

GIS Approach to Identify the Potential Service Areas and Feasibility for Demand Response Feeder Transit Service: US metropolitan Suburban Areas

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Background

- **Accessibility to the transit system is one of the major issues in US suburban areas due to the low population density.**
- **To increase the accessibility in the low population density area, a demand response feeder bus system can be a good option.**



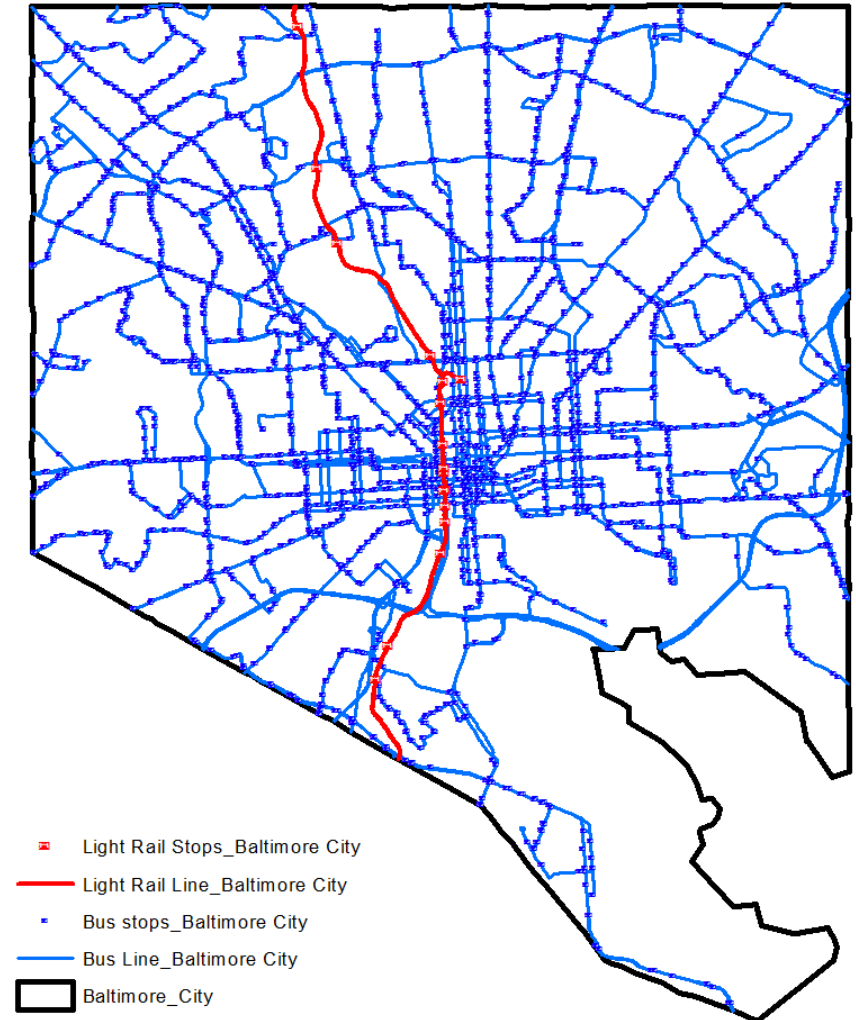
Problem Statement

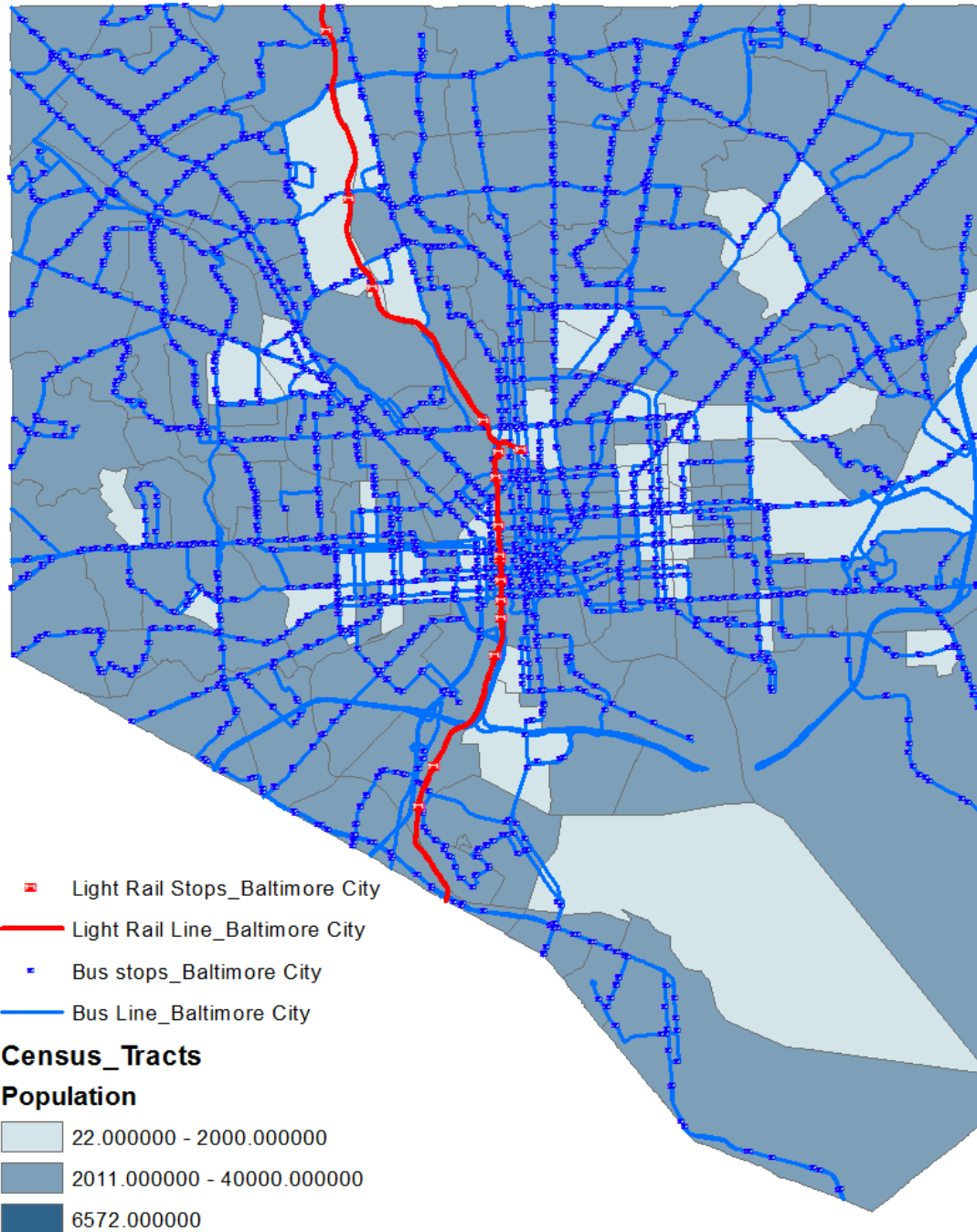
- It is difficult to provide enough feeder service in suburban areas due to low population density and high operating costs.
- Recent technological improvements and new business models of TNCs (Transportation Network Companies) can be useful to implement Demand Response Feeder Transit (DRFT) in suburban areas to provide more efficient feeder services.



Objectives

- In order to provide DRFT service, potential service areas and service feasibility must be identified.
- This study uses a Geographic Information System (GIS) to do so.
- To find out the potential service area and service feasibility, first, transit service area coverages by the existing transit service are identified.





Existing Bus and Rail Lines and Stops and Population

: But this information can not find potential feeder service areas

Methodology

- **Poor transit service areas with high demand should be found for the potential future fixed Route Service or Demand Response Feeder Transit (DRFT).**
- **To find the poor transit area:**
 - **Based on the Census Data, Auto Travel Times (considering the shortest path) and existing Transit Travel Times from every origin to every destinations are computed.**
 - **The Auto and Transit Travel Times are compared as the Degree of Circuity (DOC) (above 600%).**
 - **ODs with long Transit Travel Time (above 60 minutes).**
- **To find high demand area:**
 - **The distribution of Origin-Destination trip data considered as O-D Demand.**
- **Sociodemographic information can be considered if possible (Future study).**

