San José
Automated Guideway Transit
Feasibility Study

High-Level Ridership Findings

PodCar City 9, Mountain View, California

November 5, 2015

Laura Stuchinsky, City of San José

Gary Hsueh, Arup

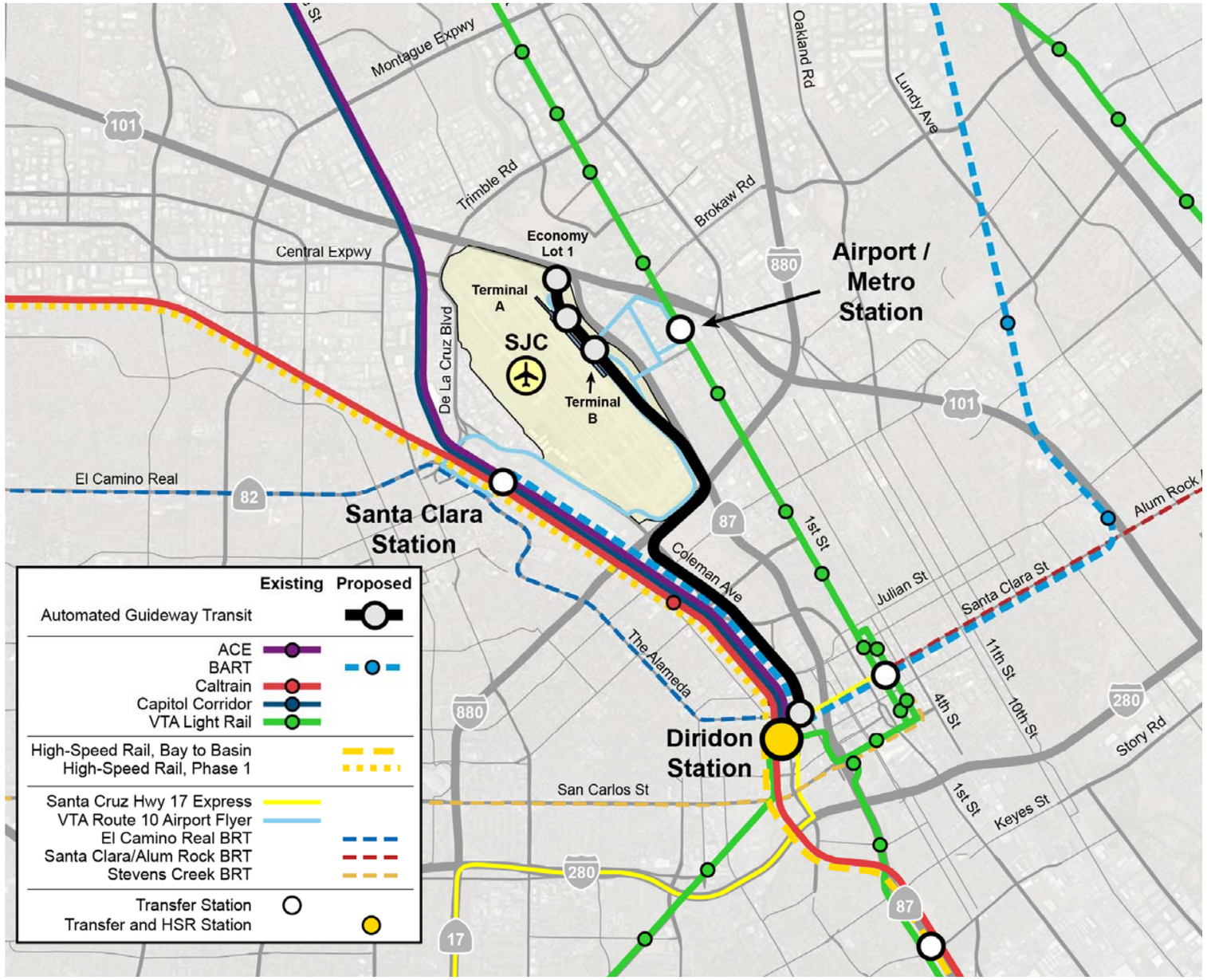
ARUP

AGT Feasibility Study Purpose

Determine feasibility of an Automated Guideway Transit (AGT) link between the Mineta San Jose International Airport and Diridon Station, Silicon Valley's premier transit station.

Determine automated transit technologies applicable to demand.

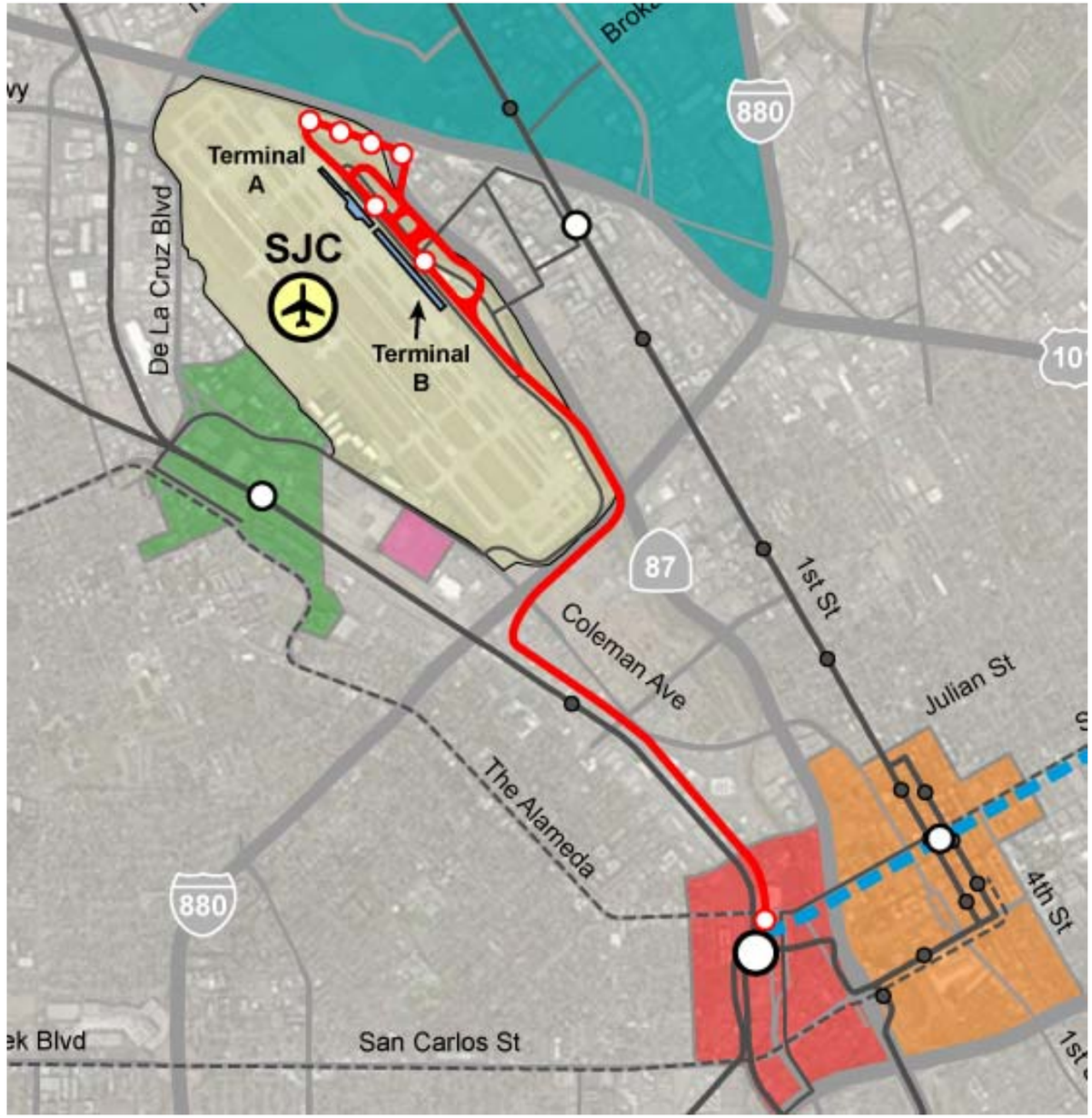
Consider the feasibility of an expanded AGT network.



