Effects of Bus Stop Spacing in Public Transportation Performance:

An Analysis of Parallel Corridors in Chicago

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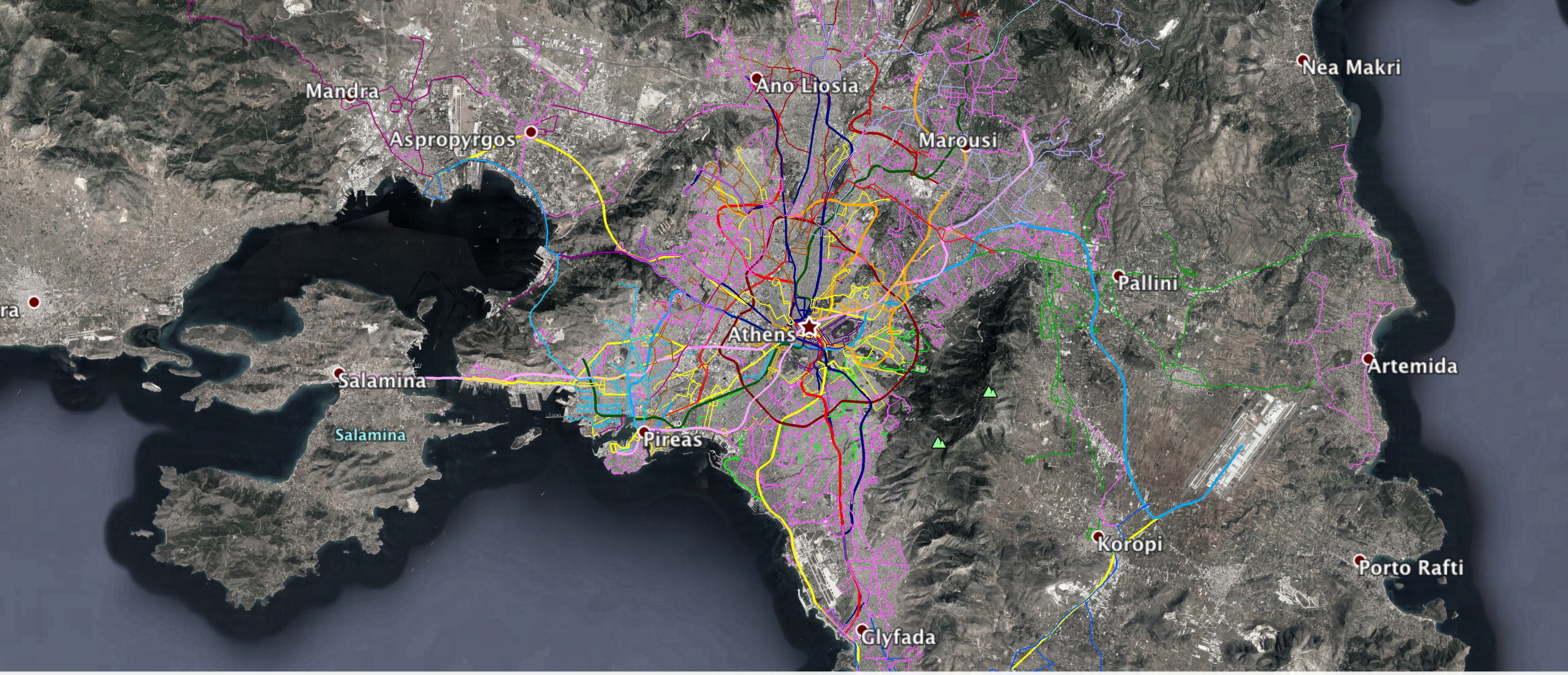
#BetterBus

TRANSPORT CHICAGO

Some Personal Facts

- Born and raised in Athens, Greece
- Redesigned the bus route network in Athens at age 17



No, seriously!

Some Personal Facts

- Born and raised in Athens, Greece
- Redesigned the bus route network in Athens at age 17
- NTUA – MS Diploma in Surveying Engineering, 2016
- (still bothering elected officials and transportation planners in the meantime…)
- IIT – ME in Transportation Engineering, 2019

- CMAP – Transportation Planning Intern, 2018-2019
- CTA – Service Planner, Bus (upcoming)

Overview

- Introduction
- Study Area
- Goals and Objectives
- Methodology
- Results
- Discussion

Introduction

Public transit is…

- Essential in dense areas
- Efficient
- Outdated
- Underfunded

Advantages of Bus networks

- Flexible routing and stop location
- Low operation and maintenance costs
- Low infrastructure costs
- Effective in high or low density areas
- Local, express or feeder service
- Eliminates coverage gaps

About stop spacing

- What is stop spacing?

  The distance between two consecutive stops along a bus route

- Useful to specify:
  - Coverage area
  - Type of service
- It is typically predefined
  - System-wide policy
  - Local deviations based on locations of interests or other factors

Why bother?

