Multimodal Approach to Planning & Implementation of Transit Signal Priority within Montgomery County Maryland

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Outline

- Overview of Transit Signal Priority
- Implementing TSP within Montgomery Co.
  - Countywide Transit Signal Priority
  - Transit Signal Priority within RTS
  - Purple Line
- Policy Questions

What is Transit Signal Priority (TSP)

TSP is a traffic signal operational strategy that facilitates the movement of transit vehicles, either buses or streetcars, through traffic signal controlled intersections.

- **Passive TSP adjusts signal timing/coordination for transit operations**
- **Active TSP is used to provide passage for transit vehicles at signalized intersections when requested.**
- **Conditional TSP requests priority only if certain conditions are met.**

Source: TSP Handbook

TSP (active, conditional priority) should NOT to be confused with Emergency Vehicle Preemption which is unconditional priority

Transit Signal Priority Strategies

- Green Extension
- Red Truncation
- Transit Only Phase
  - Queue Jump (early green)
  - Diagonal Crossing (all red)
- Phase suppression/rotation
- Phase skipping

Benefits of TSP

Improve travel time reliability and schedule, reduce delay and reduce emissions, may increase ridership

Waiting at Traffic Signals represents an average of 15% of a bus's trip time[1].

Cause of signal delay include:

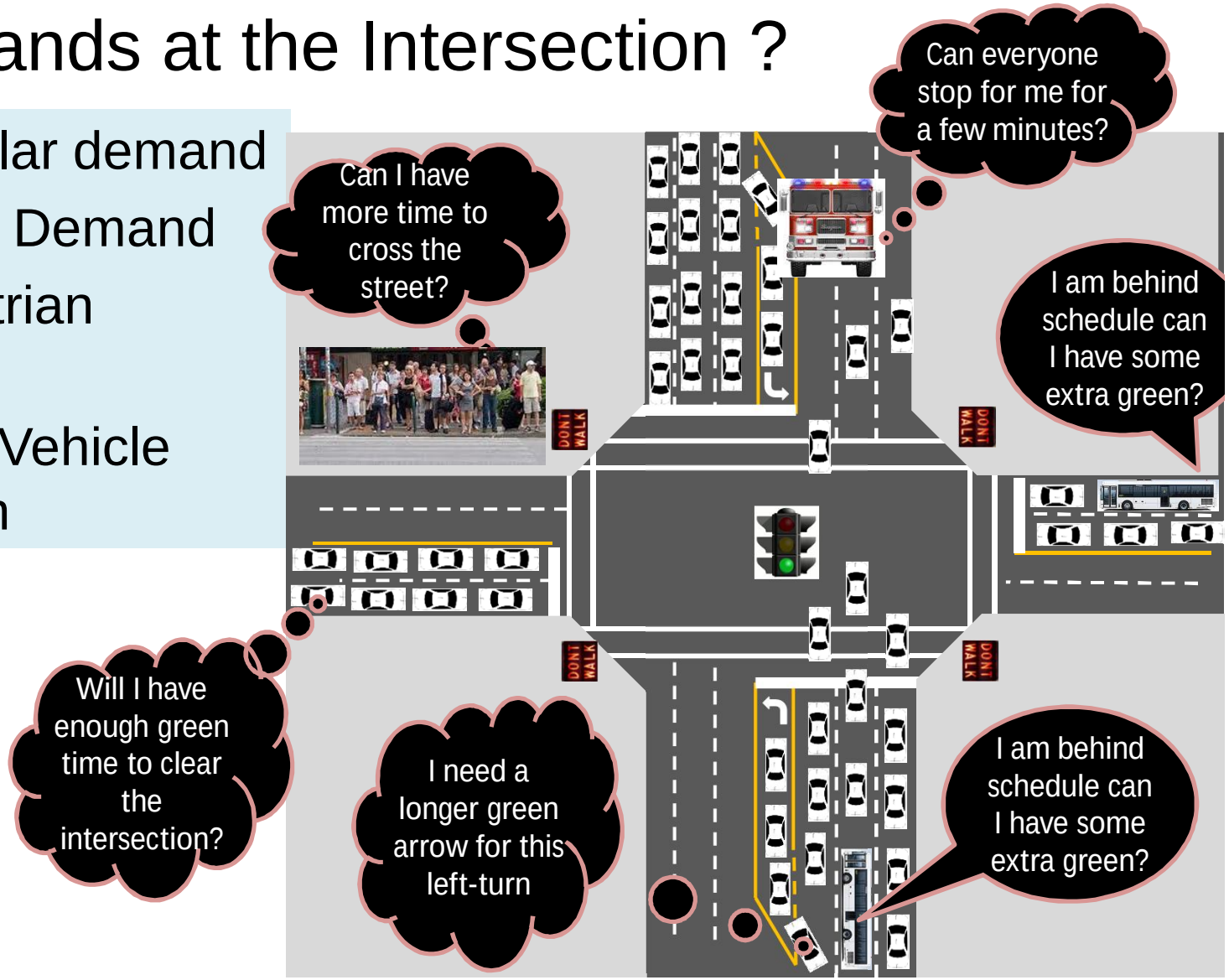
- Pedestrians Crossing
- Volume-related delay
- Accommodating side-street traffic
- Special phases (e.g. left-turns only).