Assumed Base AGT Network

San Jose Airport – 2 terminals, long-term parking

Diridon Station, next to downtown San Jose

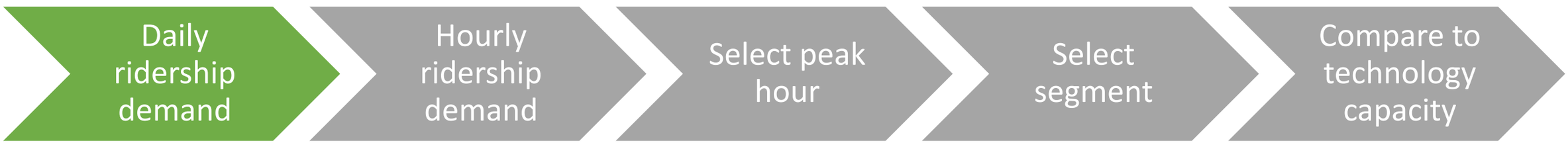


Automated Guideway Transit (AGT)

ARUP

	Automated Metro	Automated People Mover (APM)	Automated Transit Network (ATN)	
			Group Rapid Transit (GRT)	**Personal Rapid Transit (PRT)**
SERVICE TYPE	Scheduled	Scheduled	On-Demand & Scheduled	On-Demand & Scheduled
TYPICAL # CARS	4-6+ cars	1-3 cars	1 vehicle	1 vehicle
TYPICAL TRAIN CAPACITY	500-900 passengers	100-250 passengers	10-25 passengers	1-6 passengers
TYPICAL SPEED	40-60 mph	30-50 mph	15-25 mph	15-25 mph
PRACTICAL LINE CAPACITY	10,000-30,000 passengers per hour per direction (pphpd)	2,500-10,000 pphpd	2,500-5,000 pphpd	1,000-2,500 pphpd
THEORETICAL LINE CAPACITY			20,000 pphpd	10,000 pphpd
ALIGNMENT CONFIGURATION	Corridor	Corridor	Corridor (typical) or Network	Network (typical) or Corridor
REPRESENTATIVE IMAGE(S)		  		
GUIDEWAY TECHNOLOGY	Steel rail; Rubber tire on concrete	Rubber tire on concrete; Straddle beam monorail; Suspended monorail; Steel rail	Rubber tire on concrete	Rubber tire on concrete; Suspended steel rail; Supported steel rail
PROPULSION TECHNOLOGY	Electric linear induction; Electric third rail; Electric third rail	Electric third rail; Cable propelled; Electric third rail; Pneumatic	Electric third rail	On-board battery; Electric third rail
EXAMPLE SYSTEMS	Lille Metro, France Dubai Metro, United Arab Emirates Vancouver SkyTrain, Canada	Many U.S. Airports Las Vegas Monorail, Nevada Aria Resort, Las Vegas, Nevada Crystal Mover, Singapore	Morgantown, West Virginia Rivium, Netherlands	London Heathrow Airport, United Kingdom Masdar City, United Arab Emirates Suncheon Bay, South Korea

Technology Selection Process



SJC AGT Rider Markets

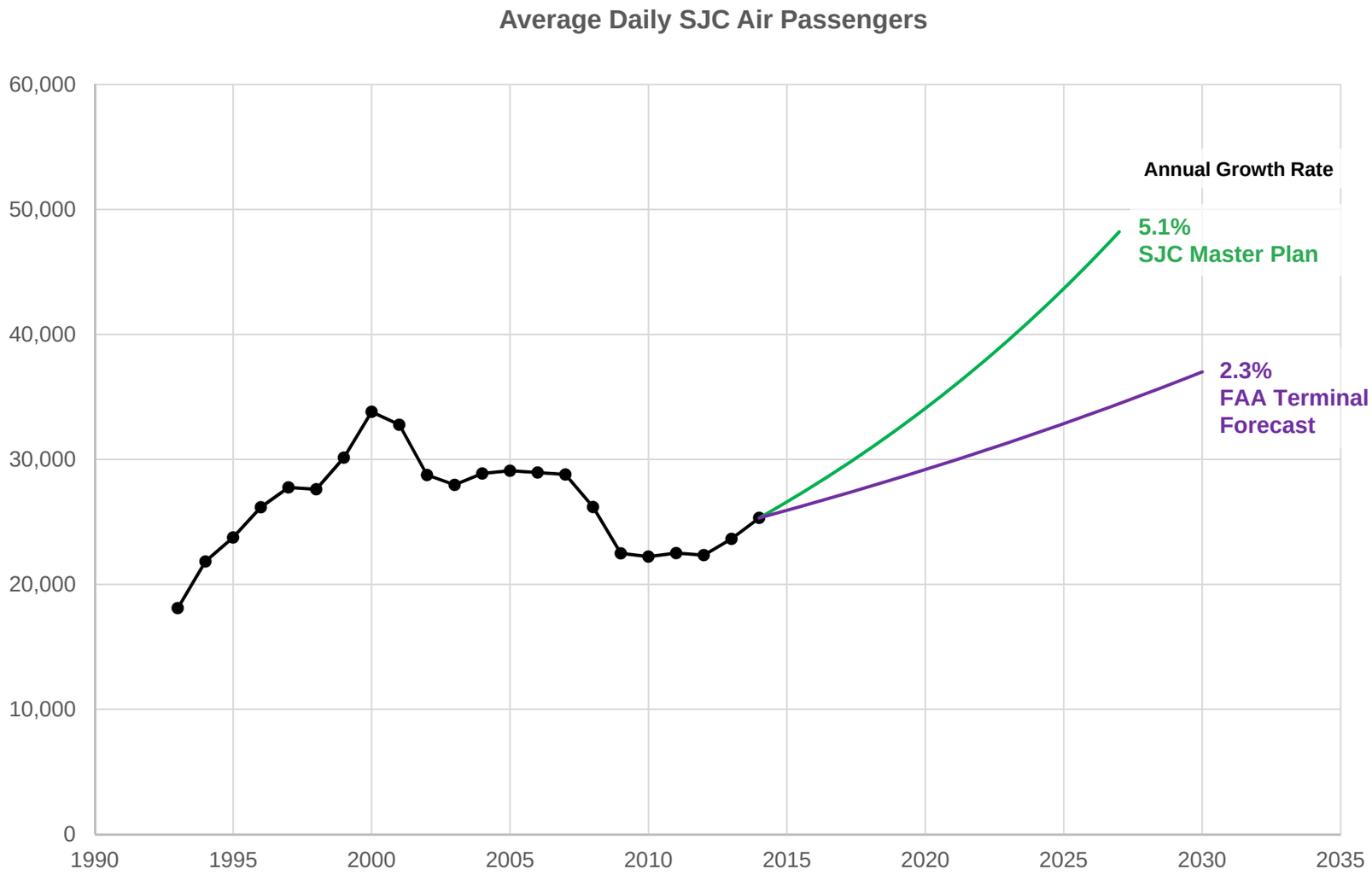
Airport-Related Trips

- **SJC Passengers + Employees ←→ Diridon**
- **Terminal A ←→ ConRAC (intra-airport)**
- **Terminal A ←→ Long-Term Parking (intra-airport)**
- **Terminal B ←→ Long-Term Parking (intra-airport)**

