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What is TRIP?
The Transit Ridership Improvement Program is a two-year study of Santa Clara Valley Transportation Authority (VTA) services designed to identify ways to improve ridership. A key output of this study, but not the only one, is the 2017 Next Network Plan, which will review the structure of the VTA network and propose improvements for implementation in 2017. The planned changes will occur in time for the opening of Bay Area Rapid Transit (BART) to Berryessa, including those required to integrate BART into the VTA network.

This report, the first of the study, analyzes the existing system and shows how certain choices will need to be thought about at the policy level.

What is the need for this study?
The need for this study arises from two converging factors—falling ridership and population growth—that pose important new questions for transportation in Santa Clara County. The County is projected to surpass 2 million residents by 2030. Combined with a rapidly growing economy throughout all parts of the Bay Area, this means more people will be traveling to more places throughout the region.

Figure 1 shows a simplified graph of these trends since 2001. Population has grown steadily, but ridership is more than 20% below its year-2001 level. Transit service quantity, measured in revenue hours, is nearly 15% lower, despite an overall level of transit expenditure that has returned to its early-2000s level when adjusted for inflation. (A revenue hour is one transit vehicle operating for one hour.)

This means that the quantity of service, as the average resident would perceive it, has been shrinking. The relevant measure here is revenue hours/capita. A key question to be discussed is what this curve should be doing. Should transit be growing with population, or faster, or slower?

Why focus on local transit?
The main focus of this study is the local transit network and especially the bus network. This network, bus and rail, constitutes 86% VTA’s service costs. Other programs, including support for Caltrain/ACE, shuttles to these services, special event services, express services, and intercounty programs, are comparatively small parts of the budget. Paratransit costs, mandated by the Americans with Disabilities Act, are also quite low by industry standards.
How to get more ridership for a fixed budget?

Ridership means how many people use a transit service, while productivity is ridership divided by the amount of service provided. If you have a fixed budget for providing service, then the only way to increase ridership is to increase productivity -- that is, growing ridership at a higher rate than the quantity of service grows.

Productivity is not the only purpose of transit, so it is not the only measure of transit’s success. Virtually all transit agencies run some service for non-ridership purposes, fully aware that low productivity will result. These “coverage” services, and the arguments for them, are discussed later in this summary. However, increasing ridership is the focus of this study, so it is important to understand how high-ridership services work.

The next sections of this summary review the key elements of high-ridership service. These assertions are confirmed both by experience in other cities and by VTA’s own performance data, as Chapter 3, Transit Service and Performance, explores in more detail. The reliability of these insights is not surprising because they arise from simple geometric facts about what a transit line is and how it relates to the geometry of cities.

High productivity transit service has two elements: First, the service is useful for many purposes, and second, this service is focused on places where the geography is favorable for transit to succeed. Four features of the geography matter in particular.

- Density -- There are many residents, jobs, and activity destinations close to each transit stop. Note that because the valley is largely built out, most growth from now on will have the effect of increasing density.
- Walkability -- It is easy to walk between those places and the stop.
- Linearity -- Transit can operate in paths that feel straight and direct to the customer.
- Proximity -- Distances that transit needs to cover are relatively short.

Another term often mentioned in the literature is the mixture of land uses along a line. Transit is more efficient if jobs, housing, and retail are interspersed, rather than having, say, only jobs at one end and only residents at the other. This diverse mix generates a more even two-way demand pattern that uses transit capacity more efficiently.

As we look closely at ridership patterns throughout this report, the close link between ridership and these built environment features will be apparent. All of these factors help explain, for example, why El Camino Real, Stevens Creek and Alum Rock Ave are some of the most productive corridors at VTA. They have all of these features, to an adequate degree, including a mixture of land uses.

Other areas like these will arise as the County continues to grow, and grow more dense, especially if there is a conscious desire for land use to evolve to forms that are more favorable to transit. (This also means favorable for cycling and walking. Linearity is the only transit need that does not also benefit cyclists and pedestrians.)

The Municipal Role

The key features of the built environment that govern transit demand are obviously not in VTA’s control. They are the result of decisions by past generations, and to the extent that they can still be changed, the power to do so lies with the municipal governments within the County.

These local governments -- along with Caltrans -- also control the street environment in which VTA operates, largely determining the travel time and reliability of transit service.

In short, VTA service is only one leg of a three-legged stool that
determines transit ridership. The other two are land use and street design, both of which are largely under the control of the cities and towns. A key theme of this study is the need for local governments to be aware of their extraordinary control over transit ridership through their role in planning land use and street design.

VTA’s Role: Service
Much is known about how service determines ridership. While many people focus on subjective features such as comfort and aesthetics, these only become relevant if the service is useful. So an understanding of usefulness is critical to deploying transit service productively.

Across the transit industry, when we look at the most productive services in any network, we usually find they are one of two kinds:

- Commuter express service over long distances, bypassing severe congestion and operating into a dense employment center where parking is difficult and expensive.
- High frequency service -- usually every 15 minutes all day -- running in places where all the built environment conditions are favorable, yielding an intense, two-way, all-day market. VTA’s services of this type are called the Core Network, and include major corridors like El Camino Real, Stevens Creek, and Alum Rock Avenue.

The first group is specialized around “nine to five” commuters, but of course the second group serves many such commuters too. The difference between the two is that the second group serves a greater diversity of trip purposes, while the first group is only for commuters traveling at rush hour. BART, for example, belongs to the second group, because its availability and frequency at any time of day is a crucial part of its offering, while Caltrain and ACE, with their low frequency and limited off-peak service, belong to the first group.

Peak Commute Service
The most successful examples of commuter express service in the Bay Area are express buses into San Francisco across the Bay Bridge. Another is Caltrain, especially for travel into San Francisco. Because these services appeal mostly to people who have a car readily available, a very strong disincentive to driving is needed to make these services succeed.

For that reason, VTA express service is less productive than expresses into dense cities like San Francisco or Seattle, as shown in Figure 5. This is because although the levels of congestion are similar, the disincentives to driving into the employment center are not. Santa Clara County’s employment is mostly in a business park format with abundant free parking.

However, express service is a tiny share of what VTA does, and is therefore not a major focus of this study. Express service is also a small part of the commuter market; most commuting is over shorter distances and happens on local services. This is why the overwhelming majority of VTA’s investment -- including all of its most productive investments, arises from more locally-serving routes, some peak-only but mostly running all day.
Frequent Service: The Core Network

Because of the geographic limitations on the ridership potential of express service, VTA’s most productive services tend to be frequent and all-day. Like most agencies, VTA shows a correlation between frequency and ridership. Where the correlation is weak, it is because of the effects of land use patterns and street design. The same land use factors (density, walkability, linearity, proximity) matter here too.

Frequency is an expensive investment, but the payoffs are often high if land use and street design are sufficiently favorable. Service that is always coming soon — usually every 15 minutes or better, has not only higher ridership but higher productivity. How can this be? After all, high frequency means a large quantity of service. Productivity is ridership divided by quantity of service, so intense levels of service should pull the ratio down. In fact, though, the correlation between high frequency and high productivity is well established in virtually all of the transit agencies we have studied and it’s geometrically obvious why:

- Waiting is the most onerous part of a transit trip, and frequency reduces waiting. (Note that waiting is not just time spent at a bus stop, but more generally time spent not where you want to be. For example, if an hourly bus gets you to work at 7:05 or 8:05, and you must be there at 8:00, then you will wait 55 minutes at your destination.)

- High frequency is the foundation of easy connections. From a ridership perspective, easy connections between lines vastly increase the potential market for each individual transit line, by making it useful to go many more places.

- Frequent service is more reliable, because you are less likely to be stranded during a disruption.

Again, the unusual power of frequency is apparent from VTA’s own performance data, as this report explores. This does not mean that any route would be productive if it ran frequently. Rather, it’s the combination of high frequency and the built environment factors (density, walkability, etc.) that really gives us the “recipe” for the most productive transit services.

An important thing that frequent services can do is form a high-frequency grid. This pattern, routine in cities like San Francisco, Chicago, and Portland and recently installed successfully in Houston, achieves an especially high level of usefulness because it is easy to travel between any two points with an L-shaped trip and a single transfer, so a huge range of potential trips are served. VTA operates this kind of network very successfully in eastern San Jose but it is not clear that it should be confined to there. While east San Jose is certainly extremely favorable transit territory, there may be other areas in the Valley that could support high frequency grid services, especially those where urban-style nodes of density and walkability are emerging.

Radial Network

Most routes lead to and from downtown. Anyone wishing to travel from one non-central location to another must pass through downtown and transfer to another route there. A radial structure makes sense when one part of a city (typically the downtown) is a dominant destination all day — for work, for play, and for commerce. Often, routes are scheduled to converge at a set time (called a “pulse”) to reduce transfer times between routes.

Grid Network

Parallel east-west routes and parallel north-south routes intersect across the city, not only downtown.

A grid structure is most suited to a city with multiple activity centers and corridors, where many people are traveling to many different destinations. Grid networks are only effective when intersecting routes operate at high frequencies, generally every 15 minutes or better, so that connections between routes do not require long, inconvenient waits.
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**Key Choices**

In the face of these trends and geometric facts, and with some understanding of possible solutions from a network design perspective, several key choices for VTA become apparent. This report is called a Choices Report because its ultimate goal is to help citizens and leaders think about these choices.

**Ridership or Coverage?**

As we've seen, some places are better for transit productivity than others, because of their built form. This means that a transit agency that was “thinking like a business,” focused on maximizing the number of customers, would focus on the highest ridership places and not serve other places, just as an airline feels no obligation to fly into towns that are too small to fill its planes.

This helps to clarify the critical difference between transit agencies and businesses. Transit is expected to both maximize its ridership and be available everywhere, but these are conflicting goals. If transit runs into areas where the development pattern implies low ridership potential, then it is doing so for a non-ridership purpose. Let’s call this purpose coverage. Coverage encompasses all the reasons that people expect transit to go everywhere in the county, even though the maximum ridership would result from a narrower focus on higher-demand areas.

Most goals for transit imply either a ridership focus or a coverage focus. Goals arising from high ridership include:

- Maximum fare revenue / minimum subsidy.
- All environmental benefits, including vehicle trip reduction, reduced emissions, reduced pollution, reduced parking needs.
- Support for high-density urban styles of development.
- Other important goals arise from coverage services:
  - Lifeline access to all residents in need, for reasons of income, age, disability, etc.
  - Support for lower-density suburban styles of development.
  - The ability to say that every municipality or electoral district is served.

This is the most fundamental question a transit agency seeking to improve ridership must face: to what extent should we allocate resources towards that ridership goal, as opposed to the competing coverage goal?

The planning of VTA services, and the evaluation of outcomes, will be much clearer if VTA could adopt a policy about the split of its resources between the two goals. To take one example, Houston’s recent “System Reimagining,” which led to a productive redesign of service implemented in August 2015, began with a Board decision to devote about 80% of the budget to high-ridership services and only 20% to coverage services, a big shift from a previous split of around 60-40. At VTA, the current ratio is about 70% ridership, 30% coverage. This should be reviewed to determine if it still reflects the balance of priorities desired by the community.

**Peak or All Day?**

Another significant trade-off at VTA is the high expectation that the agency focus intensely on the “rush hour” commute, combined with the fact that this is not always the cost-effective thing to do.

While ridership is certainly much higher during the peak, service that runs only during the peak is much more expensive for VTA to operate, for three reasons:

- The high cost of buying, storing and maintaining vehicles that are used only briefly each day.
- The higher cost of driver time due to short shifts. (VTA’s labor contract has no provision for part-time drivers, who are the most efficient way to staff peak-only service.)
- The tendency of peak-only service to be busy in only one direction, which requires all the vehicles and drivers to return empty in the other direction.

Another way of saying this is that all-day, evening, and weekend service is relatively cheap to operate compared to peak service, which is why focusing on all-day markets is often the better path to high ridership overall. The key to the all-day market is that it’s so diverse. It includes most commuting by lower-income people, whose work and training commitments rarely require them to travel only at rush hour. It also includes a wide array of trip purposes which tend to use capacity more evenly.

In general, then, we expect the study to feature a robust discussion about the relatively importance of peak-only services for the “rush hour” commute as opposed to all-day, all-direction service. (Note, of course, that all-day service is used at rush hour too.) While the rush hour is the time of highest demand, that does not necessarily make it the time of highest productivity, because of the high marginal cost of peak-only service.

**Resource Level**

As we observed above, VTA service quantity per capita has been shrinking for some time, as the agency’s resources fail to keep up with population growth. A key question is what this trend should be. Transit demand tends to grow rapidly with density, so as the Valley becomes denser, a transit system that is growing only with population is likely to fail to meet demands.

While the allocation of existing service could be adjusted to increase ridership, this will mostly take the form of shifting resources from coverage service to ridership service, with negative impacts on the people who depend on coverage service. Expanding resources, of course, can make this trade-off less painful, by allowing ridership service to grow even as basic coverage is maintained.

The latter phases of this study will consider options for both the current budget and possible quantitative growth, understanding that the latter would require new funding sources.

**Overview of this Report**

This Transit Choices report covers the topics of a typical existing conditions report, in that it reviews the network in the context of patterns of development and demographics to determine if it is still a good fit.

As we have observed, however, the correct design of a network is not just a technical judgment, as it is often necessary to weigh competing goals of transit service. These “key choices,” summarized above, become apparent in the course of this report and are explored in more detail in Chapter 5. The most important choice is the need to balance ridership goals with coverage goals, where “coverage” refers to services designed to provide access to all parts of the County regardless of low ridership.

Chapter 1 provides an overview of VTA service over the last 15 years. It shows that ridership tracks closely with the quantity of service provided. Both fell steeply during 2001-05, remaining relatively stable since, moving in parallel and rising slightly in recent years. Growth in the quantity of service has been limited partly by a lack of growth in the resource base, and by a 15% increase in the average cost per hour revenue of VTA service over the period 2001-2015.

Chapter 2 explores the features of the Santa Clara Valley that indicate transit need or transit demand. In addition to the common barriers of walkability and linearity noted above, we note the primary problem presented by the Valley’s development pattern: the centroid of population...
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is well south of the centroid of jobs, requiring a general pattern of south to north commuting that uses both road space and transit capacity inefficiently. There is also a general pattern of east to west commuting for lower income persons. While there are low-income areas in many parts of the county, the greatest concentration is in east San Jose where there are relatively few jobs or activity destinations.

Other barriers to high transit ridership include the absence of disincentives to driving other than congestion and the costs of car ownership and operation. Parking is free at most destinations. Urban centers dense and walkable enough to trigger high transit demand are in relatively early stages, though they are now emerging in the form of major projects like Santana Row, and also in the rapidly densifying historic centers such as downtown Sunnyvale.

Chapter 3 explores the fit of current service to the pattern of demand and how this generates ridership or fails to do so. VTA generates its highest productivities (ridership per unit of cost to VTA) when it runs frequent service following existing favorable development patterns (density, walkability, linearity, proximity).

Chapter 4 reviews VTA’s system of service categories, which are an important tool for both public information and for policymaking. Existing categories are logical but could benefit from more precise definition. In other agencies, branding of frequent services (generally every 15 minutes or better all day) has been an effective means of calling attention to the most attractive and liberating part of a transit network. Thus, service branding builds ridership around the high level of investment in service. VTA’s Core Network category roughly corresponds to this. The growth and refinement of this Core Network will be a key strategy for expanding transit’s usefulness and thus its ridership.

Finally, Chapter 5 expands on the key trade-offs outlined above, which are likely to be key points of discussion during the project.
1 Recent Historical Trends
Recent Trends

The Santa Clara Valley Transportation Authority (VTA) is a large transit agency serving San Jose, Silicon Valley, and the other valley communities of Santa Clara County. This Transit Choices Report reviews the transit network’s existing performance, market, and potential in order to develop a set of key policy-level questions that VTA may wish to consider in the design and evaluation of its service in the future.

This section provides a brief overview of the broad trends in VTA’s service and ridership over the past 15 years. It then dives into a more detailed assessment of VTA’s ridership, productivity, and reliability data, including route-level analysis. A market assessment follows in section two, connecting today’s existing service and outcomes to the people and places being served.

