Transit Self-Sustaining Programs

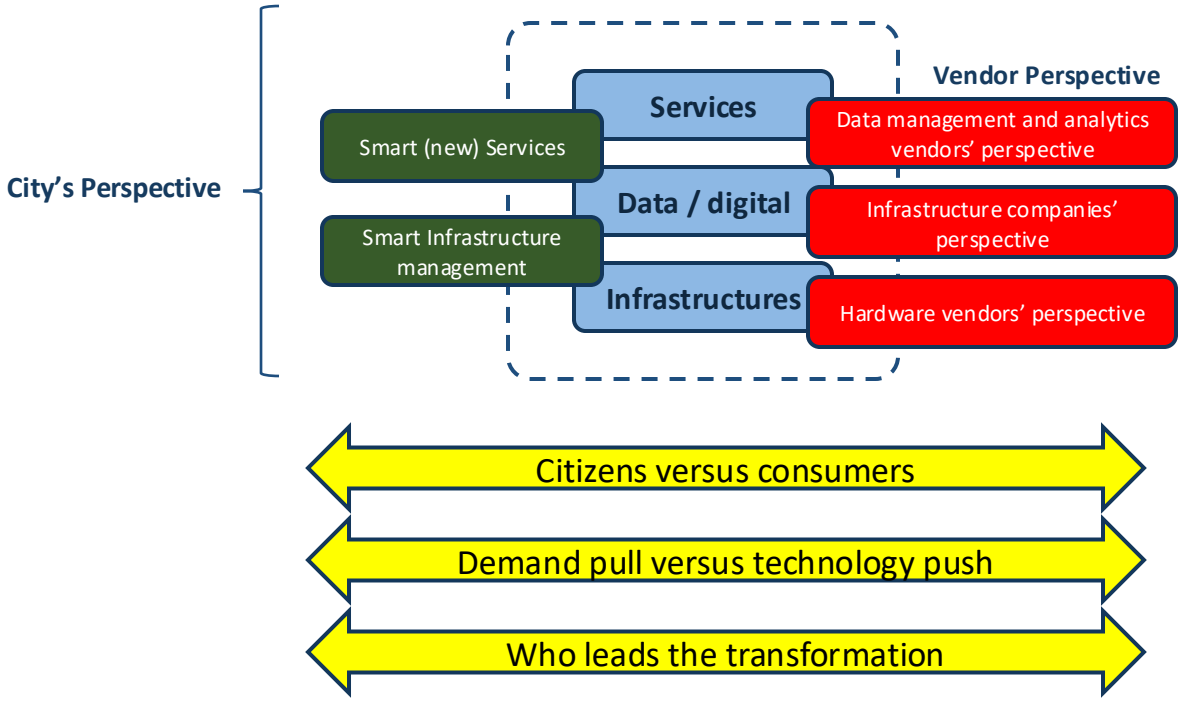
In-person briefing

Sacramento, February 2025

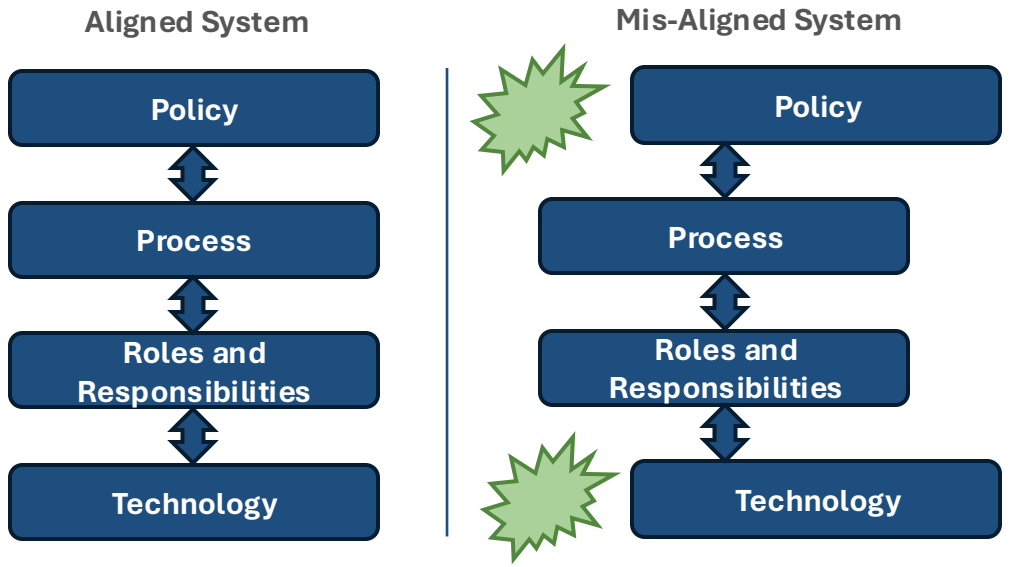
Disruption Opens Opportunities

"Never let a good crisis go to waste." Sir Winston Churchill

Opportunity to take control

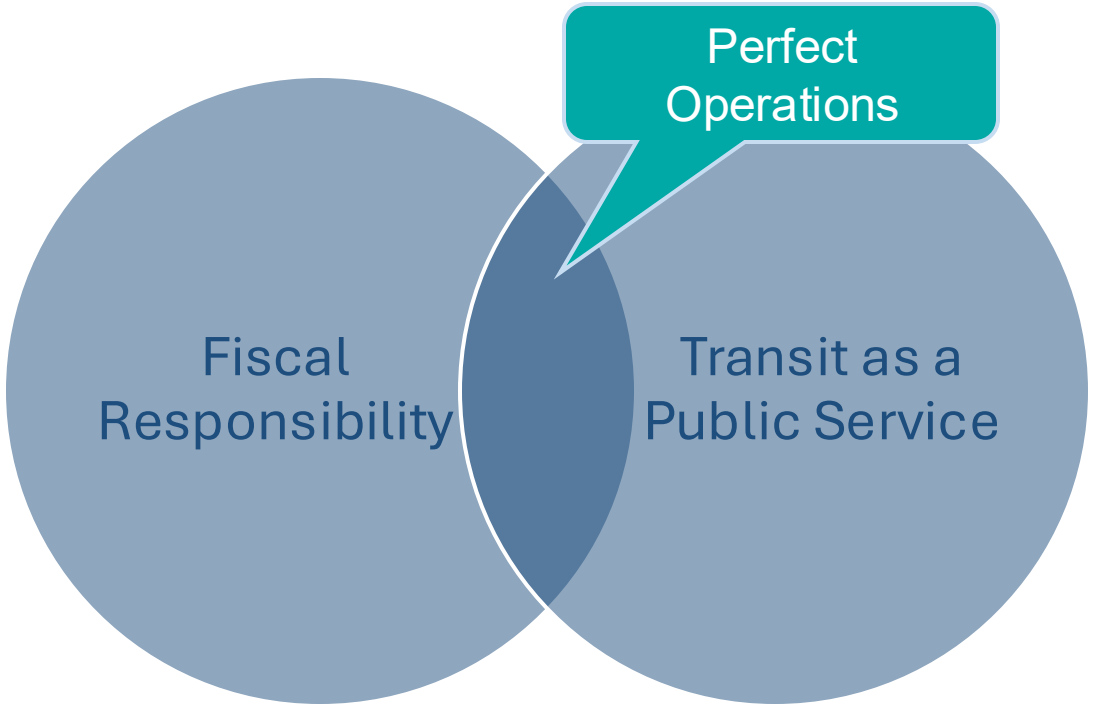


Opportunity to re-align



Rapid Technology and Policy/Political changes have misaligned the Transportation and Transit Agencies

Enabling Agencies to seek *Perfect Operations*



Instead of fighting…

….seek perfection

Council Roadmap

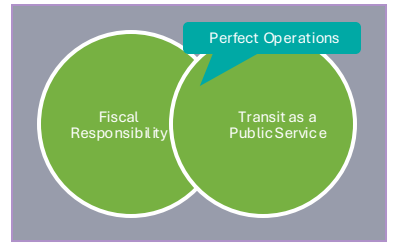
Opportunity Definition
1. Transit Opportunity Index
2. Benefit Model

Test and Refine
1. ECR Route
2. Realize intended benefits

Accelerate to all of California
1. Formalized knowledge and methods
2. Certifications
3. Open Architecture

Today

All CA Transit



Technology as Enabler
1. SFMTA PoC
2. Operational Solution
3. SMART Grant

Structure to Scale
1. Bridging Entity
2. Standardized assessments
3. Low-risk implementation
4. Benefit Realization

Vertical Scaling
1. Benefits fund next route
2. Accelerate deployment

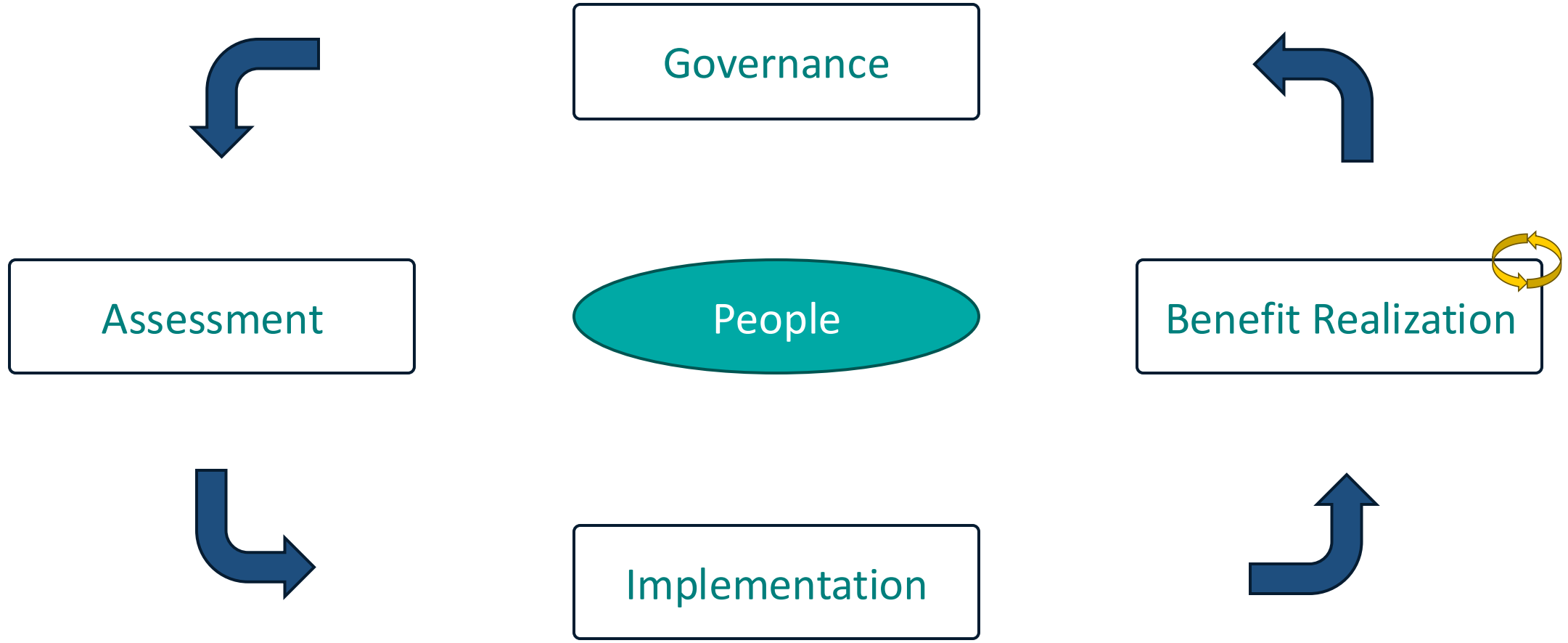
Horizontal Scaling
1. Next Transit Agencies