HSR-Related Trips

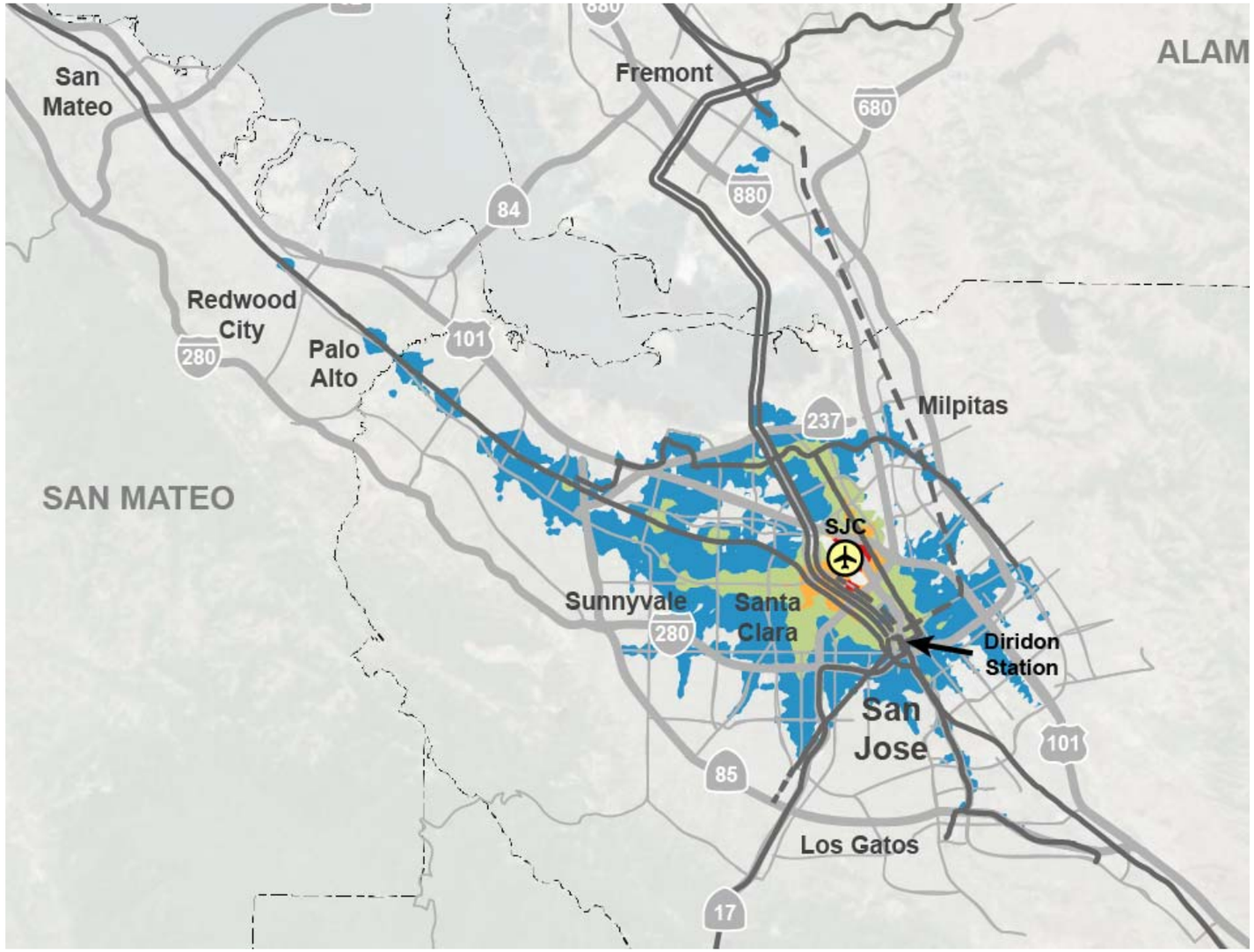
- **HSR ←→ SJC Flights**
- **HSR ←→ SJC Parking**
- **HSR ←→ SJC ConRAC**

Forecasted SJC Air Passenger Growth



SJC Transit Access – Existing

% Air Passengers within a …	
45-Minute Transit Trip	9 %
1-Hour Transit Trip	33 %



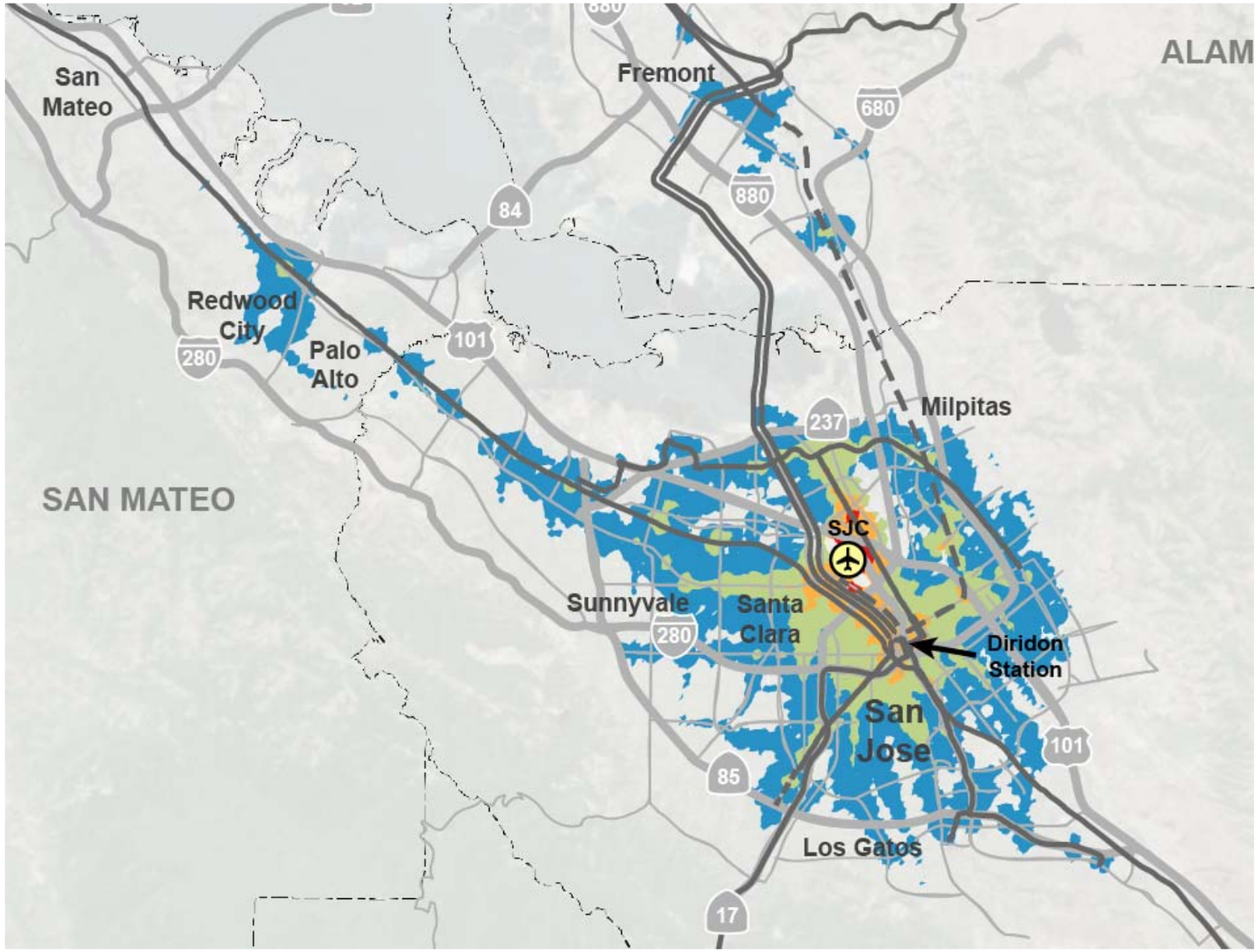
SJC Transit Access – the Potential of AGT

% Air Passengers within a …	
45-Minute Transit Trip	16 %
1-Hour Transit Trip	45 %

AGT would increase the proportion of air passengers within a 1-hour transit trip from 1/3 to almost 1/2.

The number of people who could take a 45-minute transit trip almost doubles from 9% to 16%.

The improved accessibility and competitiveness of transit suggests higher transit mode share.



Airport Transit Trips Today

Existing Transit Trips	SFO	OAK	SJC
Daily Air Passengers	140,672	30,521	25,321
Daily Employee Trips	67,160	16,000	6,200
Daily Air Passenger + Employee Trips	207,832	46,521	31,521
Daily Transit-to/from-Airport Trips	13,128	2,892	1,155*
Overall Transit Mode Share (passengers + employees)	6.3 %	6.2 %	3.7 %

The other two international airports in the Bay Area have rail connections to regional rail and consequently higher transit mode share.

