SFMTA TSP Overview - Van Ness TSP

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San Francisco's Transit-First Policy Turned 50!!!

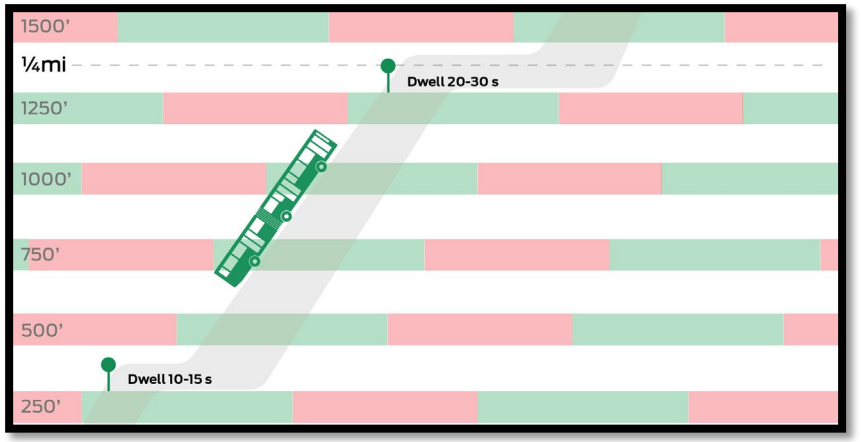
Outline

- TSP Overview
- SFMTA's TSP System Overview
- SFMTA's TSP Parameters and Guidelines
- Van Ness Improvement Project Overview
- Van Ness BRT TSP

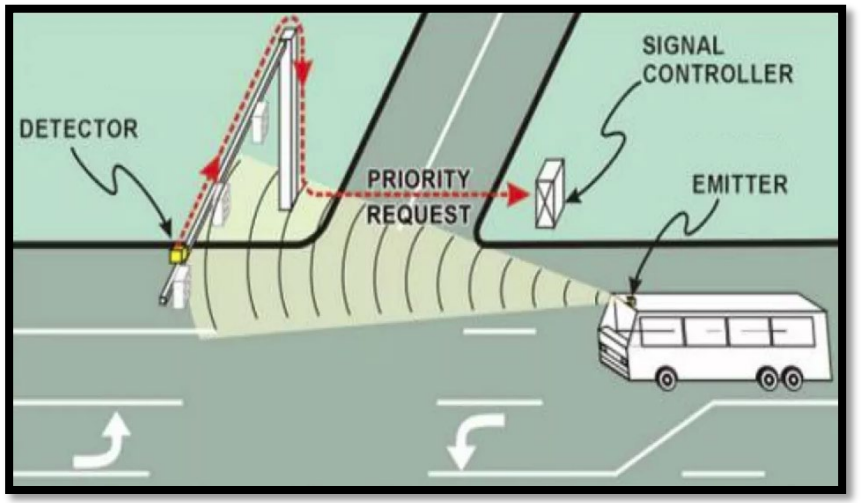
Transit Signal Priority Overview

Prioritizes transit vehicles through signalized intersections

- ***Passive*** TSP
  - Uses fixed signal timing strategies (progression, offsets, cycle lengths, dwell times, travel times)
  - No real-time communication hardware required
- ***Active*** TSP
  - Uses real-time communication hardware to modify traffic signal timing/phasing
  - ***Extension:*** extends the duration of the green light
  - ***Early Green***: reduces the duration of the red light (shorten opposing green)
  - ***Phase Swap***: rearranges signal phases to reduce transit signal delay



Passive TSP



Active TSP

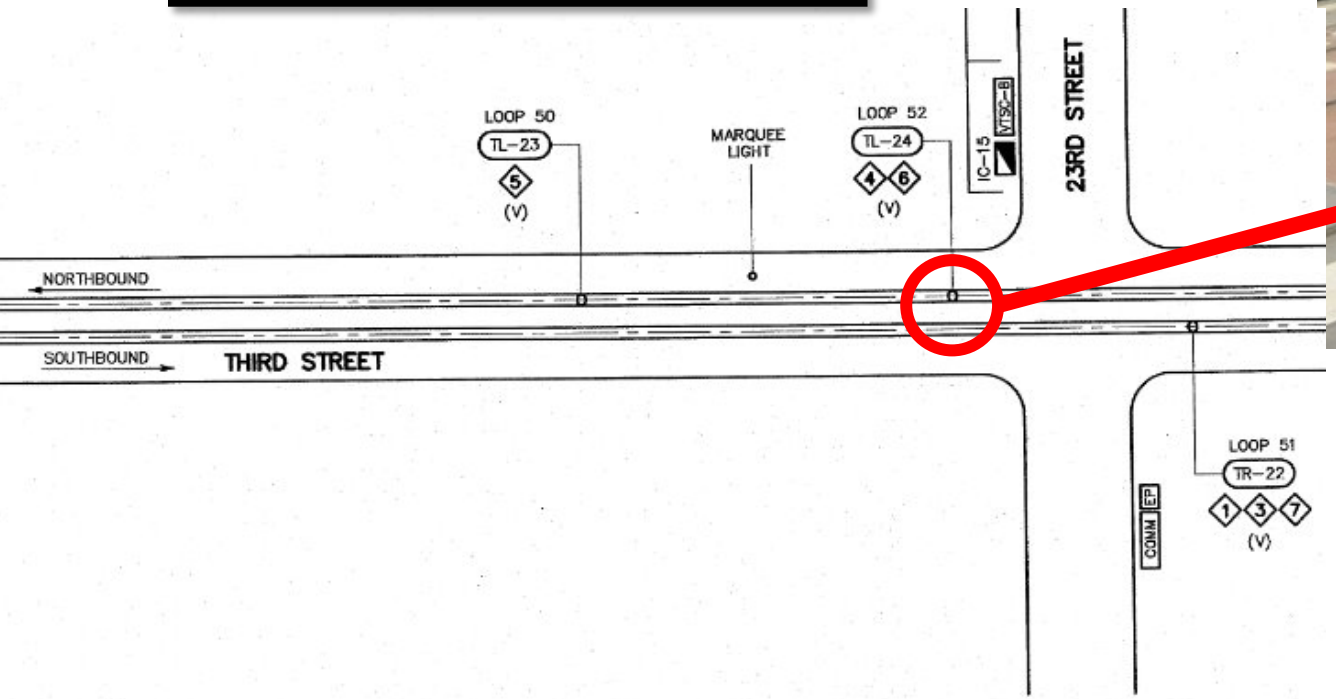
Transit Signal Priority Overview

- ***Unconditional vs Conditional TSP***
  - ***Unconditional TSP*** has no restrictions on granting TSP
  - ***Conditional TSP*** is provided if certain factors are met (e.g., bus is late, route/direction/time of day, occupancy)
    - Conditional TSP is rarely used in San Francisco and only used for Rapid vs Local Routes & special cases