Depth Scaling
1. Multi-mode optimization
2. Additional Use Cases (e.g., events, parking)
3. Safety monitoring and proactive actions

Operational Excellence
1. Federated Operational Center
2. Monitor and Improve
3. UC Research
4. Education Center

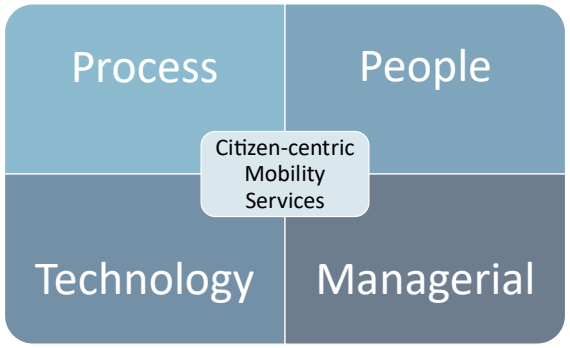
Benefits >> Investment

Self-Sustaining Program



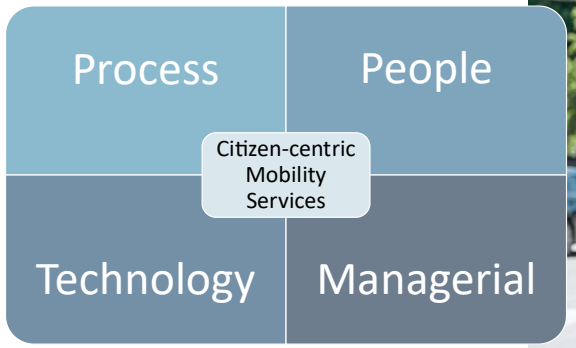
How big is the opportunity for Transit?

Transportation Agency



Operational Metrics:
- **Transit Opportunity Index**

Transit Agency



Operational Metrics:
- **On-time Performance**
- **Schedule Adherence**

The Transit Opportunity Index

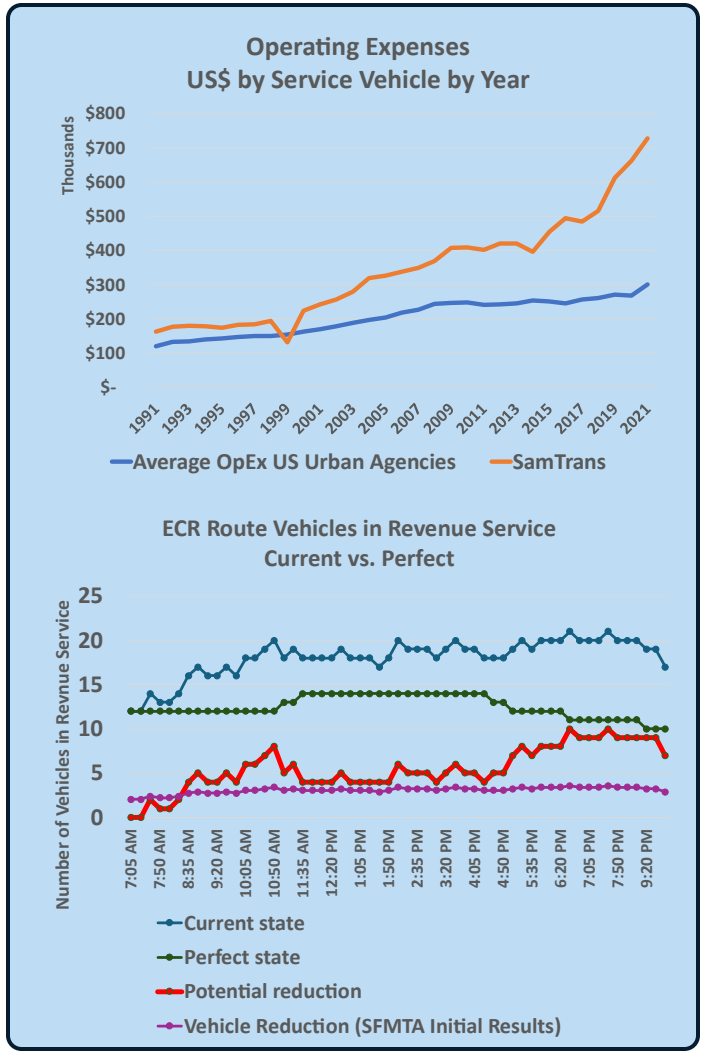
- The Transit Opportunity (TOI) Index enables assessment of the **inefficiencies** introduced in the Transit System.
- **Opportunity** is measured in the percentage of Service Hours the Transit Agency deploys to **mitigate uncertainty and poor traffic flow** in the road infrastructure.
- In essence, the Transit Opportunity Index Assessment determines the **jurisdiction's performanc**e owning the infrastructure.
- The methodology enables assessment at multiple levels ranging from the total Transit system down to the approach at the intersection to **drive highest impact interventions**.

Transit Opportunity Index Classifications

Transit Opportunity Index	Transit Opportunity Percentage
Excellent	<10%
Good	10-20%
Fair	20-30%
Poor	30-50%
Unacceptable	>50%

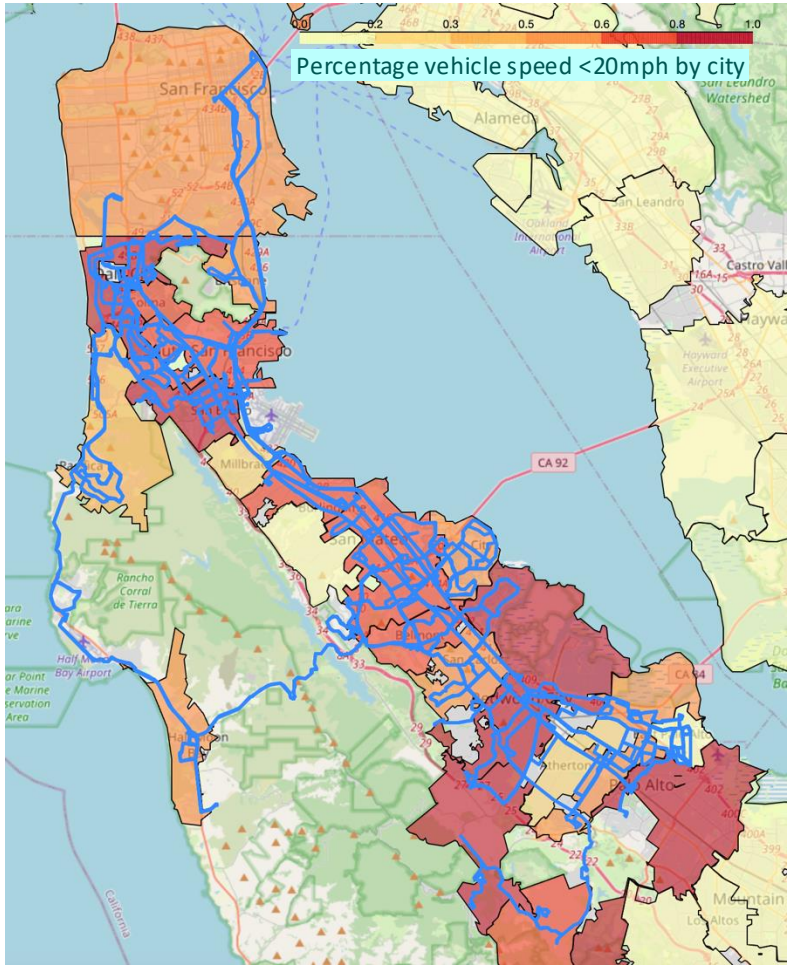
SamTrans TOI Assessment Results

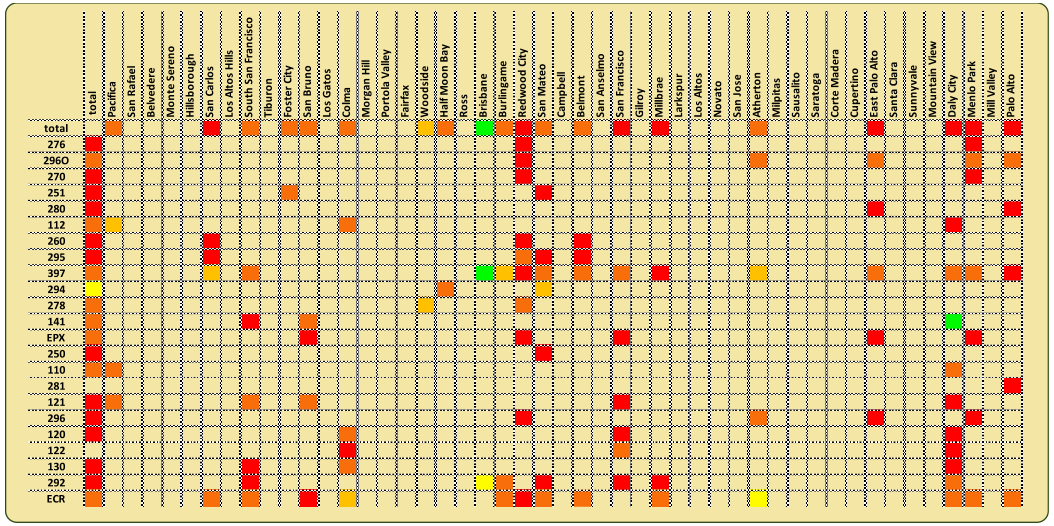
- Cities score ***Poor*** on the Transit Opportunity Index (43.2%)
- This is caused by cities and CalTrans providing uncontrolled and unpredictable traffic flow
  - Transit First policy not implemented
  - Intersections are unpredictable
  - Red-light delay is the most significant contributor to the opportunity
- SamTrans average OpEx per bus is $729k per year.
- Leveraging dynamic, multi-mode traffic flow optimization enables SamTrans Ops to remove multiple vehicles from ECR route.
- OpEx savings are sufficient to fund program to scale resulting in a self-sustaining program.
- Potential 1400kg Greenhouse Gas reduction per day on ECR route.



