



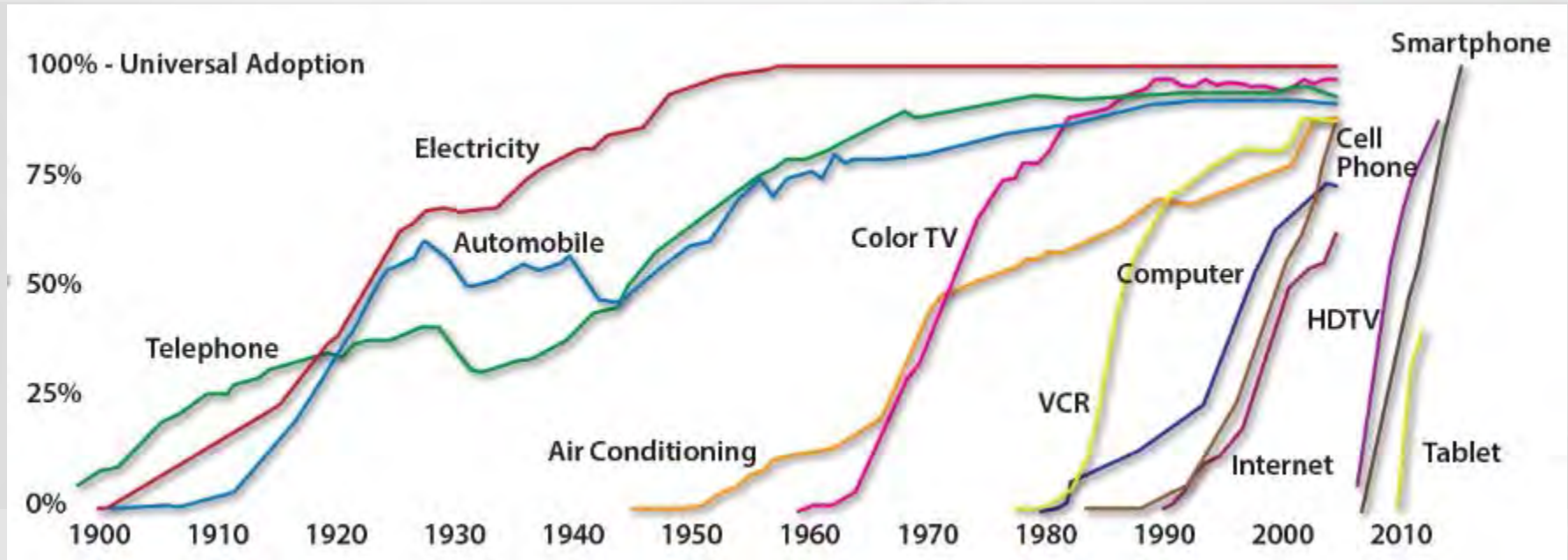
2016 FPTA/FDOT/CUTR Professional Development Workshop and
Transit Safety Summit

Autonomous Vehicles and Transit

Wednesday, June 8, 2016



Technology Adoption Rate



Automated Vehicles - An Umbrella Term



CONNECTED VEHICLES



AUTONOMOUS VEHICLES





Connected Vehicles



Applications as defined by USDOT

- Safety Critical (DSRC required)
- Mobility Enhancements (cellular might be sufficient)
- Environmental Benefits (cellular is likely sufficient)
- 55+ specific applications/uses

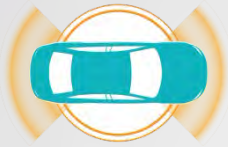
Data Gathering/ Information Exchange

- Vehicle-to-Infrastructure (V2I)
- Vehicle-to-Vehicle (V2V)
- Vehicle-to-Bike/Ped/Other (V2X)

Safety critical functions of the vehicle (steering/throttle)
not affected (operator is in control at all times)

Enhanced Situational Awareness



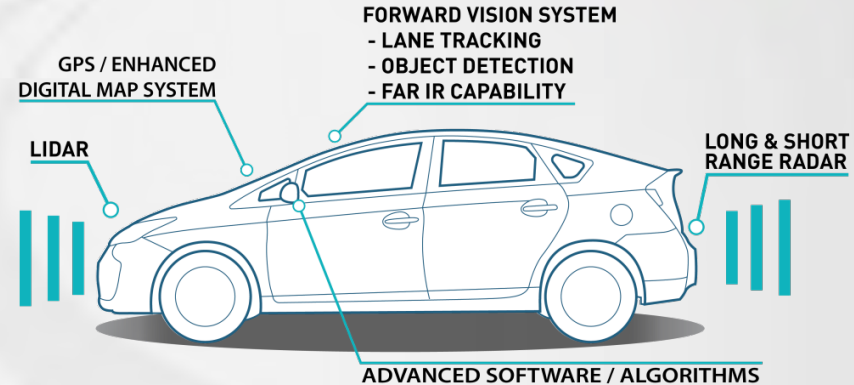


Autonomous Vehicles



Levels of Automation (as defined by NHTSA)

- **0 – No Automation**, but advanced collision warnings, blind spot monitoring, etc.
- **1 – Function Specific**, such as adaptive cruise control or active lane centering (but not at same time)
- **2 – Combined Function**, such as adaptive cruise control and active lane centering working at same time (must still be actively engaged in operation of vehicle)
- **3 – Limited Self-Driving**, Driver is not expected to monitor vehicle movements for limited time in limited situations (driver operates vehicle during part(s) of trip)
- **4 – Full Self-Driving**, No human operator expected to control safety-critical functions of the vehicle



Safety critical functions of the vehicle (steering/throttle) are affected without direct driver input