Transit Travel Time Estimation

Step 01: GTFS Data from <https://www.mta.maryland.gov/developer-resources>

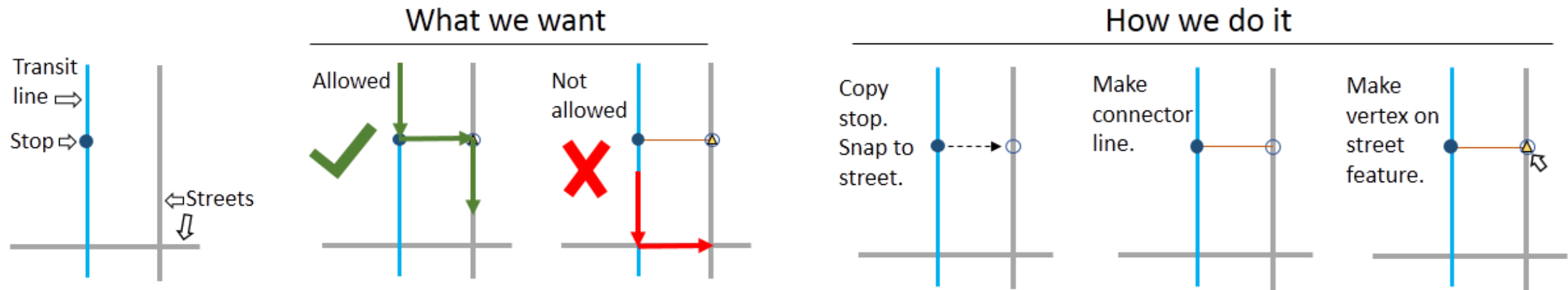
Step 02: Displaying GTFS data in ArcGIS: - Tools used

"Add GTFS to a network dataset.tbx" and "Transit Analysis Tools.tbx"

(<https://github.com/Esri/public-transit-tools/tree/master/add-GTFS-to-a-network-dataset>)

Step 03: Generating feature classes for transit lines and stops and a SQL database of the schedules

Step 04: Creating connector features between the transit lines/stops and other data



Step 05: Creating and configuring network dataset

The Network dataset is created using following feature classes

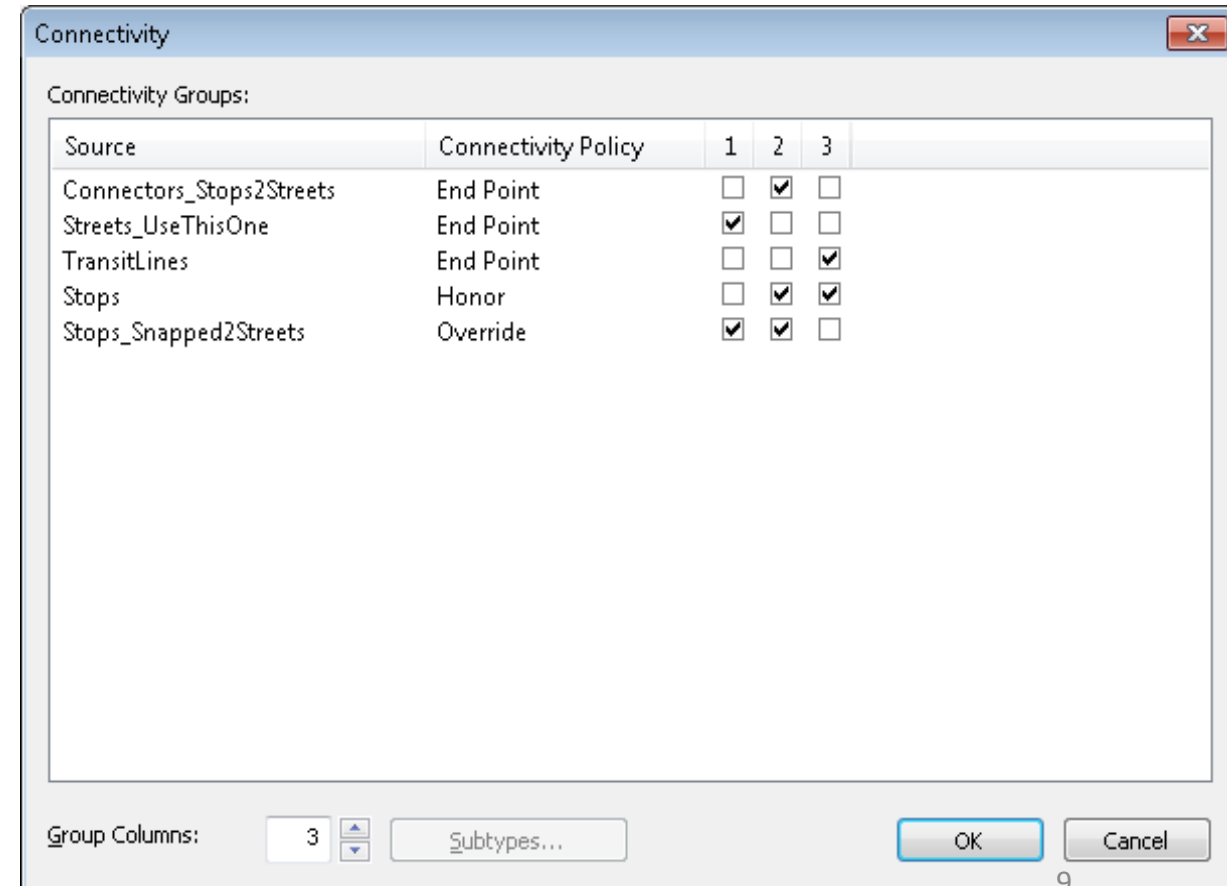
- **Connectors_Stops2Streets**
- **Streets _ Use This One**
- **Transit Lines**
- **Stops**
- **Stops_Snapped2Streets**