Recent Historic Context

To get a sense of VTA’s current condition, it is instructive to examine past service trends. We examined key indicators of service quantity, productivity, and cost to assess how the agency’s service offering has performed since 2000.

Service Quantity – Vehicle Revenue Hours

Annual revenue hours are the basic measure of how much service a transit agency provides. One revenue hour is one bus or train operating and available to customers for one hour. It puts the two requirements of the definition right next to each other. Because a revenue hour is a unit whose object does not change in value year-to-year, it is a useful bellwether to understand the total quantity of service VTA has provided.

Simply put, how many hours each year do VTA services spend in service on the road picking up passengers?

VTA operated fewer total revenue hours of service in 2015 than in 2000.

Over the past 15 years, VTA’s total quantity of service has declined substantially, from a high of 1.65 million revenue hours in 2001 of combined bus and light rail (LRT) to a low of 1.32 million in 2012—a 20% overall decline. Since 2012, service quantity has steadily increased, and as of 2015 stands at 1.4 million revenue hours, 13% below 2001, but substantially higher than the level coming out of the most recent recession.

Fewer revenue hours means that fewer resources are available for things like frequency, longer hours, or new lines responding to growth of population and employment centers. Ultimately, this results in a limited ability to target high-potential markets and useful coverage services.

Fluctuation in total service quantity is not uncommon among large city transit agencies. They must contend with variable returns from funding sources as they attempt to maintain or grow service year-to-year. Figure 9 compares the cumulative change in annual revenue hours across a range of western and west coast agencies during the same period, using National Transit Database (NTD) data. Currently, this dataset covers only the period up to 2013. While many of these peer agencies exhibit a similar trend, experiencing a major decline in the 2009-2011 period related to the recession, only VTA and AC Transit operated fewer total revenue hours by 2013 than in 2000.
Recent Trends

Ridership
We generally count ridership by counting boardings: the event of one person getting on a transit vehicle. This roughly indicates total utilization of the network, though it double counts trips that require transferring. Unfortunately, the ideal measure, total individual journeys, is still too difficult to measure reliably without near-total smartcard adoption.

Total boardings have declined substantially from a high in 2001 of over 57 million annual passenger trips. While the lowest year during this period was 2006, ridership has not fully recovered to its early 2000s level. With a total of 44.1 million trips in 2015, annual passenger trips have dropped 23% from 2001. Since 2011, steady growth in ridership is apparent.

Productivity
Productivity is a measure of ridership per quantity of service provided. The usual measure of service quantity is the revenue hour, which is one transit vehicle operating in service for one hour. Productivity is an important metric to gauge how efficiently a transit service generates ridership; simply put, it indicates how many people boarded a bus for every hour a bus was on the road.

Despite the decline in total network ridership, total annual ridership on VTA’s light rail lines increased 22% 2000-2015 as the rail system expanded to new corridors:

- Almaden: Opened 1991
- Tasman West: Opened 1999
- Tasman East/Capitol: Opened 2001, 2004
- Vasona: Opened 2005

Data Source: Santa Clara Valley Transit Authority

Figure 10: VTA Total Annual Boardings (Bus and Rail) 2000 - 2015

Figure 11: VTA Annual Ridership per Revenue Hour (Bus and Rail) 2000 - 2015

Data Source: Santa Clara Valley Transit Authority

Figure 12: VTA Total Operating Expense by Mode 2000 - 2015

Data Source: Santa Clara Valley Transit Authority

Productivity is a measure of ridership per quantity of service provided. The usual measure of service quantity is the revenue hour, which is one transit vehicle operating in service for one hour. Productivity is an important metric to gauge how efficiently a transit service generates ridership; simply put, it indicates how many people boarded a bus for every hour a bus was on the road.

The productivity of the bus system displays a similar trend to that of ridership and revenue hours—a decline in the first half of the 2000s, and then a flat line in the period since (for a 21% decline overall). If ridership and revenue hours had declined at the same rate, productivity would be constant from year to year. Declining productivity in the face of declining ridership and service quantity indicates that not only has the overall amount of service dropped, but that the service that remains has
Recent Trends

Operating Costs and Expenses
So far, we have examined service outcomes and quantity. But in dollar terms, what is the agency spending to deliver that service and produce those outcomes? Figure 12 on page 11 tracks total operating expenditure based on four components: vehicle operations, vehicle maintenance, non-vehicle maintenance (including LRT track and station upkeep), and general administration.

The biggest pieces of the cost per hour, and those that have increased the most over this span, are vehicle operations and vehicle maintenance. Some possible related factors that might be worth further investigation are:

- Changes in traffic speeds which require schedules to be written slower (adding vehicles to routes) in order to maintain schedule headway.
- Changes in labor costs for operation and maintenance personnel, largely as required by the labor contract.
- Expansion of more expensive light rail service.
- Increases in types of service that use labor less efficiently, especially services requiring short driver shifts.

Trend Comparison
When we plot service quantity (annual revenue hours), cost per revenue hour, total annual ridership, and total expenses together, a relationship between these indicators begins to emerge. VTA’s average cost per revenue hour increased, and while total operating expenses have increased (by 14%), for the bus network, costs were relatively stable, increasing only 4% over this span, but light rail costs per revenue hour increased substantially, by nearly 50%.

Without a more in-depth forensic accounting, it is impossible to say conclusively what increased costs, but we can discuss some possible related factors.

The chart shown above shows total operating expenditure based on inflation to 2015-equivalent dollars. Over this span, VTA’s total dollar spending has increased, but when adjusted for inflation, the spending level has been relatively stable, dropping through the 2000s before recovering in the period from 2011 onward.

Figure 13 shows VTA’s cost per revenue hour, the cost of each unit of service it provides, for bus, rail, and the systemwide average. Again, these numbers have been adjusted to 2015 dollars for better comparability. During this period, the average cost per revenue hour increased by 15%; for the bus network, costs were relatively stable, increasing only 4% over this span, but light rail costs per revenue hour increased substantially, by nearly 50%.

Some possible related factors that might be worth further investigation are:

- Changes in traffic speeds which require schedules to be written slower (adding vehicles to routes) in order to maintain schedule headway.
- Changes in labor costs for operation and maintenance personnel, largely as required by the labor contract.
- Expansion of more expensive light rail service.
- Increases in types of service that use labor less efficiently, especially services requiring short driver shifts.

Figure 13: VTA Cost per Revenue Hour by Mode 2000 - 2015
generated ridership less efficiently. LRT productivity, by contrast, has increased (by 14%).

Figure 14: VTA Hours, Costs and Ridership since 2000
Data Source: Santa Clara Valley Transit Authority
recovered to their early-2000s level, the combination of increased cost per revenue hour and a greater fraction of those resources put towards more expensive light rail service have been accompanied by an overall decline in the total quantity of service.

An even greater decline in ridership accompanied the service decline, despite a growing population and employment base. In short, though VTA’s operating expenses have been stable when adjusted for inflation, and are now growing, this funding base is buying fewer revenue hours. In turn, it is less able to address the changing travel needs of people in Santa Clara County as the population and economy continue to grow.

In some regards, this tracks with the performance of the economy generally. Tax-funded transit operators typically encounter a need to cut service in difficult economic circumstances. The initial drop in expenditures, revenue hours, and ridership took place in 2002-2004, lagging the early 2000s recession, before climbing through the mid-decade as the economy strengthened.

While VTA’s financial situation (in terms of the resources available to it and the cost to provide those services) has been mostly stable in the recent period, the fact remains that the level of service hasn’t kept up with population growth, and that ridership has suffered as a result.

Farebox Recovery

VTA’s total farebox recovery rate (the percentage of costs that are recovered through fares paid by passengers) has hovered between 14% - 15% in recent years, though it has dropped to 12.2% since 2013. Farebox recovery is an important measure of the overall level of subsidy required to operate a transit system.

Figure 15 shows farebox recovery rates for VTA and western and west coast peers since 2002, the first year for which data is available for all peers. While VTA’s farebox rate has been more stable than that of many of the other agencies examined, it is also the lowest by far. Several of the peer agencies have succeeded in increasing their farebox recovery rates over time; for example, Salt Lake City’s UTA reported fares equal to nearly 25% of operating expenses in 2013, up from just 15% in 2002.

Two main variables control a transit agency’s farebox rate: the cost of each fare, and the quantity of fares sold (ridership). There is a complicated relationship between these variables; for example, an agency may wish to raise its fare revenue by raising the fare, but a higher fare may create a disincentive that leads some riders to choose other travel options, reducing the number of fares collected. On the other hand, an agency may wish to grow ridership (increasing fare revenue) but strategies to do so may increase cost, unless a concerted effort is made to redirect resources away from less efficient low-ridership services.

Over the long term, sustained ridership growth in the context of relatively stable costs will produce a higher farebox ratio, as long as the fare is not substantially outstripped by the growth of costs. This is an outcome of services that are designed to generate ridership as efficiently as possible. However, services operated for purposes other than ridership, such as coverage routes providing lifeline access to low-density areas, typically produce ridership less efficiently. The degree to which a transit agency orients its budget towards either goal can have a major impact on its farebox rate.
Recent Trends

Key Chapter Findings

- Over the past 15 years, VTA’s total quantity of service declined 20%, from 1.65 million revenue hours in 2001 to a low of 1.32 million in 2011. Because the population has grown during this period, the level of VTA transit service per capita in Santa Clara County has fallen as well. However, the level of service has begun to grow since 2011.

- During this same period, ridership on VTA bus and rail routes dropped substantially as well, with 2015 annual ridership down 23% from 2000 levels, despite a growing population and a similar level of total expenditure.

- When compared to 7 western peer transit agencies, including Portland’s TriMet, Oakland’s AC Transit and Denver’s RTD, VTA has consistently had the lowest level of farebox recovery, hovering between 14% and 15% for most of the past 15 years.

- The average cost per revenue hour for VTA service (bus and rail, adjusted for inflation to 2015 dollars) has increased moderately since 2000, and as of 2015 stood at approximately 15% above the year-2000 level.
2 Market Assessment
Why Development Patterns Matter

Transit service, ridership, and performance are overwhelmingly governed by the pattern of urban development. This pattern largely determines how many people will be near a stop, whether they can walk to it, and whether transit can follow a path that will be useful to many customers. When designing for high ridership, transit agencies will naturally focus service on places where these conditions are favorable.

The image in Figure 16 offers a simple distillation of the key ways that the built environment governs transit ridership. Four facts about the environment are critical:

- **Density**: how large is the market for transit within a given distance of each stop? This is the first-order measure of transit potential. The more people or jobs are located in the fixed area around a stop, the larger is transit’s potential market.
- **Walkability**: how easy is it for people near each stop to actually reach it? If there are physical barriers to this access, including poorly connected street patterns or difficulties crossing a major street, the market of people who can reach a stop is smaller.
- **Linearity**: can transit serve an area in straight, efficient paths, or is time-consuming deviation required to reach destinations? Wherever destinations are set far back from the street, or accessed only from circuitous roadways, it is harder to combine its market with other markets to build strong and durable transit lines.
- **Proximity**: are there long gaps between destinations and strong markets that transit must traverse? For example, linking Gilroy to San Jose is a less productive market than it would be if Gilroy were closer since the distance determines the cost of providing the service.

In some cases, the diversity of land uses can also matter. This helps to determine whether demand is evenly distributed in both directions and throughout the day, both of which use service more efficiently. Mixtures of housing, retail and jobs are generally much better on this score than large areas that are all residential or all employment.

These factors determine both the costs of providing transit in a particular place and how many people are likely to find the service useful. Density and walkability tell us about the overall potential of the market: are there a lot of people around, and can they get to the place where the product is available? Linearity and proximity tell us about cost: are we going to be able to serve the market with short, fast, direct line or will our costs be higher as we must design service that uses indirect or longer paths?

Transit agencies can influence the level of ridership their services generate, and the efficiency at which they do so, by targeting these sorts of favorable land uses appropriately. However, they cannot directly control the urban form of the places they serve. Without dense, walkable places along linear street patterns, where density is continuous along efficient transit paths, transit service alone is unlikely to support a high ridership outcome. Only local governments have the ability to directly effect these characteristics of urban form; the transit agency can seek to provide a level of service that can be useful and competitive with other modes, but ultimately without a development context that produces transit-oriented places of all types, the ceiling for transit ridership is constrained.
Market Assessment

Population and Employment Growth
Santa Clara County is the heart of one of the country’s most dynamic regions. It is California’s fastest growing county with an average population growth rate of 1.1% annually since 2010. Figure 17 shows total population estimates from the American Community Survey and projected population from California’s Department of Finance indicating continued growth into the future (at a slower rates than has been observed over the past five years).

Transit Abundance and Relevance
By comparing ridership and population, we can get an idea of how relevant transit is to the daily lives of people in the region as it has grown. We can examine how much service there is per person and how many trips per resident of Santa Clara County were made on transit each year.

Figure 19 shows per capita transit ridership (based on Census and American Community Survey annual population estimates) for the same 13 year period. In 2015, this number sat at 23.4—about 2 transit trips per month per person—on average. Figure 20 shows transit abundance as how much service (in terms of revenue hours) there was per resident in the County each year. Based on these indicators, the relevance and abundance of VTA’s service has declined from its dot-com-era highs, but mostly held steady at around its current rate since 2010.

Note, however, than when revenue hours per capita are constant, it means that on average people are not seeing significant improvement in their transit service. It means only that the agency is not falling behind the needs of population growth, at least in terms of the quantity of service offered.
Market Assessment

Residential Density

As mentioned earlier, density is one of the most critical indicators for transit’s ability to generate high ridership. Where there are more people of all sorts, there are more people who may choose to use transit for their travel needs.

Residential density is the simplest measure of this. While not all trips start or end at home, nearly everybody makes at least one trip starting or ending at their place of residence every day.

Residential density in the VTA service area is concentrated in central and near eastern San Jose along the Santa Clara Street / Alum Rock corridor. Important secondary pockets of density exist west of downtown San Jose along the Stevens Creek corridor and generally throughout the eastern portion of the service area. Densities are lower across the southwest area than on the east side, but there are pockets of more concentrated development along Bascom, east of Saratoga between Campbell and Stevens Creek, and in central Cupertino.

Figure 21: Population Density
Employment Density

While most people will travel to and from a place of residence in a given day, employment density provides an indicator for other trips to destinations such as workplaces, stores, and restaurants. The more people who work in a place, the more work trips must be made to and from that location each day. Likewise, commercial areas will generate trips made by their employees and their customers. This is part of why employment density tends to be slightly more powerful than residential density in predicting ridership.

Employment concentrates more than population, as businesses tend to agglomerate into downtown cores, commercial strips, industrial parks, or large campuses. The development pattern of Santa Clara County includes a traditional dense downtown core in San Jose. Apart from that location, considerable concentrations of employment exist all along the El Camino Real and 1st St corridors, as well as throughout north San Jose.

Comparing this map to the previous one reveals a basic transportation challenge created by the pattern of development. The centroid of jobs in the County is further north than the centroid of residences, generating a heavy south-to-north commuting pattern often involving considerable distances. This pattern is a key limiting factor on transit productivity. People flow mostly one direction at a time. Buses and trains tend to be empty when moving in the reverse-peak direction, as they must to return to base or begin another trip. Where demand flows two-way, as along the Caltrain line and El Camino Real, ridership is easier to generate efficiently.

Figure 22: Employment Density
Total Employment looks at current job distribution without taking density into consideration. This view shows us the total distribution of jobs, particularly in places where density is low but overall quantity is high. However, because zone sizes vary (typically based on population), larger zones sometimes have many jobs within them, but which are distributed across a larger area.

Where many jobs are dispersed across a large area, fewer people will be near to any given stop than if they were more concentrated. Additionally, low pedestrian connectivity within these zones reduces their overall walkability, while superblocks and lack of traditional street grids extend the distance transit must travel to provide services, often requiring less direct and more circuitous paths.