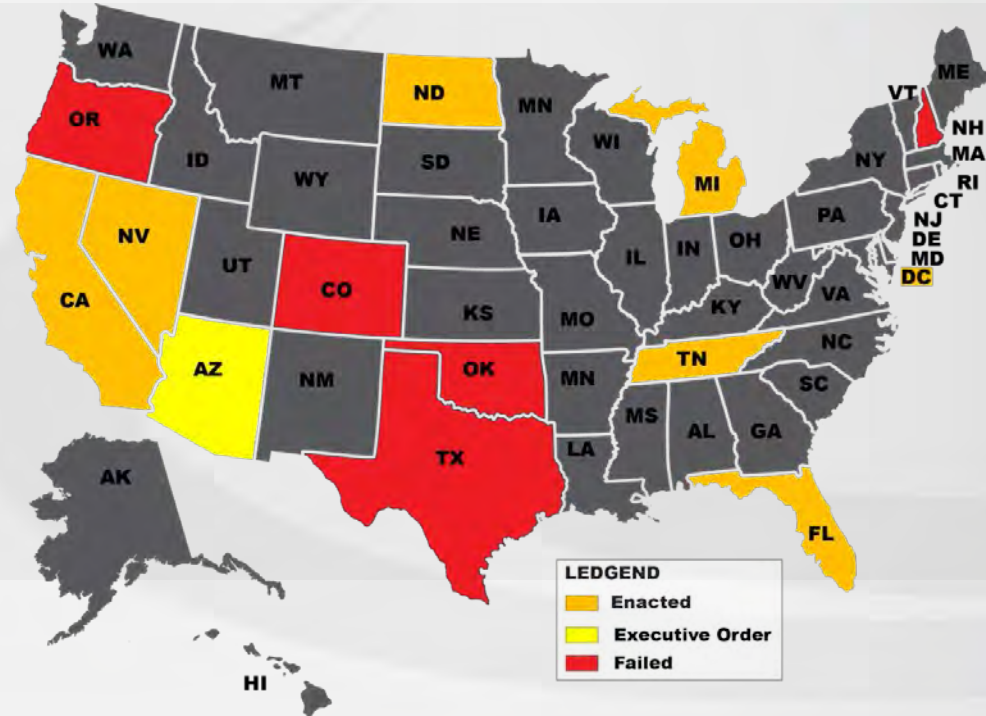


AV Legislation

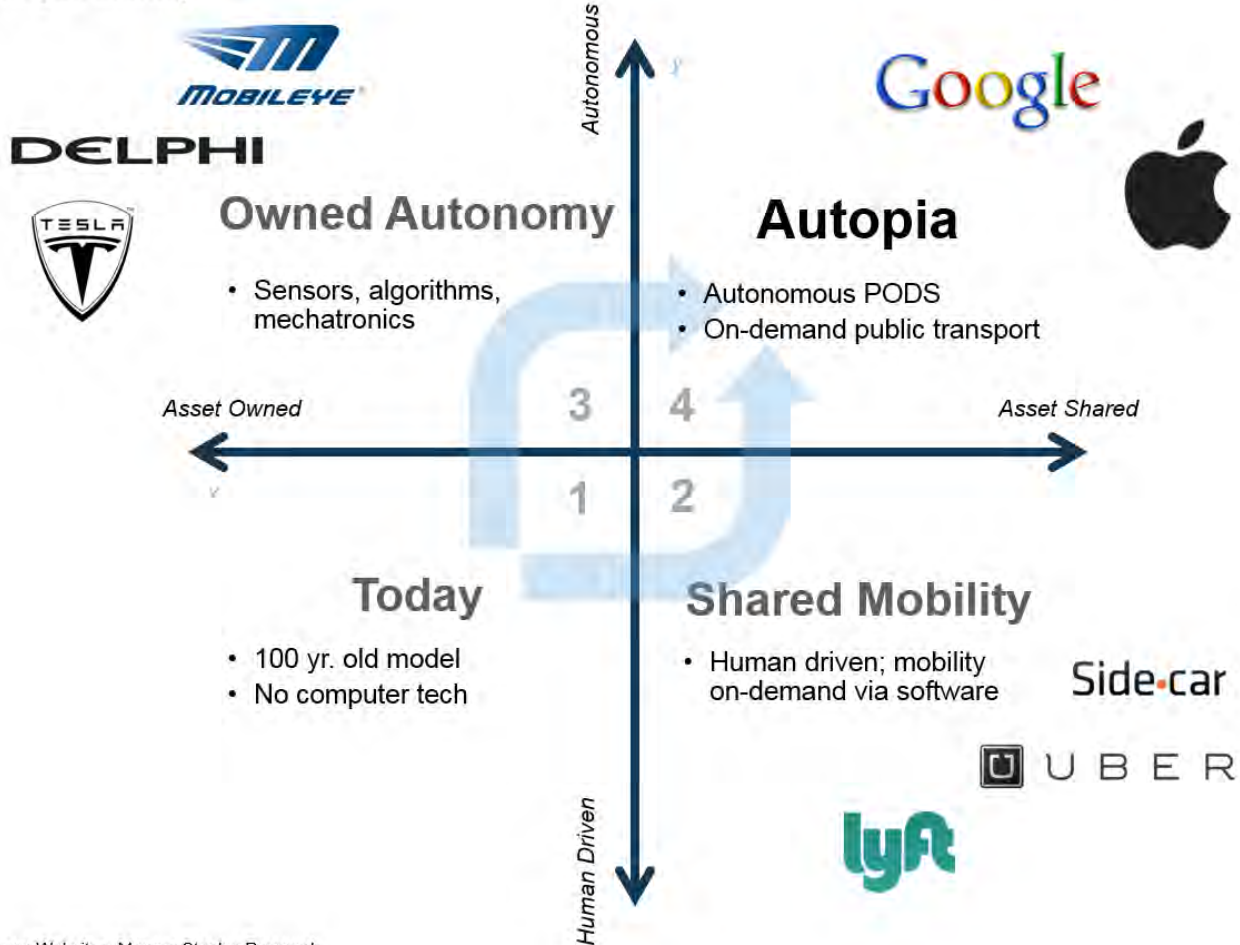


States with Enacted AV Legislation

Sixteen states introduced legislation related to autonomous vehicles in 2015, up from 12 states in 2014, nine states and D.C. in 2013, and six states in 2012.



National Conference of State Legislatures 1/19/2016



Potential Effects of AV on Urban Planning



Lane Width

- Potential less lane widths required for AV only lanes
- AV-only lane footprint for an extra lane in the future

Dedicated Lanes for Freight/Transit

- Sight Distances
- May become less of an issue

Parking Lot Location

- On-street parking repurposed
- Passenger drop off/pick up lanes at building entrance Repurposed parking lots to make better use of urban land

Development Patterns

- Higher density requirements may be more attainable
- Driveway placement and design
- Building setbacks
- Greater focus on bike/ped improvements

Blue Polygons = Parking



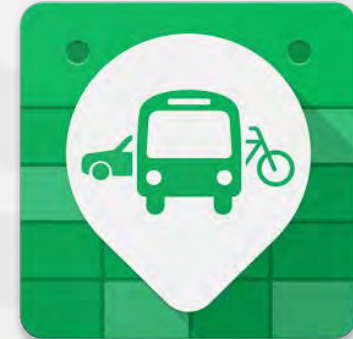
Compelling Results

Familiarity with Advanced Driver Assistance Systems

Online real-time contactless ticketing and fare management solutions

Autonomous low-speed shuttles for first/last mile solutions and underutilized routes

Ride sourcing to supplement mass transit and para-transit operations



Advanced Driver Assistance Systems



How familiar are you with ADAS?

Examples:

- Adaptive Cruise Control (ACC)
- Active Lane Centering (ALC)
- Forward Collision Warning (FCW)
- Pedestrian Detection Systems (PDS)

Next Step(s):

Provide educational opportunities for transit agencies to learn more about how these technologies could improve safety and efficiency



Online Real-Time Contactless Ticketing and Fare Management Solutions



Has your agency considered implementing?

Examples:

- Rindango – Swedish transit solution provider
- Xerox – Fare collection and open payment systems
- Vix – Account-based ticketing and open payments (Utah Transit Authority)
- Smart Card Alliance – Transit and Contactless Financial Payments White Paper

Next Step(s):

Provide educational opportunities for transit agencies to learn more about how these technologies could improve customer experience, satisfaction, and operational efficiency



Autonomous Low-Speed Vehicle to Supplement Feeder Routes and First/Last Mile



Interested in adopting this technology to enhance existing operation?

Example:

- Meridian Shuttles (pictured)
- CityMobil2 – European initiative for automated road passenger transport
- ARIBO (Autonomous Robotics for Installation and Base Operations) – Fort Bragg pilot project
- UK Autodrive Project – Innovate UK provided \$9M pounds for pilot projects in 4 British cities

Next Step(s):

Provide educational opportunities for transit agencies to learn more about how these technologies, engage interested stakeholders, and identify potential pilot project locations

**Real-Time On-Demand
Flexible Routes**



Ride Sourcing to Supplement Mass Transit



What is your opinion of these alternatives to supplement current operations?

Examples:

- Cabriolet/Taximeters – 1800s Germany
- Uber – MARTA (others) – “Guaranteed Ride Home”
- Lyft – Dallas Area Rapid Transit collaboration
- Bridj/Ford – Kansas City Transportation Authority collaboration
- Shared-Use Mobility Center – public interest organization
- FDOT’s reThink Your Commute Program (early precursor)

Next Step(s):

Provide educational opportunities for transit agencies to learn more about how these technologies could improve safety and efficiency. Identify agencies that are currently offering these services and identify additional opportunities.



Shared AVs to Replace Some Mass Transit



Where might Driverless Shared Taxi services provide more value than fixed route transit as fare costs decline due to technology?

Four Perspectives:

Society

Customer

Agency

Taxpayer

Methodology



Compare long-term costs of serving travel demand using transit and taxi options

Use actual fixed route operating data from typical transit agency

Evaluate at trip level of detail by line and time period

Test sensitivity to various fare levels

Fare Scenarios

- T3** Traditional Taxi
- T2** TNC (e.g. Uber, Lyft)
- T1** Shared TNC (e.g. UberPool, Lyft Line)
- A3** Shared AV Taxi (\$0.75 / mile)
- A2** Shared AV Taxi (\$0.50 / mile)
- A1** Shared AV Taxi (\$0.25 / mile)

Global Parameters



Transit access/egress distance

0.2 mile

Shared AV access/egress distance

0.1 mile

Shared AV wait time

3 minutes

Transit wait time

½ headway, up to 5 minutes



Shared AV Characteristics



Vehicle Occupancy

1.8 persons

Delay per Other Passenger

3 minutes

Maximum Other Passenger Delay

30% of travel time



Fare Scenarios



	T3	T2	T1	A3	A2	A1
Per initial boarding	\$2.25	\$2.70	\$2.03	\$0.00	\$0.00	\$0.00
Per mile	\$2.25	\$0.80	\$0.60	\$0.75	\$0.50	\$0.25
Per minute	\$0.30	\$0.11	\$0.08	\$0.00	\$0.00	\$0.00
Minimum Fare	\$0.00	\$5.50	\$4.13	\$0.00	\$0.00	\$0.00
Source	Tampa taxi fare, 2005 per <i>taxicab electronics.com</i>	Uber.com, Tampa	Uber less 25%	Upper range in literature	Medium range in literature	Lower range in literature



Value of Time and Social Costs



Value of Time

\$13.42 / hour

Social Cost of Emissions and Accidents

USDOT TIGER Benefit-Cost Guidance

Emissions and Accident Rates by Mode

USDOT statistics and fleet forecasts

Assume 90% crash reduction for AVs

Assume battery electric AVs

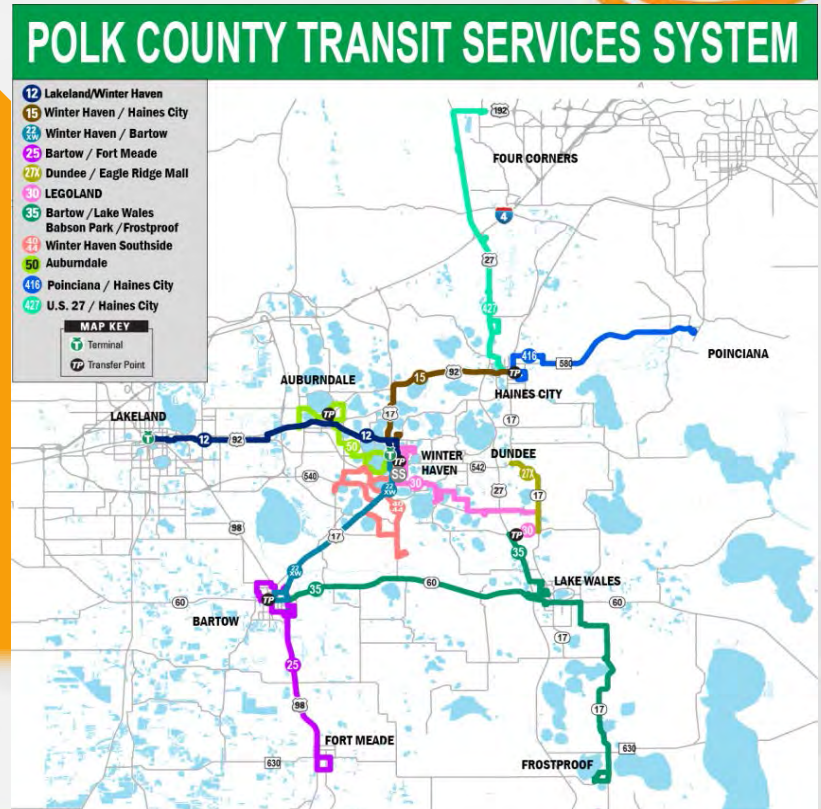


Example Transit Services



Seven selected routes in Polk County, FL

- 25 25 Bartow / Fort Meade
- 27X 27X Dundee / Eagle Ridge Mall
- 30 30 Legoland
- 35 35 Bartow / Lake Wales / Frostproof
- 40/44 40/44 Winter Haven Southside
- 50 50 Auburndale
- SS SS Smart Shuttle (Winter Haven)