Select the feature classes that will participate in the network dataset:

- Connectors_Stops2Streets
- Streets_UseThisOne
- TransitLines
- Stops
- Stops_Snapped2Streets

Access & Egress Time Estimation

- **Walking speed of pedestrians is assumed as 3 miles/hr**
- **30 seconds to get on and get off from the bus**
- **GTFS transit schedules to estimate in-vehicle transit travel time.**
- **Transit trips occur in only one direction along each transit line in this network.**
- **Transit Lines To & From direction entry equal to a constant of -1 is set.**
- **This tells the network that traversal is not allowed in the backwards direction.**



Data and Analysis

- Censuses block has 200 zone in Baltimore City.
- We calculated the Auto Travel Time from each zone to other zones.
- We calculated the Transit Travel Time from each zone to other zones.

$$\textit{Degree of Circuity Ratio} = \frac{\textit{Transit Travel}}{\textit{Auto Travel Time}} \times 100$$

Data and Analysis (High *DOC*)

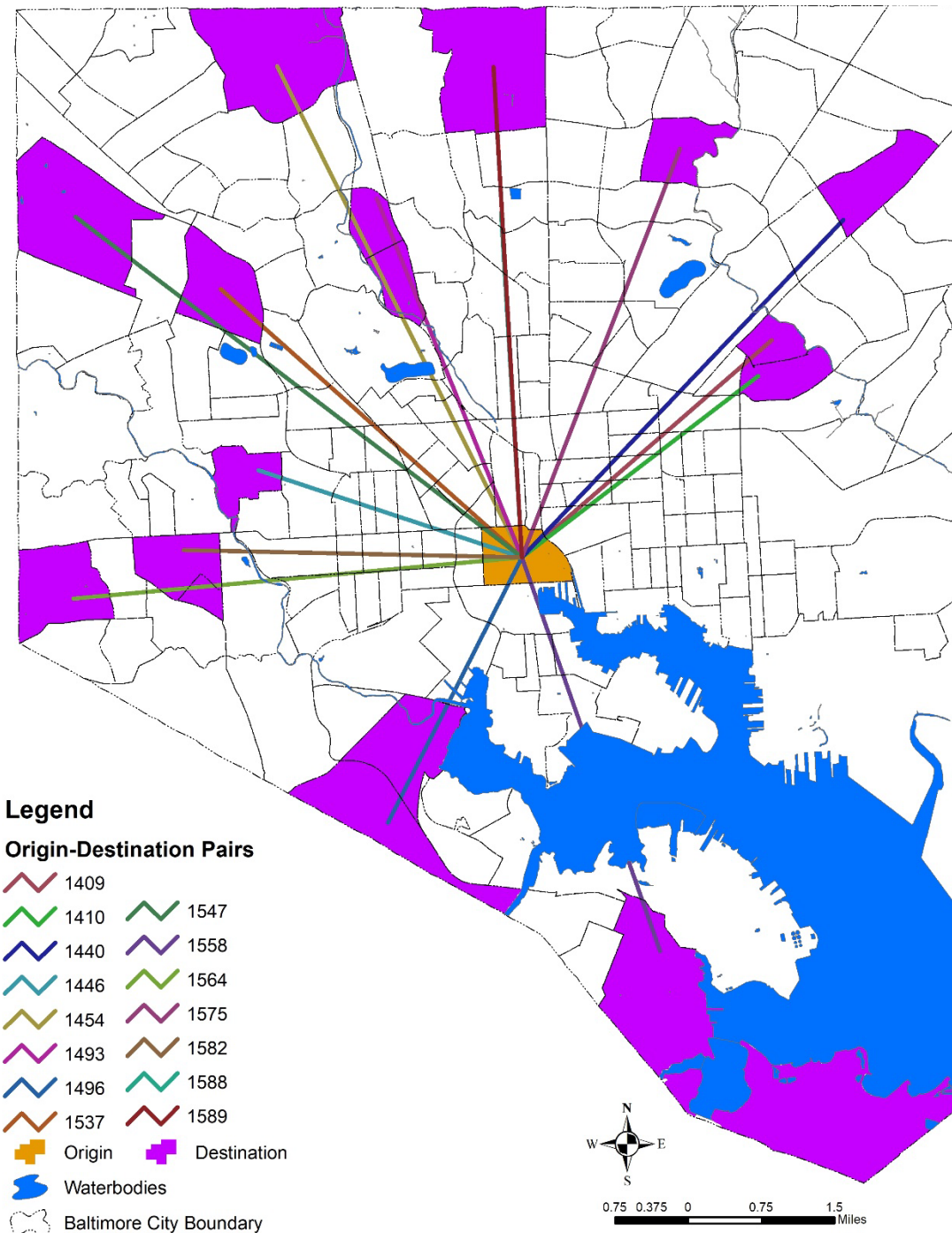
Origin	Destination	Transit Travel Time (minutes)	Auto Travel Time (minutes)	DOC Ratio
14000US24510250500	14000US24510040100	196.86	26.81	7.34
14000US24510280102	14000US24510040100	132.38	18.36	7.21
14000US24510271501	14000US24510040100	132.36	18.20	7.27
14000US24510280403	14000US24510040100	112.47	15.32	7.34
14000US24510151100	14000US24510040100	112.08	15.58	7.19
14000US24510271200	14000US24510040100	109.18	14.29	7.64
14000US24510270401	14000US24510040100	105.30	13.78	7.64
14000US24510270902	14000US24510040100	101.66	14.18	7.17
14000US24510130803	14000US24510040100	86.90	11.82	7.35
14000US24510260301	14000US24510040100	77.95	10.84	7.19
14000US24510200701	14000US24510040100	77.58	10.53	7.37
14000US24510260302	14000US24510040100	76.95	10.07	7.64
14000US24510271102	14000US24510040100	72.88	9.65	7.55
14000US24510160700	14000US24510040100	70.90	9.85	7.19
14000US24510250205	14000US24510040100	68.28	9.36	7.30
14000US24510272003	14000US24510040100	150.95	23.06	6.55
14000US24510270600	14000US24510040100	121.99	17.47	6.98
14000US24510120100	14000US24510040100	99.36	16.17	6.14
14000US24510270903	14000US24510040100	89.01	12.90	6.90
14000US24510260202	14000US24510040100	86.17	12.82	6.72
14000US24510130600	14000US24510040100	64.08	10.05	6.38
14000US24510260900	14000US24510040100	60.59	9.54	6.35

Data and Analysis (High *OD* Demand)

