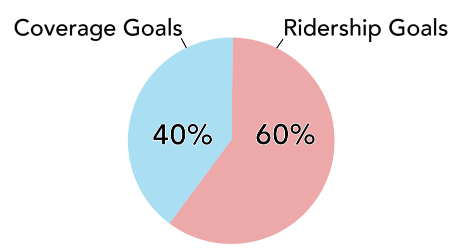
- Concentrating service into useful routes that serve large numbers of people.
- Spreading service out to make sure that people everywhere have access to at least some service.

This trade-off is described at greater length starting on page 17.

This chapter presents two network Concepts for DART's New Bus Network Plan, and compares them to the existing network. Both Concepts spend the same budget, but they show different ways to allocate these same resources.

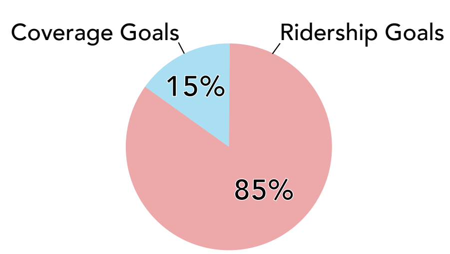
The Concepts differ in the degree to which they emphasize Ridership and Coverage goals. The existing system devotes about 55% of the bus budget toward Ridership goals and about 45% to Coverage goals and duplicative routes.

The High Coverage Concept in this report puts 60% of the bus budget toward Ridership goals and 40% toward Coverage goals.



High Coverage Concept

The High Ridership Concept puts about 85% of its resources toward Ridership goals and 15% toward Coverage goals.



High Ridership Concept

The Concepts shown in this chapter represent a spectrum of possibilities, and they are not intended to be an either/or proposition. When thinking about these Concepts and their outcomes, the choice is not "Pick one of these three"; rather, it is "Where on this spectrum of possibilities should the DART network be?"

Concepts, not proposals

A proposal is something that the proposer recommends. **At this stage, neither DART nor the consulting team is proposing or recommending anything.** The purpose of the Concepts is to illustrate the ends of the spectrum of choices that DART can make to balance frequency and coverage within its budget. The public conversation about these Concepts will guide the development of an actual network proposal, which will be presented for public consideration by the end of 2020.

Some features are common to both Concepts, as outlined on the next page, but even these are not proposals yet. In designing the Concepts, we are highlighting the Ridership-Coverage trade-off, and to do this, we made a single choice about matters that were unrelated to that trade-off, and kept that choice constant across both Concepts. Different choices could have been made, and we welcome public comment about these features of the plan.

No new money

Both Concepts are designed for the year 2022, but assume that DART can only work with its existing bus operating budget.

The existing DART operating budget presents a challenge due to the very large geographic area that DART is expected to cover. In addition, land use and development patterns in much of the region are hostile to transit and to walking, which means that getting useful transit service close to people is expensive for DART.

There is hardly any "low-hanging fruit" in the existing DART network. DART has removed most of its service duplication already. Within the limited existing budget, nearly every service improvement would require a difficult trade-off.

No preferred concept

None of the staff from DART, and none of the consultant staff, have a preference among the Concepts shown in this report.

The most important word in this report is **if.** The High Coverage Concept shows what might happen **if** DART redesigned its bus service to cover a few additional areas, while updating the network to better match today's travel demands. The High Ridership Concept shows what might happen **if** DART redesigned the bus network to make it more useful to large numbers of people and thereby to attract more riders. No decision about which direction to go has been made yet.

The big picture matters more than details

These Concepts have not been refined to the point that they would be ready to implement, because their purpose is to illustrate choices at a high altitude. Based on public feedback to the Concepts, a Draft New Bus Network Plan will be developed with details filled in.

In general, these Concepts are intended to be complete descriptions of the regularly recurring midday pattern of services, seven days a week. The Concepts also show frequencies changing throughout the day and week, but this is not meant to detail:

- Morning and evening peak services
- School peak services
- Specialized commute services consisting of only a few trips
- Local routing details such as turnarounds
- Scheduling—the Concepts identify frequencies for each period of the day, but an actual schedule will include a transition from one frequency to another.
- Minor deviations affecting small numbers of trips.

These details will be added later in a final plan, but doing so at this conceptual stage, would be premature.

"Ridership" describes the outcome for the city, including consequences like reduced congestion and emissions.

"Frequency" describes the outcome for the rider.

Assumptions

In designing these Concepts, a few key assumptions have been made regarding the future of transit in DART's service area.

Same resources in each city

Both Concepts were designed to avoid shifting much bus service among the 13 DART cities. This means that even if some bus service would attract more ridership, or provide more valued coverage, elsewhere in the service area, it was maintained in order to keep cities' service levels similar to the existing network. Some cities could have different routes, and maybe fewer routes in one of the concepts, but not less service in total once you account for higher frequencies, longer hours and more days of service.

Same speeds

Both Concepts assume that buses travel at the same average speeds as in the existing network. This means that the available budget can pay for the same amount of service in the two Concepts as in the existing system.

Higher weekend service

Both Concepts are designed to provide higher levels of weekend service than today. Routes in both Concepts were designed to provide consistent seven days per week frequencies and spans of service. Total rush hour services were reduced to fund this shift toward higher weekend service levels.

A blank slate

Both Concepts were designed from a "blank slate." If a route in a Concept resembles an existing route, this is not out of respect for history, nor is it an attempt to provide familiarity for existing riders. Rather, it indicates that the existing route makes sense in the context of the geography, people's travel demands and the design of a connected network, and thus the route is likely to be included in a redesigned network.

Matching rail frequencies

These Concepts assume that the DART Light Rail System continues to run as it does today, with the same frequency and hours of operation. Today the rail network runs every 15 minutes during rush hours and then every 20 minutes for the rest of the day.

For buses to reliably connect to light rail, their frequencies should be a multiple of the light rail frequency. The most frequent bus lines should match the light rail frequency. This means that a frequent bus service in these Concepts should run every 15 minutes at rush hour and 20 minutes for the rest of the day.

DART rides and paratransit

Neither concept assumes changes to DART Rides or Paratransit services. While the final Draft Plan may impact these services, the Concepts were designed independently.

GoLink zones

GoLink zones were only used in the High Coverage Concept, because GoLink's main purpose is offering service for people with specific needs and in specific low-density areas under specific operating conditions. Refer to page 43 for more detail on Flexible Services.

The Silver Line

Since this study is rethinking the network for 2022, the Concepts assume that the Silver Line has begun operating. The Silver Line will run every 30 minutes at rush hours, and every 60 minutes for the rest of the weekday and on weekends.

Shuttles

The intention of this planning effort is to rethink DART's services without making significant changes to the shuttles for which DART shares the cost with local business and organizations. Most of these shuttles were kept the same. Changes to the shuttle serving the University of Texas at Dallas were drafted in collaboration with UTD staff, to better serve the students while connecting to the rest of the DART's network.

What can you do?

This Report is meant to help the general public, existing transit riders, stakeholders, and elected officials understand the important questions for DART.

The consultant team and DART will be conducting surveys and other outreach efforts during the Summer of 2020. That outreach process will ask you where along the spectrum DART should come down when balancing ridership and coverage goals.

Responses from the public and stakeholders will guide the DART Board in determining the balance of goals for the Draft New Bus Network Plan. With direction from the Board, the study team will design the Draft Plan in late 2020. The Draft Plan will be presented for public and stakeholder review in early 2021.

The outreach process around these concepts will run from April through early July. Online surveys will be used to gather public input.

For more information and to get involved in the project, go to dartzoom.dart.org and:

- Take the Concepts survey;
- Share this report and ask others to give us feedback on this project;
- Visit the interactive web map to examine the Existing Network and each Concept in greater detail;
- Check the calendar of events for opportunities to learn more and give your input; and
- Request a community presentation, or communicate with the project team by emailing **serviceplanning@dart.org**.

Existing Network

The map at right shows the existing DART network. In this map, **routes are color-coded by midday frequency**:

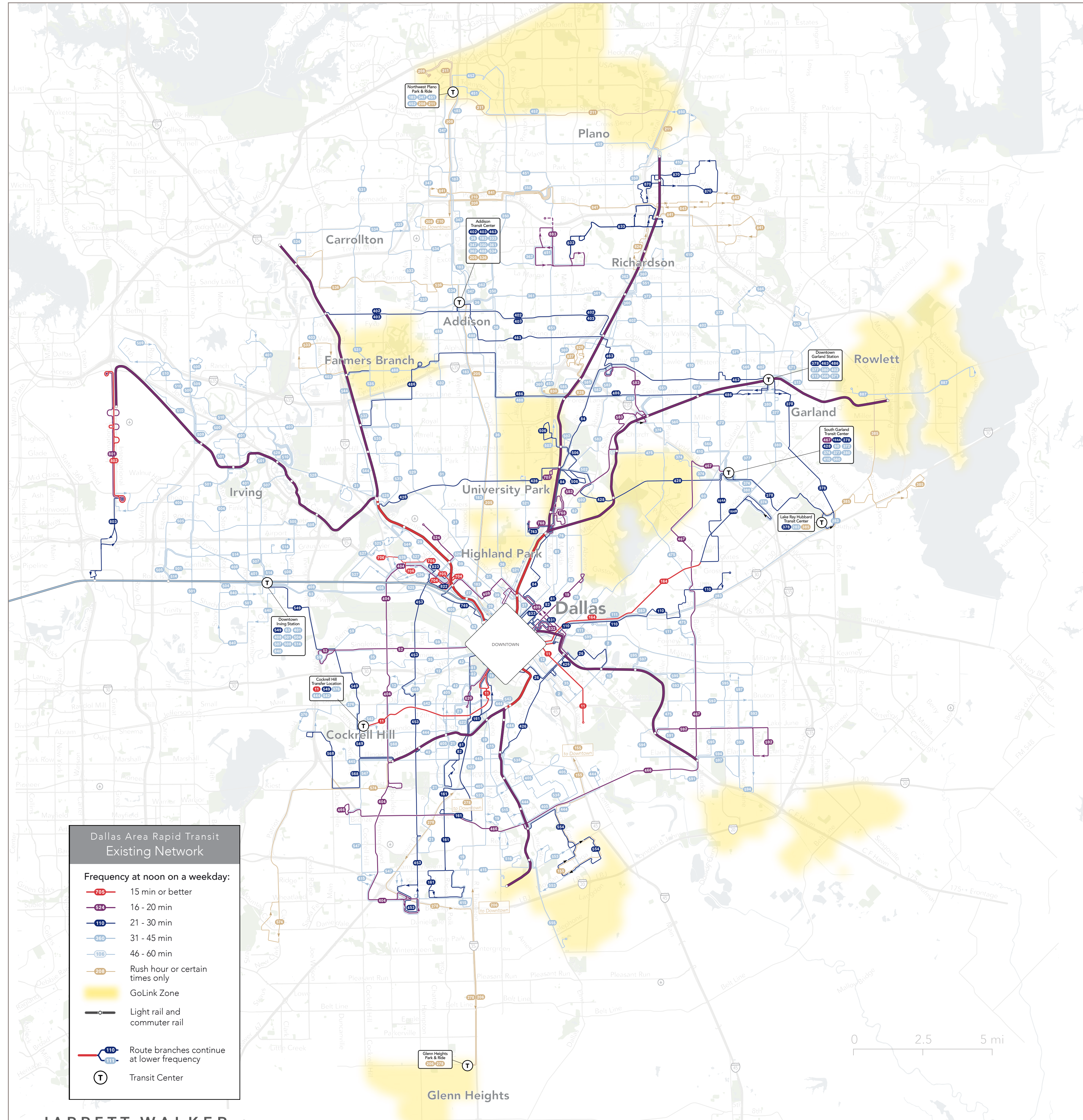
- **Bright red lines** represent routes that operate every 15 minutes or better at midday.
- **Purple lines** run every 20 minutes;
- **Dark blue lines** run every 30 minutes;
- **Light blue lines** run every 40 or 60 minutes. Light blue lines with a solid number badge offer 40 minute frequency. Light blue lines with a hollow number badge offer 60 minute frequency;
- **Rush hour only** routes are shown in brown, and run at varying frequencies for part of the weekday.
- **GoLink zones** provide flexible service within 10 minutes of a request in low density areas.
- Light rail lines are colored based on their weekday midday frequency.

Midday frequencies (rather than rush hour frequencies) help us illustrate the usefulness of the network for a diverse group of people. While travel often peaks at rush hour, many people need to travel at midday. Retail and restaurant industries change shifts throughout the day, particularly in midday and later evening. Office workers may need to travel for meetings or personal appointments. College students often attend midday classes. Parents may need to pick up a sick kid from school.

This map only shows routes' frequencies at midday, but smaller maps on the following pages show how frequencies would change over different times of the weekday and the weekend. An interactive online map provides a more detailed and searchable view of the Existing Network and the Concepts.

This map shows how little of the DART network offers short waits. Standard practice in the U.S. transit industry is to describe frequency of 15 minutes or better as "frequent service." By that definition, outside of rush hours, only a few light rail stations have frequent service, and very few bus lines are frequent. In this report we describe any route coming every 20 minutes or better as "frequent."

The Existing Network includes more variation in frequencies (and spans) than do either of the Concepts. Each existing route has a unique schedule of frequencies, start and end times throughout the week. In contrast, the Concepts are based on a simple set of service categories, each represented by a color, so that they are easily compared to one another.



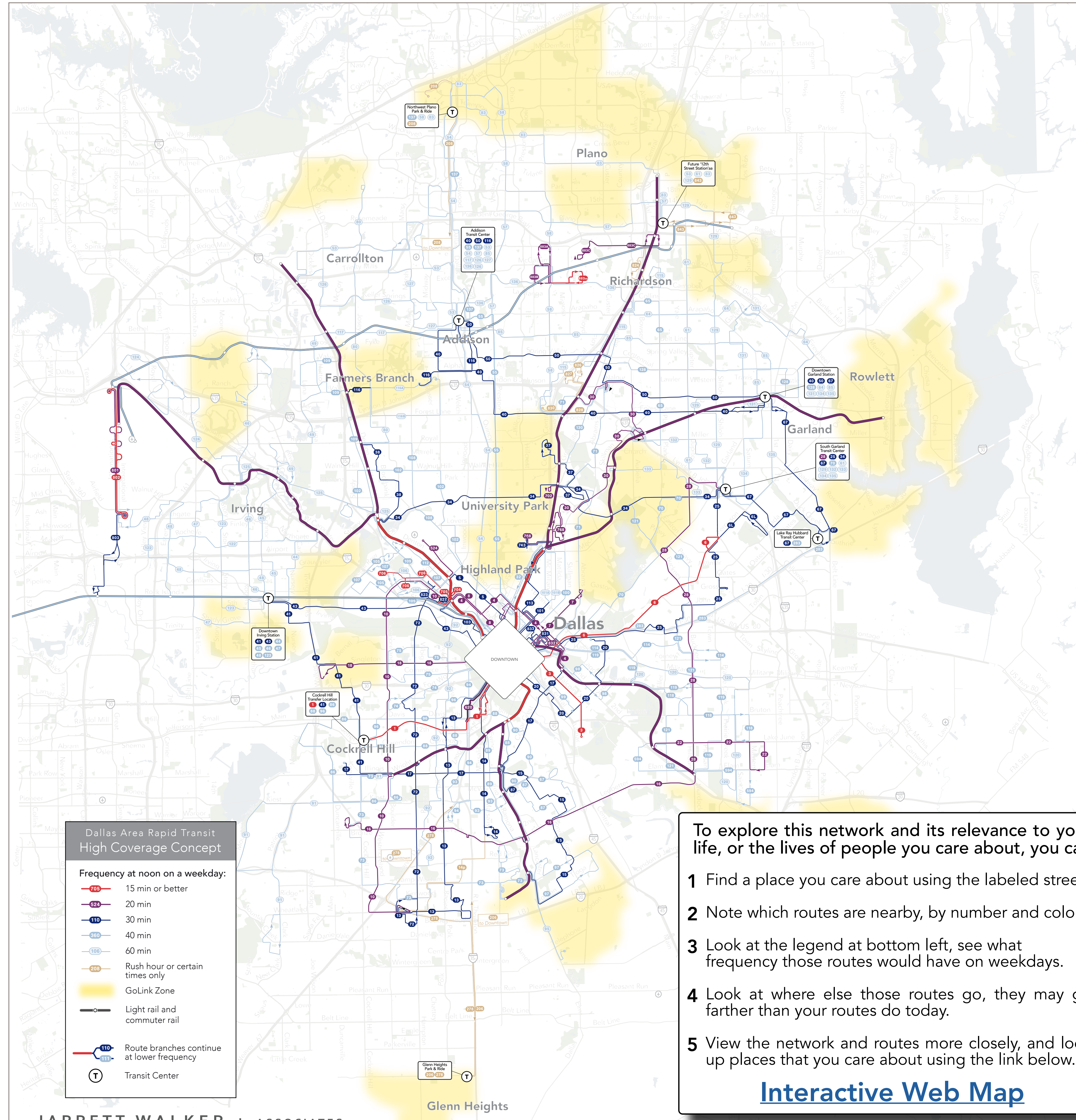
High Coverage Concept: Spreading transit out widely

The **High Coverage Concept** is designed to maintain and slightly increase coverage. All existing stops with at least one boarding per day (on average) would continue to have a transit stop in less than a 1/2 mile walk. A few areas of new development would be covered with new service as well. GoLink zones would cover areas with very low densities, allowing people to reserve a ride to transit centers and other destinations within the zone.

In this Concept, nearly every existing transit rider would still have access to service. Slightly more people would be within walking distance to service at night and during the weekend, compared to the Existing Network.

The High Coverage Concept provides a route nearby in most areas, so the service is spread just as thinly as it is in the Existing Network. **This Concept would maintain service close to every bus stop with at least one average daily boarding today, which adds up to 99.8% of boardings on the existing system.**

However, continuing to spread service out into so many routes covering such a large area means that it is not possible to increase frequencies, hours or days of service on the highest-ridership routes as the High Ridership Concept would do.



To explore this network and its relevance to your life, or the lives of people you care about, you can:

1. Find a place you care about using the labeled streets.
2. Note which routes are nearby, by number and color.
3. Look at the legend at bottom left, see what frequency those routes would have on weekdays.
4. Look at where else those routes go, they may go farther than your routes do today.
5. View the network and routes more closely, and look up places that you care about using the link below.

Interactive Web Map

High Coverage Concept: Modest frequencies and hours

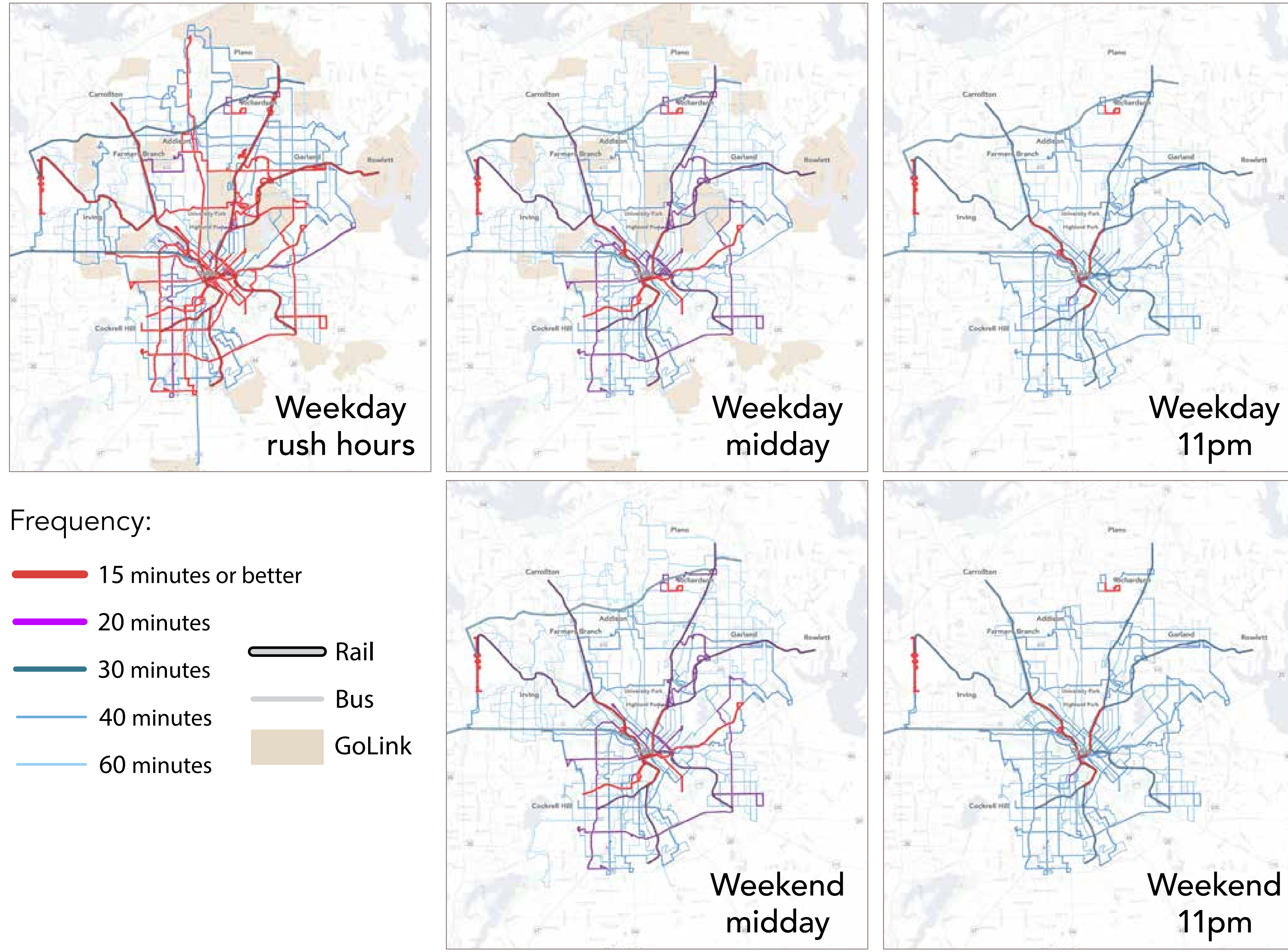
The maps on the right show how much service would be provided at different times of the day and week by the High Coverage Concept.

The High Coverage Concept frequencies are mostly comparable to the Existing Network, with only a few routes running frequently all day, and the majority of the routes operating every 30 to 60 minutes.

At rush hour many routes come every 15 minutes and offer better travel patterns without leaving anybody behind. Frequency falls during the rest of the day. Most travel times on transit would not improve compared to existing service. Many trips would continue to require advance planning to avoid long waits.

As in the Existing Network, the only frequent service on weekday and weekend nights would be on some segments of the light rail network and a couple of bus shuttles. But in the High Coverage Concept, most of the network would come every 30 minutes in the evening, an improvement over the mostly hourly service of the Existing Network at night.

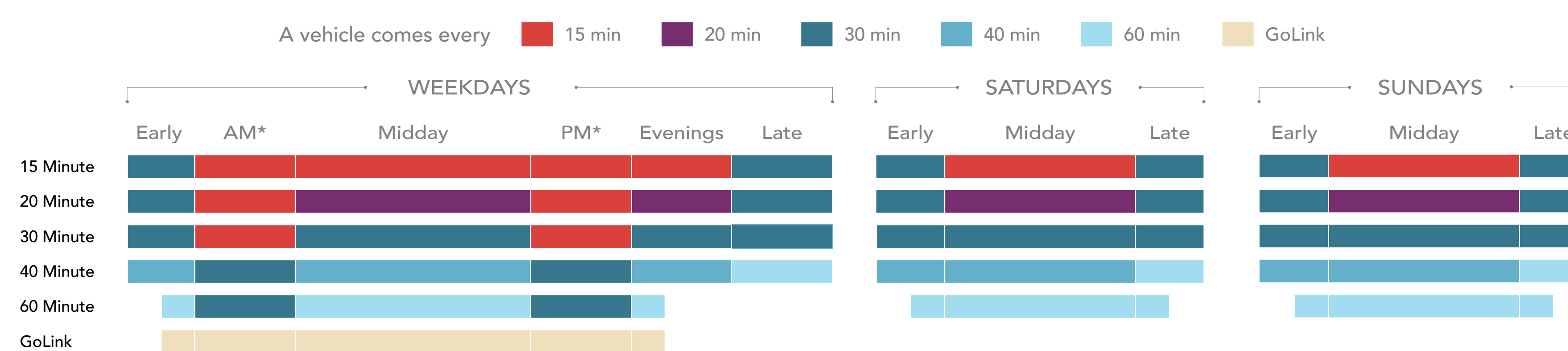
During Saturdays and Sundays at noon, the High Coverage Concept would offer three additional frequent routes (Routes 1, 3, 6) compared to the Existing Network. This would be especially useful for people with travel needs during the weekend, such as retail and service workers.



Service Types

In these Concepts every line is a route with a certain frequency and span throughout the day and the week. The weekly schedules of the service types in the High Coverage Concept are illustrated in the chart at right. The percent of routes in this Concept that offer each frequency on weekdays, at midday, is:

- 3% come every 15 minutes
- 9% every 20 minutes
- 20% every 30 minutes
- 35% every 40 minutes
- 34% every 60 minutes
- 15 GoLink Zones



*Select routes continue their midday frequency during AM & PM hours.

High Ridership Concept: More frequent service

The **High Ridership Concept** would concentrate frequent service where there are more people, jobs, and opportunities. This would dramatically increase the average resident's access to many more useful destinations in a given amount of time.

This Concept would especially improve frequencies for lower-income residents, and close to lower-wage jobs and activity centers outside of downtown.