Many of these transit challenges are unintentionally created by land-use choices and can be addressed through foresight in design. For example, by orienting office campuses around central nodes, a single transit stop can serve multiple buildings. Additionally, locating office parks in a more traditional street grid can increase walkability and allow transit more direct access.

Transit supportive employment land-uses such as mixed use areas, and traditional main streets allow for higher quality service at lower costs. In turn businesses gain access to larger transit access for employees and customers.

Figure 23: Total Employment
Market Assessment

Activity Density

Activity density maps help us see residential and employment density all at once, and calls out places where there’s a high degree of mixture.

Figure 24 combines them together to provide an indication of total activity. Higher population density is shown in red and employment density in blue. Shades of purple identify areas of mixture. The highest mixed densities are highlighted in yellow, and appear only in very small zones in downtowns. (As always, small zones make it easier for a small high density area to stand out.)

Places with a high density of both population and employment are likely to be some of the strongest markets for transit, since they combine residential, employment, commercial, and service destinations. These areas are also more likely to have large shares of people commuting by walking or cycling.

Figure 24: Activity Density
One of these is the number of people with little or no access to a personal motor vehicle (car or motorcycle). Since the census produces estimates of the number of households in each area with access to no vehicles, we can use this information to make maps of the density of these households. Obviously people with limited access to personal vehicles must find alternative methods of traveling, be they ridesharing, cycling, or transit. Which of these they choose has everything to do with availability and convenience. Obviously, if transit is of limited use for the trips a person needs to make, they are less likely to use it, even if they don’t have access to an automobile in their household. This person is not transit-dependent; we might say that they have a greater propensity towards transit use by virtue of their constrained set of options.

The VTA area displays large areas of persons without access to cars concentrated in downtown San Jose and in Mountain View, apart from the expected concentrations at universities. Scattered concentrations in east and southeast San Jose, where walking and cycling are not as easy, indicate some extreme needs for transit.

Figure 25: Zero-Vehicle Household Density
Market Assessment

Poverty

One goal that transit is often tasked with serving is the provision of affordable transportation for lower-income people. As such, we want to understand where lower-income people are located. One way to do this is by mapping the density of people in poverty. (Some reports show what percentage of each zone’s residents are in poverty, but this can be misleading because it calls out large percentages of tiny populations.)

The largest concentration of people in poverty is found on San Jose’s east side, with secondary concentrations along the Monterey and Senter corridors to the south, and between Stevens Creek and Hamilton west of downtown. In addition, small pockets of high concentrations of people in poverty are located further west especially in Campbell, Mountain View, and northern Sunnyvale. Poverty is often a feature of relatively isolated zones.

It is also important to note the degree to which poverty is not concentrated. Apart from the most affluent communities such as Saratoga, Los Altos, and Los Altos Hills, all parts of the service area have people who may come to rely on transit for reasons of income.

Figure 26: Density of People in Poverty
Market Assessment

Median Household Income

While mapping the density of people in poverty can inform the process of ensuring that the most urgent needs are met, transit is competitive across a range of incomes based on a range of choices that people may make. 

A common misconception is that transit, especially all-day transit, is just for very low income people who cannot afford a car. This is a simplistic take on a complex matter. People at many points on the income spectrum make choices about how to travel. They may have disincentives to driving depending on their situations and tastes. 

What is true is that people with fewer resources on the whole have fewer resources to devote to each of life’s costs: housing, food, and transportation. The more carefully a person must manage money, the more attractive transit’s value proposition will be. 

This doesn’t mean that lower-income people will automatically choose transit because it’s the cheapest option. The service available to them must be useful and reliable for the kinds of trips they need to make. Nor does it mean that a person further up the income spectrum is impossible to attract to transit. Not everyone likes driving, and increasing numbers of people are choosing to own fewer cars, creating voluntary transit dependence. 

Figure 27: Median Household Income
Transit Commuting

Despite the fact that only about 3% of people in Santa Clara use transit as their primary means of transportation to work, in small areas where transit is available and useful, usage rates are much higher as shown in Figure 28. This is true across the inner eastern area of San Jose where the bulk of VTA’s frequent services are located, as well as along the El Camino Real corridor in Sunnyvale and Mountain View.

It is important to remember that the work commute is only one type of trip, albeit the one that is most measured. But this data source can’t tell us anything about the other trips people are making using transit to go shopping, visit friends, see a movie, and all the other possible reasons that exist that someone might have to make a trip.

On the other hand, for many people, the work trip is the most important, time-sensitive trip they make each day, and the one that must be the most reliable. In select areas of the County, especially those near VTA’s most frequent, most reliable services, transit is a realistic choice for more than 5%, and in more limited cases 10%, of commuters.

More information on commute share by mode is available in Figure 29 on page 26.
Market Assessment

Market Factor Comparison

How do these market indicators relate to each other and to transit demand? By comparing plots of each factor, we can start to tease out ways in which different factors relate, and improve our overall understanding of the market for transit in Santa Clara County. Each of the factors we have discussed previously has an important relationship to transit; for instance, density of people and jobs signals the size of the total travel market around any given transit stop, while poverty, median income and zero-vehicle households tell us about additional motivations to use transit that certain people may have. Of course, these choice-driving features (poverty, low vehicle ownership) do not indicate transit markets by themselves, but only when they appear together with favorable development patterns (density, assessed here, but also walkability and linearity).

Transit Commuting and Density

While no single land use factor is solely responsible for people's travel choices, we can begin to observe a connection between transit commuting and population density.

Figure 30 shows population density and transit commute rate (from the 2013 American Community Survey (ACS)) for block groups within 1/4 mile of a local transit stop. We've selected only places where the opportunity to commute by transit actually exists. Here, we can see a clear, moderate correlation between population density and transit. Despite the fact that across the County, only 3% of commuters are using transit to get to work according to 2013 ACS data, limited areas have much higher rates, something we observed when examining the map on the last page. These areas of higher transit commute rates also tend to be denser; for example, among block groups with greater than 10% transit commute share, the average population density is slightly greater than 14,000 people per square mile.

The match is not stronger in part because of varying levels of walkability and different types of development patterns, as well as the level and usefulness of transit service in each place. For instance, a very dense block group that is only served by 1 trip per hour isn't going to have a very high level of transit commuting as long as its transit options are so limited.

We can also examine transit use in terms of employment density, although this requires the use of a slightly different measure. The census measures transit commuting rates, and attaches this information to the location of a respondent's home. However, places with dense employment are often not places where many people live, and if a strong mixture of uses is present, there is a good chance that walking and cycling will be attractive options as well.

Instead, we compare the density of boardings in each block group to the density of jobs. Density of boardings is measured by assigning each stop's boardings to nearby block groups within 1/4 mile of the stop location, based on the fraction of the area of the walk radius within each block group. A stop entirely within one block group would be assigned 100% of its ridership, while if it were 50% within one group, it would receive half of the ridership.

Figure 31 plots these factors together. A moderate correlation similar to that between transit commute rate and population density is visible.

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1 ACS commuting data includes only work trips, and does not include school trips.
Furthermore, among the top 25% of block groups by boarding density, the average density of employment is 12,000 jobs per square mile.

**Population Density and Income**

A common misconception about transit held by many people with less experience riding or thinking about it is that transit is a service for and primarily used by low-income people. This is tied to a social-service understanding of transit, in that its purpose is to provide a basic travel option for people who can’t afford a private automobile, and to a conception about where people live that assumes that people with higher incomes don’t live at transit-supportive densities.

Density, however, is a better predictor of ridership than income, because people who choose to live at high densities are choosing places where driving is more of a nuisance and more alternatives to it exist. So it is important to note, first of all, that density and income are less strongly correlated than many people would assume. This is shown in Figure 32.

While very high income people mostly live at low densities, there are relatively high density places (i.e., greater than 10,000 people per square mile) with median incomes well over $100,000/year, an indicator that some relatively wealthy people are looking for urban lifestyles that require less car dependence. For average incomes below that level, there appears to be no correlation between income and density at all, indicating that for a large spectrum of the population, people are choosing to live at high or low density for many reasons that may or may not be directly connected to their income level.

For a large spectrum of the population, people are choosing to live at high or low density for many reasons that may or may not be directly connected to their income level.

Correspondingly, the lower left of this plot shows numerous zones where very poor people live at very low density. These are the most difficult markets for transit, places where ridership potential is low but social-service expectations for transit may be high.

**Zero-Vehicle Households and Income**

Choosing not to own a car tends to make you more likely to use transit. Once the car isn’t available, you will consider other options for every trip. It is helpful to note how this is or is not related to income, as shown in Figure 33.
Market Assessment

Zero vehicle households are generally low in Santa Clara County, amounting to less than 10% of the overwhelming majority of block groups. Extremely high rates of carlessness (over 25% of households) seem to correlate with relative low income, but rates of 10% are found at incomes up to approximately $150,000.

It is worth noting that zero vehicle households, a measure provided by the census, is not an ideal metric; a better one would be “cars per person of driving age” in a household. Many people rely on transit and other non-car modes not because their household has no cars but because it has fewer cars than people who could potentially drive them.

Zero-Vehicle Households and Density
The strongest correlation of all is between zero-vehicle households and density, shown in Figure 34. Density predicts carlessness much better than income does, which makes sense because people at many incomes live at many densities. You must live at high density for a no-car lifestyle to be practical, since high density means both (a) that good transit is probably viable and (b) that many other destinations of interest are likely to be in walking or cycling distance.

The Bottom Line
People choose transit as a result of other choices they’ve made, notably the choice of whether to live near good transit (usually at higher density) and whether to own a car (or own enough cars for everyone in the household). These choices have many motivations other than income, as the broad spread of these scatter plots indicates.

Rather than thinking of transit as being for low income people, it is more precise to say that it’s for people who have made certain choices within the framework of their economic circumstances. These choices, notably the interlocking choices of location and vehicle ownership, are the real drivers of transit demand. This can help to counter the misleading notion that only more affluent riders are “choice” riders. Lower income people also make choices about car dependence that are very consequential for both transit ridership and congestion, as well as for their own economic prospects.

As we outlined at the beginning of this chapter, the location of a residence or job governs how viable transit can be, with the four critical variables being density, walkability, linearity, and proximity. Density is the only one of these that’s easy to describe demographically, but it’s also the most important of the four. High density zones are usually (though not always) favorable for the other conditions and thus places where high quality transit is viable. High density also makes parking more of a hassle and cars less necessary; thus low vehicle ownership naturally correlates with it. This further enhances transit’s potential in those places.

The next chapter explores these relationships further, using VTA’s ridership data. Note again that this data is only about VTA and thus under-counts ridership where other transit agencies are present.
Market Assessment

Key Chapter Findings

• Key land use factors governing transit are density, walkability, linearity and proximity.
  • Density and walkability tell us about the overall potential of the market: are there a lot of people around, and can they get to the place where the product is available?
  • Linearity and proximity tell us about cost: are we going to be able to serve the market with short, fast, direct line or will our costs be higher as we must design service that uses indirect or longer paths?

• Santa Clara County is California’s fastest growing county with an average population growth rate of 1.1% annually since 2010.

• Most growth in the county will increase density, as there is little room for horizontal growth. This density will increase traffic and also increase transit needs.

• The county’s job/housing distribution is unbalanced, with a majority of housing located to the south and east while the majority of jobs are to the north and west. By contrast, transit is most cost-effective and productive where jobs and housing are more mixed, e.g. along El Camino Real and Stevens Creek.

• While transit is used as a commute mode by only 3% of commuters countywide, the rate is much higher in some locations, typically those served by highly useful transit.

• Density is a better predictor of ridership than income, because people living at high densities are more apt to seek alternatives to driving. For the same reason, car ownership is lower in high density places, to a degree not fully explained by income alone.
Transit Service and Performance

Service Overview

VTA operates 3 light rail lines and 77 bus lines of various types, across a service area of 346 square miles inhabited by 1,889,638 people. In fiscal year 2015, more than 32 million trips were made on VTA bus routes, and more than 11 million on light rail. On an average weekday, over 140,000 boardings occur on VTA services.

VTA classifies its bus services into one of five categories: Core, Local, Community, Express, and Limited Stop. Chapter 4 explores these categories in greater detail.

Core routes are generally higher-ridership, more frequent routes in the central part of Santa Clara County. The Local and Community routes are often less frequent lines serving areas where densities are lower. The Express and Limited routes offer long-distance, limited-stop connections often using freeways and expressways/sh between regional destinations.

The two charts shown in Figure 35 display daily weekday vehicle hours and ridership by route type. Core services, the most productive, make up 2/3 of VTA’s bus service but account for 3/4 of daily boardings on the bus system. All of the other service types represent a smaller share of boardings than of service quantity. This helps to illustrate the higher ridership potential of Core services, which arises from their high frequency, easy connections, and the diversity of purposes for which they are useful.

Frequency

Figure 36 on page 32 displays VTA’s network categorized by the prevailing midday frequency of each route. Frequency is critical to focus on because it is an expensive investment that should pay off in much higher ridership, because frequency makes service so much more useful.

We define frequent service as any transit service operating at 15-minute or better headways. Industry experience has shown that this is a threshold at which riders start to trust the service to arrive within a reasonable waiting time without consulting a schedule. Frequency reveals where a transit system is focusing its resources. Showing midday frequency points to where those resources and level of convenience are available all day long—places where people can choose to rely on it for all kinds of trips.

2 We use vehicle hours rather than revenue hours to understand the total resource split, because vehicle hours include deadhead, which is the time spent running empty to and from the ends of the run. It is important to use service hours whenever doing comparisons that involve Express service, because these long one-way runs have dramatically higher deadhead than other services, since the bus and driver must deadhead the entire way in the reverse-peak direction before or after each one-way trip. When dealing with local services the difference between vehicle hours and revenue hours matters less, because deadhead does not differ so much across different service types.

Figure 35: VTA Bus Service Quantity (Vehicle Hours) and Ridership by Route Type

From this map, we can make a few key observations:

- VTA operates a frequent network of 12 major all-day routes (including segments where multiple routes are overlaid to produce a higher frequency).
- The east side of the service area, particularly within San Jose, boasts a very rich network of frequent services. Many of these routes connect to light rail as well, creating a frequent network grid through the area that enables multidirectional travel with short waiting times.
- The low frequency across the western 2/3 of the county is very striking, especially given the known pockets of density, low car ownership, and low income that can be found here near El Camino Real and Caltrain. (Caltrain, it must be remembered, is not frequent at all, rarely coming more than once an hour at most stations.) Only two major frequent corridors extend far west of downtown San Jose—El Camino Real and Stevens Creek.

There are two separate issues here, the coherence or connectivity of the frequent network and its fit with density.
Coherence or Connectivity
A basic question about transit networks is not just where they go but where you can get to along them. Transit is useless unless it connects you to many possible destinations, and we use the terms coherence or connectivity to describe how well it does that.

Whatever transit line you live on, you need to get to places that are not on that line. This requires that connections be easy. That is only possible where frequencies are high -- i.e. where red lines intersect on this map -- or where connections can be timed, as is done between some feeders and the commuter rail schedules. Timing of connections, however, only works with relatively short and specialized routes. Most VTA network are too long, and too hard to run reliably, for precise timing of connections to be viable.

This is why a frequent grid pattern of services, such as east San Jose has, is so powerful. Where red lines cross on this map, you can connect in any direction, so you can travel from many possible origins to many possible destinations.

By contrast, where less frequent blue or green lines cross on this map, the connection is very difficult, and may introduce substantial delay.

Across the western half of the county there are three frequent lines (counting LRT to Mountain View) but they do not touch each other, so no frequent connections are possible.

Figure 36: VTA Frequent Network Map After Planned 2016 Changes
Fit of Frequency with Density

The map in Figure 37 shows the Frequent Network (those routes operating at 15-minute headway or better for the peak and midday) overlaid on the map of activity density presented in Chapter 2.

VTA’s present network aims to concentrate frequency in its strongest markets, an appropriate design strategy given its imperative from the 2010 Transit Sustainability Policy to “increase transit mode share by focusing resources to target markets where transit can compete effectively”\(^3\). However, apart from the issues of connectivity outlined above, the fit of the network to density is also not ideal.