Origin	Destination	OD Trips	Origin	Destination	OD Trips
14000US24510010100	14000US24510040100	339.87	14000US24510240100	14000US24510040100	487.99
14000US24510010400	14000US24510040100	340.13	14000US24510240200	14000US24510040100	475.59
14000US24510020300	14000US24510040100	533.08	14000US24510240300	14000US24510040100	361.66
14000US24510040100	14000US24510040100	592.05	14000US24510240400	14000US24510040100	436.09
14000US24510110100	14000US24510040100	436.61	14000US24510250205	14000US24510040100	320.78
14000US24510110200	14000US24510040100	729.73	14000US24510250500	14000US24510040100	320.72
14000US24510120100	14000US24510040100	340.44	14000US24510260202	14000US24510040100	330.73
14000US24510120202	14000US24510040100	622.83	14000US24510260301	14000US24510040100	322.65
14000US24510120600	14000US24510040100	307.77	14000US24510260302	14000US24510040100	339.07
14000US24510130600	14000US24510040100	342.16	14000US24510260900	14000US24510040100	351.78
14000US24510130803	14000US24510040100	459.82	14000US24510270401	14000US24510040100	300.02
14000US24510140100	14000US24510040100	625.43	14000US24510270600	14000US24510040100	354.46
14000US24510150400	14000US24510040100	347.52	14000US24510270902	14000US24510040100	352.74
14000US24510151100	14000US24510040100	416.11	14000US24510270903	14000US24510040100	408.45
14000US24510160500	14000US24510040100	335.83	14000US24510271102	14000US24510040100	537.11
14000US24510160700	14000US24510040100	351.98	14000US24510271200	14000US24510040100	342.9
14000US24510200701	14000US24510040100	308.51	14000US24510271501	14000US24510040100	422.42
14000US24510210200	14000US24510040100	347.65	14000US24510272003	14000US24510040100	329.93
14000US24510230200	14000US24510040100	374.05	14000US24510280102	14000US24510040100	313.6
14000US24510280403	14000US24510040100	395.66			

DRFT Candidates

: High *OD* Demand
and High *DOC*
with longer than 60
minutes Transit Travel Time