33rd Ave/Geary

Image from Google Street View – March 2021

Muni Metro (Rail) TSP



Rail TSP is activated by Vetag sensors (in pavement loops) hardwired to the traffic signal controller

Bus TSP

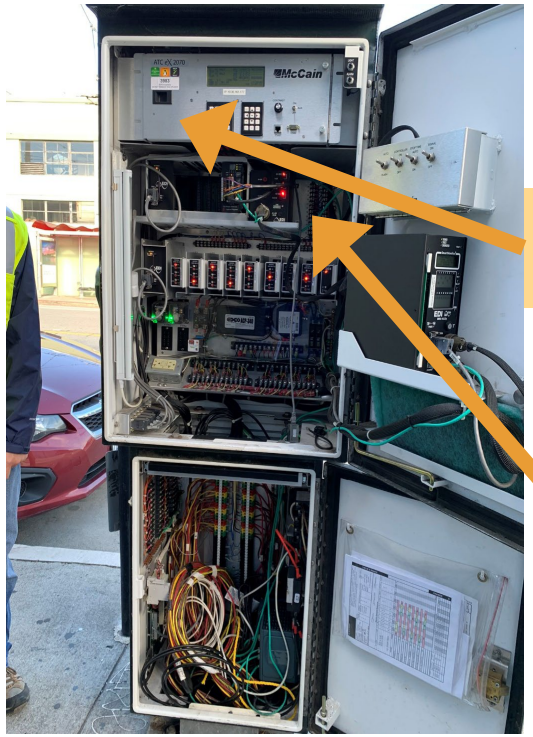
GPS Emitter

Computer

GPS Radio

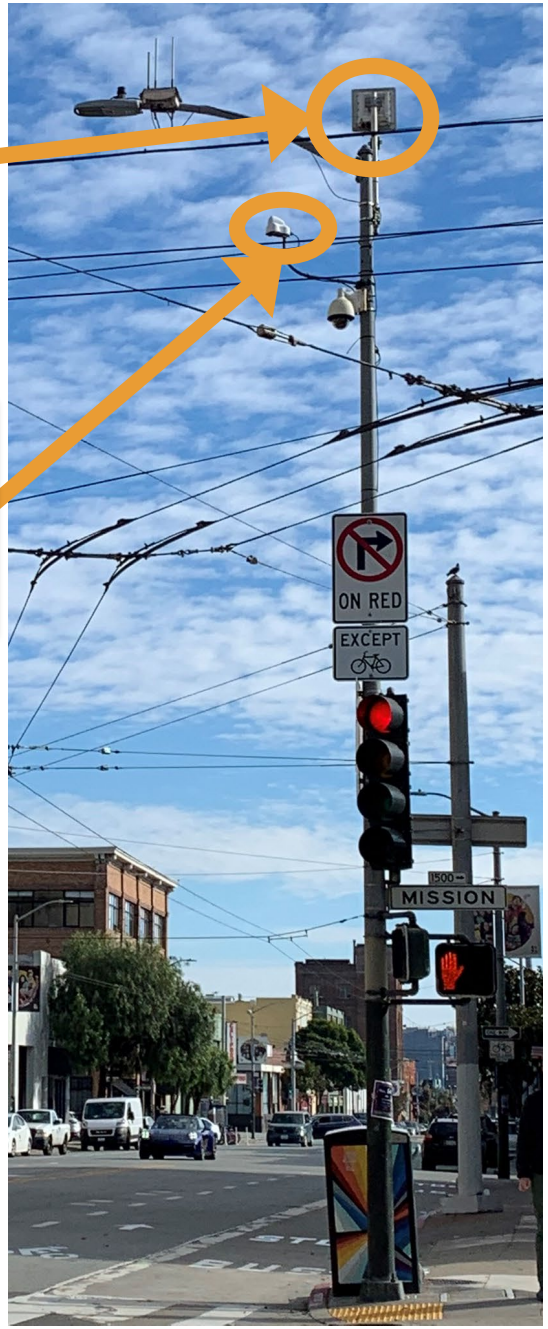
Wireless Radio

GPS Receiver



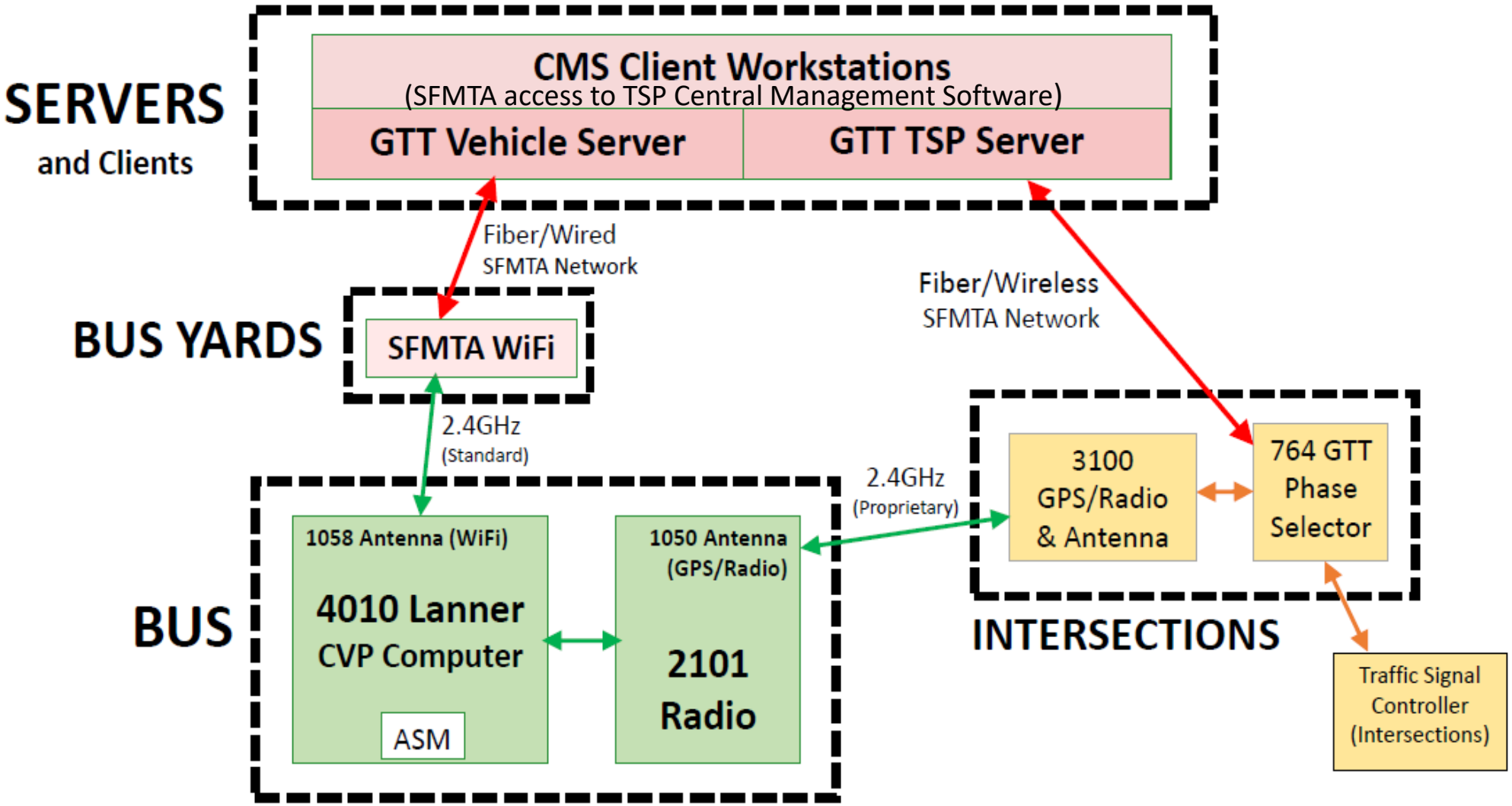
Traffic Signal Controller

Phase Selector



Bus TSP uses GPS technology

SFMTA Bus TSP Communication Architecture



Value of TSP

4%

Reduction in travel time

with improvement seen on 76% of intersection approaches

9%

Reduction in signal delay

with improvement seen on 70% of intersection approaches

