Transit Choices Report
JANUARY 2019

For Chatham Area Transit

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1 Introduction and Summary
Purpose of this Report
This report is written to help people understand how transit is currently working in the Savannah area and the choices that will need to be made about it in the future.

This is the first step in a planning process that will generate a new transit System Redesign for Chatham Area Transit (CAT).

The CAT System Redesign will be focused on the fixed route network. Fixed routes are scheduled services that come at a predictable time, ridden by people who are making different kinds of trips to different places.

This planning effort may cause CAT to consider changing or adding demand response services such as paratransit, dial-a-ride, app-enabled dial-a-ride (“microtransit”), or subsidies for hired cars. However, the focus is intentionally on the design of the fixed route network, which has a very specific role to play in the success of urban places.

Reasonable people can disagree about the purpose of transit in their own community. Transit can deliver many different outcomes, but some of these outcomes trade-off against others.

For a transit agency like CAT, learning how the community values differ—ent outcomes is an essential step in deciding where to run service, what kind of service to run, and how to define success. This report explains some of those trade-offs and helps the reader identify which choices are most consistent with his or her own values for transit.

The anticipated timeline for this process is:
- Winter 2019: Community input on key choices for the future.
- Spring 2019: Community review of new transit network concepts.

Anticipated Timeline for the Let’s Go! System Redesign

Winter 2019
- Transit Choices Report
- Public Input on Key Choices
- Develop Network Concepts
- Public Input on Network Concepts
- Draft Redesigned Network
- Public Input on Draft Redesigned Network
- Final Redesigned Network
- Potential Implementation of Redesigned Network

Spring 2019
- Winter 2019/2020: Community review of a draft System Redesign for CAT.
- 2020 or 2021: Potential implementation of the new System Redesign.

Fall 2019
- At each phase of this process CAT staff and the consulting team will engage the public, current transit riders and community stakeholders in multiple ways:
  - In-person outreach at transit stops and community events.
  - Online and paper surveys.
  - Consultation with a committee of major stakeholders.
  - Public open-house meetings.

General information and details on the latest events is posted at LetsGo.CatchaCAT.org.

CAT’s Existing Services
Today, CAT serves a portion of Chatham County:
- The City of Savannah
- Unincorporated Chatham County
- Select taxpaying parcels in Garden City

The jurisdictions that are not in CAT’s service area (meaning that they do not contribute tax revenues nor do they receive service) are:
- Pooler
- Tybee Island
- Thunderbolt
- Vernonburg
- Bloomingdale
- Port Wentworth
- Most of Garden City
- Primarily choice-oriented transit services.

In July 2017, the Chatham County Commission legislated that CAT may provide service county-wide and the county may assess and collect tax revenues county-wide. As of December 2018 the CAT service area was still a subset of the county. Additional legislative action must be taken by the state General Assembly before transit tax revenue can be collected county-wide. State legislators are scheduled to take up this matter in January 2019.

Only CAT’s general transit services are part of this System Redesign. Services paid for by other agencies, but operated by CAT, are up to the funding agency to evaluate and design. These contracted services are:
- The DOT Forsyth and DOT Downtown Loop routes, funded by the City of Savannah.
- The SSU campus shuttle, funded by Savannah State University.

While information about these contracted routes is included in this report, they will not be redesigned as part of this process.
Transit’s Many Goals

Transit can serve many different goals. It is not possible to excel towards all these goals at the same time. In addition, reasonable people will disagree about which of these goals is most important.

Understanding which goals matter most in the Savannah area is a key step in updating the CAT transit network.

Possible goals for transit include:

- **Economic**: Transit can give businesses access to more workers, workers access to more jobs, and students access to education and training.
- **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 various situations of disadvantage, providing them with access to support services and opportunity.
- **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. The social contact people gain on transit can also contribute to positive health outcomes.
- **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, the environmental benefits of transit only arise from many people riding the bus rather than driving. The same is true of some economic and health outcomes. We call such goals “ridership goals” because they are achieved through high ridership.

Other goals are served by the mere presence of transit. A bus route through a neighborhood provides residents insurance against isolation, even if few people ride it. A route may fulfill political or social obligations, for example by getting service close to every taxpayer or into every political district. We call these types of goals “coverage goals” because they are achieved by covering geographic areas with service, regardless of ridership.

High Ridership is Not CAT’s Only Goal

If CAT wanted to maximize transit ridership, it would focus its network around the busiest places where the greatest numbers of people live and work.

If CAT did this, the agency would be acting more like a business: delivering the best service in places with the most potential customers.

Businesses are under no obligation to spread their services around widely. In fact, they tend to avoid spending a lot of money to reach only a few customers.

For example, McDonald’s is not obliged to provide a restaurant within 1/2 mile of everyone in Chatham County. If it were, then the company would have to add hundreds of additional locations. Some locations would serve just a handful of homes, and most would operate at a loss because there are so few customers nearby.

People understand that less-inhabited areas will naturally have fewer McDonald’s restaurants than more-inhabited areas. We don’t describe this as McDonald’s being unfair to places where few people live; they are just acting like a private business. McDonald’s has no obligation to cover all areas with its restaurants.

Transit agencies are not private businesses. Most transit agencies decide that they do have some obligation to cover places with fewer people in them even when this would not be a “good business decision.”

The officials who ultimately 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. This is why transit agencies rarely act like private businesses.

Transit agencies are often accused of failing to maximize ridership, as if that were their only goal. In fact, most agencies are intentionally operating some coverage services that are not expected to generate high ridership.

Figure 1: Is an empty bus failing? That depends on why you are running it. High ridership isn’t transit’s only goal.
Modest Decline in Ridership Despite Stable Investment

The amount of transit service provided per capita in the Savannah area has remained fairly stable over the past ten years. Ridership has also been fairly stable, though with a large dip in 2009, due to the Great Recession, and with a decline starting in 2015.

The graph at right shows productivity for CAT and seven peer agencies. Productivity is ridership relative to service levels. Productivity answers the question: For every hour that CAT sends a bus and driver out on a route, how many people, on average, choose to ride it?

As of 2017, the end of the time period shown in this graph, CAT was in the middle of these peer agencies in terms of productivity. However, CAT staff have observed larger declines in ridership in 2018. In particular, ridership declines in 2018 have been greater on general public services than on CAT’s contracted services (the DOT and SSU routes).

All of the peer agencies shown in the graph at right saw a decline in productivity from 2015 to 2017, and for some of them the decline started much earlier. Why would productivity be falling, even as CAT (and other agencies) have held service levels constant?

While no one explanation suffices, and every community is different, a couple of nationwide trends probably explain most of the post-2015 decline in ridership:

• The very low costs of purchasing and driving cars, from a combination of historically-low interest rates and low gas prices, made it easier for lower-income people to buy and maintain cars.

• High employment, in combination with low car costs, has allowed more people to add a car to their household.

• The distances between jobs and housing continue to grow, as many cities (including Savannah) continue to sprawl outward. Longer distances force transit agencies to offer less-frequent or more expensive services, which are less attractive to potential riders.

• Increasing desirability, property values and rents in pre-war inner city neighborhoods has forced lower income residents to move farther from the center of transit networks in many cities (including Savannah). Some of the people with the greatest incentive to use transit are therefore moving away from the places where transit can be most useful.

• As these factors have made private and shared cars more appealing and more affordable, very few transit agencies have updated their bus networks with the aim of making transit more competitive. While car-based options have changed and adapted a great deal, transit offerings have not.

The effects of Uber and Lyft on national transit ridership, and on CAT transit ridership, is unclear. The latest research suggests that, on average across all U.S. transit agencies, there is no effect on transit ridership of adding Uber or Lyft to a city’s transportation offerings. However, the national average is not really helpful, because our nation’s cities, suburbs and transit networks are so different from one another.

Only two major U.S. cities (Seattle and Houston) saw gains in transit ridership from 2015 to 2016. These cities are much too big to compare to Savannah, so they are not included in the graph above. Both of these cities implemented major redesigns of their transit networks, and prioritized investments in faster and more reliable transit, starting in 2015.

Could CAT Increase Ridership?

Many factors that govern transit ridership are outside of the control of a transit agency but CAT does have power over a few factors that govern how much ridership it can attract within its fixed budget:

• How much of its investment is concentrated in services that get the highest ridership relative to their cost?

• How is transit service made appealing to potential riders?

• How do transit fares compare to the costs of other options (such as parking a car, or riding Uber or Lyft)?

• How well do transit fares work with the structure of the network?

CAT has already made decisions about the last two questions. CAT transit fares are fairly low compared to fares at peer agencies. While the CAT network does require transfers between routes for many cross-town trips, transfers are completely free. Free transfers encourage higher ridership, because they allow people to go many more places than they could on a single route for a single fare.

It is not a given that CAT should take all possible steps to increase transit ridership because doing so would trade-off against other outcomes that are important to people. This trade-off, and others, are described in detail in this report so that a reader can come to his or her own conclusion about whether CAT should try to attract more ridership than it does today.
Conflicting Goals

On page 5 we described why most transit agencies offer services that do not attract high ridership relative to their costs. These services provide “coverage,” and their mere presence (rather than their ridership) is important to many people.

Ridership and coverage goals are both laudable, but they lead transit planners 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 neighborhood at right the little dots indicate dwellings and commercial buildings and other land uses. The lines indicate roads. Most of the activity in the neighborhood is concentrated around two roads, as in most towns.

A transit agency 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 straight routes feel direct and fast to customers. Because service is concentrated onto fewer routes frequency is high and a bus is always coming through the neighborhood soon. This results in a network like the one at bottom-left.

If the transit agency 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, requiring long waits, even in the busiest places.

On a fixed budget, designing transit for both ridership and coverage is a zero-sum game. Each bus that the transit agency 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.

- In this imaginary neighborhood, 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 even need to consult a schedule to catch a bus.

- 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 fictional neighborhood.

The dots scattered around the map are people and jobs.

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

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

![Figure 3: Ridership and coverage goals, both laudable, are in direct conflict within a fixed budget.](image-url)
“When” Matters As Much As “Where”

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

The “when” aspect of transit service is:

- “Frequency” or “headway.” How many minutes are there between each bus? How long of a wait is required?
- “Span” or “duration.” How many hours of the day is service running? Does it run on weekends? Holidays?

Low frequencies and short spans are one of the main reasons that transit fails to be useful because it means service is simply not there when the customer needs to travel.

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.