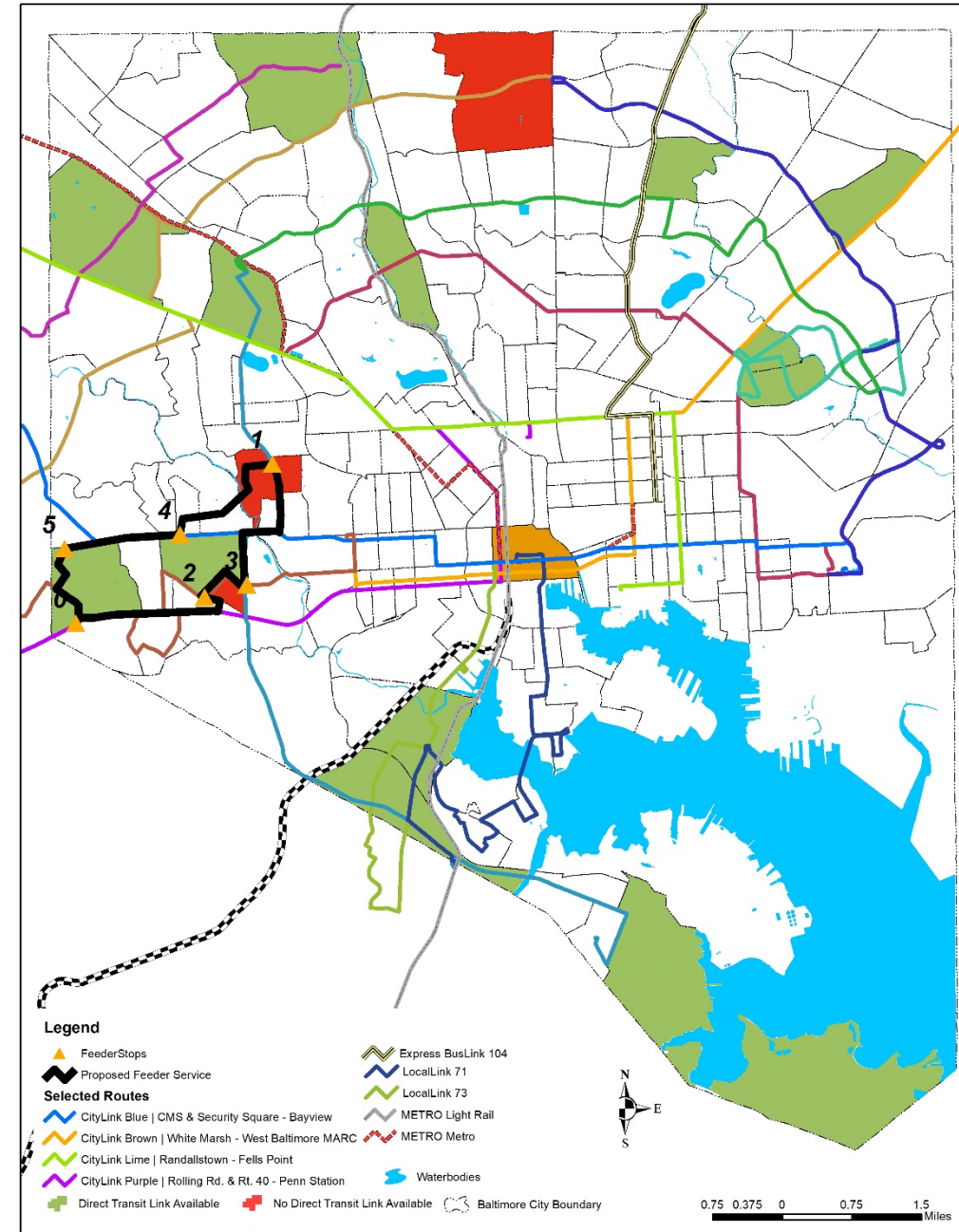