- Conditional Priority reduces severe delay and improves reliability

1. ("Overview of Transit Signal Priority." ITS America, 2004)

What Happens to TSP with Competing Demands at the Intersection ?

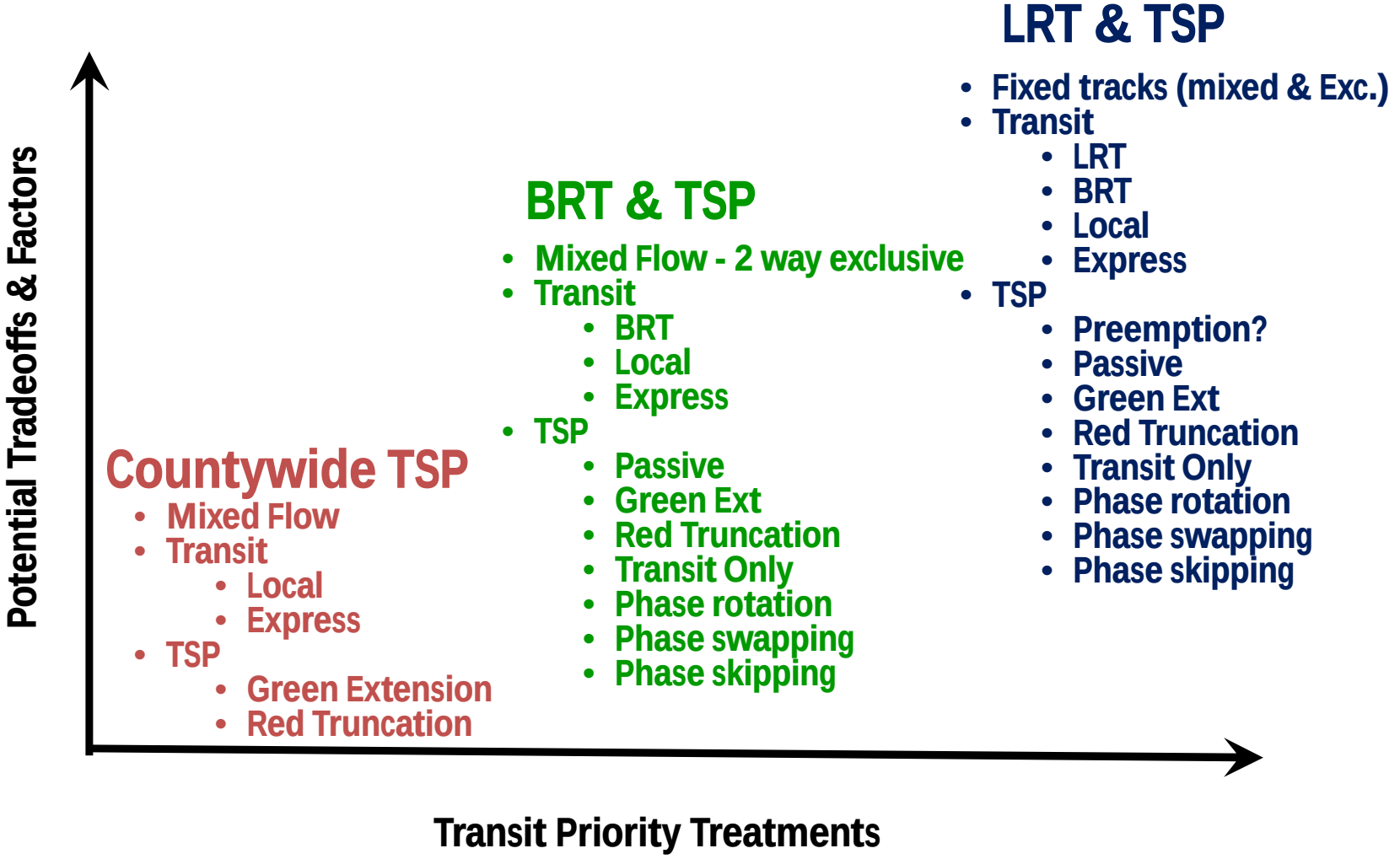
- High Vehicular demand
- High Transit Demand
- High Pedestrian Demand
- Emergency Vehicle Pre-Emption