Frequency is especially important for transit lines that go only a short distance. For short trips, time spent waiting can be more than time spent riding!

This is why short routes and small circulators, like the City of Savannah’s DOT routes (shown in red in the map on the next page), have to come very frequently in order to attract many riders.

Frequency and Waiting Time

In order to think about whether any frequency is “frequent enough” imagine waiting one-half of the frequency, on average (since statistically, you will). For example, if a bus comes every 60 minutes, your average wait will be 30 minutes. 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.

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. 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.
Existing CAT Network

The map at right shows CAT’s existing network within downtown and midtown, with every route color-coded based on its frequency during midday on a weekday.

A map of the entire CAT transit network is shown on the next page.

Only three CAT bus routes offer frequent service, and they are all contracted services, paid for by another agency.

- The frequent DOT routes are designed and paid for by the City of Savannah. They come every 10 minutes, and are shown in red in the map at right.
- CAT also operates a frequent route on SSU campus, paid for by SSU. It comes every 10 minutes on school days, and is shown in red on the map on the next page.

All of CAT’s general transit routes come every 30- or 60- minute, or make just a few trips per day.

The DOT routes are designed for trips only within the historic district. They are designed to be useful to tourists, travelers, people who work downtown, and people who live downtown. They are not expected to be useful for longer trips, into and out of downtown or across the city or county. The City’s DOT routes are an example of a more specialized service. In their case, they are specialized for short trips within downtown.

Another example of specialization is CAT’s 100X airport express, visible on the map on the next page. The 100X is designed only for trips to and from the airport (nowhere else along the way), and priced to work for travelers, not for airport workers. One of the key choices facing CAT is whether to divide its general transit budget into more specialized services like the 100X, or to design more routes that are broadly useful to many different kinds of people for different kinds of trips.

Another key choice for CAT to consider is how to space parallel routes in the area shown at right. Within midtown and downtown, there are numerous north-south routes running on parallel streets, some of them quite near to one another.

If service were consolidated into fewer parallel routes, then CAT could offer higher frequencies and longer spans (hours and days of service). However, offering fewer parallel routes means asking some people to walk further to reach a bus stop. This is a choice to consider for the midtown and downtown areas of Savannah. Are short walks to a downtown-bound bus route more valuable than shorter waits for service, or longer spans of service at night and on weekends?

Figure 4: The transit network in downtown and midtown is shown here, with each route color-coded based on its midday weekday frequency. The City’s DOT routes are the only frequent services in the area.
All routes that come downtown (except for the DOT routes) gather at the Joe Murray Rivers, Jr., Intermodal Transit Center, which is also the Greyhound bus station.

In low-frequency transit networks it is common for routes to gather at a central station for a regular “pulse” or timed connection, so that people can transfer between routes without a long wait. Only certain CAT routes pulse at the downtown transit center today. For more information about pulsing, and how it might be used in the CAT network, see page 41.

The map at right shows the entire CAT network. Most routes come every 30- or 60-minutes, or even less frequently. Many include one-way loops and deviations that make it hard to decipher where the route goes and when. While CAT’s service area is not countywide, it is still very large relative to the agency’s budget for transit service. In order to cover much of the service area, CAT has divided its budget into many routes, nearly all of them with low frequencies and short spans of service.

Figure 5: This map shows the entire CAT network, with routes color-coded by their midday weekday frequency.
Short Spans, Especially on Weekends

The table above summarizes each route’s existing frequency and span of service.

While the maps on the previous pages showed the weekday network, this graphic makes it clear how much less service is available on Saturdays and Sundays:

- Some bus routes don’t run at all on weekends (Routes 11 and 20).
- Two routes run on Saturdays but not Sundays ( Routes 4 and 28).
- Spans of service on Sundays are very short, with only one route running past 8 pm.

These statements are mostly not true of the City’s DOT routes, which offer a consistent 10-minute frequency all seven days of the week. Consistent all-week frequency is often part of a high-ridership strategy. However, the DOT routes don’t start service until 10 am on weekends, which is likely because they designed with visitors and weekday office workers in mind. Anyone working downtown on the weekends (perhaps serving brunch to the visitors) reports to work much earlier than 10 am.

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. Yet, people need to travel at all times of day and week. Service workers tend to work from very early in the morning to midday, or from midday to late at night. 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 is not useful to service workers.

In addition, anyone taking an evening class, pursuing a hobby, going to worship, or staying late at work to finish a report needs a bus ride home outside of the traditional 8-to-5 workday.

When transit agencies cut late-night and weekend service (often their first resort, during budget crises), they typically see ridership losses at all other times of the week. The inverse is also true: transit agencies that restore late night and weekend service see ridership gains, as more households forgo cars because the transit network is there for them whenever they need it.
# Development Decisions Affect Ridership

Achieving high ridership requires more than clean, comfortable or even frequent service. Many factors outside the control of CAT—land use, development, urban design, street networks—strongly affect transit’s usefulness. This is why land use planning by cities and counties is such an essential part of transit’s success.

If CAT 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, in turn, can arrange development in patterns that CAT can reach with useful, frequent transit, for a reasonable operating cost.

The way that CAT could attract higher ridership, within a fixed budget, is by targeting places where the “Ridership Recipe” is in effect:

- **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 CAT to operate, easier to understand and more appealing to customers.
- **Proximity**: Shorter distances between destinations attract more riders per hour and are cheaper for CAT to operate.

These are geometric facts of a city 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 a lot of people around, and can they get to the transit stop?”
- **Linearity and proximity tell us about both ridership potential and 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)?”

Though it is not one of the four major factors named in the Ridership Recipe, the mix of uses along a corridor 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 neighborhoods 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.

For this reason, the area between downtown and Montgomery Cross Road (along Waters, Abercorn and Montgomery) has high ridership potential. Not only does it offer linear streets, with many people and jobs nearby, but people travel in both directions, at all times of day and week, among downtown, midtown and the malls. This means that CAT’s buses in midtown are used both inbound and outbound, most hours of the week.

The “Ridership Recipe”: Signs of High Ridership Potential

<table>
<thead>
<tr>
<th><strong>Density</strong></th>
<th>How many people, jobs, and activities are near each transit stop?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Many people and jobs are within walking distance of transit.</td>
</tr>
<tr>
<td></td>
<td>Fewer people and jobs are within walking distance of transit.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Walkability</strong></th>
<th>Can people walk to and from the stop?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The dot at the center of these circles is a transit stop, while the circle is a 1/4-mile radius.</td>
</tr>
<tr>
<td></td>
<td>It must also be safe to cross the street at a stop. You usually need the stops on both sides for two-way travel.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Linearity</strong></th>
<th>Can transit run in reasonably straight lines?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A direct path between any two destinations makes transit appealing.</td>
</tr>
<tr>
<td></td>
<td>Destinations located off the straight path force transit to deviate, discouraging people who want to ride through, and increasing cost.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Proximity</strong></th>
<th>Does transit have to traverse long gaps?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short distances between many destinations are faster and cheaper to serve.</td>
</tr>
<tr>
<td></td>
<td>Long distances between destinations means a higher cost per passenger.</td>
</tr>
</tbody>
</table>

Figure 6: These four land use factors have an enormous influence over how much ridership transit can attract, and how much transit an agency can provide.
High ridership satisfies many of the goals that people typically hold for transit, but some goals are satisfied by the simple proximity of transit, regardless of ridership.

Even if few people in a neighborhood ride a transit service, they may still value it as a sort of “insurance” against isolation if their car breaks down, or if they become unable to drive. The small numbers of people who ride the service may have severe needs for transit, perhaps because they have little income, are too young to drive, or have a disability that prevents them from driving. One neighbor might describe this service as “failing” because it doesn’t get much ridership relative to its costs, but the goals it serves do not relate to its ridership. It is serving coverage goals, which may be highly valued by other people in the community.

The chart at right reports how much coverage is provided by the existing CAT network, to residents and jobs within the CAT service area.

This chart measures proximity to any service (including weekday and rush-hour only service), as well as to frequent service. The distinction is important because frequent service is most likely to attract high ridership relative to its cost.

Only 4% of residents are within 1/4 mile of frequent service – those are the people who live in downtown and midtown, near the City’s DOT routes. A much larger proportion – 44% – are within 1/4 mile of some kind of service, either frequent or infrequent.

A greater proportion of minority residents are close to some kind of service than are all residents – 53% compared to 44%.

A much greater proportion of low-income residents are close to some kind of service than are all residents – 61% compared to 44%. In addition, low-income residents are more likely to be close to frequent service, which is reflective of the number of low-income people who live downtown near the DOT routes.1

However, note that the demographic data used for this analysis is somewhat stale: it is based on a 2016 sample that is less accurate than the full Census, which was last performed in 2010. In addition, low-income residents include college and university students, many of whom are living only temporarily on low incomes, and have family resources they can draw on if need be. Finally, this analysis counted only residents and jobs within CAT’s existing service area.

Far more jobs than residents are close to frequent service, as shown in the chart at right. This is because jobs are so much more concentrated and centralized in downtown than are residents. The City’s DOT routes were designed partly in response to this job density. They help people working downtown make short trips within downtown. One fifth (21%) of the jobs in the CAT service area are near one of the City’s frequent DOT routes, or the frequent SSU campus route.

The only frequent routes in Savannah are very short. They can help with travel to and from social outings, meetings, classes, or parked cars, but they cannot help most people make the longer trip between home and work or home and campus.

Growth patterns in Chatham County have been reducing, rather than increasing, the number of residents and jobs near transit. The maps starting on page 46 show that much of the growth in the County has been far from the existing transit network, and far from places where transit is cost-effective to provide. Even if CAT is given the authority and the funding to provide service county-wide, job and residential developments that are long distances from one another will be expensive to reach even with minimal transit.

1 Maps with information about where people in poverty live are shown on page 23 and page 24.
Key Choices

Walking or Waiting?
In the downtown and midtown parts of the City of Savannah, the historic street grid offers many parallel paths. As many as seven north-south routes run down these parallel streets, none of them at high frequencies or with long spans of service.

Within a fixed budget, increasing frequency or lengthening spans requires consolidating service into fewer routes. But this increases walking distances. In places like midtown and downtown, consolidating routes to make them more frequent can actually make people’s trips faster, despite the longer walks. The math that makes this possible is demonstrated for a fictional midtown transit rider, Ms. Smith, in the diagrams at right.