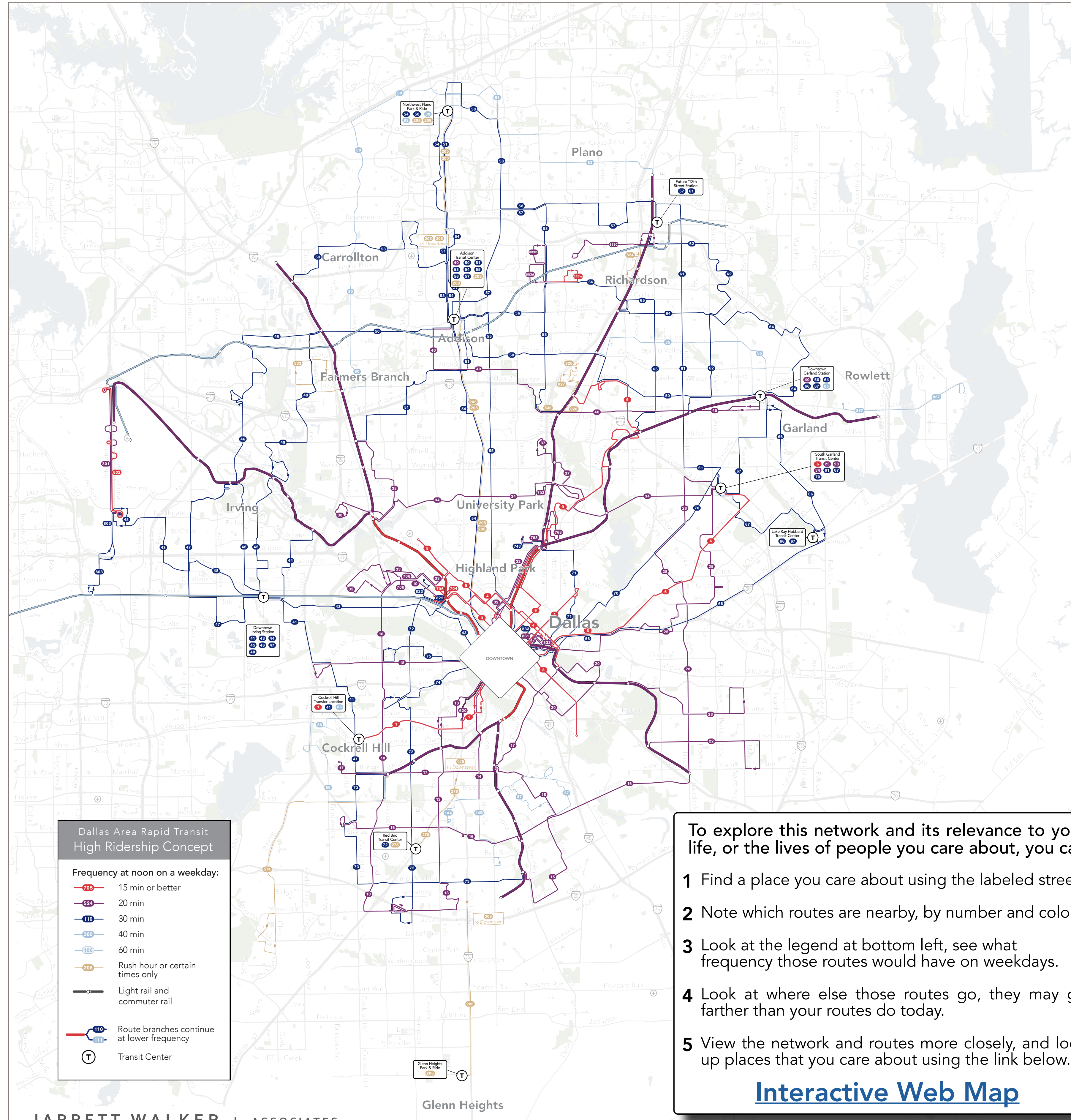
With this Concept, **most existing riders would spend less time waiting for a bus**, giving them access to more opportunities within a reasonable travel time. Transit would become time-competitive, causing more people to choose to depend on it for more of their trips.

Routes in this Concept would run later into the evenings and more frequently on weekends than in the Existing Network or in the High Coverage Concept. This makes it more likely that anyone will find transit useful for the many different times they need to travel.

The downside of concentrating service into fewer, higher frequency routes is that transit covers a smaller area. In many other cases, a place that is very close to a low-frequency route today would be walking distance from a more frequent route in this Concept. This almost always gives people a faster travel time, despite the longer walk. However, there are low-density areas in which people would be too far from transit to walk at all, and would simply lose access. Because these areas are home to few people, a relatively small number of people would lose access, but some of them have severe needs for transit.

The High Ridership Concept would get frequent service close to more people (especially lower-income people) and more jobs all day long, seven days a week. It would do so while still covering 91.7% of the boardings on existing transit services. However, this means that 8.3% of current riders would lose access to service.

This Concept would get higher ridership than the High Coverage Concept. Repeated, wide-scale research has shown that higher frequencies and longer spans of service, deployed where large numbers of people live and work, are a major predictor of ridership.



To explore this network and its relevance to your life, or the lives of people you care about, you can:

1 Find a place you care about using the labeled streets.

2 Note which routes are nearby, by number and color.

3 Look at the legend at bottom left, see what frequency those routes would have on weekdays.

4 Look at where else those routes go, they may go farther than your routes do today.

5 View the network and routes more closely, and look up places that you care about using the link below.

Interactive Web Map

High Ridership Concept: Higher frequencies for longer hours

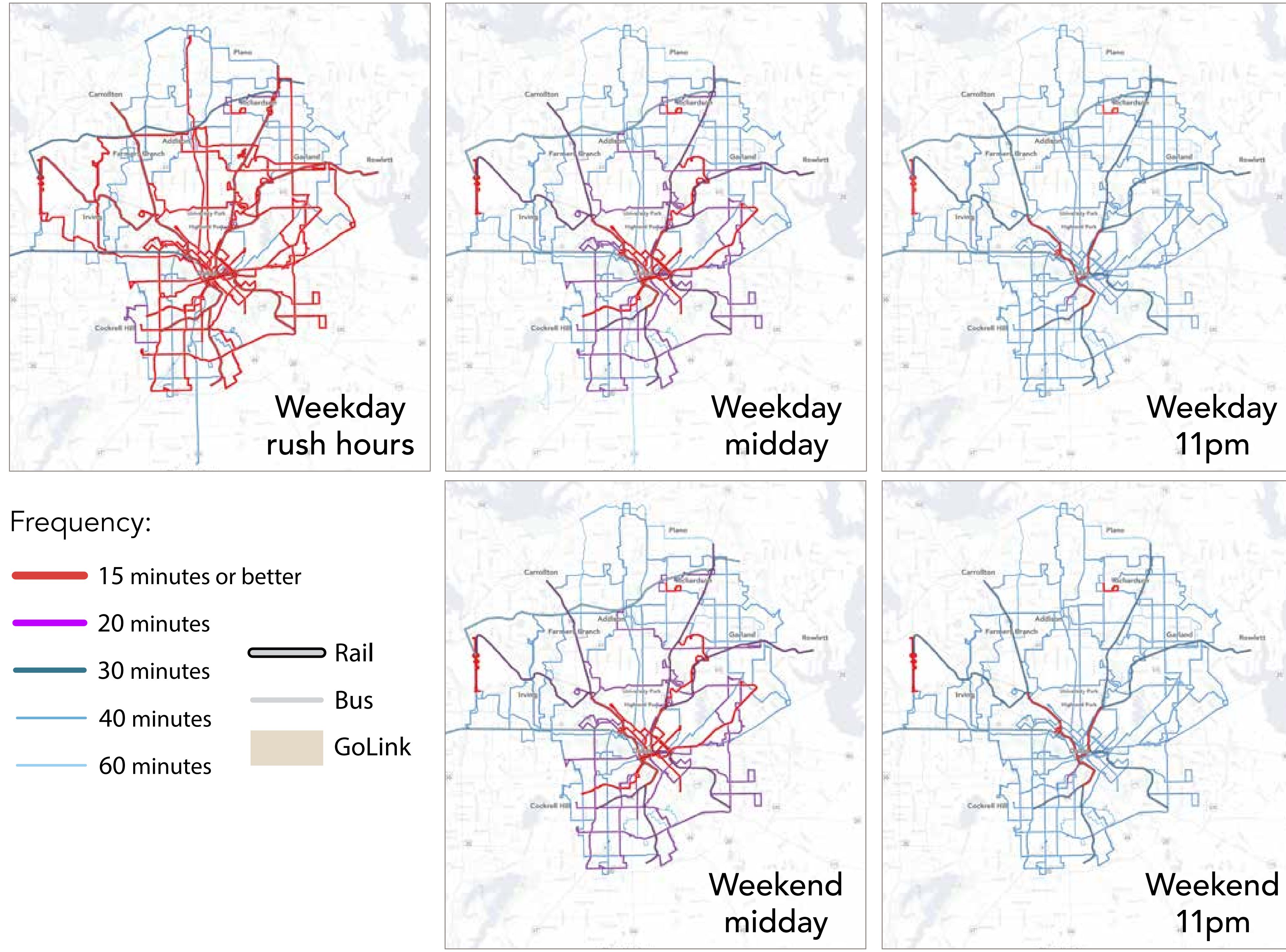
The maps on the right show how much service would be provided at different times of the day and week in the High Ridership Concept.

In this network, nearly all routes offer at least 30-minute frequency during the day, and many routes offer 15- or 20-minute frequency. This means that the bus is always coming soon, and you don't need to know the schedule to plan your trip. Because of the high frequencies, many trips on transit would take less time than they do now, even though some trips would require longer walks.

On weekdays at midday, some frequent routes would run every 20 minutes, facilitating transfers with the light rail. A higher 15-minute frequency is desirable, but the 20-minute frequency allows for better transfers with light rail trains, which themselves only come once every 20 minutes at midday.

Weekend daytime service would be the same as weekday midday service. Routes that operate every 20 minutes on the weekdays would offer that frequency seven days a week. For many routes this would be much more frequent than the existing service: although the Existing Network has some routes operating every 20 minutes, most bus routes run every 30 minutes or worse on weekends.

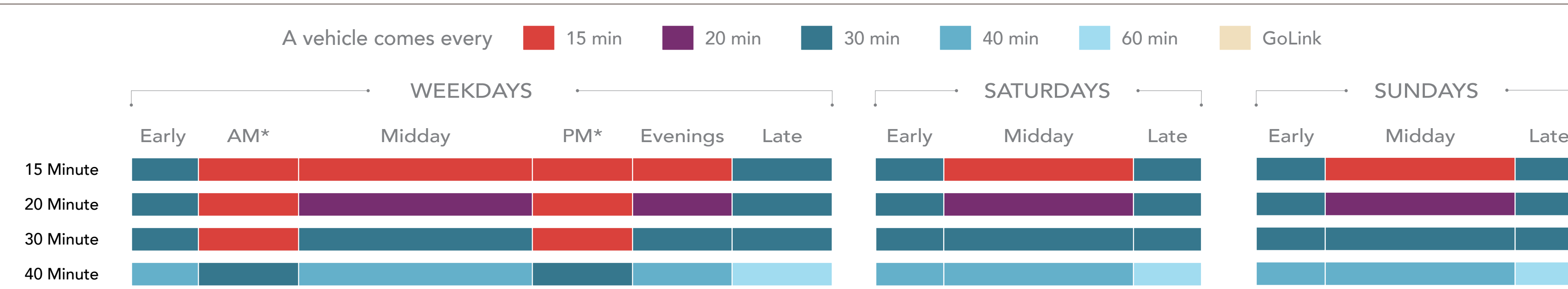
Evening service (for weekdays and weekends) would also be more frequent than in the Existing Network. Most of the routes would be running every 30 minutes, instead of every 60 minutes, and service would continue until midnight. This is twice as frequent as the existing service. More frequent evening service is useful not just for socializing and shopping, but also for the service industry, hospitals, and other workers whose shifts end at night.



Service Types

In these Concepts every line is a route with a certain frequency and span throughout the day and the week. The weekly schedules of the service types in the High Ridership Concept are illustrated in the chart at right. The percent of routes in this Concept that offer each frequency on weekdays, at midday, is:

- 10% come every 15 minutes
- 31% every 20 minutes
- 49% every 30 minutes
- 10% every 40 minutes



*Select routes continue their midday frequency during AM & PM hours.

Weekday Midday

Early | AM | Midday | PM | Evenings | Late

WEEKDAYS

The maps and graphs on this page describe access to transit at various frequencies on weekdays, at midday. Middays are an important time for many non-office commutes as well as for shopping, medical and school trips.

Rail
Bus

Frequency:
- 15 minutes or better
- 20 minutes
- 30 minutes
- 40 minutes
- 60 minutes
- GoLink

The **existing network** offers **few frequent lines** at midday: just 16 of 140 bus routes come frequently.

While the network offers high coverage of residents and jobs, poor frequencies mean that traveling at midday – the time when many service and retail workers commute – takes a long time.

In the two Concepts, the frequencies shown on this page are offered seven days a week, while in the existing network some routes offer a poorer frequency on weekends.

The **High Coverage Concept** would **increase the number of residents and jobs near any service** at midday.

The **High Ridership Concept would increase access to frequent service** at midday to:

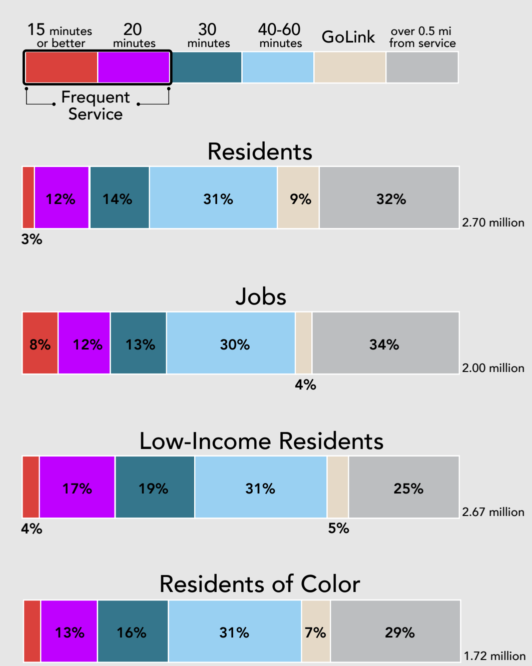
- 25% for all residents (from 15%)
- 35% for low-income residents[1] (from 21%)
- 29% for residents of color (from 17%)
- 30% for jobs (from 20%), including lower-wage jobs outside of downtowns

But the cost would be a loss of coverage – **only 49% of residents would be near at least some service**, compared to 68% today.

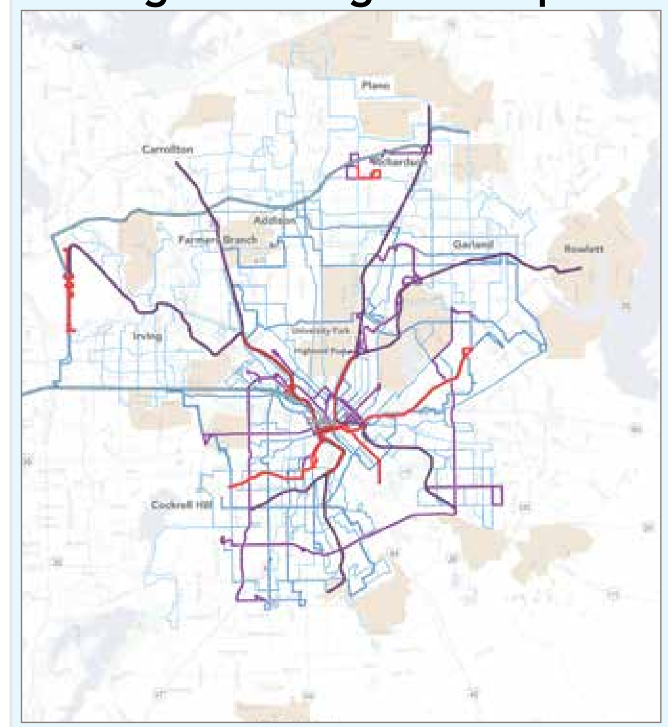
The Existing Network and both Concepts provide more coverage and better frequencies, at nearly every time of the week, to low-income residents and residents of color when compared to total residents

Existing Network

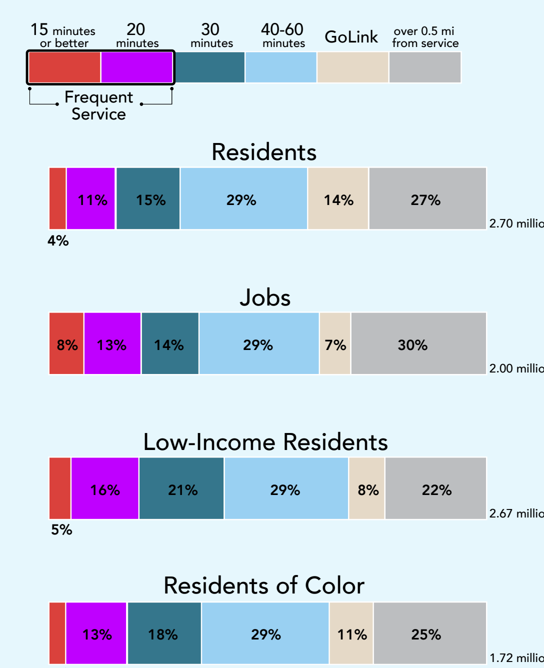
How many people and jobs are within 1/2 mile of transit, and what kind?



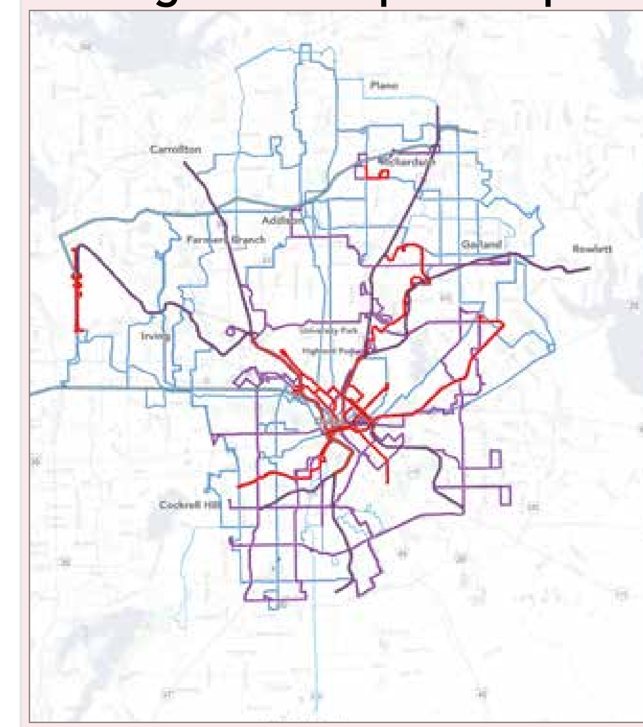
High Coverage Concept



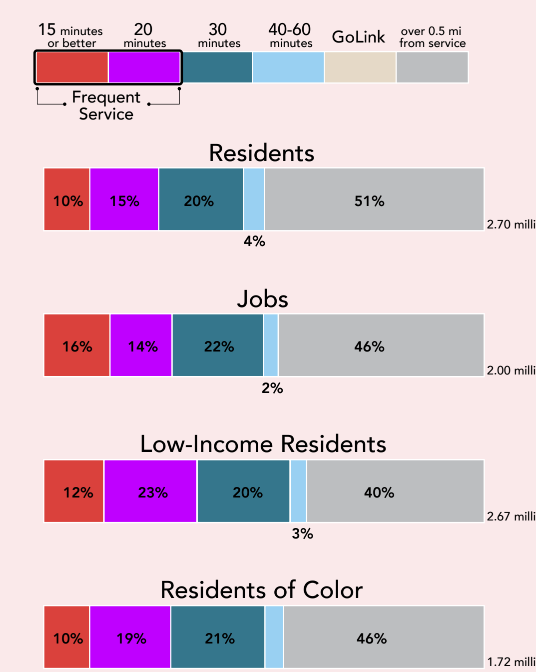
How many people and jobs are within 1/2 mile of transit, and what kind?



High Ridership Concept



How many people and jobs are within 1/2 mile of transit, and what kind?



1 For analysis of impacts and benefits to low-income residents in this chapter, any household living at 150% of the Federal Poverty Level or below was considered "low-income."

Weekday Rush Hour

Travel by all modes is highest at rush hours, especially to and from office centers such as downtown Dallas, which is also the center of the DART light rail network. Transit frequencies are often best at rush hours, to make transit an attractive option for commuters and to avoid crowding on popular lines. The graphs below report access to various frequencies during morning and evening rush hours.

Rail
Bus

Frequency:
15 minutes or better
20 minutes
30 minutes
40 minutes
60 minutes
GoLink

The **existing network** is **very focused on rush hours**. Nearly half of the bus fleet is only used at rush hours.

Light rail trains come every 15 minutes at rush hour (and every 20 minutes at other times). Because connections with buses are better if buses also come every 15 minutes at rush hours, both Concepts increase the number of 15 minute routes at rush hour.

The **High Coverage Concept** would slightly increase the number of residents near any service at rush hours. **Coverage would increase** by:

- 5% for all residents
- 4% for low-income residents
- 5% for residents of color

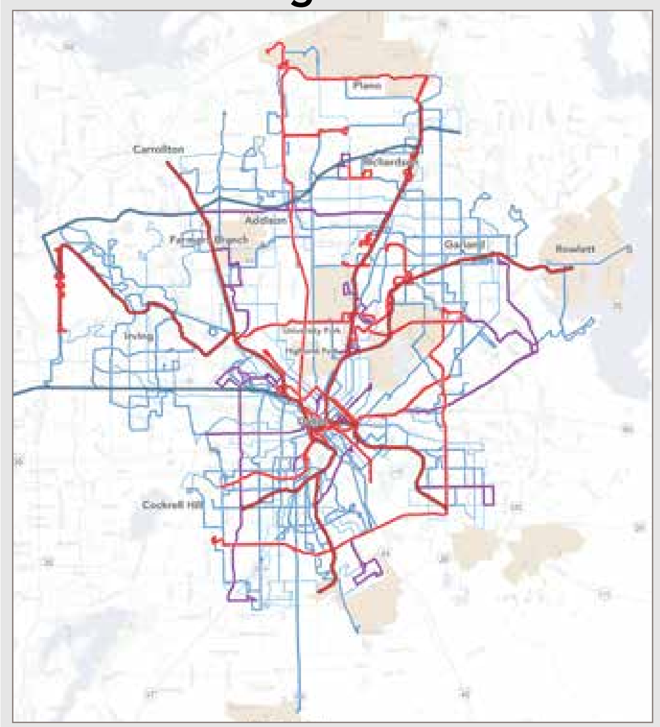
The **High Ridership Concept** would provide **more frequent service for more people** at many times of day and week. It would reduce rush hour routes to increase service at middays, nights and on weekends.

- The number of **residents near frequent service would more than quadruple,** increasing from 7% to 33% for all residents, from 10% to 44% for low-income residents, and from 9% to 37% for residents of color
- The number of **jobs on the frequent network would more than double** (from 16% to 39%)
- All routes would offer a frequency of 30 minutes or better

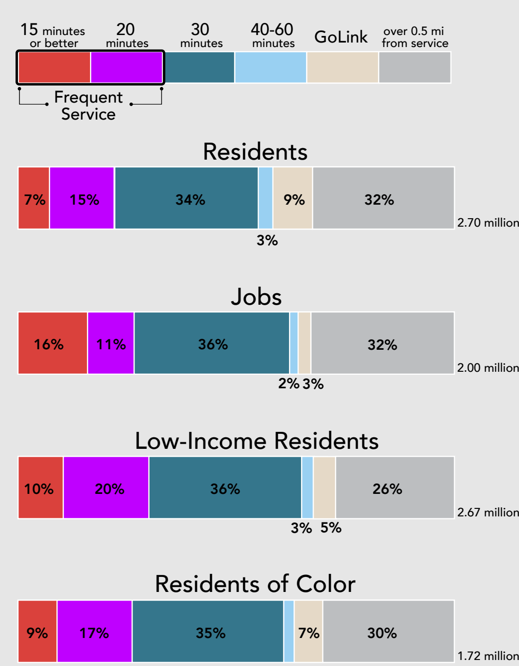
The consequence is an **overall loss of coverage**. This loss would be highest during rush hours because the existing network provides the widest coverage during rush hours.

- 52% of residents would have no service nearby (from 32%)
- 46% of jobs would have no service nearby (from 32%)

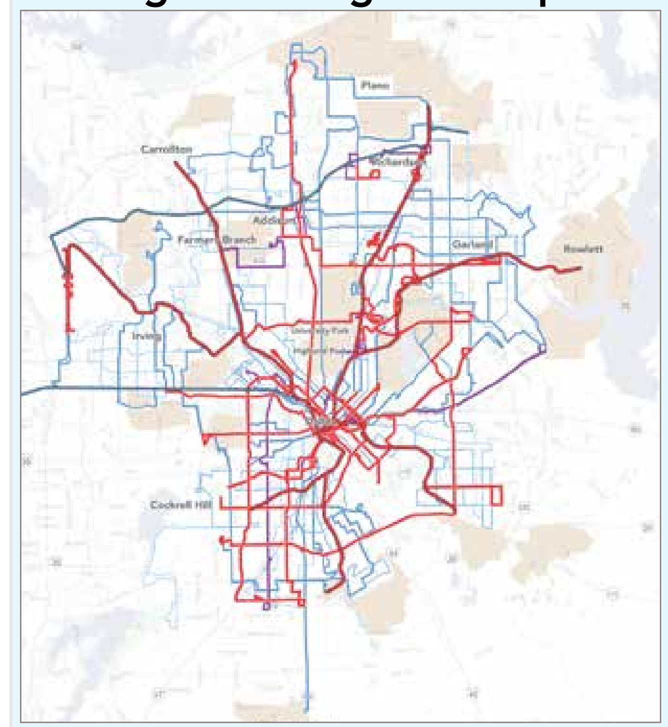
Existing Network



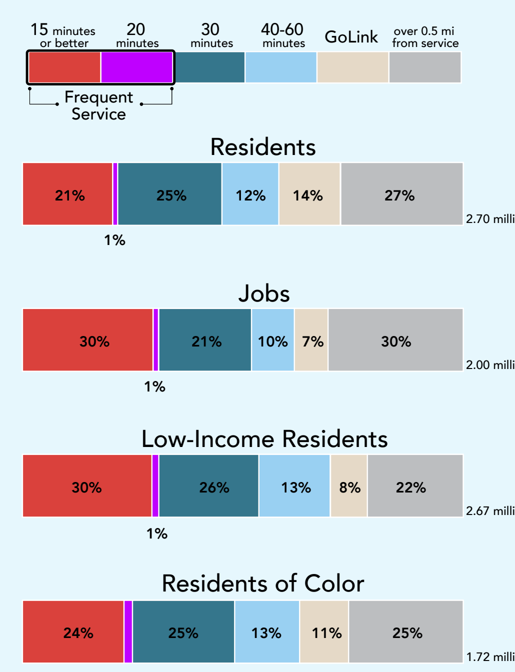
How many people and jobs are within 1/2 mile of transit, and what kind?



