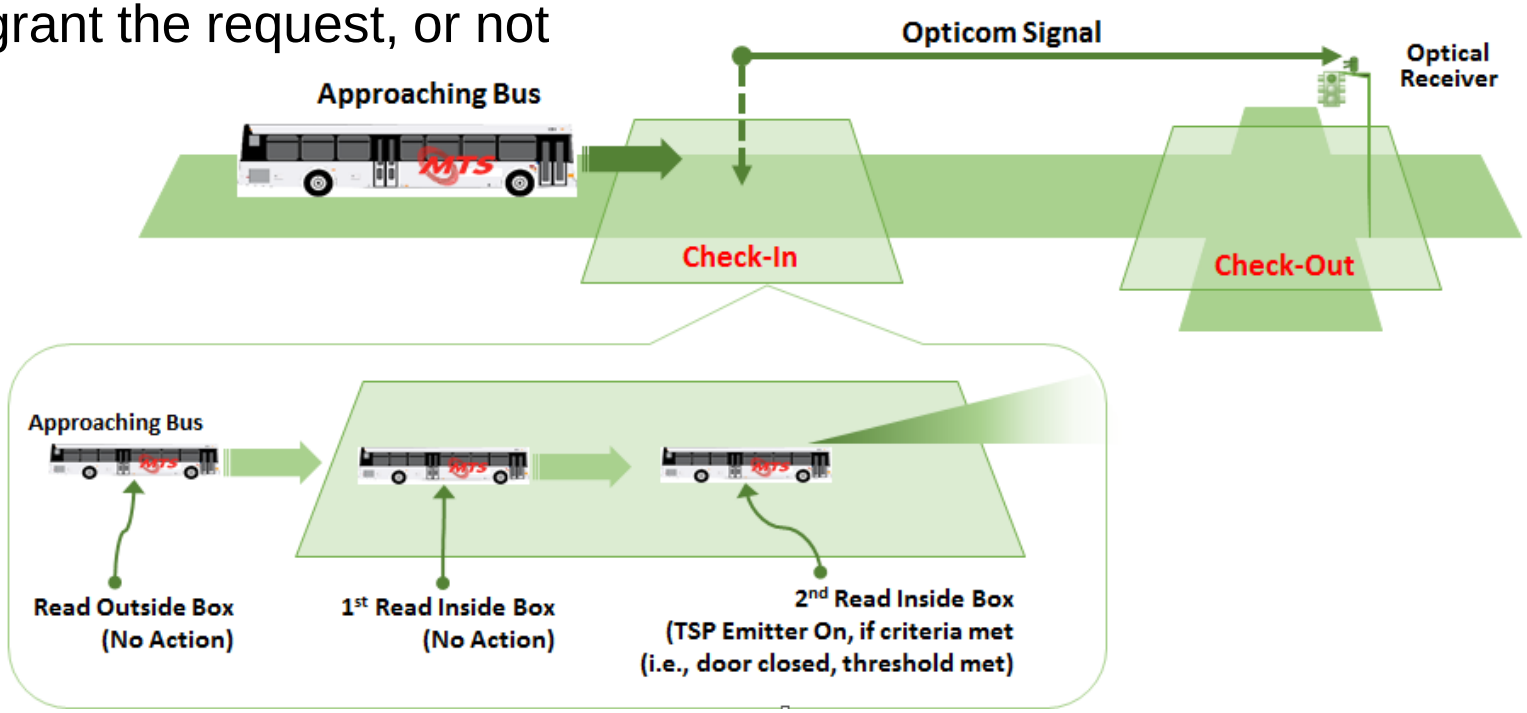
Setting the Stage for Transit Signal Priority in San Diego

IBI GROUP
June 20th, 2017

Basic Concept

- Reduce the probability of signal delay
- Bus places the request for TSP
- Signal controls whether to grant the request, or not