Consolidating parallel service into fewer routes could be a strategy for increasing frequencies, or it could allow CAT to offer longer spans of service. This would give people access to some service through midtown and downtown later at night, and on the weekends, than they currently enjoy, but for some people it would require a longer walk.

While most of CAT’s service area has disconnected street networks, and hard-to-cross main roads, the midtown and downtown areas are very walkable. For this reason, it is conceivable that people might rather walk farther, in downtown and midtown, if it means they get a shorter wait or later night service. This question is described in more detail on page 38.

The trade-off between walking and waiting relates to a larger choice about how to balance ridership and coverage goals.

Figure 8: In some situations, consolidating parallel routes onto fewer streets can make the average person’s trip faster. There may be opportunities to do this within downtown and midtown...but only if people value shorter waits and longer spans of service more than they value shorter walks.
High Ridership or Wide 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 on page 7.

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.

The CAT Board of Directors has established a policy about how much the agency’s resources would be spent serving each goal: at least 50% of the budget will be dedicated to pursuing high ridership relative to cost, while at most 50% will be dedicated to providing wide coverage even in areas where ridership will be low.

This plan will give the CAT Board an opportunity to affirm or update that policy. The other key choices arising in this plan and described in this section relate to ridership outcomes, and so community input on those other choices can inform the Board’s deliberations on the ridership/coverage balance.

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

Broadly-Useful or Specialized?

Some CAT services are specialized around small groups of people or special situations. They are designed around the preferences and tolerances of a subset of riders, or for a specific type of trip.

While specializing is a generous gesture, and is a way to seem “customer-oriented” and community-minded, most of the time it is not a path to high ridership relative to cost. High ridership transit is typically transit that is workable for a broad range of people, rather than perfect for any particular group of people.

High-ridership services not only attract high ridership themselves, but also increase ridership on the rest of the network. They multiply the usefulness of all other routes in the transit network by connecting with them. In contrast, specialized services tend to not work together with other services to form a citywide network.

In Chatham County and Savannah, there are a couple of examples (not all controlled by CAT) of specialization that is likely decreasing total transit ridership:

- CAT’s Airport Express route is designed to be useful only to airline travelers. It is not useful to airport workers, or to people who live or work near the airport. As a result, its ridership is low.
- The Savannah College of Art and Design provides an unusually large private transit network for its students. Most other universities in similar situations encourage students to use the public network for some trips, and provide shuttles only for those trips that the public network doesn’t serve well.
- The City funds two very frequent services downtown, the DOT Downtown Loop and the DOT Forsyth. The former doesn’t attract much ridership, because it is so small and circular. The latter attracts a lot of ridership. Both are specialized for very short trips within downtown, trips that are typically made by people who live downtown, people who work downtown (on weekdays, but not weekends) and tourists.
- CAT provides a modest amount of extra service during rush hours, specialized for people working 9-to-5 on weekdays. Rush hours are not the time when transit ridership is highest, even though service is slightly more useful during rush hours.

While as individuals we would like to think that a transit service designed to be perfect for us, and for people like us, will attract high ridership relative to its costs, high ridership transit networks include few services that are specialized around any particular group of people. High ridership networks are made of connected, mutually-supportive routes that are broadly useful to many different people.

The design of the DOT, SSU and SCAD shuttles are entirely up to the agencies funding those services, so the degree of specialization they represent is outside of CAT’s control. If CAT wants to pursue higher ridership with its own limited budget, one way to do so will be to take a look at the specialization within its own services, and evaluate whether it is a successful part of a high-ridership strategy.
2 Market and Need Assessments
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, where ridership is likely to be high relative to cost?
- Where are there moderate or severe needs for transit, regardless of potential ridership and cost?

These two types of considerations help us design transit networks that properly balance the competing goals of high ridership and wide coverage.

Market Assessment

The transit market is mostly defined by WHERE people are, and HOW MANY of them are there, rather than by WHO people are.

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. Low income people are, as individuals, more likely to choose transit. The map showing density of low-income residents is part of both the Market Assessment and the Need Assessment. That said, the density of all people (including low-income people) around a transit stop will still be the overriding factor in predicting whether that stop gets high ridership.

On the following pages, these maps help us visualize the transit market:

- Residential density
- Job density
- Activity density
- Density of low-income residents

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.

This is not to say that who people are is not important. It is extremely important, especially when designing transit services to achieve a coverage goal.

Need Assessment

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

If you asked a transit planner to draw you a route that met as many needs as possible, that planner would look at where low income people, seniors, youth and people with disabilities live and where they need to go.

While the densities at which these people live would matter because at higher densities a single bus stop can be useful to more people in need, the planner would still try to get the route close to even small numbers of people. In fact, the more distant and scattered people are, the more isolated they can be and the more they might need access to transit.

On the following pages, these maps help us visualize where transit needs are in Chatham County:

- Density of low-income residents
- Median household income
- Density of zero-vehicle households

These measures cannot by themselves tell us that a person has a severe need for transit. For example, some people in a zero-vehicle household can afford to hire drivers, or rarely drive but are comfortably retired. We must consider these measures in combination to understand where in Chatham County people’s needs for transit are likely to be severe.

One map included in the Need Assessment pages does not relate directly to people’s need for transit, but does speak to a type of coverage goal, and that is the map of the race or ethnicity of Chatham residents. 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.

Understanding the race or ethnicity of Chatham County residents is crucial to understanding whether transit service changes will affect people equitably. Unequal treatment on the basis of race or ethnicity is illegal under the Civil Rights Act of 1964. (Unequal treatment on the basis of other characteristics, including income and age, is also prohibited by law.) Thus, an examination of where non-white people live in Chatham County is less part of a “Need Assessment” than part of a civil rights assessment.
Service Area Boundaries

The first map in this chapter is simply the CAT service area. This is a reminder that CAT cannot serve transit markets, nor meet transit needs, outside of its existing service area.

Revenues that pay for CAT transit services are only collected from properties within the CAT service area, shown at right.

Parts of Chatham County that are outside of the CAT service area are shown in grey. The rest of Chatham County, shown in white, is inside the service area.

The maps in this chapter show information about the entire county, even though parts of the county are currently not eligible for CAT service.

Figure 9: The parts of Chatham County that are within CAT’s service area are shown in white, above. Areas outside of the service area are in grey.
Residential Density

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 map to the right shows the estimated residential density for Chatham County. The largest clusters of dense residential area in downtown, midtown, and south of Montgomery Cross Road. A few small areas of high density are to the east and west of downtown.

Low-to-moderate residential densities are also present far from the center of the region, such as on Wilmington Island and Georgetown. There are also some mobile home parks that are, at a very small scale, super dense, but are surrounded by open space or very low density developments. Mobile home parks on Quacco Road, for example, make the zone north of Quacco look moderately dense, but in fact the residents are concentrated in a small part of that zone.

By comparing this map to the map of the existing network on page 10, we can see that at least some minimal transit service is provided close to the densest residential developments in the County.

Figure 10: Places with more residents per square mile are shown in darker blue. Residential density tells us how many people could potentially benefit from nearby transit service. Residential density is a major predictor of transit ridership at any given bus stop.
Job Density

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. For this reason, job density is typically an even better predictor of transit ridership than residential density.

The map to the right shows the existing job density across Chatham County. Employment density is very high in a small area in downtown. Medical centers and malls along Waters and Abercorn contribute to dense zones south of midtown. Retail centers south of Montgomery Cross show up as moderate densities on this map, as does Georgia Southern University’s Armstrong Campus (GSU).

The pattern of high and moderate job density from downtown to the Ogletorpe Mall and GSU is fairly linear. Linearity is an essential part of the Ridership Recipe described on page 12. This linearity means that CAT could run service on north-south roads in Savannah, past a large number of jobs and activities, following routes that feel direct to all riders.

Job “centers” to the west, around the airport, barely register on this map at all. They are so dispersed, with such large campuses and so few employees per square mile, that there really is no “center” to them at all. When CAT drives a bus one mile on Jimmy DeLoach Parkway, for example, that bus passes far fewer jobs than a bus driven a mile on a road like Waters Ave. The cost of providing transit service per job is very high in places like Jimmy DeLoach Parkway.

Note that different types of employers trigger different levels of transit demand, and we cannot differentiate among them using this map.

- Retail and service job sites attract numerous customers and visitors.
- Universities and hospitals tend to generate lots of transit ridership, because they attract students or patients in large numbers, in addition to employees.
- In contrast, industrial and logistics job sites attract hardly anyone other than employees (often at only a few shift-change times a day) and suppliers (who generally arrive in a truck, with supplies).

Figure 11: Places with more jobs per square mile are shown in darker red. Job density is a very good predictor of ridership potential. Places that are dense with jobs are sometimes also destinations for many kinds of trips, as people go there for shopping, for medical care, to socialize or to access services.
People who work lower wage jobs typically have lower household incomes, and therefore have a greater incentive to use transit than more affluent people. Places that are dense with lower-wage jobs tend to support transit ridership more than places that are dense with high-wage jobs. In addition, for people who care about transit’s role in economic liberty, helping large numbers of people access low-wage jobs may be particularly meaningful.

The maps above show the density of jobs across the CAT service area, at three different wage levels. The lowest-wage jobs are at the left, in green, and the highest-wage jobs at the right, in red.

The differences in the distribution of jobs at different wage levels are small. Jobs located on either sides of highways and freeways (for example, in Pooler or along Highway 204) are slightly more likely to be low- or medium-wage than high-wage. Downtown jobs are slightly more likely to be high- or medium-wage, though there are still a great many low-wage jobs in downtown.

Figure 12: Jobs in three different wage ranges are mapped in three colors: the lowest wage jobs in green, medium wage jobs in blue, and high wage jobs in red. There are only small differences in how these jobs are distributed around the CAT service area. Downtown and midtown are dense with jobs at all wage levels.
Activity Density

Residential and job densities are combined into Activity Density in the map at right. This map helps us understand the total level of activities in a place, the mix of uses on a corridor or in an area, and their proximity and linearity.

The City of Savannah from downtown to GSU-Armstrong is dense with a mix of activities.

To a much lesser degree, there is also a mix of uses along a few linear corridors like La Roche Ave. and Skidaway Road as far as Isle of Hope; Augusta Road (Highway 21) in Port Wentworth; and Johnny Mercer Blvd./Penn Waller Road on Wilmington Island.