* 2006 VTA Line 10 Airport Flyer Automated Passenger Counter (APC) data

AGT Daily Ridership – SJC Passengers + Employees

Annual Airport Growth Rate		2030 Daily Air Passenger + Employee Trips	AGT Potential Mode Share		
			3.5 % ~Existing SJC Airport Flyer Mode Share	5 % Lower range of potential AGT Transit Mode Share	7 % Upper range of potential AGT Transit Mode Share
No Growth (2014 Traffic)	0 %	32,000	1,100	1,600	2,200
FAA Terminal Forecast	2.3 %	42,000	1,500	2,100	2,900
SJC Master Plan Forecast	5.1 %	60,000	2,100	3,000	4,200

If you built an AGT system today, ridership would almost certainly increase because of the improved transit service (first row in table above).

The potential future ridership for AGT depends on how much growth occurs at the airport and how attractive the AGT system is. The range could vary from 2x to 4x today's transit ridership.

Intra-Airport Daily Trips

	Year 2030
• **Terminal A ←→ ConRAC (intra-airport)** • 50-80 % of Terminal A rental car users use AGT	2,000 – 3,200
• **Terminal A ←→ Long-Term Parking (intra-airport)** • 100 % of air passengers parked in Long Term Parking use AGT	2,700
• **Terminal B ←→ Long-Term Parking (intra-airport)** • 100 % of air passengers parked in Long Term Parking use AGT	6,400

HSR-Related Daily AGT Ridership, HSR ←→ SJC Flights

- Quick estimate for air passenger trips from the 4 Central Valley airports that are currently not made because of poor access to larger international airports, but could be made with a HSR connection.

HSR-Related Daily AGT Ridership

- **HSR ←→ SJC Flights**
  - 100 % (+/- 25%) of HSR – SJC connecting passengers use AGT

Year 2030
1,600 – 2,700

- **HSR ←→ SJC Parking**
  - 50-80 % of park-and-ride Diridon HSR passengers park at SJC parking facilities

Year 2030
2,200 – 3,600

- **HSR ←→ SJC ConRAC**
  - 50-80 % of HSR rental car – HSR passengers use SJC rental car facilities