Qualitative Benefits

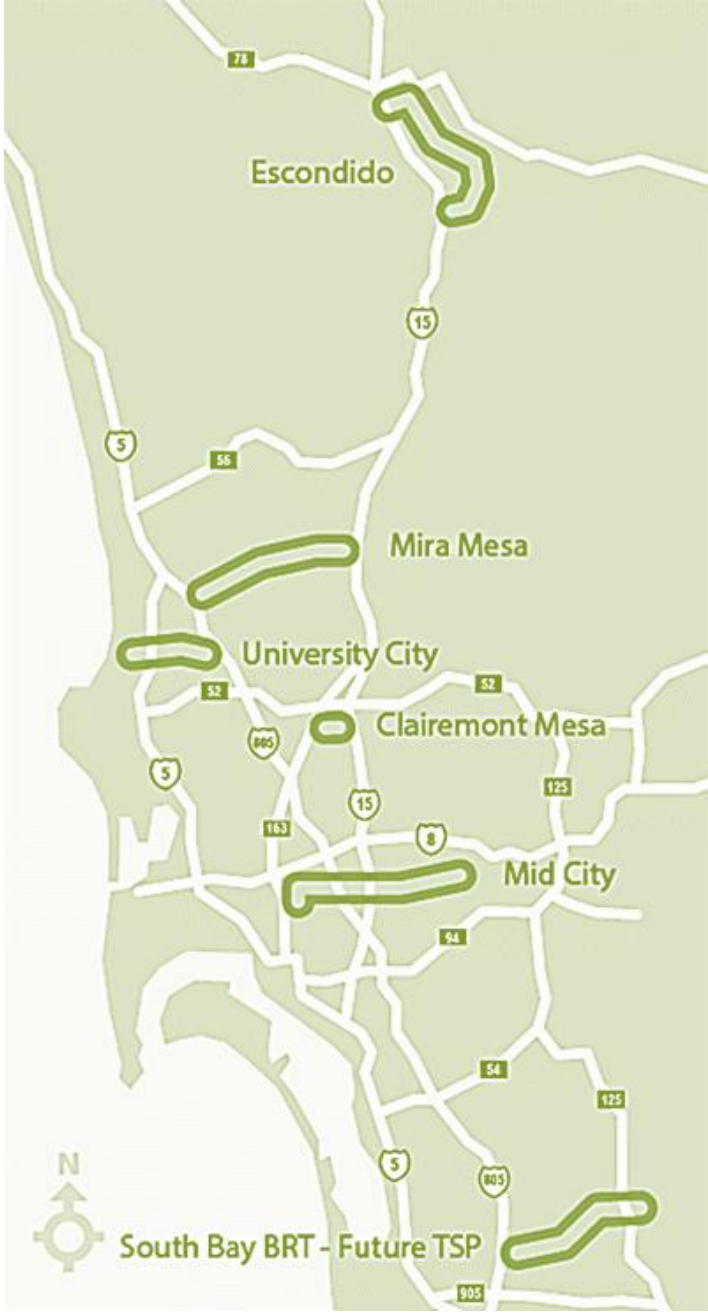
- Positive Perceptions of Transit
- Addresses Areas of Signal Delay
- Incremental Improvements Continue
- Comparatively Low Cost to Rail
- Sets Foundation for where Transit Lies in the Future

TSP: Misconceptions

Topic	Consider
TSP can be expressed as working or not working on a corridor	Rarely is a whole corridor not providing some additional green time for buses, as each intersection operates independently. The effectiveness varies
TSP is expensive	TSP is comparatively inexpensive to other BRT elements and physical priority measures. Equipment & install ranges from $10K-$20K per intersection and about $20K-$30K per intersection including design, install, & activation.
TSP corridors are all the same in the region	Actually, each corridor is unique in terms of equipment, approach, topography, design, TSP settings, and operations.
It should be easy to determine the quantitative benefits of TSP	Due to the split in data between buses & signals and variability in bus and traffic operations, it is difficult to separate TSP impacts/benefits from other factors.
TSP should be able to make sure the bus gets a "green" light	TSP activations add green time or reduce red time faced by a bus, but many factors influence if a bus clears an intersection with TSP (e.g. stops, traffic, etc)

San Diego Deployment

- 5 Corridors
  - Escondido (Rt 350)
  - SuperLoop (Rt 201, 202, 204)
  - MidCity (Rt 215)
  - Mira Mesa (Rt 237)
  - I-15 BRT (Rt 235)
  - I-15 Weekday Peak Hour (Rt 280, 290)
- More than 100 TSP enabled Signals
- More than 50 Rapid buses
- Pending: South Bay BRT