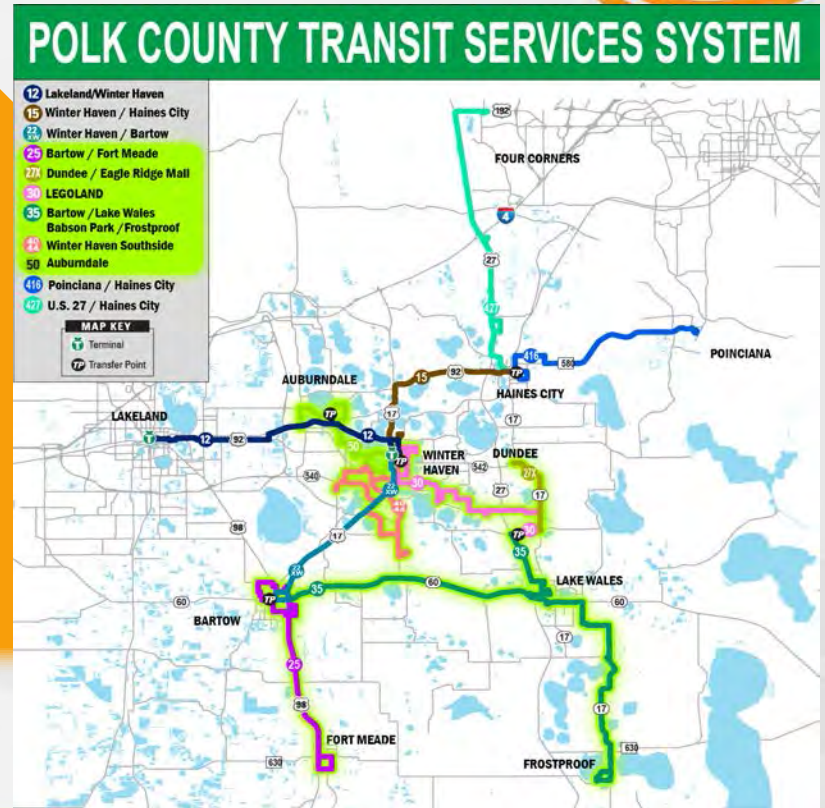


Example Transit Services

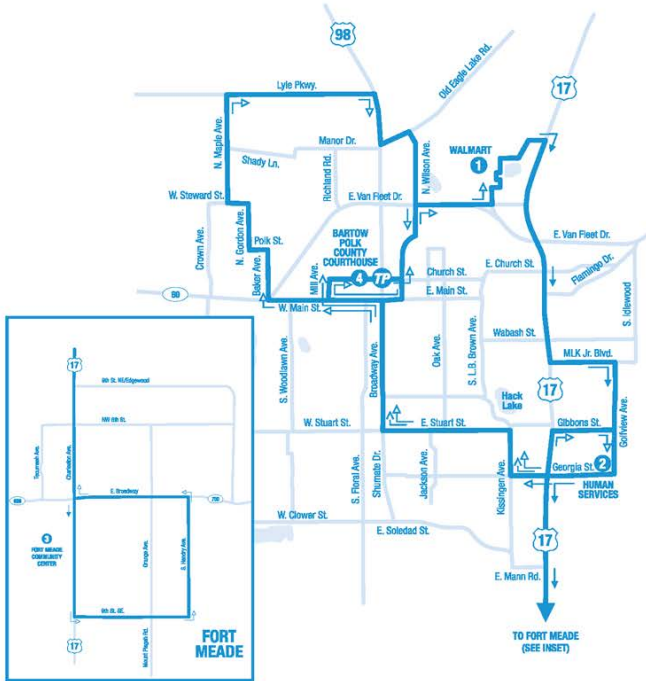


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- 25 25 Bartow / Fort Meade
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- 40/44 40/44 Winter Haven Southside
- 50 50 Auburndale
- SS SS Smart Shuttle (Winter Haven)



25 BARTOW / FORT MEADE



	1	2	3	2	4	1
	Depart Walmart at Bartow	Human Services at Bartow	Fort Meade Community Center	Human Services at Bartow	Bartow Polk County Courthouse	Arrive Walmart at Bartow
	---	6:10	---	---	6:25	6:30
	6:30	6:40	6:55	7:15	7:42	7:47
	8:00	8:10	8:25	8:45	9:12	9:17
	9:30	9:40	9:55	10:15	10:42	10:47
	11:00	11:10	11:25	11:45	12:12	12:17
WEEKDAYS	12:30	12:40	12:55	1:15	1:42	1:47
	2:00	2:10	2:25	2:45	3:12	3:17
	3:30	3:40	3:55	4:15	4:42	4:47
	5:00	5:10	5:25	5:45	6:12	6:17

TP Transfer Points

TRANSFER POINTS PUNTOS DE TRANSFERENCIA

Bartow Polk County Courthouse: Rt 22XL and RT 22XW

- ➔ First trip only: From Human Services to Bartow Polk County Courthouse
Desde Human Services hacia la Corte del Condado de Polk en Bartow
- ➔ From Walmart in Bartow to Fort Meade Community Center
Desde Walmart en Bartow hacia el Centro Comunitario de Fort Meade
- ➔ From Fort Meade Community Center to Walmart in Bartow
Desde el Centro Comunitario en Fort Meade hacia Walmart en Bartow

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27x

Dundee / Eagle Ridge Mall



27X DUNDEE / EAGLE RIDGE MALL



WEEKDAYS	SOUTHBOUND		NORTHBOUND	
	Dundee Town Hall	Eagle Ridge Mall	Eagle Ridge Mall	Dundee Town Hall
	1	2	2	1
	5:30	5:45	7:00	7:10

SATURDAY	SOUTHBOUND		NORTHBOUND	
	8:00	8:15	3:00	3:10

TP Transfer Points

TRANSFER POINTS PUNTOS DE TRANSFERENCIA
Eagle Ridge Mall: Rt 30 and RT 35

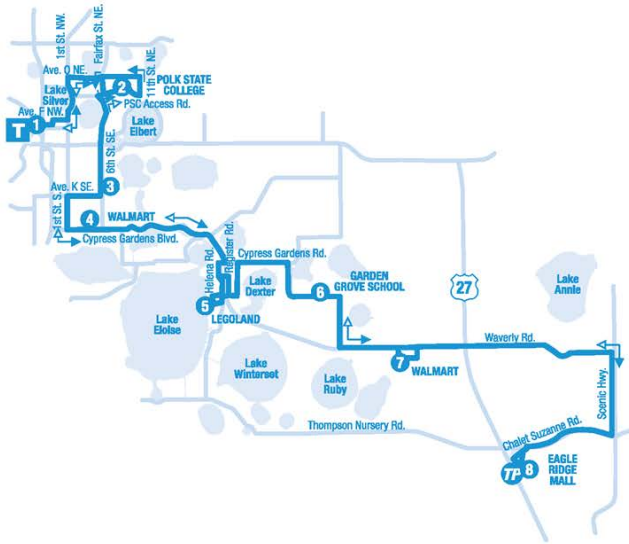
- ➔ From Dundee to Eagle Ridge Mall
Desde Dundee hacia Eagle Ridge Mall
- ➜ From Eagle Ridge Mall to Dundee
Desde Eagle Ridge Mall hacia Dundee

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30 LEGOLAND



SUN.	SAT.	EASTBOUND								WESTBOUND																																												
		1	2	3	4	5	6	7	8	8	7	6	5	4	3	2	1																																					
5:45	5:55	6:05	6:10	6:20	6:35	6:40	7:00	7:15	7:25	7:35	7:40	7:50	8:05	8:10	8:30	8:45	8:55	9:05	9:10	9:20	9:35	9:40	9:50	10:00																														
10:15	10:25	10:35	10:40	10:50	11:05	11:10	11:30	11:45	11:55	12:05	12:10	12:20	12:35	12:40	1:00	1:15	1:25	1:35	1:40	1:50	2:05	2:10	2:30	2:45	2:55	3:05	3:10	3:20	3:35	3:40	4:00	4:15	4:25	4:35	4:40	4:50	5:05	5:10	5:30	5:45	5:55	6:05	6:10	6:20	6:35	6:40	7:00							
9:45	9:55	10:05	10:10	10:20	10:35	10:40	11:00	11:15	11:25	11:35	11:40	11:50	12:05	12:10	12:30	12:45	12:55	1:05	1:10	1:20	1:35	1:40	1:50	2:00	2:10	2:20	2:30	2:40	2:50	3:00	3:10	3:20	3:30	3:40	3:50	4:00	4:10	4:20	4:30	4:40	4:50	5:00	5:10	5:20	5:30	5:40	5:50	6:00	6:10	6:20	6:30	6:40	6:50	7:00
12:15	12:25	12:35	12:40	12:50	1:05	1:10	1:30	1:45	1:55	2:05	2:10	2:20	2:35	2:40	3:00	3:15	3:25	3:35	3:40	3:50	4:05	4:10	4:20	4:30	4:40	4:50	5:00	5:10	5:20	5:30	5:40	5:50	6:00	6:10	6:20	6:30	6:40	6:50	7:00	7:10	7:20	7:30	7:40	7:50	8:00	8:10	8:20	8:30	8:40	8:50	9:00	9:10	9:20	9:30

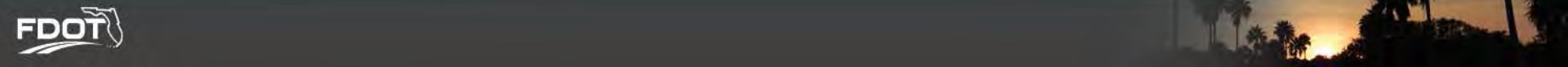
TP Transfer Points **T** Winter Haven Terminal