Though it is not one of the four major factors named in the Ridership Recipe, the mix of uses along a corridor 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 neighborhoods tend to be used in mostly one direction and mostly during rush hours—away from the residential neighborhood, towards jobs and services. Buses serving a mix of uses can be full in both directions, all day and all week.

Note that when activity density is arranged along a freeway, it cannot be well-served by transit. Only when development is on a road or a street that a bus can run down does the service feel direct for transit riders. Bus routes on freeways end up being very circuitous for riders, as buses have to drive in big loops in order to pick up riders off the freeway, and expensive for the agency to provide.

In 2017, CAT commissioned a study of all travel in the county, using cell phone data. One of the major conclusions was that local travel is very intense among downtown, the midtown hospitals and the Oglethorpe Mall, and that this pattern of travel demand is particularly transit-oriented. The study also found that travel patterns in this area are primarily north-south.

This Activity Density map gives us the best snapshot of Savannah and Chatham County’s transit disoriented development pattern. In conversations about development, many people focus on the aesthetic design of buildings and streets. The fundamental factors in determining actual transit ridership are named in the Ridership Recipe are shown in the map at right: density; the mix of uses; linearity; and proximity to other dense developments. If CAT wishes to increase ridership within its existing budget, it will have to focus transit service in the places where those factors are in force.

Figure 13: Activity density combines the information in the previous two maps – residential and job density – into one color spectrum. This map reveals a number of corridors in the County where transit ridership might be high, in both directions, at many times of the day and week.
Density of Low-Income Residents

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

A common misconception is that transit, especially all-day transit, is only useful to low-income people who cannot afford a car. People at all points on the income spectrum make choices about how to travel, based on their evaluation of cost, time, safety, comfort and other factors.

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.

The map to the right shows the density of people in poverty in Chatham County. Despite the gentrification of central Savannah neighborhoods, there are still a great many people living at low incomes in these areas.

Some of the low-income residents in downtown and midtown are surely SCAD students. University students are captured by the U.S. Census at a moment of temporary poverty in their lives.

This data dates to 2016, and is from a survey that is less accurate than the full Census taken in 2010, and soon to be taken in 2020. It is possible that this map overstates the number of people living in central neighborhoods who we would casually think of as “low-income.”

This map reveals a few places far from the center of the region where a large number of people live in a small area, in poverty. For example, Chatham City on Augusta Road, and RV parks on Ogeechee Road. In addition, there are small areas dense with low-income residents that do not appear in this data, because the Census zone they are in is so big.

The mobile home park on Quacco Road is an example.

Poverty density alone, as discussed earlier in this report, is not enough to support high 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 reduce its ridership potential.

This makes the “suburbanization of poverty” an enormous challenge for transit agencies. More and more people with severe needs for transit, living at fairly high densities, are nonetheless in a geographic situation that makes it very hard to reach them with cost-effective service.

Poverty density is, however, a major reason to consider running coverage services, regardless of ridership potential.

Figure 14: This map shows the places where large numbers of people live on low incomes. Most of dense low-income neighborhoods in the County are clustered together, and therefore easier for CAT to serve with cost-effective, direct service. A few, though, are scattered far away, making them costly to reach with service.
Median Income

Information about the median household incomes in an area can help us see where the number of people is low, but they have a severe need for transit.

The map at right shows median household income for 2016. Red areas have very low household incomes, and the pattern of red is fairly similar to the pattern of dark purple on the map on the previous page, showing areas of dense poverty.

A few places do appear red or orange on this map that do not show up on the map on the previous page. This means that they are home to a small number of residents with a severe need for transit. Transit serving them would likely attract very low ridership, but those places may still be an important target for coverage services.

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1 Some of the red zones on this map contain vanishingly few residents, such as industrial and port areas.

Figure 15: The map on the previous page conveyed information about both poverty and the number of people in a particular place. On this map, only information about income is shown. Places with very small numbers of people per square mile, but high poverty, can be identified by comparing this map to the previous one.
Households Without Cars

Not everybody has ready access to a personal automobile, and people who have less or no access will depend on other modes when they need to travel. This might include walking, cycling, getting a ride from a friend or family member, or transit.

The map at right shows the number of households without any vehicles available in Chatham County. Darker areas have more households without vehicles.

Most households without vehicles are in or near downtown and midtown. Some of them are likely SCAD students. Central Savannah is served well by the network centered on downtown, including the City’s DOT routes and the (private) SCAD shuttle network.

Some of the areas with a high density of zero-vehicle households also appear on the map of poverty density on page 23, suggesting that these are places with many potential transit riders who also have a severe need for transit.

Understanding where there are large numbers of households without vehicles can be helpful in designing high ridership services, as well as coverage services. These households represent a strong market for transit, if they are arranged in linear and proximate patterns. They can also represent a severe need for transit, if they have few other options for travel.

Figure 16: Areas with a high density of households without cars are shown above. Many households in downtown do not have cars, and to a lesser degree this is also true of neighborhoods south of Montgomery Cross Road, and along Augusta Road as far as Garden City.
Race and Ethnicity

The map at right shows where white, black, Hispanic and people of other races and ethnicities live (as of 2016). Each dot represents 50 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.

Looking closely at the map at right, we can observe that, while there is some segregation by race at the neighborhood level, the most transit-oriented and best-served parts of the county are fairly diverse.

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 people of color, through transportation decisions, is essential to the transit planning process.

Transit agency policies that protect non-white people from negative impacts are one type of coverage goal. Such policies might state, for example, that service to high-density and high-minority neighborhoods should be prioritized even if such service does not attract high ridership.

In addition to local policies, federal civil rights law protects people from discrimination in the provision of transit service on the basis of their race or ethnicity.

Savannah’s transportation and planning history, like that of nearly all American cities, has been fraught with racial discrimination by public and private actors. Particularly in the era before the Civil Rights Act of 1964, segregation and discrimination greatly affected transportation planning and government policy.

Given that history, it is somewhat encouraging to observe the lack of racial disparity present in the existing distribution of service in Chatham County. The chart shown on page 13 shows that minority residents are more likely than the average resident to be close to any type of transit, and frequent transit. The geographic and economic conditions that contribute to this result are not static and many change in coming years. These conditions can also be affected by policy decisions about land use and zoning that local jurisdictions control.

1 The dots are spread evenly across each Census zone, because people’s precise residential addresses are not known. This makes some large zones look uniformly-inhabited when in fact those residents are clustered together in a small part of the zone. All of the data shown on the maps on preceding pages has this limitation, though the use of dots on this map (instead of shading) increases the potential for confusion.

Figure 17: Each dot represents 50 residents, and is color-coded based on their race or ethnicity. Dots are spread evenly across each Census zone in which people live, and are not in their precise residential location.
3 Network and Route Performance
One measure of transit performance is the sheer amount of ridership it attracts. This can be made visible with a map of boardings at each transit stop, as shown at right.

High ridership routes and areas can appear in two ways on this map: either as large dots or as multiple medium-sized dots that are very closely spaced. Looking for those patterns we can observe that the highest boardings occur:

- On some (but not all) of the north-south routes between downtown, the Oglethorpe Mall area, and GSU.
- Near hospitals, universities and malls, in general.
- On Augusta Road as far as Brampton.
- On Skidaway Road and Pennsylvania Ave., from Derenne to E. President Street.
- On Savannah’s three frequent routes: the DOT Forsyth, the DOT Downtown Loop and the SSU Tiger Shuttle.

There are also smaller clusters or large dots, or single large dots, that are farther away from other large boardings dots. Most of them are attributable to big apartment buildings or social service providers.

Looking at this map, we must keep in mind that not every stop is offering the same level of service.

- Some of these stops are served just three times a day. Some are served every 10 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 would suggest low demand for transit near that stop.
- A large dot on an infrequent route means that ridership is high despite a low level of service, which suggests that nearby transit demand may be high.

The way we discern between these situations is described on the next page – we compare the amount of ridership on a route to the amount of service supplied to that route.

Figure 18: Average total weekday boardings at every CAT bus stop, in late summer and fall of 2018. For bus stops that are served by multiple routes, the boardings for all routes are summed to make up that dot.
Ridership Relative to Cost

People who value the environmental, business or development 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 large dot on the boardings map on the previous page until they knew what it cost the transit agency to achieve that large dot.

Ridership relative to cost is called “productivity.”¹ In this report, productivity is measured as boardings per service hour.²

Productivity = Ridership / Cost = Boardings / Service hour

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 speed of the bus (since a slower speed means that covering the same distance takes more time).
• The frequency of service along the route or to the stop. Higher frequency is delivered by increasing the number of buses being driven on the route at once.
• The daily and weekly span of service for the route (how many hours it is available).

Changing any of these factors for a transit route will affect service hours, 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.

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 with the purpose of attracting high ridership.

The table above in Figure 19 reports average weekday, Saturday and Sunday productivities for each CAT route, from August 1 through October 7 of 2018. The routes have been ordered by their average productivity across all days of the week, from least to most productive.

Graphs on page 31 make differences in weekend and weekday productivity visible. A few routes are more productive on Saturdays than on weekdays, or more productive on Sundays than on Saturdays.

Routes 20 and 100X attract just four or five riders per service hour, respectively. The most productive route in the system on any day is the City’s frequent DOT Forsyth route on Whitaker and Drayton Streets. The SSU Tiger Shuttle is also very productive, as is Route 3B on Augusta Road.

Figure 19: This table reports the productivities – boardings relative to service levels – of each CAT route. The routes are ordered according to their average productivity, with the least-productive routes at top.

The DOT Downtown Loop is not particularly productive, despite its high all-week frequency. Likely reasons for this are described later in this report.

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¹ Non-transit professionals sometimes say “efficiency” instead. This is a very reasonable use of the word “efficiency,” but in the transit profession “efficiency” has a different and specific meaning: the dollar cost at which a transit agency can deliver a service hour.

² The technical term for a service hour is “revenue hour of service,” which represents one hour of a bus and driver in operation, open to the public, accepting revenue. Revenue hours do not include the time drivers spend getting to the start of a route, which is known as deadhead. In this report we use the more intuitive term “service hour” instead of “revenue hour.”
During the rush-hour commute period, transit demand patterns change to a degree, and it’s normal for service to change in response. CAT’s Routes 11 and 20 operate a few trips during rush hours only. Route 12 offers higher frequencies during rush hours, and afternoons, than at midday. This extra service contributes to small “peaks” in the number of vehicles that CAT deploys during rush hours.

