Bus Stop Spacing and Reliability
APTA Sustainability and Multimodal Workshop

Boston, MA| 30 July 2019

FAStops
Fewer Stops = Faster Service

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Agenda

- SORTA and Bus Stop Spacing Objectives
- FAStops Approach
- FAStops Pilot & Preliminary Findings
- System-wide Implementation

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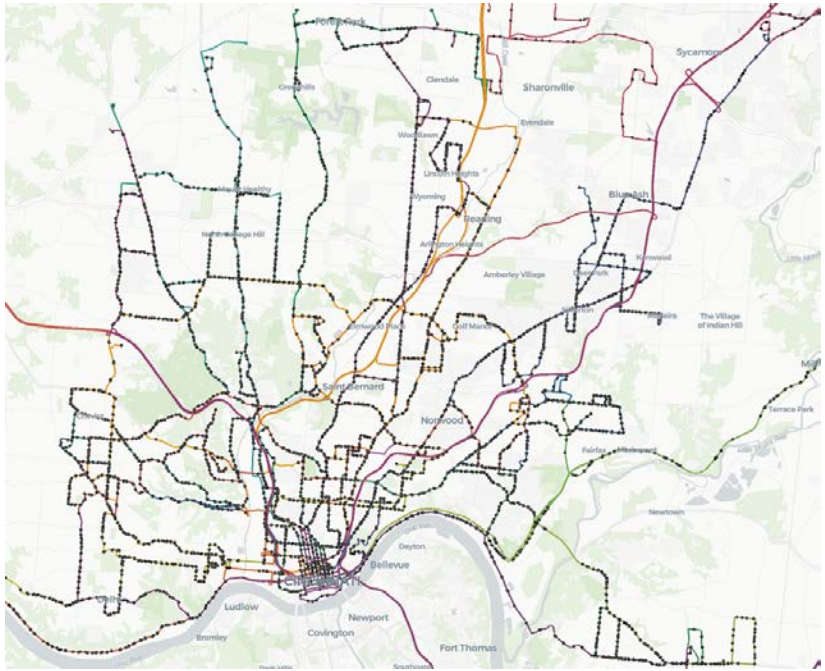
SORTA Network and Stop Spacing

- Service area population over 2M
- 45 fixed routes ≈ 4,500 stops
  - 25 Local, 20 Express
- Prioritized coverage and need-based service
- Customer requests for new stops. Easy to give, but hard to take away



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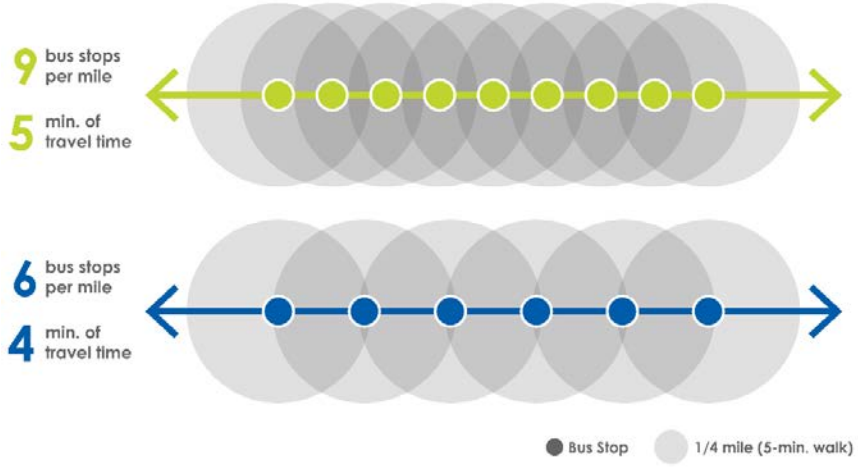
Stop Spacing Objectives

- **Faster:** Fewer stops means more time spent moving
- **More reliable:** More likely to stay on schedule
- **Smoother ride:** Less stop-and-go service
- **Better facilities:** Identify priority stops for improvements



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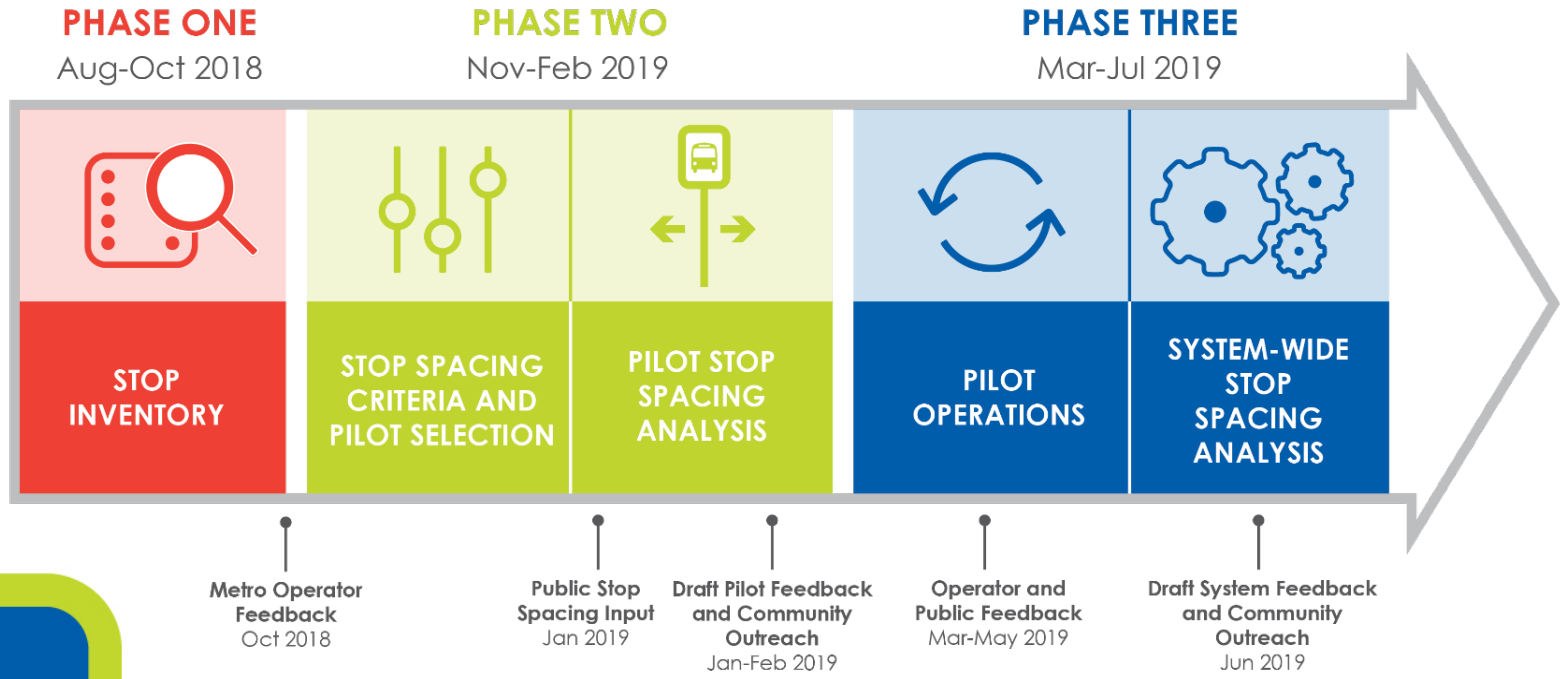
FAStops Schedule