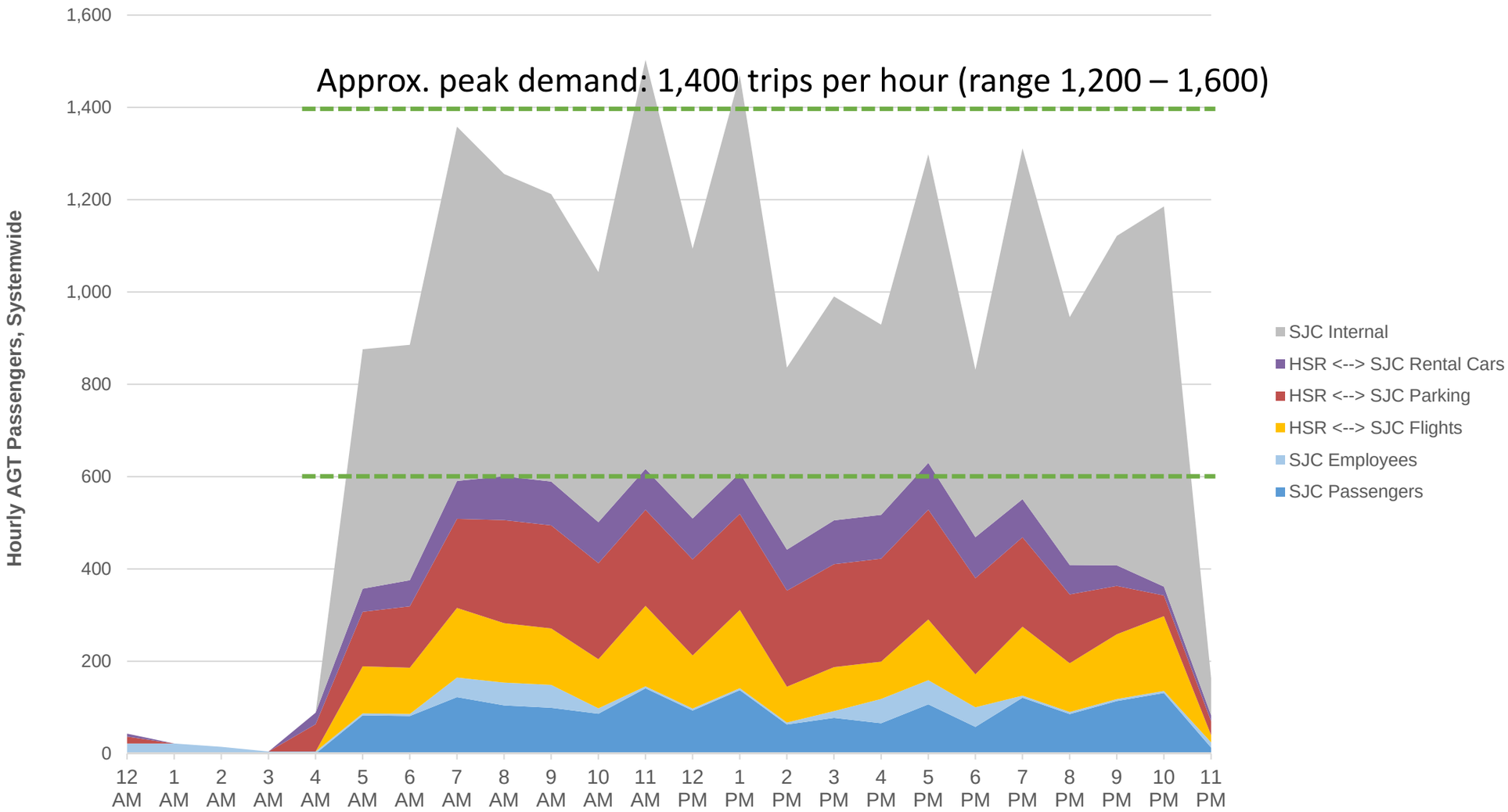
Year 2030
800 – 1,300

Summary of Daily AGT Ridership, Base AGT Network

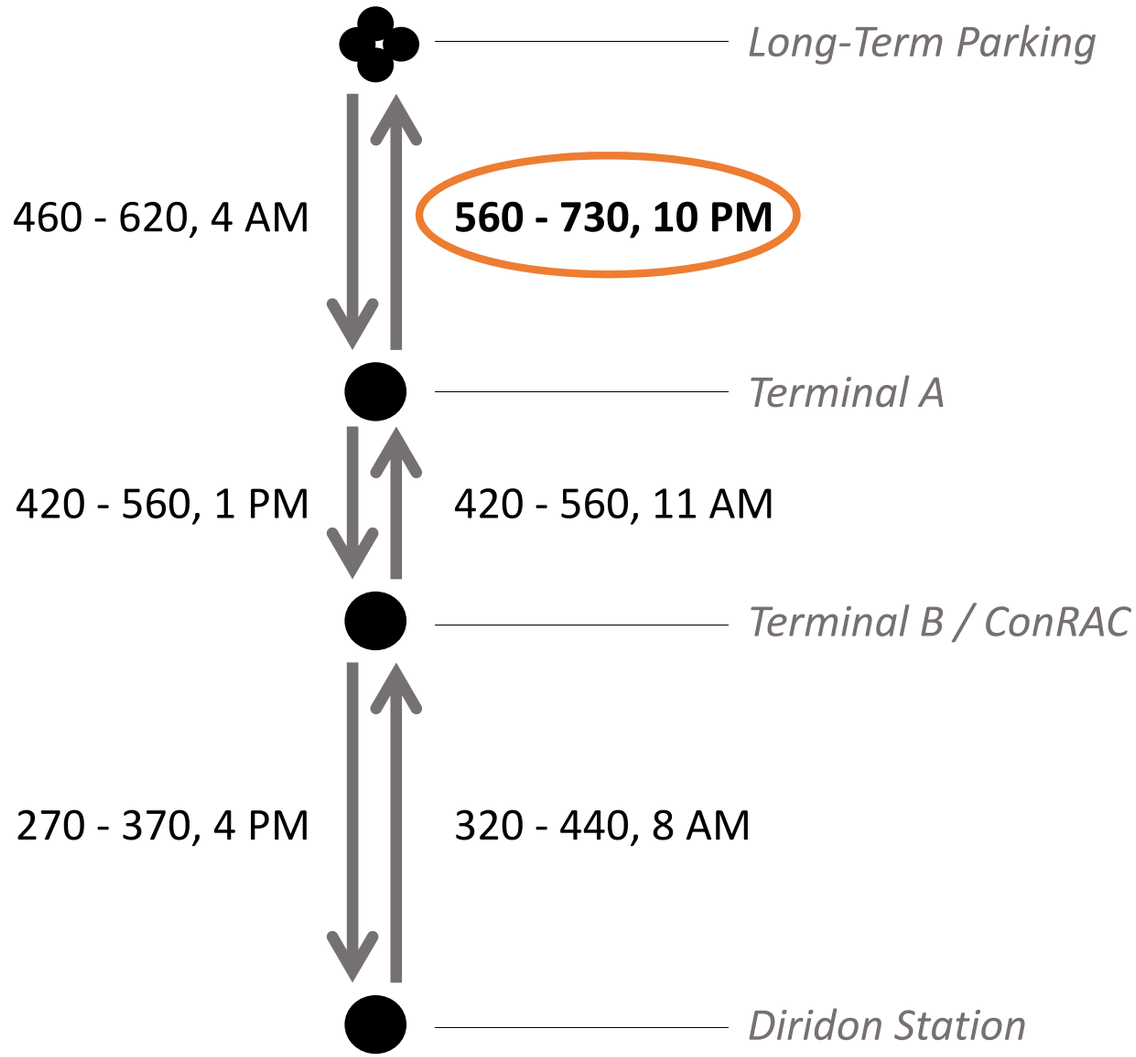
Potential Daily AGT Ridership	Year 2030
SJC Passengers + Employees	2,100 – 4,200
Intra-Airport Trips	11,100 – 12,300
HSR ←→ SJC Flights	1,600 – 2,700
HSR ←→ SJC Parking	2,200 – 3,600
HSR ←→ SJC ConRAC	800 – 1,300
Total Daily AGT Trips *without* Intra-Airport Trips	6,700 – 11,800
Total Daily AGT Trips *with* Intra-Airport Trips	17,800 – 24,100

Intra-airport trips represent a large proportion of potential AGT trips (50-60 %)

Hourly AGT Demand, Systemwide, with Intra-Airport Trips



Maximum Hourly Demand by Link, with Intra-Airport Trips



Matching Capacity… … with Demand

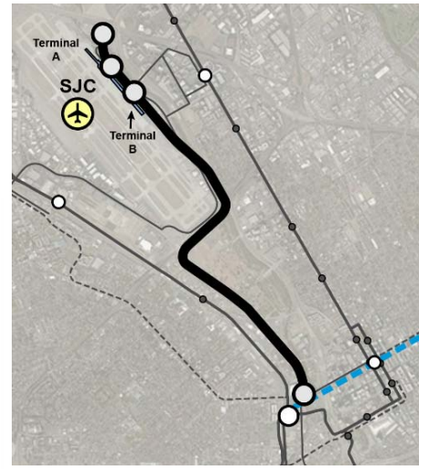
	Automated Metro	Automated People Mover (APM)	Automated Transit Network (ATN)	
			Group Rapid Transit (GRT)	Personal Rapid Transit (PRT)
SERVICE TYPE	Scheduled	Scheduled	On-Demand & Scheduled	On-Demand & Scheduled
TYPICAL # CARS	4-6+ cars	1-3 cars	1 vehicle	1 vehicle
TYPICAL TRAIN CAPACITY	500-900 passengers	100-250 passengers	10-25 passengers	1-6 passengers
TYPICAL SPEED	40-60 mph	30-50 mph	15-25 mph	15-25 mph
PRACTICAL LINE CAPACITY	10,000-30,000 passengers per hour per direction (pphpd)	2,500-10,000	2,500-5,000	1,000-2,500
THEORETICAL LINE CAPACITY			20,000 pphpd	10,000 pphpd
ALIGNMENT CONFIGURATION	Corridor	Corridor	Corridor (typical) or Network	Network (typical) or Corridor
REPRESENTATIVE IMAGE(S)				
GUIDEWAY TECHNOLOGY	Steel rail; Rubber tire on concrete	Rubber tire on concrete; Straddle beam monorail; Suspended monorail; Steel rail	Rubber tire on concrete	Rubber tire on concrete; Supported steel rail
PROPULSION TECHNOLOGY	Electric linear induction; Electric third rail; Electric third rail	Electric third rail; Cable propelled; Electric third rail; Pneumatic	Electric third rail	On-board battery; Electric third rail

Appropriate Technology Match

SJC – Diridon Trunk Demand

Maximum Hourly Demand per Direction

560-730 pphpd



AGT Costs vs. Ridership, Base AGT Network

Alternative:	Base AGT Network	BART Oakland Airport Connector	BART OAC (forecast)	Phoenix Airport People Mover
Single Track Miles (miles)	9.6	6.4	6.4	4.8
Approx. Capital Cost (millions)	$ 380*	$484	$484	$884
Cost per Track Mile (millions)	$40	$76	$76	$184
Total Daily Ridership (without intra-Airport trips)	6,700 – 11,800 †	3,300 ‡	5,000 – 7,000	
Total Daily Ridership (with intra-Airport trips)	17,800 – 24,100 †			13,000 §
Average Capital Cost per Daily Rider (without intra-Airport trips)	$32,000 – $57,000	$147,000	$69,000 – $96,800	
Average Capital Cost per Daily Rider (with intra-Airport trips)	$16,000 – $22,000			$68,000

* Costs associated with ATN.
† Ridership does not include non-airport regional transfers.

‡ Weekday ridership as of August 2015; system opened November 2014.
§ Daily ridership as of April 2015; system opened April 2013; includes Terminal 3 extension.