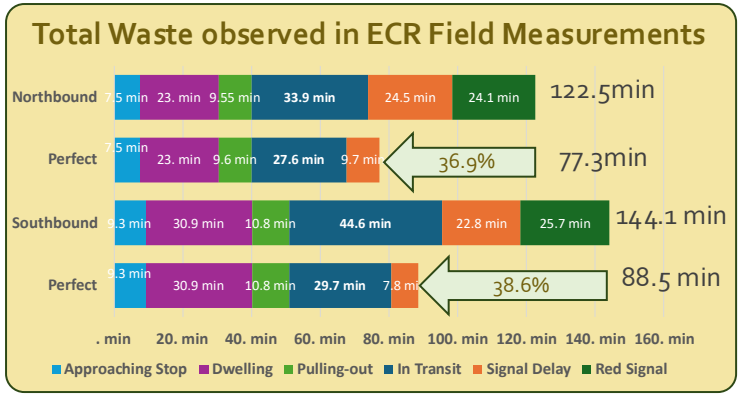
SamTrans TOI Results

SamTrans operates 76 Bus
Routes servicing 22 cities and towns





- ***Over 40% of Service Hours*** *are wasted in 14 of the 22 transportation agencies that provide SamTrans with traffic flow services.*
- *This waste is due to traffic signal delays, infrastructure choices, and uncontrolled traffic flow.*

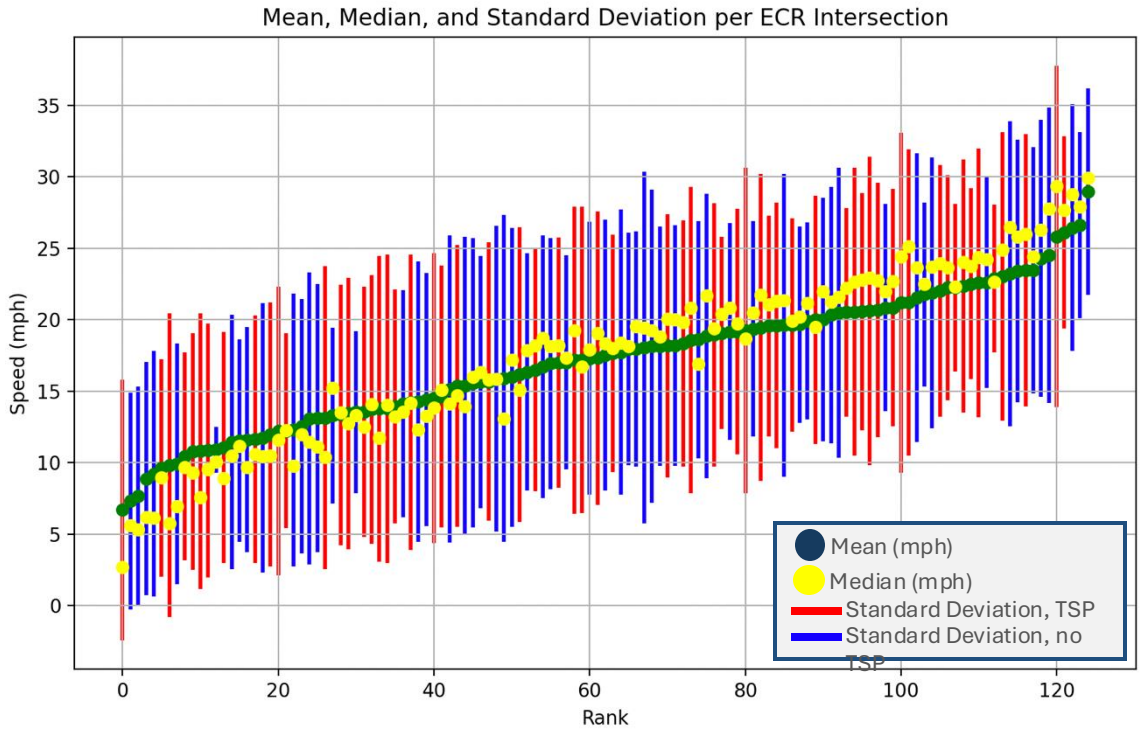


City	Waste %
Brisbane	5.35%
Woodside	27.33%
Pacifica	33.77%
Half Moon Bay	34.75%
Atherton	36.31%
Burlingame	37.40%
Colma	41.04%
Belmont	41.38%
South San Francisco	43.55%
San Mateo	46.54%
San Bruno	48.33%
Foster City	48.33%
Millbrae	50.20%
Menlo Park	50.83%
San Carlos	51.24%
Daly City	53.11%
East Palo Alto	53.69%
Redwood City	54.53%
San Francisco	55.01%
Palo Alto	57.25%

TWI Score
Excellent
Good
Fair
Poor
Unacceptable

Intersections behave unpredictably, regardless of TSP

Route ECR SamTrans intersections
CalTrans El Camino



Signal Delay is significant, and the system is unpredictable

	Location	mean	median	std dev	CV
1	CAMBRIDGE AVE & EL CAMINO REAL	28.97	29.94	7.23	25%
2	ARLINGTON DR & EL CAMINO REAL	26.61	27.94	6.51	24%
3	COLMA BLVD & EL CAMINO REAL	26.44	28.78	8.65	33%
4	MILLWOOD & EL CAMINO REAL	26.11	27.69	6.71	26%
5	ATHERTON AVE/FAIR OAKS LN & ECR	25.83	29.35	11.95	46%
6	BART ACCESS & EL CAMINO REAL	24.51	27.78	10.35	42%
7	RAY DR/ROSEDALE AVE & EL CAMINO REAL	24.29	26.27	9.7	40%
8	VALPARAISO AVE/GLENWOOD AVE & ECR	23.47	24.41	8.63	37%
9	ST FRANCIS WAY & EL CAMINO REAL	23.45	25.98	9.52	41%
10	CITATION AVE & EL CAMINO REAL	23.4	25.82	9.2	39%
116	SAN BRUNO AVE & EL CAMINO REAL	10.79	9.29	8.27	77%
117	2ND AVE & EL CAMINO REAL	10.45	9.68	7.29	70%
118	E MARKET ST/SAN PEDRO RD & MISSION ST	9.93	6.96	8.42	85%
119	VICTORIA AVE & EL CAMINO REAL	9.82	5.77	10.61	108%
120	RALSTON AVE & EL CAMINO REAL	9.64	8.98	7.62	79%
121	MURCHISON DR & EL CAMINO REAL	9.21	6.16	8.59	93%
122	SNEATH LANE & EL CAMINO REAL	8.88	6.2	8.15	92%
123	JOHN DALY/KNOWLES/HILLSIDE & MISSION ST	7.68	5.31	7.65	100%
124	JAMES AVE & EL CAMINO REAL	7.32	5.59	7.58	104%
125	4TH AVE & EL CAMINO REAL	6.69	2.71	9.12	136%

Unpredictable

The Coefficient of Variation (CV) is a statistical measure of the relative variability in a dataset. The lower the CV, the more predictable the system is, in our case the intersection. A CV > 30% is considered unpredictable.

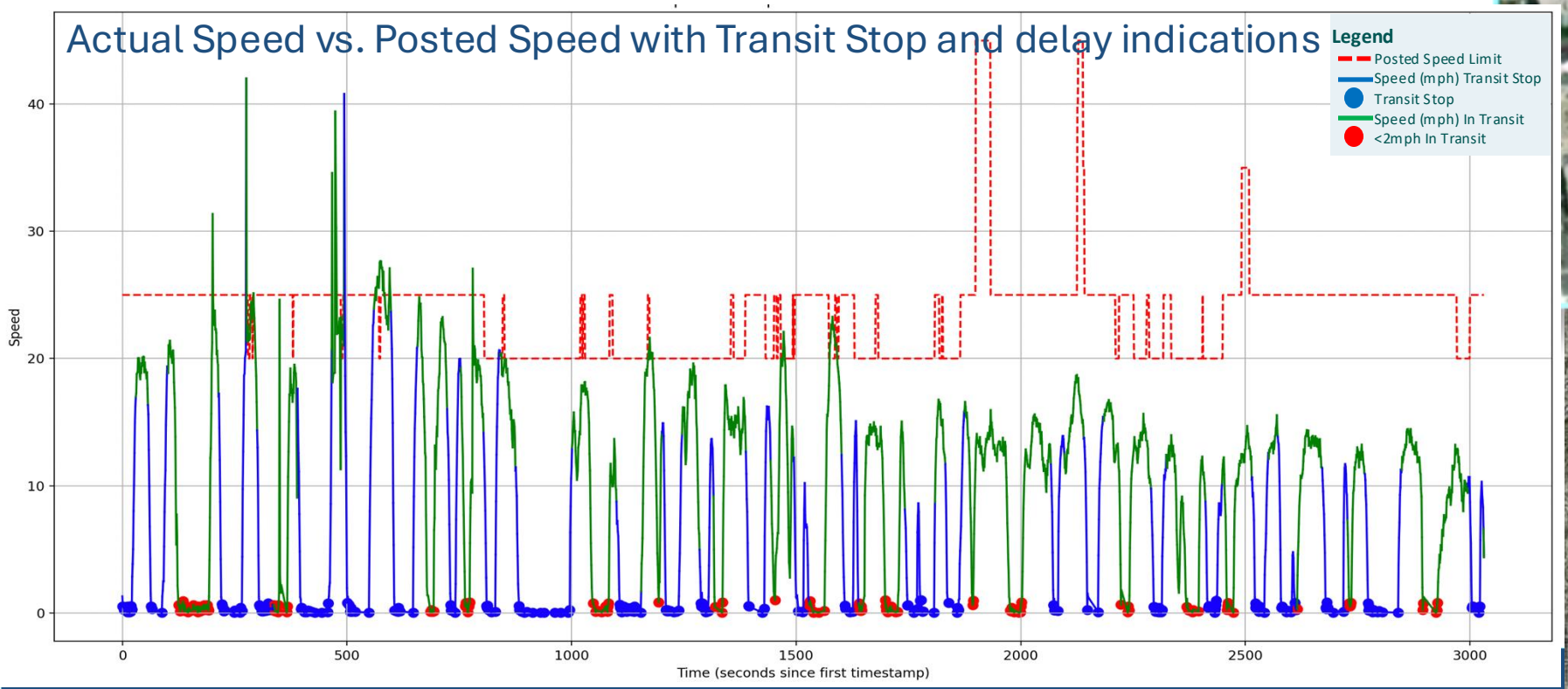
Transit Opportunity Index Assessment

- SFMTA has both Transit and Streets (Transportation) under one Director.
- Transit Planning provided Automated Vehicle Location (AVL) for vehicles collecting at 1Hz and Automated Passenger Count (APC) data for three days.
- Initial Transit Opportunity Index Assessment has been completed for Route 49 Outbound on Tuesday, 14 May 2024.
- Route 49 runs on Van Ness and Mission, where SFMTA has invested **$170M** in transit improvements related to both infrastructure and Transit Signal Prioritization.
- The assessment resulted in a ***Poor*** Transit Opportunity Index rating.
- Intersections behave ***unpredictably*** regardless of Transit Signal Prioritization.
- The results have been presented to Transit Executives, Strategy, Finance, Transit Signal Priority manager, and Traffic Engineering, which **confirmed similar results** found in their ad-hoc measurements,