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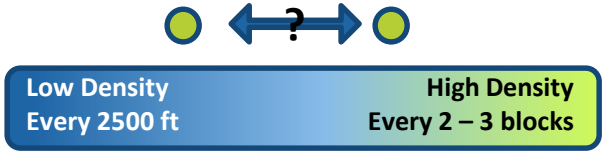
Stop Spacing and Density



How have others implemented stop spacing guidelines and practices?

- Population and employment density
- Customer considerations: activities of daily need, transit dependency, special needs

What is the proposed stop spacing for FAStops?

- Current Metro average spacing: ≈ 0.16 miles (850 feet), or 7 stops per mile

Surrounding Environment	Density	# Stops in Density Range	Desired Stop Spacing (feet)	# Stops per mile	% Stops Below Desired Spacing
High Density	> 20 residents per acre > 10 jobs per acre	< 900	800 – 1,100	5 - 7	80%
Moderate Density	10-20 residents per acre 5-10 jobs per acre	1,900+	1,000 - 1,300	4 - 5	88%
Low Density	< 10 residents per acre < 5 jobs per acre	1,700+	1,300 - 1,800	3 - 4	90%

How Does FAStops Work?

Ultimately, the model inputs consider…

- What stops *cannot* be removed -- *no matter what?* (Transit Centers, those already identified for capital improvements, time points, etc.)
- Pop/Emp density around each stop (Low, Medium, High)
- Existing stop spacing and Inbound/Outbound stop-pairing
- Maximum ‘allowable’ inbound and outbound gap creation (by density)
- Route analysis sequence, Stop ID info
- Stop Score (combination of 18 variables)

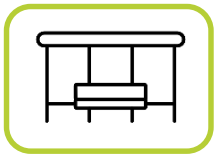
All results require detailed QAQC review with Agency Ops and Scheduling staff for manual adjustments, as appropriate

Stop Scoring

Inventory stop conditions to compare sequential stops when they are too close together and both are considered for removal

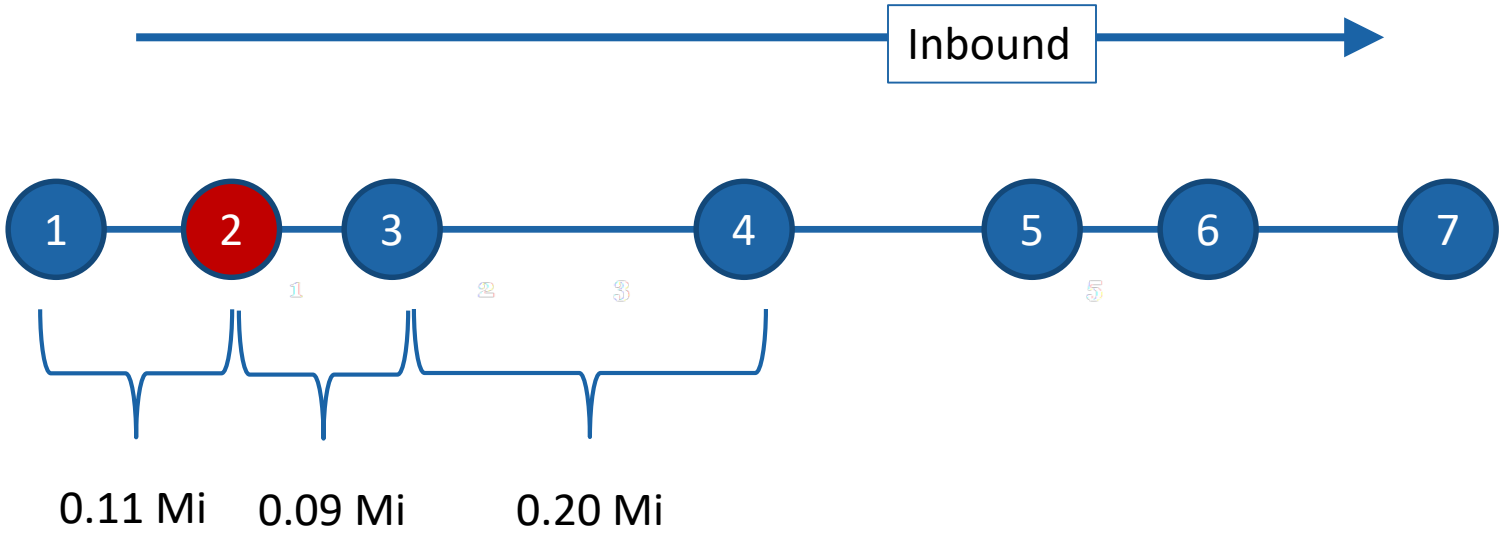
(100 pt max)

- Transit Demand (44 pts)
  - Average boardings, major destinations, transfer points, land use
- Site Selection (27 pts)
  - Current stop spacing, concrete bus pad, safe bus pull-in area, far/near side
- Amenities (16 pts)
  - Shelter, bench, lighting, arrival information, waste bins
- Pedestrian, ADA Accessibility (13 pts)
  - Sidewalk and intersection presence, ADA boarding, neighborhood access



How Does FAStops Work?