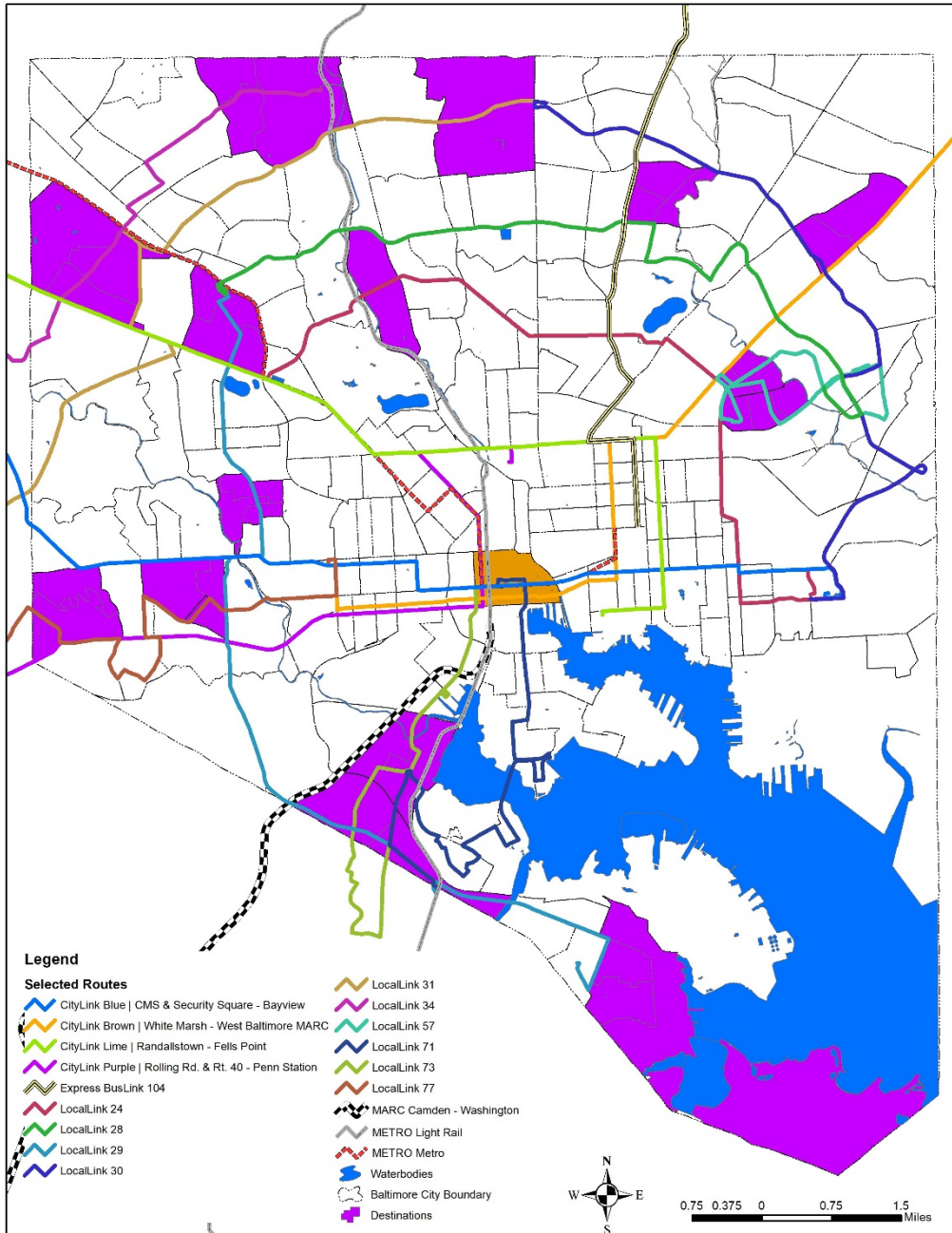