General TSP Questions/Issues

- Does the intersection cause significant signal delay to transit vehicles?
- Is there significant variability in the delay that transit vehicles experience that is greater than expected due to signal timing?
- Are transit vehicles caught in upstream queues and other congestion?
- Can transit vehicles avoid upstream queues and other congestion?
- Are there potential conflicts with other transit service when priority is granted (other main, or cross)?
- Are there physical constraints?
- Will there be significant impacts to the signal phasing (is there available green, etc.)?
- Will the person time savings and throughput increase (on main lines, on cross streets)?

Transit Service & TSP



Countywide TSP Study

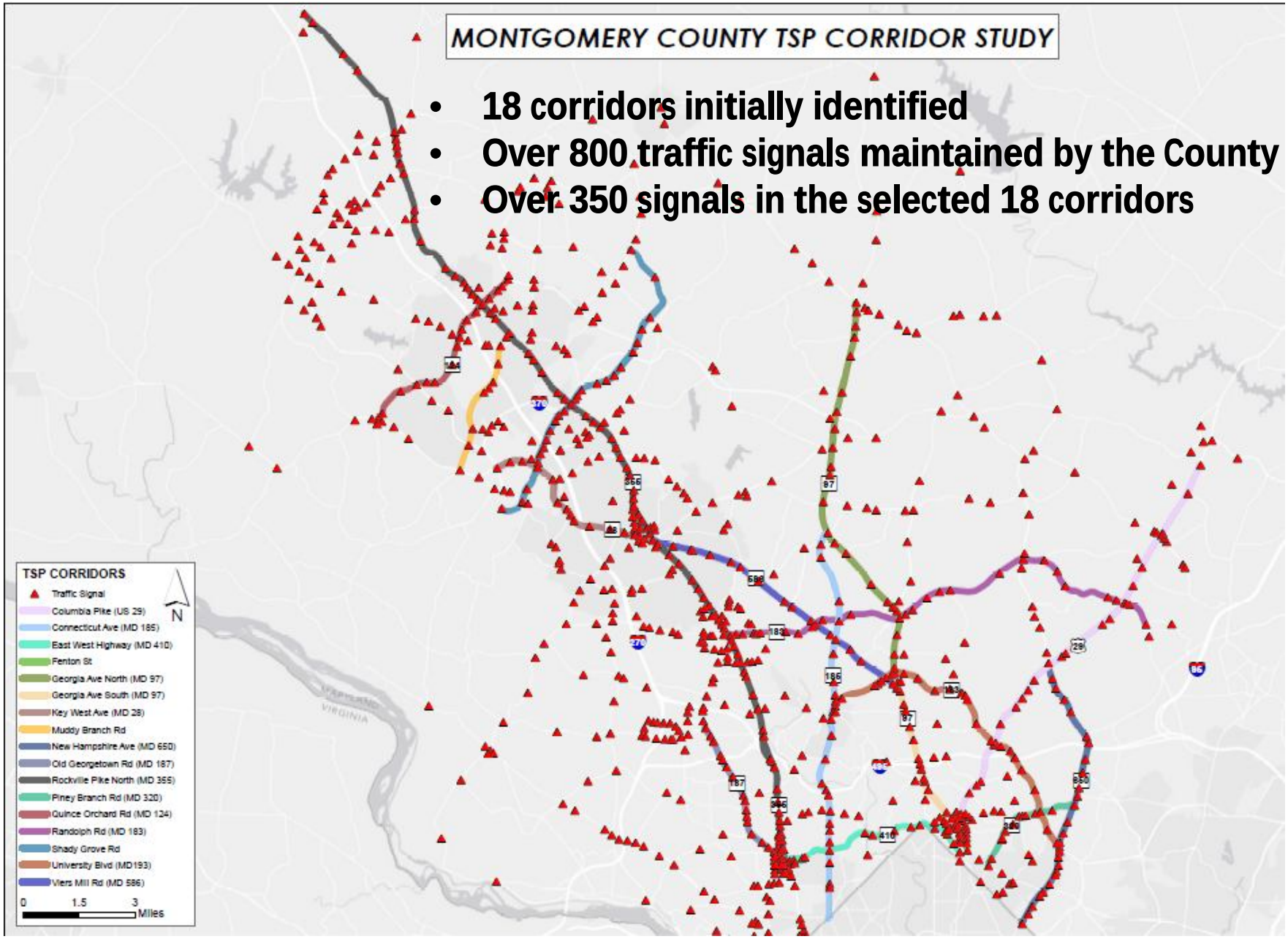
- Phase I
  - State of the Practice/ Lessons Learned
  - Infrastructure and Communications System Readiness
- Phase II
  - Needs Assessment
    - Concept of Operations Development
    - Technology Assessment and Selection
      - Data Requirement
      - Procurement and Deployment
      - Pilot Study Demonstration and Evaluation
- Phase III
  - Identify, Screen and Select Routes and Performance Metrics
  - Develop TSP Policy: Warrants and Conditional Measures
  - Coordinate with agency Stakeholders
  - Deployment Recommendations