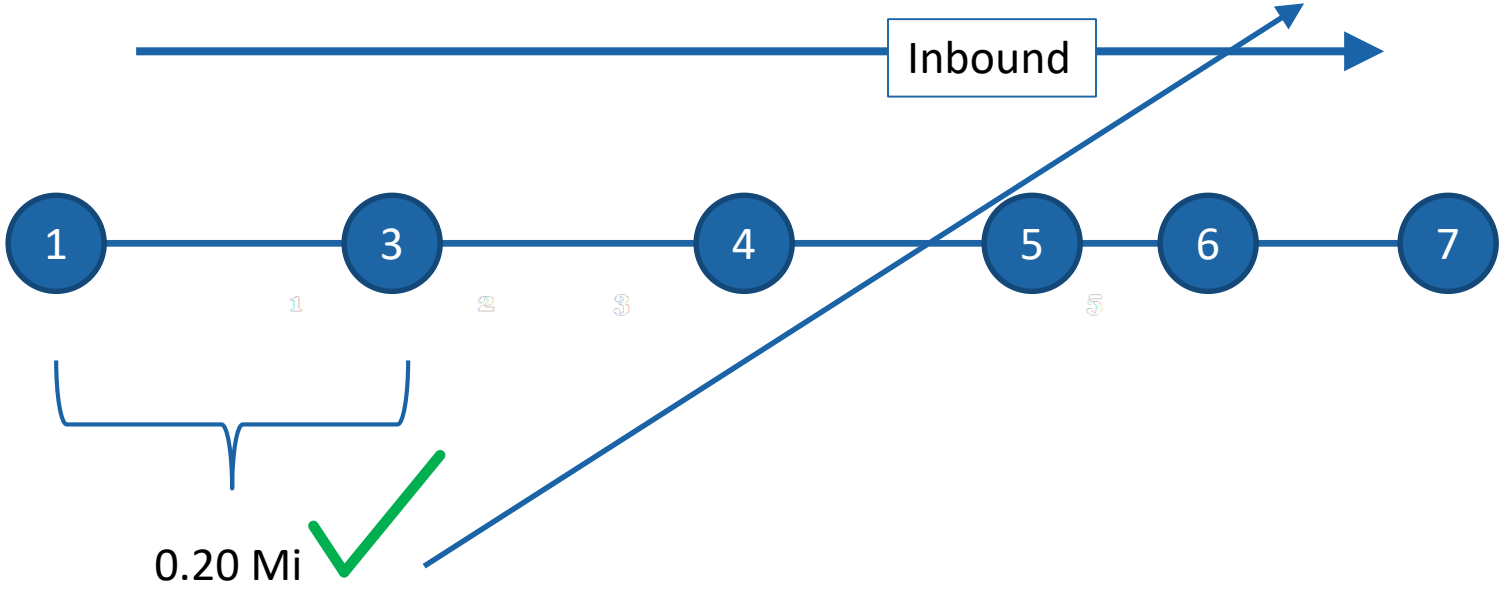
Max Gap =
0.25 Miles



Check existing stop spacing in IB direction.

How Does FAStops Work?