Candidate OD Information



Origin	Destination	OD Trips	TransitTime (minutes)	DriveDistance (miles)	DriveTime (minutes)	Routes Serving
14000US24510250500	14000US24510040100	320.72	196.8620206	9.843101028	26.81445471	CityLink Silver Curtis Bay - Penn Station
14000US24510280102	14000US24510040100	313.6	132.3784953	6.618924767	18.3572362	METRO Metro
14000US24510271501	14000US24510040100	422.42	132.3579554	6.61789777	18.1987231	METRO Light Rail
14000US24510280403	14000US24510040100	395.66	112.470078	5.623503902	15.32242492	No Direct Link
14000US24510151100	14000US24510040100	416.11	112.0803024	5.604015118	15.57988355	METRO Metro
14000US24510271200	14000US24510040100	342.9	109.1750796	5.45875398	14.29201042	No Direct Link
14000US24510270401	14000US24510040100	300.02	105.2975903	5.264879513	13.78441182	CityLink Brown Overlea - West Baltimore MARC
14000US24510270902	14000US24510040100	352.74	101.6627942	5.083139708	14.17906076	CityLink Green Towson - West Baltimore MARC
14000US24510130803	14000US24510040100	459.82	86.89748538	4.344874269	11.82318994	No Direct Link
14000US24510260301	14000US24510040100	322.65	77.95374219	3.89768711	10.84447916	City Link Brown Overlea - West Baltimore MARC, Local Link 71, METRO Light Rail
14000US24510200701	14000US24510040100	308.51	77.58461301	3.879230651	10.52648207	City Link Blue CMS & Security Square - Bayview, Express Bus Link 106
14000US24510260302	14000US24510040100	339.07	76.95326212	3.847663106	10.07388159	CityLink Brown Overlea - West Baltimore MARC
14000US24510271102	14000US24510040100	537.11	72.8841883	3.644209415	9.649365022	No Direct Link
14000US24510160700	14000US24510040100	351.98	70.89925311	3.544962656	9.854032318	No Direct Link
14000US24510250205	14000US24510040100	320.78	68.28130488	3.414065244	9.356375131	Local Link 71, Local Link 73, METRO Light Rail

Existing transit services with Proposed Feeder Transit Service (Example)



Advantages of Proposed Feeder Services

Origin	Destination	OD Trips	Auto Travel Time (mins)	Existing Transit Travel Time (mins)	Feeder Travel Time (mins)	Original DOC	New DOC
14000US24510040100	14000US24510280403	395.66	15.32	112.47	31.72	734%	207%
14000US24510040100	14000US24510200701	308.51	10.53	77.58	30.84	737%	293%
14000US24510040100	14000US24510200702	342.90	14.29	109.18	28.40	764%	199%
14000US24510040100	14000US24510160700	351.98	9.85	70.90	26.16	719%	265%

Conclusion

- **39 ODs were identified with high OD demand (more than 300 trips a day).**
- **22 ODs were identified with high DOC (more than 600 Percentage) and long Transit Travel Time (above 60 mins).**
- **15 candidate ODs (overlapped by two above) were found for Demand Responsive Feeder Transit service.**
- **The transit travel times of existing transit services were more than 60 minutes with higher than 600% DOC, while proposed demand responsive feeder service can save transit travel time by providing the services to the nearest existing transit services (Less than 30 minutes and lower than 300% DOC).**
- **In the future research, sociodemographic inputs will be added to identify candidate ODs.**

Questions?