If we compare this map to the map of poverty density, (see Figure 26 on page 23), we can observe that the current pattern of frequent service seems to be tracking poverty more closely than density. This matters to ridership, because density is a better predictor of ridership than poverty, but it also matters to meeting the needs of low income riders.

Frequent services currently concentrate where poverty is highest, in eastern San Jose, but this is an area with many residences but few jobs or activity destinations. The frequent network does not appear adequate to connect East San Jose residents to a sufficiently wide range of opportunities such as jobs, school, retail, and other activity centers. (Note that lower income people are more likely to need to travel at all times of day, so peak-only services have little relevance to them.)

\(^3\) VTA Transit Sustainability Policy, 2010, p. 3.
Transit Service and Performance

Peak Frequency Map

Does the issues with the frequent network improve much during rush hour? While the peak service level is substantially higher, the availability of frequent service doesn’t expand dramatically.

Figure 38 shows the frequency of service during the AM peak period, when several routes’ and segments of routes’ frequencies increase for the rush hour.

Comparing this map to the previous one, peak frequency increases consist mostly of 20-minute services rising to every 15 minutes, (orange lines turning red). Most of these are in San Jose, though they include the line to Gilroy and some service in Milpitas.

Meanwhile, in the west half of the county, only a small area of northern Sunnyvale gains high frequency service during the peak period. All of the issues of connectivity and fit with density addressed above continue to exist.

Again, this map does not show the full picture of peak-only service, especially in the main employment areas, because other operators provide significant peak service there. These include the Caltrain and ACE shuttles, Stanford’s shuttle system, and extensive private sector services for specific employers.

Figure 38: VTA Peak Frequency Map After Planned 2016 Changes
Geographic Pattern of Ridership

Figure 39 displays VTA’s weekday ridership pattern by stop. Each stop in the network is shown, sized by the total cumulative number of average daily boardings that happen at that stop across all routes that provide service there. The data on this map was collected in March 2015.

Note that major transfer points, identifiable on the previous map as places where frequent lines (including rail) intersect, will show high boardings that may not reflect local area demand.

Note how strongly ridership follows frequency by comparing this map to the previous one.

Each of the light rail lines exhibits quite high average daily ridership, with nearly 2/3 of light rail stations seeing over 250 average daily boardings per day. Since light rail investments typically target strong target markets, and generally feature high frequency service, a high quantity of total ridership is to be expected on those corridors.

The areas with the most high ridership stops are in downtown and the eastern side of San Jose, west along El Camino Real, and west along Stevens Creek. These areas, which together make up the bulk of the area served by VTA’s frequent network, have the greatest number of stops with over 100 and over 250 average daily boardings. This holds true along the length of both west side corridors and along Alum Rock, King, McKee, and Story in the east.

There are also several secondary

Figure 39: Average Weekday Ridership by Stop
corridors not presently part of the all-day frequent network (though they do have 15-minute service during peak periods) but which have numerous stops in the 10-50 and 50-100 average daily boardings ranges:

- Winchester, particularly the segment south of Stevens Creek
- Bascom between Stevens Creek and Curtner
- Monterey St.
- Senter Rd.
- Oakland Rd. from central Milpitas south to downtown San Jose

Apart from the major frequent network corridors, other important nodes pop out as more isolated locations of high-ridership stops, including:

- Bus stops near the airport, connecting to El Camino Real services and LRT served by route 10.
- Transit centers where many routes connect, such as Great Mall and Winchester.
- Historic downtowns with dense mixed use, such as Sunnyvale, which also include Caltrain connections.
- Light rail stops connecting to bus routes, such as Lockheed Martin, Capitol Ave, and Santa Teresa.
- Shopping centers, including Westgate at Saratoga and Prospect.
- Community colleges that attract commuter students from a distance, such as De Anza College, Evergreen Valley Community College, Mission College, and Foothill College.

Also of note are areas where we don’t see many high ridership stops on this map, but there are sources of transit demand.

- Palo Alto, Stanford, and the Shoreline area of Mountain View show low boardings, but this partly reflects the abundance of local transit not directly provided by VTA. Stanford has its own extensive shuttle system. Palo Alto and Shoreline are also served by Caltrain shuttles and by SamTrans, apart from frequent services on El Camino Real.

- Infrequent corridors (like Sunnyvale-Saratoga, Wolfe, or Curtner), typically do not have the sustained pattern of high-ridership (50 average daily boardings or above) stops found on the frequent network, and their highest-ridership points are likely to be transfer points or major nodes, rather than long segments where a strong market is matched with a high level of service.

### Transit Productivity

Productivity, or boardings per revenue hour, is essentially ridership per unit of service cost, i.e. “bang for the buck.” We discussed this measure briefly for the entire network in Chapter 1. For every hour a transit vehicle is in service, how many people board the bus? Productivity reveals how effective a revenue hour is at generating ridership when invested in one service relative to another.

Productivity is strictly about the goal of ridership. Services that are designed for other goals, like coverage or congestion mitigation, may not perform well on the productivity metric. This does not mean that these services are failing or that the transit agency should cut them. It just means that they are not serving a ridership goal.

Further sections of this report will discuss VTA’s performance relative to other goals.

### Productivity by Frequency

What do routes that generate ridership efficiently have in common? In examining transit systems in cities around the country, we have found a general correlation between transit route frequency and productivity, as shown in Figure 40. (Note that this chart excludes peak-only routes and extremely infrequent routes).

The chart in Figure 41 displays the productivity (boardings per revenue hour) of each VTA route on the y axis, with frequency on the x axis. Each point is colored based on which of VTA’s route categories it falls within. Since this displays productivity data based on ridership and revenue...
hour numbers from 2015, the 181 is shown in the 30-minute group here. In addition split frequency routes, such as route 25, are grouped into their highest frequency segment. Note that high frequency, which is described as a low number of minutes between consecutive trips, is to the left on the x-axis. Services that operate only during limited periods of the day are grouped together in the peak-only pane of the chart.

Frequent services tend to produce more ridership per revenue hour, even though they also have the highest cost.

As observed before, more frequent services tend to produce more productivity (ridership per revenue hour), even though, on the surface, high frequency means more revenue hours which should pull the ratio down. This happens because frequent service is the most useful and convenient service for riders and transit agencies target this most expensive service towards their strongest markets. Most of the highest-productivity services fall into VTA’s Core Network, which includes the majority of its high-frequency routes.

It is important to note that no fare is charged on routes 201 (downtown San Jose shuttle) and 10 (serving the airport), two of the higher productivity routes.

There are other high productivity services that do not operate at high frequency. Among the 30-minute routes, six operate at better than 30 boardings per revenue hour, and three 60-minute routes meet this standard. These routes, which may support higher frequency, are investigated more closely in the next section.

Where are VTA’s most productive services?

Figure 42 shows VTA’s most and least productive local routes broken out by productivity quartile (the same number of routes in each category). The upper quartile are VTA’s most productive routes. The lower quartile are VTA’s lowest-productivity routes. Routes are colored based on which of VTA’s service categories they fall into.

The match between VTA’s frequent network and its most productive services is immediately evident, as the major frequent corridors (22, 23, 72) all show up in the top quartile, as do several routes which are either near-frequent (as in the case of the 66 and
Several of the westside crosstown corridors also appear in the upper quartile, particularly those flowing through Sunnyvale and Cupertino. In the third and lower quartiles, the absolute lowest performers tend to be highly duplicative infrequent routes or circuitous local coverage routes like the 88, 34, and 35. Note how these routes, or the areas served, tend to be unfavorable on two or more of the key built environment factors: density, walkability, or linearity. Even setting aside the issue of frequency, a long, straight route is more likely to be useful for a wide range of purposes, compared to a small and squiggly one. No long, straight routes are in the bottom quartile.

20-minute routes
Among the four 20-minute routes, the 73 along Senter Road in southern San Jose stands apart, achieving better that 40 boardings per revenue hour—the second highest productivity among all routes in the network. A detailed map of the 73 is shown above. Route 73 offers a relatively high level of service (20 minute during the midday, with 15 minute peak service) to a short direct corridor with pockets of high density housing and employment at both ends and along the route. The southern portion of the route along Senter passes through zones with population densities in excess of 15,000-20,000 people per square mile. Further northwest along Senter, the route serves a dense employment area at Tully before proceeding into downtown San Jose.

The 73 provides a useful example of how routes serving the same area can generate very different ridership outcomes. Compare the map of the 73 to route 42 in Figure 44. In terms of the ridership recipe:

- The 73 and 42 both serve some of the same relatively dense terrain of southeast San Jose.
Transit Service and Performance

- While the 73 operates in a straight line on Monterey for nearly its entire length, the 42 turns east towards its eastern terminus at Evergreen Valley Community College, an important destination and the busiest stop on its route. To get there, it traverses a long stretch of very low density along Yerba Buena Road with only a single-digit number of boardings.

- The 73 stays with Monterey, while the 42 makes two long (one-to-two mile) deviations in this segment. Deviations add time to the route, making it more expensive, but it also means that it can provide direct service to destinations like the Edenview Community Center on Branham (the northeast corner of the northern deviation off Monterey).

Simply put, the 73 is a highly productive route, generating ridership in a way we would expect with the ridership recipe in mind: a decent level of service to dense locations in close proximity to one another, operating on a very linear path. On the other hand, the 42 serves a dense market for its southern half and is anchored by a strong destination (the college) at its northeast end, but it runs a serpentine path in order to serve some destinations away from the straightest route. It must also traverse a gap in development to get to the college. The lack of linearity means a weak market with weak ridership.

Infrequent Crosstown Routes

Earlier, in our initial examination of the network frequency map, we noted that an interesting characteristic of VTA’s network is the lack of frequent north-south crosstown service in the western portion of the service area. Of note, nearly all of the crosstown services fitting this role in the network are high-ridership, despite running only hourly or half-hourly and often being so close together that their service areas overlap.

Routes 26, 53, 54, 55, and 57 all generate over 30 boardings per revenue hour and fall within the highest quartile of local services operated by VTA. These routes are shown by their productivity in the productivity chart in page 16.

One of VTA’s most productive corridors is El Camino Real, consisting of Local route 22 and its Rapid overlay, the 522. The routes serving this corridor record more than 21,000 boardings on an average weekday, operating at high frequencies very productively. The agency’s ongoing work towards BRT on the street further indicates its vital importance for travel in the region. Yet despite this, no all-day frequent connections to the 22 or 522 are available across the entire region west of downtown San Jose other than route 10, which is of limited use for all-direction travel given its focus on the airport.

At first glance, the area between these corridors may not appear well suited to high-frequency transit. From the maps in the market analysis section of this report, we can observe that residential and employment density along Hollenbeck, Sunnyvale-Saratoga/De Anza, Wolfe, and Saratoga/Kelly (as well as Winchester or Bascom) is generally lower than in important regional centers like downtown, Sunnyvale, Santa Clara, or Mountain View, or along the two existing radial westside corridors. Some of these street segments, like De Anza, are designed like freeways, hostile to pedestrians, thus difficult to serve with transit.

In isolation from the rest of the network, none of these corridors would seem an ideal choice for frequent transit. However, crosstown segments are a key element of a multidirectional network, and a crucial link for non-radial trips.

Imagine a person located between Wolfe and Saratoga along Stevens Creek who needs to travel to somewhere around Reed and Wolfe. The first stage of their trip would be simple and reliable - wait just a few minutes (never more than 12) for a 323 or 23, and ride to Wolfe. However, the transfer to the 26 means changing to an infrequent route, and the average wait will be 15 minutes, maybe even longer if you just

![Westside crosstown corridors](image-url)
Transit Service and Performance

Let's examine one of these routes, the 55 (shown in Figure 46). The 55 runs every 30 minutes throughout the day with a peak frequent segment north of El Camino Real. Looking at the map in Figure 47, we see that the ridership at stops north of the Caltrain station and El Camino Real is not substantially greater than the southern segment. Boardings on the northern segment are largely in the southbound (red) direction, while boardings on the southern segment are generally northbound (blue).

This suggests that the bulk of northward ridership is collected south of El Camino Real, despite the lower level of service in that segment.

No frequent all-day routes operate north-south in the portion of the network west of Bascom.

Grid transit networks, like that in east San Jose, solve this problem by making sure a bus is always coming on both legs of the trip. While the unique market of some of the segments in question on the west side may not be as strong as in other locations already served by frequent transit, a frequent grid connection across the west side improves the connection to all sorts of destinations along the dense El Camino Real and Stevens Creek corridors.

Catching an infrequent bus from home, you can wait until the last minute before you leave to go to the stop, but with a transfer, it is difficult for you to be sure that you are not going to be left out on the street. This uncertainty is a major detriment to the sense of spontaneity transit can provide.

None of the routes intersecting El Camino Real offer an all-day frequent connection running north-south in the western potion of the service area. This means that any trips involving a transfer between the 22 or 23 and a intersecting route will involve at least one long wait, and two-seat trips across the area that don’t involve either corridor will definitely require long waits during each leg. If we take half the headway of a route as the average wait before arrival, we can see how frequency improves the speed of trips:

- Trip 1: two 15-minute frequent routes: 15 minute total average wait (7.5 + 7.5)
- Trip 2: one 15-minute frequent route, one 30-minute route: 22.5 minute total average wait (7.5 + 15)
- Trip 3: two 30-minute routes: 30 minute total average wait (15 + 15)

Regardless of how far we are going, trips involving a transfer will always be faster, more convenient, and more reliable the more frequent each connection is.

The high productivity of several routes may indicate a potential market for such frequent service in future. However, it is difficult to say at this time which route or corridor would be the obvious choice for a new frequent grid element, as many of the routes overlap or run quite close together, cannibalizing each other’s markets.
Peaking

VTA’s bus network serves people making all sorts of trips all day long. While a common assumption is that transit ridership is much higher during morning and evening peaks, VTA’s ridership shows a predominantly all-day pattern with only slight increases during the peaks (even when ridership on peak-only express services is included), as shown in Figure 47. Average hourly ridership during the morning peak is only 3% higher than midday, and ridership during the afternoon peak is only 10% higher than midday.

VTA’s bus ridership is barely peaked, with average afternoon peak ridership only 10% higher than midday ridership.

Many of VTA’s routes operate at higher frequencies during the peak periods. Many 20- and 30-minute routes run every 15 minutes during the peaks. On average, this increase in service levels does not attract a proportionate increase in ridership. As a result, average productivity is higher in the midday and lower on the p.m. peak.

The lack of big a.m. and p.m. peaks in ridership in a place with so much peak congestion likely arises from the demographics of current VTA bus riders. People go all sorts of places (work, school, home, shopping) throughout the day, no matter their income. Yet low income people have a particularly strong motivation to use transit for these trips, and low-wage jobs are more likely to begin and end at non-peak hours.

Ridership from one hour to the next on any particular route has much to do with the mix of land uses it serves, the types of jobs it provides access to, its midday level of service, and whether it connects with highly peaked services such as Caltrain or ACE. When we look at individual routes, we are able to make specific observations about commonalities among the most heavily- and lightly-peaked routes. Two examples are examined on the following pages.

Data Source: Santa Clara Valley Transit Authority
Consider the 64-Almaden LRT - McKee & White, shown in Figure 48. This is a highly productive route operating at 15-minute headways in its northern segment on McKee and 30 minute headways south of San Jose on Lincoln. Its ridership displays essentially no peaking. In fact, during the afternoon commute, ridership drops from the high levels sustained throughout the midday.

The 64 serves relatively few places where peak commutes dominate the market. Downtown San Jose certainly holds some peaked jobs, but it also has the all-day demand of its mixed use and university. Most of the 64 serves areas where all kinds of demand occurs. It makes many connections with other routes to create an even more diverse range of trips possible. This adds up to a route that performs very well despite its small role in rush hour commuting.