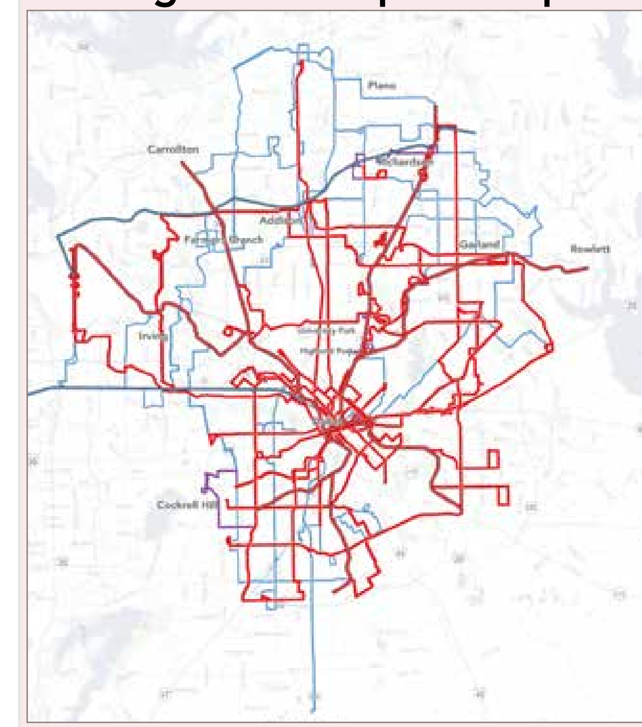
High Coverage Concept



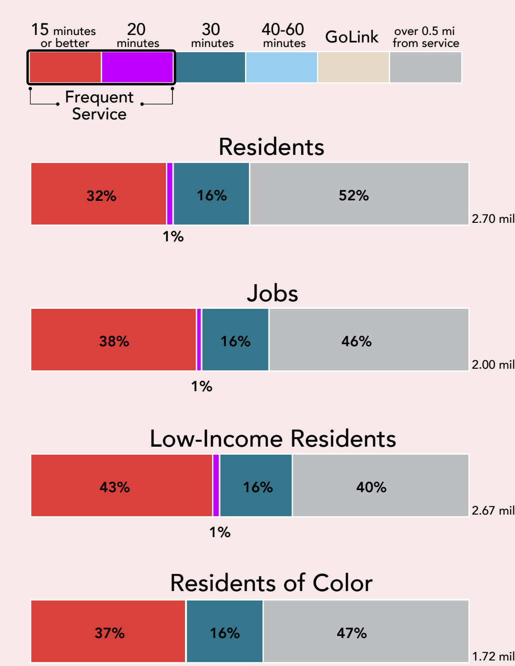
How many people and jobs are within 1/2 mile of transit, and what kind?



High Ridership Concept



How many people and jobs are within 1/2 mile of transit, and what kind?



Weekday Late

On most routes, night service doesn't attract as many riders as daytime service, but it is an important part of a high-ridership network because it allows so many people to rely on transit. It helps retail and service workers travel home from work, allows people to socialize and visit, and provides a "just-in-case" option for 8-to-5 commuters. The maps below show frequencies at 11 pm on weekdays.

Rail
Bus

Frequency:
15 minutes or better
20 minutes
30 minutes
40 minutes
60 minutes
GoLink

The **existing network** offers late night service on many routes, though mostly at poor frequencies.

In the **High Coverage Concept**, small increases to daytime coverage of residents and jobs would be paid for by reducing some nighttime service. As a result, **fewer residents and jobs would have service nearby late on weekday nights.**

In the **High Ridership Concept**, slightly more residents and jobs would be near service late at night, and most of them at better frequencies.

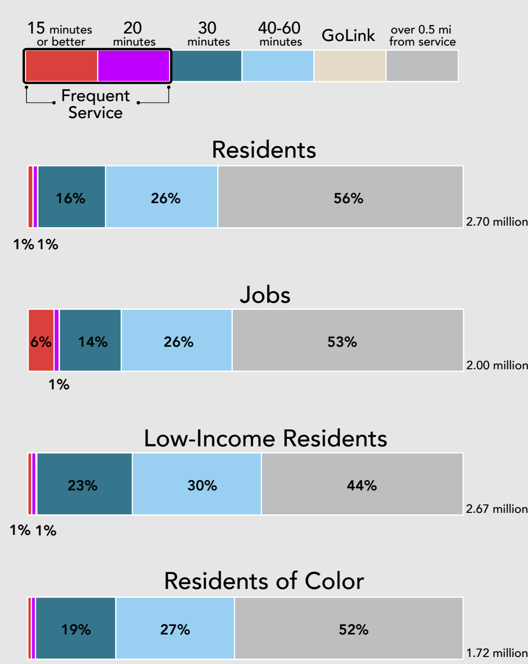
Late on weekday nights this Concept would **more than double the number of people near service coming every 30 minutes or better** to:

- 45% for all residents (from 18%)
- 56% for low-income residents (from 25%)
- 49% for residents of color (from 21%)
- 51% for jobs (from 21%), especially jobs outside of downtown Dallas

A **slightly larger share of people would be near any service late into the night**, compared to the existing network (48% compared to 44% for all residents). This holds true when looking at low-income residents, residents of color and jobs.

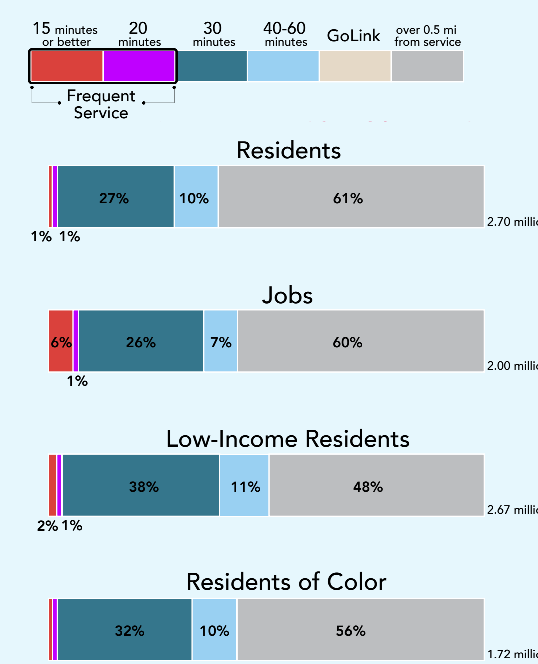
Existing Network

How many people and jobs are within 1/2 mile of transit, and what kind?

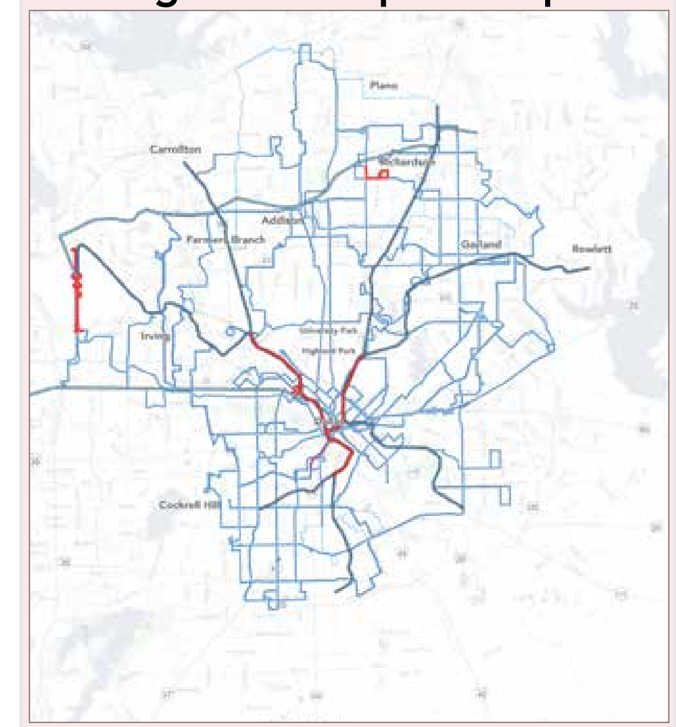


High Coverage Concept

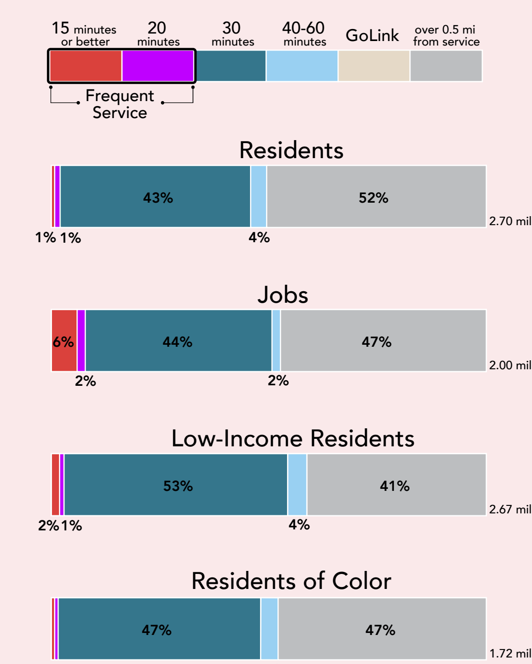
How many people and jobs are within 1/2 mile of transit, and what kind?



High Ridership Concept



How many people and jobs are within 1/2 mile of transit, and what kind?



Weekend Midday

Early | Midday | Evenings | Late

WEEKENDS

Weekend travel has grown over the past 50 years, as the U.S. economy has shifted towards consumption and services, and as car transportation has become cheaper. Most retail and service workers are required to take at least one weekend shift per week, so weekend transit service is essential for their commutes.

Rail
Bus

Frequency:
15 minutes or better
20 minutes
30 minutes
40 minutes
60 minutes
GoLink

In the existing network, service levels fall on weekends. Fewer people are covered on weekends at midday than on weekdays, but DART has recently increased Saturday frequencies so that access to frequent service is nearly as good on Saturdays at midday as it is on weekdays at midday.

In both Concepts, the frequencies shown for weekday midday (on page 72) are offered seven days a week.

The **High Coverage Concept** would **slightly increase the number of people near any service on weekends** by:

- 2% for all residents
- 2% for low-income residents
- 3% for residents of color
- 3% for jobs

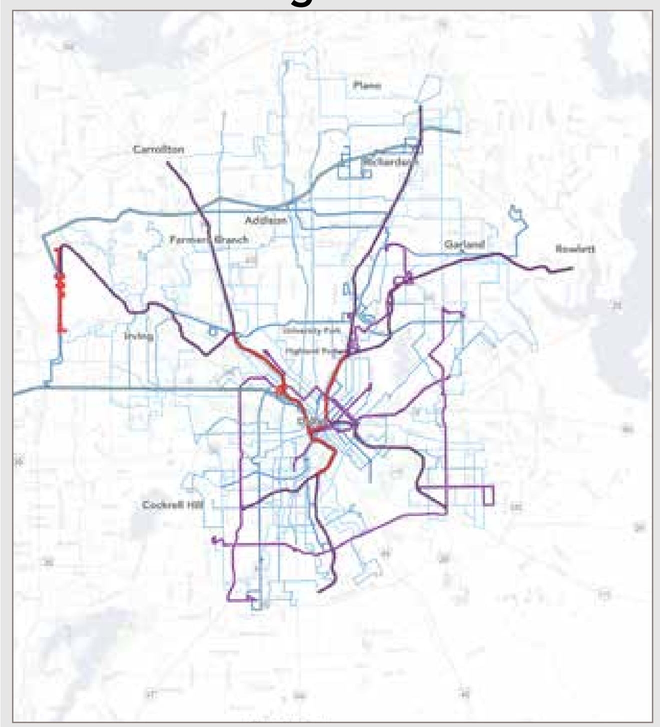
The **High Ridership Concept** would **greatly increase the number of people near frequent service on weekends** to:

- 25% for all residents (from 14%)
- 35% for low-income residents (from 22%)
- 28% for residents of color (from 17%)
- 30% for jobs (from 17%), especially lower-wage jobs outside of downtown

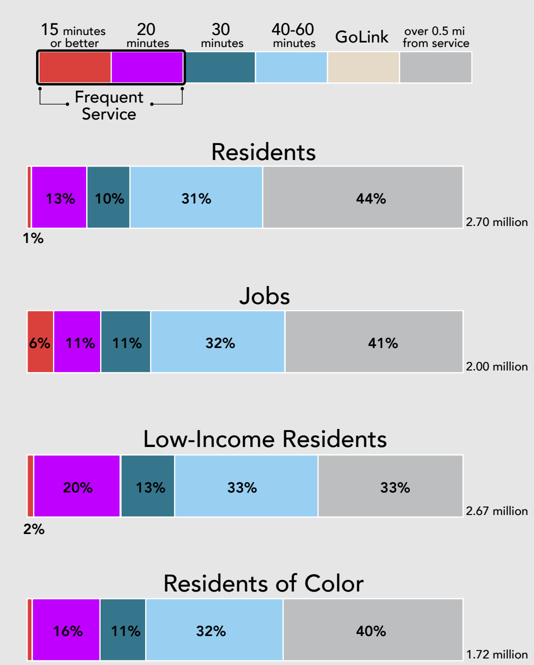
But this Concept would mean a **loss of weekend coverage for some** people and jobs:

- 51% of residents would have no service nearby (from 44%)
- 46% of jobs would have no service nearby (from 41%)

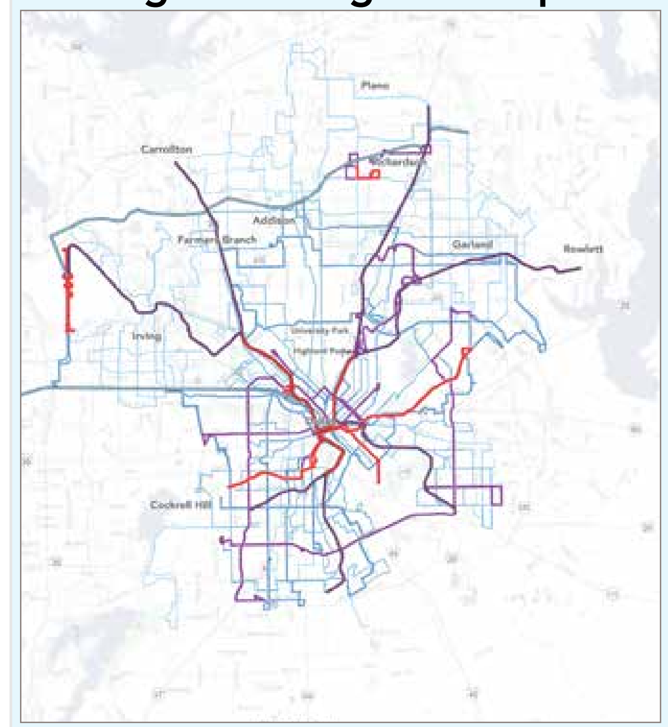
Existing Network



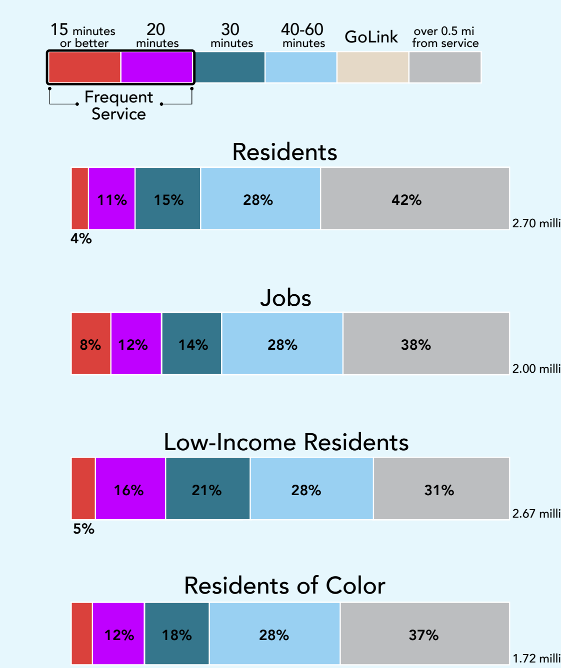
How many people and jobs are within 1/2 mile of transit, and what kind?



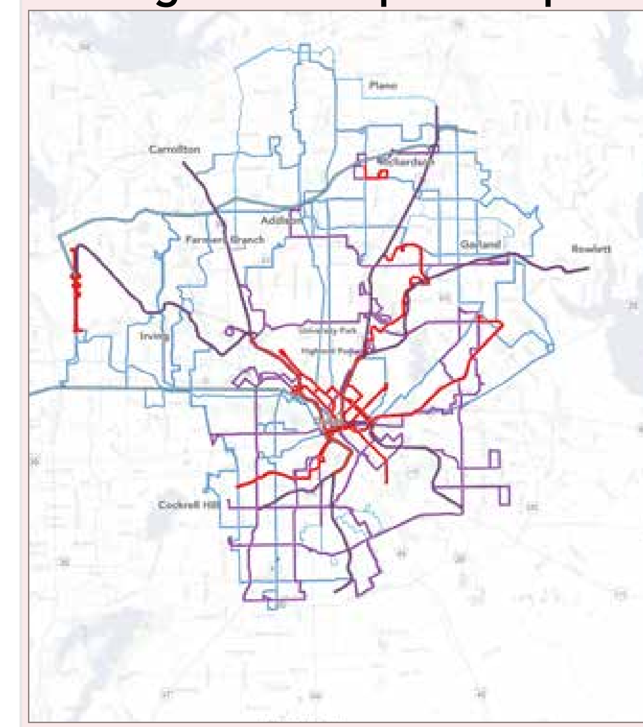
High Coverage Concept



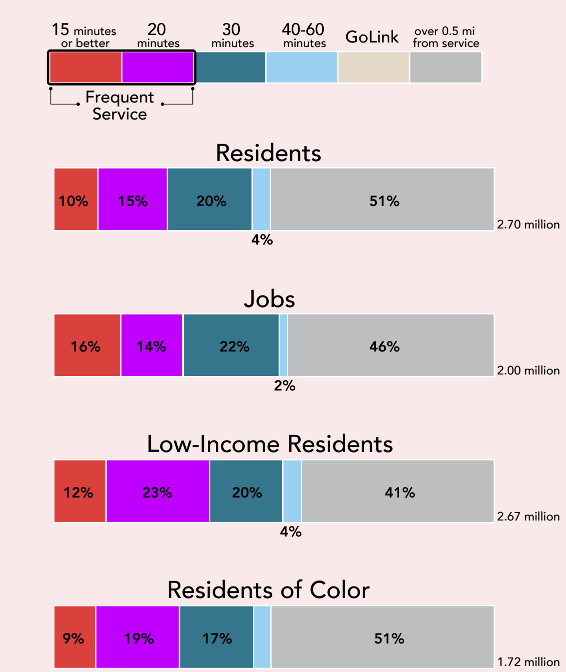
How many people and jobs are within 1/2 mile of transit, and what kind?



High Ridership Concept

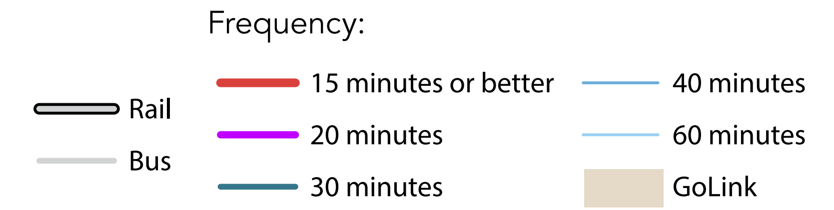


How many people and jobs are within 1/2 mile of transit, and what kind?



Weekend Late

While night service rarely carries as many riders as daytime service, it allows people to build their lives around transit, knowing that they can do most of what they want to do on the transit network, and they won't be left stranded. Weekend night service is also critical for the commutes of bar, restaurant and retail workers.



In the existing network, there is little service on weekend nights, compared to weekday daytimes**.**

The **High Coverage Concept** would **very slightly increase the number of people near any service on weekend nights** by:

- 1% for all residents
- 2% for low-income residents
- 1% for residents of color
- 1% for jobs

In the **High Ridership Concept**, **more residents and jobs would be near service on weekend nights**, and most of them at better frequencies.

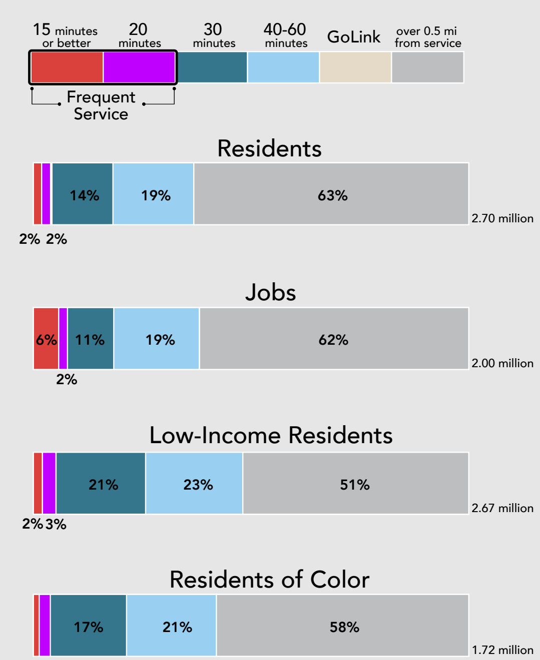
Late on weekend nights this Concept would **more than double the number of people near service coming every 30 minutes or better** to:

- 45% for all residents (from 18%)
- 56% for low-income residents (from 26%)
- 49% for residents of color (from 20%)
- 51% for jobs (from 19%), especially jobs outside of downtown Dallas

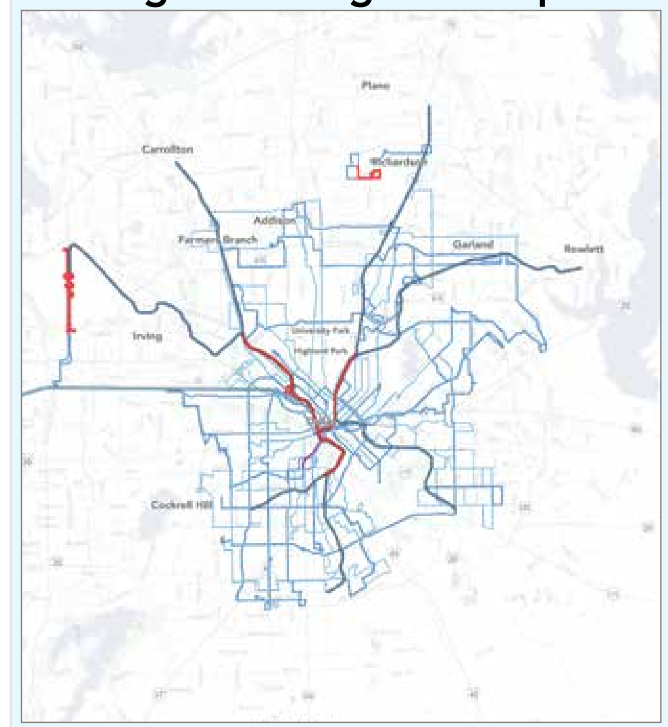
A larger share of people would be near any service on weekend nights, compared to the Existing Network (48% compared to 47% of all residents). This holds true for low-income residents, residents of color and especially for jobs.

Existing Network

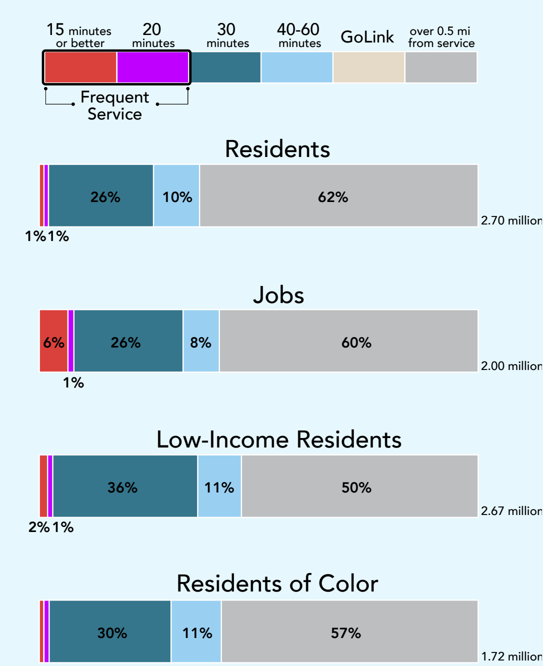
How many people and jobs are within 1/2 mile of transit, and what kind?



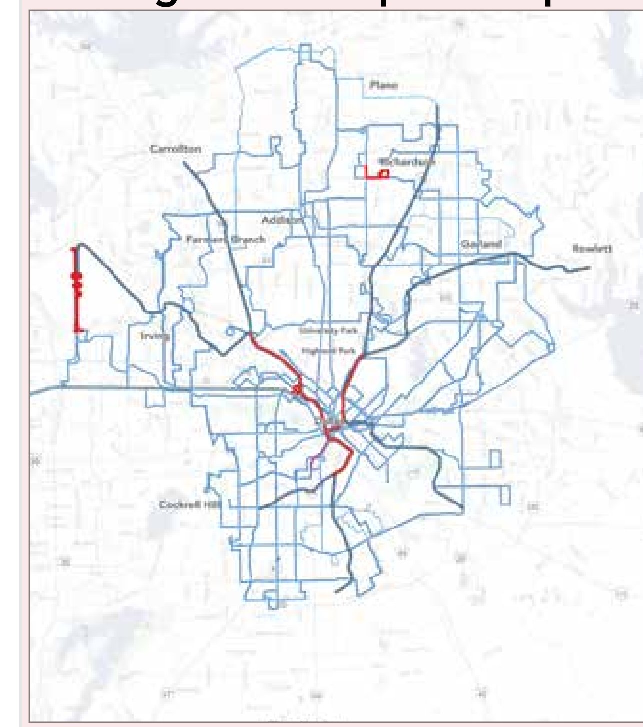
High Coverage Concept



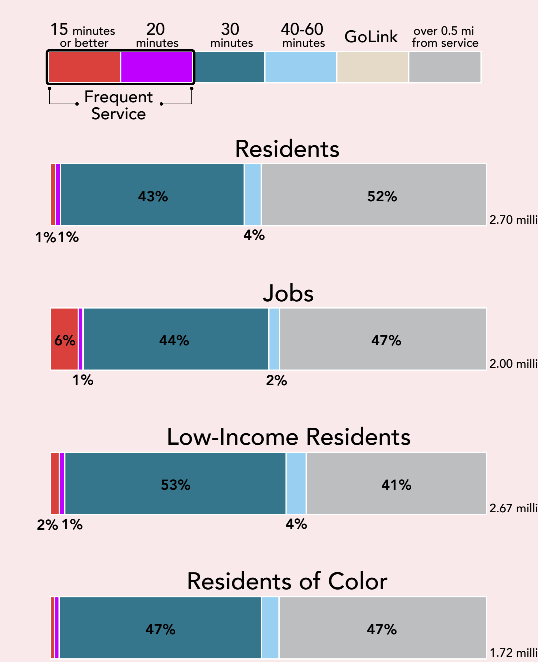
How many people and jobs are within 1/2 mile of transit, and what kind?



High Ridership Concept



How many people and jobs are within 1/2 mile of transit, and what kind?