Peaking has some extra costs that are often invisible to the public:
- Transit agencies must maintain a larger fleet of buses to handle the peaks, but those buses sit idle the rest of the day and week. For each extra bus that is run during peaks, an agency has to purchase the bus, store it and maintain it.
- Rush hour services are often provided using split shifts for drivers with less seniority. Split shifts often require drivers to be away from home in the morning and evening but with pay for only hours worked. These shifts can be difficult to keep staffed adequately.

The graph at right in Figure 20 shows the amount of service CAT is putting on the street throughout a weekday to the ridership attracted by that service.

- The orange line shows how many CAT vehicles are out driving routes. There are two mild peaks in vehicle deployments, at 9 am and 5 pm.
- The blue line shows how many riders those vehicles attract within each hour. Ridership has a small peak at 7 am, is flat 8 am through 11 am, and then grows to a large 3 pm peak.
- The green line shows ridership relative to vehicles. This is similar to the productivity measure introduced on the previous page, but it changes from hour to hour. It is highest from noon through 3 pm.

Rush-hour routes are sometimes thought of as targeting the highest-demand time of the day. Yet CAT’s peaked routes (the 11, 12 and 20) are, as we can see in the table on the previous page, among the least productive. The graph at right shows that ridership is actually highest at midday and in the early afternoon, when service workers are changing shifts and students are getting out of school.

All people, regardless of their income, value flexibility and independence. If a transit service does not support a midday trip home to pick up a sick child, or a late night at the office finishing a report, more affluent people can easily respond by using a private car. Service and retail workers typically commute outside of rush hours. They, too, can choose another option (such as a ride from a family member, an inexpensive car, or a hired ride) if the transit network is not there when they need it.

As of the 2010 Census, 29% of U.S. workers did not work a traditional weekday, daytime schedule. Add to them all the people who work a second job, are studying, or need to run errands in the evening, and we can imagine the proportion of Chatham County residents whose travel needs go far beyond the morning and evening weekday rush hours.

Given the extra costs of running more vehicles during rush hours, it would be reasonable to expect higher productivity, and to ask passengers to tolerate more crowded buses, during rush hours than at other (less expensive) times of day. Each rush-hour passenger is costing CAT more to serve than a passenger riding at midday, yet rush-hour passengers enjoy shorter waits.

If CAT wishes to increase ridership within its fixed budget, then shifting a little bit of service away from traditional rush hours in order to offer more consistent all-day schedules is a strategy worth considering.

Weekend Productivity

The graph at right in Figure 21 shows each route’s productivity through weekdays, Saturdays and Sundays.

Some routes are quite productive on weekend days, even though on most routes a lower level of service is offered on one or both weekend days than on weekdays. The average productivity of all service on Sundays is 22 boardings per hour, the same as for weekdays. (The average productivity of Saturday service is 20 boardings per hour.) This suggests that the underlying demand for transit in Chatham County is fairly flat across the days of the week. Despite this, CAT offers more service on weekdays than on weekends. This is the case in most transit systems, for a few reasons:

- Transportation planners are traditionally focused on weekday rush-hours, because those have been the times when our roads are most congested. Transit service is therefore sometimes prioritized for rush-hours.
- People who make decisions about transit service (including consulting transit planners) generally work white-collar schedules, weekdays 8-to-5. It can be hard for us to notice how many potential transit riders work other types of schedules.
- Data has traditionally been collected for 8-to-5 commutes more than commutes at other times.\(^3\)
- The U.S. economy has, in the past 20 years, shifted more towards service jobs and other jobs that do not follow a weekday 8-to-5 schedule.

Many transit agencies have begun to shift some service from weekdays to weekends (and from rush-hours to nights), or are focusing any new investments on nights and weekends.

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\(^3\) Even sophisticated new data collection efforts using cell phone movements still assume that someone’s “Work” is the place they are from 9 am to 5 pm, which is not at all how retail and service workers are scheduled. CAT obtained such cell phone data to measure travel demands in 2015 and 2016, but only for Tuesday, Wednesdays and Thursdays.
Productivity and Frequency Relate

When deciding where to add service or reduce service, transit agencies don’t simply look at total ridership – they look at ridership relative to cost.

Every public dollar CAT is spending to provide transit in one way is not being spent in another way. An important part of public accountability is saying not only how many riders use a service, but also how much it costs CAT to serve them. This helps everyone make their own judgment about whether the service is worthwhile as it is, or whether more good could be done for more people by spending those public resources in a different way.

The official transit word for “ridership relative to cost” is “productivity.” Productivity is the number of people who boarded buses, divided by the number of hours buses were on the road.¹

The scatterplot at right shows individual routes from 26 mid-sized cities, plotted according to their weekday frequency and their productivity. There is an upward curve to the left, showing that more frequent routes are likely to be more productive.

Chatham County routes (CAT routes, and the DOT- and SSU-funded shuttles) are shown as orange circles.

Productivity represents boardings divided by service hours, which are the hours that each bus and driver are on the road, working a route. Service hours are the major component of a transit agency’s operating cost for bus service.

Providing higher frequencies requires spending more service hours. And yet, more frequent services tend to have higher ridership not just in total, but also per service hour.

While a higher frequency increases service hours, the higher ridership it attracts often makes up for it, and then some. The result is higher productivity.

Turning up the frequency of just any route won’t lead to higher productivity. This is evidenced by the long column of dots in the chart that have 15-minute frequency. Some of them have very low productivities.²

On average, when frequent service is designed as part of a connected network, and made available to people in a suitably dense, walkable place, higher productivity is the result.

¹ Time on the road is the dominant factor in transit operating cost. The vehicle and fuel are only minor contributors. This is why service hours are a good proxy for operating cost.
² Similarly, there are some 60-minute routes that have high productivities. Transit planners probably have their eye on these routes, and hope to increase their frequencies if more funding becomes available.

Figure 23: In this scatterplot, each route at 26 U.S. transit agencies is plotted according to its midday frequency and its productivity. More frequent routes tend to be slightly more productive. This means that not only are they attracting more total riders, they are attracting more riders relative to their costs... even though providing higher frequencies is more costly!
The chart at right shows individual routes based on their frequency and productivity, just like the one on the previous page, but only for routes operated by CAT in Chatham County. The dot for each route is also scaled based on the total amount of ridership each route attracts.

As in other cities, more frequent routes tend to be more productive.

The “outliers” are the most interesting parts of this graph:

- Some low-frequency routes (such as the 3 B, 27 and 28) are quite productive. This can be partly explained by the way they combine to offer higher than hourly frequencies for some trips.

- The City’s DOT Downtown Loop is much less productive than the City’s DOT Forsyth route. These two routes share a very high frequency, and seven-day-per-week span, but they have very different shapes – the Downtown Loop is a circulator, whereas the Forsyth route is more like a line. Because of its shape, the Downtown Loop cannot compete very well against walking, for people who are in a hurry.

- The Route 14 on Abercorn is quite productive, despite only coming once every 30 minutes. This is likely because it offers such a linear and direct ride, over a long distance, among many dense neighborhoods and big destinations. In addition, it runs longer at nights and on weekends than any other route; many different types of people can depend on it for many different types of trips.

Figure 24: In this scatterplot, routes are plotted according to their midday frequency and their productivity.
Cost per Boarding

The table at right repeats the route-by-route productivity that was already shown on page 29. It adds information about the average operating cost per boarding on each route.

Operating cost per boarding is directly related to productivity. Productivity describes riders relative to service hours. Each service hour costs CAT a certain amount to deliver. Routes with more boardings per service hour are therefore dividing their operating costs over a larger number of boardings.

Subsidy per Boarding

If someone cares about public subsidies for transit, then operating cost per boarding will help them see something that matters to them. The subsidy for a rider on any of these routes is simply what it costs CAT to serve them, minus whatever they pay as a fare. For example:

- The average cost per boarding on Route 20 is $24.39. If someone boards that bus and pays a cash fare of $1.50, then the subsidy for their ride is $24.39 – $1.50 = $22.89.
- The average cost per boarding on Route 3 B is $2.91. The average subsidy for someone paying a full fare is therefore $1.41.
- The City’s DOT Forsyth gets such high ridership that its average cost per boarding is very low, at $2.32. However, it is free, which means that the subsidy per rider is actually slightly higher than on the aforementioned 3 B. (That subsidy is provided by the City, not by CAT)

No public transportation service covers all of its costs with fares, much less makes a profit. Our highways and roadways lose money constantly, which we address by raising tax money to subsidize their continued maintenance and use. The percent of operating costs that transit agencies recover through fares ranges from 0% to 30%.

When transit agencies decide to pursue high ridership, it is not to make a profit – though rising ridership can help an agency recover more of its costs through fares. And when transit agencies raise fares, it is almost always so that they can back-fill declining revenues from other sources and prevent service cuts.

Cost per boarding and subsidy per boarding matter to CAT not because CAT is trying to make money off of passengers, but because CAT is accountable to the public for how much it spends to serve a given number of people. When costs per boarding are high, it indicates that a great deal of public resources are being spent to serve a small number of people. Decision makers will ask: How else could that money be spent? Could we touch more lives if we did things differently?

Subsidizing dial-a-ride, Uber, Lyft or taxis

Estimates of public subsidy are also helpful when an agency is thinking about subsidizing a different kind of transportation service, in lieu of fixed route transit service. For example, in the past, planners have suggested that CAT eliminate Route 20 and instead provide Uber subsidies for residents of that area. This may be the right thing to do, but as a steward of public tax revenues CAT will ask reasonable questions like:

- How would the public subsidy per ride for Uber compare to the subsidy currently provided to Route 20 riders?
- How would it compare to the subsidy provided to riders of other CAT routes?
- Are there reasons to provide certain people with higher subsidies for their rides, than other people?
- For example, seniors and people with disabilities commonly receive much higher subsidies in the form of paratransit service.
- Is there a maximum subsidy per ride that CAT (and its taxpayers) can tolerate, for any service?

As the math described on this page should make clear, there are three ways to reduce subsidy per ride: raise fares, increase ridership, or decrease operating cost.