Additionally, the northern end of the 64 has a high concentration of people in poverty and low-to-median family incomes. Transit is a more competitive option for all sorts of trips for people with less income to devote to transportation. Many lower-paying jobs start and end at times throughout the day other than the traditional 9-to-5 shift, and many low-income workers have multiple jobs, which they must commute to at different times throughout the day. This relatively dense area has frequent service and all the network effects that entails (easy transfers with short waits to access destinations in all directions), ensuring that transit is a more attractive choice for trips throughout the day.
On the other hand, the graph for route 32 (San Antonio Shopping Center in Mountain View to downtown San Jose, mainly serving Monroe and Middlefield) reveals a very highly peaked pattern. This route’s busiest hours are 7:00 a.m., 8:00 a.m., 4:00 p.m. and 5:00 p.m., during the peak periods when its frequency increases from every 45 minutes to every 30 minutes. The 32 serves less dense, and much less mixed, land uses for most of its extent. Given its poor frequency during the midday and limited span (operating only between 5:00 a.m. and 7:00 p.m.), the route is most useful for people whose commutes fall within those traditional peak commute hours.

**Figure 50: San Antonio Shopping Center - Santa Clara TC Ridership by Hour**

**Figure 51: 32-San Antonio Shopping Center - Santa Clara TC Route Profile**

<table>
<thead>
<tr>
<th>Boardings per stop</th>
<th>People / square mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>blue / red indicates direction</td>
<td></td>
</tr>
<tr>
<td>0 - 5</td>
<td>75 - 125</td>
</tr>
<tr>
<td>5 - 15</td>
<td>&gt;125</td>
</tr>
<tr>
<td>15 - 75</td>
<td></td>
</tr>
<tr>
<td>Points of interest</td>
<td>Employees / square mile</td>
</tr>
<tr>
<td>hospital</td>
<td>45</td>
</tr>
<tr>
<td>university</td>
<td>70</td>
</tr>
<tr>
<td>high school</td>
<td>125</td>
</tr>
<tr>
<td>shopping</td>
<td>&gt;125</td>
</tr>
</tbody>
</table>

Data Source: ACS 2013, Santa Clara Valley Transit Authority
Transit Service and Performance

Service / Ridership Match

The chart at right shows two lines:

- The quantity of service (bus trips, shown in red) provided during each hour of the day, relative to the average service level across all 24 hours of the day. For example, in the hour starting at 12:00 p.m. VTA provides about 45% more bus service than the average across all hours, and in the hour starting at 4:00 p.m. VTA provides about 95% more bus service than the average.

- Ridership (boardings, shown in blue) during each hour of the day, relative to average ridership across all 24 hours of the day. For example, in the hour starting at 12:00 p.m. boardings are about 65% higher than the average across all hours, and in the hour starting at 4:00 p.m. boardings are about 90% higher than the average.

Comparing service levels and boardings for each hour to a daily average allows us to observe each factor’s relative level of peaking, across 24 hours of operations. We can make a few observations about the shapes of these peaks, and their relationship to one another:

- During the a.m. peak period, the ridership line tracks with the service line, instead of rising higher above it. This means that, on average, peak buses are not much more crowded than midday buses.

- Another way of describing this phenomenon is that higher demand during the peaks doesn’t result in higher productivity, as it does in most agencies, because VTA adds so much service on the peaks. This suggests that VTA could achieve higher overall productivity by reducing the quantity of peak service. In addition, peak bus trips are more expensive for an agency to provide than midday bus trips, so even if peak bus trips were to achieve the same productivity as midday bus trips, their cost-per-rider would be higher.

- In the mid-afternoon, ridership rises hours before service quantity rises. This is the time of the day when buses are most crowded, as indicated by the blue line being higher than the red line. Some early-afternoon ridership is surely related to school schedules, but ridership grows out of proportion to service quantity starting at 12:00 p.m., long before students get out of school.

This analysis suggests that VTA is offering more service during peaks than it would if maximizing productivity or minimizing cost per rider were the agency’s primary goals. In other words, there may be more ridership growth potential in all-day service than in peak service.

Figure 52: Hourly Data (trips and boardings per trip) compared to average

Data Source: Santa Clara Valley Transit Authority
Transit Service and Performance

Coverage & Frequent Network Reach

We use the productivity metric to assess how well a transit route succeeds at the goal of generating high ridership per unit of cost. Transit can be asked to pursue other goals. One of the most common is referred to as the coverage goal: how many people across the agency’s service area are able to access the transit system? VTA’s Transit Sustainability Policy asks the agency to “balance service productivity and service coverage.”

Coverage is the number of people and jobs near transit stops served by VTA. For this analysis, we considered an area to be served if it is within 1/4 mile of all-day service, a typical industry-standard walk distance. This is a relatively tight standard; some analyses use a longer distance up to 1/2 mile, and others include peak-only services. There is some evidence that people walk further to better service, so being over 1/4 mile from frequent service might still count as being served though this analysis treats such a situation as “no service.” We also do not include peak-only services (or peak service levels), because they are only available for a limited number of hours per day and thus do not represent the most common condition of the network, or the period in which the majority of boardings per day happen (from approximately 10 a.m. until 4 p.m.).

Using 2013 population and employment data from the American Community Survey (ACS) and Longitudinal Employer-Household Dynamics (LEHD) program, we performed a coverage analysis using spatial interpolation to estimate the number of people within a 1/4 mile buffer around each stop, weighted by the portion of each block group within that area. There is some evidence that people walk further to better service, so being over 1/4 mile from frequent service might still count as being served though this analysis treats such a situation as “no service.” We also do not include peak-only services (or peak service levels), because they are only available for a limited number of hours per day and thus do not represent the most common condition of the network, or the period in which the majority of boardings per day happen (from approximately 10 a.m. until 4 p.m.).

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If you have any questions or need further clarification, please feel free to ask. We are here to help.
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service type is in more suitable markets. On the other hand, a network designed to maximize coverage will measure its success in part by seeking to grow the total number of people and jobs near service of any kind. If VTA shifted more of its resources to focus on either one, the other would experience a negative shift. This is one way of gauging the impacts of a choice within the ridership/coverage trade off.

Current Plans

2016-2017 Transit Service Plan

VTA’s short range plan includes a range of changes to be implemented over the next two years. VTA is also preparing a BART Integration Plan (BTIP) that would be implemented in conjunction with Berryessa service. The TSP includes changes to routes to accommodate the Spring 2016 opening of the Warm Springs station, but does not include any planning related to BART extension to SCC. Our review of this plan focuses on the most important near-term service changes that affect the structure of the network as a whole, particularly changes to weekday service.

CHANGES RELATED TO WARM SPRINGS BART

VTA operates few routes in the vicinity of Warm Springs station, so changes required to serve this station are minor in the context of the network as a whole. Changes to VTA routes operating in the vicinity of Warm Springs BART are as

Figure 55: 2016-2017 TSP Network Changes

2016-17 TSP Changes

<table>
<thead>
<tr>
<th>VTA Route Frequencies:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every 15 minutes or less</td>
</tr>
<tr>
<td>Every 20 minutes</td>
</tr>
<tr>
<td>Every 30 - 59 minutes</td>
</tr>
<tr>
<td>Every 60 minutes or greater</td>
</tr>
</tbody>
</table>

| Peak-Only |
| VTA light rail |
| VTA Transit Center |

| Line Changes: |
| Early 2016 Changes |
| Late 2016/17 Changes |

| Other Transit Services: |
| Caltrain / ACE commuter rail |
| natural area |
| outside Santa Clara Co. |
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follows:

• 180 (Great Mall TC - Warm Springs BART). The 180’s north end terminus would be moved from Fremont BART to Warm Springs BART. Service between Great Mall and Eastridge and Aborn (currently three trips per day) would be discontinued. Additionally, midday frequency would be reduced from 30 minute headway to 60 minutes.

• 181 (San Jose Diridon - Fremont BART). The 181 would operate at 15 minute frequency through the midday, an improvement from its current midday headway of 30 minutes. No changes to the route in order to serve Warm Springs are planned at this time.

• 120 (Fremont BART - Lockheed Martin TC). The 120 would now deviate to serve Warm Springs before continuing on to Fremont station. Additionally, service west of Lockheed Martin to the Shoreline area would be discontinued, and an additional daily round trip added.

• 140 (Fremont BART - Mission College). The 140 would deviate to serve Warm Springs in the same way as the 120.

OTHER MAJOR ROUTING OR FREQUENCY CHANGES

Other than changes related to BART, most of the other changes in the TSP are quite minor, effecting single or a small number of trips, or very short route segments. A number of more major changes to the network are planned, which are reviewed in this section. We have created a network map in the same style as the existing system map (which showed several changes from the TSP expected to be implemented imminently, such as the frequency change on the 180), showing the network with all changes implemented.

Four new routes are proposed:

• Line 11, a 30-minute service connecting downtown and the airport.
• Line 56, a new peak-only service running every 30 minutes between Sunnyvale Caltrain and North San Jose via Scott and Trimble.
• Line 354, a 30-minute peak-only limited stop service duplicating segments of the 54 and 55 between Lockheed Martin and De Anza College via Sunnyvale Caltrain. Implementing this route would require moving the S22 stop on at El Camino Real and Hollenbeck one block east to Mathilda, and rerouting the 54 in this vicinity in order to maintain a transfer point between the 54 and S22.
• BRT S22, an upgrade of the existing S22 using BRT vehicles and infrastructure treatments running every 10 minutes.

When examining frequency changes, we are most focused on changes that effect qualitatively different experience for the rider, rather than minor tweaks that may improve reliability or precisely match demand patterns—essentially, changes that move routes between the frequency classes we have already established in this report.

The following major frequency changes are planned:

• Line 181 - upgrade to 15 minute headway from current 30.
• Line 22 - reduce to 15 minute headway from current 12 to accompany new 10 minute S22 BRT service.
• Line 522 - increased to every 10 minutes.
• Line 32 - increase frequency from 60 to 45 minute.
• Line 57 - increase peak frequency to 30 minute from current 60.
• Lines 61 and 62 - Combine on Bascom between Curtner and downtown to achieve combined 15 minute frequency. These routes are currently scheduled in a manner that aspires to this. The July 2016 service change would add sufficient vehicles to restore the combined headway as reliable.

Finally, several significant changes to route structure are proposed:

• In Gilroy, current routes 14 and 17 would run as a loop, adding weekend service to the 17 segment. To offset this cost, weekend service would be discontinued on the 18.
• The 51 and 81 would be merged into a new route 81, extending from downtown San Jose to De Anza College, then north through Mountain View using the same routing as the 51. This change would allow the segment currently run as the 51 to operate at 30-minute frequency during weekdays, and add Saturday service to the segment.
• As previously mentioned, route 180’s trips south of Great Mall would be discontinued.

CHANGE ASSESSMENT

All in all, the changes proposed here are mostly quite minor, but several are very important improvements.

• Changes to the 181 and 61/62 will add two extensive frequent network elements, adding a first all-day frequent north-south element on the inner west side of San Jose and greatly improving the connection to BART from San Jose and Great Mall.

• In the El Camino Real corridor, the introduction of Alum Rock BRT and accompanying frequency changes will increase the overall level of service in VTA’s premier transit corridor. The BRT improvements and added frequency on the limited-stop S22 will reduce wait times and increase convenience, particularly for longer trips, but the reduction of the frequency of the 22 from 12 to 15 minutes will slightly reduce its usefulness for short trips.

• Since Warm Springs BART is far from most VTA services, the changes required to address it are quite minor, simply adding deviations to the 180, 120, and 140 to serve the station. These changes are temporary until the BART extension to San Jose is opened. These do not substantially impact the portions of the network where most of VTA’s ridership is located—east San Jose, and the major westside radial corridors.

• No major changes are proposed to east side service apart from the two canceled 180 trips between Great Mall and Eastridge.

• Linking the 51 and 81 together into a new route 81 has the positive aspect of closing a coverage gap on Homestead between Wolfe and Hollenbeck, and adds weekend service to the 51 segment. These are unlikely to be high-ridership changes, as the 51 serves a very low density area, and the 81 offers a much longer path east and west from Cupertino towards downtown San Jose than the 23/323.

Capital vs Operating Priorities

VTA’s Transit Capital Program comprises a package of transit investments that include a variety of infrastructure projects currently in planning or constructing, such as the Alum Rock and El Camino Real BRT corridors.

The purpose of this report is not to discuss the merits of any of these projects in detail. However, one of the major observations of this report has been to note the substantial decline in total transit service per capita in Santa Clara County over the past 15 years. As we’ve explained, this issue impacts the overall viability of the transit system as a useful travel option for all sorts of trips, as fewer resources are available for all the competing demands placed on transit, whether delivering frequent service to high-density places, extending late night hours or weekend service, or maintaining lifeline coverage service to lower-density places.

If voters approve a transportation sales tax ballot measure in 2016, new funds will be available which VTA could use for a variety of purposes, including the construction of important regional capital projects. Some portion of these resources could also be invested into bus operations, beginning to reverse the recent trend of falling transit service per capita.
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in Santa Clara County. Future stages of this study may evaluate alternatives which address the decline in service per capita by allocating future sales tax revenue in different ways.

Fare Policy

Setting fares correctly is a complex issue that we do not address in this report. However, since this focus of this study is network design, it is important to note how fare policy is affecting VTA’s ability to offer an efficient and attractive network.

VTA’s fare includes three pricing tiers (Adult, Youth, and Senior), within which a range of fare types are available, including single ride, day, and monthly passes. Importantly, fares on Express routes are double that of local routes and light rail. The various VTA base fares are shown in Figure 56.

This structure imposes an extremely high transfer penalty (100%) on people who have not purchased a monthly or day pass. This means that a simple one-transfer round trip, perhaps within the convenient frequent grid in eastern San Jose, costs $8, or $6 if you have a Clipper card. One of the most important advantages of a grid network design is the ability to make fast, reliable grid movements involving a transfer. While the service is in place to facilitate this, VTA’s fare structure is working at cross purposes with its network design.

VTA’s fare structure is working at cross purposes with its network design.

Free transfers used to be the rule in transit. Passengers would pay their fare and receive a transfer slip to be used on the next bus. Over the last several decades, concern about the way these slips were abused -- by giving or selling them to others, for example -- led to their elimination at many agencies. However, this reason for not offering free transfers does not apply to customers using the Clipper card. Many transfer-dependent transit systems -- including those of San Francisco and Portland -- have retained free transfers because they consider it essential to the efficient functioning of their network.

Further analysis would be required to gauge the ridership and financial impact of removing the fare penalty (by allowing transfers within a set time window), but this is an important step towards a transit system that allows truly multidirectional travel across Santa Clara County.

VTA Fare Structure (Adult Age 19-64)

- Single Ride - $2 (Regular & Limited Stop Buses, Light Rail)
- Express Single Ride - $4
- Community Bus - $1.25
- 8-Hour Light Rail Pass - $4
- Day Pass - $6 (Clipper Only)
- Express Day Pass - $12 (Clipper Only)
- Monthly Pass - $70
- Express Monthly Pass - $140
- Annual Pass Subscription - $770

Figure 56: VTA Fare Structure
Key Chapter Findings

- Productivity (ridership/service provided) is strongest where frequency is highest. This matches a nationally-observed correlation between frequency and productivity.

- VTA’s most productive routes tend be frequent routes serving dense, mixed-use places.

- VTA’s frequent service is very concentrated in San Jose. There are some indications that a more extensive frequent network could succeed.

- There is relatively little peaking in ridership. Average ridership in the morning and evening peaks is only 10% higher than the average midday.

- On average, VTA service does not get more crowded during commute peaks, because so much service is added at this time while ridership rises only moderately. This is unusual and suggests that peak service may be inefficient or excessive.
4 Service Branding
To many people, all buses look alike. Bus routes tend to be numerous, so they can also overwhelm people with complexity. It’s often hard to find a service that might be useful to you out of a list of 77 bus routes, or on a map that shows them all on top of each other, and it’s easy to come away from that effort with the feeling that buses are intrinsically confusing. But bus services are not all alike, and their differences can be made clear. Different types of service have different purposes and are useful for different kinds of trips. Transit systems become clearer – to both potential riders and stakeholders – when those distinctions are obvious.