TRANSFER POINTS PUNTO DE TRANSFERENCIA
Winter Haven Downtown Terminal: Rt 12, 15, 22XW, 40/44 and 50
Eagle Ridge Mall: Rt 35 and RT 27X

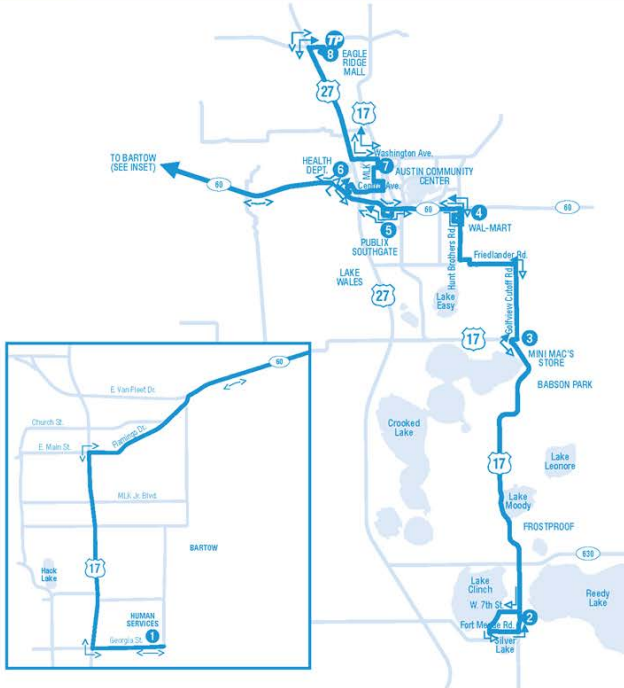
➔ From Winter Haven Terminal to Eagle Ridge Mall
 Desde la Terminal de Winter Haven hacia Eagle Ridge Mall

➔ From Eagle Ridge Mall to Winter Haven Terminal
 Desde Eagle Ridge Mall hacia la Terminal de Winter Haven

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35 LAKE WALES / BABSON PARK / FROSTPROOF



	1	2	3	4	5	6	7	8		6	7	8	9	4	3	2	1
WEEDAYS	8:00	---	---	6:32	6:37	6:40	6:45	7:05		7:15	7:25	7:29	7:32	7:37	7:45	8:05	---
	---	8:05	8:25	8:32	8:37	8:40	8:45	9:05		9:15	9:25	9:29	9:32	9:37	9:45	10:05	---
	---	10:05	10:25	10:32	10:37	10:40	10:45	11:05		12:15	12:25	12:29	12:32	12:37	12:45	1:05	---
	---	1:05	1:25	1:32	1:37	1:40	1:45	2:05		2:15	2:25	2:29	2:32	2:37	2:45	3:05	---
	---	3:05	3:25	3:32	3:37	3:40	3:45	4:05		4:15	4:25	4:29	4:32	4:37	4:45	5:05	---
	---	5:05	5:25	5:32	5:37	5:40	5:45	6:05		6:15	6:25	6:29	---	---	---	---	7:00
SATURDAY	6:00	---	---	6:32	6:37	6:40	6:45	7:05		7:15	7:25	7:29	7:32	7:37	7:45	8:05	---
	---	8:05	8:25	8:32	8:37	8:40	8:45	9:05		9:15	9:25	9:29	9:32	9:37	9:45	10:05	---
	---	10:05	10:25	10:32	10:37	10:40	10:45	11:05		12:15	12:25	12:29	12:32	12:37	12:45	1:05	---
	---	1:05	1:25	1:32	1:37	1:40	1:45	2:05		2:15	2:25	2:29	2:32	2:37	2:45	3:05	---
	---	3:05	3:25	3:32	3:37	3:40	3:45	4:05		4:15	4:25	4:29	---	---	---	---	5:00

TP Transfer Points **T** Winter Haven Terminal

TRANSFER POINTS PUNTOS DE TRANSFERENCIA
Eagle Ridge Mall: Rt 30 and RT 27X

- From Human Services in Bartow to Eagle Ridge Mall
Desde Human Services en Bartow hacia Eagle Ridge Mall
- From Eagle Ridge Mall to Human Services in Bartow
Desde Eagle Ridge Mall hacia Human Services en Bartow
- From Frostproof to Eagle Ridge Mall
Desde Frostproof hacia Eagle Ridge Mall
- From Eagle Ridge Mall to Frostproof
Desde Eagle Ridge Mall hacia Frostproof

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44
40

Winter Haven Southside



40/44 WINTER HAVEN SOUTHSIDE



	1	2	3	4	5	6	7	8	1
WEEKDAYS	5:45	5:50	6:00	6:15	6:35	6:41	6:50	6:55	7:05
	7:15	7:20	7:30	7:45	8:05	8:11	8:20	8:25	8:35
	8:45	8:50	9:00	9:15	9:35	9:41	9:50	9:55	10:05
	10:15	10:20	10:30	10:45	11:05	11:11	11:20	11:25	11:35
	11:45	11:50	12:00	12:15	12:35	12:41	12:50	12:55	1:05
	1:15	1:20	1:30	1:45	2:05	2:11	2:20	2:25	2:35
	2:45	2:50	3:00	3:15	3:35	3:41	3:50	3:55	4:05
	4:15	4:20	4:30	4:45	5:05	5:11	5:20	5:25	5:35
	5:45	5:50	6:00	6:15	6:35	6:41	6:50	6:55	7:05
SATURDAY	6:45	6:50	7:00	7:15	7:35	7:41	7:50	7:55	8:05
	10:15	10:20	10:30	10:45	11:05	11:11	11:20	11:25	11:35
	1:45	1:50	2:00	2:15	2:35	2:41	2:50	2:55	3:05

TP Transfer Points **T** Winter Haven Terminal

TRANSFER POINTS PUNTOS DE TRANSFERENCIA
Winter Haven Downtown Terminal: Rt 12, 15, 22XW, 30 and 50

- ➔ From Winter Haven Terminal to Spirit Lake Rd & Country Pl.
Desde la Terminal de Winter Haven hacia Spirit Lake Rd & Country Pl
- ➔ From Spirit Lake Rd & Country Pl. to Winter Haven Terminal
Desde Spirit Lake Rd & Country Pl hacia la Terminal de Winter Haven

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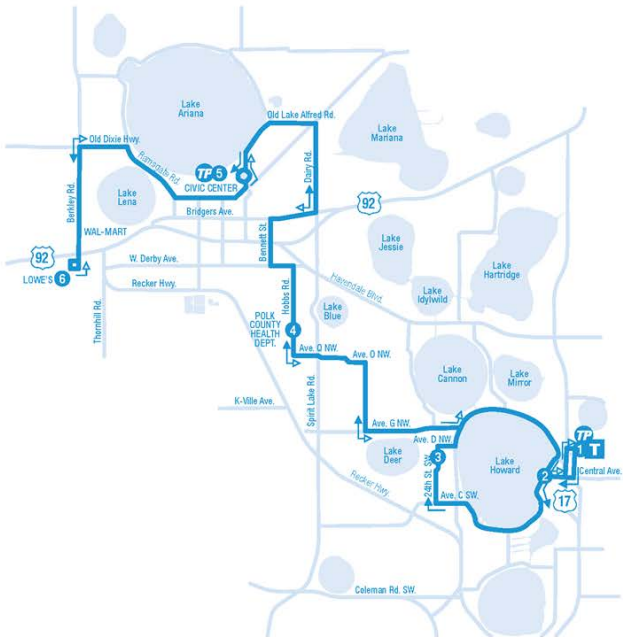


50

Auburndale



50 AUBURNDALE



	1	2	3	4	5	6	5	4	2	1
WEEKDAYS	Depart Winter Haven Downtown Terminal	Fraizer Towers	24th St. NW, & Ave. D NW	Hobbs Rd. at Polk County Health Department	Auburndale Civic Center	Lowe's Auburndale	Auburndale Civic Center	Hobbs Rd. at Polk County Health Department	Fraizer Towers	Arrive Winter Haven Downtown Terminal
	5:45	5:50	5:55	6:05	6:15	6:25	6:35	6:50	7:00	7:05
	7:15	7:20	7:25	7:35	7:45	7:55	8:05	8:20	8:30	8:35
	8:45	8:50	8:55	9:05	9:15	9:25	9:35	9:50	10:00	10:05
	10:15	10:20	10:25	10:35	10:45	10:55	11:05	11:20	11:30	11:35
	11:45	11:50	11:55	12:05	12:15	12:25	12:35	12:50	1:00	1:05
	1:15	1:20	1:25	1:35	1:45	1:55	2:05	2:20	2:30	2:35
	2:45	2:50	2:55	3:05	3:15	3:25	3:35	3:50	4:00	4:05
	4:15	4:20	4:25	4:35	4:45	4:55	5:05	5:20	5:30	5:35
	5:45	5:50	5:55	6:05	6:15	6:25	6:35	6:50	7:00	7:05
SAT.	8:15	8:20	8:25	8:35	8:45	8:55	9:05	9:20	9:30	9:35
	12:15	12:20	12:25	12:35	12:45	12:55	1:05	1:20	1:30	1:35

TP Transfer Points **T** Winter Haven Terminal

TRANSFER POINTS PUNTOS DE TRANSFERENCIA
 Winter Haven Downtown Terminal: Rt 12, 15, 22XW, 30 and 40/44
 Auburndale Civic Center: Rt 12

- ➔ From Winter Haven Terminal to Lowe's
Desde la Terminal de Winter Haven hacia Lowe's
- ➜ From Lowe's to Winter Haven Terminal
Desde Lowe's hacia la Terminal de Winter Haven