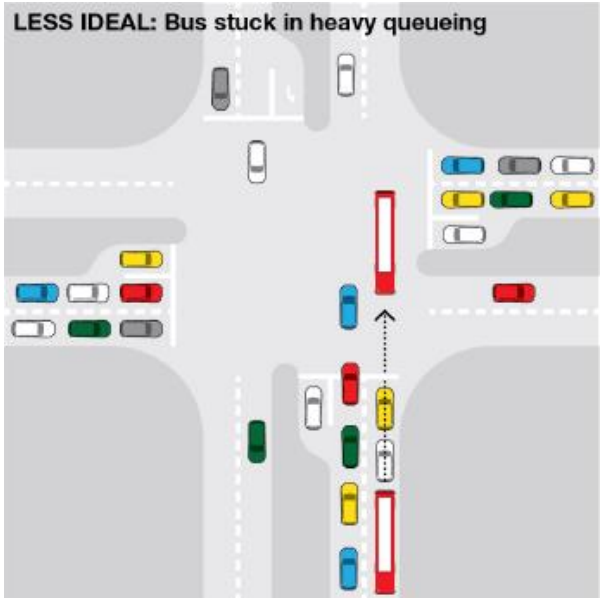
San Diego Future

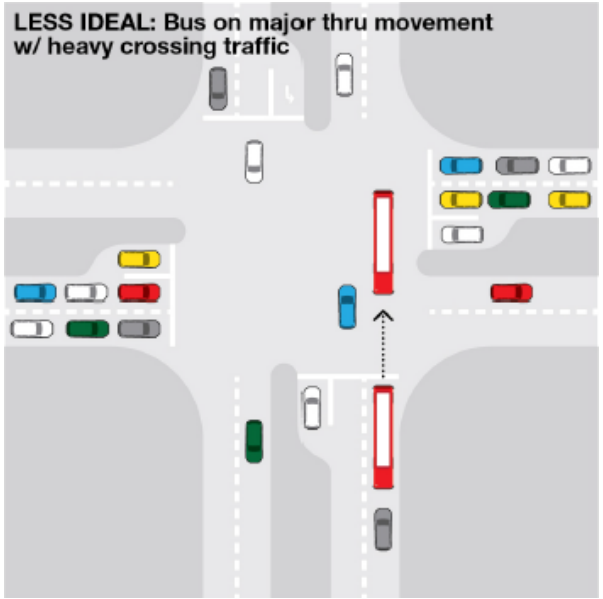
1. University Ave (San Diego)
2. Mission Ave (Oceanside)
3. Genesee Ave (San Diego)
4. Highland Ave (National City, Chula Vista)
5. Main St (El Cajon)
6. H St (Chula Vista)
7. 54th (San Diego)
8. Taylor St/Linda Vista (San Diego)
9. Fairmount Ave (San Diego)
10. College Ave (San Diego, Lemon Grove)

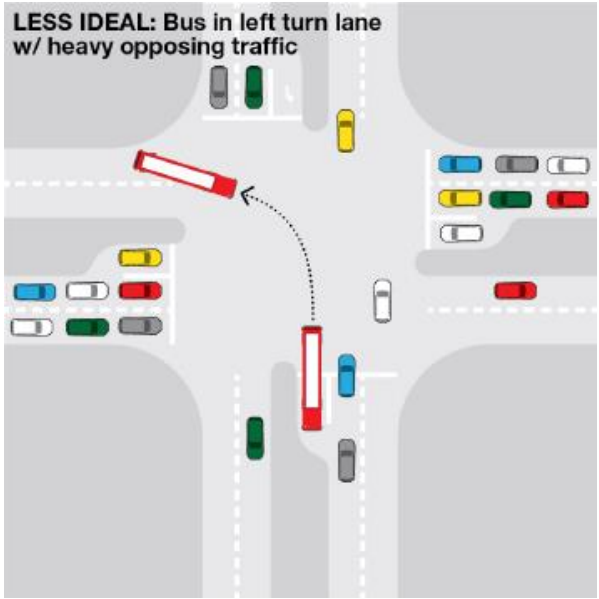

2050
Revenue Constrained
Rapid Services
October 2015
Rapid Transit
Local Bus
Intermodal Transit Center
MILES
0 3 6
0 4 8
KILOMETERS
N
SANDAG
Del Mar
Barona Reservation
Capitan Grande Reservation
Santee
San Diego
La Mesa
El Cajon
Sycuan Reservation
Lemon Grove
Jamul Indian Village
Coronado
National City
Chula Vista
San Diego
Imperial Beach
UNITED STATES
MEXICO
Tijuana, B.C.