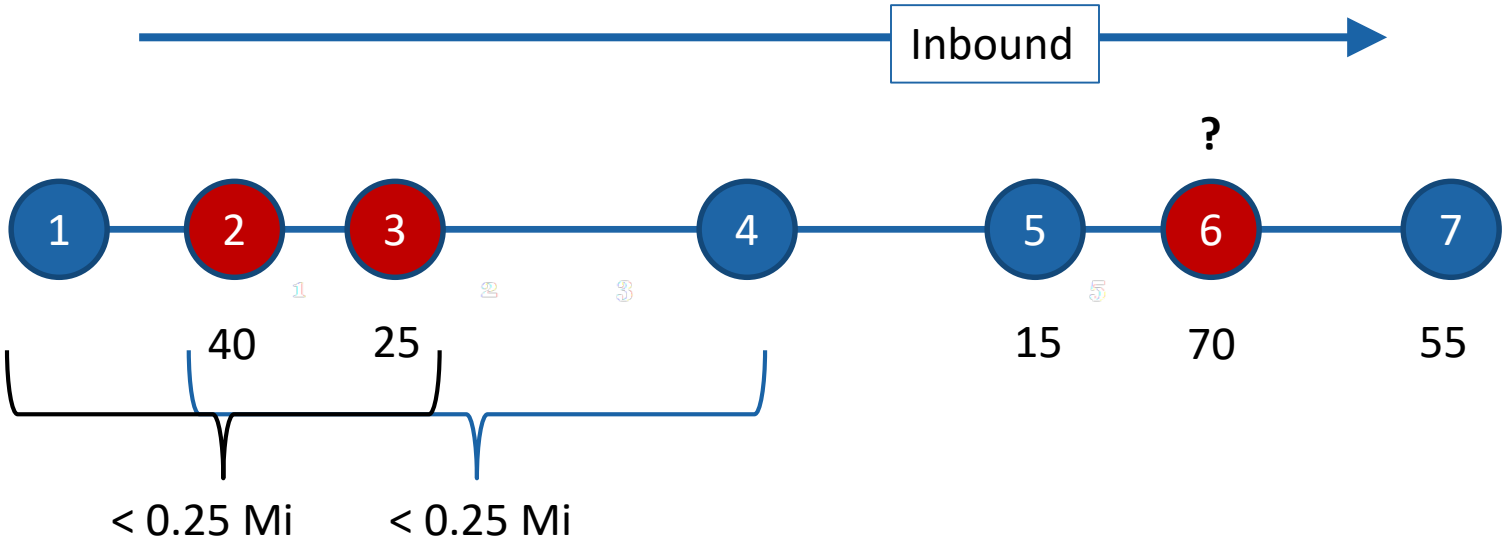
Max Gap =
0.25 Miles



Check resultant spacing vs. Max Gap allowance

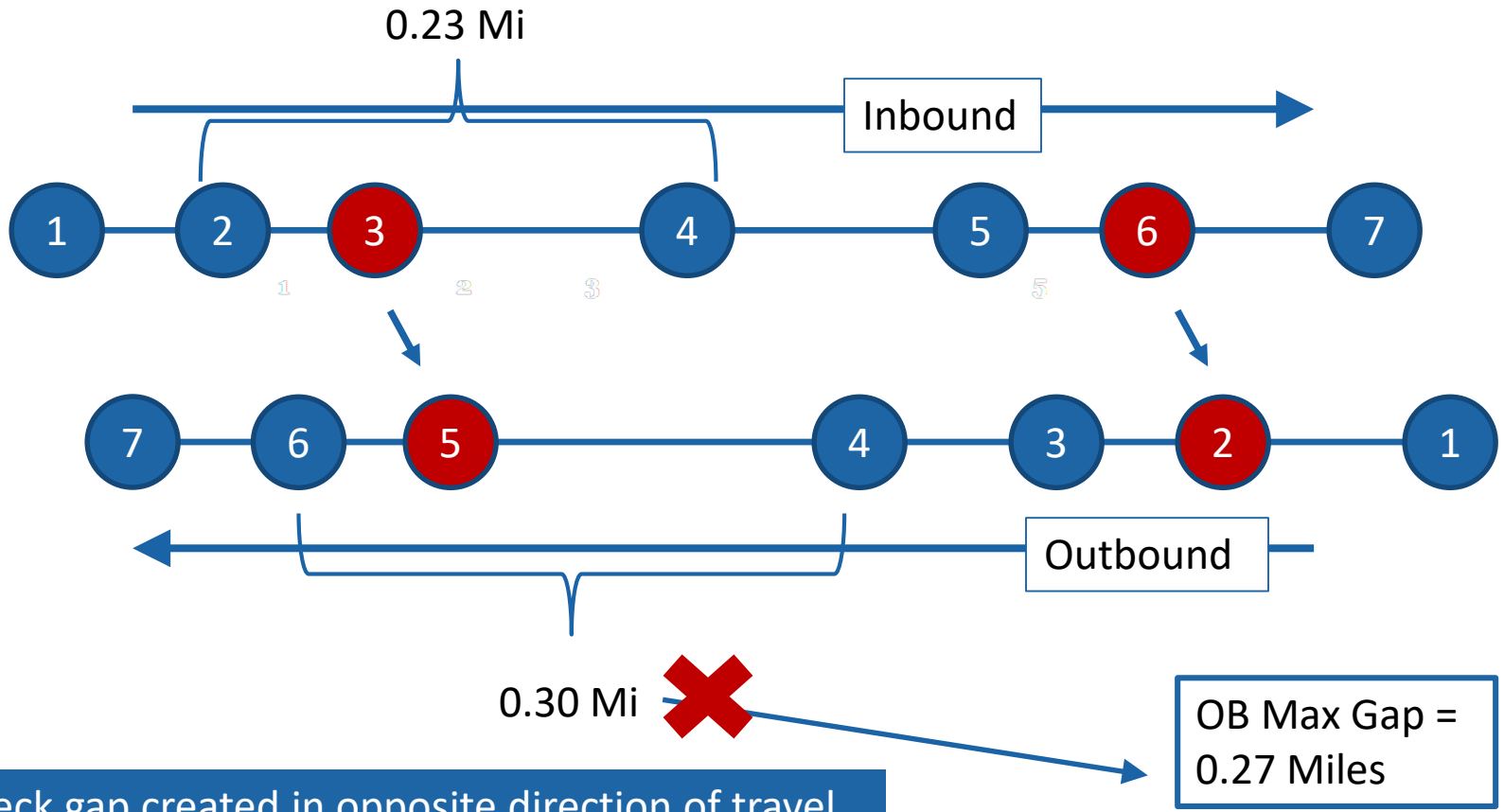
How Does FAStops Work?

Max Gap =
0.25 Miles



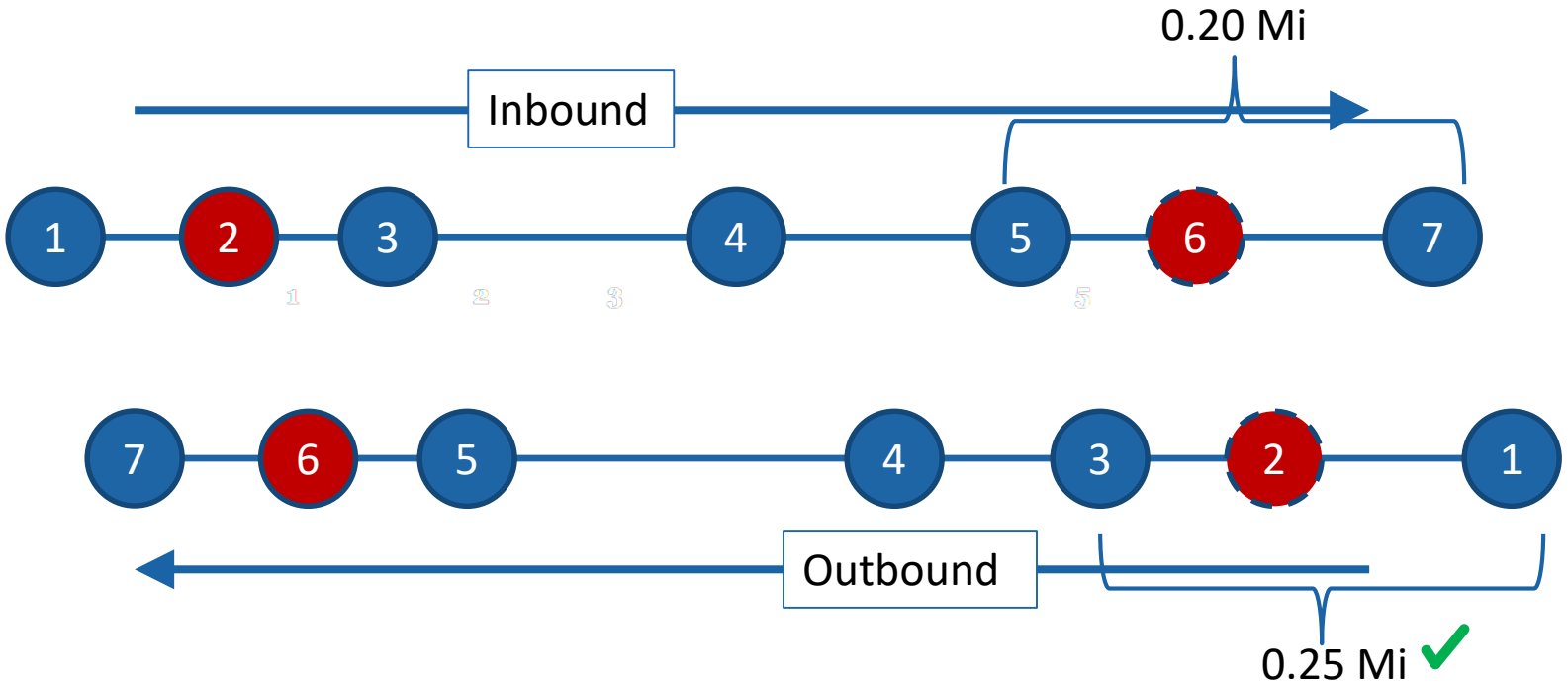
Bottom Line: The gap created is most important. The stop score is used when sequential stops are eligible for removal.

How Does FAStops Work?



Check gap created in opposite direction of travel

How Does FAStops Work?