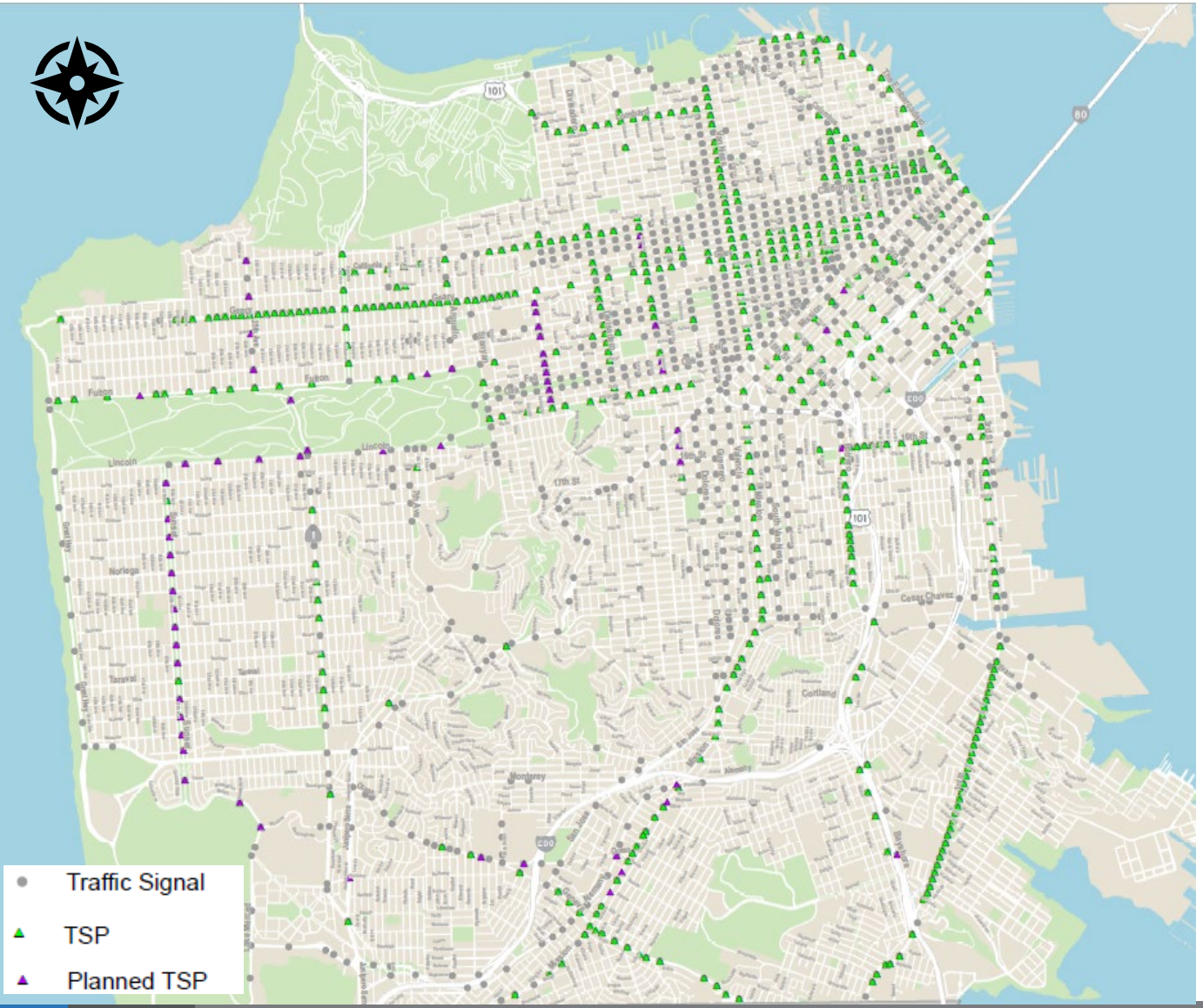
11%

Reduction in stop rate

with improvement seen on 75% of intersection approaches

- Based on “Value of TSP Report -2021” prepared by GTT
- TSP was disabled systemwide for 3 weeks to collect and compare TSP enabled vs TSP disabled
- 103 intersections on eight routes were used for the report

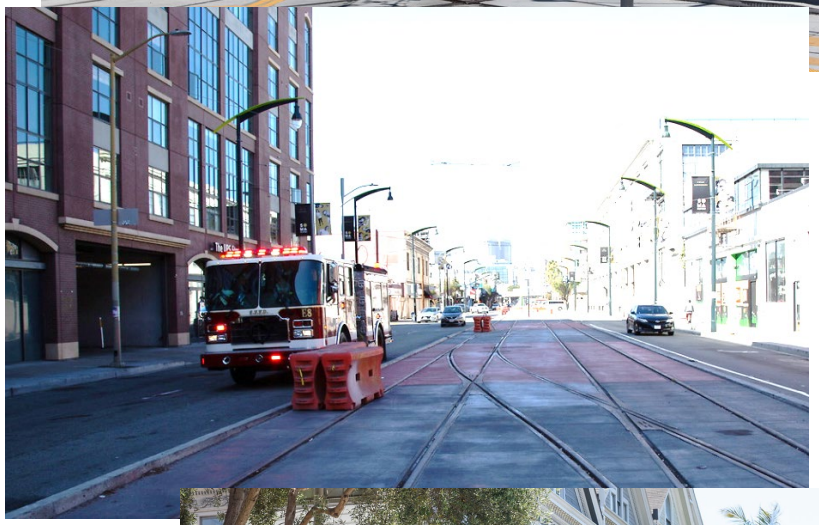
SFMTA TSP System Overview



- Buses equipped with TSP: 859 (entire active bus fleet)
- Signalized intersections
  - Total: 1290
  - with Transit: 1041
  - with Bus TSP: 545
  - with Rail TSP: 123
  - with Rail TSP & Bus TSP/EVP: 98
  - with Emergency Preemption: 700