Development

- Less than Ideal conditions for TSP
  - Heavy Queuing
  - Crossing major through movements
  - Left Turns with heavy traffic

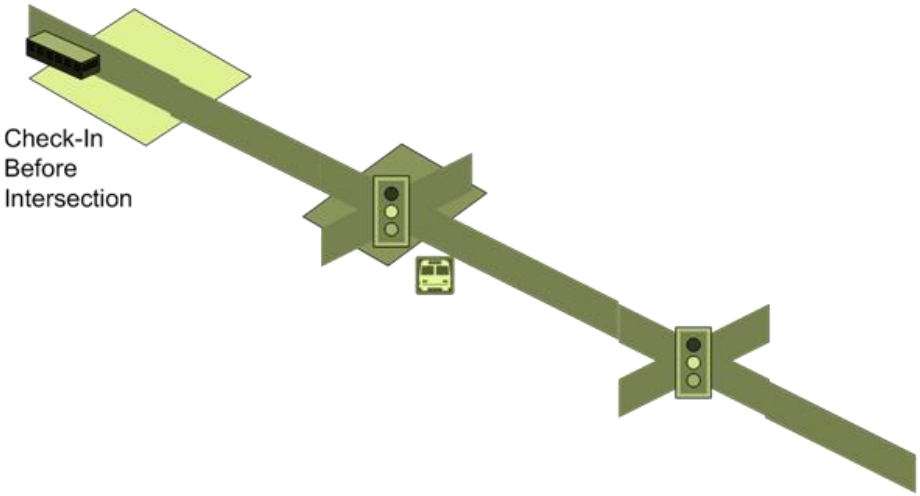






Development "Rules of Thumb"

- Trigger Points
  - Green Extensions/Early Green Max
  - 50th and 95th percentile queues
  - Storage Capacity
  - Sight Distances
  - Intersection Spacing

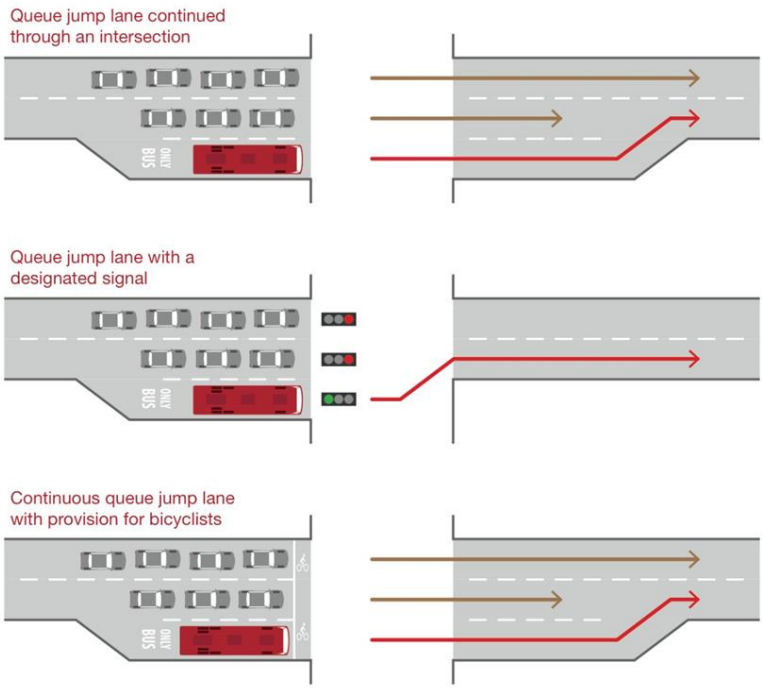


Development "Rules of Thumb"

- Transit Stops
  - Consolidate
  - Avoid Near-side stops

- Physical Transit Priority
  - Median Guideways
  - Exclusive Transit Lanes
  - Stop Modifications
  - Curp Extensions/Platforms
  - Queue Jump Lanes

SETTING THE STAGE FOR TSP IN SAN DIEGO



Sheet 1
Phase 1

TSP Design Worksheet – Regents Road and Health Center Drive/ Country Day Lane

Sheet 1
Phase 1

Traffic Controller Phasing

1	2	3	4
CH-C	CH-A	X	CH-B
SBL	NB		EB
TSP 5	6	7	8
OVL CH-B/A	CH-C	X	CH-D
NBL	SB		WB

*Controller operating **FREE** 24 hrs

Key

Detection range:

Cabinet Location:

Aerial Photograph

Opticom Detector Location

Traffic Signal Controller

Parameter	Programming Location	Value
Pre-emption Parameters		
Minimum Green Before Pre-emption Force Off	F/1+0+8	4
Maximum Pre-emption Time Before Failure	F/1+0+9	4
Minimum Time Between Same Pre-emption	F/1+0+A	0
Disable Low Priority	E/125+C+8	_____
Bus Delay	F/1+A+D	0
Max Early Green	F/1+A+E	25
Max Green Extension	F/1+A+F	25
Coordination Functions		
Coordination Extra	C/1+E+E	_____8
Configuration Data		
Low Priority A	E/125+F+A	____5___
Low Priority B	E/125+F+B	____5___
Low Priority C	E/125+F+C	_____
Low Priority D	E/125+F+D	_____

Opticom Phase Selector General Parameters

Parameter	Value
Unit Settings (General Tab)	
Enable Log On: Valid ID	√
Enable Log On: Valid ID	√
Enable Log On: Valid ID	√
Low Priority Configuration Profile	
Limit Time Between Calls	3
Limit Time Between Calls Enabled	√
Priority Enabled	√

Opticom Phase Selector Per-Channel Parameters

Parameter	Controller Channel			
	A (NBL/NB)	B (EBL/EB)	C (SBL/SB)	D (WB)
Channel Settings				
Low Priority Max Call Time	360	360		
Low Priority Call Hold Time	2	2		
Low Priority Call Delay Time	0	0		
Range Intensity				
Primary Detector (from class 0 to class 9)	672 (512')	707(515')		
Auxiliary Detector (from class 0 to class 9)				
Relation Between Channels and Phase Selectors (PHS)				
PHS on Lower Rack, Slot # 12 channel A		X		
PHS on Lower Rack, Slot # 12 channel B				X
PHS on Lower Rack, Slot # 12 channel C	X			
PHS on Lower Rack, Slot # 12 channel D			X	

ACS Check-In & Check-Out Parameters

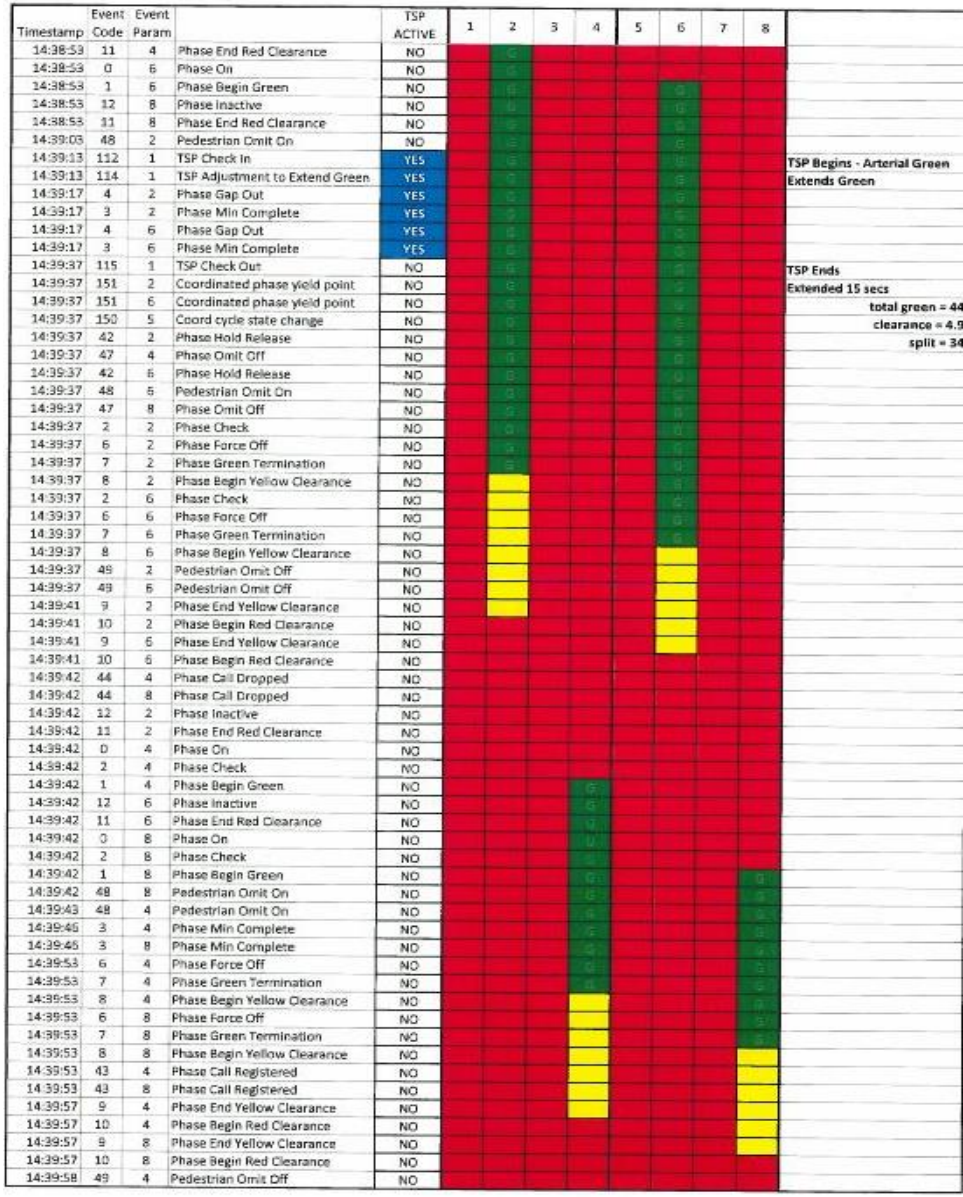
Parameters	EBR	NBL
Check In Box		
Box Center Latitude	32.878576	32.877468
Box Center Longitude	-117.21977	-117.218353
Distance from Stop Bar (feet)	390	378
Box Width (feet)	250	250
Box Length (feet)	150	150
Check Out Box		
Box Center Latitude	32.878646	32.8786464
Box Center Longitude	-117.21836	-117.21836
Box Width (feet)	150	150
Box Length (feet)	150	150