Countywide TSP Signal Priority Options

- In conjunction with no other transit priority treatments
  - Extend Green Phase
  - Truncate Red Phase
- Build upon Traffic Signal System Modernization (TSSM) project and ATMS transit CAD/AVL upgrades & Technology Assessment
  - Econolite ASC/3 traffic signal controller with TSP
  - Distributed TSP Architecture
  - GTT Opticom GPS system for TSP

Countywide TSP
Three Level Screening

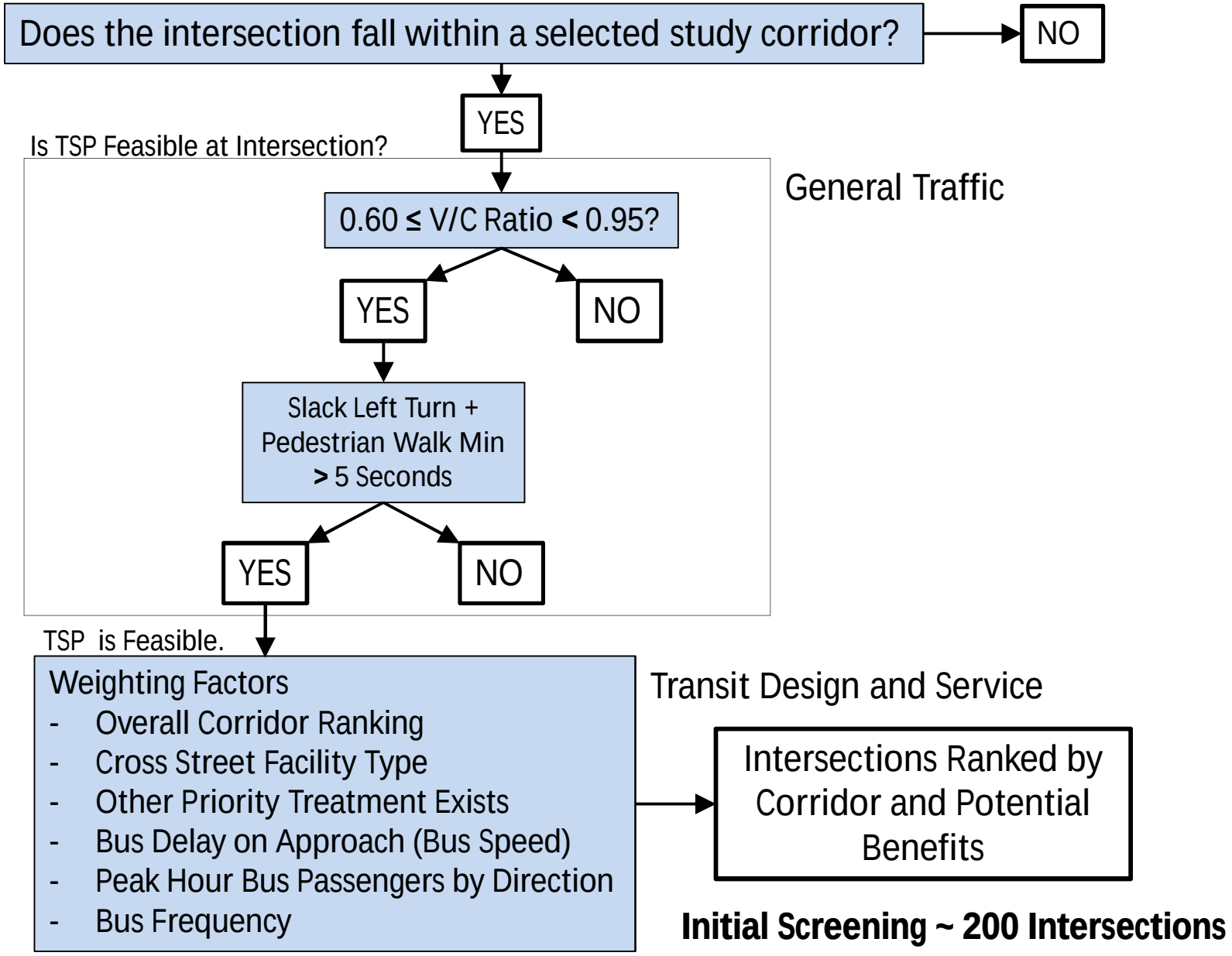
- Corridor / Segment
  - Which bus routes and vehicles should be TSP enabled?
- Intersection
  - Which intersections should provide for TSP?
- Trip (Conditional TSP)
  - TSP provided when conditions are met:
    - Time of Day
    - Vehicle running late
    - Does not cause undo impact on traffic system operations