<table>
<thead>
<tr>
<th>Route</th>
<th>Productivity (Boardings per service hour)</th>
<th>Operating Cost per Boarding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weekdays</td>
<td>Saturdays</td>
</tr>
<tr>
<td>20 Skidaway Island / Coffee Bluff</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>100X Airport Express</td>
<td>3</td>
<td>4</td>
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<tr>
<td>11 Chandler</td>
<td>11</td>
<td>11</td>
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<tr>
<td>6 Cross Town</td>
<td>12</td>
<td>6</td>
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<td>12 Henry</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>4 Bernard</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>3 West Chatham</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>29 W Guinnnett / Clovisdale</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>DOT D DOT Downtown Loop (City-funded)</td>
<td>14</td>
<td>31</td>
</tr>
<tr>
<td>10 East Savannah</td>
<td>23</td>
<td>16</td>
</tr>
<tr>
<td>25 MLK Jr Blvd / Westside Ave</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>17 Silk Hope</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td>31 Skidaway / Sandfly</td>
<td>24</td>
<td>23</td>
</tr>
<tr>
<td>27 Waters</td>
<td>28</td>
<td>17</td>
</tr>
<tr>
<td>28 Waters</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>80 SSU Tiger Shuttle (SSU-funded)</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>14 Abercorn Local</td>
<td>28</td>
<td>25</td>
</tr>
<tr>
<td>3 B Augusta / Garden City / Hudson Hill</td>
<td>40</td>
<td>25</td>
</tr>
<tr>
<td>DOT F DOT Forsyth (City-funded)</td>
<td>34</td>
<td>45</td>
</tr>
</tbody>
</table>

Figure 25: This table repeats the productivities of each CAT route, already shown in the table on page 29. It adds the cost per boarding for each route, in the columns to the right. Routes are ordered according to their average cost per boarding, from highest to lowest.
On-Time Performance

On-time performance is a measure of how reliably buses depart when customers expect them to depart. Reliability is particularly important when a transit network is built of infrequent routes. If another bus is not coming soon, the timeliness of each bus is extremely important.

This is even more true when low-frequency buses pulse so that passengers can make a quick transfer, as a few routes do at CAT’s downtown transit center. If an arriving bus is late and misses the pulse by just a few minutes, that can cause passengers to be an hour or two late to their destinations.

If CAT continues to offer a network of mostly low-frequency routes, the reliability of departures will be very important, and the low levels of On-Time Performance that CAT is currently delivering will be especially problematic.

CAT has recently invested in technology that will give the agency a better understanding of routes’ and buses’ reliability. This technology is still being implemented, so the figures reported on this page are estimates based on its early results.

The most recent estimate is that about 65% of arrivals and departures at major bus stops are “on-time.” (CAT defines a bus as being “on-time” if it departs from a major bus stop between 1 minute earlier to 5 minutes later than the schedule says.)

The chart at right shows more specific information about the reliability of individual routes:

- The portion of each bar in pink or red is the percent of departures that happen late, i.e. more than 5 minutes after scheduled.
- The portion of each bar in shades of green is the percentage of departures that happen early, i.e. more than 1 minute before scheduled.

For passengers, an early departure can be much worse than a late one. If a route that comes every 60-minutes is 8 minutes late, someone might be 8 minutes late to work, and that is bad. But if it’s 8 minutes early, they probably weren’t at the bus stop in time to catch it, and they have to catch the next bus—which means they are now 60 minutes late to work.

CAT is delivering an unusually high percentage of early departures, as shown by the green bars. This is especially true for routes 25, 4, 27, 28 and 3. However, some of these early departures may arise from problems matching the reliability data to schedules, rather than the bus not being where riders expect it when they expect it.

Early departures and late departures are inversely related: routes with bigger green bars tend to have smaller red bars. This is because when schedules are "too tight," drivers rarely arrive early (which is a good thing) but often arrive late (which is bad).

When schedules are “too loose” (which shows up in green, at left) it simply means that it takes less time to drive a section of the route than the CAT schedulers thought it would, back when they wrote the schedules (which in some cases was many years ago). Schedules can become “too loose" if ridership decreases, as it has recently for CAT. Fewer riders can mean fewer times that buses are pulling over, stopping, taking fares, and pulling back into traffic, which can contribute to buses arriving early.

As years go by, schedules can also become “too tight” (which shows up in pink and red, at left) because agencies are constantly fielding requests from the public to do more within their existing budget. They extend routes a little bit, they add a deviation, they add bus stops, and all of these things add more driving time. This can result in drivers not getting needed breaks, and can cause buses to be late.

Getting schedules that are “just right” is technically challenging. It requires internal resources like sufficient staffing in the scheduling department, up-to-date software, and training. It also requires thoughtful cooperation and collaboration with drivers, who have the tough job of making the schedules work with the realities they encounter on the roads.

At the end of this System Redesign process, CAT will write new up-to-date schedules for all of its planned routes.

Figure 26: By investing in new technology, CAT has gained the ability to understand more specifically the reliability of each route. While all routes, on average, arrive and depart major bus stops “on-time” about 65% of the time, individual routes have very different conditions. Some routes now take less time to drive than they used to, and have many early departures (shown in green). Other routes take more time to drive than they used to, and have many late departures (shown in pink or red).
4 Network Design Considerations
Combined Frequencies

The map at right is repeated from the introduction. It shows all CAT routes, color-coded by their weekday frequencies.

Two of the interesting outliers in the productivity scatterplot on page 33 are routes that participate in combined frequencies, which can be seen on this map.

- Route 3 B is the most productive of the hourly routes. It serves Augusta Ave. and circulates through employment areas on either side of Augusta Ave.
  - Route 3 B is different from the other hourly routes because it offers a somewhat additive frequency with Route 3. Someone traveling on Augusta Ave., as far as Brampton Road could take either Route 3 or Route 3 B, though in one direction they would have to ride through Route 3 B’s circuitous deviations.
  - About half of Route 3 B’s boardings are on Augusta Ave., the straight segment it shares with Route 3.
  - Routes 3 and 3 B therefore almost operate like a single 30-minute frequency route, for some short trips.\(^1\)
  - Routes 27 and 28, the next-most-productive hourly routes, do operate as a single 30-minute frequency route. They are shown in the map at right as a single dark blue line on Waters Ave., with their two light-blue numbers on it.
  - CAT staff have written the Route 27 and 28 schedules so that someone traveling along Waters Ave. has the benefit of 30-minute frequency, and can take whichever bus comes first.
  - This probably explains why the two hourly routes are just as productive as the other 30-minute frequency services.

The CAT network is radial, meaning that nearly all of its routes go into a dense center of activity, downtown Savannah. A radial network design ensures that anyone looking to travel downtown can make their trip without a transfer. Radial networks also make transfers between low-frequency routes possible with a “pulse,” which is described on page 41. A natural, geometric consequence of radial networks is that as bus routes near downtown, they are either routed onto the same streets or they run on very nearby streets.

In Savannah, for the most part the transit network does the latter: as routes near downtown, they each run on a unique street, a very short distance from one another. This is most apparent downtown and in

\(^1\) Route 3 continues a long way to the west, to serve low-density areas around the airport, so its lower productivity is unsurprising.

Figure 27: The CAT network is made mostly of low-frequency routes, but a few of them combine to offer higher frequencies on shared segments. Routes 27 and 28 are scheduled to provide a consistent 30-minute frequency on Waters Ave. Routes 3 and 3 B offer a less-consistent 30-minute frequency on Augusta Ave.
midtown, where five to seven routes run nearby one another but on separate streets.

Downtown and midtown present a very strong market for transit – with dense mixed-use development, continuous over multiple miles, along linear and walkable routes. It is reasonable for CAT to offer so much service there, given what a strong market for transit it is.

In the current arrangement, five to seven parallel streets have one or more transit routes going down them. If someone wishes to travel to downtown and doesn’t like to wait a long time, they must do a complicated survey of schedules (or use a transit planning app) to figure out which street to walk to. Once underway, if they miss that bus, they have to start again, and walk to a different street. Nearby, infrequent, parallel routes make trip planning more complicated for customers.

Dividing transit service among more streets inevitably leads to lower frequencies on each street, and therefore longer waits. It also leads to shorter spans on each street, and therefore service may no longer be running when someone needs it.

If parallel routes can be consolidated onto a few main streets, frequency can be made better and waits can be shorter. However, more walking is required. This is why walking distance and waiting time are inexorably linked in any transit network, and trade-off against one another.

These duplicative routes could in the future be designed and scheduled to have combined frequencies: if two routes on the same street come every 60 minutes, then they can be designed to arrive exactly 30 minutes apart, and someone traveling a short distance could wait at a single stop for either bus. CAT has already done this with Routes 27 and 28, and the productivity of those routes demonstrates the power of higher frequencies.

Key Choice: Walking or Waiting?
The numerous routes running parallel through downtown and midtown raise a key choice for CAT and its stakeholders:

• Is it more important to provide short walks to service in midtown and downtown? Or,
• Is it more important to provide a higher level of service in midtown and downtown, in the form of either shorter waits or longer hours of service?

At present, most of the routes running through midtown and downtown are somewhat duplicative and competitive among one another.

Ridership is divided among them, yet they do not combine to offer the higher frequencies that would attract new riders and increase productivity.

The illustrations on page 14 show how this trade-off arises. By concentrating service onto fewer parallel streets, CAT could offer shorter waits for service or service later at night and on weekends. This would probably attract higher ridership over time. However, it would require some people to make longer walks to a bus stop.
One-Way Loops and One-Way Splits

The City’s DOT Downtown Loop is not very productive, despite its high frequency. This is probably because it is a one-way loop. People find loops aesthetically appealing, but rarely want to travel in circles.\(^2\) More often they want to go directly to their destination.

A small circular loop like the DOT Downtown struggles to compete with walking for most people.

Someone’s average wait for these 10-minute frequency routes will be 5 minutes. Once they have caught the bus, they must spend time riding around it in a semi-circle. Meanwhile, the walking time from one side of the loop to another is very short. As a result of all of this, the only trips for which using the loop is faster than walking are trips between opposite corners of the loop.

Because it is a one-way loop, even if a person gets a fairly direct trip on the way there (for example, from Price & Liberty to MLK & Liberty), their return trip will be very circuitous. For every round trip, they will have to ride the whole loop.

This is why short routes and loops, especially one-way loops, must be extremely frequent to attract high ridership. If you walk up to the stop, and you have more than a few minutes’ wait for your bus, it is probably faster to just start walking.

This is the most likely explanation for why the DOT Downtown Loop doesn’t attract as many riders as the DOT Forsyth. The DOT Forsyth is shaped less like a loop and more like a line. It goes a distance that is too far for most people to walk, and it doesn’t require people to ride out-of-direction by very much. As a result, it is faster than walking for nearly all of the trips along its length.