TSP Notes

Sight lines limited based on field observations due to angle of reciever turrets.
10-2-2012: Quicknet Dow nload
10-3-2012: Phase Selector Configured

Monitoring & Effectiveness

- **Coordination with Cities and SANDAG**
- Network Communication and Data Collection
- GTFS Data
- Ongoing Troubleshooting
- Traffic Controller Challenges and High Resolution Logs
- Increased value with Physical Changes to roadways and intersections



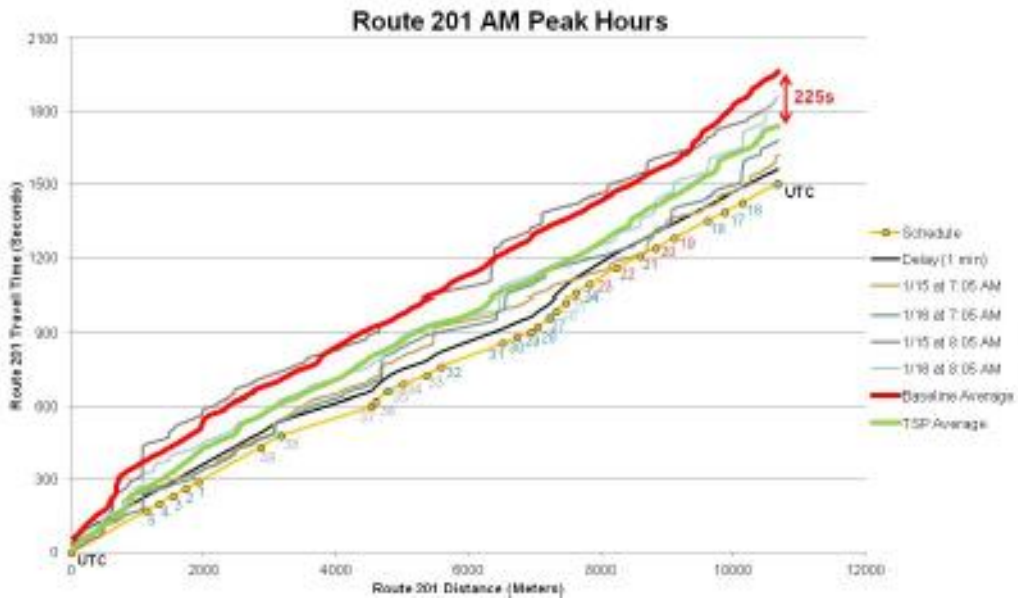
Timestamp	Event Code	Event Param		TSP ACTIVE	1	2	3	4	5	6	7	8	
14:38:53	11	4	Phase End Red Clearance	NO									
14:38:53	0	6	Phase On	NO									
14:38:53	1	6	Phase Begin Green	NO									
14:38:53	12	8	Phase Inactive	NO									
14:38:53	11	8	Phase End Red Clearance	NO									
14:39:03	48	2	Pedestrian Omit On	NO									
14:39:13	112	1	TSP Check In	YES									TSP Begins - Arterial Green
14:39:13	114	1	TSP Adjustment to Extend Green	YES									Extends Green
14:39:17	4	2	Phase Gap Out	YES									
14:39:17	3	2	Phase Min Complete	YES									
14:39:17	4	6	Phase Gap Out	YES									
14:39:17	3	6	Phase Min Complete	YES									
14:39:37	115	1	TSP Check Out	NO									TSP Ends
14:39:37	151	2	Coordinated phase yield point	NO									Extended 15 secs
14:39:37	151	6	Coordinated phase yield point	NO									total green = 44
14:39:37	150	5	Coord cycle state change	NO									clearance = 4.9
14:39:37	42	2	Phase Hold Release	NO									split = 34
14:39:37	47	4	Phase Omit Off	NO									
14:39:37	42	6	Phase Hold Release	NO									
14:39:37	48	5	Pedestrian Omit On	NO									
14:39:37	47	8	Phase Omit Off	NO									
14:39:37	2	2	Phase Check	NO									
14:39:37	6	2	Phase Force Off	NO									
14:39:37	7	2	Phase Green Termination	NO									
14:39:37	8	2	Phase Begin Yellow Clearance	NO									
14:39:37	2	6	Phase Check	NO									
14:39:37	6	6	Phase Force Off	NO									
14:39:37	7	6	Phase Green Termination	NO									
14:39:37	8	6	Phase Begin Yellow Clearance	NO									
14:39:37	49	2	Pedestrian Omit Off	NO									
14:39:37	49	6	Pedestrian Omit Off	NO									
14:39:41	9	2	Phase End Yellow Clearance	NO									
14:39:41	10	2	Phase Begin Red Clearance	NO									
14:39:41	9	6	Phase End Yellow Clearance	NO									
14:39:41	10	6	Phase Begin Red Clearance	NO									
14:39:42	44	4	Phase Call Dropped	NO									
14:39:42	44	8	Phase Call Dropped	NO									
14:39:42	12	2	Phase Inactive	NO									
14:39:42	11	2	Phase End Red Clearance	NO									
14:39:42	0	4	Phase On	NO									