Example: Route 49, Trip 11500024 Outbound

Van Ness and Mission. Tuesday, 14 May 2024

- AVL data: 2365 Points
- Duration: 69.83min, Avg Speed: 6.12mph
- Transit Opportunity Index: 32.1% - ***Poor*** rating



Planning and Operational Excellence requires predictability - *Intersection Performance*

Rank	ID	STREET1	STREET2	PREEMPT_PR		Mean (mph)	Median (mph)	stddev	cv
1	14864	HAYES	VAN NESS	TSP		23.95	23.59	5.58	23%
2	14820	GROVE	VAN NESS	TSP		23.93	24.13	7.25	30%
3	14797	CALIFORNIA	VAN NESS	TSP		21.82	23.02	7.44	34%
4	15349	GREENWICH	VAN NESS	TSP		20.64	20.67	3.83	19%
5	15389	TURK	VAN NESS	TSP		20.18	20.98	7.95	39%
6	14786	CLAY	VAN NESS	TSP		19.87	20.63	7.64	38%
7	15459	PINE	VAN NESS	TSP		19.76	21.29	8.28	42%
8	14863	FELL	VAN NESS	TSP		19.67	22.08	9.65	49%
9	14770	VAN NESS	WASHINGTON	TSP		19.30	21.68	8.45	44%
10	14751	FRANCISCO	VAN NESS	TSP		19.24	20.04	7.00	36%
68	14517	EXCELSIOR	MISSION	TSP		6.69	5.01	6.54	98%
69	14819	MCALLISTER	VAN NESS	TSP		6.66	2.01	7.84	118%
70	14785	SUTTER	VAN NESS	TSP		6.48	2.16	7.43	115%
71	14787	SACRAMENTO	VAN NESS	TSP		6.47	1.65	7.59	117%
72	14593	MARKET	SOUTH VAN NESS	None		6.32	1.40	7.53	119%
73	14816	EDDY	VAN NESS	None		5.84	0.99	7.30	125%
74	14749	CHESTNUT	VAN NESS	TSP		5.78	1.81	6.74	116%
75	15007	12TH ST	MISSION	None		5.45	3.05	5.79	106%
76	15388	O'FARRELL	VAN NESS	TSP		5.33	0.86	7.09	133%
77	15677	FRIDA KAHLO	CITY COLLEGE TERMINAL	None		2.58	0.86	3.77	146%

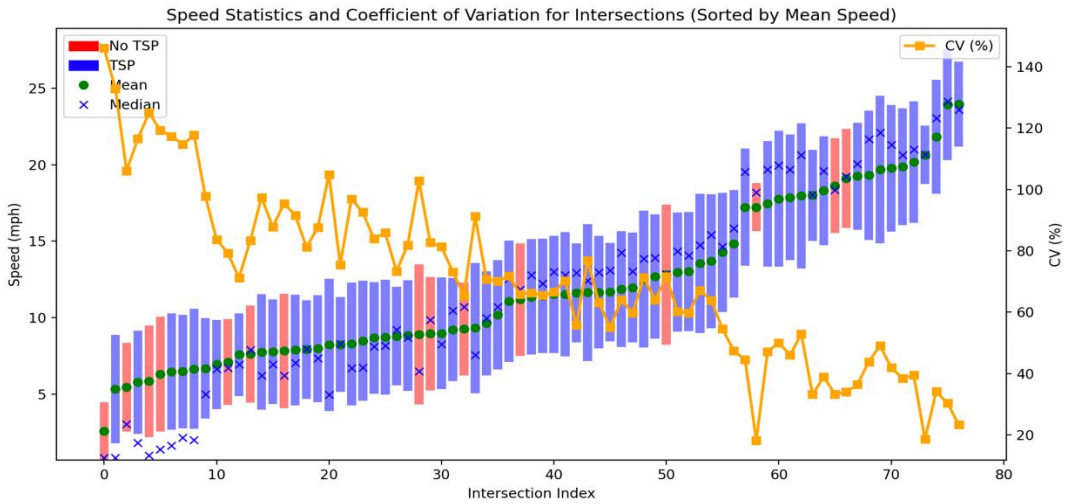
Top 10

Bottom 10

Unpredictable

The Coefficient of Variation (CV) is a statistical measure of the relative variability in a dataset. The lower the CV, the more predictable the system is, in our case the intersection. A CV > 30% is considered unpredictable.

- The intersections Route 49 traverse through are ***all unpredictable*** except for 3 (Hayes, Grove, Greenwich)
- No clear distinction between intersections with or without TSP
- Transit Planners respond to unpredictable intersection behavior by adding vehicles to the system

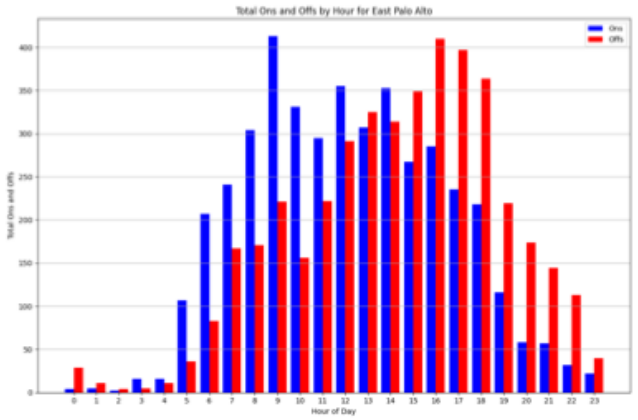


Palo Alto and East Palo Alto

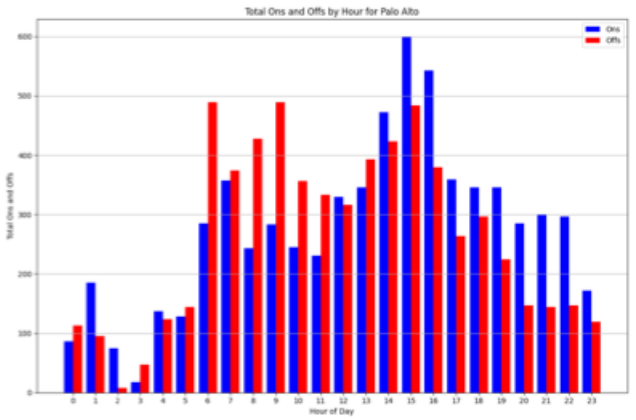
50m^2 Grid

Equity: Ridership

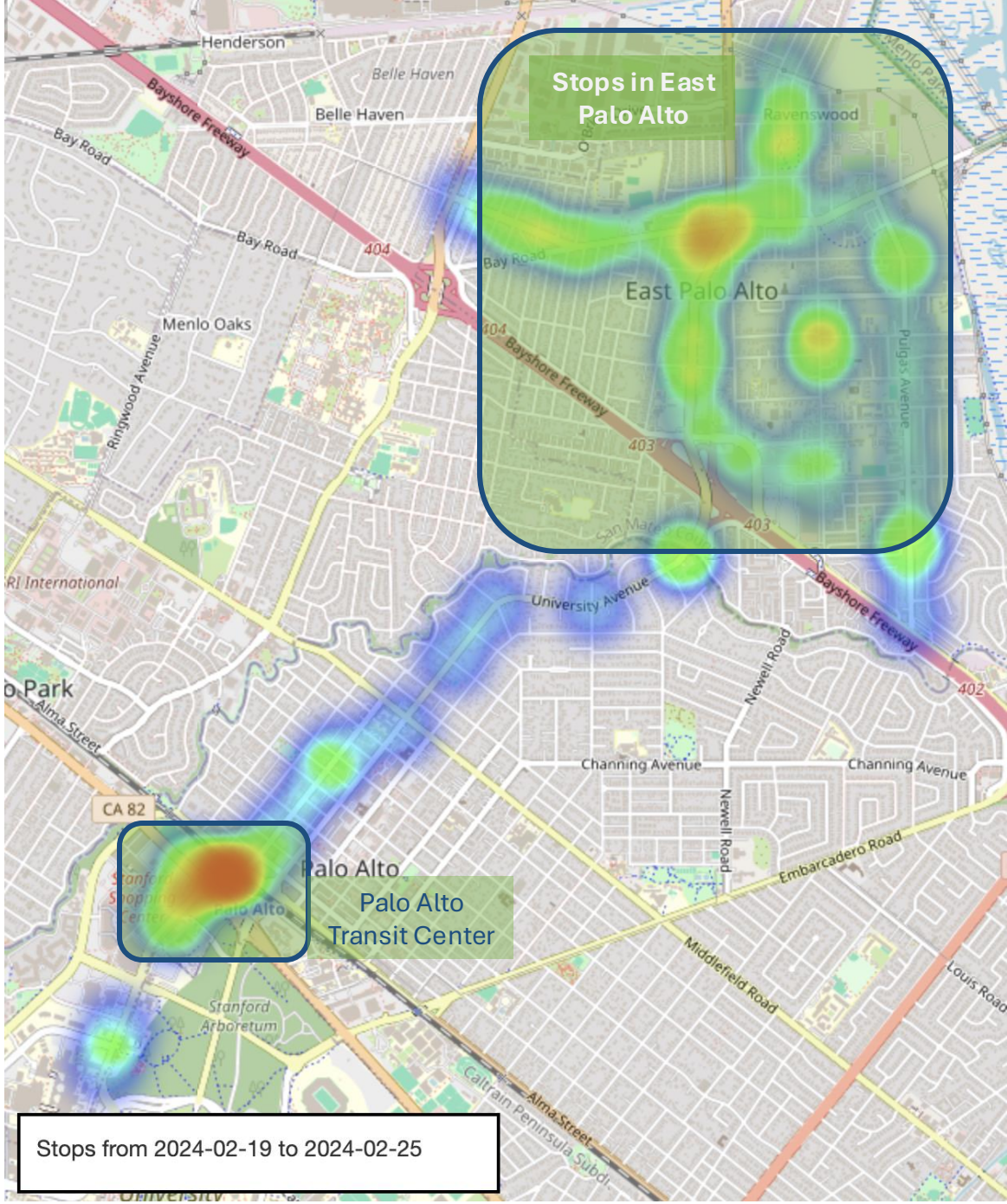
- East Palo Alto has a high number of Transit Dependent people
- People travel from and to the Palo Alto Transit Center to connect to CalTrain and other SamTrans routes like ECR