TSP vs Preemption

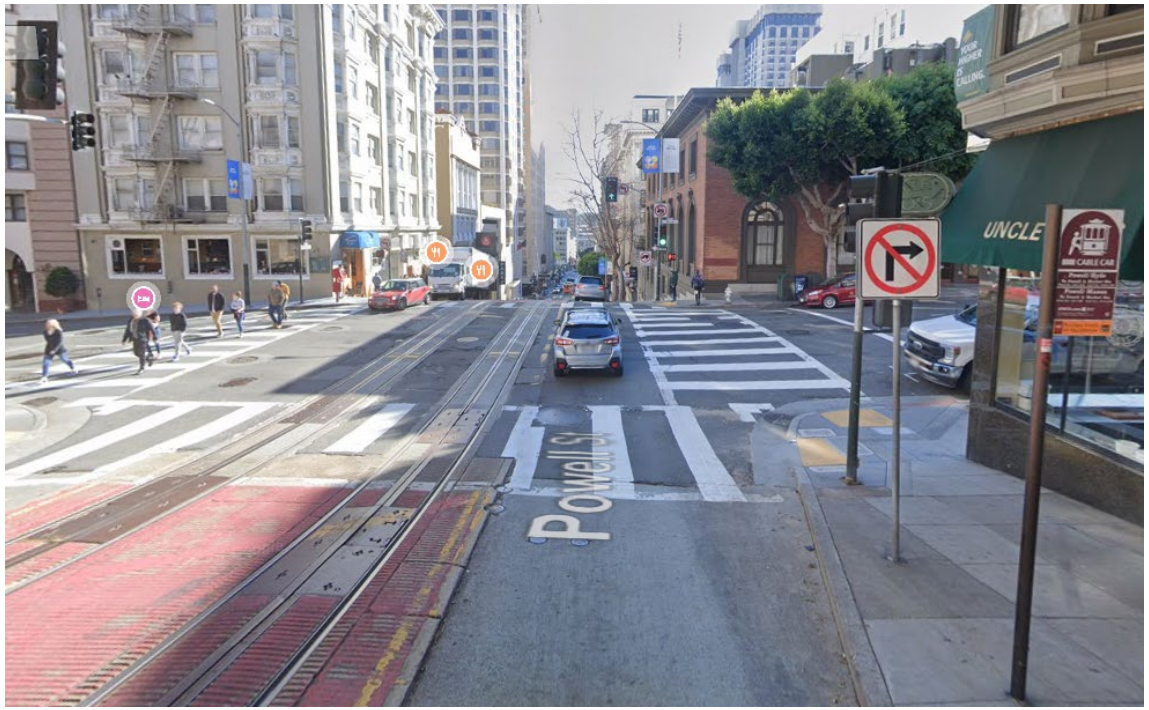
- TSP is granted depending on when in the signal cycle transit vehicles request TSP
- TSP is set up to get back into coordination as soon as possible
- Preemption
  - Overrides TSP
  - Is always granted
  - Truncates all pedestrian phases and vehicle phases in conflict with the preempting vehicle
  - Holds desired phase green for extended periods
  - Typically used for emergency vehicles & heavy rail



SFMTA Preemption Use Cases

- San Francisco Fire Department
- Cable Car
- Light Rail Vehicle Special Movement (e.g. switchback, entering tunnel, serving accessible platform while blocking intersection, conflicting transit movements)