14:39:42	2	4	Phase Check	NO									
14:39:42	1	4	Phase Begin Green	NO									
14:39:42	12	6	Phase Inactive	NO									
14:39:42	11	6	Phase End Red Clearance	NO									
14:39:42	0	8	Phase On	NO									
14:39:42	2	8	Phase Check	NO									
14:39:42	1	8	Phase Begin Green	NO									
14:39:42	48	8	Pedestrian Omit On	NO									
14:39:43	48	4	Pedestrian Omit On	NO									
14:39:46	3	4	Phase Min Complete	NO									
14:39:46	3	8	Phase Min Complete	NO									
14:39:53	6	4	Phase Force Off	NO									
14:39:53	7	4	Phase Green Termination	NO									
14:39:53	8	4	Phase Begin Yellow Clearance	NO									
14:39:53	6	8	Phase Force Off	NO									
14:39:53	7	8	Phase Green Termination	NO									
14:39:53	8	8	Phase Begin Yellow Clearance	NO									
14:39:53	43	4	Phase Call Registered	NO									
14:39:53	43	8	Phase Call Registered	NO									
14:39:57	9	4	Phase End Yellow Clearance	NO									
14:39:57	10	4	Phase Begin Red Clearance	NO									
14:39:57	9	8	Phase End Yellow Clearance	NO									
14:39:57	10	8	Phase Begin Red Clearance	NO									
14:39:58	49	4	Pedestrian Omit Off	NO									

Factors Affecting TSP Operations and Performance

Topography	Traffic queues at the intersections	Cross-street traffic volumes	Bus left turns on route	Oncoming traffic volumes
Near-side or Far-side stops	Volume of Boarding's	Transit Operation methods (headways vs. schedule)	Transit vehicle operator experience	Transit vehicle characteristics
Community characteristics (residential vs. business, schools)	Types of Boarding's (Boarders with special needs and bicycles)	Proximity of corridor intersections	TSP technologies used and ambient or environmental conditions	Parameters and Thresholds

Lessons Learned: Big Picture

- Signals are always only an opportunity for delay, and TSP is a method of reducing the probability of that delay
- TSP measurements indicate run time reductions from 2%-16% with 6%-10% typical
- Centralized TSP data collection, and transit and signal data comparison remains difficult



Lessons Learned – Planning

- TSP may not be effective outbound from a transfer point for the first few intersections
- Where possible, limit left-turns at signalized intersections across median transitways
- Physical Treatments are most effective where significant traffic queues occur, they are also more difficult to implement in these areas.
- Detailed understanding of signal operations on a corridor are necessary early in planning.