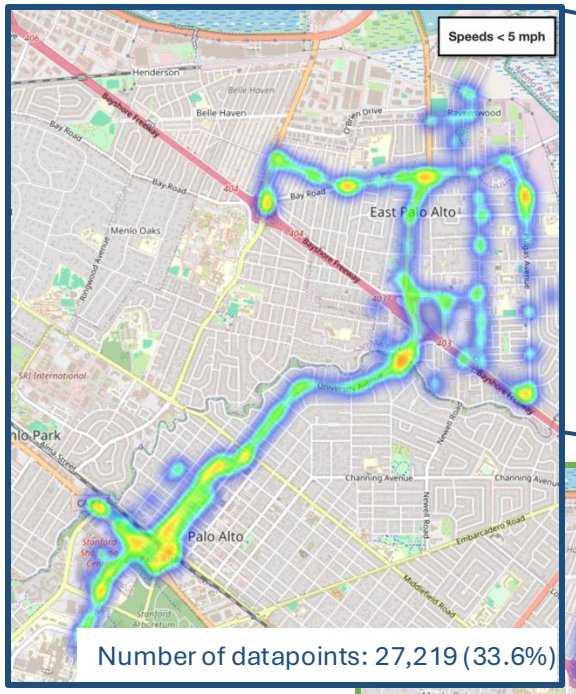
East Palo Alto: **Ons** in the morning, **Offs** in the afternoon

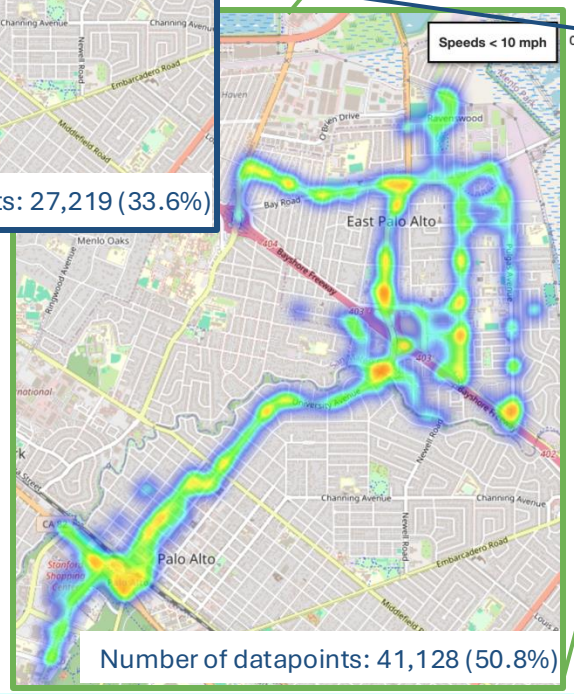


Palo Alto: **Offs** in the morning, **Ons** in the afternoon

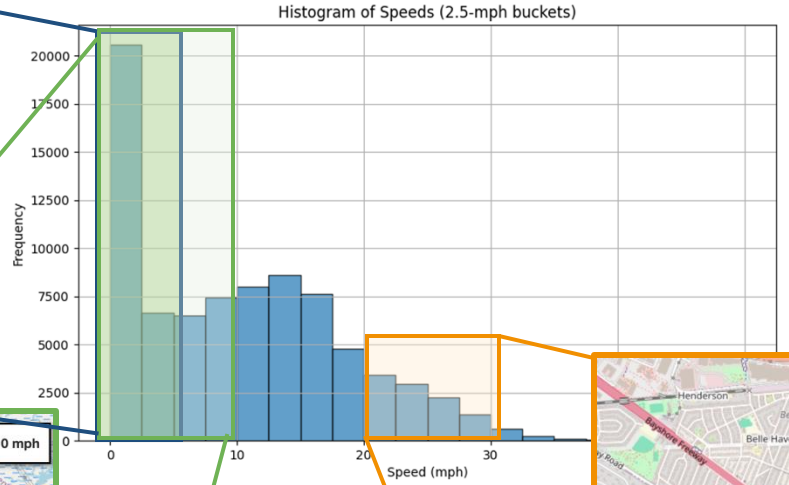


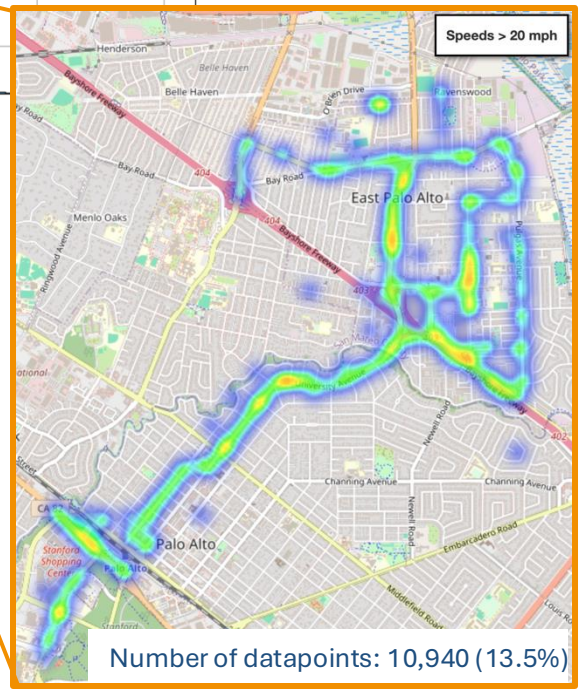
Do the Cities of East Palo Alto and Palo Alto enable SamTrans to operate at the posted speed limit?





Number of datapoints: 81,027 (100%)





Result Transit Opportunity Index Assessment

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Woodside	27.33%
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Half Moon Bay	34.75%
Atherton	36.31%
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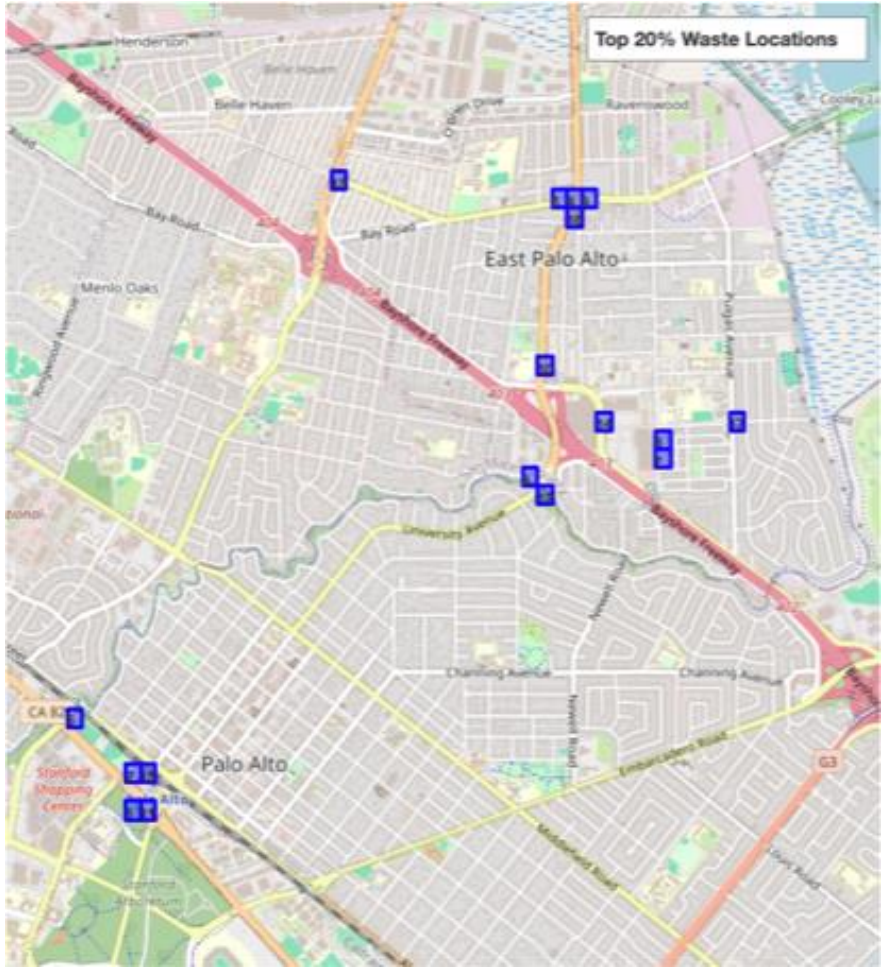
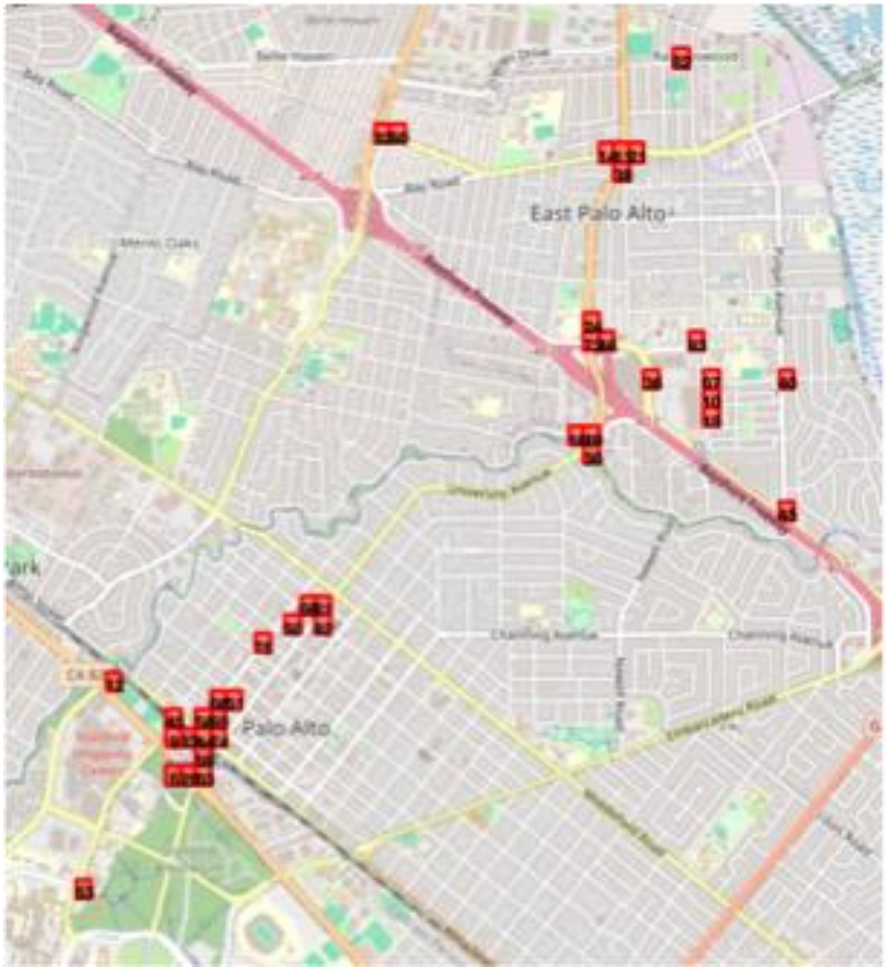
Daly City	53.11%
East Palo Alto	53.69%
Redwood City	54.53%
San Francisco	55.01%
Palo Alto	57.25%