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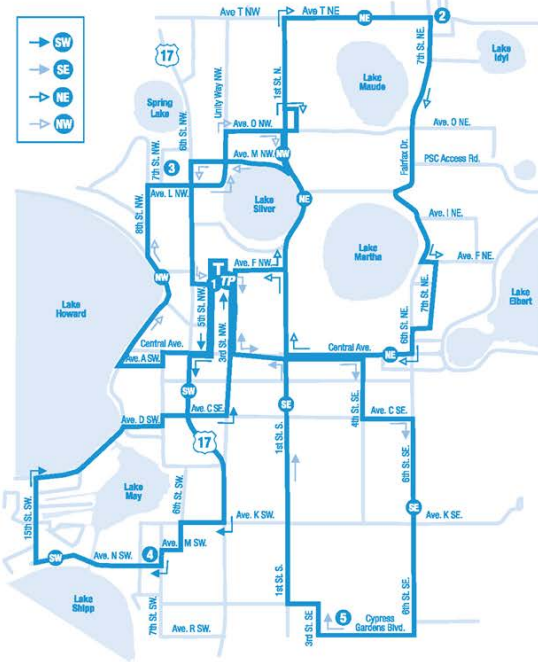


SS

Smart Shuttle



SS SMART SHUTTLE

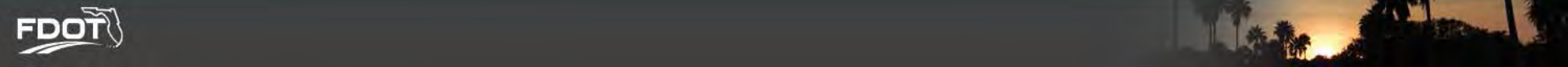


WEEKDAYS	1	2	1
	NORTHEAST		
	8:15	8:28	8:40
	10:15	10:28	10:40
	12:15	12:28	12:40
2:15	2:28	2:40	
WEEKDAYS	1	3	1
	NORTHWEST		
	8:40	8:53	9:05
	10:40	10:53	11:05
	12:40	12:53	1:05
2:40	2:53	3:05	
WEEKDAYS	1	4	1
	SOUTHWEST		
	9:15	9:28	9:40
	11:15	11:28	11:40
	1:15	1:28	1:40
3:15	3:28	3:40	
WEEKDAYS	1	5	1
	SOUTHEAST		
	9:40	9:53	10:05
	11:40	11:53	12:05
	1:40	1:53	2:05
3:40	3:53	4:05	

TP Transfer Points **T** Winter Haven Terminal

TRANSFER POINTS PUNTOS DE TRANSFERENCIA
 Winter Haven Downtown Terminal: Rt 12, 15, 22XV, 30, 40/44 and 50

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Performance Measures



AV Advantage when >1

Society

Transit Social Cost / AV Social Cost
includes total travel time, accidents, emissions

Customer

Transit Travel Cost / AV Travel Cost
includes total travel time, fare cost

Agency

System Average Productivity / Service Productivity
compares average passengers per revenue hour with selected trip