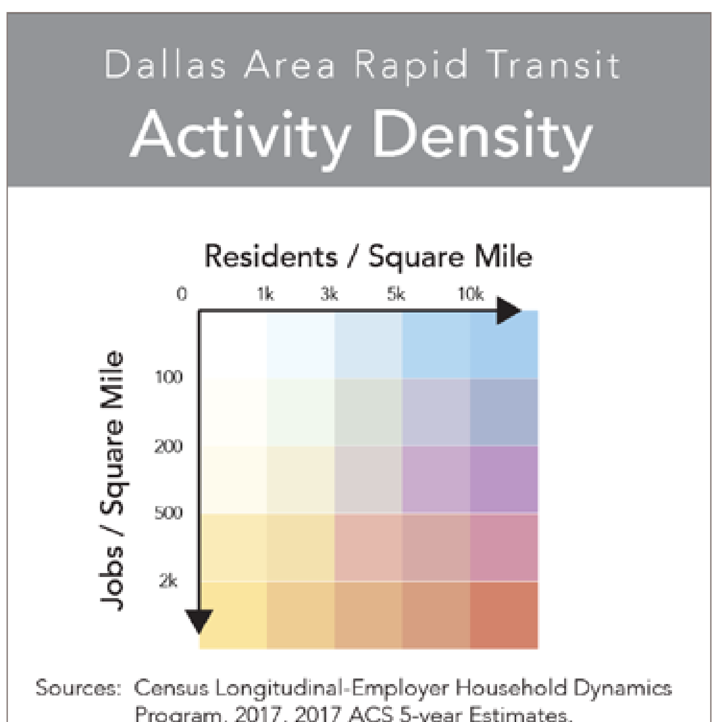


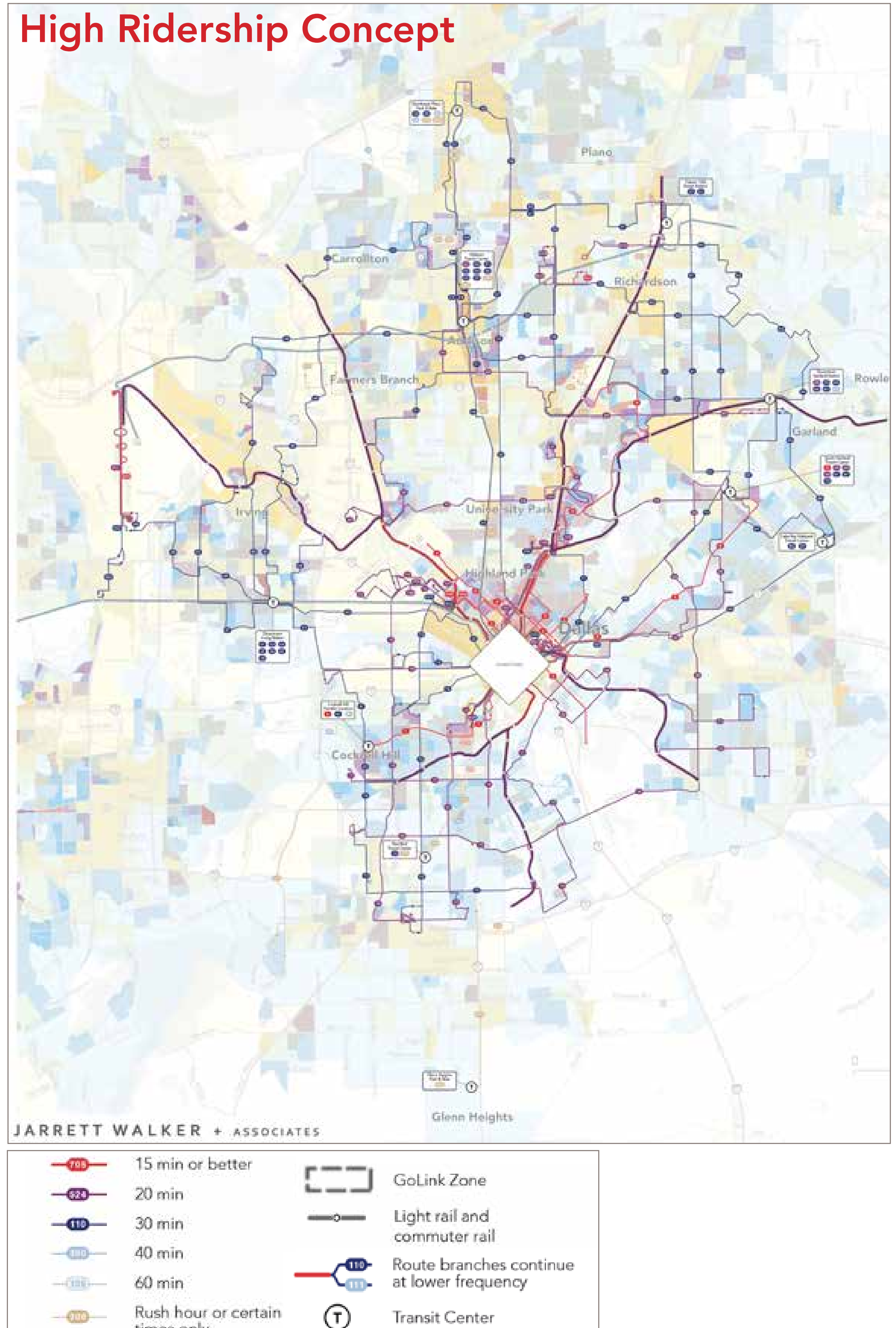
The Concepts and land use

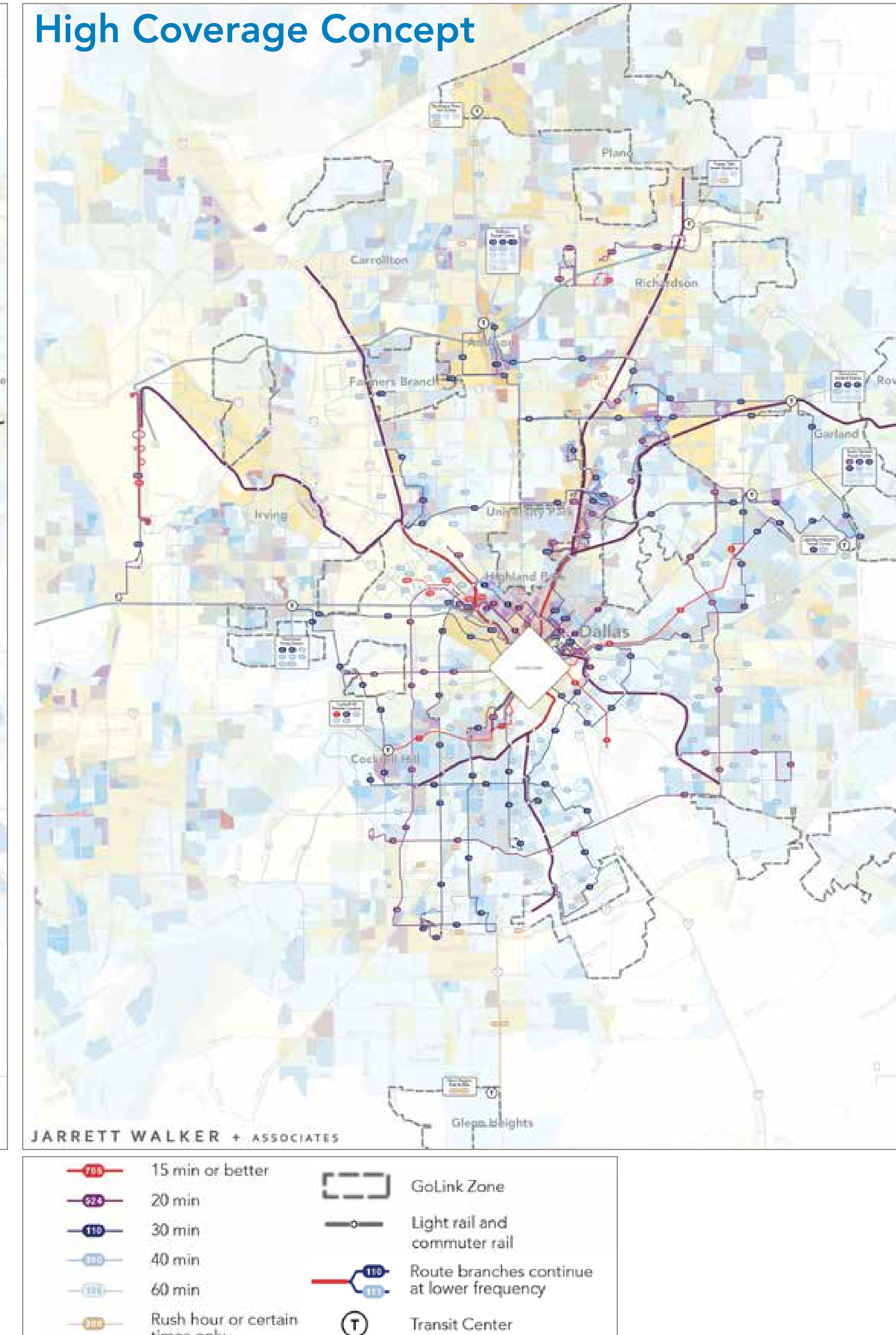
The maps at right show the two Concepts in the context of combined residential and job density. These maps show many different types of activity: homes, workplace, shopping, industry, entertainment and more. Residential density is shown in shades of blue, job density is shown in shades of yellow, and places where residents and jobs are both present, are shown in shades of red. The darker the color, the denser the area.

These maps illustrate the trade-off between focusing attractive, frequent service where the most people and jobs are, and spreading service out to get close to everyone. Notice that in the High Ridership Concept, frequent routes are serving places shaded darkly because they are so dense with people, thus the potential to increase ridership is higher.

In contrast, the High Coverage Concept has many more routes (and GoLink zones) covering most of the service area, including low-density places. As a result, few routes are frequent.





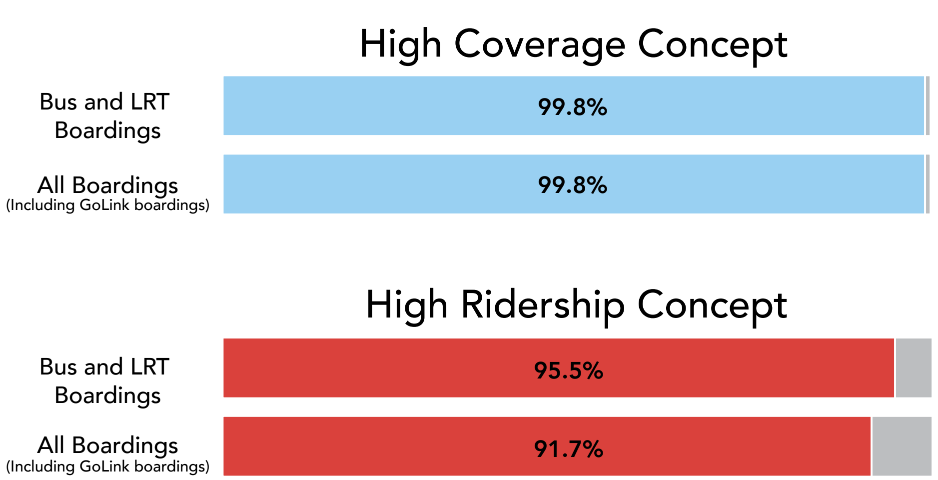


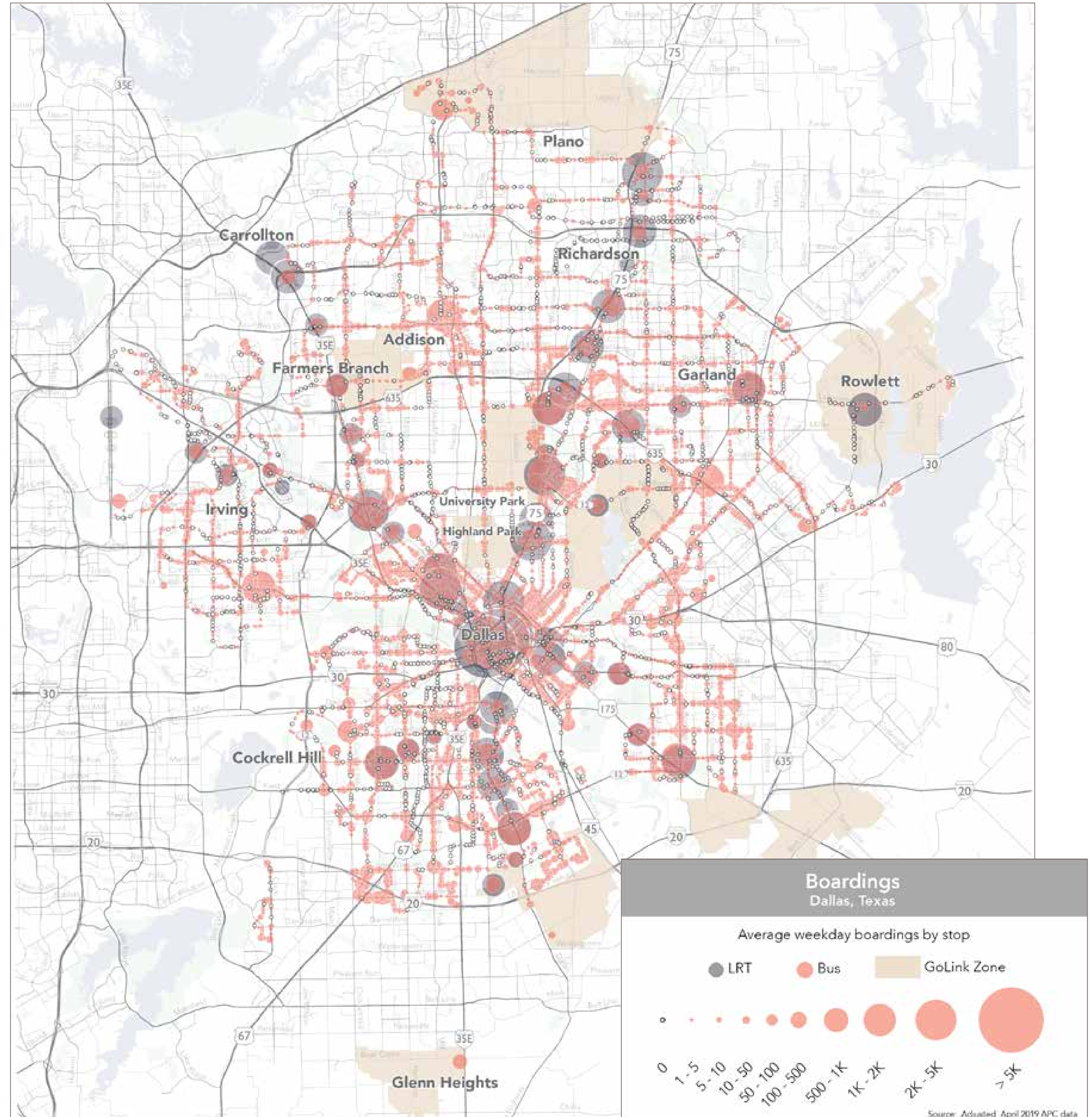
Covering existing riders

The boarding map shown at right illustrates where people are boarding the bus (red dots) and light rail (black dots). The largest red dots in this map are at light rail stations and bus transit centers, where many routes come together and many people transfer among them. Most of the large dots are located in dense areas.

Of the boardings that take place on the Existing Network (either on a fixed route or in a GoLink zone) on the average weekday, the High Coverage Concept gets a bus stop within 1/2 mile walk of 99.8% of them. The High Coverage Concept is designed to maintain service to all existing riders, ensuring anyone who rides the bus today would retain access.

In contrast, the High Ridership Concept gets service that close to 91.7% of existing boardings on an existing fixed route or GoLink. The High Ridership Concept is designed to improve services to the highest-demand corridors, where more people, jobs and opportunities are. Service is targeted at main streets, major employment, hospitals, shopping malls and high schools. These more frequent routes are located in places where the vast majority of the existing riders currently are, which is why the Concept covers many fewer square miles than the Existing Network but still covers almost 92% of existing riders boarding locations. A small percentage of existing DART riders would lose all transit access under this Concept, while transit travel would get better for the vast majority of existing riders.





Average daily bus and light rail boardings on the Existing Network. The High Coverage Concept was designed to get service close to all stops with at least one average daily boarding.

Serving travel demands

We can compare the two Concepts to the total travel demand in the DART service area. This travel demand is for all kinds of trips (work and non-work), at all times of day, and by any mode (for example, driving, transit or walking).

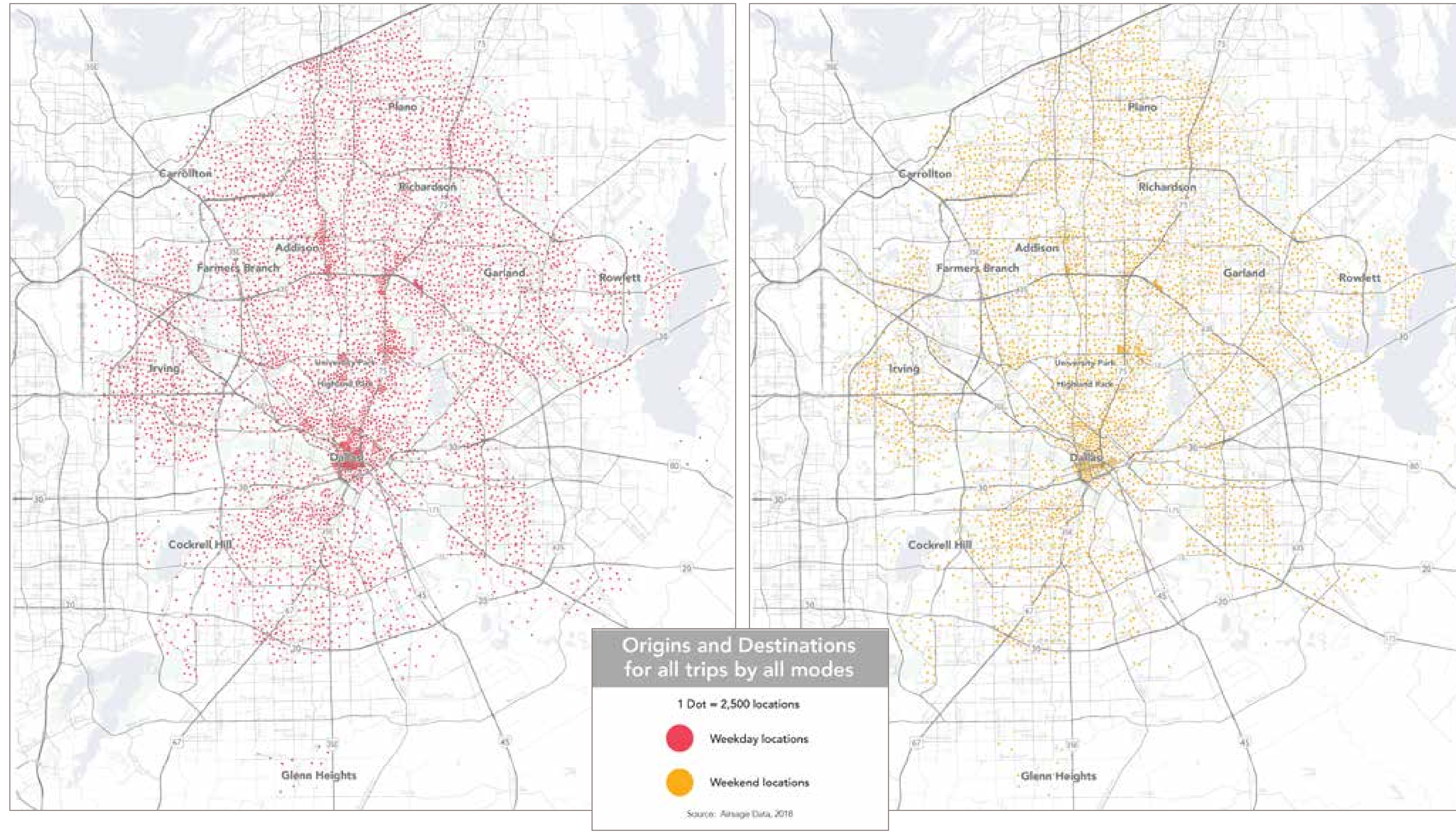
Each dot on the maps at right represents 2,500 travel origins and destinations in a location, for all trips. The maps reveal the most dense areas in the region.

The High Coverage Concept would not get *frequent* service close to more of these points, but it **would slightly increase the number of these points that are near any service** (~5%).

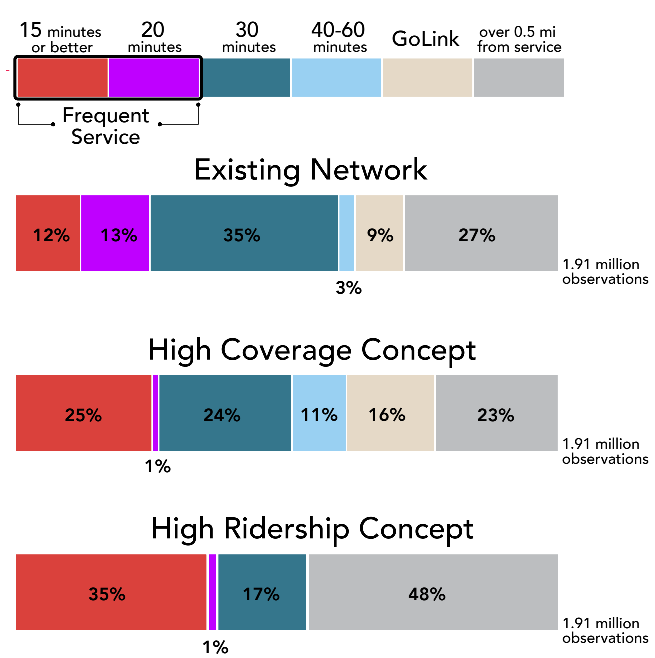
In contrast, **the High Ridership Concept would get frequent service close to many more of these trip start and end locations:**

- 36% of trip start and end points would be near frequent service during rush hours (compared to 25% on the Existing Network),
- 30% during weekdays at midday (compared to 26%), and
- 27% during weekends at midday (compared to 16%).

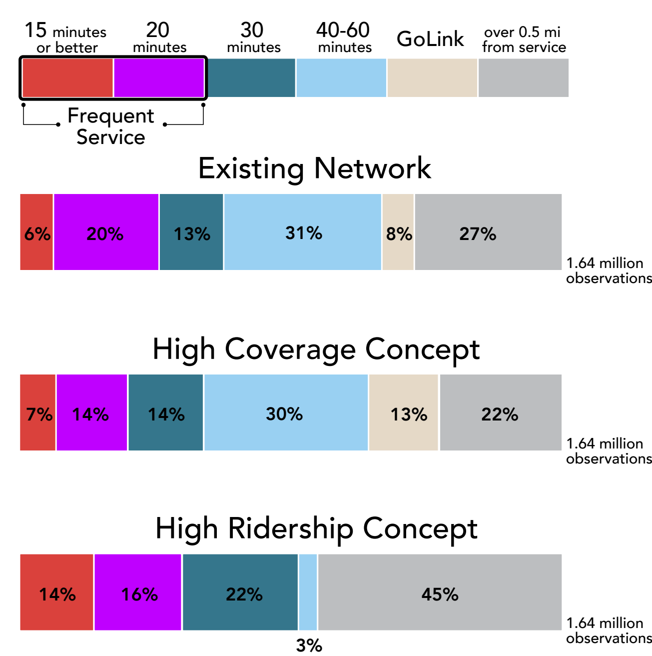
However, **fewer of these points would be near any kind of service on weekends in the High Ridership Concept.** (52%, compared to 49% in the Existing Network).



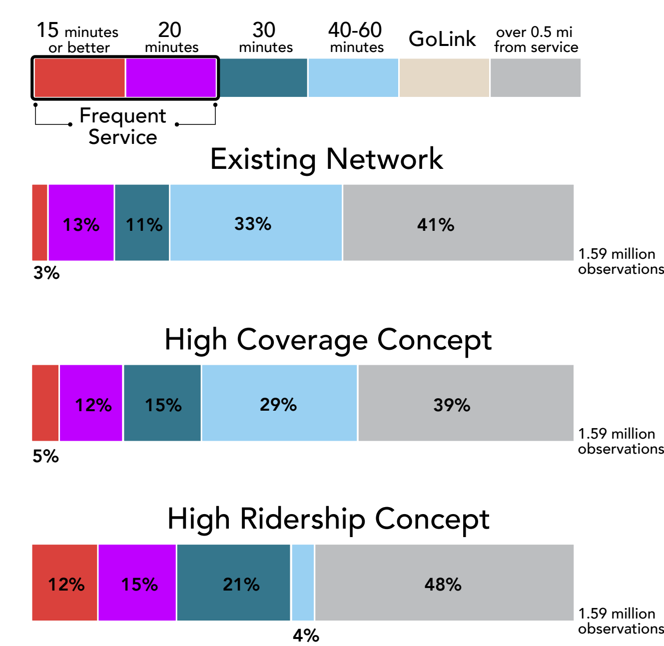
Weekday Rush Hours



Weekday Midday



Weekend Midday



Improving most travel times

To understand the benefits of a network change, a potential rider should ask: ***Where could I get to, in a reasonable amount of time, from where I am?***

This question describes your freedom to seek opportunities. To the extent that you want to do things outside of your neighborhood, your life will be more free, and you will have more opportunities, if you can get to more places in a reasonable amount of time. Think about all the places you can go, or the things you can do if you spend less time waiting for a ride.

The travel time tables on this page show the approximate change in travel time (rounded to the nearest five minutes) that a person would experience traveling at noon among 12 sample locations in DART's service area. The color of the cell indicates how much longer or shorter the trip is in each Concept compared to the Existing Network.

All of the trip times for the calculations at right include waiting - the difference between when someone *wanted* to leave and when they *had* to leave to arrive at their destination on time. A bus that is 10 minutes faster is of little use if it gets you somewhere 30 minutes before you wanted to be there. Waiting happens at the end of a trip, not just at the beginning. Infrequent transit nearly always requires waiting, for this reason.

The High Coverage Concept is fairly similar to the Existing Network, without much improvement in either route frequency or directness. For these reasons almost half of the trips would take the same amount of time in the High Coverage Concept as in the Existing Network. Half of the trips would get faster and a few trips would get slower, but on average little would change.

In the High Ridership Concept, service would be concentrated into more frequent routes between the area's busiest job, education and housing centers. Some people would be asked to walk a little farther to get to a more frequent service. Some routes would become more direct. These changes allow the Concept to make travel between dense places faster than in the Existing Network - this is why so many trips are shown in green for the High Ridership Concept on the previous page.