Which locations contribute?

Top 20% Opportunity Locations



Top 40, grid size 50m^2

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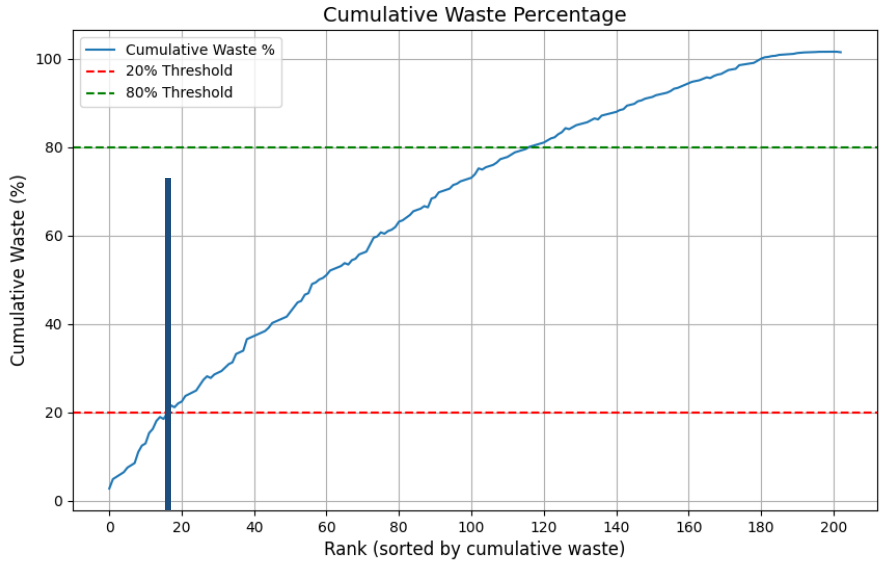
Value of the Opportunity

- Total opportunity is over **327h** in the week of Feb 19 – 25, 2024, or **~17,000h per year**.
- At 12kg CO_2 emission per service hour, this results in 204 metric tons of climate impact per year.
- At $188/h, the **value** of the opportunity is **$3.2M/year**
  - 18 50m2 squares introduce 20% of the opportunity at 8 locations
  - If we could realize 50% of the opportunity at those locations, $319k OpEx could be reduced
- When 100% of all opportunity would be realized, trips would be shortened by 47%.



SamTrans Operations and the Smart City Mobility Council are engaging with East Palo Alto for opportunity capitalization actions.

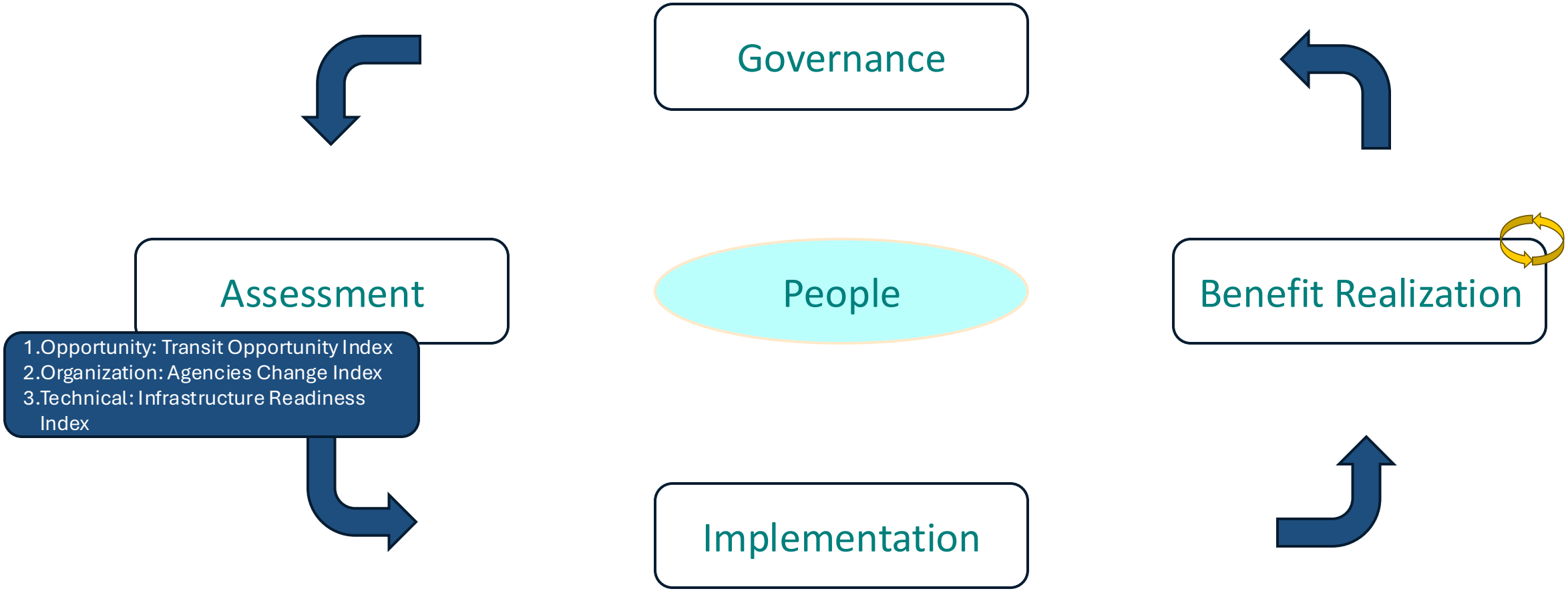
- CalSTA seeks to develop guidelines to establish self-sustaining programs

- Questions to answer:
  - Technology is proven but does the deployment of next-generation Multi-mode Traffic Flow Optimization solutions result in ***realizing*** the benefits?
  - Are Transportation and Transit Agencies able to form the program?
  - What is the current state of the ITS technology?
  - What is the initial investment needed, return on investment, total cost?

- Increased Ridership
- Environmental Sustainability
- Operational Efficiency
- Reduced Congestion
- Social Equity
- Economic Growth and Productivity
- Improved Public Perception and Mode Shift

Benefits >> Investment

Self-Sustaining Program



Technology as Enabler

Results SFMTA Proof of Concept

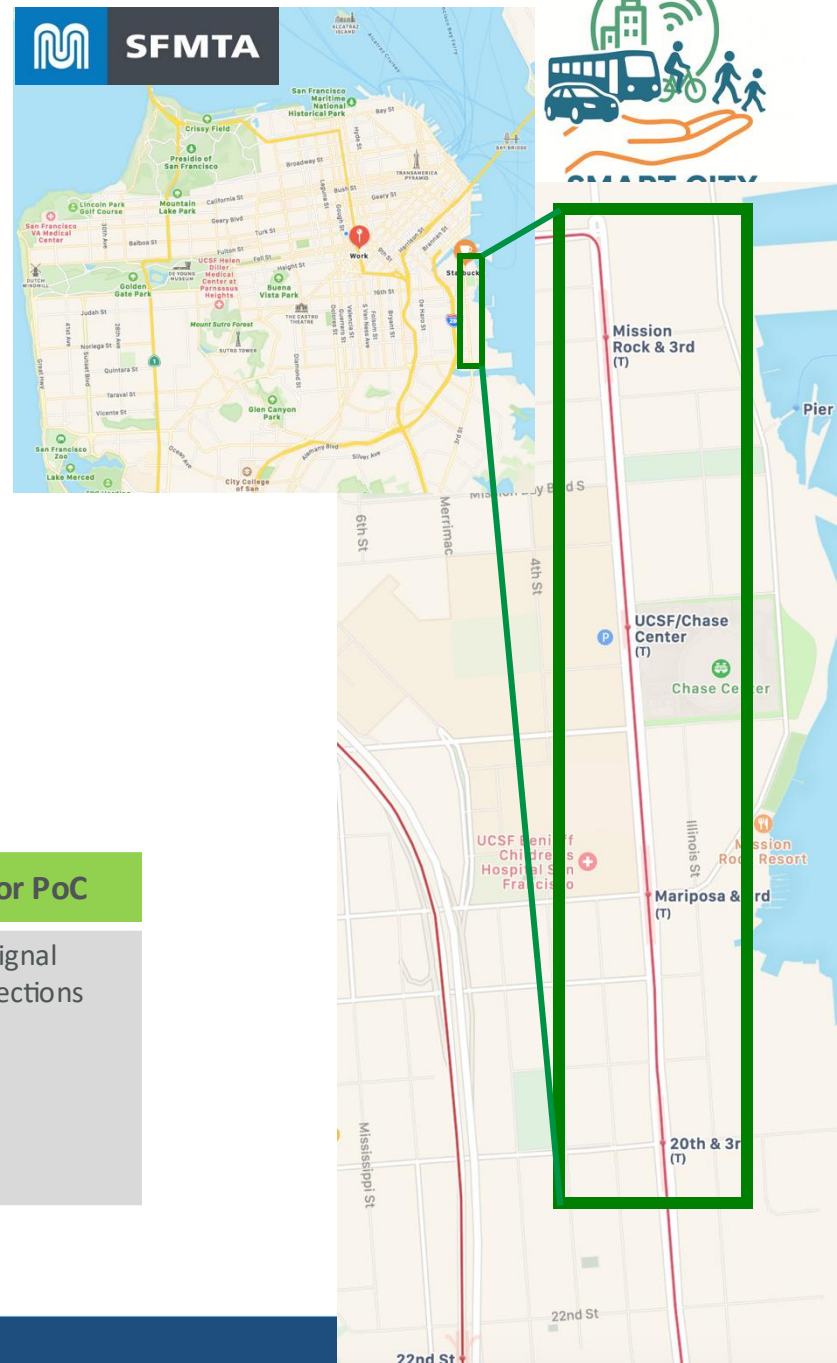
Awaiting fund transfer from MTC to scale testing to 75 intersections