TSP Corridor Ranking

- Maximize benefits to transit operations with the least impact on traffic flow.
- Transit Measures
  - Bus routes (busses)
  - Average PM peak hour bus speeds
  - Productivity (Riders per vehicle mile)
- Traffic Characteristics
  - AADT,
  - Signal density
  - Number of arterial cross streets
  - Number of intersections with failing LOS
  - Traffic signal cycle lengths
  - Pedestrian volumes
  - Average PM peak travel speeds.
- High Rank: Georgia (MD 97) North, Colesville Rd (US 29)
- Low Rank: Muddy Branch Rd, Quince Orchard Rd (MD 124)

TSP Intersection Selection Flow Chart

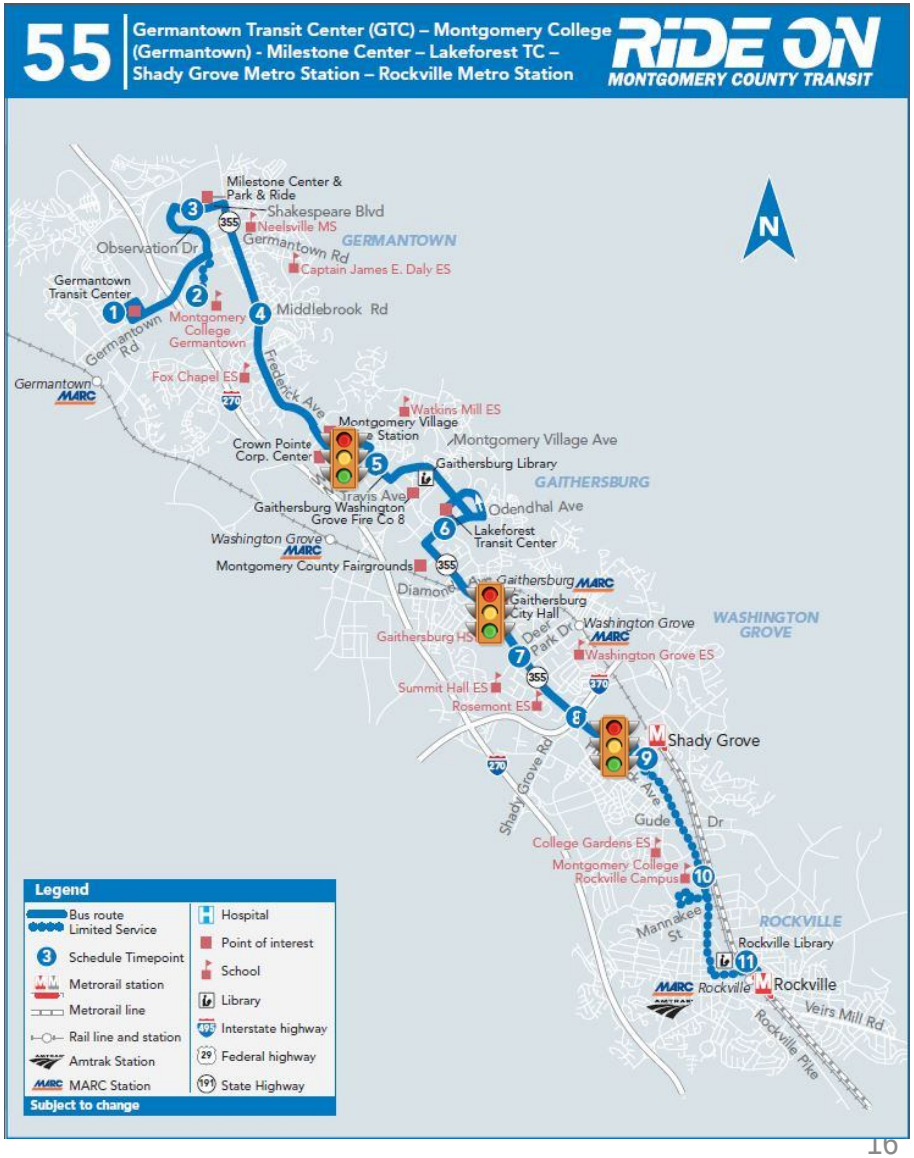


Countywide TSP Study
Proposed Conditional Criteria

- Buses 5 minutes behind schedule.
- First come first served basis (no special consideration to direction, corridor, operator, or type of service).
- A TSP request will be granted only when it can be accommodated safely within the traffic signal controller phases at the intersection.
- TSP signal strategy options
  - green extension
  - red truncation.
- Lockout after a request is granted (3 cycles)

TSP Technology Pilot Test Status

- TSP Technology test fully operation January 2013
- Five buses equipped with emitters
- Three traffic signals equipped with roadside receivers
- Data collection underway for:
  - late buses detected by roadside equipment
  - late buses reported by ORBCAD
- Ride On evaluation underway to identify any change in bus on time performance



Montgomery County Functional Master Plan
Priority Transit Corridors & Traffic Signals