The key to clear communication about a local bus network is a well-designed system of service categories, manifested across the information system and also in policy. In this chapter, we review the principles behind service categories, the outcomes that these systems are seeking, and VTA’s current position.

VTA already has service categories, and some of them are presented throughout the information system. Express services, for example, are red on the system map, have their own range of line numbers, and have a different fleet. “Community” service indicates lifeline services to low-density areas, usually infrequent and with low ridership expectations. This is the essence of how categories are useful. Service categories help people (both customers and stakeholders) figure out quickly which parts of the complexity matter to them. It may be appropriate to extend the same thinking to other categories.

This chapter reviews the VTA category system and points out ways that it could be clarified and made more useful to both customers and stakeholders. In the figure, we identify four tiers of Frequency and Span:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Span</th>
</tr>
</thead>
</table>
| Candidate Frequent, also called Local or just Half-Hourly. These lines tend to run every 30 minutes or better all day and often have the highest productivity (boardings per revenue hour). Their purpose, and thus the logical measures of success, are so different. VTA measures the success of expresses using average load rather than productivity (boardings per revenue hour). Whereas productivity speaks of ridership per unit of cost, average load does not. Average load is implicitly per bus trip, but the cost of a bus trip varies widely based on length and whether it runs one-way or two-way. Assessing expresses in terms of productivity would yield very low scores, as these long routes carry few passengers but for relatively long distances. All-day inter County express service (Dumbarton Bridge, Santa Cruz-San Jose, Fremont-San Jose) is somewhat different because it is the only transit linking its endpoints. For that reason it does have all-day service in addition to intensive peak service, and is not as narrowly specialized as most VTA expresses.

Overview of Useful Branding Distinctions

Are these the right categories? Are they defined in a way that helps both riders and policymakers understand what each one does and how they work together? To assess this, the next section considers the logic of service branding distinctions.

Figure 57 is a matrix showing how coherent brands can arise from two kinds of distinctions:

- Frequency and span. (Is it there when I need it?)
- Speed vs. Stop Spacing (How far will I walk to a stop? How fast will it go?)

To illustrate the distinctions, the matrix contains examples from VTA or from nearby transit services.

Frequency tends to vary with span; frequent lines have the biggest markets, so they usually also have the longest duration. The relationship between speed and stop spacing, on the other hand, is inverse; wider stop spacing delivers higher speed.

In the figure, we identify four tiers of Frequency and Span:

- Frequent. Every 15 minutes or better all day. This generally corresponds to what VTA calls its Core Network, although VTA’s Core category includes routes that are less frequent but aspire to be. This is a very distinct product for reasons outlined above.
- Candidate Frequent, also called Local or just Half-Hourly. These lines tend to run every 30 minutes or better all day and often have the different kinds of trips. Transit systems become clearer – to both potential riders and stakeholders – when those distinctions are obvious.

The key to clear communication about a local bus network is a well-designed system of service categories, manifested across the information system and also in policy. In this chapter, we review the principles behind service categories, the outcomes that these systems are seeking, and VTA’s current position.

VTA already has service categories, and some of them are presented throughout the information system. Express services, for example, are red on the system map, have their own range of line numbers, and have a different fleet. “Community” service indicates lifeline services to low-density areas, usually infrequent and with low ridership expectations. This is the essence of how categories are useful. Service categories help people (both customers and stakeholders) figure out quickly which parts of the complexity matter to them. It may be appropriate to extend the same thinking to other categories.

This chapter reviews the VTA category system and points out ways that it could be clarified and made more useful to both customers and stakeholders. In the figure, we identify four tiers of Frequency and Span:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Span</th>
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</table>
| Candidate Frequent, also called Local or just Half-Hourly. These lines tend to run every 30 minutes or better all day and often have the highest productivity (boardings per revenue hour). Their purpose, and thus the logical measures of success, are so different. VTA measures the success of expresses using average load rather than productivity (boardings per revenue hour). Whereas productivity speaks of ridership per unit of cost, average load does not. Average load is implicitly per bus trip, but the cost of a bus trip varies widely based on length and whether it runs one-way or two-way. Assessing expresses in terms of productivity would yield very low scores, as these long routes carry few passengers but for relatively long distances. All-day inter County express service (Dumbarton Bridge, Santa Cruz-San Jose, Fremont-San Jose) is somewhat different because it is the only transit linking its endpoints. For that reason it does have all-day service in addition to intensive peak service, and is not as narrowly specialized as most VTA expresses.

Overview of Useful Branding Distinctions

Are these the right categories? Are they defined in a way that helps both riders and policymakers understand what each one does and how they work together? To assess this, the next section considers the logic of service branding distinctions.

Figure 57 is a matrix showing how coherent brands can arise from two kinds of distinctions:

- Frequency and span. (Is it there when I need it?)
- Speed vs. Stop Spacing (How far will I walk to a stop? How fast will it go?)

To illustrate the distinctions, the matrix contains examples from VTA or from nearby transit services.

Frequency tends to vary with span; frequent lines have the biggest markets, so they usually also have the longest duration. The relationship between speed and stop spacing, on the other hand, is inverse; wider stop spacing delivers higher speed.

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Service Branding

potential to grow into Frequent lines in the future.

• Infrequent, running every hour or so. Local services in this category, like VTA’s community routes, have low ridership expectations. Longer lines, such as Caltrain or the Hwy 17 express, can do well despite low frequency because frequency expectations are lower for longer trips.

• Peak-Only. Many services run peak-only because they focus narrowly on the “nine to five” commute market.

There are many ways to manifest and brand these distinctions. Houston, for example, has taught its customers colors for these categories, calling First, Second, and Third Tier. Dallas has focused on speed and frequency, calling participants “Frequent,” “Mid-frequency,” “Infrequent,” and “Peak.”

In determining how long a total trip will take, frequency (waiting time) is the dominant factor for short trips but in-vehicle travel time, governed by speed, is the dominant factor for longer trips.

• Demand is lower for longer trips, because (all other things being equal) people try to arrange their lives to minimize trip distances.

Both of these factors explain why Caltrain’s infrequent service is acceptable for very long trips, such as Silicon Valley to San Francisco, but not if you’re just going a couple of stations. It also explains why you might wait an hour for a flight to Los Angeles but a day for a flight to London.

That’s why the upper-leftmost corner of this table (frequent and nonstop) is empty in most cities: relatively few people are going very long distances, so it’s hard to assemble the intensity of demand to support very high frequency service without making intermediate stops, unless – as with the BART transbay tube – there is simply nothing to stop for. San Jose - Fremont express service is in this cell now, but it will be more efficient when replaced by BART, which makes more stops and is thus more of a Rapid service.

A Better Frame than “Bus vs. Rail” The table also highlights all the ways that rail and bus services can be more similar than different. Caltrain and Commuter Express buses are in the same cell—high speed but low frequency and span. Light rail and Bus Rapid Transit are in the same area—especially if BRT has exclusive lanes. If VTA had frequent local streetcars comparable to San Francisco’s F-Market & Wharves service, these would be in the same cell as frequent local buses. In all these cases, rail and bus are two ways of implement a service that has a similar role in the network and a similar range of uses. What’s more, service branding helps make bus service clearer, thus reducing one of the biggest negatives that people cite about buses as opposed to trains – that they are just too complicated and uncertain.

Relationship to Trip Distance

This table also reveals how a customer’s intended trip distance relates to the key distinctions shown. The longer a customer’s trip is, the more speed they need (which is upward in the table) but the more patience they have for lower frequency (rightward in the table). This happens for two reasons:

1. In determining how long a total trip will take, frequency (waiting time) is the dominant factor for short trips but in-vehicle travel time, governed by speed, is the dominant factor for longer trips.

2. Demand is lower for longer trips, because (all other things being equal) people try to arrange their lives to minimize trip distances.

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In the same figure, we identify four tiers of Speed vs Stop Spacing:

• Nonstop means “serving a long nonstop segment through which most riders pass.” VTA’s commuter express buses, including the inter County Dumbarton and Highway 17 services, meet this definition.

• Limited or Rapid means “serving widely but regularly spaced stops.” There is obviously a wide range of stop spacing here, from several miles on BART to a half mile on parts of the Light Rail and BRT systems, but this range generally indicates faster speed than locals due to wider spacing, but still a regular pattern of stops along the line, unlike nonstop.

• Local. This typically means stop spacing of 1/4 mile or less, the typical historic behavior of bus routes intended to be continuously useful to all points along the line.

• Flexible. This category includes all transit services where the route varies based on customer demand, including deviated fixed routes, Dial-a-Rides, etc.

No transit agency keeps track of all 12 cells in this matrix, nor should it. A few are naturally empty. But the matrix helps us see how critical distinctions of speed, stop spacing, frequency and span interact to form meaningful categories. They also help show why most existing VTA service categories already make sense, because the distinctions they make line up with these crucial distinctions. They may also be helpful in refining the exact definitions of these existing categories.

| Span and Frequency | Frequent (“Core”) | Candidate Frequent | Infrequent | Peak-only
|---------------------|------------------|-------------------|------------|---------
| ≤15 min all day, long span | Every <=30 min all day, long span | Every 60+ min all day and other short spans
| All-day Expresses (Mostly Intercounty) | Commuter Express Bus or Rail Events.
| Frequent | “Rapid” (Light Rail, Bus Rapid Transit, Rapid Bus
| “Core” Locales | “Core” Nonstop
| Local | Rapid or Ltd. Nonstop
| Community Routes | Workplace Shuttles (to Caltrain, ACE, etc)
Service Branding

Defining vs Secondary Characteristics

The definitions of service categories often become confused over time because too many features are cited as part of a category, and this creates confusion over how to categorize a service that has some of these features but no others. The confusion is most obvious in conversations about “Bus Rapid Transit” (BRT) where some people emphasize the speed and reliability that arises from the exclusive right of way, others emphasize what stations need to look like, while others emphasize the attractiveness of infrastructure or fleet. While all of these features are parts of the best Bus Rapid Transit systems, there is constant disagreement about the minimal definition: What features must a service have to be called BRT at all? For this reason, the definition of a category must not just be a long pile of features. It should also clarify which features are definitive of the category. Definitive means that if a service does not have that feature, it should not be in that category.

For reasons outlined below, we recommend that the distinctions outlined in the last section (first, frequency and span; second, stop spacing vs speed) be the defining features of VTA’s service categories. We especially recommend clarifying, and branding even more strongly, the categories that promise frequent service (every 15 minutes or better) at most times of day.

Relationship to Cost and Ridership Expectations

As we explore the table of categories, it is helpful to note that certain services tend to be more expensive to provide than others, and therefore tend to come with higher ridership expectations. These categories as shown by their ridership expectations in Figure 58 on page 53.

In particular:

• Frequency and Span (leftward on the chart) are expensive. The cost of service doubles with a doubling of frequency, and also grows in proportion to extensions of the service day. However:

• Peak-only service (far right in the chart) is also expensive, especially long peak runs. The high cost of peak-only service arise from (a) the need to own fleet that is used only briefly, (b) the need to compensate employees for awkward shifts, and (c) the high cost of serving demand that goes in only one direction at a time, as the driver must be paid to return to their starting point, usually with their vehicle, at the end of each shift.

• Nonstop service (upward) is expensive because a long distance must be crossed to connect the endpoints. Rapid service is not intrinsically expensive as service, but usually comes with infrastructure that needs a ridership justification.

As a result of these costs, ridership expectations tend to be higher in the cells marked red. Slightly lower expectations attach to the cells shaded in orange.

Low ridership expectations attach to the cheapest services – infrequent fixed routes, whose purpose (as we will explore in the next chapter) is not really ridership at all.

Frequent Network Branding and VTA’s Core Network

Many transit agencies are finding value in identifying and branding all of their services that run frequently all day, where “frequently” almost always means “every 15 minutes or better.” This brand more or less corresponds to VTA’s “Core” category, but with more rigorous standards for inclusion. These “Frequent Networks” offer several kinds of value that make them worth identifying and marketing:

• “Turn up and go.” High frequency means that you experience service as going when you’re going, instead of requiring you to plan you trip around a schedule. This is a major qualitative difference in the experience of transit, and vastly expands the range of situations in which people might find it useful.

• Easy Connections. Where two infrequent lines cross, the untrained eye may imagine that the lines connect with each other, but the experienced rider knows that they really do not. Low frequency means long waits for connections, often prohibitively long. By contrast, wherever high-frequency lines cross, the connection is easy. Frequency thus makes lines work together readily, forming a network that can be used for travel between any two points in the network. The Frequent Network is a network in a way that the collection of infrequent routes is not.

• Reliability. High frequency is a backstop for reliability problems. Breakdowns and delays matter less if another bus is always coming soon.

• High Ridership. In most transit networks, the Frequent services are among the most productive.

6 Partly to avoid this debate, VTA and other agencies often use the term “rapid bus” or “rapid” to denote “not in an exclusive right of way, and therefore not really Bus Rapid Transit, but definitely faster than a local bus.”

7 See, for example, the Bus Rapid Transit Standard by the Institute for Transportation and Development Policy (ITDP) for one attempt to argue for a strict set of definitions. https://www.itdp.org/library/standards-and-guides/the-bus-rapid-transit-standard/ The ITDP BRT standard is controversial in the US, partly because it excludes many projects that would be called BRT by the Federal Transit Administration, largely due to the lack of exclusive lanes.

Figure 58: Ridership Expectations by Service Category
Service Branding

- Permanence. Frequency is so expensive that the investment isn’t made in corridors where ridership potential isn’t strong, due to built environment features. As a result, the Frequent Network is generally the most permanent part of any transit system, apart from rail.

- Land Use Synergies. Because of their high usefulness and permanence, Frequent Networks are excellent locations for densification, lower parking ratios, etc.

- Affordability. Unlike rail, which tends to inflate property values around its stations, Frequent Networks can be so extensive that land along them remains relatively available at many price points. They are therefore a key tool for getting useful transit to lower income residents, and connecting them to opportunities.

- Full Employment. Transportation is one of the leading barriers to low income persons trying to hold jobs, and the Frequent Network is a particularly effective tool for that purpose. It runs long hours, comes soon, and can be relied on, both critical for workers who punch time clocks and whose shifts are rarely “nine to five.”

- A Focus for Infrastructure and Priority. As Frequent Networks grow, and grow more permanent, they are obvious top-priority places for infrastructure investment and transit priority. Some cities recognize frequent network streets in their street classification systems, so that appropriate priority can be given to transit there.

VTA has an emerging Frequent Network brand, called the “Core” Network, which seeks to foster many of these values. It includes major lines that run every 15 minutes or better at least on weekdays. As such, Core is currently an aspirational term, not a term that strictly describes the existing system.

One question for VTA is whether the term “Core” is sufficiently self-explanatory. The term has useful connotations such as “fundamental,” “at the center of things,” etc., but it does not tell a potential rider what the value proposition is for them.

This is why the emerging practice, in North America and to some extent overseas, is to use the word “frequent” in some form as the name of the service. This is understood as “frequent most of the time,” including long evening and weekend spans, because the whole point is that service is coming soon, whenever you need it.

A brand like “Frequent Network” is introduced to signal high frequency and a long span. The exact guarantee that the term will signify needs to be refined as the brand is developed, but it usually means service running every 15 minutes or better at least 14 hours a day, 7 days a week, with some service continuing in the evening or early morning for a total service day of 18-20 hours. These definitions obviously vary based on the intensity of the transit market, so the guarantee will be higher in San Francisco than in most other parts of the region.

Unlike aspirational brands, it must also signify a guarantee of service now, to the customer of today. The term Candidate Frequent can be helpful in identifying – to the public and to stakeholders – the intention to introduce Frequent service in the future. Frequent service can also be used to leverage desired outcomes from municipal partners. For example, it may make sense, as a VTA investment, to introduce Frequent service only if certain speed and reliability improvements are achieved, or if development reaches a certain level.
Service Branding

Branding Service Categories
Service categories are most effective when they are presented both to the public and to stakeholders using the same language. While some agencies use one set of categories for policy-making and another for presenting service to the public, this yields a much weaker effect.