Out of the 66 trips we analyzed:

- 50% would get faster under the High Coverage Concept
- 40% would take roughly the same time in the High Coverage Concept as in the Existing Network
- 78% would be faster under the High Ridership Concept
- Almost 30% of the trips would be much faster, by 20 minutes or more, under the High Ridership Concept

High Coverage Concept

Shorter by 20+ minutes	Shorter by 5 to 19 minutes	Change is less than 5 minutes	Longer by 5 to 19 minutes	Longer by 20+ minutes

	Downtown Dallas	Downtown Irving	Downtown Rowlett	Legacy	S Vernon & W Illinois	Addison	Malcolm X	South Garland	Methodist Charlton	Brookhaven	Eastfield	Richland
Downtown Dallas		- 0:05	~	~	~	~	~	- 0:05	~	- 0:05	- 0:10	- 0:05
Downtown Irving			~	- 0:10	- 0:10	~	- 0:05	- 0:10	- 0:10	- 0:10	- 0:15	- 0:15
Downtown Rowlett				~	~	~	~	+ 0:10	~	+ 0:15	- 0:05	~
Legacy (Northwest Plano)					~	~	~	- 0:05	~	~	- 0:05	- 0:35
S Vernon & W Illinois						+ 0:05	- 0:10	- 0:05	- 0:10	~	- 0:10	- 0:05
Addison Transit Center							~	+ 0:10	~	- 0:10	- 0:05	~
Malcolm X Transit Center								- 0:05	~	~	- 0:20	- 0:05
South Garland Transit Center									~	+ 0:25	- 0:30	+ 0:05
Methodist Charlton Medical Center										~	- 0:10	- 0:05
Brookhaven Community College											- 0:15	- 0:05
Eastfield Community College												- 0:05
Richland Community College												

How the High Coverage Concept would affect travel times, compared to the Existing Network.

High Ridership Concept

Shorter by 20+ minutes	Shorter by 5 to 19 minutes	Change is less than 5 minutes	Longer by 5 to 19 minutes	Longer by 20+ minutes

	Downtown Dallas	Downtown Irving	Downtown Rowlett	Legacy	S Vernon & W Illinois	Addison	Malcolm X	South Garland	Methodist Charlton	Brookhaven	Eastfield	Richland
Downtown Dallas		- 0:05	~	- 0:15	- 0:05	- 0:15	+ 0:05	- 0:15	~	~	- 0:15	- 0:05
Downtown Irving			~	~	- 0:15	- 0:25	- 0:05	- 0:20	- 0:10	- 0:05	- 0:20	- 0:20
Downtown Rowlett				- 0:15	- 0:05	- 0:05	- 0:05	- 0:05	~	+ 0:10	- 0:30	- 0:05
Legacy (Northwest Plano)					- 0:15	- 0:15	- 0:20	- 0:35	- 0:10	- 0:20	- 0:25	- 0:25
S Vernon & W Illinois						- 0:15	- 0:15	- 0:25	- 0:25	~	- 0:20	- 0:10
Addison Transit Center							- 0:20	- 0:10	- 0:15	- 0:10	- 0:20	- 0:05
Malcolm X Transit Center								- 0:20	~	- 0:05	- 0:20	- 0:10
South Garland Transit Center									- 0:15	+ 0:05	- 0:35	- 0:05
Methodist Charlton Medical Center										~	+ 0:15	- 0:10
Brookhaven Community College											- 0:15	+ 0:05
Eastfield Community College												- 0:25
Richland Community College												

How the High Ridership Concept would affect travel times, compared to the Existing Network.

Comparing travel time savings

The table at right shows the same information as the two tables on the previous page. It is intended to facilitate the comparison of travel times for particular trips, between the two Concepts. The values in each cell still represent the difference in travel time of each Concept to the Existing Network. However, in this table, the color of the cell indicates which Concept is faster or slower for each trip, with the darker colors representing the faster Concept and the lighter colors representing the slower Concept. Grey cells indicate that the approximate change in travel time is the same for both concepts.

Out of the 66 trips we analyzed:

- 70% would be faster in the High Ridership Concept
- 10% would be faster in the High Coverage Concept
- 20% would have the same change in both Concepts

Coverage Faster | Coverage Slower | Same Change | Ridership Slower | Ridership Faster

	Downtown Dallas	Downtown Irving	Downtown Rowlett	Legacy	S Vernon & W Illinois	Addison	Malcolm X	South Garland	Methodist Charlton	Brookhaven	Eastfield	Richland
Downtown Dallas		- 0:05 / - 0:05	~ / ~	~ / - 0:15	~ / - 0:05	~ / - 0:15	~ / + 0:05	- 0:05 / - 0:15	~ / ~	- 0:05 / ~	- 0:10 / - 0:15	- 0:05 / - 0:05
Downtown Irving			~ / ~	- 0:10 / ~	- 0:10 / - 0:15	~ / - 0:25	- 0:05 / - 0:05	- 0:10 / - 0:20	- 0:10 / - 0:10	- 0:10 / - 0:05	- 0:15 / - 0:20	- 0:15 / - 0:20
Downtown Rowlett				~ / - 0:15	~ / - 0:05	~ / - 0:05	~ / - 0:05	+ 0:10 / - 0:05	~ / ~	+ 0:15 / + 0:10	- 0:05 / - 0:30	~ / - 0:05
Legacy (Northwest Plano)					~ / - 0:15	~ / - 0:15	~ / - 0:20	- 0:05 / - 0:35	~ / - 0:10	~ / - 0:20	- 0:05 / - 0:25	- 0:35 / - 0:25
S Vernon & W Illinois						+ 0:05 / - 0:15	- 0:10 / - 0:15	- 0:05 / - 0:25	- 0:10 / - 0:25	~ / ~	- 0:10 / - 0:20	- 0:05 / - 0:10
Addison Transit Center							~ / - 0:20	+ 0:10 / - 0:10	~ / - 0:15	- 0:10 / - 0:10	- 0:05 / - 0:20	~ / - 0:05
Malcolm X Transit Center								- 0:05 / - 0:20	~ / ~	~ / - 0:05	- 0:20 / - 0:20	- 0:05 / - 0:10
South Garland Transit Center									~ / - 0:15	+ 0:25 / + 0:05	- 0:30 / - 0:35	+ 0:05 / - 0:05
Methodist Charlton Medical Center										~ / ~	- 0:10 / + 0:15	- 0:05 / - 0:10
Brookhaven Community College											- 0:15 / - 0:15	- 0:05 / + 0:05
Eastfield Community College												- 0:05 / - 0:25
Richland Community College												

How do travel times compare between the two Concepts for each individual trip?

Example travel stories

DART faces a difficult trade-off when designing its bus network, and the two Concepts illustrate that trade-off. While the High Ridership Concept offers much better frequencies and spans, it leaves uncovered parts of the DART service area where small numbers of people with severe needs for transit live, work and travel.

This major downside of the High Ridership Concept is easily seen on the map on page 70. It is also clear in the numbers: while the High Coverage Concept covers 99.8% of existing boardings with some service, the High Ridership Concept covers only 91.7% of existing boardings.

This means that, under the High Ridership Concept, places where some existing DART riders start or end their trips would no longer have service nearby. It is easy to understand why this would have a negative effect on their lives, for some of them a very severe negative effect.

Why, then, would an agency even *consider* shifting service from coverage to ridership, when the negative effects are so easy to see and may be so severe for certain individuals?

Some agencies decide to make this shift because high-coverage, poor-frequency networks have their own negative effects, including for people with severe needs. Those effects are harder to see on a map, and harder to notice because they have been accruing for years. When transit doesn't run at the times or on the days when someone needs it, they may be severely harmed. When transit trips take many hours, lower-income residents may not be able to afford that extra time and are forced to go into debt for a car, or (even worse) not apply for a job or not enroll in school. These severe effects are happening in the Existing Network, as it fails to be useful for people who live close to it and need it, but who can't use it.

The other reason some agencies decide to cut coverage is to increase the number of people, including low-income and minority people, who actually use the system. Ridership is one measure of a transit system's performance, and it matters to many different kinds of people for different reasons. Spreading service out into many routes, each with a poor frequency and short hours of service, is simply not a high-ridership strategy.

The purpose of the examples on the following pages is to help people understand:

- How better frequencies, longer hours of service and more direct routes would make most existing riders' trips faster;
- Why, therefore, more people would choose to use transit under the High Ridership Concept; and
- Why, if DART wishes to increase ridership on its system, the agency might implement something like the High Ridership Concept despite the obvious negative impacts on a small number of existing riders.

All four of the trip examples on the following pages are possible on the Existing Network and in both Concepts. We could have chosen one or more examples that were not possible on all three networks, such as a trip that must happen when service isn't running, or from a place where service isn't offered. For example, an early-morning weekend commute might be possible on the High Ridership Concept but not in the High Coverage Concept or the Existing Network. Or a trip from a low-density neighborhood might be impossible in the High Ridership Concept, because that network would be uncovered, but it would be possible in the other two networks.

Trusting that the consequence of service *simply not existing at the time or in the place that someone needs it* is fairly obvious to the reader, we instead chose four examples that show the subtle effects of coverage, frequency, route directness and walking distance.

Keep in mind that, just like in the Existing Network, these example trips can be made in more than one way. At different times of day, as frequencies change, the best itinerary for each trip might be different. A rider limited in their ability to walk may opt for a slower overall trip which saves them from multiple transfers. A rider who is in a hurry may bring a bicycle with them and only ride transit for one leg of their journey.

Calculating Travel Times

Every transit trip is made up of walking, waiting, and riding.

Often when people think of riding somewhere by transit they only consider the time spent on the bus or train. It is important to remember that every transit trip is made up of time spent walking (or rolling) and time spent waiting.

Walking to and from a stop

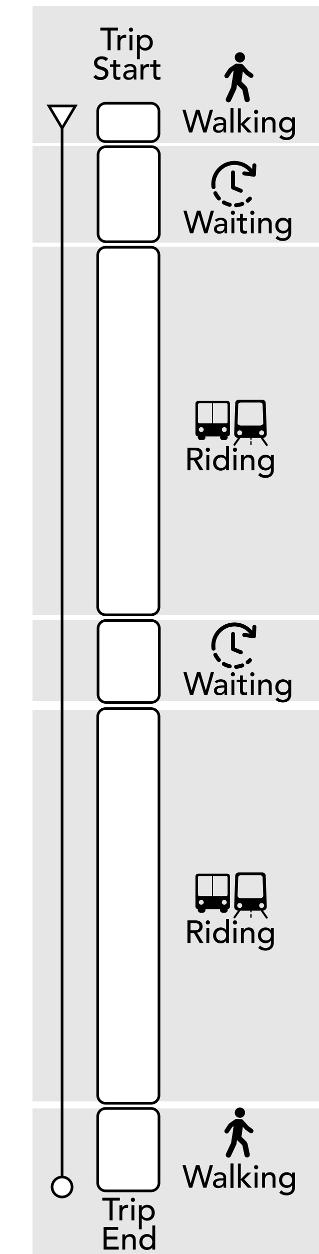
Most transit trips begin and end with walking (or rolling) to and from your destinations. Under a High Ridership Concept walking may be increased as routes are consolidated to create more frequent service.

Waiting for the next bus or train

Waiting doesn't just happen at the start of your ride, it also happens at the end. You may not need to leave the house long before your departure, but if your bus is infrequent, you have to choose between being very early or too late. The High Ridership Concept sees lower overall waiting times due to higher frequencies on most routes.

Riding to your destination

Time spent riding transit will remain similar between the Existing Network and the Concepts. We assumed no speed changes between the Existing Network and the Concepts and used corridor speeds for new alignments.



Jimmy Roberts

Trip Start: Lives near West Saner Ave & Garapan Dr.

Trip End: Works the front desk for a Hotel in Addison.

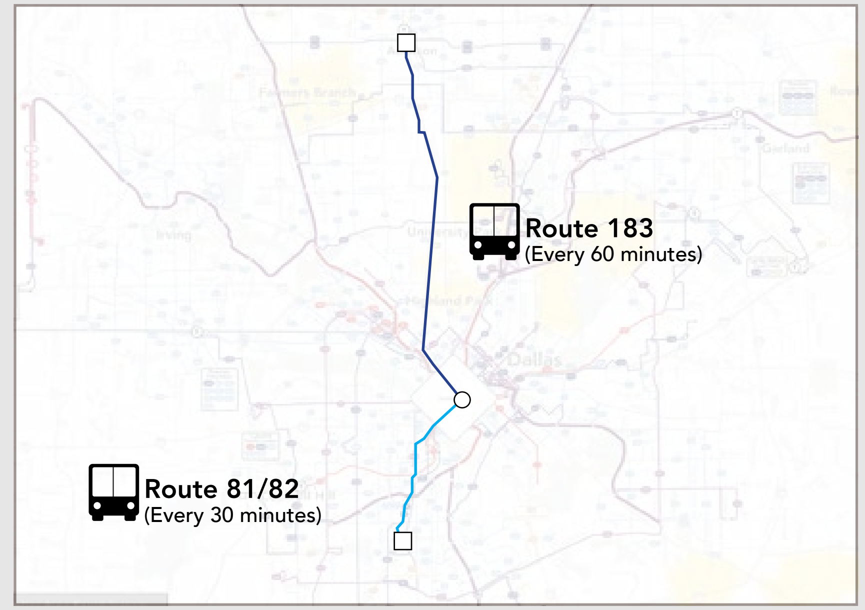
Jimmy grew up and has lived in Dallas his whole life. He commutes and runs errands by bus from his home in Oak Cliff. He works at the front desk for a hotel in Addison and needs to commute Tuesdays - Saturdays. This page reflects how an average midday trip would look for Jimmy under each Concept.

On the **Existing Network**, Jimmy's midday trip takes about **1 hour and 58 minutes** to complete. It requires a single transferring downtown and 11 minutes of walking.

The **High Coverage Concept** maintains the same midday trip time about **1 hour and 58 minutes** as today. His new trip continues to transfer downtown, but requires him to walk to a new stop when he leaves home.

The **High Ridership Concept** provides a faster trip of about **1 hour and 43 minutes**, saving Jimmy 35 minutes compared to today. His travel pattern matches the High Coverage Concept, but with higher frequencies on both routes Jimmy spends less of his time waiting for a bus.

Existing Network

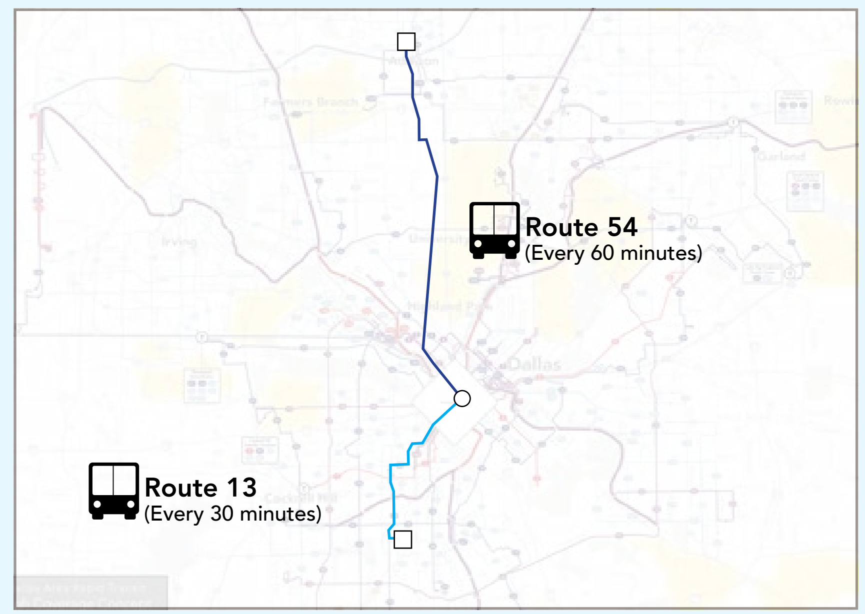


1 Hour 58 Minutes

11 minutes walking, 45 minutes waiting, 62 minutes riding

- Starts trip at home near Saner Ave & Garapan Dr, in Oak Cliff.
- Walks 3 minutes to Garapan Dr & Grayson Dr.
- Waits 15 minutes for Route 81/82.
- Rides **Route 81/82** for 26 minutes to Commerce St. & Griffin St.
- Walks 6 minutes to West Transfer Center.
- Waits 30 minutes to transfer to Route 54.
- Rides **Route 183** for 36 minutes to Quorum Dr & Belt Line Rd.
- Walks 2 minutes to hotel job.

High Coverage Concept

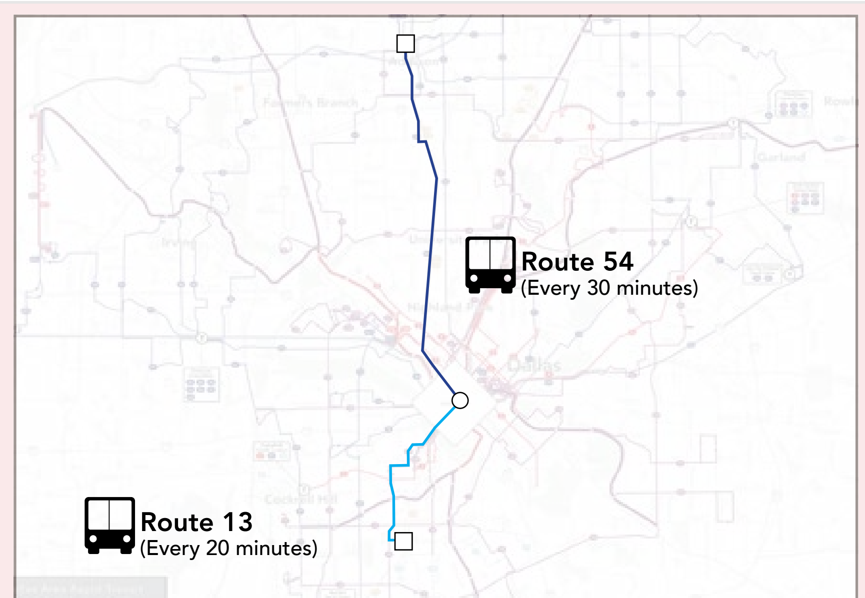


1 Hour 58 Minutes

11 minutes walking, 45 minutes waiting, 62 minutes riding

- Starts trip at home near Saner Ave & Garapan Dr, in Oak Cliff.
- Walks 3 minutes to Polk St & Saner Ave.
- Waits 15 minutes for Route 13.
- Rides **Route 13** for 26 minutes to Commerce St & Griffin St.
- Walks 6 minutes to West Transfer Center.
- Waits 30 minutes to transfer to Route 54.
- Rides **Route 54** for 36 minutes to Quorum Dr & Belt Line Rd.
- Walks 2 minutes to hotel job.

High Ridership Concept



1 Hour 38 Minutes

11 minutes walking, 25 minutes waiting, 62 minutes riding

- Starts trip at home near Saner Ave & Garapan Dr, in Oak Cliff.
- Walks 3 minutes to Polk St & Saner Ave.
- Waits 10 minutes for Route 13.
- Rides **Route 13** for 26 minutes to Commerce St & Griffin St.
- Walks 6 minutes to West Transfer Center.
- Waits 15 minutes to transfer to Route 54.
- Rides **Route 54** for 36 minutes to Quorum Dr & Belt Line Rd.
- Walks 2 minutes to hotel job.

Michael Wright

Trip Start: Lives near MacArthur Blvd & Shady Grove Rd.

Trip End: Works as a hospital manager at Methodist Charlton Medical Center.

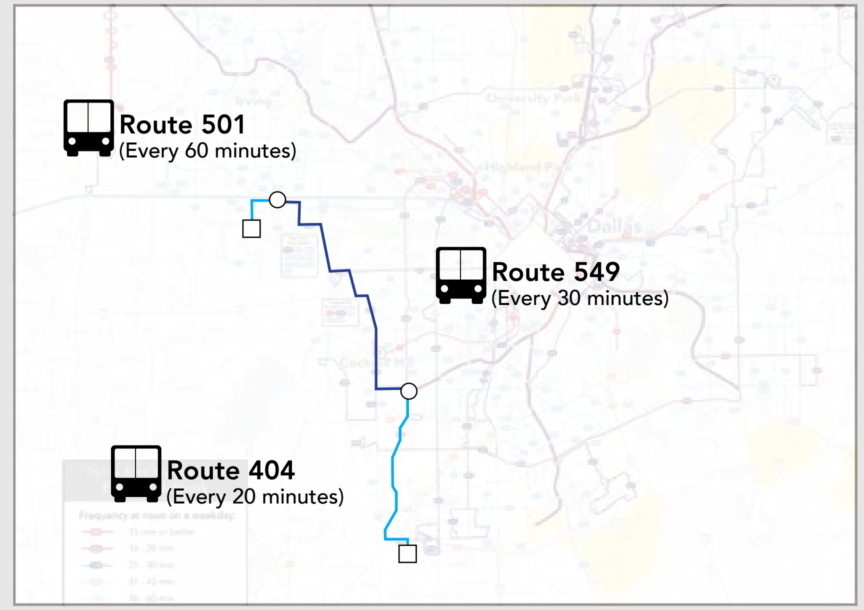
Michael recently moved to Irving and works as a manager at Methodist Charlton Medical Center in Oak Cliff. He is hoping to begin commuting to work by transit, but often needs to go home early to care for an aging family member. This page reflects how an average midday trip would look for Michael under each Concept.

On the **Existing Network**, Michael's midday trip takes about 2 hours and 6 minutes to complete. It requires two transfers, one of which is a timed connection, and the majority of his time is spent on Route 549 (46 minutes).

The **High Coverage Concept** provides a midday trip of about **2 hour and 3 minutes**, comparable to today. The small savings is due to a slightly more direct route compared to today. This trip retains the timed connection in downtown Irving, helping to guarantee a reliable transfer.

The **High Ridership Concept** provides a faster midday trip of about **1 hour and 47 minutes**, saving Michael 19 minutes compared to today. The majority of the time savings comes from a higher frequency on his initial bus in Irving.

Existing Network

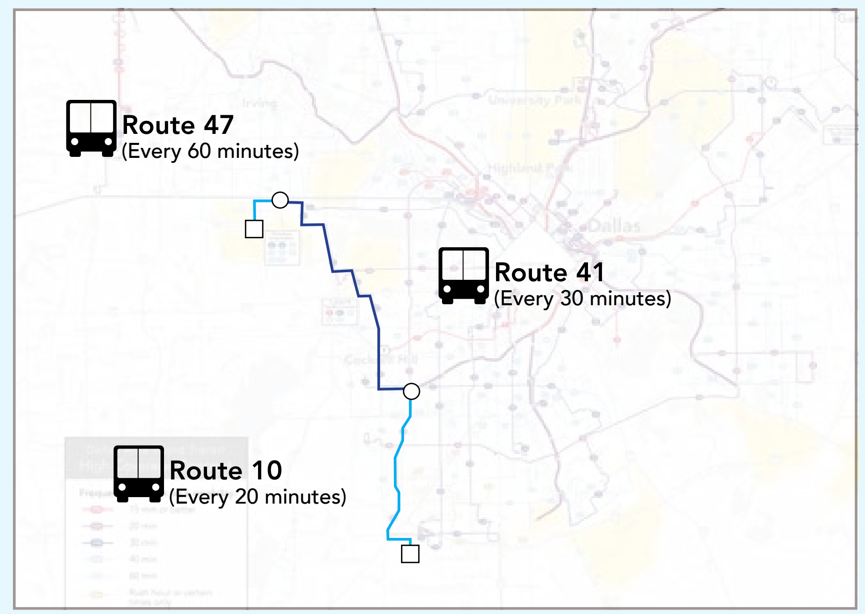


2 Hours 6 Minutes

3 minutes walking, 45 minutes waiting, 78 minutes riding

- Starts trip at home near MacArthur Blvd & Shady Grove Rd.
- Walks 1 minute to a stop on Shady Grove Rd.
- Waits 30 minutes for Route 501.
- Rides **Route 501** for 7 minutes to Downtown Irving Transit Center.
- Waits 5 minutes for a timed connection to Route 549.
- Rides **Route 549** for 46 minutes to Westmoreland Rd & Illinois Ave.
- Waits 10 minutes for Route 404.
- Rides **Route 404** for 25 minutes to Wheatland Rd & Virginia Dr.
- Walks 2 minutes to Methodist Charlton Medical Center.

High Coverage Concept

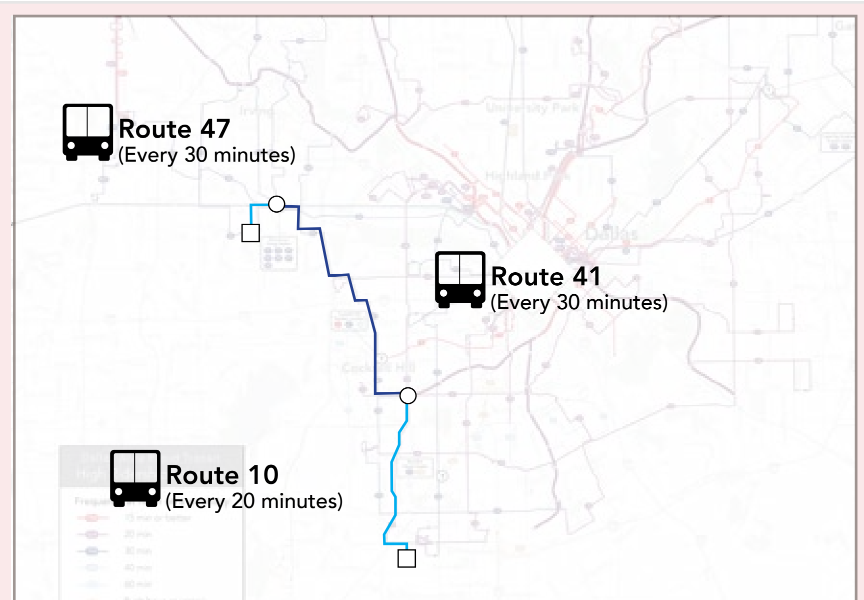


2 Hours 3 Minutes

3 minutes walking, 45 minutes waiting, 75 minutes riding

- Starts trip at home near MacArthur Blvd & Shady Grove Rd.
- Walks 1 minute to a stop on Shady Grove Rd.
- Waits 30 minutes for Route 47.
- Rides **Route 47** for 7 minutes to Downtown Irving Transit Center.
- Waits 5 minutes for a timed connection to Route 41.
- Rides **Route 41** for 43 minutes to Westmoreland Rd & Illinois Ave.
- Waits 10 minutes for Route 10.
- Rides **Route 10** for 25 minutes to Wheatland Rd & Virginia Dr.
- Walks 2 minutes to Methodist Charlton Medical Center.

High Ridership Concept



1 Hour 47 Minutes

3 minutes walking, 30 minutes waiting, 74 minutes riding

- Starts trip at home near MacArthur Blvd & Shady Grove Rd.
- Walks 1 minute to a stop on Shady Grove Rd.
- Waits 15 minutes for Route 47.
- Rides **Route 47** for 7 minutes to Downtown Irving Transit Center.
- Waits 5 minutes for a timed connection to Route 41.
- Rides **Route 41** for 42 minutes to Westmoreland Rd & Illinois Ave.
- Waits 10 minutes for Route 10.
- Rides **Route 10** for 25 minutes to Wheatland Rd & Virginia Dr.
- Walks 2 minutes to Methodist Charlton Medical Center.

Isabelle Chará

Trip Start: Lives near East Northwest Hwy & Bucknell Dr.