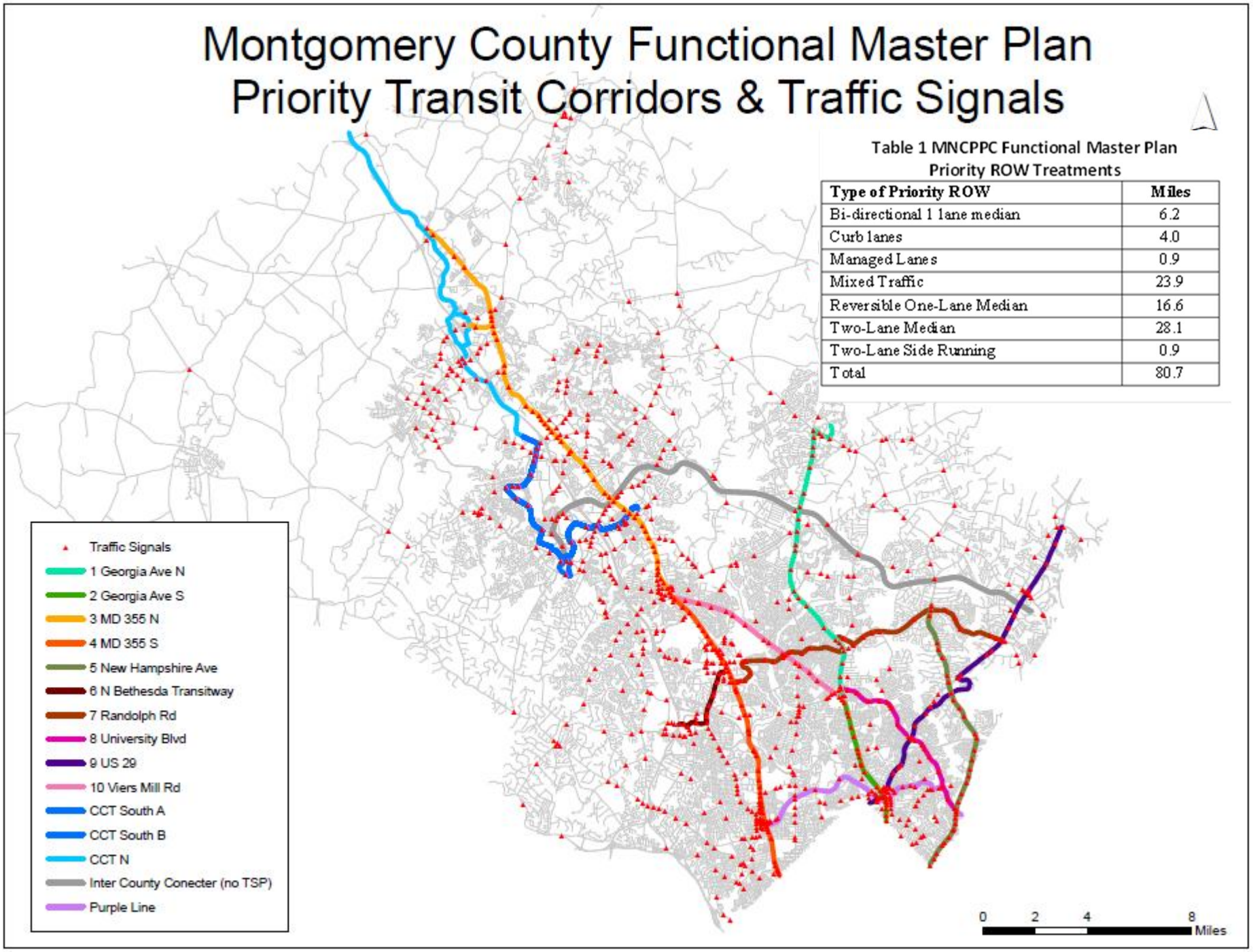


Table 1 MNCPPC Functional Master Plan
Priority ROW Treatments

Type of Priority ROW	Miles
Bi-directional 1 lane median	6.2
Curb lanes	4.0
Managed Lanes	0.9
Mixed Traffic	23.9
Reversible One-Lane Median	16.6
Two-Lane Median	28.1
Two-Lane Side Running	0.9
Total	80.7

Transit Signal Priority Considerations Countywide versus RTS

Countywide – Current Ops

- Current service in mixed flow (no other special treatment)
- All transit in corridor treated equally
- Corridors selected on most potential transit benefit with least potential traffic harm
- First come first served transit priority request granted
- Person throughput auto and transit equal
- Traffic signals coordinated for all traffic
- Traffic coordination allowed to recover between requests
- TSP options:
  - Green extension (through)
  - Truncated red (through or cross)

Within RTS – Ops

- Future service in tandem with RTS ROW and other priority treatments
- How should RTS, Express, Local & peak in or out be given priority?
- Corridors from County Transit Functional Master Plan
- What service gets priority when there are multiple requests?
- Should RTS service get additional priority?
- Should signals be coordinated for RTS vehicle flow?
- How often should priority be granted?
- New Signal treatment Options:
  - Passive priority
  - Transit only phase

TSP within RTS System
Proposed Purpose & Goal

- *Purpose:*

  Help maintain consistent transit vehicle flows and travel times for RTS Service while reducing delays due to stops at traffic signals.

- *Goal:*

  Improve expected Transit Travel Times for travelers using the RTS system through improving reliability and reducing delays without undo negative impacts to the overall transportation system performance or other travelers.