Once service categories are presented to the public, they can be called brands. VTA currently has some strongly branded services, like the Expresses, but it also has many categories that it keeps track of internally but that are not presented to the public very forcefully, such as the Core Network.

Branding a product within the network is obviously different from agency branding, but the plethora of two-word brands shows that everyone knows the difference. When we hear two-word brands like “Microsoft Excel,” or “Google Maps” we immediately understand two things:

- The first word is the company, while the second is the product, and
- This product is one of a series that are all designed to work together, as part of a larger whole.

Service categories work exactly like tech brands in this respect. Los Angeles Metro, for example, distinguishes between Metro Rapid and Metro Local buses, a stop spacing distinction.

These brands do not represent competitors, but rather different and complementary tools all brought to you by a single organizing entity. The key is to use the tools together, it’s best to be clear on how they’re different from each other. Figure 60 shows a selection of maps and other frequent Network brand elements from Los Angeles, Minneapolis and Portland, three cities whose transit agencies brand and

Figure 60: Frequent Network brand elements

Every 15 Minutes (or Less)
Service Branding

promote a distinct Frequent Network.

Conclusion and Recommendation

VTA’s system of service categories is already broadly logical. Our suggestions are largely matters of clarification and branding, namely:

1. Be clear that the defining features of a brand are frequency, span, and stop spacing, and that other features – for example, levels of amenity or types of infrastructure – are secondary features that follow from the defining features but never substitute for them. There is no evidence that this has actually happened at VTA, but it is a perennial caution because there are many situations where the temptation to do this is high.

2. Consider replacing the term Core with Frequent, which is more explicit about what the distinguishing feature of that service is and why people should care about it.

3. Consistent with the previous point, move the downtown San Jose shuttle, Line 201, from the Community category to the Core or Frequent category. It was placed in the Community category because it is very short, but to customers and stakeholders, the frequency is the more important defining feature.

4. Strengthen the relevance and public understanding of the categories by making them more explicit in branding and information. In particular, strongly brand the Frequent Network across the information system, including by making it one of the most prominent visual layer on the network map. The data reviewed in this report provides insights but is not sufficient to tell VTA what to do. Network planning decisions arise from the combination of facts and values. Value judgments—choices about how to balance different goals—will also be needed, and the next steps of the study will encourage discussion on these. This short chapter outlines the major ones.
Service Branding

Key Chapter Findings

• Transit services can be classified based on multiple attributes, but the most relevant to customers focus on usefulness.

• Classification is reflected in customer information (maps, apps, schedules, infrastructure, vehicles), and in goals and outcomes.

• The most important categories to communicating the usefulness of a transit service are frequency and span: when is the service available, and how long is the wait to access it likely to be?

• Frequent Network Branding is focused on quickly communicating what level of service is available in which places, and where transit is most useful.

• VTA’s current classification is already broadly logical, but the connection to frequency could be made more explicit by renaming the “Core” class to “Frequent,” and reclassifying a few routes based on this distinction.
5 Key Questions
Key Questions

The Ridership / Coverage Tradeoff

VTA’s performance data—like that of most agencies—reveals that not all services are justified by ridership. Many services exist despite not just low ridership, but despite any reasonable prospect of high ridership in the future. These services run in areas where the development pattern—especially the transit-critical features of density, walkability, linearity, and proximity—largely ensure low ridership potential. All of VTA’s Community services are in this category, as are some segments of other lines.

Rather than judging such services as failing, it is more accurate to describe them as having a non-ridership purpose.

Every transit network is a mixture of services designed for high ridership and those designed for a competing goal, which can be called coverage. This trade-off arises unavoidably from the nature of the transit product. This is not an either-or choice; no transit agency is at either extreme; every transit agency operates services geared towards either goal, and identifying them clearly is necessary to translate policy-level direction on the purpose of transit into service planning.

Ridership Goal: “Maximize Ridership”

Do you want transit to be designed for maximum ridership for the budget? This goal serves several common intentions for transit, including:

- Low subsidy, because more of the revenue comes from fares.
- Vehicle trip reduction and emissions benefits.
- Support for dense urban development, because a focus on ridership tends to serve these areas well.

The Ridership goal is often meant by “running transit like a business.” Unlike government services, businesses are motivated by the goal of maximum profit. In the case of local transit, where the fare paid by each customer is reasonably constant, this would mean maximizing the number of customers at a given cost.

Government services have a more complex set of motives, but they do resemble businesses when they are trying to maximize the number of users. So it is important to understand both why transit sometimes runs like a business and why it sometimes, intentionally, does not.

Every private business chooses which markets it will enter based on the market—especially the transit-critical features of density, walkability, linearity, and proximity—largely ensuring low ridership potential. All of VTA’s Community services are in this category, as are some segments of other lines.

Before you can plan transit routes, you must first decide what you want transit to do.

Imagine you are the transit planner for this fictional town. The dots scattered around the map are people and jobs; the streets shown are ones on which transit can be operated. The buses are the resources the town has to run transit.

Support for dense urban development, because a focus on ridership tends to serve these areas well.

When you say “for all,” you implicitly say “every last one, no matter how expensive it is to get to them.” The resulting network would run less service in high-demand areas so that it can run more service in low-demand areas, to ensure that everyone has some access. Service is spread out, which also means that it is spread thin. The resulting frequencies are low, and service may not run long hours. Because the service is not very useful, even in areas of high transit demand, ridership is typically poor.

But while the Coverage goal is not what would motivate a private business, it has played an important role in the shaping of every North American public transit system. Excluding so much of a service area tends to be politically unacceptable. Concerns about line frequency— not high demand, but extreme needs experienced by small numbers of people—are also a reason to devote resources to the coverage goal.

The Two Goals in Practice

Why does a Ridership goal cause service to be concentrated in the highest-demand areas? Because as we noted in Chapter 3, frequency correlates with high productivity (ridership per unit of cost). High-frequency service, serving a favorable built environment, consistently generates the highest “bang for buck,” that is, ridership per unit of cost.

High-ridership planning therefore starts with high all-day frequency and extends it as far as it will go, focusing on the places where the most people will benefit from it. That, in turn, means dense and walkable places where many people are near the stops and can get to the stops. A transit line along an already-busy corridor can also stimulate new development.

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Before you can plan transit routes, you must first decide what you want transit to do.
growth along that corridor, encouraging new retail, employment activity and residential growth.

When coverage is the goal, service is spread out so as to maximize the number of people who are near any service. The result is always low frequencies, because low frequency allows a limited resource to be spread over more area. Most coverage services run every hour, and for shorter hours than other services do. The Community service category at VTA typifies coverage services: hourly routes, often circuitous, because the goal is a little service over a large area.

The Current Balance
So throughout this study, we will ask: What percentage of resources do you want to devote to the goal of Ridership, and what percentage to Coverage?

We estimate that approximately 70% of VTA’s non-express bus service is where it would be if ridership were the agency’s only goal, while the other 30% serves coverage purposes. (We have excluded the Express services from this calculation because the measures of ridership are so different for them.) Moving towards ridership would mean shifting resources from service providing coverage to low-density areas and investing it in frequent service to dense places, while moving towards coverage would entail the opposite. The next phase of this study will develop some conceptual alternatives to help people consider this tradeoff, and to decide whether VTA should revise the current balance, increasing ridership at the expense of coverage or vice versa.

One important note is that all current performance standards (as set forth in the Transit Sustainability Policy) are ridership-based; that is, they are based on measures of how effectively each route generates ridership given investment. However, as mentioned in the section on service branding, these measures alone may not be appropriate for low-cost, infrequent services serving primarily the coverage goal. A clear choice to allocate some portion of VTA’s resources towards the coverage goal may also invite a discussion of additional service standards that could be used to assess those routes’ performance towards non-ridership goals.

How to Serve the Peak?
Another significant trade-off at VTA is the high expectation that the agency focuses intensely on the peak or “rush hour” commute, combined with the fact that this is not always the cost-effective thing to do.

While ridership is certainly higher during the peak, service cost also rises very dramatically at that time. Service that runs only during the peak is much more expensive for VTA to operate, for three reasons:

- The high cost of buying, storing and maintaining vehicles that are used only briefly each day.
- The higher cost of driver time due to short shifts. (VTA’s labor contract has no provision for part time drivers, who are the most efficient way to staff peak-only service.)
- The tendency of peak-only service to be busy in only one direction, which requires all the vehicles and drivers to return empty in the other direction.

Another way of saying this is that all-day, evening, and weekend service is relatively cheap to operate compared to peak service, which is why focusing on all-day markets is often a better path to high ridership overall. The key to the all-day market is that it’s so diverse. It includes most commuting by lower-income people, whose work and training commitments rarely require them to travel only at rush hour. It also includes a wide array of trip purposes which tend to use capacity more evenly.

In general, then, we expect the study to feature a discussion about the relative importance of peak-only services for the “rush hour” commute as opposed to all-day, all-direction service. (Note, of course, that all-day service is used at rush hour too.) While the rush hour is the time of highest demand, that does not necessarily make it the time of highest productivity, because of the high marginal cost of peak-only service.

Network Design
VTA’s most intensive services are very concentrated in San Jose, with two major frequent lines extending westward but no frequent north-south service in the western half of the County. San Jose is a strong market, generating a tremendous amount of the agency’s ridership. Further improvements to routing or frequency could likely make it even better, but the key driver of ridership that the agency controls, useful high-frequency service, is already in place.

If the agency is to grow its ridership and increase transit mode share, as mandated by the Transit Sustainability Policy, it must expand its frequent network to replicate the successes of the eastside grid. It has found success in radial frequent routes along El Camino Real and Stevens Creek, the two strongest westside radial corridors, but has so far not seriously directed resources towards a set of frequent grid services similar to that in place west of downtown.

Such a service design would be expensive, but some of it could be potentially forged out of existing duplicative services, especially the complex braid of partly overlapping routes that flow north-south through Sunnyvale and Cupertino. Further west, Mountain View has poor frequency for such high density and low income, and here the problem may also be that service is offered by too many overlapping routes, in this case routes generated by a multitude of operators and arrangements. Some efficiencies may also be possible in the northeast, in the context of BART’s opening to Berryessa. But the route pattern covering most of the rest of the County shows little sign of easily re-allocated wasted service.

The next step of this study, the conceptual service alternatives, will explore these possibilities in more detail.

Service Hierarchy
In Chapter 4, we discussed VTA’s current service hierarchy, and the idea of branding service based on the mobility outcomes they can provide. VTA current groups in services into several categories: Core, Local, Community, Express and Limited, but these categories do not necessarily match to easily explained service outcomes. For instance, the Core network includes services like the 22 and 23, routes which deliver a high level of frequency to key markets. It also includes the 55, a 30-minute route serving Sunnyvale-Saratoga road, far outside the “core” of the network in a geographic sense, and offering a lower level of service to the customer.

As discussed in Chapter 4, VTA may wish to consider its options around service branding in the future, in order to better communicate actual attributes of the network to customers more easily.

Resource Level
Perhaps the most fundamental question about transit in this region is “how much”? We opened this report with the observation that many of the key indicators for the richness and impact of transit (quantity, ridership, relevance, productivity) have fallen or flatlined for VTA’s network over the past 15 years. The population, with an average population growth rate of 1.1% annually since 2010, has been growing faster than the transit service (as measured in terms of revenue hours, the basic transit service unit). The choice for policymakers and voters may be whether transit should be an important and viable mode the get around the heart of Silicon Valley.

If the County continues to grow, it will do so mainly by increasing density within the already developed area. This will increase both demand and ridership potential for VTA, as more people will live on its busiest lines. Frequent network branding can also help insure that people who want...
Key Questions

to rely on transit can located where transit will serve them well, further increasing ridership potential.

Growth in demand will use existing capacity to a degree, but will soon need new capacity. New destinations will also arise—housing developments, corporate campuses, shopping centers—and with them, new demands on transit to provide more service to satisfy all the trips those sorts of places generate.

Chapter 1 showed that in general, ridership has tracked with the quantity of service. This means that if higher ridership is desired—with benefits including less reliance on cars, higher fare revenue, and support for more energy- and emissions-efficient urban form, more service will be needed as well.

Some of this increase could be achieved by cutting coverage services, but this would sacrifice other values, including lifeline access and the inclusion of every member city. So if the current balance of ridership and coverage services is desired, and the needs of population growth are to be met, overall resources will eventually need to grow.
Appendix A: Ridership / Coverage Analysis
Appendix A: Ridership / Coverage Analysis

To get a sense of the current mix of priorities in VTA’s existing bus network, we performed a basic accounting of the extent to which different routes service each of the ridership and coverage goals. The route-by-route accounting is shown in the tables on the next few pages, a summary on the chart on this page.

Methodological Description

This ridership/coverage analysis is not designed to identify ridership potential, or routes which serve places where high ridership indicators are present. Instead, it is intended simply to gauge the extent to which each route (and the network at large) is oriented towards either goal. In other words, given the “three-legged stool” of transit ridership (land use, street network and service provision), how focused is the transit service element on ridership?

An analysis of this sort can be performed through a variety of methods, but we prefer to simplify it to the greatest extent possible. Thus:

- All Frequent routes (operating every 15 minutes or better during the peak and midday periods) are initially considered to be 100% ridership routes, since it is assumed that the investment in such a high level of service is generally not warranted without the expectation of a favorable ridership outcome.

- All 60 minute routes are assumed to be operated for 100% coverage purposes, because such a low frequency is very rarely rewarded with much ridership as it is the least useful, most inconvenient sort of all-day service. Fittingly, most of VTA’s 60-minute services are feeders routed through low-density, peripheral areas.

- All 30 minute services are initially considered to be 50% ridership, 50% coverage oriented, since this moderate service level is sometimes a capacity-driven coverage solution, but at other times a precursor to the establishment of a future high-ridership frequent route.

- Limited and Express services were assigned to their own category, since these routes serve other goals in addition to the ridership/coverage outcomes, such as connecting outlying areas to job centers, taking advantage of HOV infrastructure and available external funding, and providing a congestion reduction element.

Starting from this initial classification and goal allocation, each route was examined in isolation, and its goal orientation adjusted if a compelling rationale to do so was found. The tables on the next page include some information used for this assessment, including productivity, total average daily ridership, frequency by time period, and span.

Additionally, we used interactive data visualization tools to examine the pattern of ridership on routes.

To provide an example of how such a judgement might be made, consider route 26 (Sunnyvale/Lockheed - Eastridge). This is a very long route operating at 30 minute frequency during the peak and midday, with a limited segment between Lockheed and El Camino Real that runs every 15 minutes during the peak periods. Of all bus routes in the network, it generates the 8th most average daily boardings, and is the 8th most productive as measured by boardings per revenue hour. By examining its ridership pattern as shown at right, we can see that its highest-ridership segments are on its frequent segment, and also in the portion of the route that traverses the east side of San Jose along Tully.

As a 30-minute route, its ridership/coverage split was initially set to 50/50, but based on its performance relative to other routes in its class, and even to more frequent routes, its clear that this is an example of a route that is substantially more focused on ridership than its class baseline. While its clearly not a 100% ridership route since it mostly operates at 30-minute headways, the great majority of its revenue hours are where they would be if ridership were the only goal. Thus, we adjusted its ridership coverage split to 80% ridership, 20% coverage, and its daily revenue hours are allocated as such.

We went through the same process for each route, resulting in the eventual split shown in the table. It should be noted that while the precise split of local resources shown here is approximately 66% ridership, 34% coverage, but understanding that this is a process based on professional judgement and multifactor assessment, we have reported the result rounded to the nearest 10%.