Nearly half of riders on the DOT Downtown are using it for a leisure trip, and are visiting from out of town. They are less likely to be in a hurry, and are more likely to have ample time for a “tour” of the area.

Other CAT routes have one-way loops and one-way splits in the middle of a longer line. These present additional difficulties.

For example, Route 25 (shown in Figure 30) includes a one-way split at Garrard Ave. and Chatham Parkway. When the bus is outbound towards Interstate 16 it follows Garrard and Ogeechee Roads. When it is inbound back to downtown, it doesn’t serve those roads at all, and instead takes Chatham Parkway straight to Louis Mills Boulevard. This means that if someone living on Garrard wants to ride this bus to reach the retail or services to the north, their trip going there is fine...but to get back they must ride all the way to downtown and back!\(^3\)

Other routes have similar one-way splits that require people to ride a great deal more of the route than they would like. The most severe are on Routes 3 and 20:

- Route 3’s coverage of the low-density employment areas on Jimmy Deloach Parkway, Gulfstream Road and Miller Road is all one-way, which makes travel between those jobs and the housing on Highlands and Benton Blvds. pretty much impossible, even though they are all served by the same route.

- Route 20 vies with Route 3 for the biggest and most complex one-way splits and loops. Using Route 20 for a round trip requires ample time for a “tour” of the area.

Route 11 has two very large one way loops on its end that require lots of out-of-direction riding. Route 3 B has multiple one-way loops, but they are small, so they are not as time-consuming. Route 28 has a mid-route split that is narrow enough (1/2 mile) for some people to walk, so that they needn’t ride around the whole route in order to get back home again.

The extra travel forced by one-way splits on some CAT routes is so great that many people probably can’t bear it. The people who choose to rely on these routes may do so in one direction only, figuring out some way to complete their round trip besides riding the entire route. They might make a very long walk, get a ride from a coworker or family member, or pay for a ride from a taxi, Uber or Lyft.

One-way loops and one-way splits are coverage tools. They provide lifeline access to service over a larger area, but they make the service so time-consuming to use that few people will choose to rely on it. They also make route schedules and the network as a whole complex and hard to decipher.

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\(^2\) An exception are tourists, who are sometimes not trying to get anywhere in particular, and happy to travel in circles in order to see a place. In fact, the very word, “tourist,” is derived from “tour,” the Latin and French word for a circular journey. “Tour” originates from the Greek “tórnos,” which was a tool used to make a circle.

\(^3\) Or, they could catch one Route 25 bus, ride it south, and then get off and transfer to another northbound Route 25 bus to get home. This is also very time-consuming.
Deviations

Besides circuitous one-way loops and one-way splits, another source of complexity in CAT routes is deviations.

People almost never want to be taken out of direction when they are on their way somewhere. This is part of the reason that linearity is an ingredient in the Ridership Recipe described on page 12.

Routes with deviations on them can only feel direct to the people who are bound for the deviation itself – for most other riders, they feel like an infuriating waste of time. The other reason linearity is part of the Ridership Recipe is that circuitous and deviating routes are simply longer, and therefore cost more for CAT to operate. (In the drawing above, imagine stretching out the lines of the Circuitous and Deviating routes. They would be much longer, and therefore take more time and money to drive a bus down, than the Direct route.)

The longer a route is, the lower the level of service it can offer for the same cost. The shorter a route is, the more can be spent on frequency or long spans.

The four outlines to the right are four of the five least-productive CAT routes. They all include at least one major deviation in the middle of the route. Routes 11 and 20 are incredibly circuitous, as well.

Deviations are not always bad for ridership. Routes with deviations sometimes attract high ridership relative to their cost. The number of riders added thanks to a deviation is occasionally big enough to make up for the negative impacts on operating costs and on through-riders.

Deviations are often used as a coverage tool. They bring service close to a larger number of people and places. They reduce walking distances to bus stops. In most cases, they discourage more ridership than they attract, but ridership is not the goal of a coverage service.

4 Some highly-productive CAT routes have deviations, such as Routes 3 B, 14 and 27.
Pulsing Low-Frequency Routes

CAT operates a mostly low-frequency network. This is because:

- CAT has decided that it is important to get some minimal service close to a large area, and a large number of people, which means that not very much service is available to focus into fewer, more frequent routes.
- CAT’s operating budget is small.
- CAT’s service area is large.

These three facts taken together yield a network of low-frequency routes.

When low-frequency routes cross, this does not mean there is a connection between them. For example, Routes 6 and 17 both stop at the Super Walmart on Ogeechee Road. Transferring between them requires waiting about 45 minutes at most times of day.

When frequent bus lines cross, it’s almost like roads intersecting: someone can transfer and travel in any direction, with just a short wait. When low-frequency lines cross, the transfer requires much more planning, and is riskier, and may just take too long. Low-frequency routes cannot act as a network the same way that high-frequency routes can, because transfers between them tend to be onerous.

Transfers between existing CAT routes are most common for Routes 3, 10, 14, 25 and 27. All of those routes except for Route 10 offer 30-minute frequency, or combine with another route to offer 30-minute frequency.1

A transfer between low-frequency routes can be appealing if the routes are designed to meet one another at the same time and the same place, in a recurring pattern. This is called a “pulse” or a “timed connection.”

One of the great reasons to run a radial network, in which every route goes downtown, is so that low-frequency routes can pulse with one another in a central location. In this way, each route offers people the opportunity to travel from anywhere to anywhere on the entire network. This makes a radial network useful for cross-county travel, not just for downtown travel.

These timed-connections or pulses occur when multiple buses dwell at the same location, allow a few minutes for transfers among them, and then continue on. CAT offers a pulse at its downtown transit center, but it is not as complete as it once was. There is a pulse at the top of each hour, in which three routes participate; and a pulse at the half hour, in which four routes participate. The rest of the CAT routes make one of the pulses during only part of the day, or don’t make either pulse at all.

As routes are lengthened and deviations are added, schedules need to be lengthened, and this can often result in a bus no longer participating in the pulse.

Poor On-Time Performance and Pulsing

Poor on-time performance can be devastating for pulsed connections. If buses run every 60 minutes and their connection is pulsed, but one bus is late, then transferring passengers must wait almost the full 60 minutes for the next bus. These are the situations in which transit riders are seen sprinting after a bus that is pulling away. Being an hour late to work more than once will cost working people their jobs.

Scheduling repeated timed-connections among infrequent routes requires recurring frequency patterns. For example, a pair of routes can connect repeatedly throughout the day if both have 60-minute frequencies. If one of the routes sometimes takes 70 minutes for the round trip, then the pulse is missed.

Deviations and Pulsing

Recurring frequency patterns, and therefore pulsing, is less feasible when routes vary in distance throughout the day due to special deviations. For example, until recently Route 17 made a deviation off Highway 17 to Savannah Morning News, on its last trip of the evening. This added 6 minutes to the scheduled drive time into downtown. CAT recently ended this deviation.

Deviations that only happen a few times a day are a tool to provide coverage in response to requests and severe needs. However, they are not compatible with the pulsing that makes a low-frequency coverage network useful for travel county-wide.
Specialization

Route 100X – Airport Express

Route 100X is one of the least productive among CAT routes, averaging 5 boardings per hour. This is because it is very specialized around the preferences of a group of people who are just too small in number to fill its buses:

- It runs “express” between downtown and the airport, to offer time-sensitive air travelers a fast ride.
- It is priced for people who can afford to fly in airplanes, with a $5.00 one-way fare. In contrast, CAT’s regular routes, and the Route 3 that circulates near the airport, cost $1.50.
- It’s daily schedule is too short for a full-time shift at the airport, with just 8.5 hours between the first arrival and the last departure.

The total effect of its route, its fare and its span is that it is really only useful for people who are flying. It’s fare would discourage people who live, work or shop near the airport, and it only makes one stop between Interstate 95 and the airport anyway. It is surely too expensive for the airport workers. And it doesn’t run long enough for workers’ shifts.

Because it is useful for such a small group of people, CAT cannot justify providing the levels of frequency and span that might (or might not) attract more riders per hour. A bus that departs the airport only 7 times per day (and 6 times on Sunday, which is a big travel day) is statistically unlikely to be going at the right time for an air traveler. With about 85 minutes between each bus, the average wait to use it will be 42.5 minutes, which means more often than not an air traveler will hire a car instead.

Meanwhile, nearby, Route 3 circulates past the entrance to the airport, but does not go into the airport. On weekdays and Saturdays, it offers a higher frequency and a longer span than the 100X, and a lower fare.

CAT is sending two routes to nearly the same place, but the routes are designed such that it is nearly impossible for the target customers of either route to use the other.

A transit agency can divide its service budget into more routes, each specialized around a subset of potential riders. This specialization generally results in lower total ridership. Some transit agencies choose instead to design services that are *workable* for a large number of people, but not ideal for any subset of customers. This allows them to offer higher frequencies and longer spans, on a smaller set of routes, which leads to higher total ridership.

Figure 31: The Route 100X (shown in green, in the map at top) is designed for the preferences and tolerances of airline travelers. At a small airport, that’s a small number of people. As a result, its ridership and productivity are very low.
The SCAD Transit Network

The Savannah College of Art and Design (SCAD) operates a large transit network for its students and staff. It also provides subsidized hired car rides at night. The SCAD network (shown at right) overlaps the CAT network a great deal, but is specialized around the preferences and tolerances of students.

Most universities and large colleges operate private shuttle networks for their students and staff, at their own expense. They provide for transit trips that the local public transit agency could not justify serving, given all the other needs in the community.

It is totally reasonable and responsible for SCAD to be providing transit service for its students and staff. That said, it is unusual for an urban university to offer such a replete private transit network: the number of routes, lengths of route, frequencies and spans are greater than what is offered at other universities.

In addition, urban universities typically expect their students to make use of the public transit available, rather than relying entirely on university-provided transportation. Urban university administrators or student bodies will often purchase bulk transit passes for all students, so that students can ride fare-free on the public system. Students and staff may have access to discounted passes thanks to subsidies provided by the university and the transit agency. Regardless of the mechanisms for encouragement, nearly every large urban university expects and encourages students to use the general public system, and provides specialized private shuttles only for the types of trips that the public system does not serve.¹

SCAD is very different in this respect. The SCAD transit network (called the “Bee Line”) duplicates services provided by CAT and the City. It includes long routes, such as the shopper line that goes all the way south past Oglethorpe Mall and GSU-Armstrong, as shown at far right. There are many places SCAD students probably want to go that CAT’s other potential riders go too, and they could conceivably share buses to get there.