Trip End: Attends classes at Eastfield College.

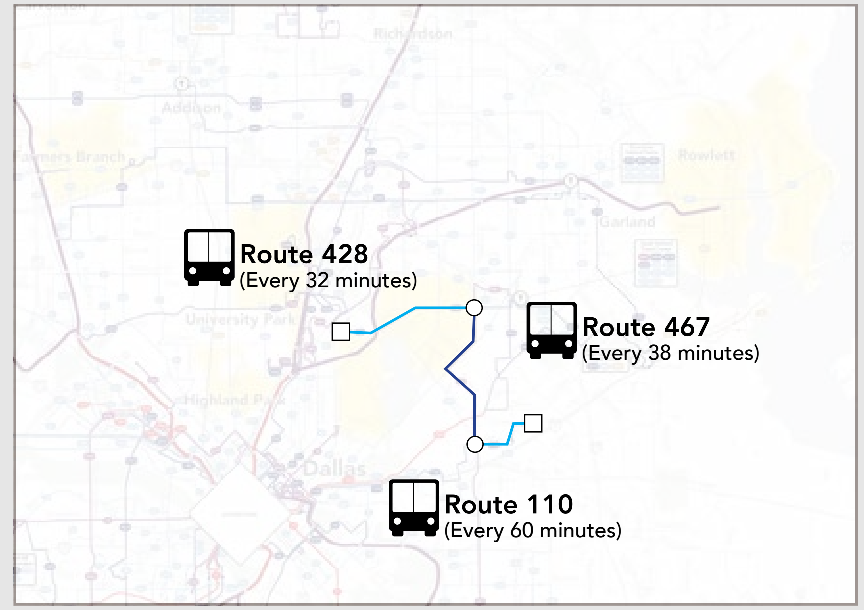
Isabelle lives in Northeast Dallas, near White Rock Lake, and is attending courses at Eastfield College. She relies on transit for her commute and needs to commute at different times of the day, depending on her class schedule each term. This page reflects how an average midday trip would look for Isabelle under each Concept.

On the **Existing Network**, Isabelle's midday trip takes about 1 hour and 43 minutes to complete. It requires two transfers and the majority of her time is spent waiting for a bus to arrive.

The **High Coverage Concept** provides a faster midday trip of about **1 hour and 14 minutes**, saving Isabelle **29 minutes** of total trip time compared to today. Her new trip would require only one transfer, and reduces her total wait time by 25 minutes.

The **High Ridership Concept** provides a faster midday trip of about **1 hour and 4 minutes**, saving Isabelle **39 minutes** compared to today. The travel pattern matches the High Coverage Concept, but the higher frequency on her initial route saves her an additional 10 minutes of waiting.

Existing Network

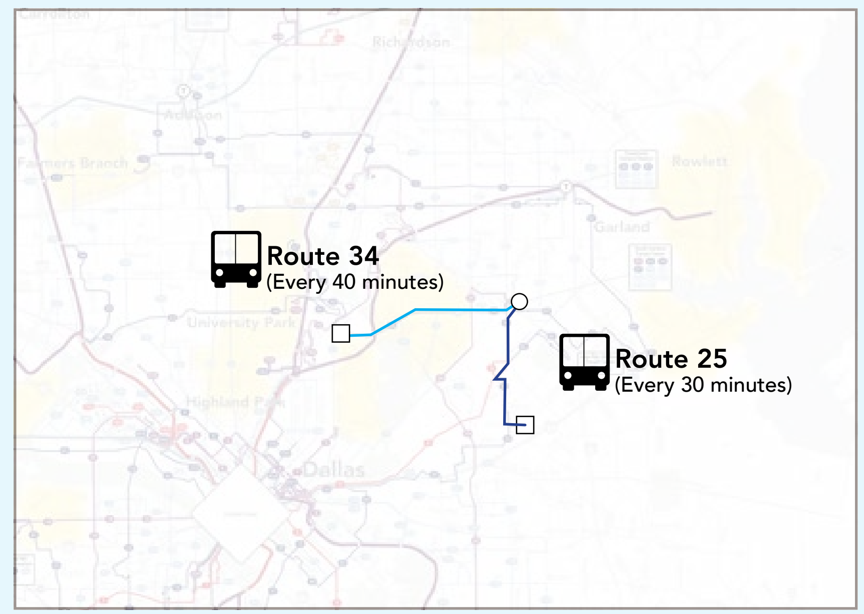


1 Hour 43 Minutes

6 minutes walking, 55 minutes waiting, 42 minutes riding

- Starts trip at home near East Northwest Hwy & Bucknell Dr.
- Walks 4 minutes to a stop on East Northwest Hwy.
- Waits 15 minutes for Route 428.
- Rides **Route 428** for 16 minutes to East Northwest Hwy & Jupiter Rd.
- Waits 10 minutes to transfer to Route 467.
- Rides **Route 467** for 19 minutes to Buckner Blvd & John West Rd.
- Waits 30 minutes to transfer to Route 110.
- Rides **Route 110** for 7 minutes to Eastfield College.
- Walks 2 minutes to classroom building.

High Coverage Concept

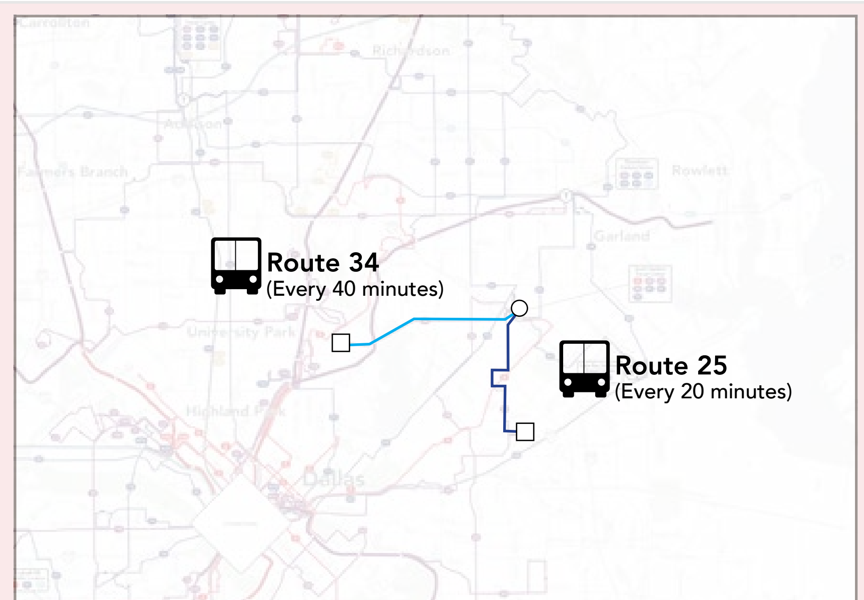


1 Hour 14 Minutes

6 minutes walking, 30 minutes waiting, 38 minutes riding

- Starts trip at home near East Northwest Hwy & Bucknell Dr.
- Walks 4 minutes to a stop on East Northwest Hwy.
- Waits 15 minutes for Route 34.
- Rides **Route 34** for 20 minutes to South Garland Transit Center.
- Waits 15 minutes for pulse transfer to Route 25.
- Rides **Route 25** for 18 minutes to Eastfield College.
- Walks 2 minutes to classroom building.

High Ridership Concept



1 Hour 4 Minutes

6 minutes walking, 20 minutes waiting, 38 minutes riding

- Starts trip at home near East Northwest Hwy & Bucknell Dr.
- Walks 4 minutes to a stop on East Northwest Hwy.
- Waits 10 minutes for Route 34.
- Rides **Route 34** for 20 minutes to South Garland Transit Center.
- Waits 10 minutes transfer to Route 25.
- Rides **Route 25** for 18 minutes to Eastfield College.
- Walks 2 minutes to classroom building.

Kayla Harrison

Trip Start: Lives near Arapaho Rd & Yale Blvd.

Trip End: Meets with friends in Deep Ellum.

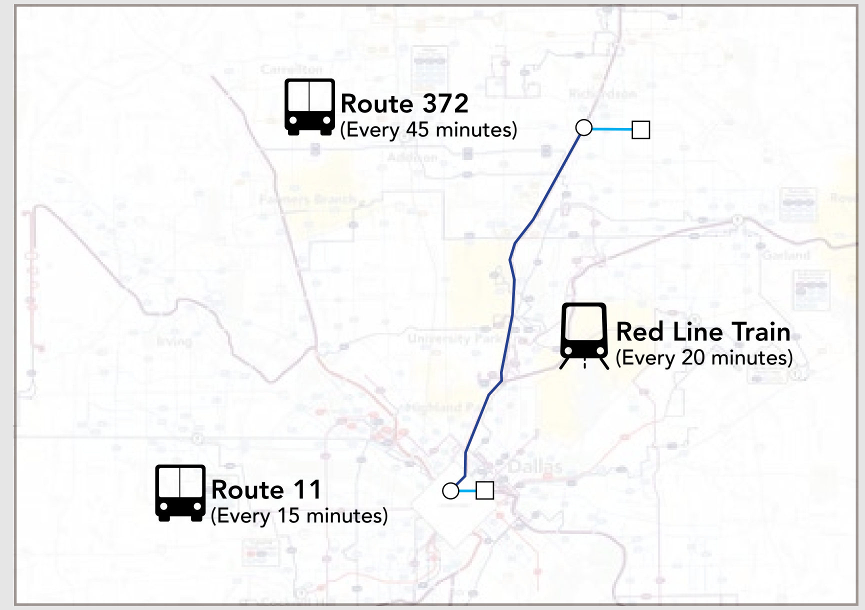
Kayla lives in Richardson and often uses transit to meet up with friends on her day off. This page reflects how Kayla could use transit in each concept to meet with friends for lunch in Deep Ellum.

On the **Existing Network**, Kayla's midday trip takes about 1 hour and 32 minutes to complete. It requires two transfers to and from Light Rail.

The **High Coverage Concept** provides a midday trip of about **1 hour and 35 minutes**, comparable to today. This trip requires less walking, but her initial wait time increases by 7 minutes, due to the worse frequency on her initial bus.

The **High Ridership Concept** provides a faster midday trip of about **1 hour and 17 minutes**, saving Kayla 15 minutes compared to the existing time. This travel pattern matches the High Coverage Concept, but the higher frequencies on both bus routes means Kayla can arrive sooner or leave later.

Existing Network

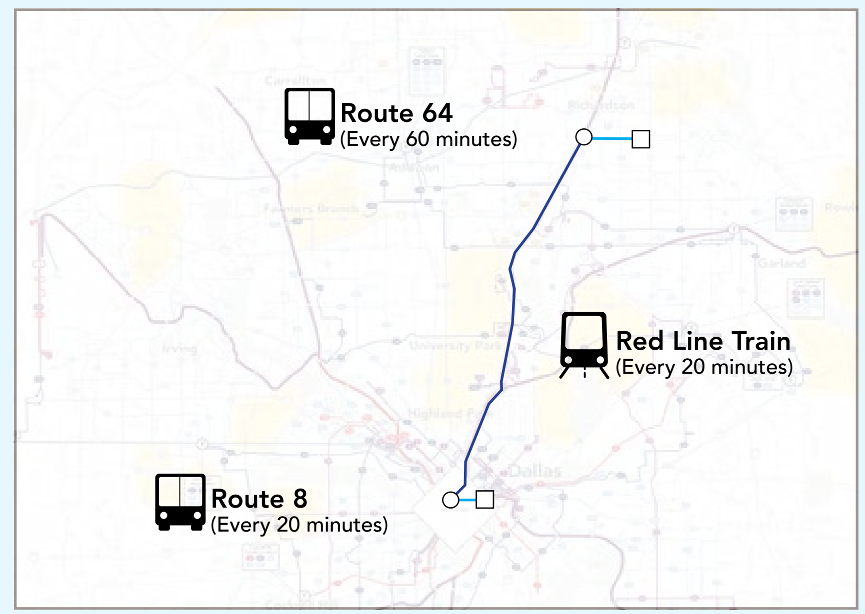


1 Hour 32 Minutes

8 minutes walking, 40 minutes waiting, 44 minutes riding

- Starts trip at home near Arapaho Rd & Yale Blvd, in Richardson.
- Walks 2 minutes to bus stop on E Arapaho Rd.
- Waits 23 minutes for Route 372.
- Rides **Route 372** for 7 minutes to Arapaho Center Station.
- Waits 10 minutes to transfer to Light Rail.
- Rides **Light Rail** for 30 minutes to St. Paul Station.
- Walks 4 minutes to Pacific Ave & Olive St.
- Waits 7 minutes to transfer to Route 11.
- Rides **Route 11** for 7 minutes to Deep Ellum.
- Walks 2 minutes to meet with friends.

High Coverage Concept

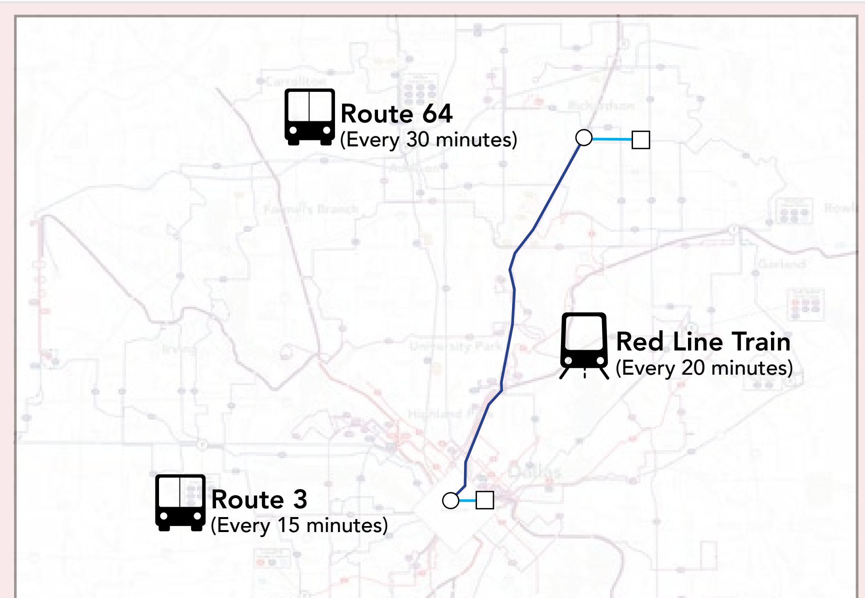


1 Hour 35 Minutes

5 minutes walking, 50 minutes waiting, 40 minutes riding

- Starts trip at home near Arapaho Rd & Yale Blvd, in Richardson.
- Walks 2 minutes to bus stop on E Arapaho Rd.
- Waits 30 minutes for Route 64.
- Rides **Route 64** for 7 minutes to Arapaho Center Station.
- Waits 10 minutes to transfer to Light Rail.
- Rides **Light Rail** for 28 minutes to Pearl / Arts District Station.
- Walks 1 minute to N Pearl St & Crockett St.
- Waits 10 minutes to transfer to Route 8.
- Rides **Route 8** for 5 minutes to Deep Ellum.
- Walks 2 minutes to meet with friends.

High Ridership Concept



1 Hour 17 Minutes

5 minutes walking, 32 minutes waiting, 40 minutes riding

- Starts trip at home near Arapaho Rd & Yale Blvd, in Richardson.
- Walks 2 minutes to bus stop on E Arapaho Rd.
- Waits 15 minutes for Route 64.
- Rides **Route 64** for 7 minutes to Arapaho Center Station.
- Waits 10 minutes to transfer to Light Rail.
- Rides **Light Rail** for 28 minutes to Pearl / Arts District Station.
- Walks 1 minute to N Pearl St & Crockett St.
- Waits 7 minutes to transfer to Route 3.
- Rides **Route 3** for 5 minutes to Deep Ellum.
- Walks 2 minutes to meet with friends.

8 Key Choices

Walking or waiting?

Data and centuries of experience have taught transit providers that more people will walk farther, to get a faster trip, than will wait for a low-frequency service.

In pursuit of higher ridership, a transit agency would offer better frequencies but ask people to walk a little farther. This choice therefore relates to the bigger choice about how to balance ridership and coverage goals within DART's limited bus budget.

The High Ridership Concept would provide shorter waits, but longer walks, in some parts of the city, particularly in places that developed with a well-connected street network before World War II. **The High Coverage Concept would provide shorter walks in those places, but longer waits**, similar to what people experience in the existing network.

How important are rush hours?

DART treats rush hours as very important, running some rush-hour-only routes and increasing frequencies on many of its routes just during rush hours.

Providing extra service at rush hours is expensive, both because rush-hour-only routes are not very productive compared to all-day routes with decent frequencies, and because scaling the agency and the fleet up to provide a surge of service for limited time periods has extra costs.

Shifting some service off of rush hours, into other times and other days, is a likely path to higher ridership within DART's fixed budget. There are also non-ridership reasons to provide more service outside of rush hours, because people need transportation at all times of day and week, even times when productivity is low.

The High Ridership Concept would shift some service from rush hours to weekdays at midday and night, and especially to Saturdays and Sundays. This would make the network less ideal for 8-to-5 commuters, but more useful to people who work in service or retail, or in industrial jobs with round-the-clock shift times, or anyone else who wants to travel for work, errands or socializing every day. **The High Coverage Concept would shift a little bit of service away from rush hours to other times,** but in order to maintain full coverage most routes would offer poorer frequencies and shorter hours than in the High Ridership Concept.

What can be done about falling speeds?

DART has been shoring up reliability by scheduling its buses to run 5-7% slower on weekdays since 2012.

DART has also been doing what it can to shore up operating speeds – removing some very low-ridership stops, eliminating deviations and introducing fare cards that speed-up boardings. This is a worthwhile effort but cannot counteract the slowing effects of traffic congestion.

The 13 cities that collect sales taxes to fund DART's bus service also manage many of the streets on which DART buses are stuck in traffic. The slower the buses run, the less frequency DART can provide with those tax revenues.

Municipalities are the only ones that can protect their investment in transit service by managing streets so that buses can operate quickly and reliably. Municipalities can also advocate for similar protections from the agencies that manage the region's highways and freeways.

Without an intervention by the agencies in control of roads, DART will be left with no choice but to spend more on slower service, or to cut frequencies as routes slow down.

Recently, in an effort to improve bus speeds DART has been coordinating with the City of Dallas, Richardson, Addison, Plano, Farmer's Branch and Garland to implement transit signal priority (TSP), which will provide priority to transit at intersections, for select routes.

Both of the Concepts assume the same bus operating speeds as in the existing network. If speeds continue to fall, the routes, frequencies and spans shown in either Concept (and in the existing network) would need to be reduced so that DART can spend more of its service ensuring reliability despite slower speeds. Alternatively, DART would need to raise additional funding to maintain routes, frequencies and spans, with high reliability, while speeds fall.

If the agencies that design and regulate roads take steps to make transit service faster, it would free up some service that is currently spent ensuring reliability at low speeds. This would allow DART to redeploy that service to provide greater coverage, higher frequencies or longer spans.

Pursue higher ridership, or maintain high coverage?

In every public transit system, a basic trade-off must be made between concentrating service into useful routes that serve large numbers of people, and spreading service out to make sure that people everywhere have access to at least some service. This trade-off is described at greater length starting on page 17.

A transit agency needn't choose one extreme or the other – the choice is not binary. However, the two goals trade-off against one another. This means that within a fixed budget, a shift towards one goal is necessarily a shift away from the other. Providing higher frequencies and achieving higher ridership would require reducing geographic coverage, and vice versa.

Nothing we say in this report should be taken to imply that DART should strike a different balance than it does today. When we describe potential high-ridership strategies, there is always an implied "if" statement: *"IF DART wanted to increase ridership, here are some things that could be done, and here are some trade-offs involved."* The choice about how to balance ridership and coverage goals will rest with the public, stakeholders and ultimately the DART Board of Directors.

Ridership strategies

If a transit agency wants to pursue higher ridership within its limited budget, it will consider strategies like:

- Looking at routes with the most ridership relative to cost, where existing riders are showing that the service is pretty useful, and finding ways to make those routes even more useful to more people.
- Making transit more time-competitive against driving, by offering higher frequencies, more direct trips and higher speeds.
- Offering sustained all-week services that allow large numbers of households to give up a car (or stop hiring cars for certain trips), so that a greater number of people choose to depend on transit every day. This means providing higher levels of service on weekends and at night than are currently offered.
- Adding service in places and ways that attracts additional riders at a low subsidy per rider, and avoiding service investments that attract few new riders or require a high investment per rider.
- Sending clear signals to existing riders, businesses, social services, developers and future riders about where the most

permanent and useful transit service is. People and organizations that value transit can choose to locate near it, and in doing so they help the cities continue to build permanent transit markets around DART's most cost-effective services.

Coverage motivations

There are two distinct purposes that non-ridership transit can serve, both generally described as "coverage":

- Service can be deployed near people who have a severe need for transit, even if there are too few people or if the barriers to transit are too great for the service to be productive relative to its cost. Service can be deployed so that all geographic areas, and in DART's case all 13 cities that contribute funding, have a certain level of service within their boundaries.

In practice, many coverage routes have a mix of purposes. Maintaining service in every contributing city may be a political decision that relates to agreements and expectations between governmental partners, but it always has at least a minimal social purpose because there are people with severe needs for transit everywhere.

Existing network split: 55%–45%

Many agencies find it helpful to set a policy about how much of their budget they will set aside to provide coverage while focusing the rest of their budget on the pursuit of higher ridership. Of the DART bus budget, about 45% is currently spent providing coverage services, that do not get high ridership relative to their costs.

This balance, with 55% of the budget spent pursuing high ridership and 45% providing coverage, does not reflect an explicit policy. It has arisen from many years of public input, requests from riders, staff judgments and direction from the Board of Directors on smaller service changes.

The two Concepts illustrate different balances of investment towards ridership and coverage goals:

- **The High Coverage Concept shows how 60% of the budget could be spent towards productive services, while 40% is reserved for low-ridership services.**
- **The High Ridership Concept shows how 85% of the bus service budget could be spent serving large numbers of people with highly productive services.** Only 15% is reserved for coverage services with either social or political equity purposes.

This plan will give the DART Board an opportunity to affirm or update the existing 55%–45% balance of purposes in the bus budget. This plan also gives the public, riders and stakeholders an opportunity to give input on this major trade-off and inform the Board's policy decision.

The other key choices arising in this plan and described earlier in this section relate to ridership outcomes. Some people will not have an opinion about the right balance of spending on ridership and coverage goals, but their input on more concrete choices – such as walking vs. waiting, and the importance of rush hours – can inform the Board's decision about the ridership/coverage balance.

The next chapter describes the two Concepts, and shows how they would each perform relative to ridership or coverage goals.

Contrasting Concepts

The two Concepts shown in this report illustrate the very different ways that DART could redesign its bus network.

- The **High Coverage Concept** shows how the network could be redesigned to better-suit today's travel patterns, but while continuing to cover nearly every place and person who is covered by some service today. The High Coverage Concept is very similar to the existing network, because the existing network is actually quite expertly designed towards the goal of high coverage.
- The ridership strategies listed above are epitomized in the **High Ridership Concept**, but come at a stark cost – the loss of coverage of places where DART currently offers service.

Both Concepts are constrained by the existing bus service budget, which is small considering the long distances and non-transit development patterns DART serves.

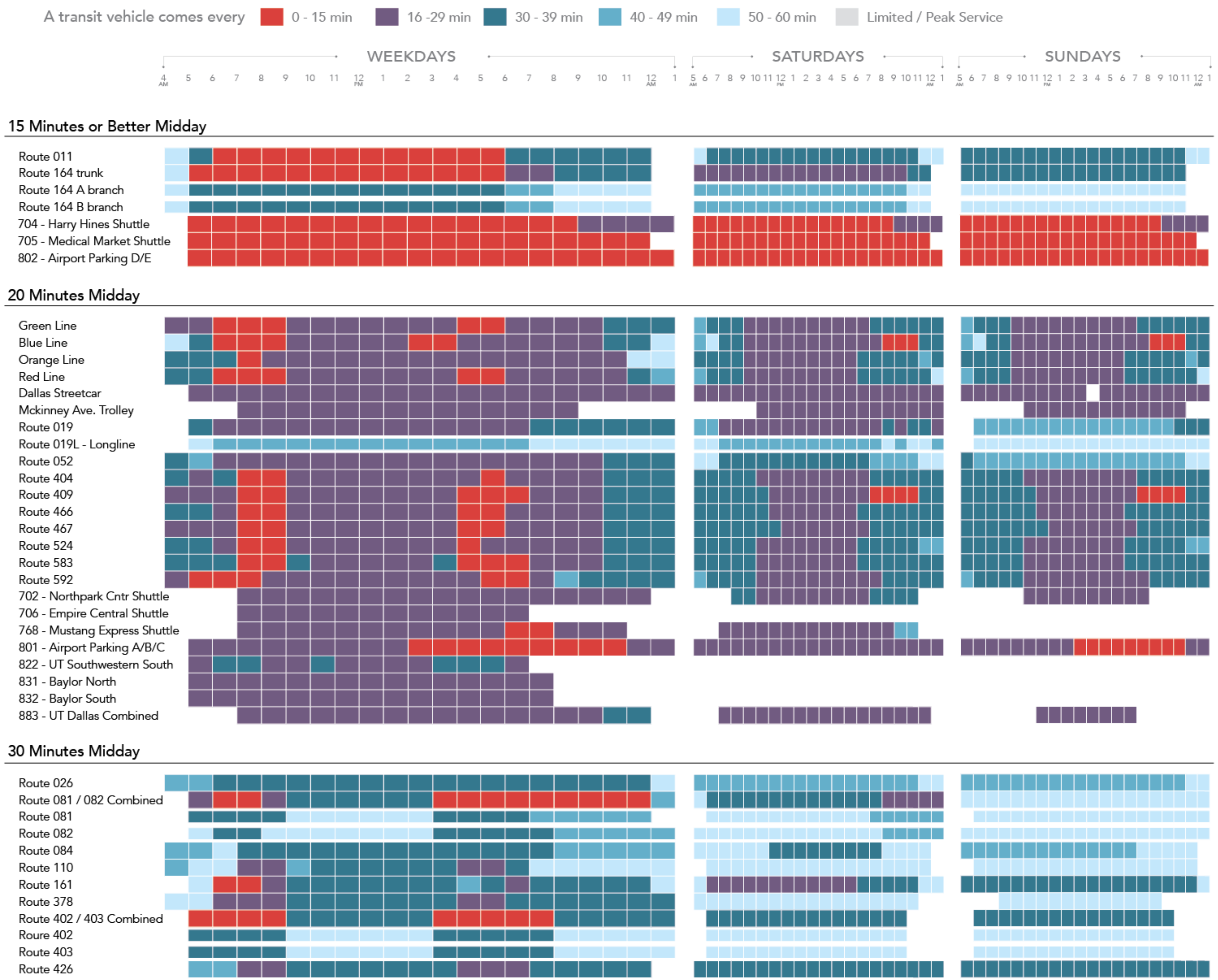
Making these choices

Some of these choices relate to one another. For example, shifting service investment away from rush hours is part of a higher-ridership strategy. Asking people in dense areas with well-connected street networks to walk farther to reach a more frequent route is part of a higher-ridership strategy. For this reason, if DART decides to pursue higher ridership in its New Network Plan, that will imply other related choices.