Transit Signal Priority within RTS Signal Priority Options

- Within Mixed Flow Operations (as before)
  - Extend Green Phase
  - Truncate Red Phase
- With RTS Right of Way treatments or queue jump lanes (new options)
  - Passive – Adjusts signal coordination to support unimpeded flow of transit vehicles within corridor
  - Exclusive Transit Phase – Provide a transit only phase for transit vehicles at intersections

Transit Priority Treatment versus Signal Operations

	Potential Signal Treatments*			
ROW Treatments	**Passive**	**Extend Green**	**Red Truncate**	**Insert Transit Phase**
Non-RTS Corridor		✓	✓	
Mixed Flow		✓	✓	
Mixed Flow w Queue Jump	✓	✓	✓	Transit only Early Green
Dedicated Curb Lanes	✓	✓	✓	
Managed Lane (dedicated 1 way Pk)	✓	✓	✓	
1 Lane Medan Busway (bi-dir)	✓	✓	✓	
1 Lane Median Busway (1 way)	✓	✓	✓	✓
2 Lane Side Busway (2 way)	✓	✓	✓	✓
2 Lane Median Busway (2 way)	✓	✓	✓	✓
LRT ROW (Purple Line)	✓	✓	✓	✓
	* Also depends on allowed turns and transit service in guideway			

Other Characteristics Impacting TSP and Signal Operations

	Turns Permitted		Traffic	Transit Service in Priority ROW			
ROW Treatments	**Right**	**Left**	**Lane Use**	**LRT**	**RTS**	**Express***	**Local**
Non-RTS Corridor	Y	Y	Y		N	Y	Y
Mixed Flow	Y	Y	Y		Y	Y	Y
Mixed Flow w Queue Jump	Y	Y	Right Trn		Y	Y	Y
Dedicated Curb Lanes	?	Y	Right Trn		Y	?	?
Managed Lane (dedicated 1 way Pk)	?	Y	Right Trn		Y	?	?
1 Lane Medan Busway (bi-dir)	?	?	N		Y	?	N
1 Lane Median Busway (1 way)	Y	?	N		Y	?	N
2 Lane Side Busway (2 way)	Y	Y	N		Y	?	N
2 Lane Median Busway (2 way)	Y	N	N		Y	?	N
LRT ROW (Purple Line)	?	?	N	Y	?	N	N
					* Non-RTS WMATA, MTA, etc.		