OB Max Gap = 0.27 Miles

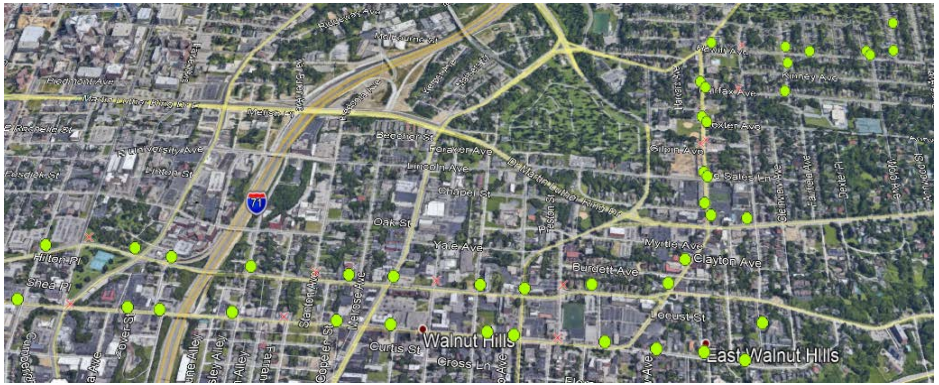
Maximize removals while preserving valued stops

FAStops Model Limitations

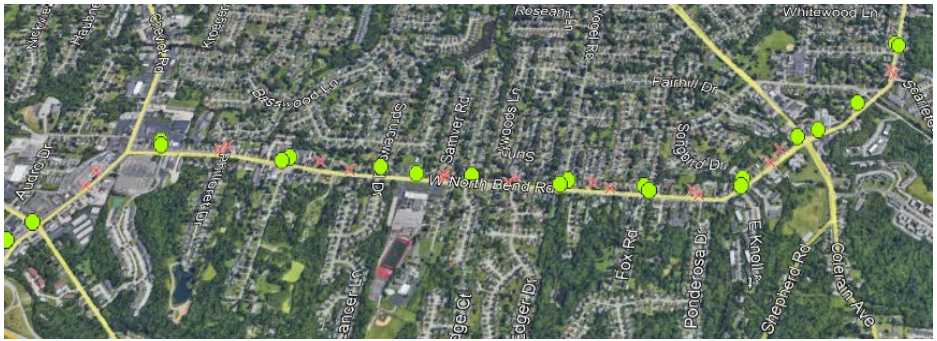
- Pre-processing of stop inventory data
- Can be hard to trace logic in response to questions
- Results may be different route to route for shared stops
- Existing stop spacing patterns can lead to less than optimal results
- Manual adjustments
  - Orphans and Xtra service stops
  - Hills and grade challenges
  - Operator and public feedback
  - Exiting, built environment

Verifying FAStops Removal Analysis

- Public & Operator feedback
  - Input on current stop spacing problem areas
  - Feedback on draft pilot stop spacing and removals
- Consultant/SORTA QC
  - Visual and data-driven review of draft model results
- Pilot performance data
  - On-time performance, ridership, delay and run time savings



Sample results: route #31



Sample results: route #41

FAStops Pilot

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FAStops Pilot Routes

Priority travel corridors

- High ridership routes, crosstown and commuter services

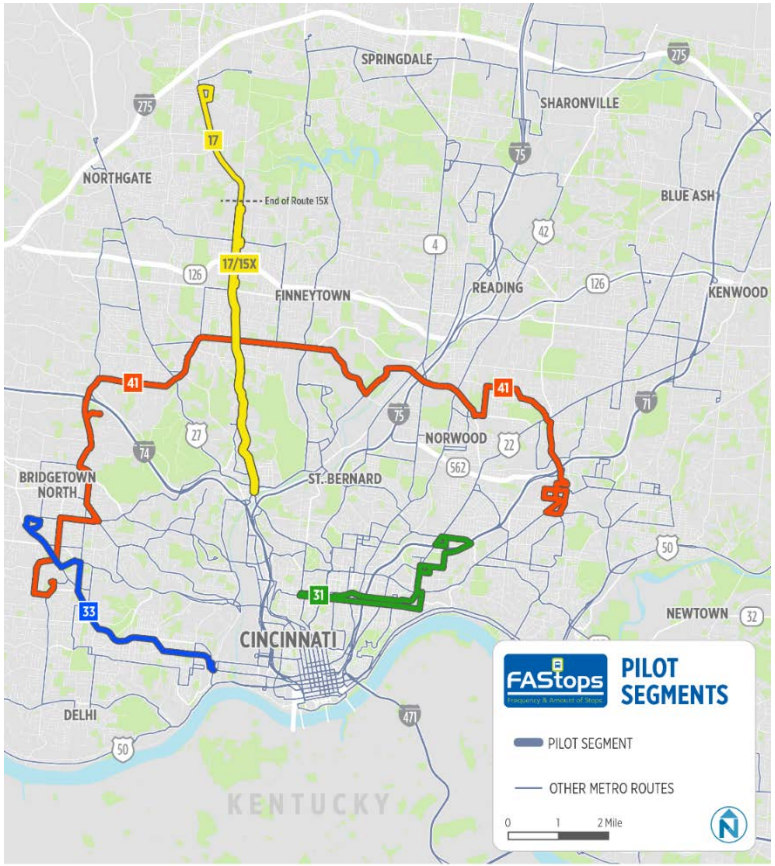
Corridor segments

- Use time points to measure improvement
- Minimize conflict with other routes

Geography

- Equity coverage

Pilot Routes: 17/15X, 31, 33, 41



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Challenges to Calculating Travel Time Savings

- Existing schedules / Time Points (TPs) not modified
  - Schedules still tailored to reflect baseline traffic conditions and operations
  - Passenger trip planning information not updated
- Operating policies
  - Implementation of normal service changes (Spring Pick); driver changes
  - On-Time Performance (OTP) driver requirements
- Automated data collection
  - Interpreting reports of OTP ‘Arrival’ and ‘Departure’ times/adherence

Frequency of Time Stopped

(excludes boarding/alighting dwell time)

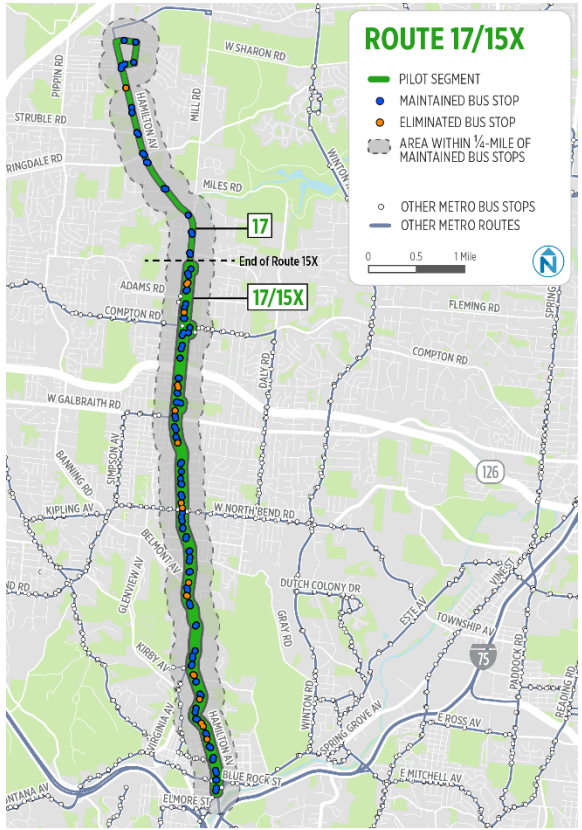
Route	Period (daily avg)	0.5 – 2 min	2 - 4 min	4-6 min	6-9 min
17	Baseline	1447	205	43	23
	Pilot	1324 **(-9%)**	181 **(-12%)**	49 **(+14%)**	26 **(+13%)**
31	Baseline	571	91	24	20
	Pilot	619 **(+8%)**	105 **(+15%)**	26 **(+8%)**	23 **(+15%)**
33	Baseline	1045	138	29	23
	Pilot	1354 **(+30%)**	189 **(+37%)**	32 **(+10%)**	23 **(0%)**
41	Baseline	498	54	18	11
	Pilot	575 **(+15%)**	59 **(+9%)**	12 **(-33%)**	14 **(+27%)**