This specialization is not up to CAT, and is not a matter of public accountability, since SCAD is a private institution with its own goals and its own source of funds. However, this specialization does affect CAT’s relevance in the community, and the overall productivity of its network.

University students tend to cause high ridership wherever they are, and especially when large universities are located in a dense, walkable place, at the center of a transit network. Other transit agencies in CAT’s situation are serving thousands of university students, and this contributes to higher ridership and productivity. Very few public transit systems are made so irrelevant to student life by such an excellent and generous university network as the SCAD Bee Line.

We can think of all of the transit provided in Savannah, by the City, CAT and SCAD, as one large “budget.” Today that total budget results in a certain amount of ridership, relevance and mobility it can achieve.

Neither SCAD routes nor CAT routes run as late as people would like them to, or as frequently. They are duplicative, serving the same areas at the same times. If SCAD and CAT had the type of partnership that is typical with other universities, in other cities, they could combine some of their efforts and likely achieve more.

¹ Augusta University, in downtown Augusta, provides a nearby example. The university runs five private shuttle routes, for trips that the public agency can’t justify serving to the level desired by the university. Students ride the public bus system “free” with their student IDs, and can use the public network to go many more places than the University network goes. There are many other similar examples of such university/agency partnerships, with both public and private universities.

Figure 32: SCAD provides an unusually generous transit network for its students and staff. In addition to shuttles going shorter distances between SCAD facilities, longer routes – like the “shopper” drawn in black, at right – help students access the rest of the city.
5 Recent Trends
Ridership and Costs Compared to Peers

The charts on this page show some basic data about the performance of the CAT bus system, compared to similar systems in similar urban areas.

Investment
In the past decade, the amount of fixed route service CAT has been able to provide has stayed roughly flat, as has the population in its service area. The graph at right in Figure 33 shows fixed route service hours per capita for CAT (in black) and for seven peer cities.

CAT’s service area is very large and most of it is sparsely populated. This means that it has to “do more with less,” compared to these peers.

Relevance
Transit ridership on the CAT network has also been fairly flat over the past decade. The graph at right in Figure 34 shows relevance for this group of peers, measured by ridership relative to service area population. CAT has, like most other cities, seen a modest decline in ridership since 2015. (The potential reasons for this are described on page 6.)

Productivity
Annual average productivity (boardings per service hour) has also declined since 2015 in nearly all of these peer cities. CAT is in the “middle of the pack” among these peers in terms of productivity (for all CAT bus routes, included City- and SSU-contracted services). CAT’s productivity losses are only slightly steeper than the average loss among these peers, as shown in the graph in Figure 35.

Vehicle Operating and Maintenance Cost
The graph at far right, in Figure 36, shows the total operating costs each agency bares to deliver an hour of bus service, either for fixed routes or paratransit. (Some of the peers also offer dial-a-ride, which is included.) Transit agencies face inflation in costs just as consumers do. This group of agencies has seen an inflation in operating costs, on average, though some of these agencies have lowered their costs per hour since peaks in 2012-2014.

Some of the inflation in CAT’s operating costs (and those of peer agencies) may be due to the maintenance and staff costs of keeping older buses on the road longer. In this way, higher operating costs can be borne instead of higher capital costs to buy new vehicles.
Lack of Growth Around the Existing Network

Between 2000 and 2016 the population of Chatham County increased by about 25%, from 232,000 to 289,000. The map at right shows how residential densities in and around the CAT service area changed during that same period. Areas shaded purple gained residents, and those shaded in orange lost residents.

Anyone who lives in the Savannah area is probably aware of the growth that has taken place along Highway 204 and Interstate 95. These areas are shaded very light purple on the map. They represent very low residential densities, and yet are such a large area that they represent a large number of people.

In the areas served by existing transit, a few places gained residents and a few places lost residents, with overall little net change. Some U.S. cities saw an influx of new residents into walkable, central areas like midtown and downtown, between 2000 and 2016, but this has not happened in Savannah. (Reinvestment in residential properties downtown is quite visible, but this does not equate to larger numbers of people living in those homes.)

Low-density residential growth in suburban areas around freeways, combined with a lack of residential growth in the center of the city, is troubling for a few reasons:

- Low-density development rarely generates high ridership relative to costs, because transit agencies have to drive a bus so far in order to reach a large number of people. The longer a route must be, the less frequency or span CAT can afford to provide on that route, and therefore the less it can attract riders.
- Development around freeways is particularly hard to serve with useful transit, and rarely attracts high ridership relative to costs.
- The fewer people live near existing service, the more CAT will have to spend driving buses farther away, and the less ridership is achievable within any given budget.

City and County officials, and private actors like developers and Real Estate Investment Trusts, make the development decisions that affect density, linearity and proximity for new growth. In that way, they have an enormous influence over CAT’s ability to attract ridership within its fixed budget.

1 This map uses the 2016 American Community Survey estimate, which is not as accurate as the full-decennial Census. More accurate data will be available after the 2020 Census is complete.

Figure 37: Increases in residential density appear on this map in shades of purple, and decreases in shades of orange. Between 2000 and 2016, there was a slight decrease in residents living downtown, while a large number of new residents moved in at very lowdensities along I-95 and other freeways.
Between 2002 and 2015 the number of jobs in Chatham County increased by about 22%, from 117,000 to 143,000. (There was probably a bigger increase through 2008, and then losses due to the Great Recession.)

The map at right shows which areas gained and lost job density during this period. The pattern is much more mixed than the patterns of residential density change shown on the previous page.

Larger areas of high job growth can be seen around the intersection of Eisenhower & Waters Ave, as well as along both Interstate 80 and Pooler Parkway near the airport.

Moderate job gains near Waters Ave. as far south as Montgomery Cross Road are promising for transit ridership, because buses providing direct service through this area can serve such jobs. The very low-density jobs that developed around the airport and freeways are very difficult for transit to serve well, and therefore not a source of high ridership relative to cost. The net change in job density downtown is slightly negative.

CAT’s ability to attract high ridership relative to its costs depends on the “Ridership Recipe” described on page 12. Jobs can be served with useful transit, and can therefore contribute to high transit ridership, if they are:

• **Dense**, so that many jobs and destinations are within walking distance of any given bus stop.

• **Walkable**, so that people can actually get to the jobs and destinations. No matter how dense the area, if buildings are divided by freeway ramps, wide highways or other barriers, they cannot contribute to high ridership relative to costs.

• **Proximate**, so that CAT can spend less of its operating budget covering the distance necessary to reach many jobs.

• **Linear**, so that bus routes can feel direct to all riders, while still getting within walking distance of large numbers of jobs. Freeway-oriented developments look linear on a map, but are in fact impossible to serve with useful transit.

Most of the decisions about the Ridership Recipe are made by City and County officials, and by private investors, not by CAT. Yet they have a huge impact on CAT’s ability to help large numbers of people reach employment and other sources of opportunity.

Figure 38: In the period from 2002 to 2015, the distribution and density of jobs around the CAT service area changed only slightly, with some increases around Eisenhower & Waters Ave., as well as very low density job growth around freeways.
Glossary
<table>
<thead>
<tr>
<th>Access</th>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial road</td>
<td>A high-capacity through road.</td>
</tr>
<tr>
<td>Circulator</td>
<td>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.</td>
</tr>
<tr>
<td>Commuter express service</td>
<td>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.” <a href="http://www.fta.dot.gov/12876_3906.html">http://www.fta.dot.gov/12876_3906.html</a></td>
</tr>
<tr>
<td>Connection</td>
<td>A connection or transfer takes place when a person uses two transit vehicles to make a trip.</td>
</tr>
<tr>
<td>Coverage</td>
<td>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. Coverage can also refer to service that is made available in a place without an expectation that it will attract high ridership. It’s availability is what is valuable.</td>
</tr>
<tr>
<td>Deadhead hours</td>
<td>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.</td>
</tr>
<tr>
<td>Dial-a-ride</td>
<td>Demand response service, usually requires booking a day in advance, over the phone.</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Lay-people some times refer to “transit efficiency,” by which they mean the number of people served relative to cost. In the transit industry, the more correct word for this is “productivity,” passengers per service hour. “Efficiency” technically means the number of service hours that an agency can deliver for a given cost, i.e. how efficiently they put service on the street (not how much it is used by riders).</td>
</tr>
<tr>
<td>Express</td>
<td>Express can have a range of meanings when applied to transit. It most often describes a route with a long non-stop segment, such as CAT’s 100X route between downtown and the airport. 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.</td>
</tr>
<tr>
<td>Farebox recovery</td>
<td>Farebox recovery is a measure of how much of a transit system, network or route’s operating cost is recovered through fares.</td>
</tr>
<tr>
<td>Fixed route transit</td>
<td>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.</td>
</tr>
<tr>
<td>Frequency</td>
<td>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.</td>
</tr>
<tr>
<td>Headway</td>
<td>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.”</td>
</tr>
<tr>
<td>Investment</td>
<td>In this report, investment refers to service hours per capita, a measure of the relative level of transit service.</td>
</tr>
<tr>
<td>Isochrone</td>
<td>An illustration to help visualize where someone can go from a location, in a certain amount of time, using transit or by walking.</td>
</tr>
<tr>
<td>Land use</td>
<td>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.</td>
</tr>
<tr>
<td>Layover</td>
<td>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.</td>
</tr>
<tr>
<td>Longline</td>
<td>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.”</td>
</tr>
<tr>
<td>Microtransit</td>
<td>Demand response service, like dial-a-ride, but usually distinguished by same day or instant booking, often with an app.</td>
</tr>
<tr>
<td>Mobility</td>
<td>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 travelling 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.</td>
</tr>
<tr>
<td>Mode share</td>
<td>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.</td>
</tr>
</tbody>
</table>
**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 between trips to make up for a delay. Unlike layover, which is a driver’s break time, recovery time can be cut short so that the next trip can depart on-time.

**Relevance**

In this report, relevance refers to 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. In this report, the term “Service Hours” is used instead.

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**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.

**Service 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. The more technical transit term is “Revenue Hours.”

**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.

**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 (called “Service Hours” or “Revenue Hours”), driving between the garage and the start or end of service (called “Deadhead Hours”), or in layover and recovery time.