Factors			
X street Fac. Type	Primary	Secondary	Local
X street Transit Service	RTS	High Freq	Low Freg
Bus stop location	Near	Far	
Bicycle & Pedestrian	Priority Area	Excess Ped Time	
HCM V/C Ratio	>0.6	<0.95	
Available Green time(phases)	Non-TSP phases > 1		
Time Since Last TSP Accuation	3 cycles for non-RTS corridor		
Ridership	Assume ridership > 100 pass /direction / hour		

Emerging Technology

- The US DOT Connected Vehicle Program
  - DSRC real time short range communications between vehicles and/or roadside
  - Transit vehicles can be “aware” of each other, and downstream or cross-street conditions
  - Smart vehicles with real time information
  - Developing applications and conducting pilots now
- New System Components
  - Priority Request Generators and Servers to address multiple simultaneous requests
  - Automatic Passenger Counters
  - Predictive and coordinated priority progression (along a corridor)

Transit Signal Priority
Policy Questions

- How should potential signal operations change when combined with other priority treatments options (queue jumps, exclusive guideway, etc.)?
- What types of transit service will be eligible for signal priority (RTS, Express, Local) and in which directions (peak, off-peak, cross)?
- How often should priority be granted when requested?
- What weights should be given to transit ridership versus general traffic?
- Should the TOC be integrated or separate?
- How should we plan to evolve with Advances in Technology (e.g. Connected Vehicles)

Thank you

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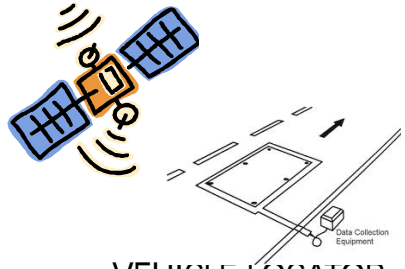
BACKUP SUPPORT SLIDES

1. Example: Active Priority; Actuated Transit Phase, Distributed System

TRANSIT LANE or QUEUE JUMP



VEHICLE LOCATOR

2

1

APPROACHING TRANSIT VEHICLE

Priority Request Generator

3

Priority Request Server

TRANSIT SIGNAL

4

SIGNAL CONTROLLER

Measures: Transit Characteristics

- Stop location
  - Near
  - Far
- Other Priority Treatments (existing, potential)
  - Dedicated lane
  - Queue jump
  - Bus bulbs
- Signal Delay per vehicle (by approach; AM, PM, Midday; Local, limited, express; etc.)
  - % with delay
  - Average delay
  - Distribution (will be skewed)
  - % GT X
- Transit Service
  - Vehicles per hour (by approach; AM, PM, Midday; Local, limited, express; etc.)
  - Vehicles per hour routing, straight, left, right (by approach; AM, PM, Midday; Local, limited, express; etc.)
  - Passengers per vehicle (by approach; AM, PM, Midday; Local, limited, express; etc.)
  - % Vehicle trips on time (by approach; AM, PM, Midday; Local, limited, express; etc.)
  - Impact on transit progression (do we want to tie priority together for groups of signals, e.g. Us29 at University).

Measures: Traffic Characteristics

- Performance
  - Volume (by approach; AM, PM, Midday)
  - Intersection LOS (by approach; AM, PM, Midday)
  - Queue length, average, max (by approach; AM, PM, Midday)
  - Delay, average, max (by approach; AM, PM, Midday)
  - Volume-to-Capacity Ratio (by approach; AM, PM, Midday)
  - Available green (by approach; AM, PM, Midday)
  - Corridor/mid block LOS (is the intersection impacted by other near by intersections, is upstream congestion significant)
  - Pedestrians and bicycles per hour
- Signal
  - Controller type and capabilities
  - Coordinated ? Boundaries ?
  - Timing (phases, actuated, AM, PM, Midday)
  - cycle length
- Physical
  - Number of lanes by type and approach
  - Pedestrian and bicycle features (actuated request, bike lanes, pedestrian island, accessibility)