- Long spacing reduces travel time (typically)
- Long spacing also decreases coverage area
- Long spacing increases dwell time
- Short spacing minimizes walking times (think elders and riders with disabilities)
- Short spacing frustrates commuters

Study Area – Chicago Transit Authority

Second largest public transit agency in the US

- 1.97 billion annual passenger miles
- 1.5 million average weekday unlinked trips
- 140 bus routes
- 52.3 million annual bus revenue miles on over 25,000 daily bus trips

Studied Corridors

- Halsted (#8)
- Ashland (#9, #X9)
- Damen (#50)
- Western (#49, #X49)

Stop Spacing Policy

- 1/8 mile on regular routes
- 1/2 mile on express routes
- 1/4 mile on routes #9,#49 with the introduction of express service
- 1/4 mile walking distance to bus stop

Goals and Objectives

- Analyze coverage area of each route based on stop spacing
- Analyze scheduling and ridership patterns along these corridors
- Compare these patterns before and after the stop consolidation
- Discuss the patterns related to stop spacing

Methodology

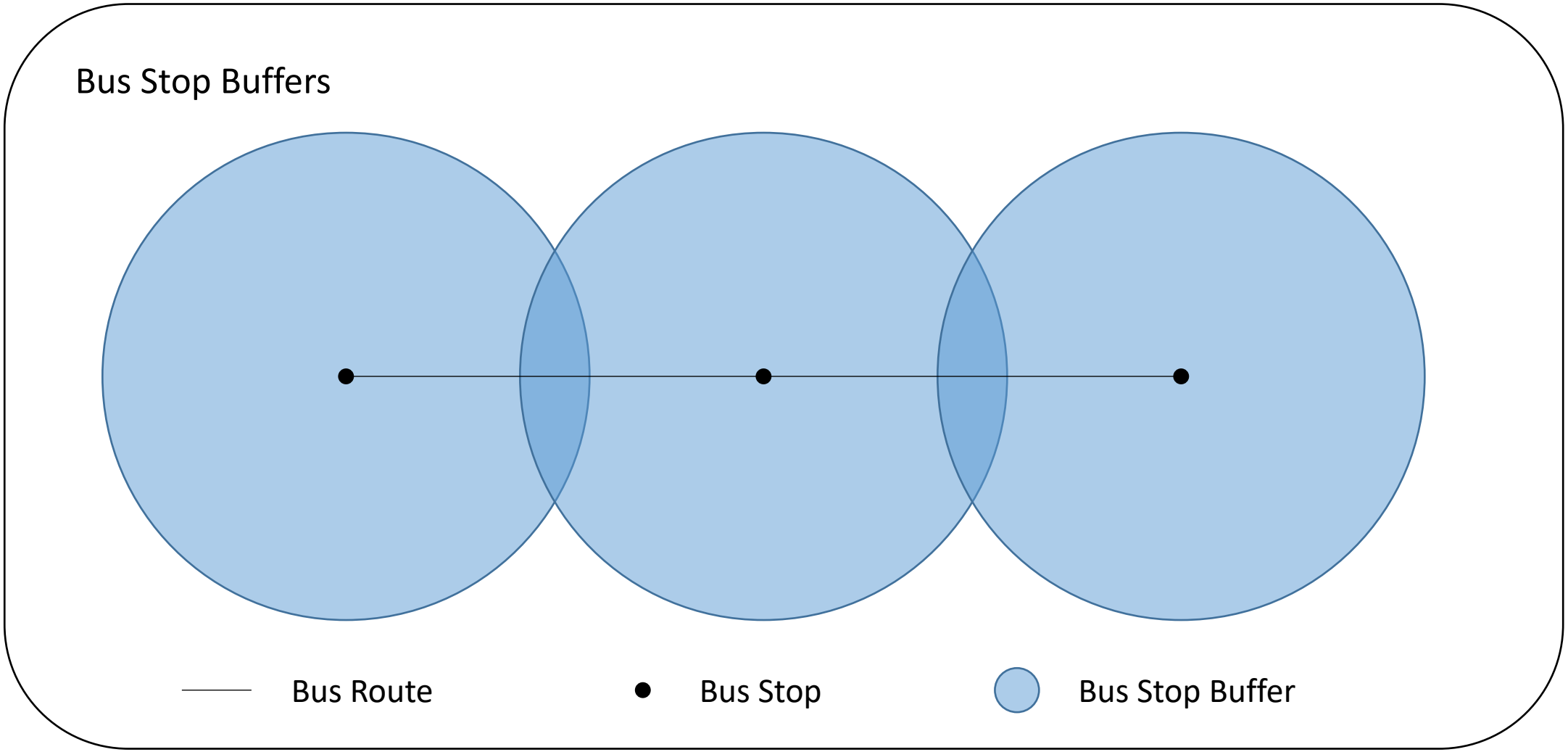
Service Area Analysis

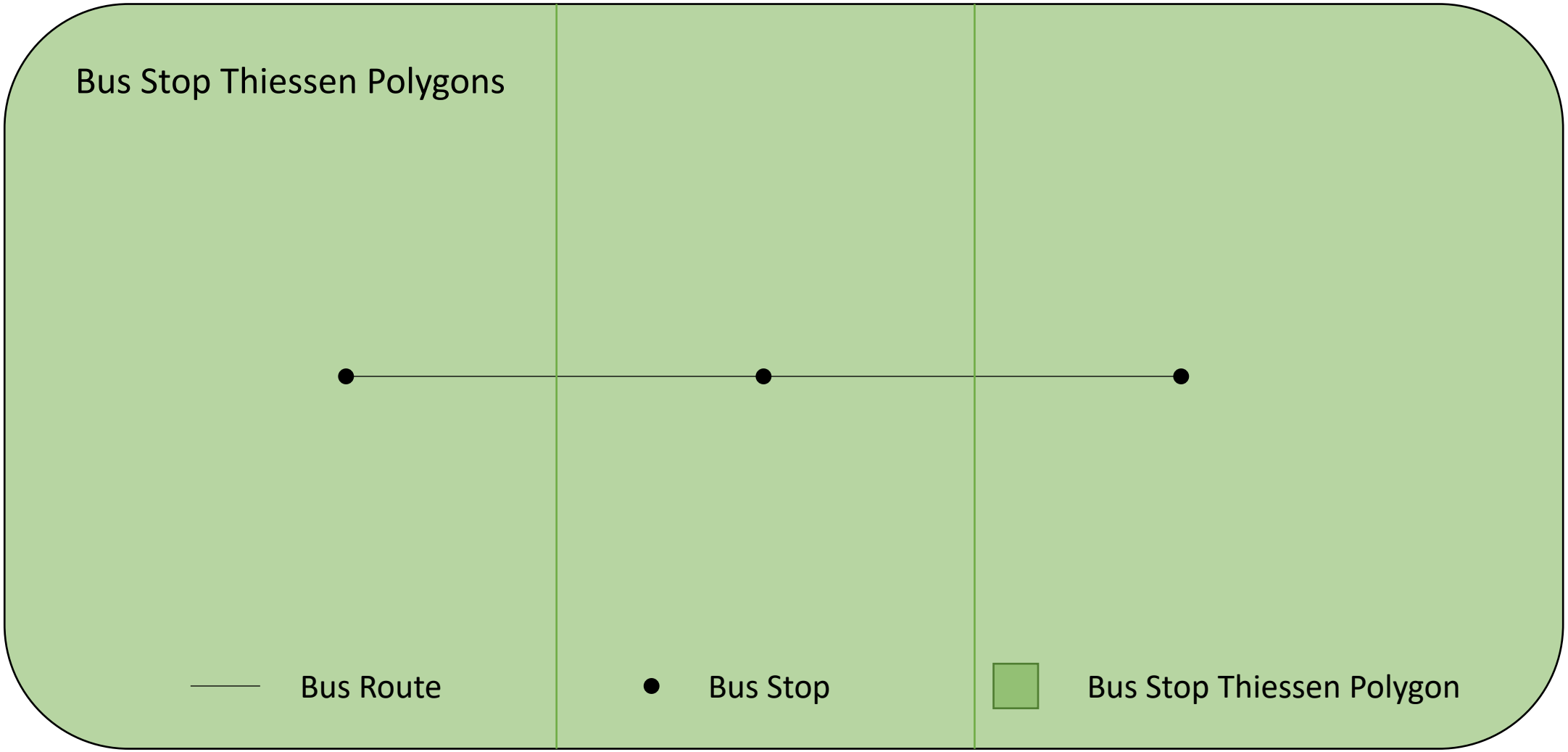
Travel Time and Ridership Analysis

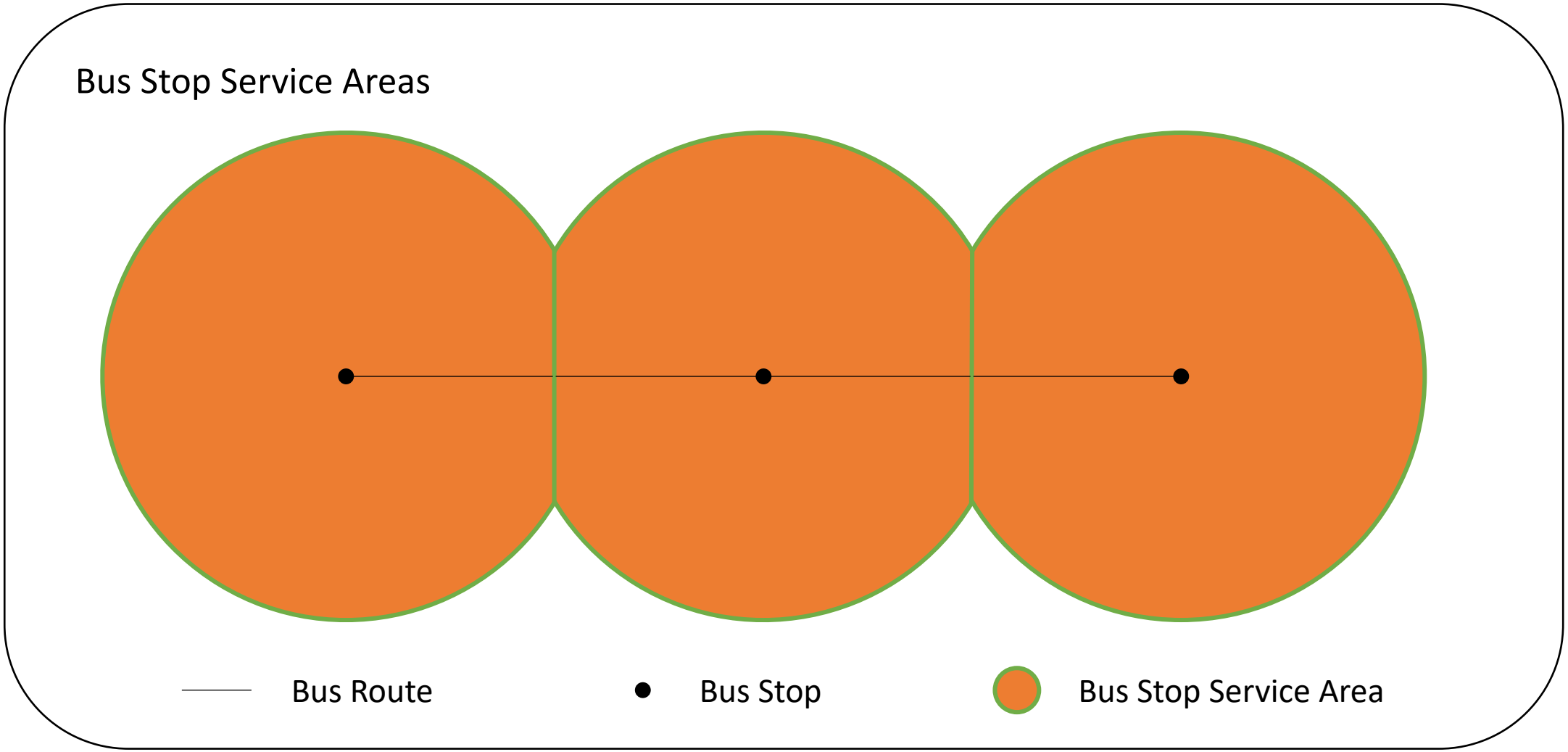
Icons: fontawesome.com

Service Area Analysis

- Stop buffer
  - 1/4 mile circular buffer around stop
  - May overlap with other stops
- Stop Voronoi polygon
  - The area that, at any location, one stop is the closest of all in a route
  - Cannot overlap with other stops
- Stop service area
  - The combination of the stop's buffer and Voronoi polygon
- Route service area
  - The total of the service areas of all stops serving the route


Bus Stop Buffers
Bus Route
Bus Stop
Bus Stop Buffer


Bus Stop Thiessen Polygons
Bus Route
Bus Stop
Bus Stop Thiessen Polygon


Bus Stop Service Areas
Bus Route
Bus Stop
Bus Stop Service Area

Service Area – Performance Measures

- Stop service area ratio
  - The percentage of the buffer area that is dedicated to this stop
  - Measured as stop service area / stop buffer
  - Longer spacings lead to higher values and less overlap between stops
- Route service area ratio
  - The ratio of the route service area to the route line buffer (1/4 mile along the line)
  - Measured as route service area / route buffer
  - Shorter spacings lead to higher values and fewer coverage gaps along the route