SFMTA Connected Corridor PoC

Overview

Activities

1. Network 10 intersections and centralize traffic phase decision-making out of the controllers (keep safety at the intersection)
2. Understand in real-time position, speed, and size of every vehicle and pedestrian (without storing any personal data)
3. Optimize based on prioritization: Emergency Vehicles, LRV, Bus, Truck, Pedestrian, Bike/Scooter/Car with proven, world-class optimization algorithms
4. But most importantly, build all the processes, role & responsibilities, technology and management tools to scale to large numbers of intersections



Grant Goals: Connected Corridor PoC

Deploy Multi-Modal Intelligent Traffic Signal Systems (MMITSS) to networked intersections

Desired Outcomes:

- Increase safety to all modes
- Improve public transit speeds
- Reduce signal delays
- Reduce idling and GHG emissions

Project Funded by FHWA – Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grant

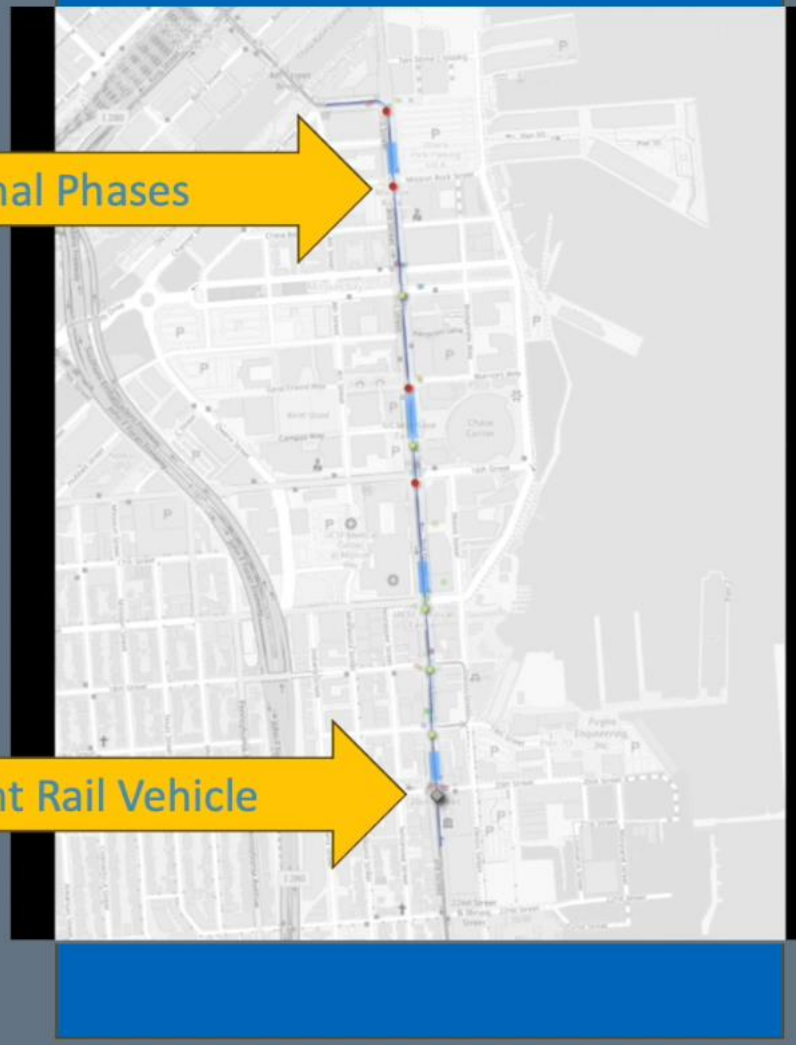
U.S. Department of Transportation Federal Highway Administration

Let's Race!

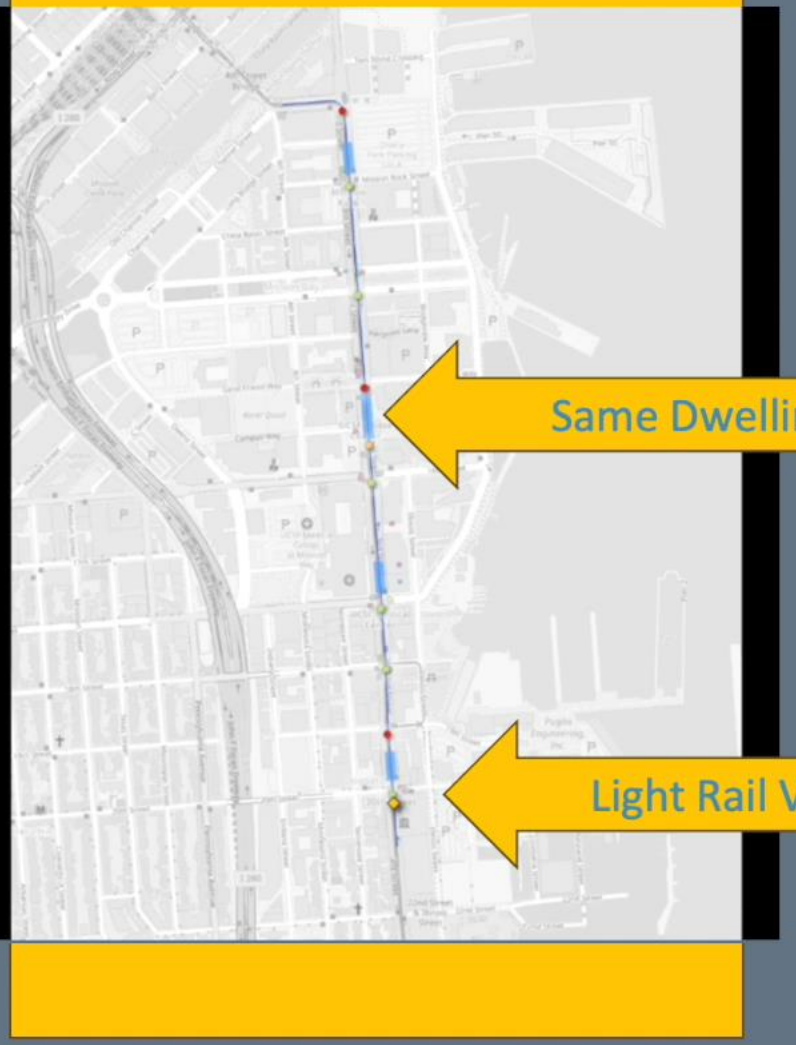
Simulation generated with SFMTA
PoC Connected Corridor Data
11am – 12pm