Baseline - values are based on a sample size of daily operations prior to Pilot implementation (2/12 to 2/14/2019 and 2/19 to 2/20/2019)
Pilot - values are based on a sample size of daily operations during Pilot service (4/16 to 4/18/2019 and 5/15 to 5/16/2019)

Rte. 17 - Pilot Summary

No. of Stops	No. Stops for Removal	% Stop Removal
123	22	18%

- Pilot OB trips average arrival at TPs 1minute sooner than baseline
- OB trips average arrival at TPs 2 min ahead of projected (based on inline operations between TPs)



Peak Hrs.	Inline Adherence			TP Adherence		
	Baseline Avg	Pilot Avg	Change	Baseline Avg	Pilot Avg	Change
IB	(-)02:41	(-)02:25	(+)00:16	(-)02:17	(-)02:31	**(-)00:14**
OB	(-)02:45	(-)03:15	(-)00:29	(-)04:31	(-)05:41	**(-)01:10**

Off-Peak Hrs.	Inline Adherence			TP Adherence		
	Baseline Avg	Pilot Avg	Change	Baseline Avg	Pilot Avg	Change
IB	(-)02:37	(-)02:30	(+)00:07	(-)02:12	(-)02:36	**(-)00:24**
OB	(-)02:52	(-)03:26	(-)00:33	(-)04:54	(-)05:53	**(-)00:58**

Inline Adherence - average of all reported schedule Adherence values (projected to next TP) throughout service
TP Adherence - averages **only** the schedule Adherence values reported as buses arrive **at** Time Points
(-) time values indicate buses operating ahead of schedule - **Early**; **(+)** time values indicated buses operating behind schedule - **Late**

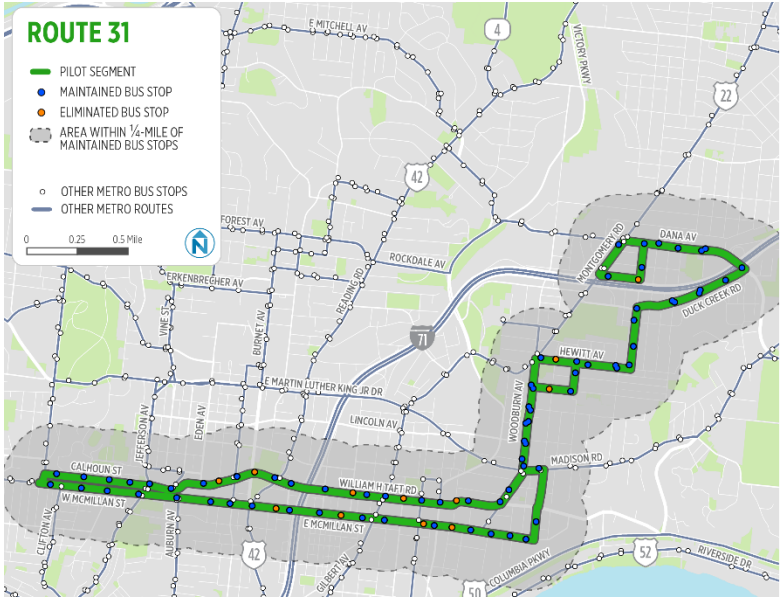
Rte. 31 - Pilot Summary

- EB trips arrived roughly 20 to 25 seconds earlier at TPs during <u>peak</u> hours of Pilot.
- WB trips arrived roughly 25 to 30 seconds earlier at TPs during <u>off-peak</u> hours of Pilot period

No. of Stops	No. Stops for Removal	% Stop Removal
85	13	15%

Peak Hrs.	Inline Adherence			TP Adherence		
	Baseline Avg	Pilot Avg	Change	Baseline Avg	Pilot Avg	Change
EB	(-)01:52	(-)02:16	(-)00:24	(-)02:29	(-)02:50	**(-)00:20**
WB	(-)02:36	(-)02:36	00:00	(-)03:17	(-)03:16	**(-)00:01**

Off-Peak Hrs.	Inline Adherence			TP Adherence		
	Baseline Avg	Pilot Avg	Change	Baseline Avg	Pilot Avg	Change
EB	(-)01:45	(-)01:49	(-)00:04	(-)02:16	(-)02:24	**(-)00:08**
WB	(-)01:40	(-)02:10	(-)00:30	(-)02:12	(-)02:37	**(-)00:24**



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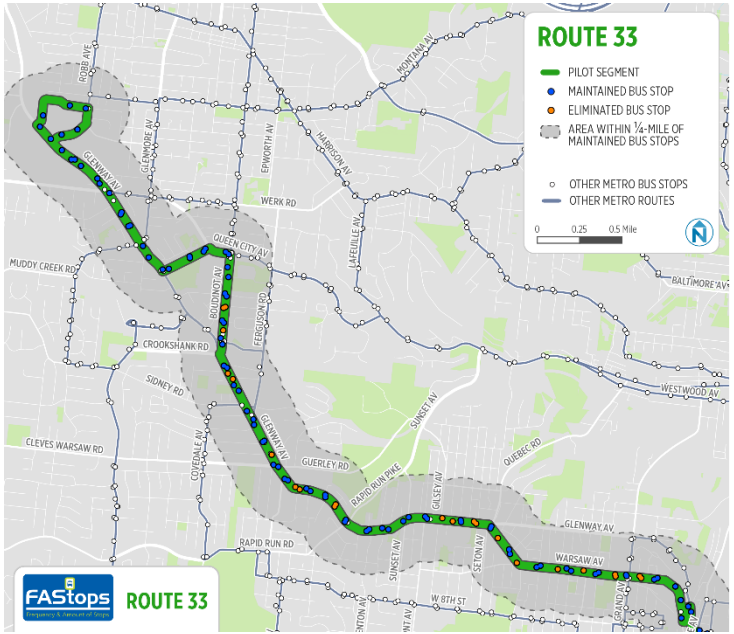
Rte. 33 - Pilot Summary