Travel Time and Ridership Analysis

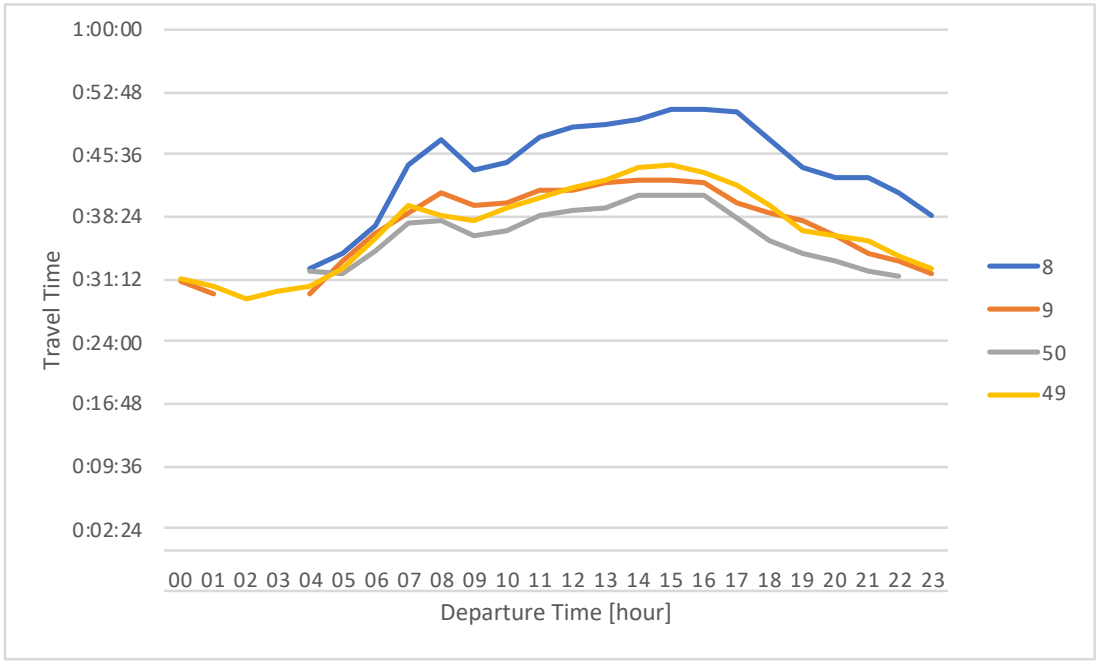
- GTFS weekday scheduled data extracted and summarized:
  - By route: travel times between routes are compared
  - By period: each route is compared in different periods, having modified stop spacing in each period
  - Examined segments: Southbound Addison to Cermak
- Ridership:
  - Average weekday boardings per route
  - Summarized by quarter

Results – Service Area Analysis

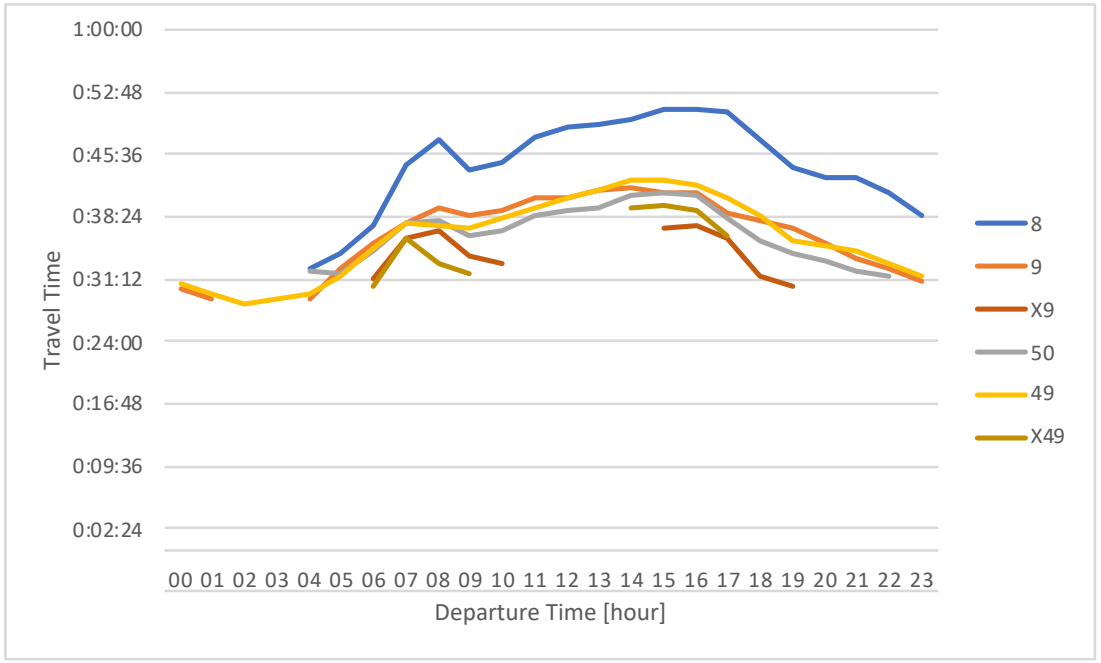
Route	Stop Spacing [mi]	Stop Service Area [acres]	Stop Buffer Size [acres]	% Stop Service Area to Buffer	Route Service Area [acres]	Route Buffer Size [acres]	% Route Service Area to Buffer
8	0.138	4.075	11.626	35.05%	423.84	426.58	99.36%
9	0.203	5.907	11.626	50.81%	531.66	543.67	97.80%
X9	0.483	11.626	11.626	100.00%	410.37	525.88	78.03%
50	0.133	3.936	11.626	33.86%	340.43	354.89	95.93%
49	0.193	5.777	11.626	49.69%	473.72	482.83	98.11%
X49	0.445	10.836	11.626	93.20%	379.27	482.83	78.55%