Observations – Base AGT Network

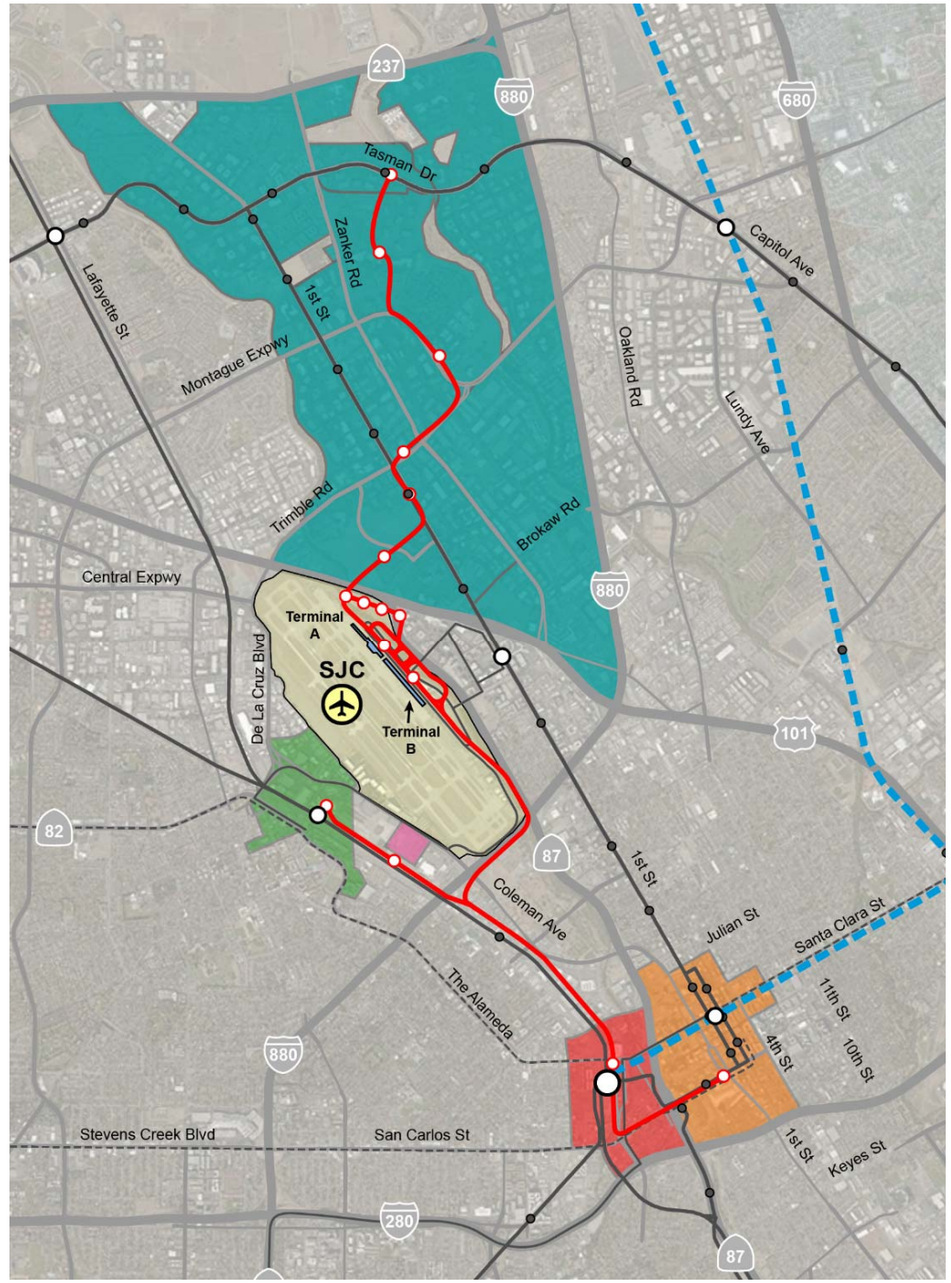
- Daily ridership of 6,700 to 11,800 fits roughly between a high-performing local bus route and a low-performing Bus Rapid Transit route.
- Potential synergy exists with HSR and airport parking / rental car facilities.
- Intra-airport trips for parking and rental car activity increase potential daily ridership by 11,100-12,300 trips, to a daily total of 17,800-24,100 trips.
- PRT appears to provide sufficient capacity to connect the Airport to Diridon Station, based on the maximum hourly demand on any one link.
- VTA could test a modified airport flyer route to and from Diridon Station and/or downtown San José.
- Compared to other recent AGT systems, the Base PRT Network at SJC would be cost effective, even more so when intra-airport trips are served.

Expanded AGT Network

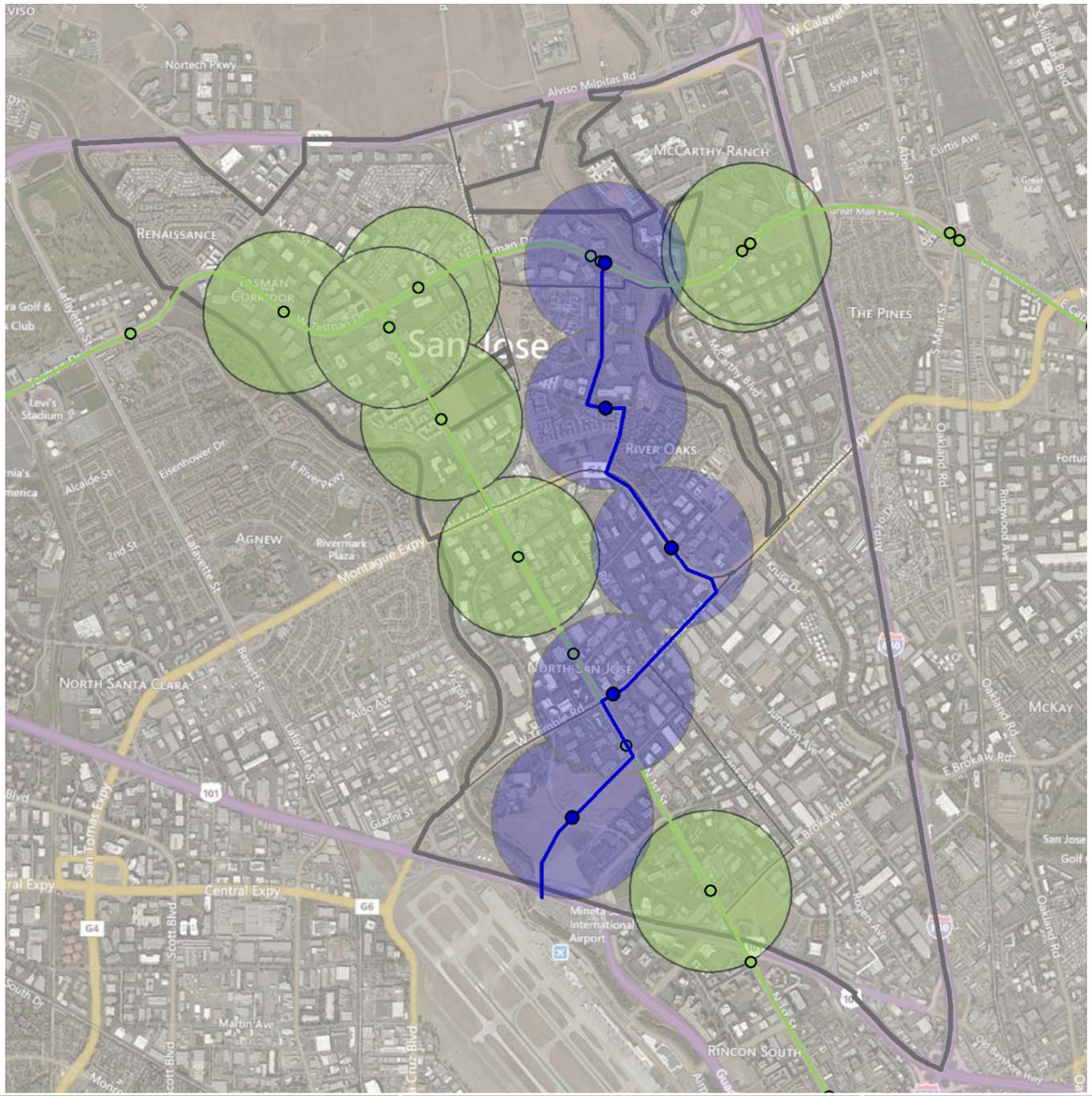
Adds stations to serve North San José, complementary to N. 1st Street LRT corridor

Adds Santa Clara station (and Avaya Stadium, not analyzed)

Adds Downtown San José / Convention Center station



Expanded AGT Network – North San José Catchment



Potential extension to North San José

Green = LRT 1/3 mile catchment
Blue = AGT 1/3 mile catchment
Transfers from AGT to LRT at two LRT stations

- LRT + AGT combined, approximately 65% geographic coverage
- Anticipated to be accessible to 80% of future (2030) population and jobs, due to density along 1st Street

- AGT mode share assumptions
  - 6 % AGT mode share in areas with walk access to AGT
  - 3 % AGT mode share in areas with walk access to LRT, assuming LRT-AGT transfer

- **Only capturing trips to other stations in network: Airport, Diridon, Santa Clara, Downtown San José**