Taxpayer

Transit Subsidy per Passenger / AV Fare Cost
includes marginal transit O&M costs

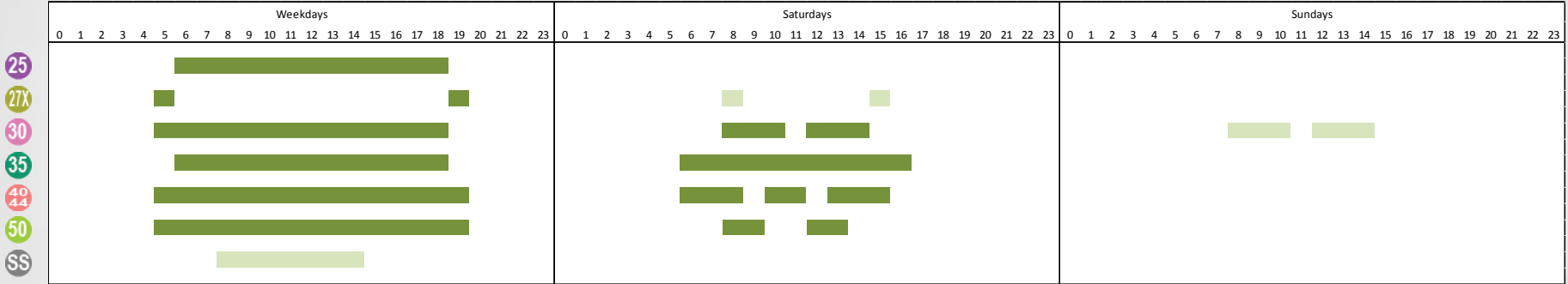
Line Summary



Society

T3 Traditional Taxi

■ Transit Advantage ■ AV Advantage



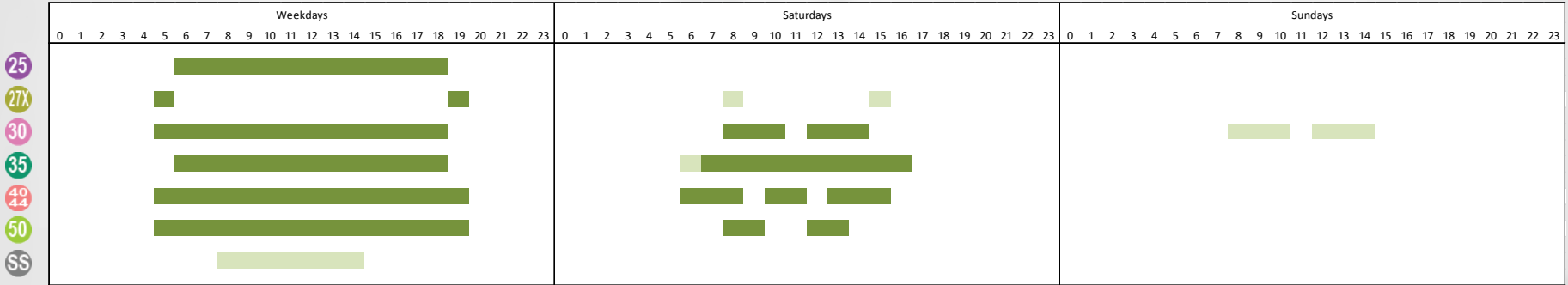
Line Summary



Society

T2 TNC

■ Transit Advantage ■ AV Advantage



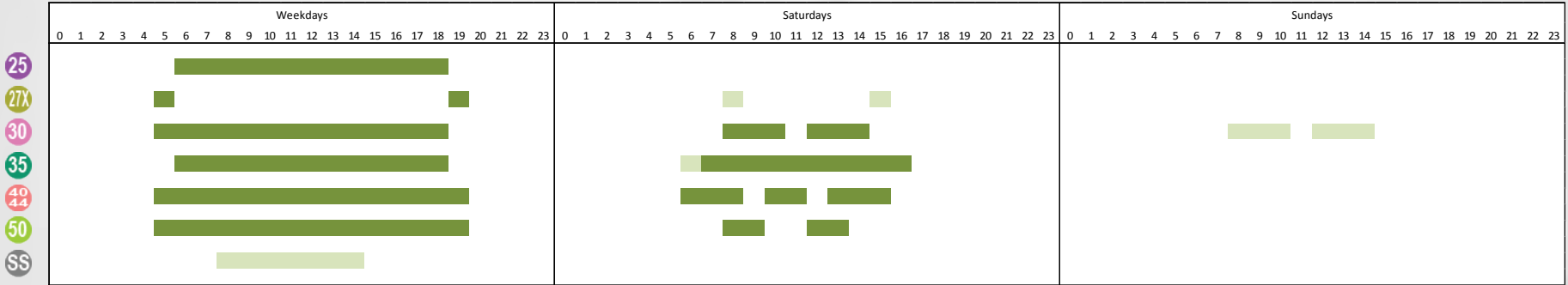
Line Summary



Society

T1 Shared TNC

■ Transit Advantage ■ AV Advantage



Line Summary

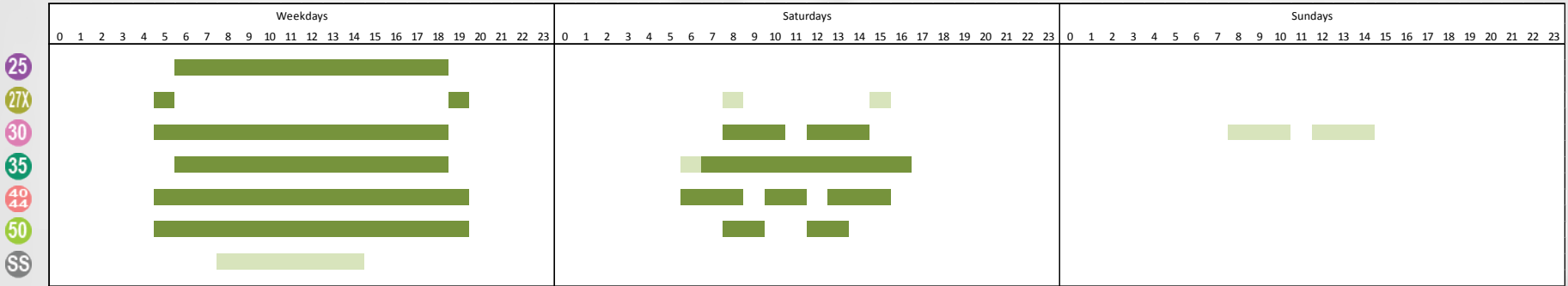


Society

A3

Shared AV at \$0.75 per mile

■ Transit Advantage ■ AV Advantage



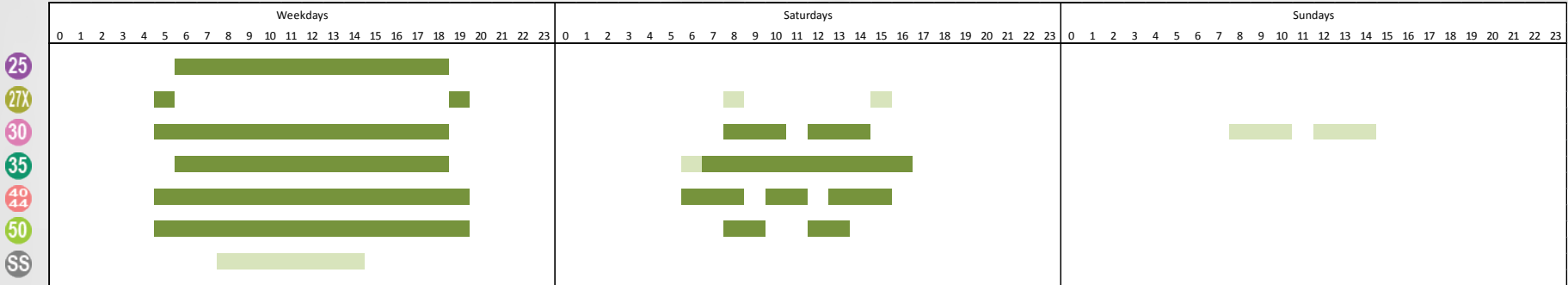
Line Summary



Society

A2 Shared AV at \$0.50 per mile

■ Transit Advantage ■ AV Advantage



Line Summary

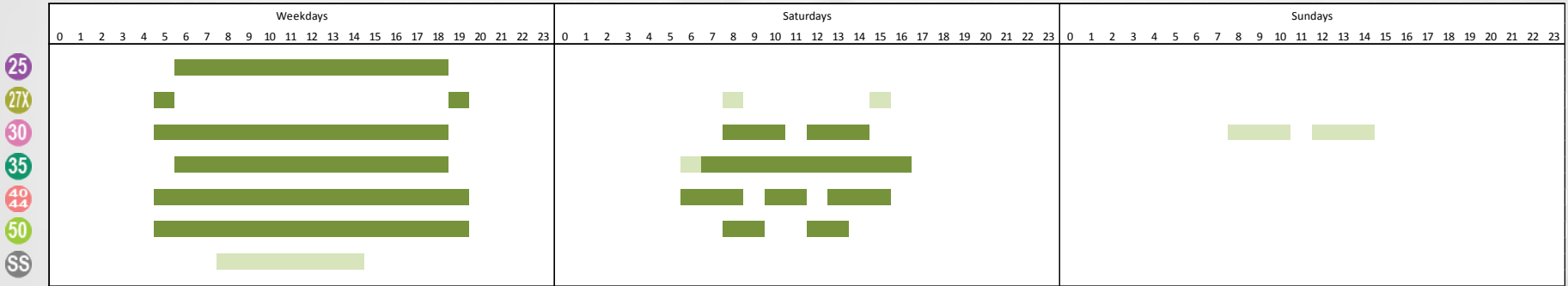


Society

A1

Shared AV at \$0.25 per mile

■ Transit Advantage ■ AV Advantage



Findings



Except for very low productivity circulator line (SS Smart Shuttle), fixed route maintains advantages under all fare scenarios from Society perspective.

SS productivity < 1 boarding per revenue hour

Society

Line Summary

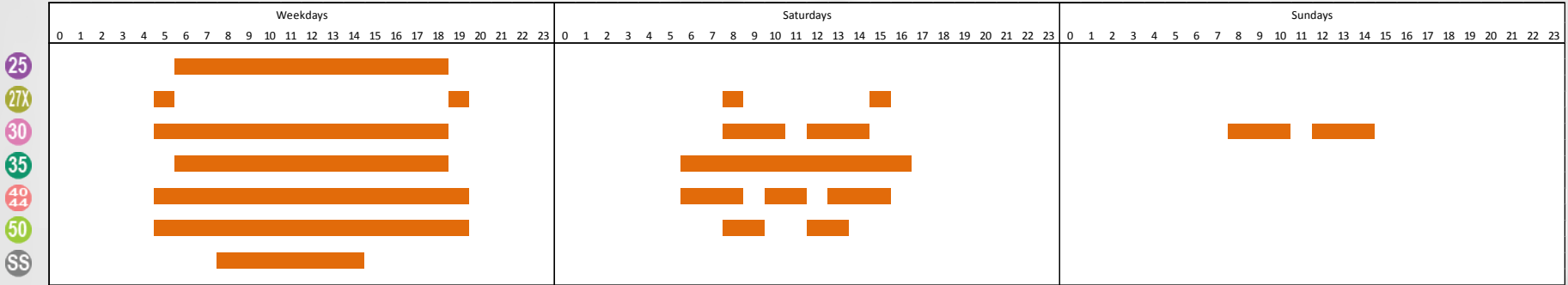


Customer

T3

Traditional Taxi

Transit Advantage AV Advantage



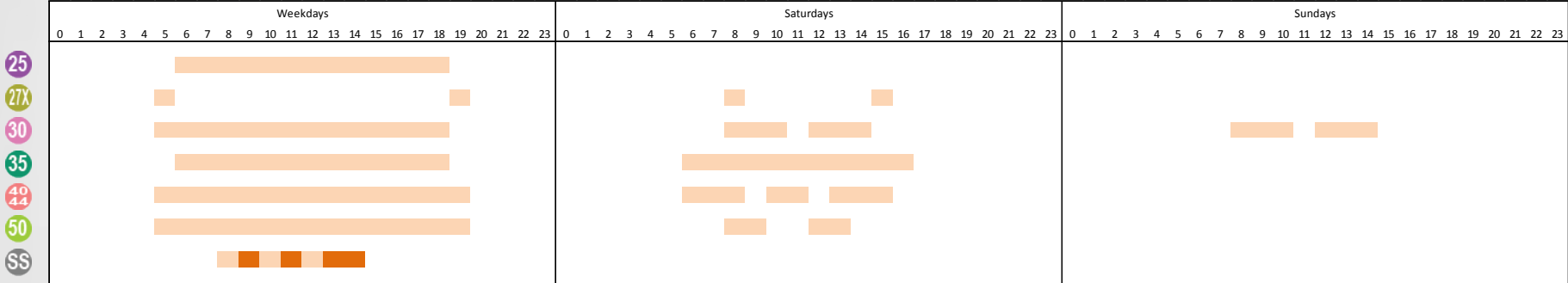
Line Summary



Customer

T2 TNC

Transit Advantage AV Advantage



Line Summary

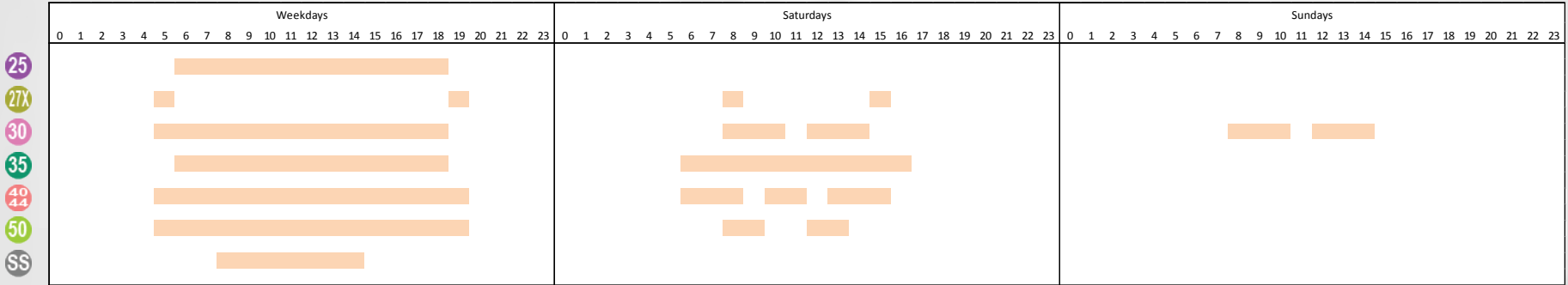


Customer

T1

Shared TNC

Transit Advantage
 AV Advantage



Line Summary



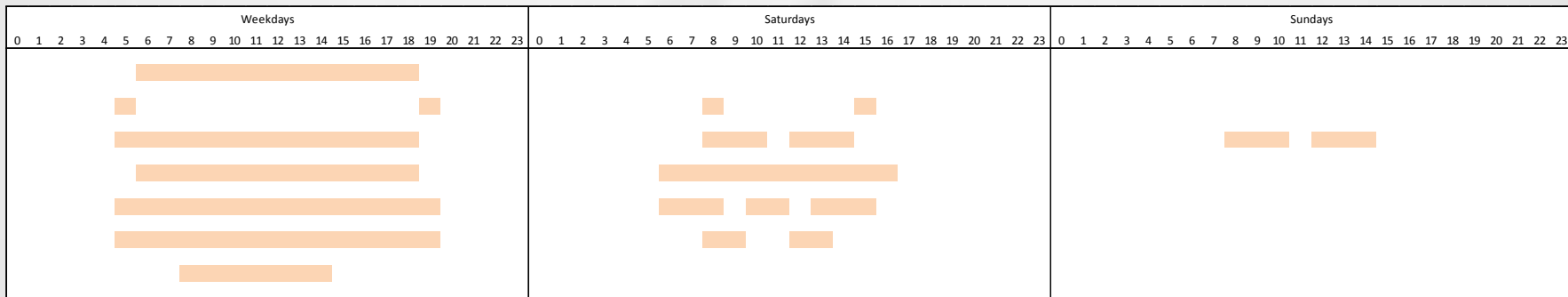
Customer

A3

Shared AV at \$0.75 per mile

Transit Advantage AV Advantage

- 25
- 27X
- 30
- 35
- 40
- 44
- 50
- SS



Line Summary

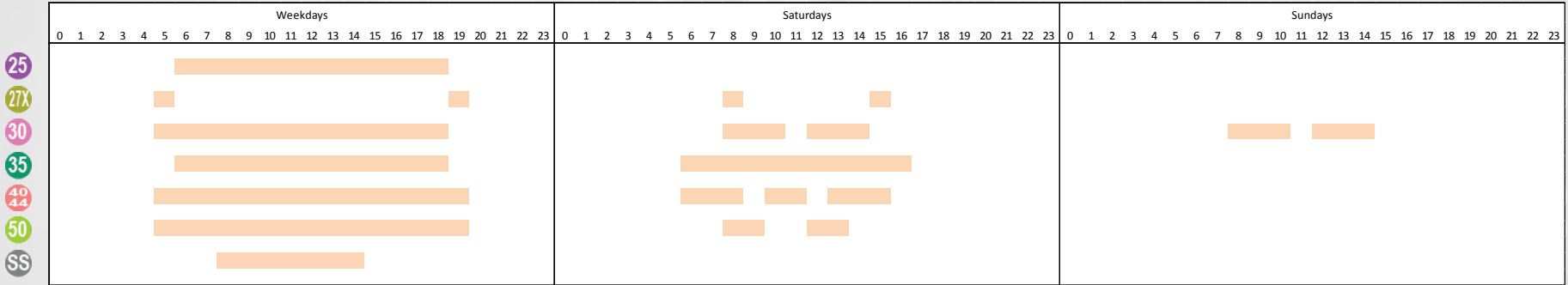


Customer

A1

Shared AV at \$0.25 per mile

Transit Advantage AV Advantage



Findings



As taxi services become less expensive, transit provides greater relative value on longer trips with fixed fare.