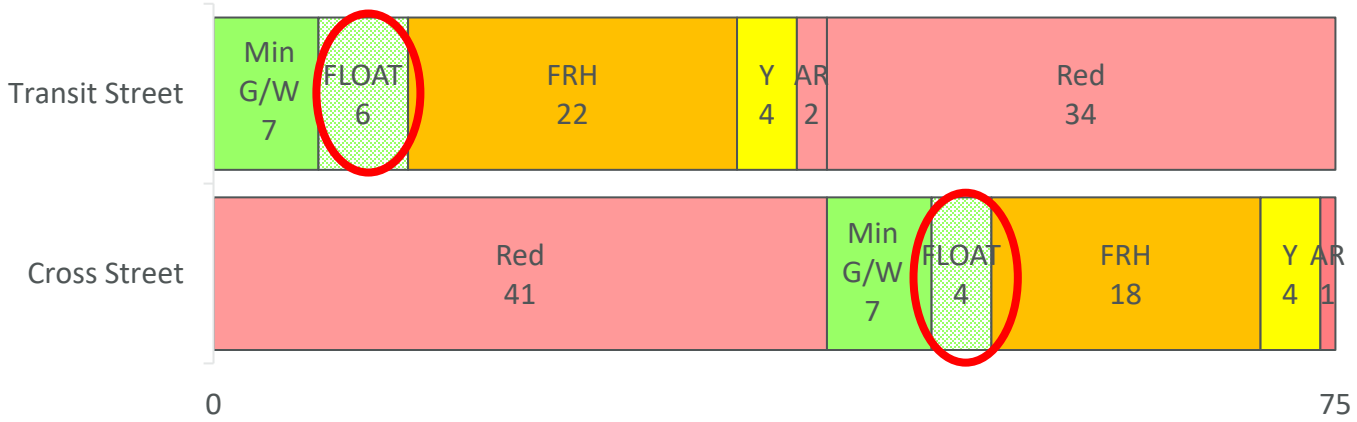
Bush/Powell



St Francis Circle

SFMTA TSP Terminology

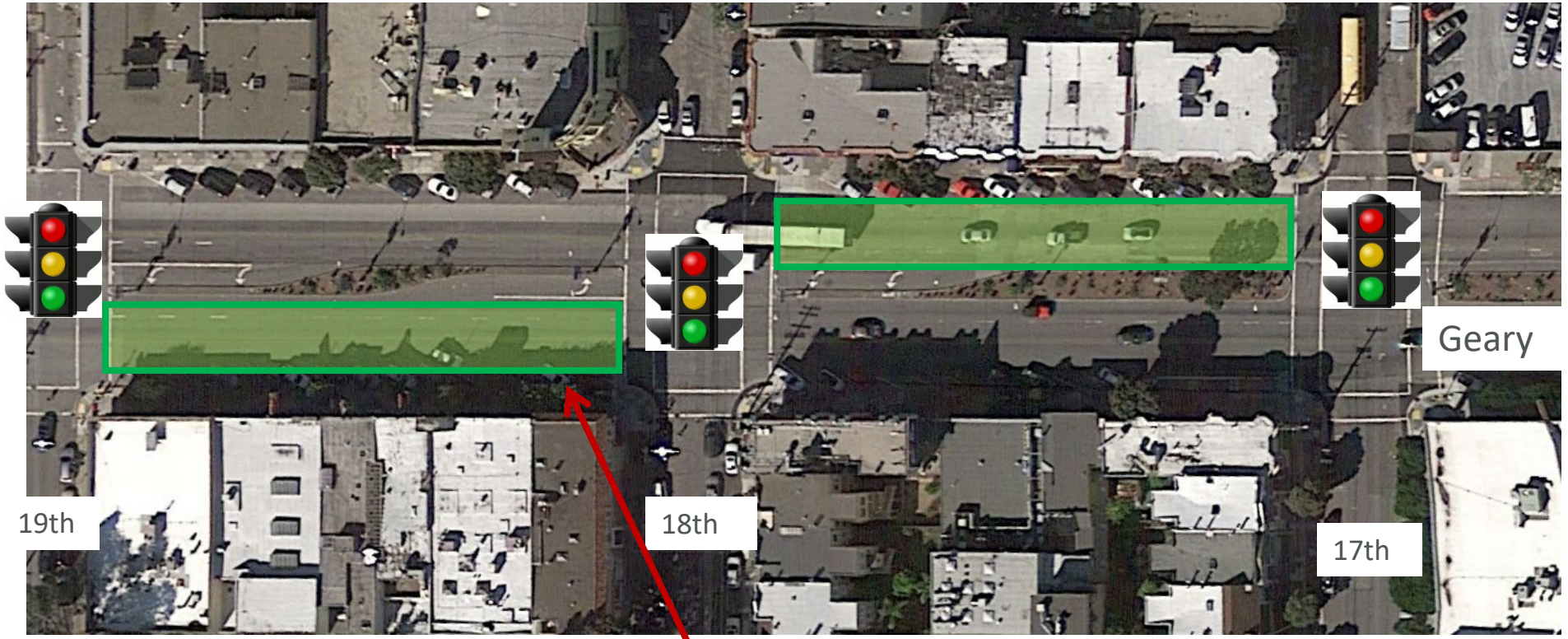
- **Cycle Float** is the difference between the selected cycle length and minimum cycle length



Selected Cycle Length = 75 secs
Minimum Cycle Length = 65secs
Available Float = 6+4 = 10 secs available for TSP

- **Recovery Green** – if [X] seconds of TSP Extension is granted, the next cycle will be reduced by the same amount to allow controller to get back into coordination
- **Drop Free** – controller drops out of coordination into Free mode to serve TSP request
- **Reservice Inhibit** – prevents a subsequent TSP call from being granted within a specified interval to ensure that the intersection returns to coordination before providing TSP

Bus GPS Detection Zone

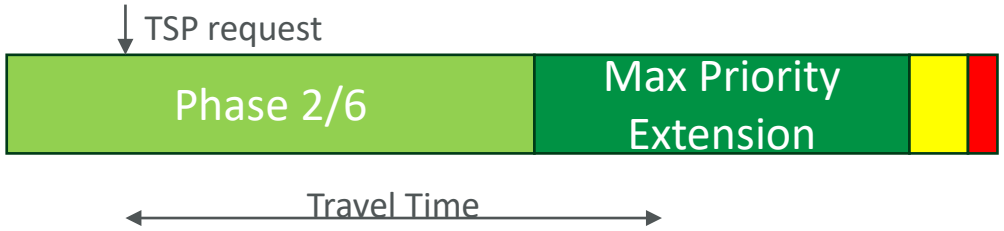


Bus makes the TSP request when it enters the detection zone.

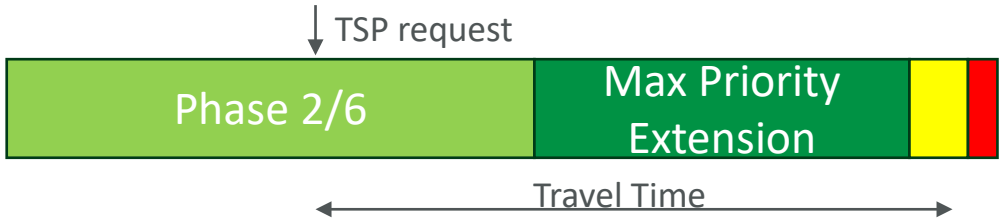
How TSP is Granted

Controller determines if TSP is needed based on transit vehicle's expected arrival time

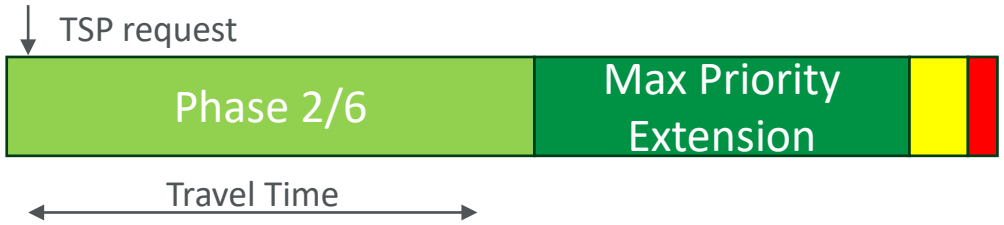
- Extension Provided



- Extension Not Provided



- Extension Not Needed



SFMTA TSP Parameters

- **Extension Values**
  - Min Extension of 7 seconds
  - Max Extension of 20 seconds
- **Early Green TSP values**
  - Principal Arterials - Reduce by 4 seconds
  - Minor Arterials – Reduce by up to 10 seconds
- **Vehicle Left Turns**
  - Skip or Swap Leading LTs to Lagging LTs
- **Reservice Inhibit**
  - One full cycle

Cycle Length	Recommended Max Extension
75 seconds or less	7 to 15 seconds
Over 75 seconds	7 to 20 seconds