No. of Stops	No. Stops for Removal	% Stop Removal
109	24	22%

- Pilot OB trips arrived roughly 20 to 25 seconds earlier at TPs during off-peak hours
- Greatest increase in frequency of non-dwell time vehicle stop occurrence among Pilot routes

Peak Hrs.	Inline Adherence			TP Adherence		
	Baseline Avg	Pilot Avg	Change	Baseline Avg	Pilot Avg	Change
IB	(-)01:15	(-)01:20	(-)00:04	(-)02:03	(-)01:51	**(+)00:11**
OB	(-)02:47	(-)02:23	(+)00:23	(-)04:31	(-)04:21	**(+)00:09**

Off-Peak Hrs.	Inline Adherence			TP Adherence		
	Baseline Avg	Pilot Avg	Change	Baseline Avg	Pilot Avg	Change
IB	(-)01:28	(-)01:04	(+)00:24	(-)02:09	(-)01:50	**(+)00:18**
OB	(-)02:00	(-)02:05	(-)00:04	(-)04:02	(-)04:25	**(-)00:23**



Inline Adherence - average of all reported schedule Adherence values (projected to next TP) throughout service
TP Adherence - averages **only** the schedule Adherence values reported as buses arrive **at** Time Points
(-) time values indicate buses operating ahead of schedule - **Early**; **(+)** time values indicated buses operating behind schedule - **Late**

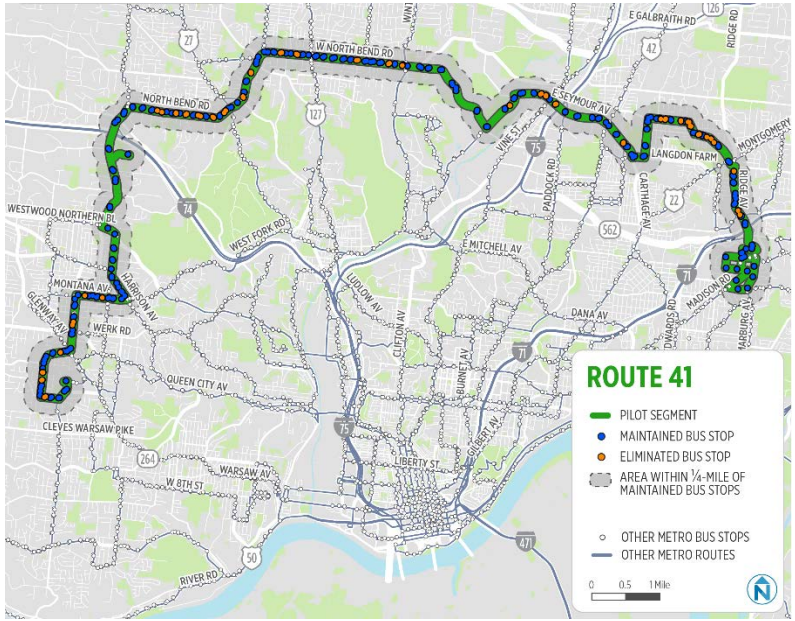
Rte. 41 - Pilot Summary

- WB trips arrived roughly 1.75 to 3 minutes earlier at TPs during Pilot period
- EB trips arrived roughly 0.75 to 1.25 minutes earlier at TPs during Pilot period

No. of Stops	No. Stops for Removal	% Stop Removal
284	69	24%

Peak Hrs.	Inline Adherence			TP Adherence		
	Baseline Avg	Pilot Avg	Change	Baseline Avg	Pilot Avg	Change
EB	(-)02:44	(-)04:10	(-)01:26	(-)03:33	(-)04:48	**(-)01:15**
WB	(-)03:22	(-)05:45	(-)02:23	(-)04:03	(-)07:14	**(-)03:10**

Off-Peak Hrs.	Inline Adherence			TP Adherence		
	Baseline Avg	Pilot Avg	Change	Baseline Avg	Pilot Avg	Change
EB	(-)02:37	(-)03:17	(-)00:40	(-)03:35	(-)04:18	**(-)00:42**
WB	(-)02:41	(-)04:04	(-)01:23	(-)03:33	(-)05:18	**(-)01:44**



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TP Adherence - averages **only** the schedule Adherence values reported as buses arrive **at** Time Points
(-) time values indicate buses operating ahead of schedule - **Early**; **(+)** time values indicated buses operating behind schedule - **Late**

Public Engagement

- **Oct 2018:** Operator input on problem stop locations
- **Dec 2018:** News release, project website and CARTO online visualization launch
- **Jan/Feb 2019:** Pilot area community meetings
- **Mar 2019:** Pilot launch
- **May 2019:** Passenger and operator Pilot feedback
- **July 2019:** Phase 2 service area community meetings
- **Nov 2019:** Phase 3 service area community meetings

We appreciate that the agency responded to our feedback on stops to remove.

- SORTA Operators

More recovery time at end of line

- SORTA Operators

I haven't timed it, but when I ride the 17 it feels like it gets downtown 5 or 10 minutes faster.

- Passenger

Rte 33 (along Warsaw) is much faster to get through the area.

- SORTA Operators

Rte. 41 used to get delayed due to construction but we are able to make up the time now.

- Passenger

Major Takeaways/Lessons Learned

- Stop scoring should be much less complex
  - Ridership tells us *a lot* about a stop
  - Top 5 or so variables important to agency and customers
- Could push maximum spacing thresholds further
- Anticipate client feedback to build in the model (ex: senior centers, high ridership stops, etc.)
- Be even more active in the public messaging
- Create more rules like automatic eliminations below certain spacing/ridership