The decision of whether to pursue higher ridership is not a technical decision. There is also no morally correct answer, since both high ridership and high coverage deliver benefits that people care about. Every transit agency can balance ridership and coverage goals in a way that speaks to local values – the right balance for one metropolitan area may not be right for another. This choice is difficult because there simply isn't enough transit service to be everything to everyone. The most important outcome of this project is a New Bus Network that fits local values for transit, and is one that DART and its stakeholders understand and believe in.

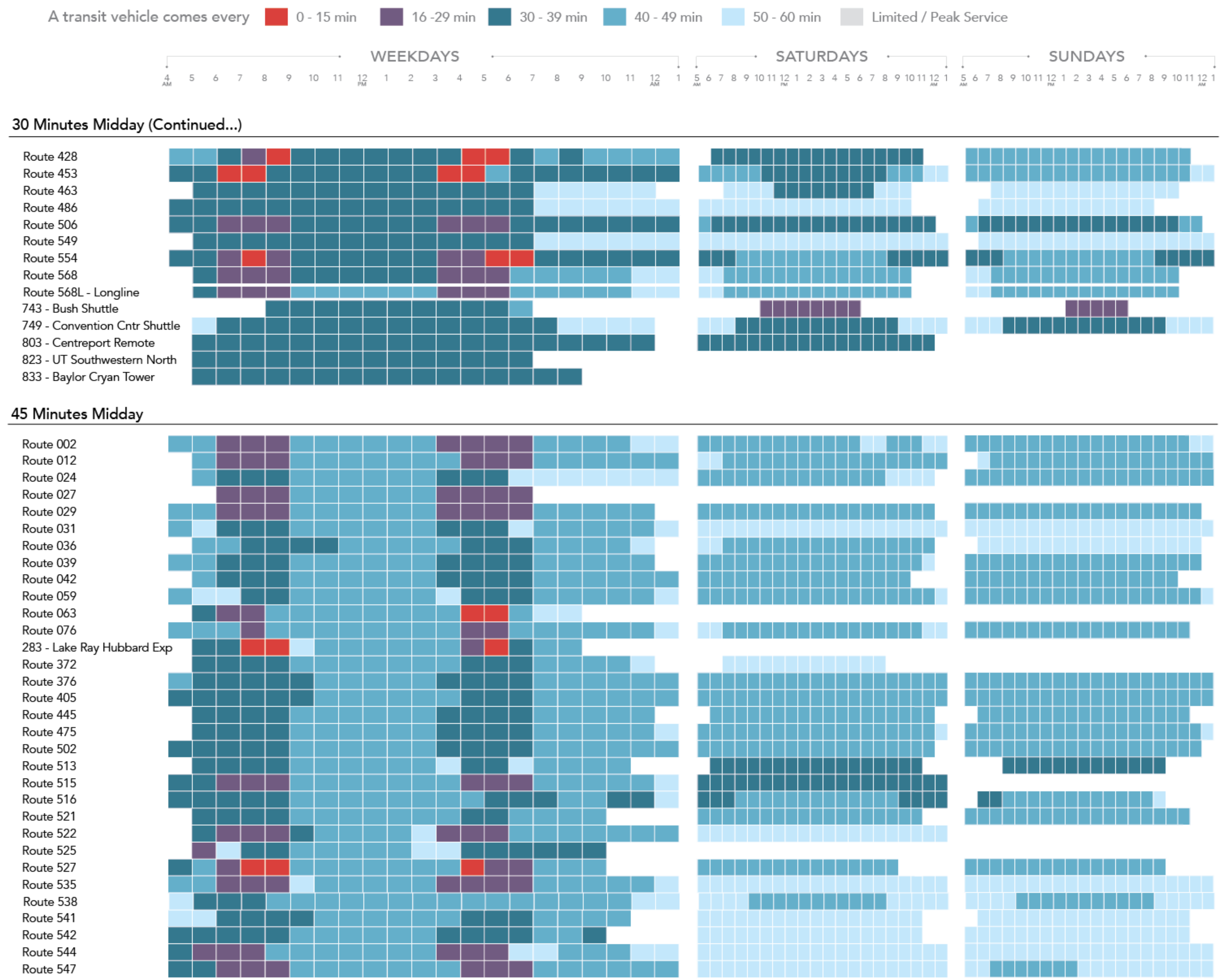
A Appendix

DART Existing Transit Frequencies and Spans



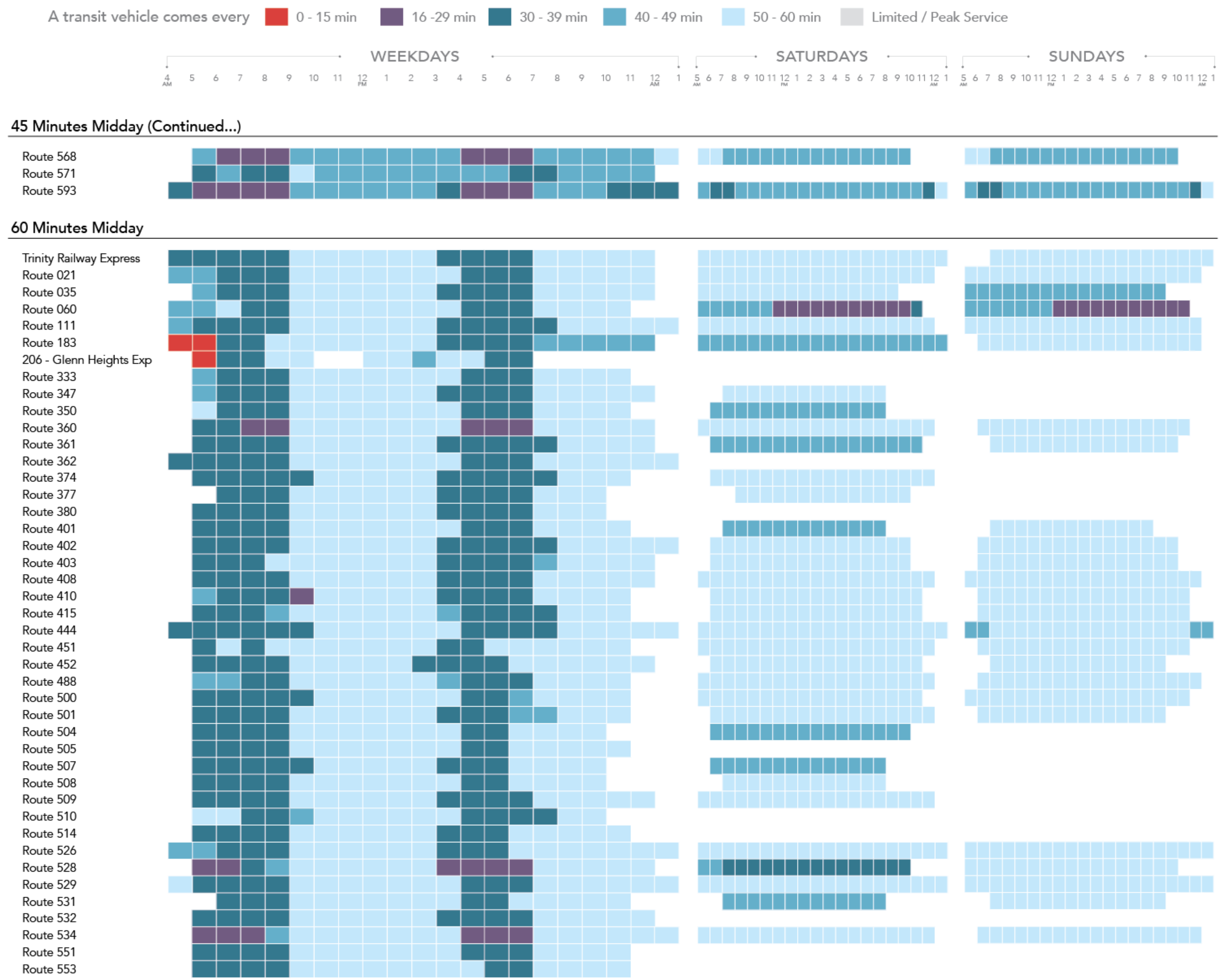
Based on October 2019 schedules

DART Existing Transit Frequencies and Spans



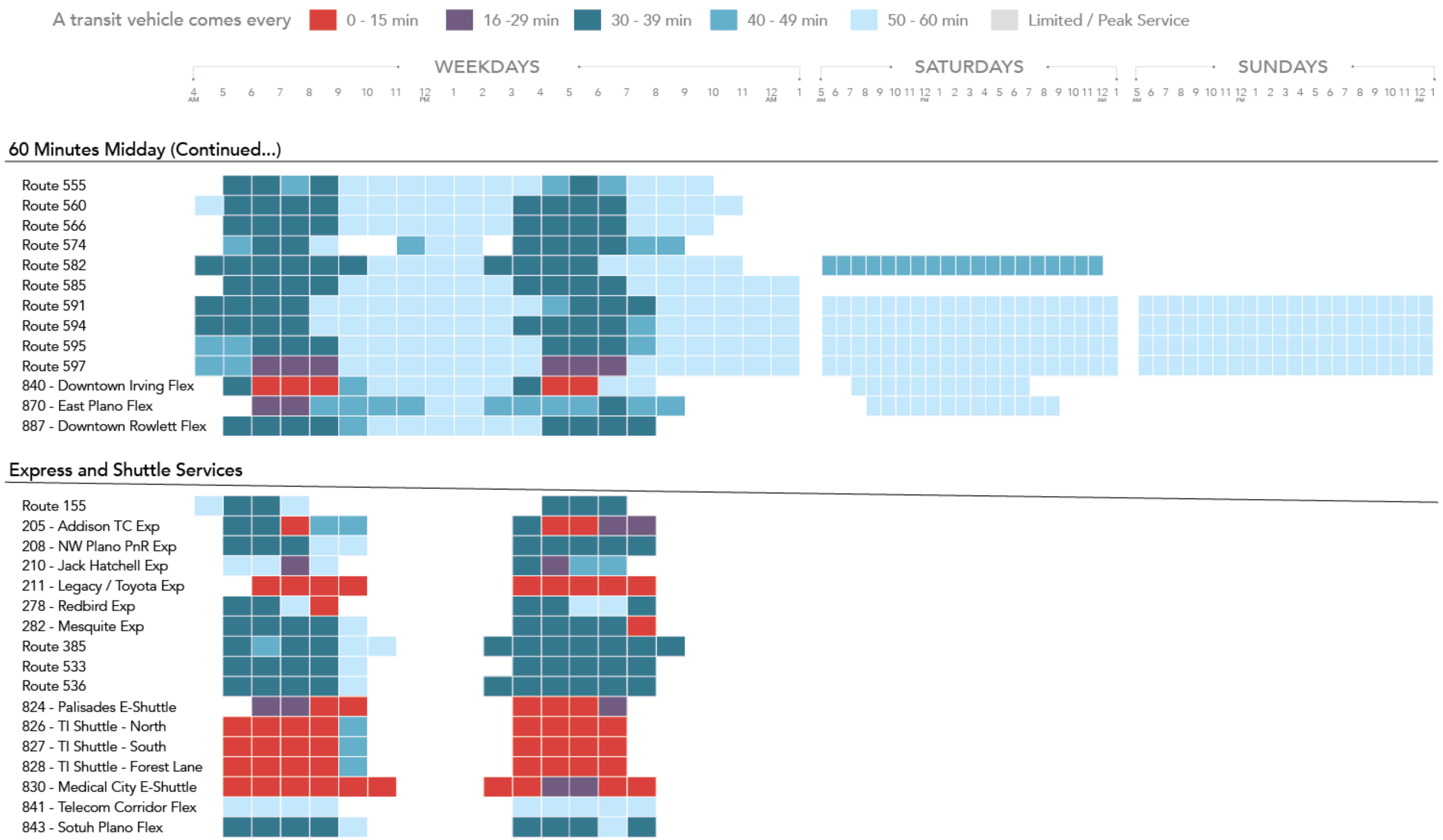
Based on October 2019 schedules

DART Existing Transit Frequencies and Spans



Based on October 2019 schedules

DART Existing Transit Frequencies and Spans

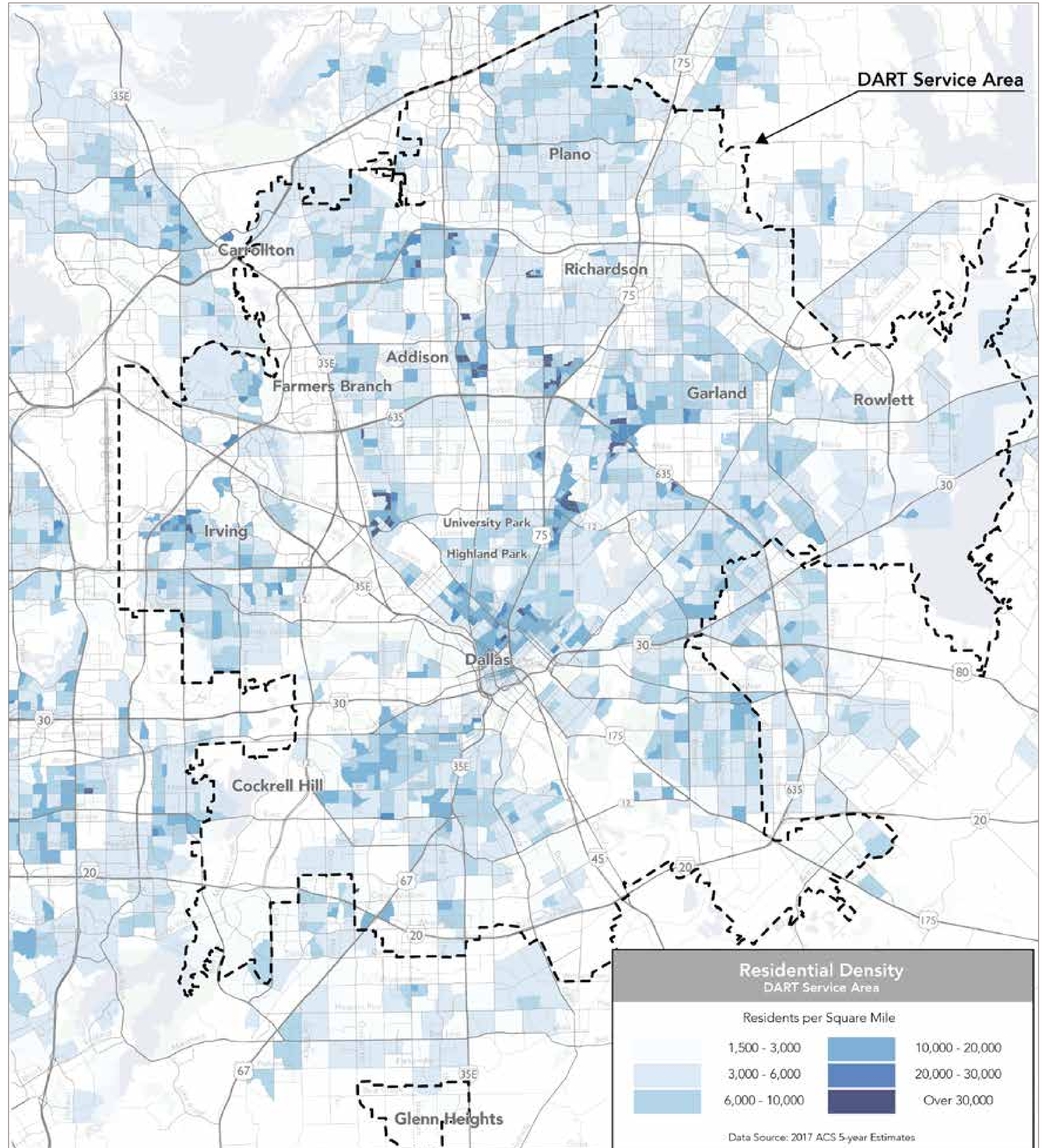


Based on October 2019 schedules

Residential Density Map

Residential density is the simplest measure of public transit's ridership potential. Nearly everybody makes at least one trip starting or ending at their place of residence every day.

The data in this map was combined with the data in the Job Density map on the following page to make the Activity Density map shown on page 31.



This map shows where people live in the DART Service Area at moderate and high densities.

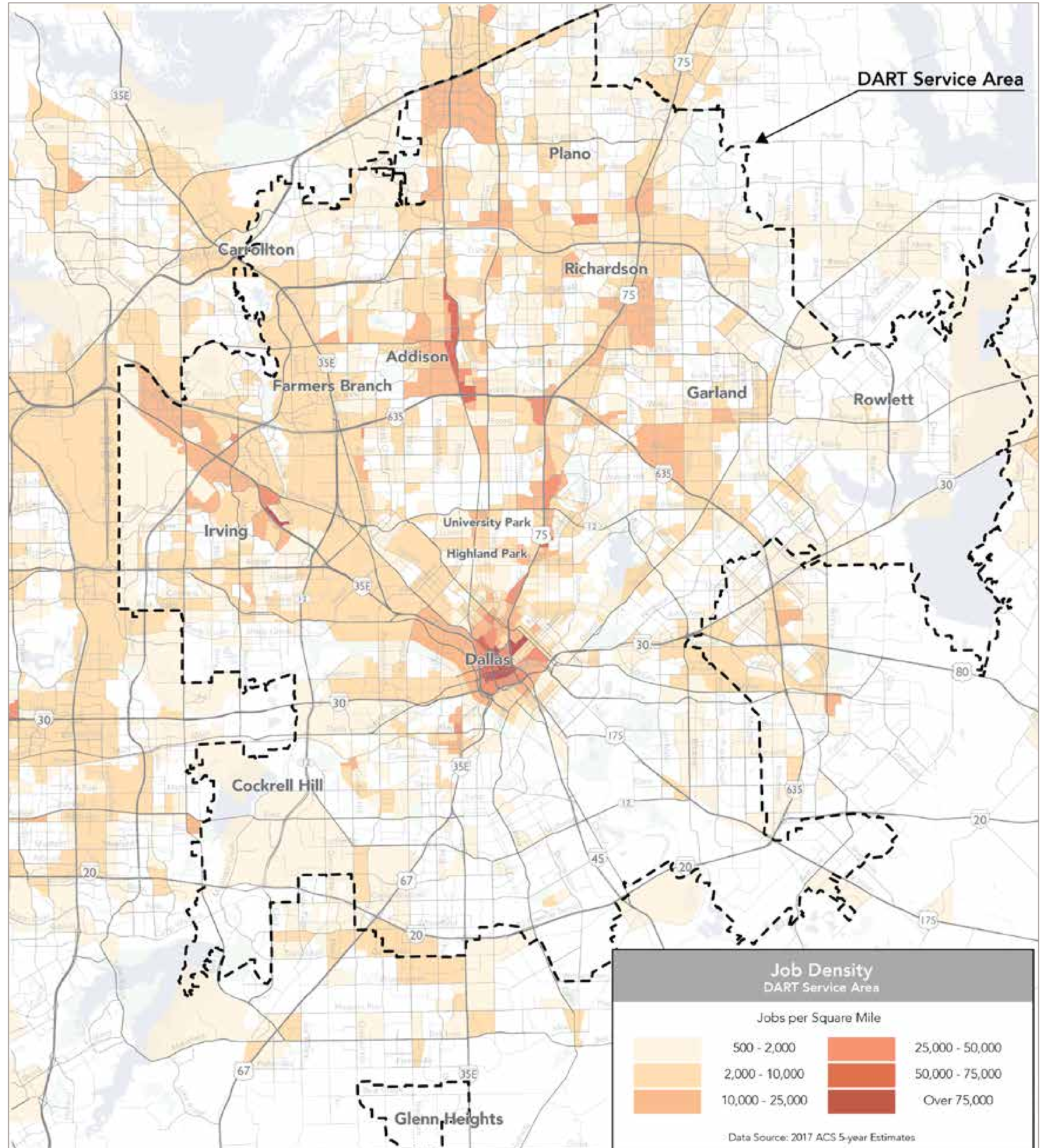
Job Density Map

The data in this map was combined with the data in the Residential Density map on the previous page to make the Activity Density map shown on page 31.

A map of job density shows us not only the places people travel for work, but also places people go for services, shopping, community, health care, and more. ***A person's workplace may be, throughout the day, a destination for dozens or even hundreds of people.***

Low density commercial and industrial zones are difficult for DART to serve. While in total they account for a large number of jobs, these jobs tend to be dispersed with poor street connectivity and separated form any other density. Examples of these areas include DFW Airport, International Commerce Park, the old Texas Stadium area, and Valwood Industrial Park area.

Notice that dense employment areas are more centralized, and more concentrated along freeways, than are dense residential areas (as shown on the previous page). Job density is a better predictor of ridership potential than residential density, but the areas next to freeways and near freeway interchanges are expensive to serve for reasons described starting on page 57.



This map shows where people work in the DART Service Area at moderate and high densities. Job density shows us where very important trips take people to work, but they also show where people may be going for shopping, for services, and to reach other opportunities.

Estimate of route purposes in the High Ridership Concept

Route	%Ridership	%Coverage	Annual Cost	Notes
1	100%	0%	$4,656,000	Serves dense areas
3	100%	0%	$3,106,000	Serves dense areas
4	100%	0%	$2,781,000	Serves dense areas
5	100%	0%	$2,940,000	Serves dense areas
6	100%	0%	$4,425,000	Serves dense areas
9	100%	0%	$7,022,000	Serves dense areas
10	100%	0%	$4,748,000	Serves dense areas
13	100%	0%	$4,265,000	Serves dense areas
14	100%	0%	$2,275,000	Serves dense areas
14A	75%	25%	$412,000	Has some productive segments
14B	75%	25%	$437,000	Has some productive segments
15	100%	0%	$2,845,000	Currently productive
16	100%	0%	$4,446,000	Currently productive
17	100%	0%	$3,536,000	Serves dense areas
18	100%	0%	$2,531,000	Currently productive
20	100%	0%	$2,585,000	Serves dense areas
22	100%	0%	$1,752,000	Serves dense areas
23	100%	0%	$1,810,000	Serves dense areas
25	100%	0%	$4,350,000	Serves dense areas
28	100%	0%	$3,816,000	Serves dense areas
32	100%	0%	$2,168,000	Complements the LRT

Route	%Ridership	%Coverage	Annual Cost	Notes
33	100%	0%	$1,797,000	Currently productive
34	100%	0%	$4,576,000	Serves dense areas
37	100%	0%	$1,753,000	Currently productive
38	100%	0%	$2,457,000	Serves dense areas
40	100%	0%	$5,274,000	Serves dense areas
41	100%	0%	$2,210,000	Currently productive
43	100%	0%	$2,779,000	Currently productive
44	0%	100%	$1,189,000	Currently productive
45	0%	100%	$1,238,000	Currently productive
46	75%	25%	$3,174,000	Has some productive segments
47	75%	25%	$2,202,000	Has some productive segments
48	100%	0%	$1,877,000	Currently productive
49	50%	50%	$1,989,000	Unproductive but serves dense areas
50	100%	0%	$4,241,000	Serves dense areas
51	100%	0%	$2,392,000	Serves dense areas
53	100%	0%	$2,781,000	Currently productive
54	100%	0%	$4,486,000	Serves dense areas
55	100%	0%	$3,474,000	Serves dense areas
56	50%	50%	$2,010,000	Serves low density areas with potential
57	50%	50%	$2,952,000	Currently unproductive
58	75%	25%	$3,673,000	Currently productive, weak segments

Estimate of route purposes in the High Ridership Concept (continued)

Route	%Ridership	%Coverage	Annual Cost	Notes
61	100%	0%	$2,205,000	Serves dense areas
62	75%	25%	$2,779,000	Currently productive with weak segment
64	100%	0%	$2,697,000	Currently productive with weak segment
65	100%	0%	$1,328,000	Currently productive
66	100%	0%	$4,003,000	Currently productive
66p	100%	0%	$540,000	Rush hour route, high productivity
67	100%	0%	$2,957,000	Currently productive
70	0%	100%	$2,778,000	Currently unproduc-tive
71	75%	25%	$1,986,000	Currently productive with weak segment
72	100%	0%	$3,409,000	Currently unproduc-tive
73	50%	50%	$2,532,000	Few very strong segments
74	100%	0%	$1,572,000	Serves dense areas
75	75%	25%	$1,802,000	Few very strong segments
80	25%	75%	$2,579,000	Serves low density areas
83	0%	100%	$1,874,000	Serves low density areas
85	75%	25%	$1,700,000	Currently productive with weak segments
86	0%	100%	$3,413,000	Serves low density areas
87	0%	100%	$1,850,000	Serves low density areas
205	100%	0%	$1,752,000	Rush hour route, high productivity

Route	%Ridership	%Coverage	Annual Cost	Notes
206	100%	0%	$1,239,000	Rush hour route, high productivity
208	100%	0%	$1,554,000	Rush hour route
278	100%	0%	$684,000	Rush hour route, high productivity
533	100%	0%	$155,000	Rush hour route, high productivity
574	100%	0%	$519,000	Rush hour route, high productivity
702	100%	0%	$530,000	Currently productive
768	100%	0%	$361,000	Serves dense areas
803	75%	25%	$137,000	Serves mid density
822	100%	0%	$49,000	Shuttle serving medical center
823	100%	0%	$49,000	Shuttle serving medical center
824	75%	25%	$64,000	Galatyn Park Station Area shuttle
826	75%	25%	$92,000	TI Shuttle connecting parking lots
827	75%	25%	$92,000	TI Shuttle connecting parking lots
828	75%	25%	$92,000	TI Shuttle connecting parking lots
830	75%	25%	$37,000	Medical City shuttle
831	100%	0%	$17,000	Baylor Medical Center Shuttle
832	100%	0%	$17,000	Baylor Medical Center Shuttle
833	100%	0%	$17,000	Currently productive
883	100%	0%	$994,000	Service for UT Dallas
887	0%	100%	$266,000	Downtown Rowlett Shuttle

Estimate of route purposes in the High Coverage Concept (continued)

Route	%Ridership	%Coverage	Annual Cost	Notes
1	100%	0%	$3,218,000	Serves dense areas
3	100%	0%	$1,990,000	Serves dense areas
4	100%	0%	$3,271,000	Currently productive
5	100%	0%	$1,596,000	Serves dense areas
6	100%	0%	$3,311,000	Serves dense areas
6L	100%	0%	$992,000	Currently productive
7	100%	0%	$1,667,000	Serves dense areas
8	100%	0%	$1,666,000	Serves dense areas
10	100%	0%	$4,749,000	Serves dense areas
13	100%	0%	$3,431,000	Serves dense areas
14	75%	25%	$2,043,000	Has some productive segments
14p	75%	25%	$480,000	Has some productive segments
15	100%	0%	$2,143,000	Currently productive
16	75%	25%	$4,264,,000	Currently productive
17	75%	25%	$2,677,000	Serves dense areas
18	100%	0%	$2,531,000	Currently productive
20	100%	0%	$1,960,000	Currently productive
22	100%	0%	$1,758,000	Serves dense areas
25	75%	25%	$3,550,000	Currently productive
28	100%	0%	$3,772,000	Serves dense areas
30	100%	0%	$4,078,000	Currently productive