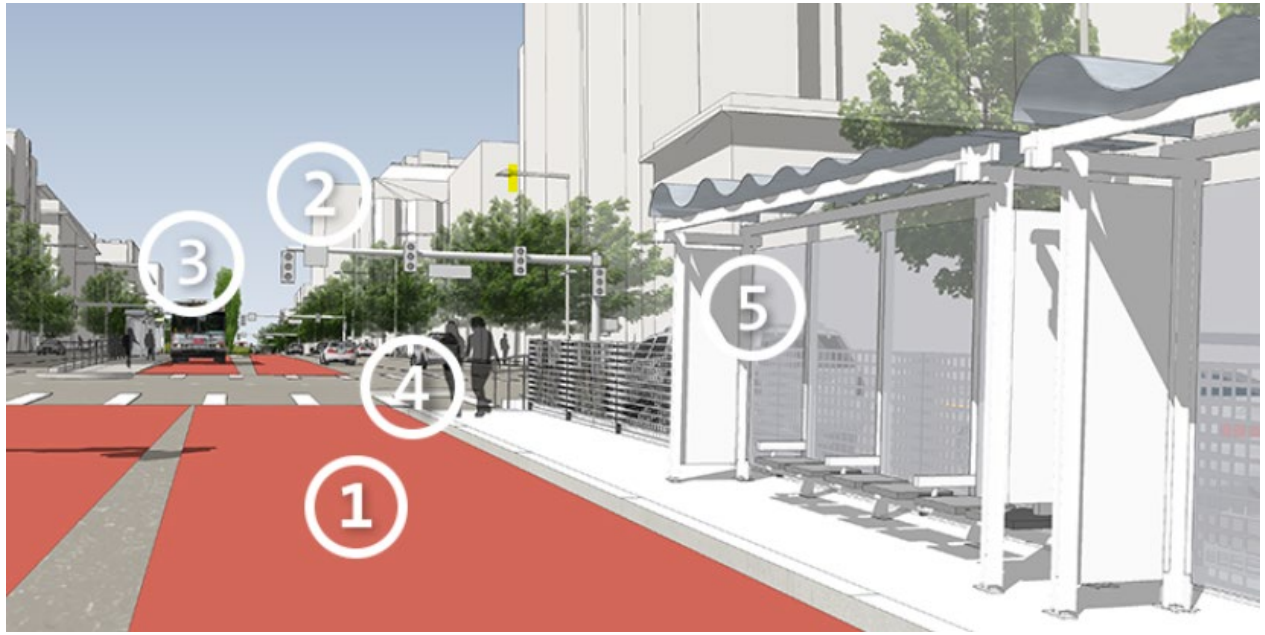
SFMTA TSP Guidelines

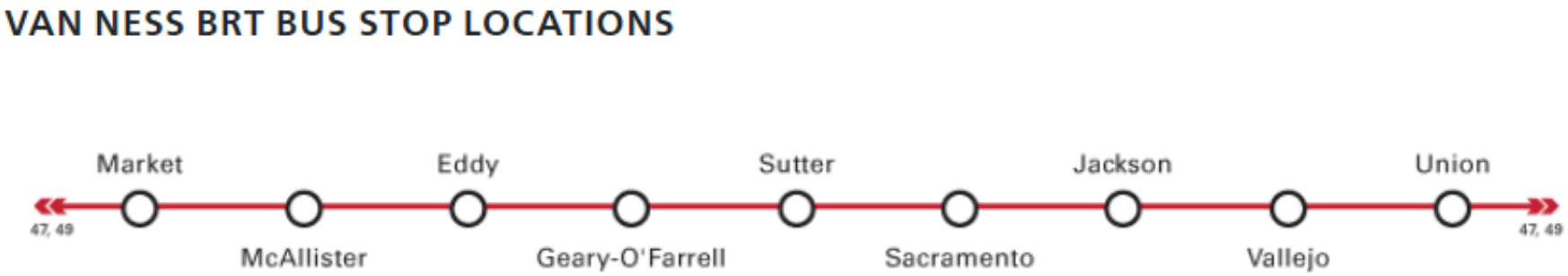
- Nearside Stops
  - No TSP for buses
  - TSP for rail
- Conditional TSP
  - Rapid vs Local Routes
- Multiple TSP calls at the same time
  - Serve current Green Phase
  - First Come First Served

Van Ness Improvement Project Overview

1. Two miles of red, center-running transit lanes
2. Eliminated most left turns for cars
3. Transit Signal Priority
4. Streetscape enhancements
5. Dedicated station platforms – nine northbound and nine southbound transit stops

Also, pedestrian bulbs and full curb-to-curb rebuild of street and utility infrastructure





Van Ness BRT: Before and After

Before

After

Van Ness Improvement Project Challenges

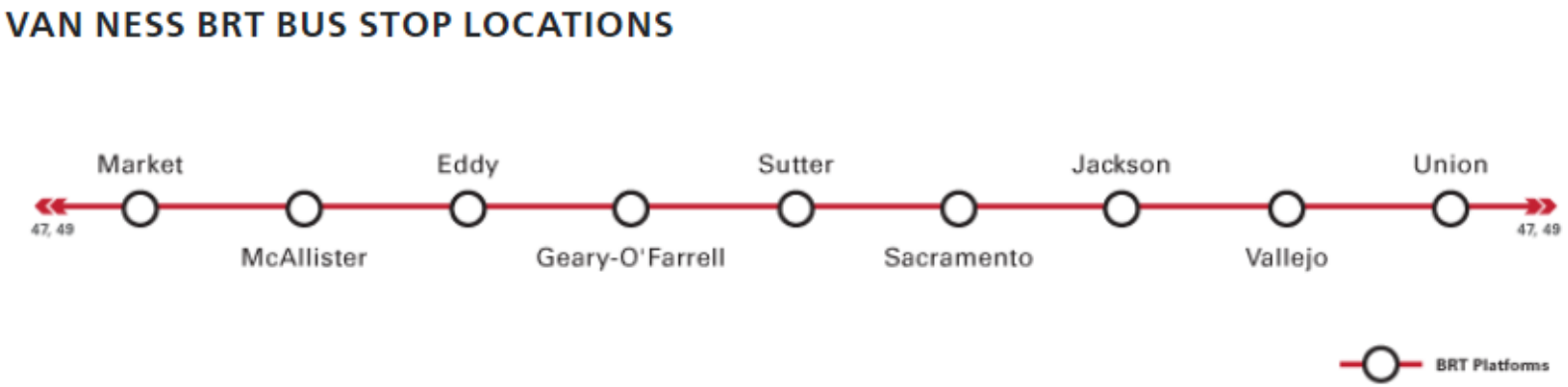
Overall Project Challenges:

- Took nearly 20 years to complete
- High implementation costs
- Required approval from multiple agencies (e.g., SFMTA, SFCTA, SF Board of Supervisors, Caltrans, FTA)
- Community input process was time-intensive (e.g., 100+ community meetings)
- Utility construction impacts often conflated with BRT scope

Van Ness BRT Project

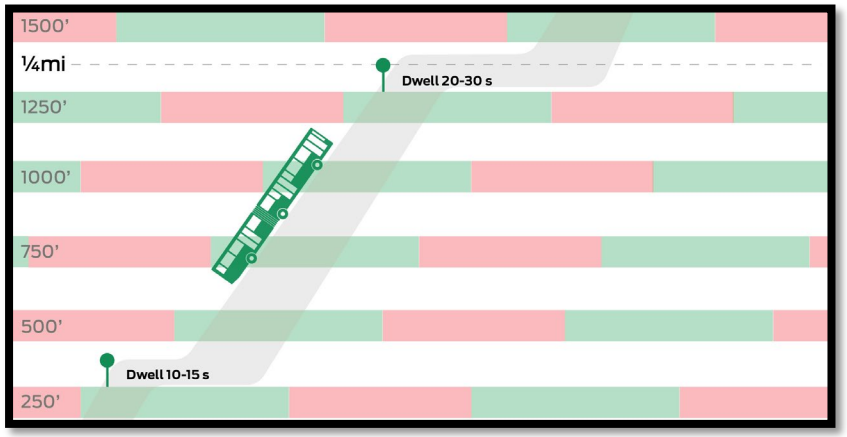
TSP Specific Design Challenges:

- Nearside stops to accommodate large vehicle turns onto Van Ness
- Number of intersections within the project (29)
- Closely spaced intersections (~350 ft)
- Transitioning buses exiting the busway
- Multiple iterations to properly set up timing parameters for prioritizing transit



Offset optimization process (Passive TSP)

- Spreadsheet-based calculator for optimizing offsets on an intersection-to-intersection basis
- Vehicle and transit delays are also calculated
- Vehicle data (vehicle speed)
- Transit data (dwell times, transit stop locations, transit speed)
- Intersection/signal timing data (distance between signals, beginning of green in cycle, length of green in cycle, current offsets, cycle length)
- Iterative process
- Ideally, offsets are considered optimized when most, if not all, intersections have transit/vehicles arrive during the green



Passive TSP Calculations (offsets)

Offsets Analysis - Van Ness BRT

Proposed Conditions for Dial 2

Prioritize SB

Offsets

	Market	Fell	Hayes	Grove	McAllister	Golden Gate	Turk	Eddy
2	54	54	54	55	40	52	60	55
Current	54	35	39	55	62	52	50	21
17	x	X	x		x			X

Transit - NB

	Market	Fell	Hayes	Grove	McAllister	Golden Gate	Turk	Eddy
(+) Green Elapsed / (-) Time to Green	0	18	29	40	36	35	38	7
Remaining Green	37	26	20	11	10	15	9	40

Transit - SB

	Market	Fell	Hayes	Grove	McAllister	Golden Gate	Turk	Eddy
(+) Green Elapsed / (-) Time to Green	12	33	22	10	5	30	11	-26
Remaining Green	25	11	27	41	41	16	36	N/A

Vehicles - NB

	Market	Fell	Hayes	Grove	McAllister	Golden Gate	Turk	Eddy
(+) Green Elapsed / (-) Time to Green	0	16	23	30	-30	2	5	18
Remaining Green	37	28	25	20	N/A	44	42	29
Time since red started	N/A	N/A	N/A	N/A	14.47727	N/A	N/A	N/A

Vehicles - SB

	Market	Fell	Hayes	Grove	McAllister	Golden Gate	Turk	Eddy
(+) Green Elapsed / (-) Time to Green	-39	42	34	25	25	-32	42	39
Remaining Green	N/A	1	14	26	21	N/A	5	7
Time since red started	14	N/A	N/A	N/A	N/A	12	N/A	N/A

Ranges for conditional formatting - Vehicles			
Ideal	2	15	
Acceptable	-10	2	> 15
Unfavorable	< -10		

Passive TSP Calculations (transit data inputs)

Offsets Analysis - Van Ness BRT

Inputs

Cycle Length	
Dial	Cycle Length
1	90
2	90
3	90

Current Offsets

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1	CL60	0	CL60	50		60		50		55		56		55		79		0		10		65		77		79		9		20		31	
2	CL90	54	CL90	35		39		55		62		52		50		46		40		32		10		67		89		71		63		65	
3	CL90	54	CL90	50		60		50		45		56		55		79		0		10		65		77		79		9		16		28	

TRANSIT INPUTS

Start of NB transit phase in cycle

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	
2		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	
3		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	

NB Transit Green Phase Length

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1		37		46.5		48.5		50.5		45.5		50		46.5		46.5		46.5		44.5		44.5		47.5		47.5		46.5		46.5		44	
2		37		43.5		48.5		50.5		45.5		50		46.5		46.5		46.5		44.5		44.5		47.5		47.5		46.5		46.5		44	
3		37		46.5		48.5		50.5		45.5		50		46.5		46.5		46.5		44.5		44.5		47.5		47.5		46.5		46.5		44	

Start of SB transit phase in cycle

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	
2		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	
3		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	

SB Transit Green Phase Length

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1		37		46.5		48.5		50.5		45.5		46		46.5		46.5		46.5		44.5		44.5		47.5		47.5		46.5		46.5		44	
2		37		43.5		48.5		50.5		45.5		46		46.5		46.5		46.5		44.5		44.5		47.5		47.5		46.5		46.5		44	
3		37		46.5		48.5		50.5		45.5		46		46.5		46.5		46.5		44.5		44.5		47.5		47.5		46.5		46.5		44	

NB Transit Target Travel Times1 (includes dwell from below)

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1		→	13	→	11	→	12	→	62	→	11	→	11	→	54	→	11	→	11	→	50	→	11	→	11	→	44	→	11	→	11	→	11
2		→	13	→	11	→	12	→	71	→	11	→	11	→	54	→	11	→	11	→	52	→	11	→	11	→	42	→	11	→	11	→	11
3		→	13	→	11	→	12	→	66	→	11	→	11	→	51	→	11	→	11	→	54	→	11	→	11	→	45	→	11	→	11	→	11

SB Transit Target Travel Times1 (includes Dwell from below)

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1		←	65	←	11	←	11	←	20	←	54	←	11	←	11	←	47	←	11	←	53	←	11	←	11	←	46	←	11	←	11	←	11
2		←	69	←	11	←	11	←	20	←	53	←	11	←	11	←	53	←	11	←	53	←	11	←	11	←	53	←	11	←	11	←	11
3		←	68	←	11	←	11	←	20	←	54	←	11	←	11	←	55	←	11	←	56	←	11	←	11	←	61	←	11	←	11	←	11

Passive TSP Calculations (vehicle data inputs)

NB Dwell (ENTER IN TABLE BELOW!)

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1		→		→		→		→	27	→		→		→	28	→		→		→	24	→		→		→	18	→		→		→	
2		→		→		→		→	36	→		→		→	28	→		→		→	26	→		→		→	16	→		→		→	
3		→		→		→		→	31	→		→		→	25	→		→		→	28	→		→		→	19	→		→		→	

SB Dwell (ENTER IN TABLE BELOW!(

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1		←	36	←		←		←		←	27	←		←		←	21	←		←	27	←		←		←	20	←		←		←	
2		←	40	←		←		←		←	26	←		←		←	27	←		←	27	←		←		←	27	←		←		←	
3		←	39	←		←		←		←	27	←		←		←	29	←		←	30	←		←		←	35	←		←		←	

VEHICLE INPUTS

Start of NB phase in cycle

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	
2		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	
3		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	

NB Green Phase Length

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1		37		46.5		48.5		50.5		45.5		46		46.5		46.5		46.5		44.5		44.5		47.5		47.5		46.5		46.5		44	
2		37		43.5		48.5		50.5		45.5		46		46.5		46.5		46.5		44.5		44.5		47.5		47.5		46.5		46.5		44	
3		37		46.5		48.5		50.5		45.5		46		46.5		46.5		46.5		44.5		44.5		47.5		47.5		46.5		46.5		44	