Current TNC fare structure achieves near parity with fixed route transit for typical trip of 5.9 miles.

Customer

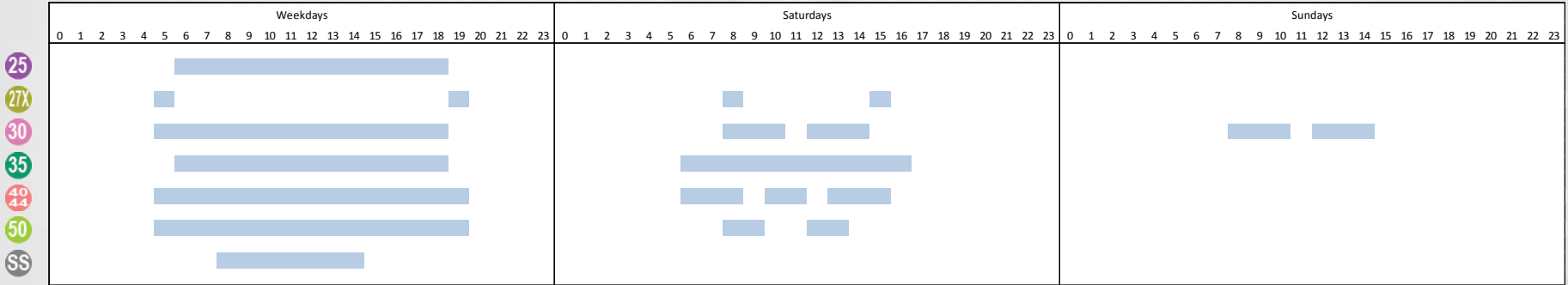
Line Summary



Agency

T3 Traditional Taxi

■ Transit Advantage ■ AV Advantage



Line Summary

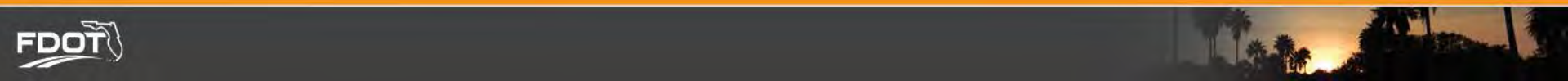


Agency

T2 TNC

Transit Advantage AV Advantage

	Weekdays																							Saturdays																							Sundays																																										
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23																	
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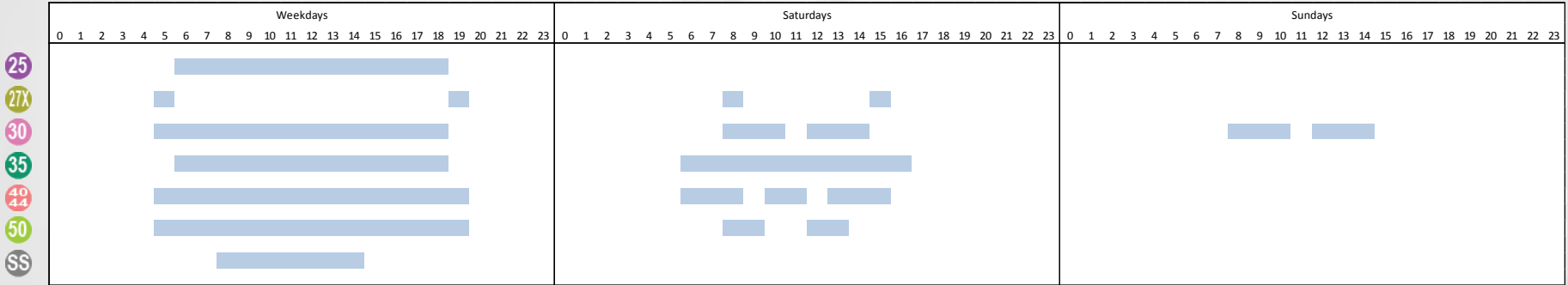
Line Summary



Agency

T1 Shared TNC

■ Transit Advantage
 ■ AV Advantage



Line Summary

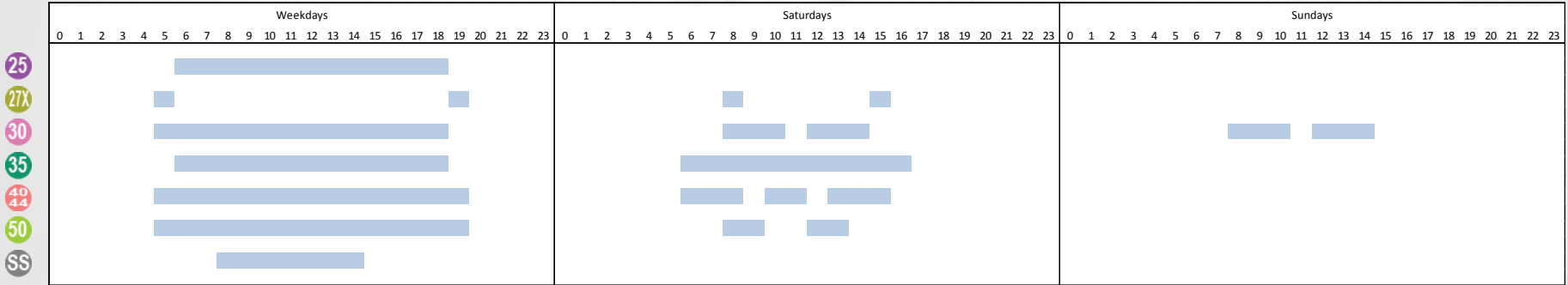


Agency

A3

Shared AV at \$0.75 per mile

■ Transit Advantage ■ AV Advantage



Line Summary

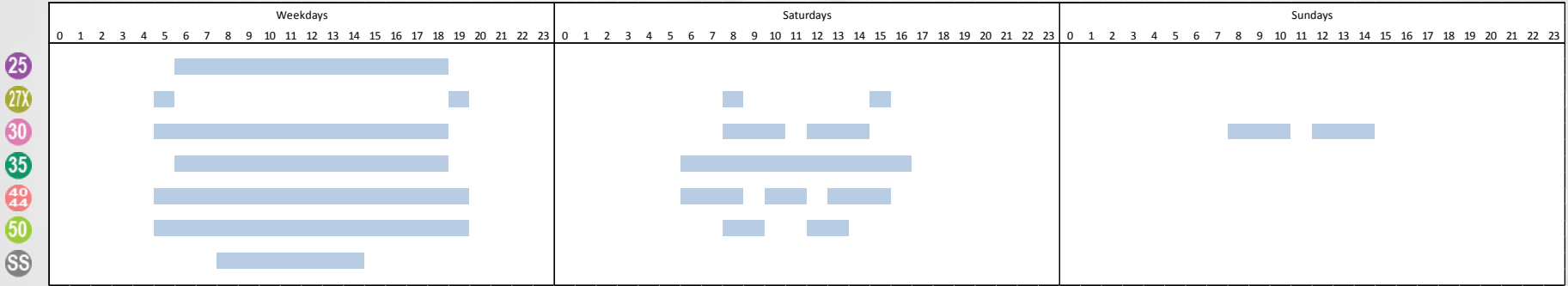


Agency

A2

Shared AV at \$0.50 per mile

Transit Advantage AV Advantage



Line Summary

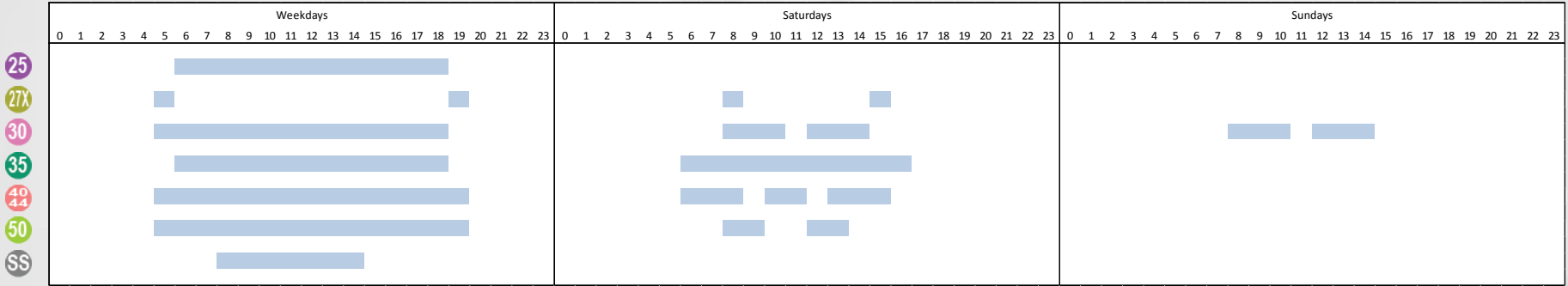


Agency

A1

Shared AV at \$0.25 per mile

Transit Advantage
 AV Advantage



Findings



All lines evaluated were below Citrus Connection's system-wide average productivity of 18 passengers per revenue hour.