Results – Travel Time Analysis

Before Stop Consolidation

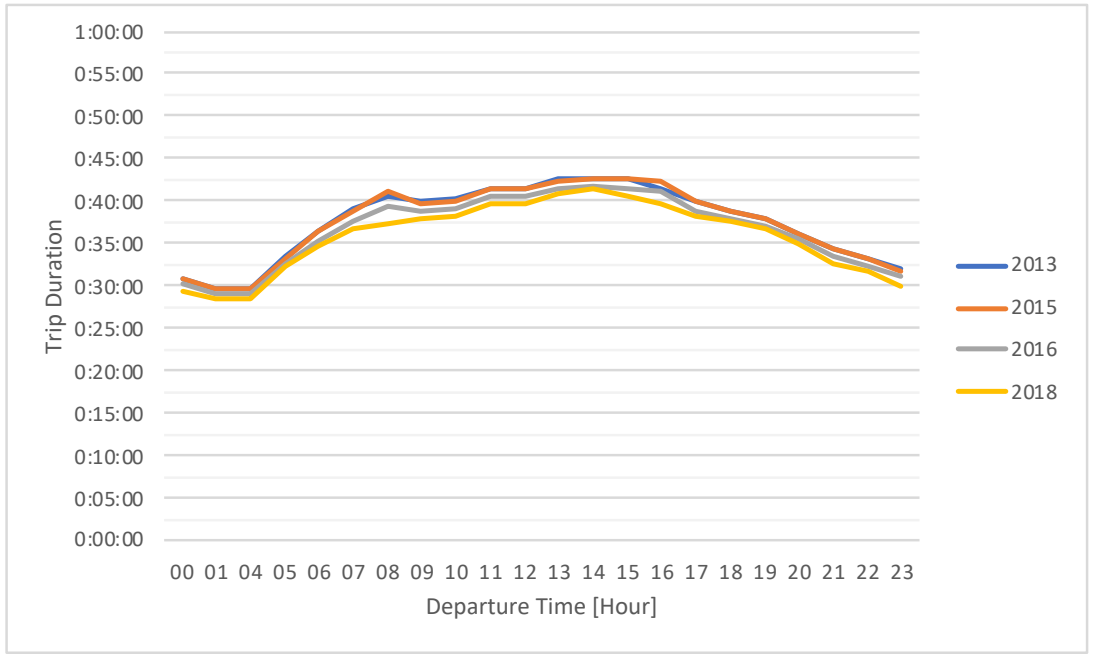


After Stop Consolidation

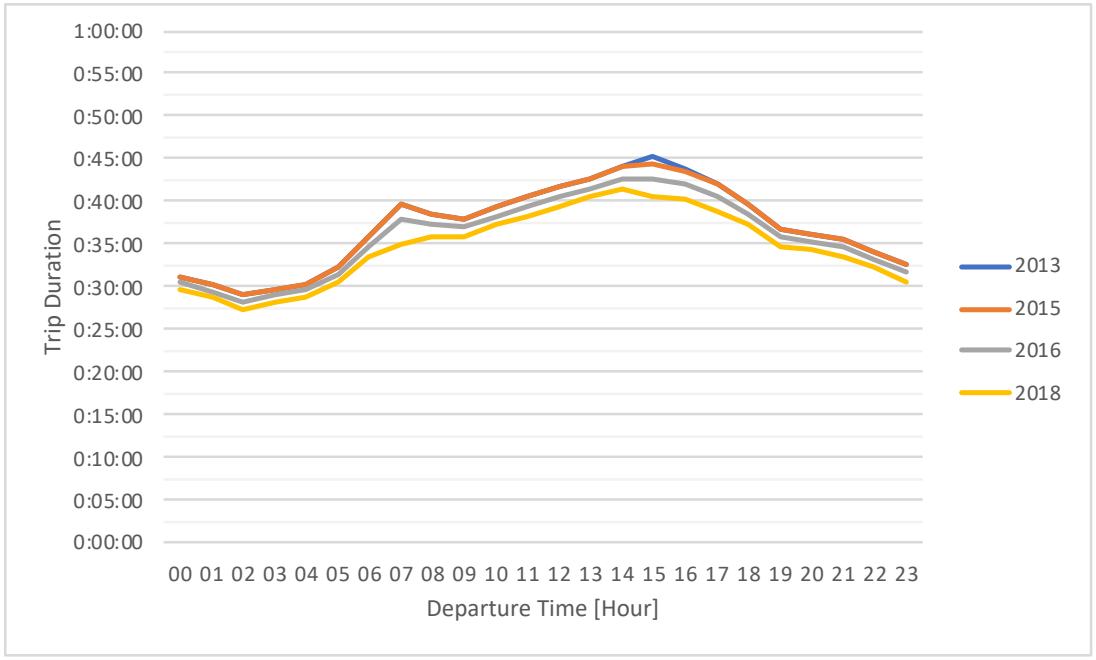


Results – Travel Time Analysis (cont.)