<table>
<thead>
<tr>
<th>Entire Bus Network</th>
<th>Local Bus Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local System</td>
<td>93%</td>
</tr>
<tr>
<td>Ridership</td>
<td>70%</td>
</tr>
<tr>
<td>Coverage</td>
<td>30%</td>
</tr>
<tr>
<td>Express</td>
<td>7%</td>
</tr>
</tbody>
</table>

Figure 62: Ridership / Coverage Split Table
## Appendix A: Ridership / Coverage Analysis

<table>
<thead>
<tr>
<th>#</th>
<th>Type</th>
<th>Name</th>
<th>AM</th>
<th>Mid</th>
<th>PM</th>
<th>Span</th>
<th>Rev Hrs</th>
<th>Avg. Daily Boardings</th>
<th>Productivity</th>
<th>Ridership%</th>
<th>Coverage%</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Local</td>
<td>SANTA CLARA TRANSIT-METRO AIRPORT</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>5a-1130p</td>
<td>37.87</td>
<td>1355.1</td>
<td>35.79</td>
<td>100%</td>
<td>0%</td>
<td>Major all-day frequent or 20 minute corridor.</td>
</tr>
<tr>
<td>13</td>
<td>Community</td>
<td>ALMADEN &amp; MCKEAN- OHLONE/CHYNWTH</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>630a-730p</td>
<td>10.05</td>
<td>193.4</td>
<td>19.24</td>
<td>0%</td>
<td>100%</td>
<td>Local coverage route serving low density area.</td>
</tr>
<tr>
<td>14</td>
<td>Community</td>
<td>GILROY TRANS CTR - ST. LOUISE HOSP</td>
<td>45</td>
<td>40</td>
<td>45</td>
<td>8a-6p</td>
<td>9.42</td>
<td>169.4</td>
<td>17.99</td>
<td>0%</td>
<td>100%</td>
<td>Local coverage route serving low density area.</td>
</tr>
<tr>
<td>16</td>
<td>Community</td>
<td>M.H. CIVIC CTR - BURNETT AVE</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>630a-9a, 2p-530p</td>
<td>5.63</td>
<td>100.1</td>
<td>17.77</td>
<td>0%</td>
<td>100%</td>
<td>Local coverage route serving low density area.</td>
</tr>
<tr>
<td>17</td>
<td>Community</td>
<td>GILROY TRNS CTR - MNTRY &amp; LS ANIMAS</td>
<td>45</td>
<td>40</td>
<td>40</td>
<td>730a-530p</td>
<td>4.88</td>
<td>57.3</td>
<td>11.73</td>
<td>0%</td>
<td>100%</td>
<td>Local coverage route serving low density area.</td>
</tr>
<tr>
<td>18</td>
<td>Community</td>
<td>GILROY TRANS CTR - GAVILAN COLLEGE</td>
<td>30</td>
<td>40</td>
<td>45</td>
<td>7a-6p</td>
<td>6.35</td>
<td>201</td>
<td>31.65</td>
<td>0%</td>
<td>100%</td>
<td>Local coverage route serving low density area.</td>
</tr>
<tr>
<td>19</td>
<td>Community</td>
<td>GILROY TRANS CTR - WREN &amp; MANTELLI</td>
<td>45</td>
<td>40</td>
<td>45</td>
<td>530a-7p</td>
<td>8.92</td>
<td>286.7</td>
<td>32.15</td>
<td>0%</td>
<td>100%</td>
<td>Coverage service far outside the core dense area of the network.</td>
</tr>
<tr>
<td>22</td>
<td>Core</td>
<td>PALO ALTO - EASTRIDGE</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>24 hrs.</td>
<td>356.20</td>
<td>14178.7</td>
<td>39.81</td>
<td>100%</td>
<td>0%</td>
<td>Major all-day frequent or 20 minute corridor.</td>
</tr>
<tr>
<td>23</td>
<td>Core</td>
<td>DE ANZA COL - ALUM ROCK CTR</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>530a-1a</td>
<td>207.90</td>
<td>8397.2</td>
<td>40.39</td>
<td>100%</td>
<td>0%</td>
<td>Major all-day frequent or 20 minute corridor.</td>
</tr>
<tr>
<td>25</td>
<td>Core</td>
<td>DE ANZA COL - ALUM ROCK CTR</td>
<td>10/30</td>
<td>10/30</td>
<td>10/30</td>
<td>5a-12mid</td>
<td>224.57</td>
<td>7269.5</td>
<td>32.37</td>
<td>75%</td>
<td>25%</td>
<td>Important connection east-west across the city. Frequent segment west of Bascom very high ridership. Low density market generates little ridership in the long segment between Bascom and Cupertino.</td>
</tr>
<tr>
<td>26</td>
<td>Core</td>
<td>SUNNYVALE/LOCKHEED - EASTRIDGE</td>
<td>15/30</td>
<td>30</td>
<td>15/30</td>
<td>530a-11p</td>
<td>113.95</td>
<td>4005.1</td>
<td>35.15</td>
<td>80%</td>
<td>20%</td>
<td>High productivity crosstown grid element with frequent segment in east.</td>
</tr>
<tr>
<td>27</td>
<td>Local</td>
<td>GOOD SAM HOSP - KAISER SAN JOSE</td>
<td>30</td>
<td>45</td>
<td>30</td>
<td>6a-8p</td>
<td>36.47</td>
<td>822.7</td>
<td>22.56</td>
<td>0%</td>
<td>100%</td>
<td>Local coverage route serving low density area.</td>
</tr>
<tr>
<td>31</td>
<td>Local</td>
<td>EVERGREEN VALLEY COL - EASTRIDGE</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>6a-10p</td>
<td>24.17</td>
<td>689.9</td>
<td>28.55</td>
<td>10%</td>
<td>90%</td>
<td>Low-productivity coverage route serving moderately dense areas, may be important E-W grid element, but perhaps better market north on Arques/Scott for segment west of Sunnyvale?</td>
</tr>
<tr>
<td>32</td>
<td>Community</td>
<td>SN ANTONIO SHOP CTR - STA CLARA TC</td>
<td>30</td>
<td>45</td>
<td>30</td>
<td>6a-730p</td>
<td>44.27</td>
<td>1093.6</td>
<td>24.70</td>
<td>50%</td>
<td>50%</td>
<td>-</td>
</tr>
<tr>
<td>34</td>
<td>Community</td>
<td>SN ANTONIO SHOP CTR - DOWNTOWN MV</td>
<td>60</td>
<td>930a-3p</td>
<td>4.55</td>
<td>69.6</td>
<td>15.30</td>
<td>0%</td>
<td>100%</td>
<td>Local coverage route serving low density area.</td>
<td>-</td>
<td>4.55</td>
</tr>
</tbody>
</table>
## Appendix A: Ridership / Coverage Analysis

<table>
<thead>
<tr>
<th></th>
<th>Type</th>
<th>Route Description</th>
<th>Frequency</th>
<th>Hour</th>
<th>Start-End Time</th>
<th>Boardings</th>
<th>Alighting</th>
<th>Ridership Only (%)</th>
<th>Coverage Only (%)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>Local</td>
<td>DNTN MTN VIEW - STANFORD SHOP CTR</td>
<td>30/30/30</td>
<td>6a</td>
<td>930p</td>
<td>54.0</td>
<td>1123.8</td>
<td>20.78</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Short, infrequent coverage route duplicating high-tier service on El Camino Real or longer trips.</td>
</tr>
<tr>
<td>37</td>
<td>Community</td>
<td>WEST VALLEY COLLEGE - CAPITOL LRT</td>
<td>630a-10p</td>
<td>3.62</td>
<td>986.6</td>
<td>22.82</td>
<td>30%</td>
<td>70%</td>
<td></td>
<td>Short, low ridership, low frequency route, but some connection between the college/TC and rail station may be desirable in ridership-only network.</td>
</tr>
<tr>
<td>39</td>
<td>Community</td>
<td>THE VILLAGES - EASTRIDGE</td>
<td>630a-730p</td>
<td>1.53</td>
<td>458.5</td>
<td>31.55</td>
<td>0%</td>
<td>100%</td>
<td></td>
<td>Short, infrequent coverage route duplicating high-tier service on El Camino Real or longer trips.</td>
</tr>
<tr>
<td>40</td>
<td>Local</td>
<td>FOOTHILL COL - LA AVENIDA &amp; SHOR</td>
<td>630a-1030p</td>
<td>35.25</td>
<td>1040.4</td>
<td>29.51</td>
<td>50%</td>
<td>50%</td>
<td></td>
<td>Infrequent route with many deviations, only serves one major destination.</td>
</tr>
<tr>
<td>42</td>
<td>Community</td>
<td>KAISER SJ - EVERGREEN VALLEY COL</td>
<td>630a-7p</td>
<td>30.73</td>
<td>641</td>
<td>20.86</td>
<td>10%</td>
<td>90%</td>
<td></td>
<td>Infrequent route with many deviations, only serves one major destination.</td>
</tr>
<tr>
<td>45</td>
<td>Community</td>
<td>ALUM ROCK TC - PENITENCIA CK TC</td>
<td>630a-630p</td>
<td>8.15</td>
<td>227.1</td>
<td>27.87</td>
<td>0%</td>
<td>100%</td>
<td></td>
<td>Infrequent route with many deviations, only serves one major destination.</td>
</tr>
<tr>
<td>46</td>
<td>Local</td>
<td>GREAT MALL - MILPITAS HIGH SCHOOL</td>
<td>6a-630p</td>
<td>17.38</td>
<td>604.2</td>
<td>34.76</td>
<td>0%</td>
<td>100%</td>
<td></td>
<td>Infrequent route with many deviations, only serves one major destination.</td>
</tr>
<tr>
<td>47</td>
<td>Local</td>
<td>GREAT MALL - MCCARTHY RANCH</td>
<td>6a-930p</td>
<td>27.95</td>
<td>847.7</td>
<td>30.33</td>
<td>50%</td>
<td>50%</td>
<td></td>
<td>Infrequent route with many deviations, only serves one major destination.</td>
</tr>
<tr>
<td>48</td>
<td>Community</td>
<td>LOS GATOS - WINCHESTER LRT</td>
<td>6a-7p</td>
<td>14.20</td>
<td>366.8</td>
<td>25.83</td>
<td>0%</td>
<td>100%</td>
<td></td>
<td>Infrequent route with many deviations, only serves one major destination.</td>
</tr>
<tr>
<td>49</td>
<td>Community</td>
<td>LOS GATOS - WINCHESTER LRT</td>
<td>630a-730p</td>
<td>15.77</td>
<td>298.1</td>
<td>18.91</td>
<td>0%</td>
<td>100%</td>
<td></td>
<td>Infrequent route with many deviations, only serves one major destination.</td>
</tr>
<tr>
<td>51</td>
<td>Local</td>
<td>DE ANZA - MOFFETT/AMES CTR</td>
<td>630a-630p</td>
<td>25.78</td>
<td>766.5</td>
<td>29.73</td>
<td>0%</td>
<td>100%</td>
<td></td>
<td>Infrequent route with many deviations, only serves one major destination.</td>
</tr>
<tr>
<td>52</td>
<td>Local</td>
<td>FOOTHILL COLLEGE - DWNTOWN MTN VIEW</td>
<td>7a-930p</td>
<td>19.33</td>
<td>480.3</td>
<td>24.84</td>
<td>50%</td>
<td>50%</td>
<td></td>
<td>Ridership-only network would have some connection between college and downtown Mountain View, but unclear whether El Monte or San Antonio is a better street. Both low density, coverage territory.</td>
</tr>
<tr>
<td>53</td>
<td>Local</td>
<td>WV COLLEGE- SUNNYVALE TRANS CTR</td>
<td>7a-630p</td>
<td>20.87</td>
<td>676.9</td>
<td>32.44</td>
<td>0%</td>
<td>100%</td>
<td></td>
<td>Low-frequent, low-ridership, low-cost route, direct connection between WV College, Cupertino and El Camino Real, but the 57 is a more frequent, direct and shorter way to get to the college from El Camino Real from most places east of Sunnyvale. Low-density area around route other than around Sunnyvale downtown and Cupertino..</td>
</tr>
</tbody>
</table>
## Appendix A: Ridership / Coverage Analysis

<table>
<thead>
<tr>
<th>ID</th>
<th>Type</th>
<th>Location</th>
<th>Hours</th>
<th>Coverage</th>
<th>Ridership</th>
<th>Productivity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>Local</td>
<td>DE ANZA COLLEGE - LOCKHEED</td>
<td>6a-9p</td>
<td>30.02</td>
<td>1092.2</td>
<td>37.64</td>
<td>Critical direct westside connection between De Anza and Sunnyvale, but infrequent, and lower density north of downtown Sunnyvale. A 100% ridership network would likely have a route on either Sunnyvale-Saratoga or Hollenbeck between De Anza and Sunnyvale.</td>
</tr>
<tr>
<td>55</td>
<td>Core</td>
<td>DE ANZA COLLEGE - GREAT AMERICA</td>
<td>530a-1030p</td>
<td>76.52</td>
<td>2416.7</td>
<td>31.58</td>
<td>75%</td>
</tr>
<tr>
<td>57</td>
<td>Local</td>
<td>WEST VALLEY COLL - GREAT AMERICA</td>
<td>530a-1030p</td>
<td>53.43</td>
<td>1604.1</td>
<td>30.02</td>
<td>100%</td>
</tr>
<tr>
<td>58</td>
<td>Local</td>
<td>WEST VALLEY COLLEGE - ALVISO</td>
<td>6a-730p</td>
<td>42.13</td>
<td>756.8</td>
<td>17.96</td>
<td>0%</td>
</tr>
<tr>
<td>60</td>
<td>Core</td>
<td>WINCHESTER TC - GT AMERICA</td>
<td>530a-1030p</td>
<td>77.63</td>
<td>2259.3</td>
<td>29.10</td>
<td>75%</td>
</tr>
<tr>
<td>61</td>
<td>Core</td>
<td>GOOD SAM HOSP - SIERRA &amp; PIEDMONT</td>
<td>6a-9p</td>
<td>59.95</td>
<td>1784.4</td>
<td>29.76</td>
<td>75%</td>
</tr>
<tr>
<td>62</td>
<td>Core</td>
<td>GOOD SAM HOSP - SIERRA &amp; PIEDMONT</td>
<td>6a-1030p</td>
<td>60.75</td>
<td>1717.4</td>
<td>28.27</td>
<td>50%</td>
</tr>
<tr>
<td>63</td>
<td>Local</td>
<td>ALMADEN EXPY - SAN JOSE STATE</td>
<td>630a-10p</td>
<td>38.27</td>
<td>942.3</td>
<td>24.62</td>
<td>25%</td>
</tr>
<tr>
<td>64</td>
<td>Core</td>
<td>ALMADEN LRT - MCKEE &amp; WHITE</td>
<td>530a-11p</td>
<td>100.53</td>
<td>3714.6</td>
<td>36.95</td>
<td>50%</td>
</tr>
<tr>
<td>65</td>
<td>Community</td>
<td>KOOSER &amp; BLOSSOM HILL DNTN S.J.</td>
<td>630a-7p</td>
<td>31.40</td>
<td>620.4</td>
<td>19.76</td>
<td>50%</td>
</tr>
<tr>
<td>#</td>
<td>Type</td>
<td>Description</td>
<td>Frequency</td>
<td>Headway</td>
<td>Minute Passengers</td>
<td>Peak Hour Passengers</td>
<td>Ridership/Usage</td>
</tr>
<tr>
<td>----</td>
<td>------</td>
<td>-------------</td>
<td>-----------</td>
<td>---------</td>
<td>-------------------</td>
<td>---------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>66</td>
<td>Core</td>
<td>KAISER SAN JOSE - MILPITAS/ DIXON</td>
<td>15-20-15</td>
<td>1130pm</td>
<td>181.30</td>
<td>6314.1</td>
<td>34.83</td>
</tr>
<tr>
<td>68</td>
<td>Core</td>
<td>GILROY TC - SAN JOSE DIRIDON</td>
<td>15-20-15</td>
<td>1230pm</td>
<td>198.58</td>
<td>5276.3</td>
<td>26.57</td>
</tr>
<tr>
<td>70</td>
<td>Core</td>
<td>CAPITOL LRT STN - GREAT MALL/Main</td>
<td>15-15-15</td>
<td>11pm</td>
<td>162.03</td>
<td>4860.6</td>
<td>30.00</td>
</tr>
<tr>
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<td>FREMONT BART - LOCKHEED MARTIN</td>
<td>6 trips each direction</td>
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<td>12.60</td>
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## Appendix A: Ridership / Coverage Analysis

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