Daily AGT Ridership Matrix, Expanded AGT Network

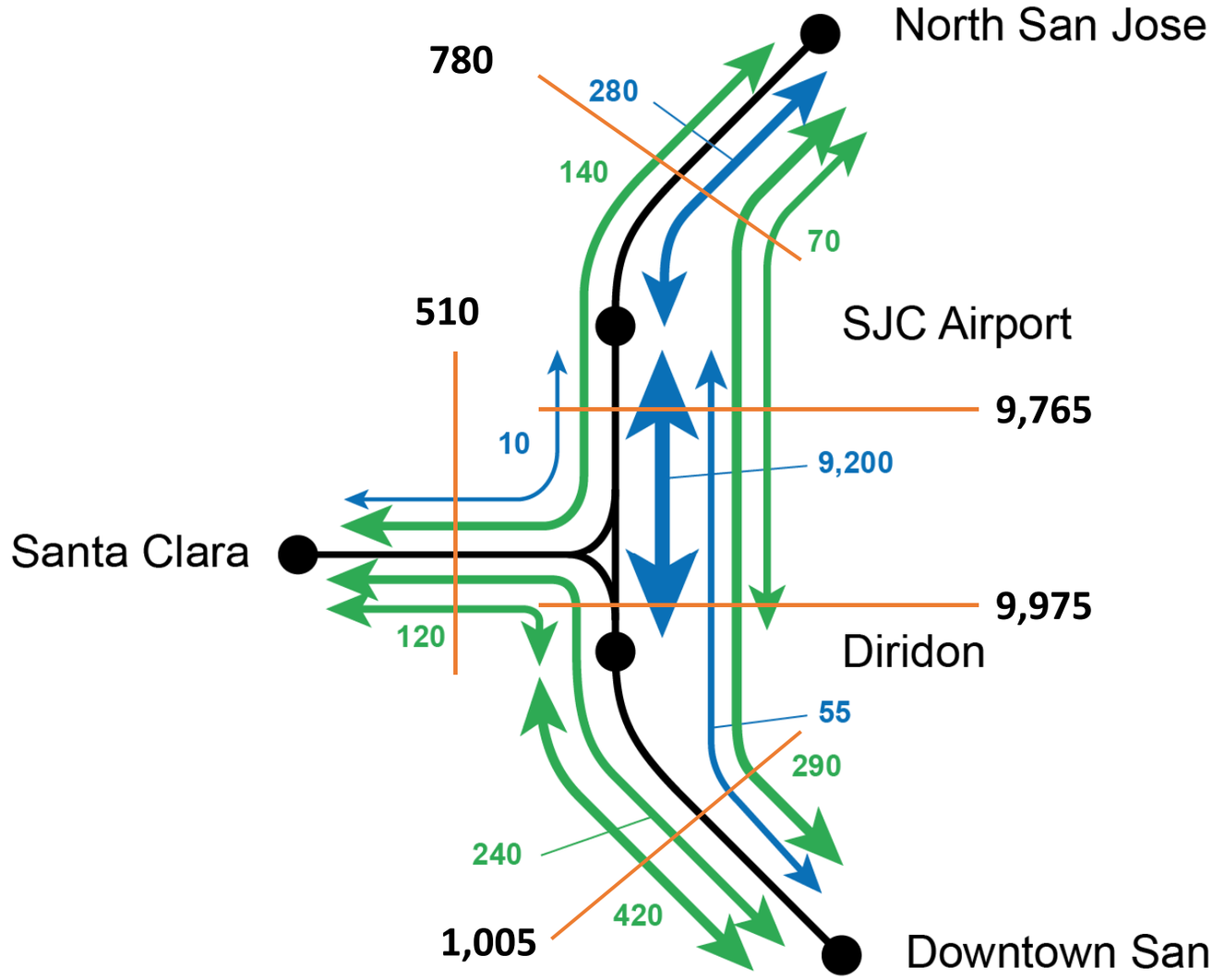
From… …To	Airport	Diridon	NSJ	SC	DTSJ	Other	TOTAL
Airport	*	4,600	140	5	30	-	4,775
Diridon Area	4,600		35	60	210	-	4,905
North San José	140	35		70	145	???	390
Santa Clara	5	60	70		120	???	255
Downtown San José	30	210	145	120		???	505
Other	-	-	???	???	???		???
TOTAL	4,775	4,905	390	255	505	???	10,830 +

*Intra-Airport Trips add another 11,100-12,300 trips

Summary of Daily AGT Ridership, Base and Expanded AGT Network

Potential Daily AGT Ridership, Year 2030	Base AGT Network	Expanded AGT Network
SJC (Passengers + Employees + HSR)	6,700 – 11,800	6,700 – 11,800
SJC (Passengers + Employees) with Expanded AGT Network	-	350
Intra-Airport Trips	11,100 – 12,300	11,100 – 12,300
Non-Airport Transit Trips within Expanded AGT Network	-	1,280
Non-Airport Transit Trips beyond Expanded AGT Network	-	???
Total Daily AGT Trips *without* Intra-Airport Trips	6,700 – 11,800	8,300 – 13,400
Total Daily AGT Trips *with* Intra-Airport Trips	17,800 – 24,100	19,400 – 25,700

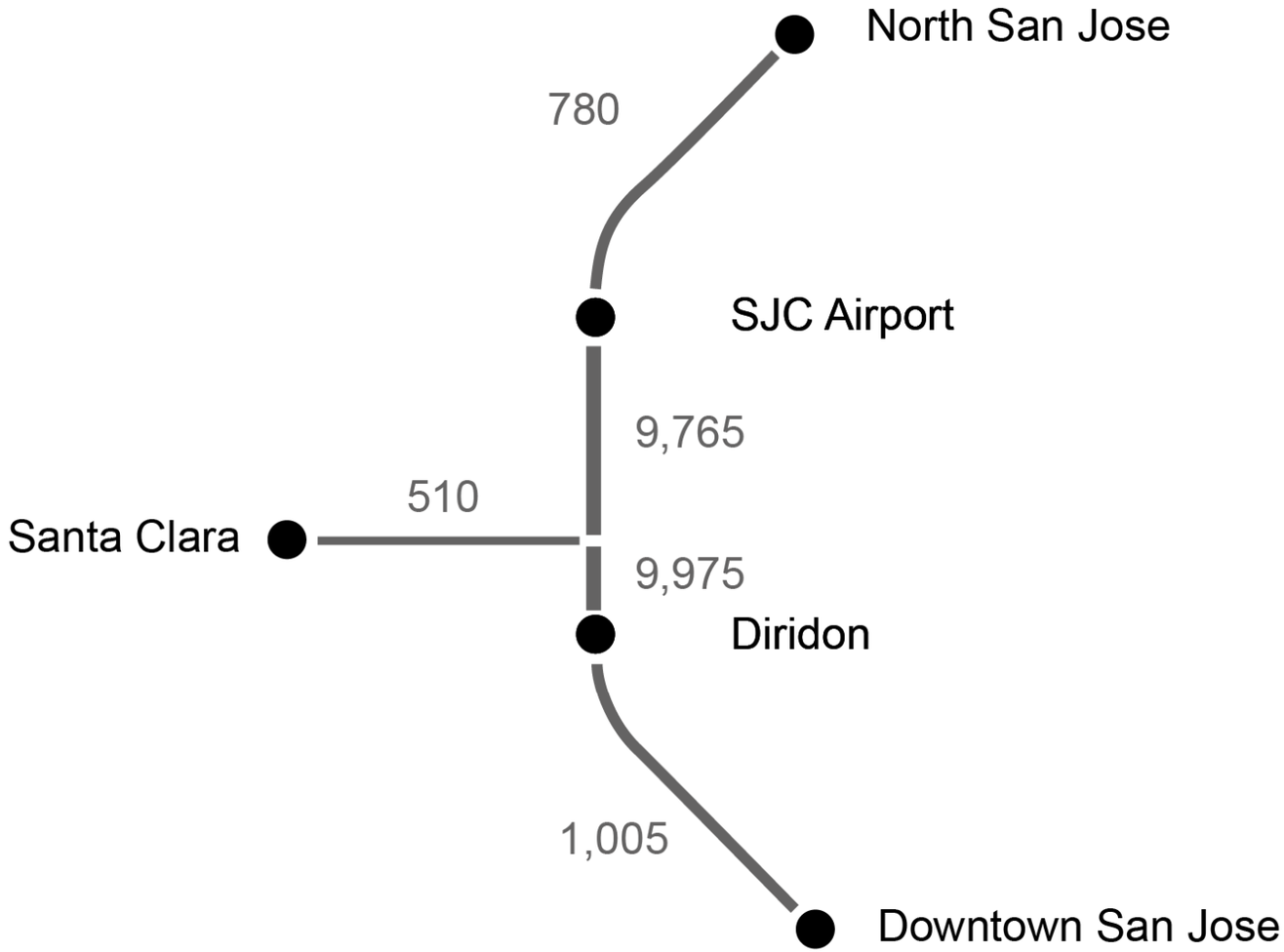
Daily AGT Ridership, Expanded AGT Network