#9 Ashland



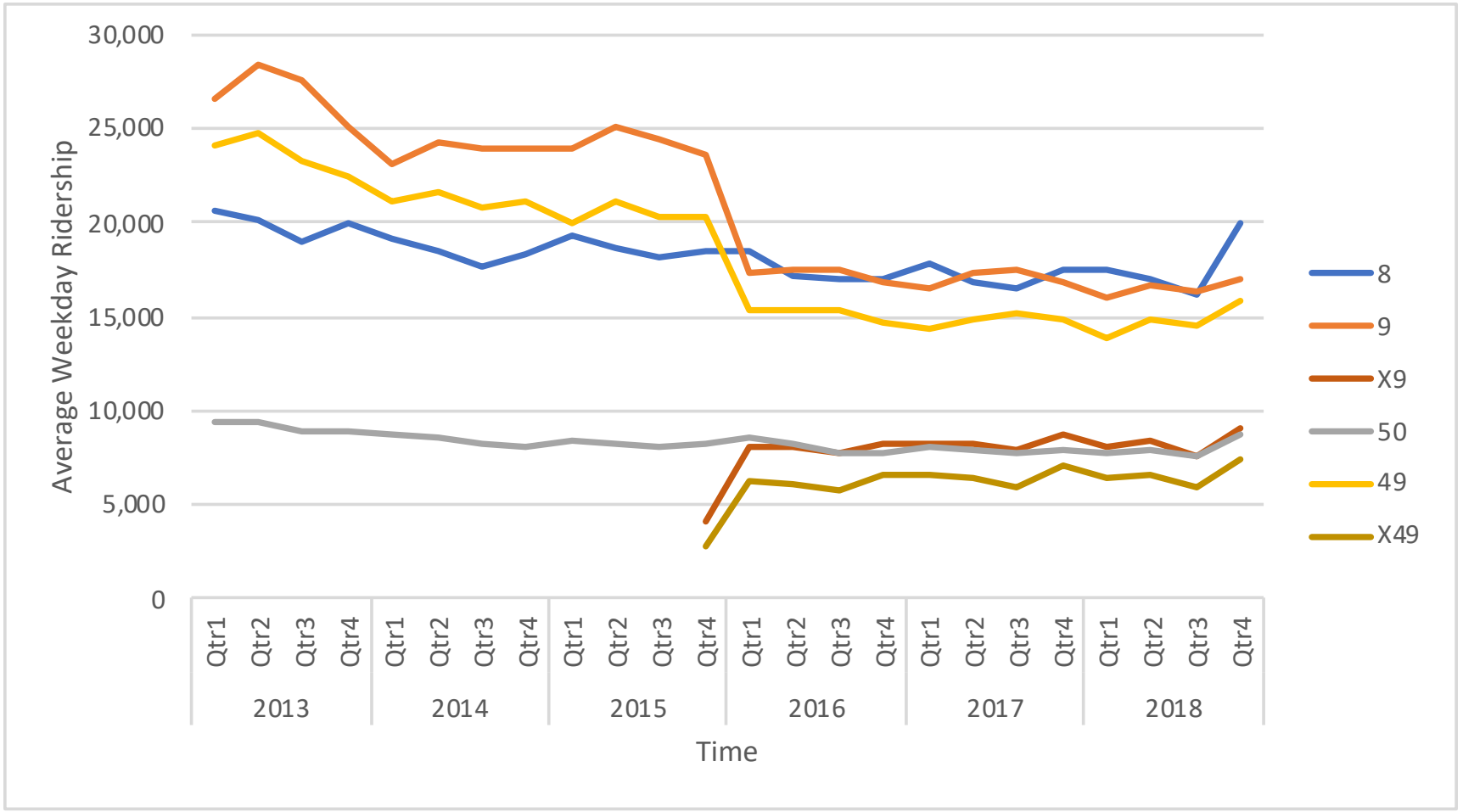
#49 Western



Results – Travel Time Analysis (cont.)