Route	%Ridership	%Coverage	Annual Cost	Notes
32	50%	50%	$969,000	Low boardings today
34	100%	0%	$3,530,000	Serves dense areas
37	100%	0%	$713,000	Currently productive
37A	75%	25%	$288,000	Serves low density
37B	100%	0%	$328,000	Currently productive
38	100%	0%	$1,313,000	Has some productive segments
40	75%	25%	$4,051,000	Serves some low density areas
41	100%	0%	$2,214,000	Currently productive
43	100%	0%	$2,460,000	Currently productive
44	0%	100%	$387,000	Currently unproductive
45	0%	100%	$414,000	Currently unproductive
46	75%	25%	$876,000	Has some productive segments
47	75%	25%	$1,084,000	Has some productive segments
48	75%	25%	$640,000	Has some productive segments
49	50%	50%	$908,000	Currently unproductive
50	100%	0%	$3,403,000	Serves dense areas
53	75%	25%	$1,261,000	Currently productive
54	100%	0%	$1,858,000	Serves dense areas
55	75%	25%	$2,457,000	Serves dense areas
57	25%	75%	$1,606,000	Serves some low density areas

Estimate of route purposes in the High Coverage Concept (continued)

Route	%Ridership	%Coverage	Annual Cost	Notes
58	75%	25%	$1,731,000	Serves some low density areas
61	75%	25%	$1,250,000	Serves some low density areas
64	25%	75%	$1,242,000	Unproductive with strong segment
65	75%	25%	$1,372,000	Currently productive with weak segment
67	75%	25%	$1,707,000	Currently productive
70	0%	100%	$1,942,000	Serves low density areas
71	25%	75%	$3,560,000	Serves low density areas
72	100%	0%	$3,240,000	Currently productive
73	50%	50%	$3,050,000	Few strong segments
74	75%	25%	$1,072,000	Weak segment
75	25%	75%	$2,225,000	Serves low density areas
80	25%	75%	$960,000	Currently productive with strong segment
83	0%	100%	$1,280,000	Serves low density areas
85	50%	50%	$1,733,000	Currently productive with weak segments
86	0%	100%	$1,737,000	Serves low density areas
87	50%	50%	$1,851,000	Serves low density areas
88	0%	100%	$2,206,000	Serves low density areas
89	0%	100%	$1,057,000	Serves low density areas
90	0%	100%	$424,000	Serves low density areas

Route	%Ridership	%Coverage	Annual Cost	Notes
91	0%	100%	$1,025,000	Serves low density areas
92	25%	75%	$684,000	Currently productive with strong segment
93	25%	75%	$1,671,000	Serves low density areas
94	0%	100%	$1,236,000	Serves low density areas
95	0%	100%	$437,000	Serves low density areas
96	0%	100%	$1,231,000	Serves low density areas
97	50%	50%	$1,276,000	Serves low density areas
98	50%	50%	$1,032,000	Stops with high boardings
99	0%	100%	$622,000	Serves low density areas
100	25%	75%	$1,174,000	Unproductive with strong segment
101	100%	0%	$690,000	Currently productive
101A	100%	0%	$493,000	Currently productive
101B	0%	100%	$602,000	Serves low density areas
102	25%	75%	$2,290,000	Serves low density areas
103	25%	75%	$1,327,000	Unproductive with strong segment
104	0%	100%	$385,000	Serves low density areas
105	0%	100%	$721,000	Serves low density areas
106	50%	50%	$277,000	Weak segments
107	50%	50%	$656,000	Weak segments

Estimate of route purposes in the High Coverage Concept (continued)

Route	%Ridership	%Coverage	Annual Cost	Notes
108	0%	100%	$798,000	Serves low density areas
109	0%	100%	$1,590,000	Serves low density areas
112	0%	100%	$582,000	Serves low density areas
113	25%	75%	$1,324,000	Unproductive with strong segment
114	0%	100%	$1,260,000	Serves low density areas
115	50%	50%	$933,000	Covers low density areas
116	25%	75%	$1,301,000	Has a strong segment
116A	0%	100%	$869,000	Serves low density areas
116B	0%	100%	$691,000	Serves low density areas
117	0%	100%	$1,037,000	Currently unproductive
118	75%	25%	$1,070,000	Currently productive with weak segment
119	0%	100%	$1,227,000	Serves low density areas
120	0%	100%	$664,000	Serves low density areas
121	0%	100%	$1,619,000	Serves low density areas
122	0%	100%	$624,000	Serves low density areas
123	0%	100%	$374,000	Serves low density areas
124	0%	100%	$930,000	Serves low density areas
125	0%	100%	$910,000	Serves low density areas
126	0%	100%	$429,000	Serves low density areas

Route	%Ridership	%Coverage	Annual Cost	Notes
127	0%	100%	$476,000	Serves non-dense areas
128	0%	100%	$1,742,000	Serves non-dense areas
129	0%	100%	$1,045,000	Serves non-dense areas
130	0%	100%	$931,000	Serves non-dense areas
131	0%	100%	$422,000	Serves non-dense areas
132	25%	75%	$332,000	Unproductive with strong segment
133	50%	50%	$656,000	Weak segments
134	100%	0%	$411,000	Currently productive
135	0%	100%	$339,000	Currently unproductive
136	0%	100%	$951,000	Currently unproductive
137	0%	100%	$1,245,000	Currently unproductive
206	100%	0%	$1,239,000	Rush hour route, high productivity
208	100%	0%	$1,554,000	Rush hour route, high productivity
278	100%	0%	$684,000	Rush hour route, high productivity
283	75%	25%	$1,545,000	Rush hour route, high productivity
524	75%	25%	$943,000	Currently unproductive with strong segments
594	0%	100%	$752,000	Currently unproductive
702	100%	0%	$530,000	Currently productive
768	100%	0%	$361,000	Serves dense areas

Estimate of route purposes in the High Coverage Concept (continued)

Route	%Ridership	%Coverage	Annual Cost	Notes
803	75%	25%	$137,000	Serves mid density areas
822	100%	0%	$49,000	Shuttle serving medical center
823	100%	0%	$49,000	Shuttle serving medical center
824	75%	25%	$64,000	Galatyn Park Station Area shuttle
826	75%	25%	$92,000	TI Shuttle connecting parking lots
827	75%	25%	$92,000	TI Shuttle connecting parking lots
828	75%	25%	$92,000	TI Shuttle connecting parking lots
830	75%	25%	$37,000	Medical City shuttle
831	100%	0%	$17,000	Productive Baylor Medical Center Shuttle
832	100%	0%	$17,000	Productive Baylor Medical Center Shuttle
833	100%	0%	$17,000	Currently productive
843	25%	75%	$128,000	South Plano Flex shuttle
883	100%	0%	$994,000	Service for UT Dallas

Route	%Ridership	%Coverage	Annual Cost	Notes
West Dallas	0%	100%	$156,000	Coverage GoLink zone
Expanded Park City	0%	100%	$66,000	Coverage GoLink zone
Expanded Lake Highlands	0%	100%	$39,000	Coverage GoLink zone
Expanded Rylie	0%	100%	$31,000	Coverage GoLink zone
South Garland	0%	100%	$161,000	Coverage GoLink zone
Glenn Heights	0%	100%	$78,000	Coverage GoLink zone
South Irving	0%	100%	$142,000	Coverage GoLink zone
East Irving	0%	100%	$102,000	Coverage GoLink zone
Cypress Waters	0%	100%	$186,000	Coverage GoLink zone
NW Carrollton	0%	100%	$128,0006	Coverage GoLink zone
Farmers Branch	0%	100%	$-	Coverage GoLink zone
Central Plano	0%	100%	$162,000	Coverage GoLink zone
Expanded N Central Plano	0%	100%	$97,000	Coverage GoLink zone
East Plano	0%	100%	$162,000	Coverage GoLink zone
East Telecom	0%	100%	$125,000	Coverage GoLink zone

Estimate of route purposes in the Existing Network

Route	%Ridership	%Coverage	Annual Cost	Notes
2	75%	25%	$1,481,000	Productive route serving low density
11	100%	0%	$4,280,000	Currently productive
12	50%	50%	$2,200,000	Unproductive segments
19	65%	20%	$3,069,000	Duplicating sections of route 81
21	0%	90%	$1,171,000	Duplicating sections of routes 81 and 82
24	100%	0%	$1,014,000	Currently productive
26	50%	50%	$1,486,000	Unproductive with strong segments
27	0%	100%	$318,000	Serves low density areas
29	50%	50%	$1,514,000	Unproductive with strong segments
31	25%	75%	$2,424,000	Currently unproductive
35	25%	75%	$1,417,000	Currently unproductive
36	75%	25%	$2,119,000	Serves dense areas
39	60%	20%	$1,012,000	Currently productive, duplication of 20% with route 31
42	0%	100%	$1,184,000	Serves low density areas
52	50%	50%	$1,810,000	Productive serving some dense areas
59	25%	50%	$1,340,000	Currently productive, duplication of 25% with route 52 and 59
60	25%	75%	$1,524,000	Serves non-dense areas
63	75%	25%	$1,014,000	Currently productive

Route	%Ridership	%Coverage	Annual Cost	Notes
76	75%	25%	$1,520,000	Productive serving unproductive segment
81	50%	50%	$1,415,000	Unproductive serving some dense areas
82	50%	50%	$1,197,000	Unproductive serving some dense areas
84	25%	75%	$2,172,000	Unproductive serving some dense areas
110	75%	25%	$1,560,000	Currently productive with weak segment
111	25%	75%	$1,241,000	Currently unproductive
155	25%	75%	$257,000	Productive serving some low density areas
161	45%	45%	$2,827,000	Currently unproductive with 10% of duplication
164	70%	20%	$3,641,000	Currently productive with 10% of duplication
183	75%	25%	$1,826,000	Currently productive serving some dense areas
205	25%	75%	$502,000	Rush hour route, high productivity
206	100%	0%	$1,239,000	Rush hour route, high productivity
208	100%	0%	$1,554,000	Rush hour route, high productivity
210	0%	100%	$618,000	Currently unproductive
211	0%	100%	$882,000	Currently unproductive
278	100%	0%	$684,000	Rush hour route, high productivity

Estimate of route purposes in the Existing Network (continued)

Route	%Ridership	%Coverage	Annual Cost	Notes
283	75%	25%	$1,545,000	Rush hour route, high productivity
333	25%	75%	$450,000	Currently unproductive
347	25%	75%	$1,192,000	Currently unproductive
350	0%	100%	$1,489,000	Currently unproductive
360	75%	25%	$1,260,000	Currently productive with weak segment
361	25%	75%	$791,000	Productive route serving low density
362	0%	100%	$955,000	Currently unproductive
372	50%	50%	$1,209,000	Productive route serving low density
374	25%	75%	$1,244,000	Currently productive with strong segment
376	0%	100%	$651,000	Serves non-dense areas
377	75%	25%	$472,000	Currently productive
378	75%	25%	$2,110,000	Currently productive
380	25%	75%	$452,000	Currently unproductive with strong segment
385	0%	100%	$548,000	Currently unproductive
401	100%	0%	$1,321,000	Currently productive
402	75%	25%	$2,401,000	Productive route serving low density
403	75%	25%	$2,430,000	Currently unproductive
404	75%	25%	$5,031,000	Currently productive with weak segments
405	75%	25%	$2,829,000	Serves dense areas

Route	%Ridership	%Coverage	Annual Cost	Notes
408	100%	0%	$2,229,000	Currently productive
409	75%	25%	$2,737,000	Currently productive
410	75%	25%	$1,702,000	Currently productive
415	0%	100%	$1,315,000	Serves non-dense areas
428	75%	25%	$3,095,000	Currently unproductive serving dense areas
444	25%	75%	$1,911,000	Currently unproductive
445	100%	0%	$1,204,000	Currently productive
451	75%	25%	$1,759,000	Currently productive
452	25%	75%	$1,307,000	Currently unproductive
463	100%	0%	$2,053,000	Currently productive
466	75%	25%	$4,426,000	Currently productive serving weak segment
467	100%	0%	$3,860,000	Currently productive
475	50%	50%	$2,163,000	Currently unproductive serving dense areas
486	100%	0%	$2,792,000	Currently productive
488	50%	25%	$2,098,000	25% Duplication with route 486
500	0%	100%	$544,000	Currently unproductive, serves non-dense areas
501	50%	50%	$1,645,000	Currently productive serving weak segment
502	75%	25%	$1,040,000	Currently productive, weak segment

Estimate of route purposes in the Existing Network (continued)

Route	%Ridership	%Coverage	Annual Cost	Notes
504	25%	75%	$618,000	Currently unproductive
505	0%	100%	$618,000	Currently unproductive
506	75%	25%	$1,265,000	Currently productive
507	25%	75%	$476,000	Currently unproductive with strong segment
508	0%	100%	$430,000	Currently unproductive
509	0%	100%	$643,000	Currently unproductive
510	0%	100%	$838,000	Currently unproductive
513	0%	100%	$582,000	Currently unproductive
514	50%	50%	$675,000	Currently unproductive serving dense areas
515	0%	100%	$1,103,000	Currently unproductive
516	0%	100%	$605,000	Currently unproductive
521	25%	75%	$725,000	Currently unproductive
522	50%	50%	$1,023,000	Currently unproductive serving strong segments
524	75%	25%	$950,000	Currently unproductive with strong segments
525	0%	100%	$581,000	Currently unproductive
526	50%	50%	$483,000	Currently productive serving low dense areas
527	75%	25%	$899,000	Currently productive
528	0%	100%	$948,000	Currently productive serving low density
529	0%	100%	$1,017,000	Currently unproductive
531	25%	75%	$879,000	Serving non-dense areas
532	0%	100%	$438,000	Currently unproductive
533	50%	50%	$155,000	Currently productive serving low density
534	75%	25%	$1,660,000	Currently productive
535	75%	25%	$1,775,000	Currently unproductive serving dense areas
536	25%	75%	$504,000	Currently unproductive
538	50%	50%	$1,386,855	Productive serving low density
541	25%	75%	$1,111,000	Currently unproductive
542	0%	100%	$809,000	Currently unproductive
544	25%	75%	$1,635,000	Currently unproductive
547	0%	100%	$1,624,000	Currently unproductive
549	75%	25%	$1,752,000	Currently productive
551	100%	0%	$520,000	Currently productive
553	75%	25%	$350,000	Currently productive serving low density
554	75%	25%	$1,491,000	Currently productive serving low density
555	0%	100%	$304,000	Currently unproductive
560	25%	75%	$457,000	Serves strong segment

Estimate of route purposes in the Existing Network (continued)

Route	%Ridership	%Coverage	Annual Cost	Notes
566	25%	75%	$423,000	Currently unproductive
568	25%	75%	$1,488,000	Currently unproductive
571	25%	75%	$1,055,000	Currently unproductive
574	0%	100%	$519,000	Serves low density
582	0%	100%	$734,000	Currently unproductive
583	100%	0%	$3,270,000	Currently productive
585	0%	100%	$750,000	Currently unproductive
591	0%	100%	$574,000	Currently unproductive
592	100%	0%	$1,691,000	Currently productive serving low density
593	100%	0%	$1,334,000	Currently productive serving low density
594	0%	100%	$740,000	Currently unproductive
595	0%	100%	$1,336,000	Currently unproductive
597	25%	75%	$1,726,000	Currently unproductive
702	100%	0%	$367,000	Currently productive
749	100%	0%	$926,000	Serves dense areas
768	100%	0%	$361,000	Serves dense areas
803	75%	25%	$137,000	Serves mid density
822	100%	0%	$49,000	Shuttle serving medical center
823	100%	0%	$49,000	Shuttle serving medical center

Route	%Ridership	%Coverage	Annual Cost	Notes
824	75%	25%	$64,000	Galatyn Park Station Area shuttle
826	75%	25%	$92,000	TI Shuttle connecting parking lots
827	75%	25%	$92,000	TI Shuttle connecting parking lots
828	75%	25%	$92,000	TI Shuttle connecting parking lots
830	75%	25%	$37,000	Medical City shuttle
831	100%	0%	$17,000	Productive Baylor Medical Center Shuttle
832	100%	0%	$17,000	Productive Baylor Medical Center Shuttle
833	100%	0%	$17,000	Currently productive
840	0%	100%	$419,000	Irving Shuttle
841	25%	75%	$280,000	Telecom Corridor Flex shuttle
843	25%	75%	$128,000	South Plano Flex shuttle
870	0%	100%	$532,000	East Plano Flex Shuttle
883	100%	0%	$994,000	Service for UT Dallas
887	0%	100%	$266,000	Downtown Rowlett Shuttle

Estimate of route purposes in the Existing Network (continued)

Route	%Ridership	%Coverage	Annual Cost	Notes
Far North Plano	0%	100%	$295,000	Coverage GoLink zone
Inland Port	0%	100%	$222,000	Coverage GoLink zone
Kleberg	0%	100%	$374,000	Coverage GoLink zone
Legacy West	0%	100%	$586,000	Coverage GoLink zone
North Central Plano	0%	100%	$477,000	Coverage GoLink zone
Rowlett	0%	100%	$497,000	Coverage GoLink zone
Rylie	0%	100%	$164,000	Coverage GoLink zone
Farmers Branch	0%	100%	$91,000	Coverage GoLink zone
Glenn Heights	0%	100%	$78,000	Coverage GoLink zone
Lake Highlands	0%	100%	$83,000	Coverage GoLink zone
Lakewood	0%	100%	$80,000	Coverage GoLink zone
North Dallas	0%	100%	$97,000	Coverage GoLink zone
Park Cities	0%	100%	$67,000	Coverage GoLink zone

G Glossary

Access	The number of jobs or residents reachable from a starting location by transit and walking. Access is often calculated for many starting points in a network, based on some assumed travel-time "budget," and summarized on a map.
Arterial road	A high-capacity through road.
Circulator	Circulator is often used to describe a service that provides transit coverage to a low-density area, because the travel paths that result are so often circular in shape. In some places a circulator is also operated downtown. Large circular transit routes that offer high speed or high frequency and serve high demand areas, however, are generally referred to as loops.
Commuter express service	An FTA designation that distinguishes between fixed routes that must be supplemented by paratransit, and fixed routes that may not. From the FTA's website: "Commuter bus service means fixed route bus service, characterized by service predominantly in one direction during peak periods, limited stops, use of multi-ride tickets, and routes of extended length, usually between the central business district and outlying suburbs. Commuter bus service may also include other service, characterized by a limited route structure, limited stops, and a coordinated relationship to another mode of transportation." http://www.fta.dot.gov/12876_3906.html
Connection	A connection or transfer takes place when a person uses two transit vehicles to make a trip.
Coverage	Coverage can refer to the amount of geographic space, the proportion of people or the proportion of jobs that are within a certain distance of transit service. An assumption about how far people will walk to a given transit service—often ranging from 1/4 to 1/2 mile—must be made in order to estimate coverage.
Deadhead hours	The time a vehicle spends between the garage and the start or end of revenue service, or between the end of a trip on one route and the beginning of a trip on another route.
Dial-a-ride	Demand response service, usually requires booking a day in advance, over the phone.
Express	Express can have a range of meanings when applied to transit. It most often describes a route with a long non-stop segment. It can also be used to describe a route with wide stop spacing and overall faster speeds, though that is more commonly called a rapid.
Farebox recovery	Farebox recovery is a measure of how much of a transit system, network or route's operating cost is recovered through fares. It is often expressed as a percentage. Typical U.S. farebox recovery rates range from 5% to 30% in the largest and densest cities.
Feeder	A local route that connects or feeds into a radial route. Low-frequency feeders sometimes pulse so that transferring is more convenient
Fixed route transit	Fixed route transit describes any transit service that is operated on the same predictable route. In contrast, paratransit and demand-responsive service may always or often follow different routes for each vehicle trip, as they serve different customers and their trips.
Frequency	Frequency is often expressed in minutes, i.e. a service that comes every 15 minutes has "15 minute frequency." A more technical term for frequency is headway.

Grid Network	A network of routes that intersect all over the city. Grid networks are best suited for places with many activity centers, as opposed to radial networks, where most people are traveling to a central location. Grid networks require high-frequency to make transfers short, reliable and convenient.
Headway	Headway is the time between successive trips at a stop, a more technical transit term for frequency. A service that comes every 15 minutes can be said to have a "15 minute headway."
Investment	Service or revenue hours per capita, a measure of the relative level of transit service.
Isochrone	An illustration to help visualize where someone can go from a location, in a certain amount of time, using transit or by walking.
Land use	Land use describes the way a parcel of land is being used, for example as commercial, industrial or multi-family residential. Land use descriptions can be general or very specific. Land use is distinct from zoning, as land may be rezoned under existing uses and buildings long before changes to its use take place.
Layover	Time for driver breaks between trips. Usually included in revenue hours. Unlike recovery time, layover time sometimes cannot be skipped even when a bus is behind schedule, if drivers are guaranteed a break. Layover time can also be designed to include time for a "pulse" connection with other routes. Layover time is an essential part of the service offering on a route, because it ensures the driver is able to function reliably and may support a pulse. In some agencies, "layover" and "recovery" are used synonymously or interchangeably to mean the same thing.
Longline	Some routes have a more frequent inner segment and a less frequent outer segment. At the end of the inner segment, some buses turn around and come back, while others continue on to a more distant turnaround point. The outer, less-frequent segment is often called the "longline," though technically the longline is the longest path that buses on that route travel, and its length is the inner segment plus the outer segment. The inner segment is called the "shortline."
Microtransit	Demand response service, like dial-a-ride, but usually distinguished by same day or instant booking, often with an app.
Mobility	Mobility is generally used to express the ease with which people can move from place to place. It is distinct from access, which describes the extent to which people can meet their needs nearby. In some places, people have high access (they are able to meet all of their needs without traveling very far or at all) and low mobility (because traveling long distances is difficult or slow). In other places, mobility is high and access is low.
Mode share	Mode share is a technical term for the percentage of a population that uses a particular mode (e.g. transit, walking, driving) for traveling. Mode share information in the U.S. is generally reported for commute trips.
National Transit Database	The National Transit Database is a federal clearinghouse of general information about transit in the U.S. and information specific to each transit agency. Agencies of a certain size are required to submit financial and performance data to the NTD each year. https://www.transit.dot.gov/ntd/
One-seat-ride	A trip that requires boarding only one transit vehicle (no transfers).

Paratransit	Paratransit is a transit service that provides on-demand curb-to-curb travel for people with disabilities, per the American's with Disabilities Act. It is required by this U.S. law to be provided to people who have a disability that prevents them from using fixed route transit service, within 3/4 mile of fixed route transit, during all times when fixed route transit is operating.
Peak	In some places, two peaks of travel (and transit) demand take place each day: in the morning and afternoon, as people travel to and from work and school. However, in many places travel demand peaks only once, in the midday or afternoon, as service shifts change and students leave school.
Peak-only	A transit service that is peak-only operates only during the morning and afternoon travel peaks.
Productivity	The word productivity is often used in transit to describe the number of people served per unit of cost. Productivity can be expressed for an entire transit system, a subset of the system, individual lines or even for segments of lines.
Pulse	A pulse takes place when two or more transit services arrive together at the same place at the same time, so that their passengers may transfer among them with minimal waiting.
Radial	A route or network design where most routes go to and from a central point (typically a downtown). As opposed to a grid network.
Rapid	Rapid can have a range of meanings when applied to transit. It most often describes a route with wider stop spacing and overall faster speed.
Recovery time	Extra time built into a schedule to protect a route's on-time performance in case of unexpected delays. Unlike layover, which is a driver's break time, recovery time can be cut short so that the next trip can depart on-time. In some systems, recovery time includes time used to make a "pulse" connection with other routes. Recovery is an essential part of the service offering on a route, because it contributes to the route's reliability and to connections with other routes, and it also reduces the effective speed of the route. In some agencies, "layover" and "recovery" are used synonymously or interchangeably to mean the same thing.
Relevance	Boardings per capita, a measure of how relevant transit is to the population it serves.
Revenue hours	The time a transit vehicle and its operator spend out in public, available to passengers and (potentially) collecting revenue. Usually includes layover and recovery time, but excludes deadhead.
Ride check	The National Transit Database requires that transit agencies regularly sample on all of their services to collect ridership and on-time performance information. This is often performed using surveyors on transit vehicles, though increasingly it is performed by automated counters and GPS devices on transit vehicles. It is sometimes called a ride check.
Ridership	Ridership refers informally to the number of boardings or trips taken on a transit system or a particular transit service.
Shortline	Some routes have a more frequent inner segment and a less frequent outer segment. At the end of the inner segment some buses turn around and come back, while others continue on to a more distant turnaround point. The outer, less-frequent segment is often called the "longline," though technically the longline is the longest path that buses on that route travel, and its length is the inner segment plus the outer segment. The inner segment is called the "shortline."
Span	The span of a transit service is the number of hours it operates during the day, e.g. a service that runs from 6:00 am to 11:30 pm would have a 17.5 hour span. Span can also describe the number of days per week and per year that a service is operated.
Street connectivity	The degree to which streets connect to one another, and multiple paths exist between any two points, is describe as that place's connectivity. Areas with many cul-de-sacs or loops and few through routes have low connectivity; areas with grid-like street patterns have high connectivity. Low connectivity discourages trips by slower modes (such as walking or bicycling), and presents challenges for transit routing.
Transfer	When a person uses more than one transit vehicle to make a trip, they transfer in between vehicles. This is also often called a connection.
Transit dependency	If a person has a severe need for transit, due to a disability or to lack of access to an automobile, they are often referred to as transit dependent. However, transit dependency is in fact a spectrum, not a category. People with disabilities and people without their own cars may have access to rides or taxis, but the extent to which they use those rides may depend on the availability and quality of transit service.
Transit orientation	As with transit dependency, transit orientation is a spectrum, not a category. People who are living or working around higher activity densities, in places where walking to transit is safe and appealing, or who do not have easy access to an automobile may have some degree of transit orientation. Transit orientation can exist among poor and affluent populations alike.
Tripper	A tripper is a special type of transit service that makes only a few or a single trip each day. Transit agencies often send one or more trippers to relieve crowding on certain routes, or to provide direct service where none exists at other hours. Trippers often run at the start and end of school days or work shifts.
Vehicle hours	The time during which a transit vehicle is away from the garage, whether providing revenue service (represented by "revenue hours"), driving between the garage and the start or end of service (represented by "deadhead hours") or in layover and recovery time.