Lessons Learned – Design

- Consider trade-offs between pedestrian access to/from stations and bus movement at signals
- Always place advance and stop line detection for buses in dedicated bus lanes
- Avoid near-side transit stops near signals on transitways.
- Current Signal Controller Considerations
- Keep options open for future flexibility (e.g. TSP equipment – RF, CV, Center to Center)

Lessons Learned – Design

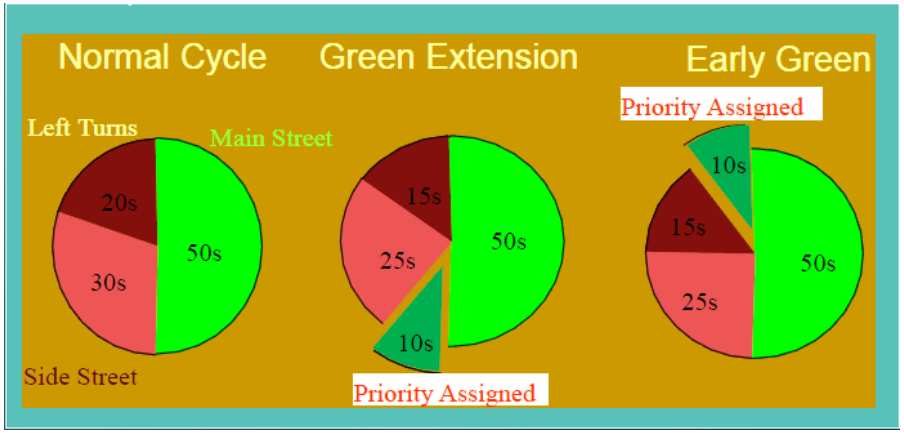
- Specifications:
  - Appropriate Equipment Set
  - Selecting specific controller software/firmware
  - May require some sole source pieces of equipment
  - Testing
- Passive TSP signal coordination
- Still no Caltrans TSP in the region

Current Standard
1:170E Traffic Controller
Serial Communications
McCain 233RV2.1A or MC1.C firmware
764 GTT Multimode Phase Selector Card
768 GTT Auxiliary Harness
721/722 GTT Optical Receiver

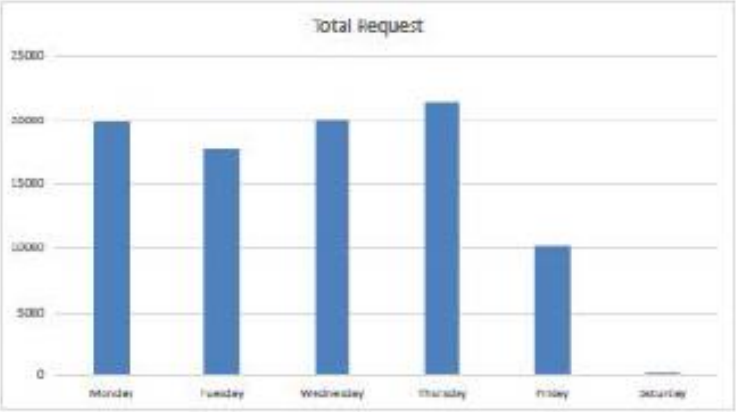
Current Standard
2:2070ATC Traffic Controller
Ethernet/IP Communications
McCain Omni eX Software
764 GTT Multimode Phase Selector Card
768 GTT Auxiliary Harness
721/722 GTT Optical Receiver
Managed Rugged Comm Switch

Lessons Learned –Operation

- If new software, firmware, or equipment is involved, leave plenty of lead time for bench testing and possible “fixes”
- TSP green extensions and early greens are typically set between 15 & 25 seconds, and with cycle lengths 80 seconds or greater
- Signal coordination should be in place prior to construction, or updates made after
- Many configuration details:
  - TSP equipment functional and updated timings in place
  - Implement TSP settings at all signals
  - Configure and load TSP on buses



Lessons Learned – Operations



- Checking Operations
  - Allow two weeks of “operations prior to drawing TSP data/results
  - Easier to identify problem locations
  - On network communication equipped corridors, can identify TSP requests but difficult to determine:
    - How many would have been green anyway
    - How many green extensions/early greens and for how long
    - Did bus clear the intersection?
  - Before and After TT Runs

Questions?

Thank you!

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