SFMTA

Reference Day



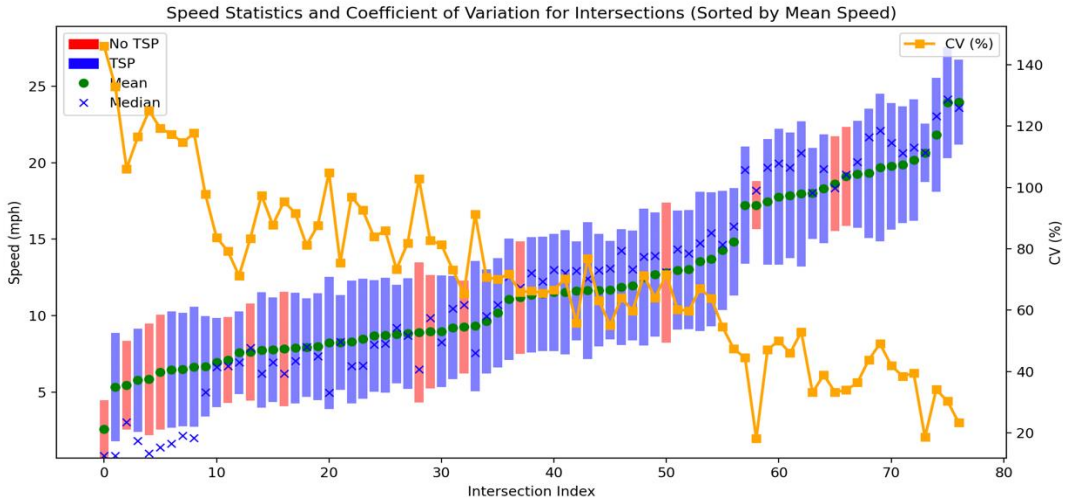
Test Day TNL Technology



Technology deployment results in predictable intersection behavior

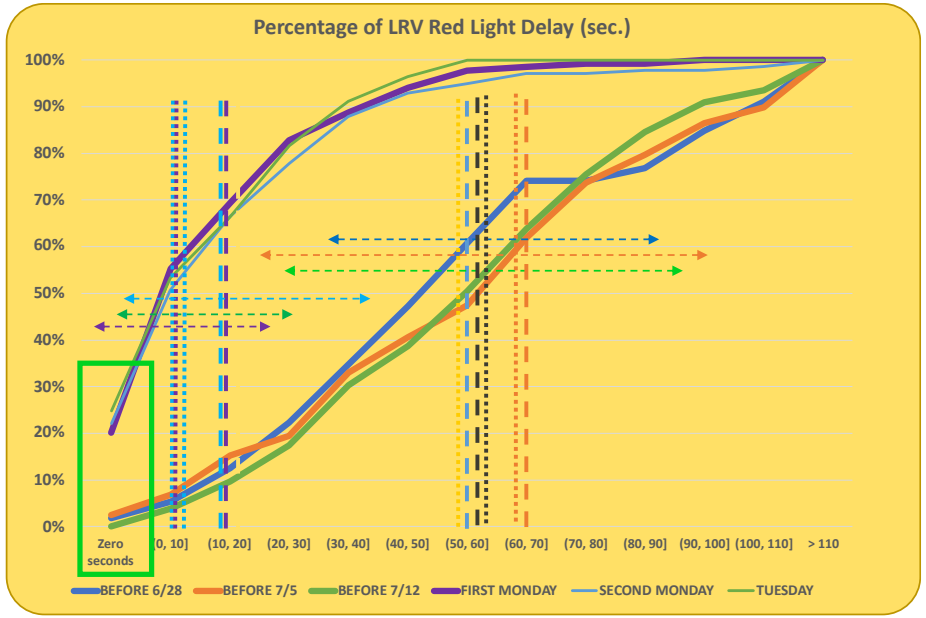
From Unpredictable to Control

Performance of Route 49 on Van Ness and Mission



T-Line Current

- 12-14 LRVs
- 80 min travel

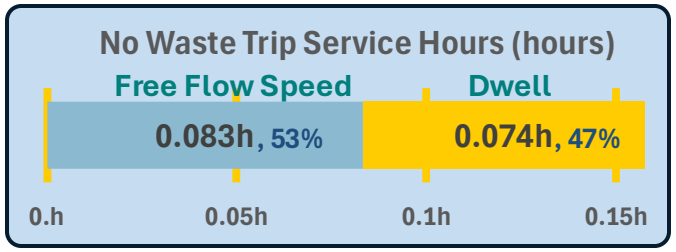


SFMTA Transit Planners Estimates

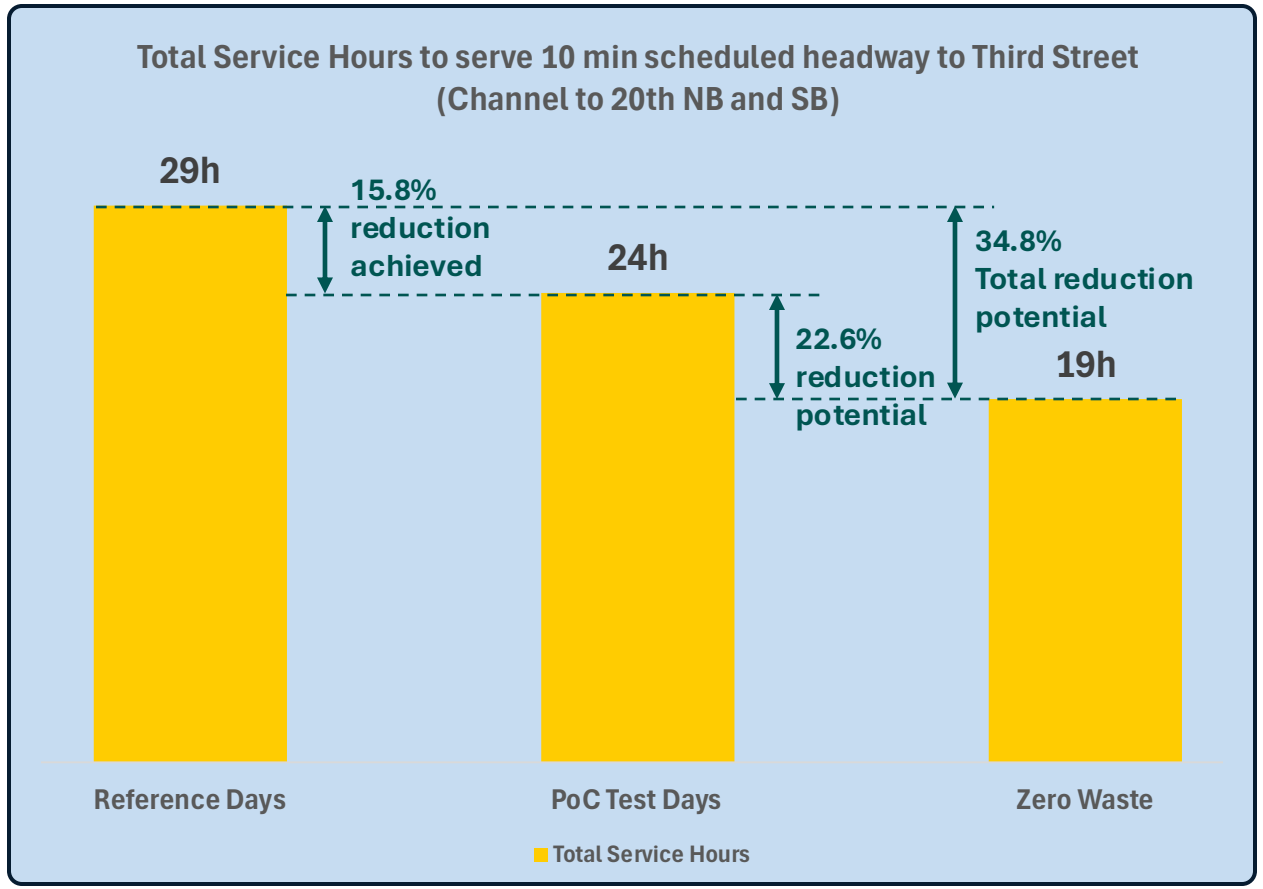
- 8-11 LRVs
- 60 min travel

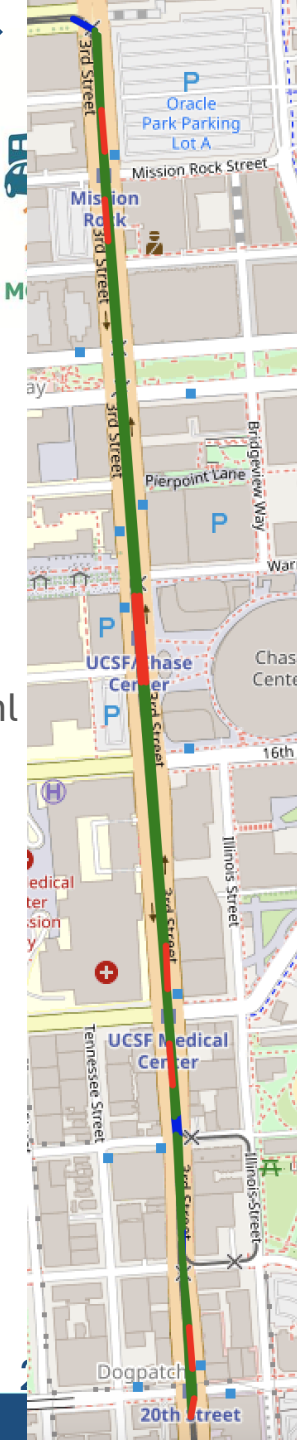
OpEx: $1.4M / vehicle / year

Service Hours is the measure of how many operational hours are spent to serve the citizens – Results SFMTA



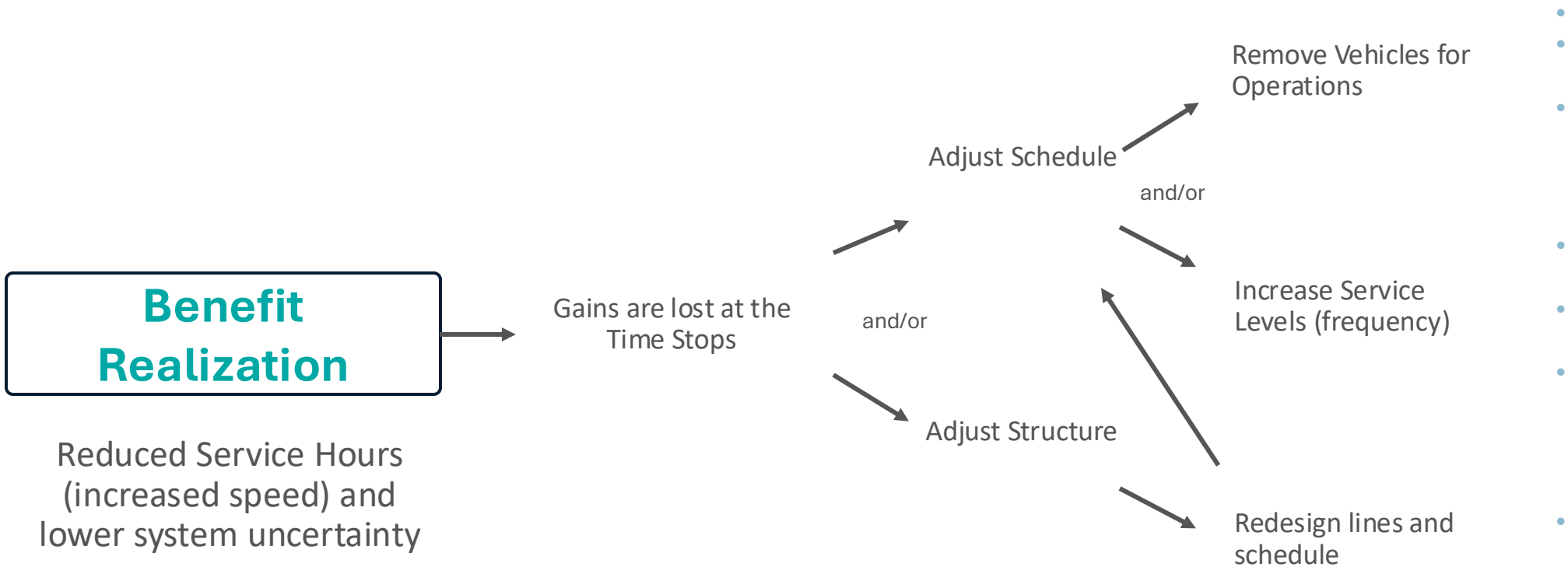
CA Total Operating	Annual OpEx
All Modes	$7,123,409,819
Bus	$4,038,151,765
LRV	$888,279,841





Source Location Data: SFMTA – Transit Vehicle Location History (2021), downloaded from https://data.sfgov.org/Transportation/SFMTA-Transit-Vehicle-Location-History-2021-/9722-grnf/about_data
Source OpEx: TS2.1 Service Data and Operating Expenses Time Series by Mode.xlsx, downloaded from https://www.transit.dot.gov/ntd/data-product/ts21-service-data-and-operating-expenses-time-series-mode-2

CalSTA needs us to provide the benefit model and organizational commitment



Technology enables schedule and structure adjustment. The benefit model defines the expected impact on travelers, climate, congestion, etc.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