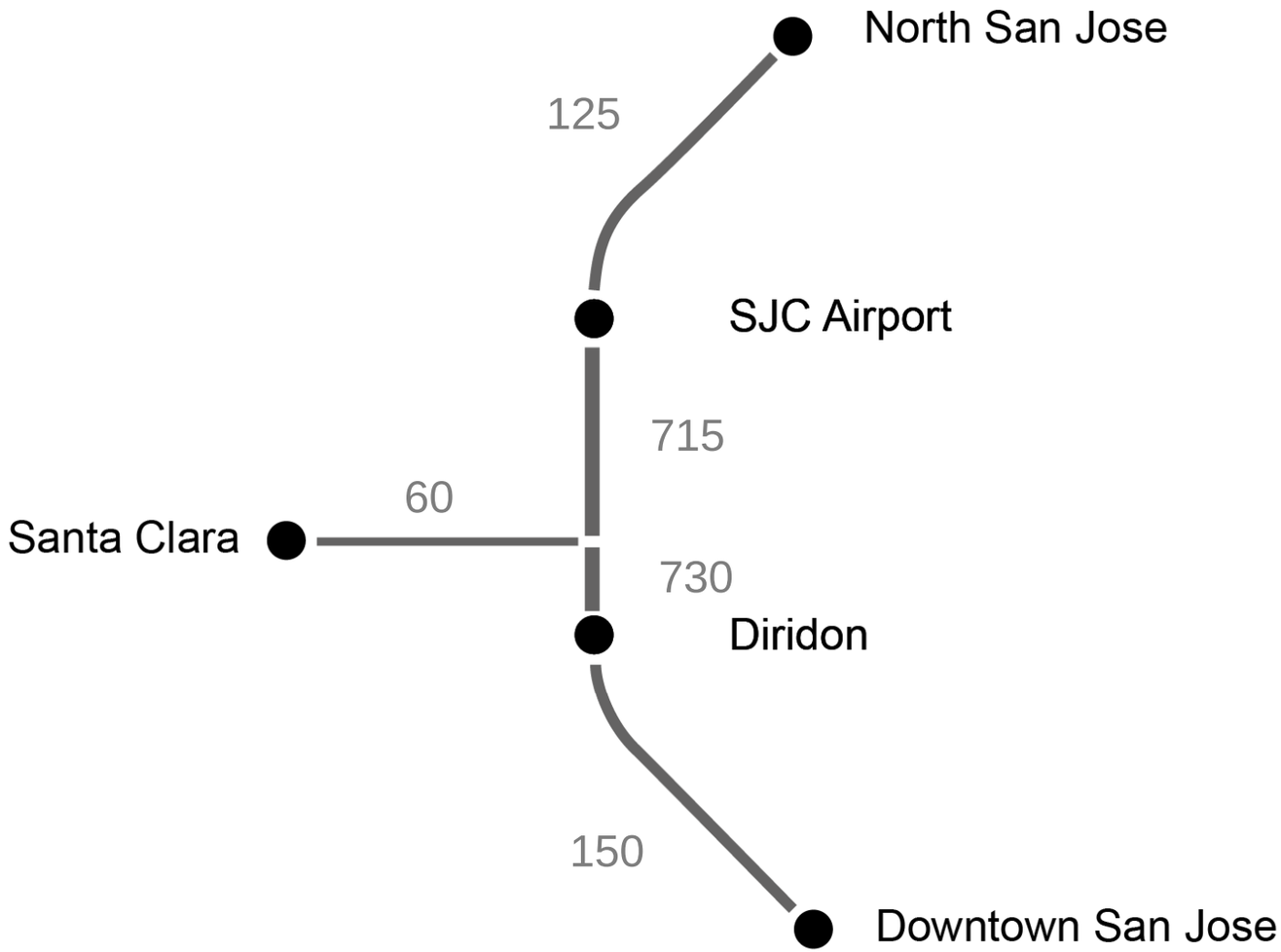
Assumptions

- 6% transit mode share
- All transit trips use AGT, except North San José ←→ Downtown San José, where 70% use AGT, 30% use LRT

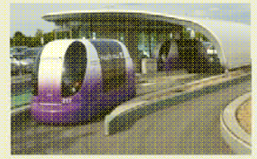
Daily Segment Loads, Expanded AGT Network



Hourly Segment Loads, Expanded AGT Network



Matching Capacity… … with Demand

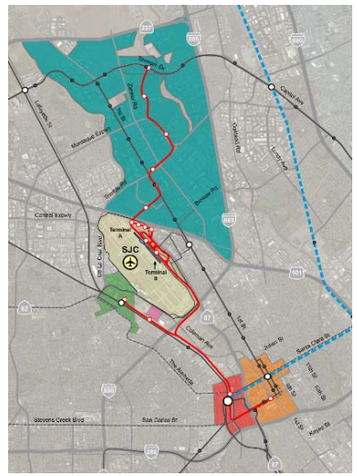
	Automated Metro	Automated People Mover (APM)	Automated Transit Network (ATN)	
			Group Rapid Transit (GRT)	Personal Rapid Transit (PRT)
SERVICE TYPE	Scheduled	Scheduled	On-Demand & Scheduled	On-Demand & Scheduled
TYPICAL # CARS	4-6+ cars	1-3 cars	1 vehicle	1 vehicle
TYPICAL TRAIN CAPACITY	500-900 passengers	100-250 passengers	10-25 passengers	1-6 passengers
TYPICAL SPEED	40-60 mph	30-50 mph	15-25 mph	15-25 mph
PRACTICAL LINE CAPACITY	10,000-30,000 passengers per hour per direction (pphpd)	2,500-10,000	2,500-5,000	1,000-2,500
THEORETICAL LINE CAPACITY			20,000 pphpd	10,000 pphpd
ALIGNMENT CONFIGURATION	Corridor	Corridor	Corridor (typical) or Network	Network (typical) or Corridor
REPRESENTATIVE IMAGE(S)				
GUIDEWAY TECHNOLOGY	Steel rail; Rubber tire on concrete	Rubber tire on concrete; Straddle beam monorail; Suspended monorail; Steel rail	Rubber tire on concrete	Rubber tire on concrete; Supported steel rail
PROPULSION TECHNOLOGY	Electric linear induction; Electric third rail; Electric third rail	Electric third rail; Cable propelled; Electric third rail; Pneumatic	Electric third rail	On-board battery; Electric third rail

Appropriate Technology Match

Expanded AGT Network Demand

Maximum Hourly Demand per Direction

730 pphpd



AGT Costs vs. Ridership, Base and Expanded AGT Network

Alternative:	Base AGT Network	Expanded AGT Network	BART Oakland Airport Connector	Phoenix Airport People Mover
Single Track Miles (miles)	9.6	20.9	6.4	4.8
Approx. Capital Cost (millions)	$ 380*	$ 830*	$484	$884
Cost per Track Mile (millions)	$40	$40	$76	$184
Total Daily Ridership (without intra-Airport trips)	6,700 – 11,800 †	8,300 – 13,400 †	3,300 ‡	
Total Daily Ridership (with intra-Airport trips)	17,800 – 24,100 †	19,400 – 25,700 †		13,000 §
Average Capital Cost per Daily Rider (without intra-Airport trips)	$32,000 – $57,000	$62,000 – $100,000	$147,000	
Average Capital Cost per Daily Rider (with intra-Airport trips)	$16,000 – $22,000	$32,000 – $43,000		$68,000

* Costs assuming ATN. APM costs would likely be higher.
† Ridership does not include non-airport regional transfers.

‡ Weekday ridership as of August 2015; system opened November 2014.
§ Daily ridership as of April 2015; system opened April 2013; includes Terminal 3 extension.

Observations – Expanded AGT Network

Advantages

(+) Expanded network makes key sub-regional connections.

(+) Additional ridership potential with transfers from AGT to regional transit and HSR at Diridon Station.

(+) Cost per passenger is likely within range of other airport rail connections.

Disadvantages

(-) Cost per passenger is higher than for base AGT network.

(-) More expensive than bus-based alternatives.

(-) Could be perceived as competition to VTA LRT (for North San José to Downtown and to Diridon).