Each line represents opportunity to improve overall productivity by substituting AV services.

Agency

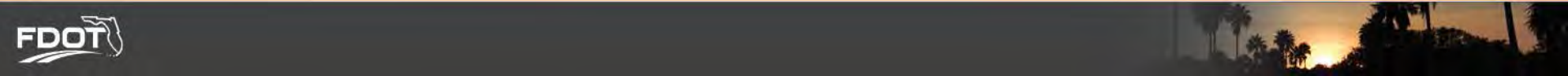
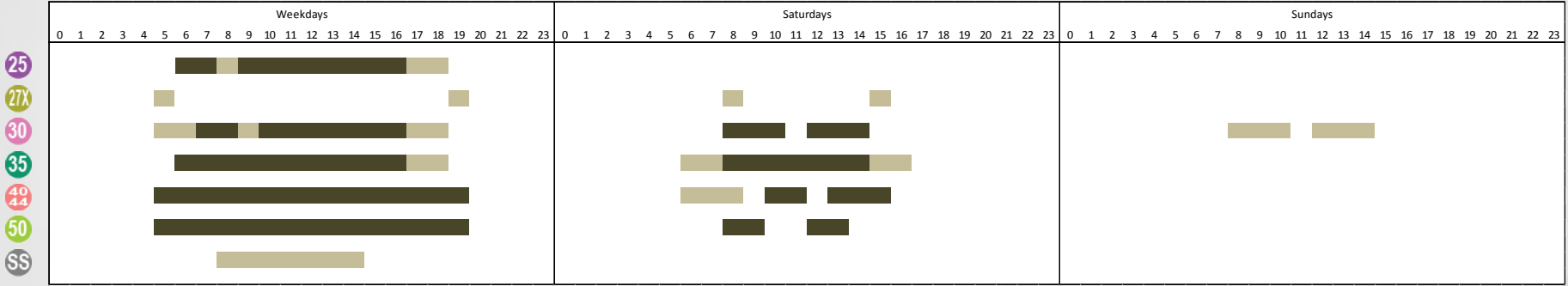
Line Summary



Taxpayer

T3 Traditional Taxi

■ Transit Advantage ■ AV Advantage



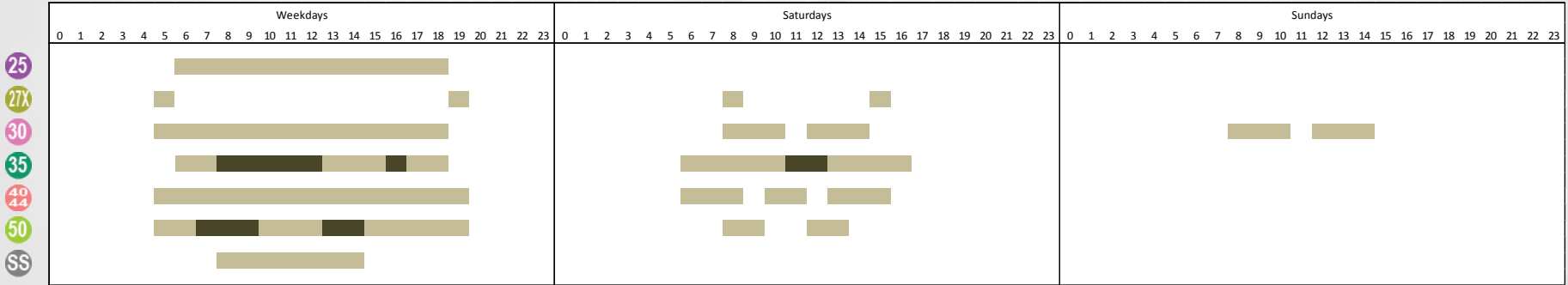
Line Summary



Taxpayer

T1 Shared TNC

■ Transit Advantage ■ AV Advantage



Line Summary

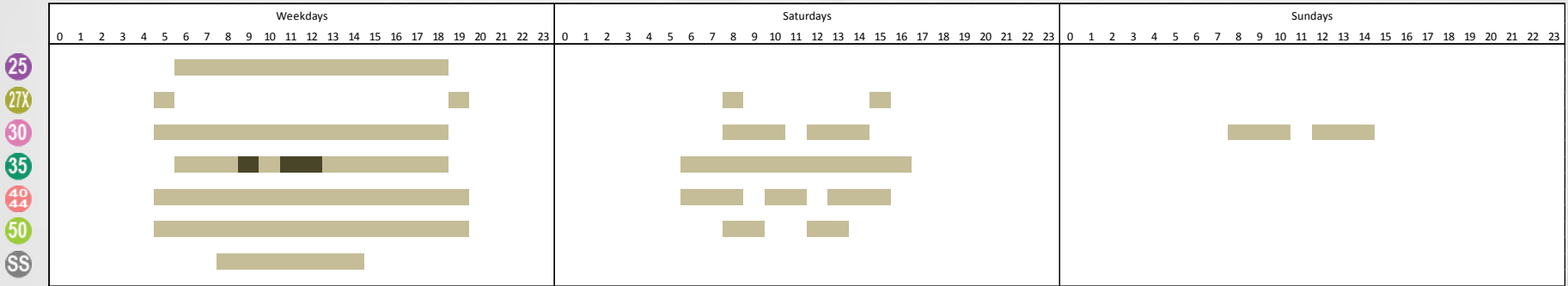


Taxpayer

A3

Shared AV at \$0.75 per mile

■ Transit Advantage ■ AV Advantage



Line Summary

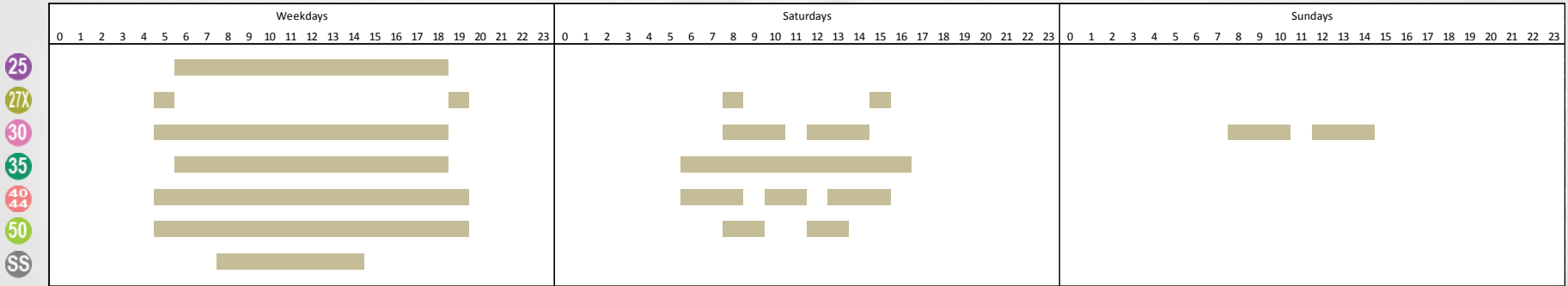


Taxpayer

A1

Shared AV at \$0.25 per mile

■ Transit Advantage ■ AV Advantage



Findings



AV fare cost at \$0.50 per mile is less than subsidy per passenger on all lines.

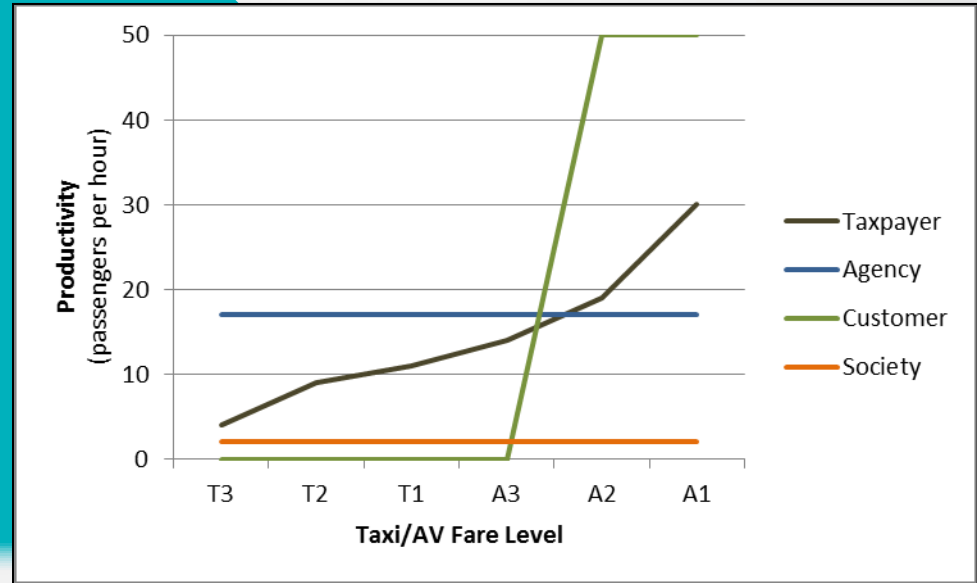
Transit agency should consider TNC partnerships or directly operated AVs for services in less productive areas and at less productive times.

Taxpayer

Productivity Assessment



Sensitivity of break-even transit service productivity to AV fare level based on Citrus Connection cost structure



Potential Transit Agency Responses



- Focus fixed route transit on densest corridors
- Invest in transit priority features
- Expand TNC partnerships for integrated trip planning and payment
- Explore taxi/AV fare subsidy programs
- Monitor advances in autonomous transit



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Questions?

Email questions/comments to:
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