Full SORTA Network Analysis

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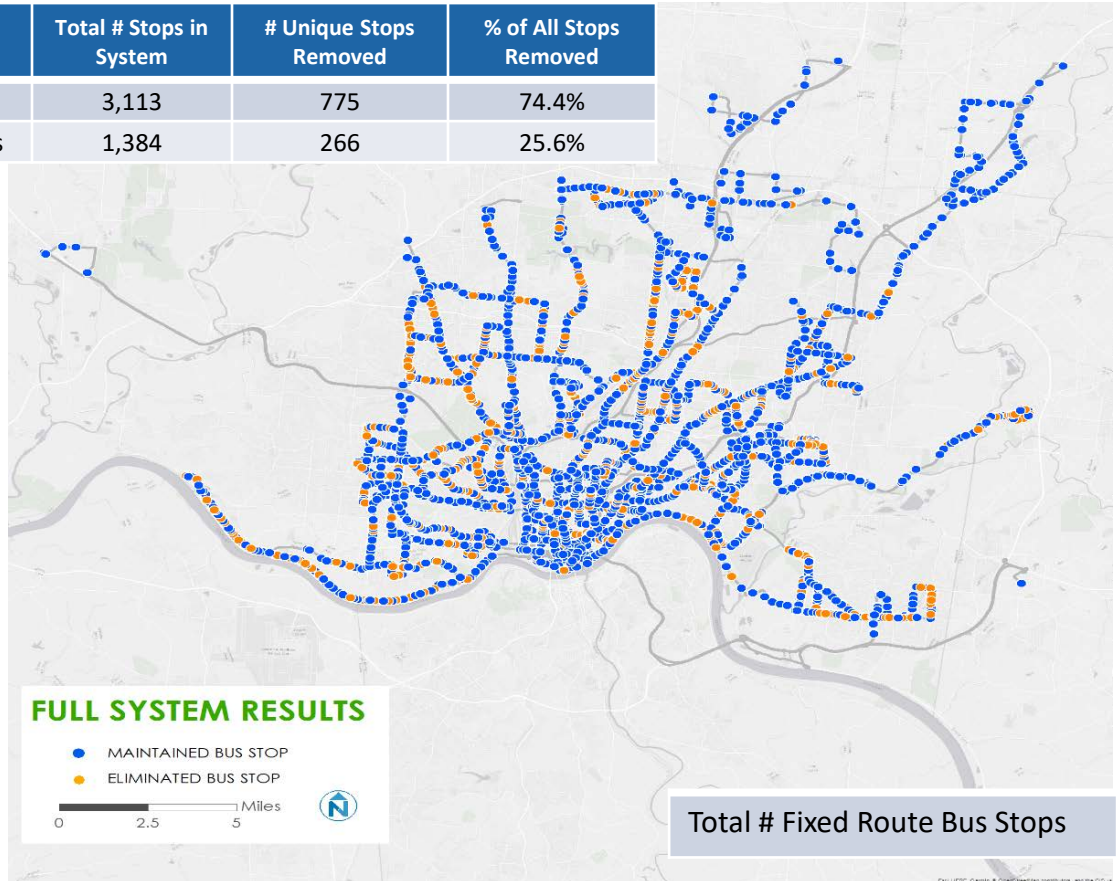
FAStops Network Analysis Overview

# Stops Serving	Total # Stops in System	# Unique Stops Removed	% of All Stops Removed
1 route	3,113	775	74.4%
2 or more routes	1,384	266	25.6%



45 fixed routes

- 25 Local
- 20 Express & MetroPlus

	Baseline (existing)	FAStops (proposed)
Total # Fixed Route Bus Stops	4,497	3,456

FAStops Network Analysis Overview

- 4,497 unique stops in FAStops database
- 1,041 (23%) recommended for removal
  - Only 6% of existing riders would need to switch stops

Route Type	Number of Stops†	Number of Removals†	% Removal (all removals)	% Removal (all stops)
Express	2,155	380	27%	18%
Local	4,707	1,018	73%	22%

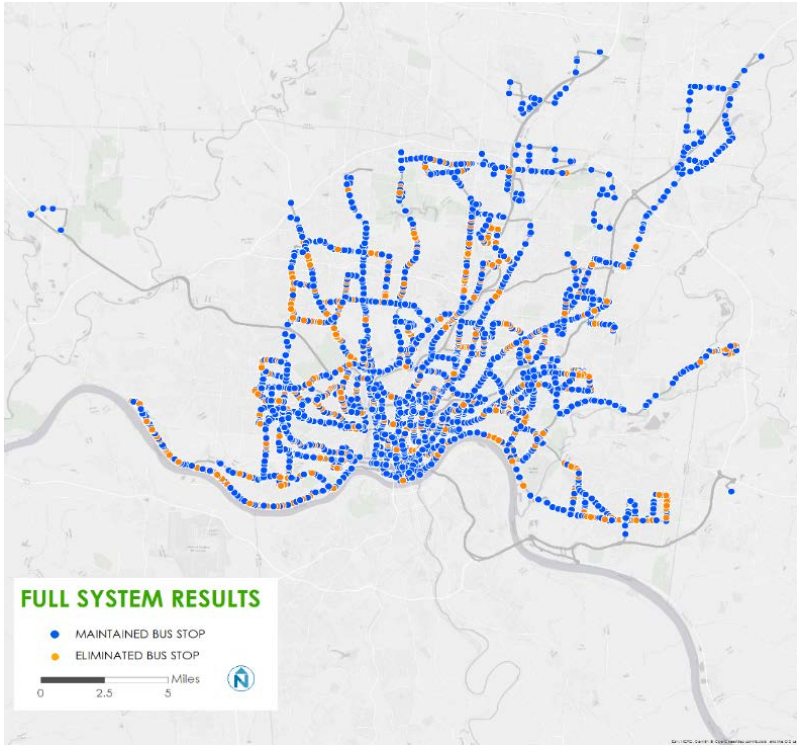
Stop Positions	Number of Stops†	Number of Removals†	% Removal (total by position)	% Removal (all removals)	% Removal (all stops)
Far Side	1,066	219	21%	21%	5%
Mid-Block	873	257	29%	25%	6%
Near Side	2,558	565	22%	54%	13%

† - count includes duplicate stops shared by multiple routes

Next Steps

- Phase 2 FAStops Implementation
  - August 2019
- Phase 3 FAStops Implementation
  - December 2019

- Additional Considerations
  - Stop consolidation opportunities
  - Operations and safety improvements
  - Passenger amenity improvements



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FAStops Benefits

- Low-Cost, Low-Labor deployment
- Improved OTP and running times
  - Mitigate O&M increases by not having to add more buses
  - Supports route pulsing at transfer points
- Does not require full scheduling revamp
- Inventory identified other improvement opportunities
  - Stop amenity and ADA compliance
  - Operational, driver and customer safety
- Happier operators - more recovery time, less stress

Thank You

https://www.go-metro.com/fastops

Khaled Shammout, Director of Transit Development
Southwest Ohio Regional Transit Authority(SORTA)/Metro - Cincinnati, OH
kshammout@go-metro.com
(513) 632-7671

Jimi Mitchell, Senior Associate
Nelson\Nygaard Consulting - Los Angeles, CA
jmitchell@nelsonnygaard.com
(213) 694-4457