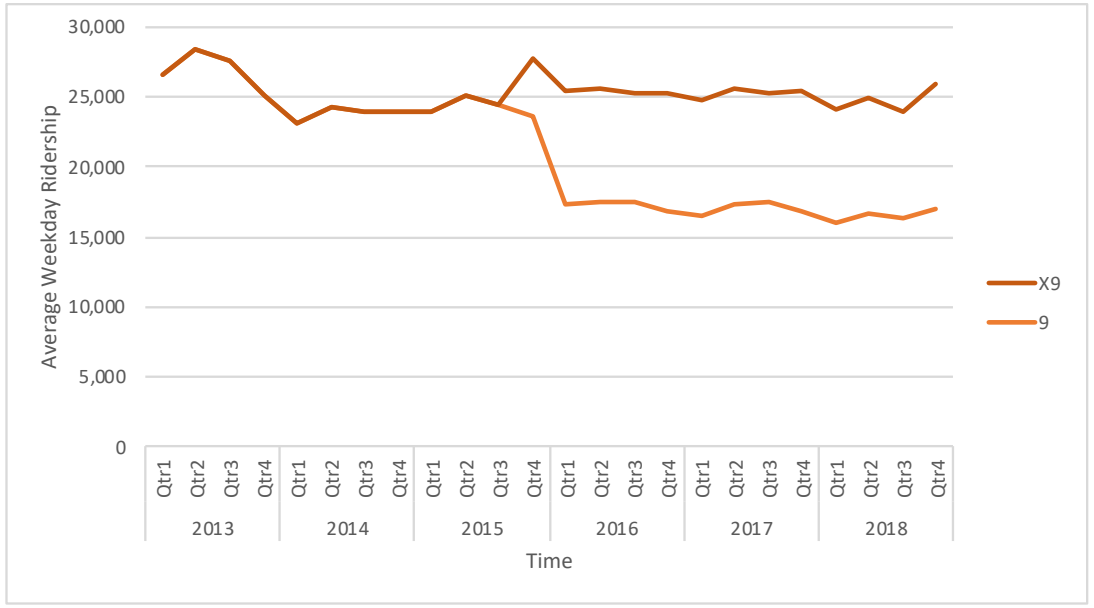
	2013		2015		2016		2018			
Route	Mean Travel Time	Std Travel Time	Mean Travel Time	Std Travel Time	Mean Travel Time	Std Travel Time	Mean Travel Time	Std Travel Time	% Mean 2013-2018	% Mean 2016-2018
8	40:04	4:26	45:14	5:39	45:14	5:39	43:11	5:19	7.78%	-4.53%
9	38:28	4:24	38:34	4:27	37:29	4:17	36:36	4:13	-4.85%	-2.36%
X9					34:48	2:40	40:17	5:03		15.76%
50	37:02	3:18	36:56	3:14	36:58	3:15	37:02	3:16	0.00%	0.18%
49	38:33	5:01	38:24	4:56	37:09	4:42	35:46	4:24	-7.22%	-3.72%
X49					35:56	3:39	36:07	3:39		0.51%

Results – Ridership Analysis

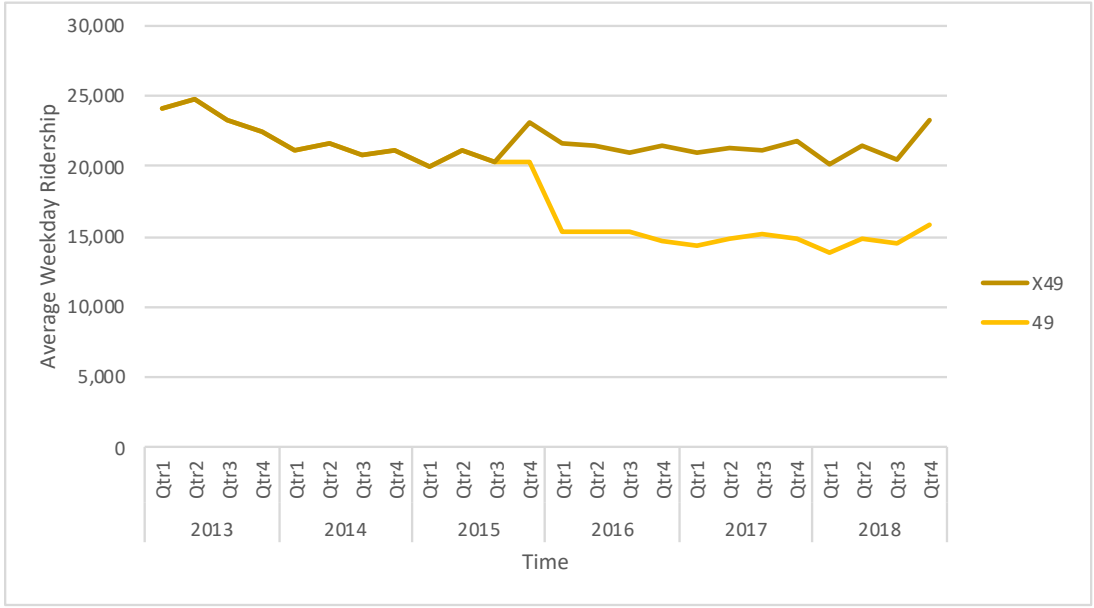


Results – Ridership Analysis (cont.)

Cumulative Ridership
Ashland Ave (#9, #X9)



Cumulative Ridership
Western Ave (#49, #X49)



Discussion

- The stop consolidation led to decreased travel times without identified ridership impacts
- Stop spacing should be based on a balanced compromise of speed and coverage
- Consolidating bus stops may make transit more attractive; savings can be reallocated to network improvements
- Consolidating bus stops may also lead to longer dwell times
- A specific coverage level should be maintained, based on each case

Thank you!

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