Start of SB phase in cycle

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	
2		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	
3		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0		0	

SB Green Phase Length

Dial		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
1		37		46.5		48.5		50.5		45.5		46		46.5		46.5		46.5		44.5		44.5		47.5		47.5		46.5		46.5		44	
2		37		43.5		48.5		50.5		45.5		46		46.5		46.5		46.5		44.5		44.5		47.5		47.5		46.5		46.5		44	
3		37		46.5		48.5		50.5		45.5		46		46.5		46.5		46.5		44.5		44.5		47.5		47.5		46.5		46.5		44	

Vehicle Target Travel Times[2]

		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
2 NB →		→	9.41	→	7.82	→	8.7	→	14.7	→	8	→	7.82	→	7.82	→	7.82	→	7.8	→	7.82	→	8	→	8	→	7.82	→	7.82	→	8.18	→	8	
6 SB ←		←	10.6	←	7.82	←	7.82	←	14.7	←	9	←	7.82	←	7.82	←	7.82	←	7.82	←	7.82	←	8	←	8	←	7.82	←	7.82	←	7.82	←	8	

Transit Target Travel Time WITHOUT DWELL[2]

		Market		Fell		Hayes		Grove		McAllister		Golden Gate		Turk		Eddy		Ellis		O'Farrell		Geary		Post		Sutter		Bush		Pine		California	
2 NB →		→	12.8	→	10.7	→	11.9	→	20.1	→	10.66	→	10.7	→	10.7	→	10.7	→	10.6	→	10.7	→	10.66	→	10.7	→	10.7	→	10.7	→	11.2	→	10.7	
6 SB ←		←	14.5	←	10.7	←	10.7	←	20.1	←	11.87	←	10.7	←	10.7	←	10.7	←	10.7	←	10.7	←	10.66	←	10.7	←	10.7	←	10.7	←	10.7	←	11.2	

Distances between intersections (feet)[3]

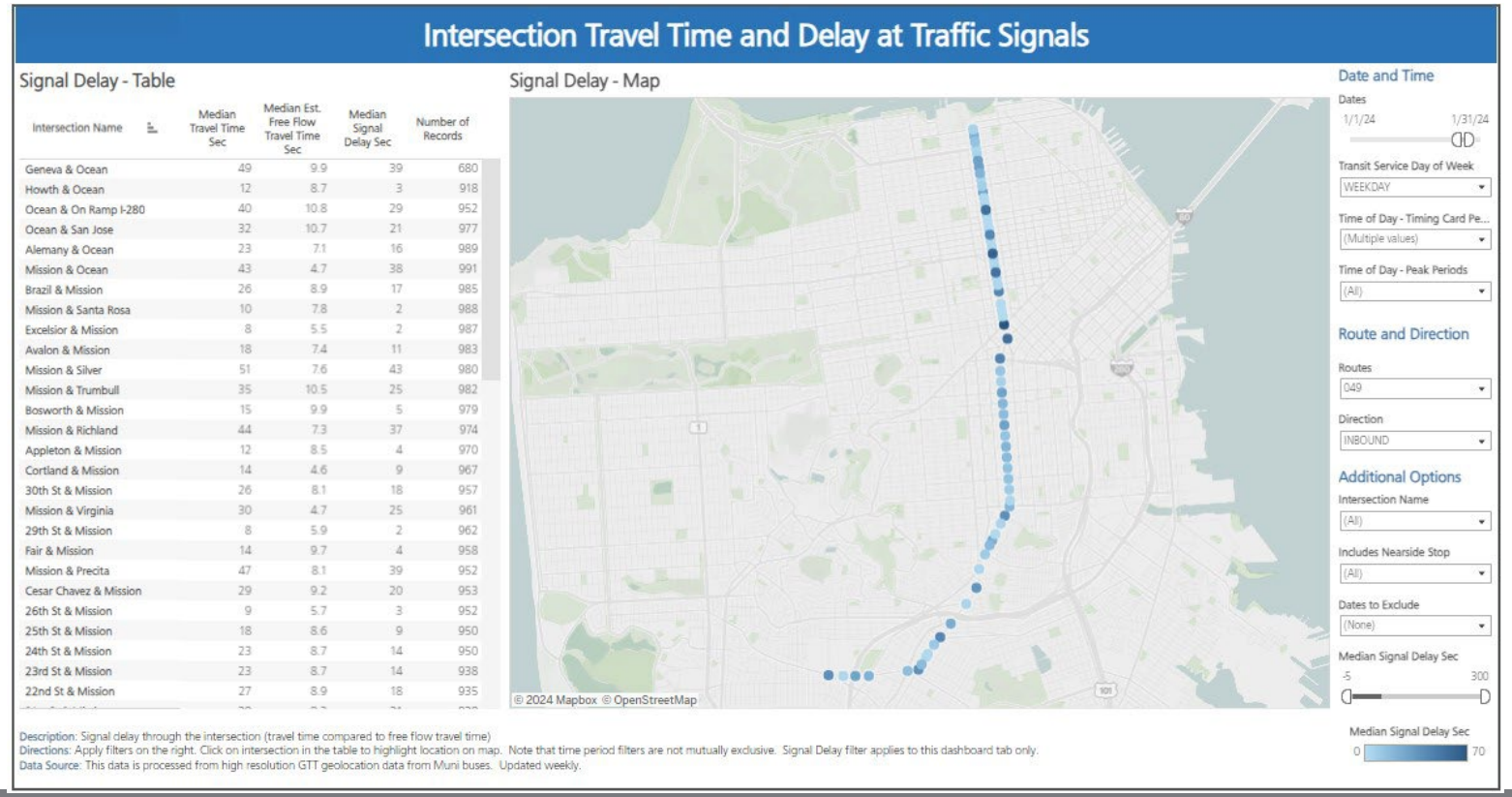
		Market	414	Fell	344	Hayes	383	Grove	648	McAllister	344	Golden Gate	344	Turk	344	Eddy	344	Ellis	343	O'Farrell	344	Geary	344	Post	344	Sutter	344	Bush	344	Pine	360	California	344	
2 NB →																																		
6 SB ←		Market	467	Fell	344	Hayes	344	Grove	648	McAllister	383	Golden Gate	344	Turk	344	Eddy	344	Ellis	344	O'Farrell	344	Geary	344	Post	344	Sutter	344	Bush	344	Pine	344	California	360	

Data Analysis

- Travel time reduced by up to 8 minutes (30%) per direction
- Ridership recovery (49 Van Ness/Mission): 131% post-Covid

Next Steps for Van Ness TSP

- Continue to monitor performance through transit travel time data dashboards
- Further adjustments to offsets
- Newer TSP technologies for SFMTA's next generation TSP system



Thank you