National Transit Map - United States: Methodology Report

METHODOLOGY REPORT

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CTS 15-12

GLOBAL TRANSIT INNOVATIONS

University of Minnesota

Technical Report Documentation Page

1. Report No.	2.	3. Recipients Accession No.	
CTS 15-12			
4. Title and Subtitle National Transit Map - United States: Methodology Report		5. Report Date December 2015 6.	
7. Author(s) Yingling Fan		8. Performing Organization Report No.	
9. Performing Organization Name and Address Humphrey School of Public Affairs University of Minnesota 301 19th Avenue S Minneapolis, MN 55455		10. Project/Task/Work Unit No. 11. Contract (C) or Grant (G) No.	
12. Sponsoring Organization Name and Address Center for Transportation Studies University of Minnesota 200 Transportation and Safety Building 511 Washington Ave. SE Minneapolis, MN 55455		13. Type of Report and Period Covered Methodology Report 14. Sponsoring Agency Code	
15. Supplementary Notes http://www.cts.umn.edu/Publications/ResearchReports/			
16. Abstract (Limit: 250 words) The National Transit Map – United States describes the availability and performance of transit services in each of the 497 U.S. Census-defined urbanized areas (UZAs) using 2013 data from the U.S. National Transit Database (NTD). Three types of transit availability and performance indicators are visualized in the map: (1) Presence of various transit modes in each UZA; (2) Amount of transit facilities in each UZA (both in total and by mode), including number of transit vehicles operated at maximum service, number of transit stations, and transitway mileage; (3) Annual performance of transit services in each UZA (both in total and by mode), including annual fare revenue earned, annual vehicle revenue miles, and annual unlinked passenger trips. Available online at gti.umn.edu, the map makes NTD data more accessible to researcher communities and the public. People interested in knowing mode-specific transit service availability and performance can explore the map in various ways to examine geographic patterns.			
17. Document Analysis/Descriptors public transit, digital mapping, visualization, urban areas, urban transit, United States		18. Availability Statement No restrictions. Document available from: National Technical Information Services, Alexandria, Virginia 22312	
19. Security Class (this report) Unclassified	20. Security Class (this page) Unclassified	21. No. of Pages 14	22. Price

A Global Transit Innovations (GTI) Data System

NATIONAL TRANSIT MAP – UNITED STATES

Methodology Report

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December 2015

GLOBAL TRANSIT INNOVATIONS

UNIVERSITY OF MINNESOTA

CITATION OF THE NATIONAL TRANSIT MAP – UNITED STATES (U.S.)

Publications and research reports based on the National Transit Map – United States data system must cite it appropriately. The citation should include the following:

> Fan, Yingling. *National Transit Map – United States: A Global Transit Innovations Data System* [Machine-readable database]. Minneapolis: University of Minnesota, 2015.

OVERVIEW

The National Transit Map – United States (U.S.) describes the availability and performance of transit services in each of the 497 U.S. Census-defined urbanized areas (UZAs) using 2013 data from the U.S. National Transit Database. Three types of transit availability and performance indicators are included:

- Presence of various transit modes in each UZA;
- Levels of transit services in each UZA (both in total and by mode), including number of transit vehicles operated at maximum service (VOMS), number of transit stations, and transit way mileage (i.e., track mileage for rail modes and lane/route miles for fixed-route and fixed-schedule non-rail modes); and
- Annual performance of transit services in each UZA (both in total and by mode), including annual fare revenue earned, annual vehicle revenue miles, and annual unlinked passenger trips.

DATA SOURCES

Data used to create the National Transit Map come from the United States National Transit Database (NTD) 2013 data files available at http://www.ntdprogram.gov/ntdprogram/data.htm. The following 2013 data files were used:

- 2013 Agency Information.xls
- 2013 Agency UZAs.xls
- 2013 Agency Mode Service.xls
- 2013 Fare Revenue Earned By Mode.xls
- 2013 Service.xls
- 2013 Transit Station.xls
- 2013 Transit Way Mileage.xls

In addition to the 2013 NTD data files above, 2010 Census data on UZAs were used. Census UZA data are available at http://www.census.gov/geo/reference/ua/urban-rural-2010.html. The following two 2010 Census UZA files were used:

- ua_list_ua.xls (includes population measurement of each UZA)
- tl_2010_us_uac10.zip (ESRI shapefiles describing UZA boundaries)

STUDY AREA

The Census Bureau defines urban area as densely developed residential, commercial, and other nonresidential areas. Census-identified urban areas are further categorized into two types:

- Urbanized Areas (UZAs) of 50,000 or more people; and
- Urban Clusters (UCs) of at least 2,500 and less than 50,000 people.

In the 2010 Census, there were 497 UZAs (including 11 in Puerto Rico) and 3,095 UCs (including 8 in Puerto Rico). These 497 UZAs are the study area of the National Transit Map, as shown in Figure 1. Of the 312 million people in the U.S. in 2010, 80.9% lived in Census-defined urban areas, 71.5% lived in UZAs, and 9.4% lived in UCs. The remaining 19.1% were rural.

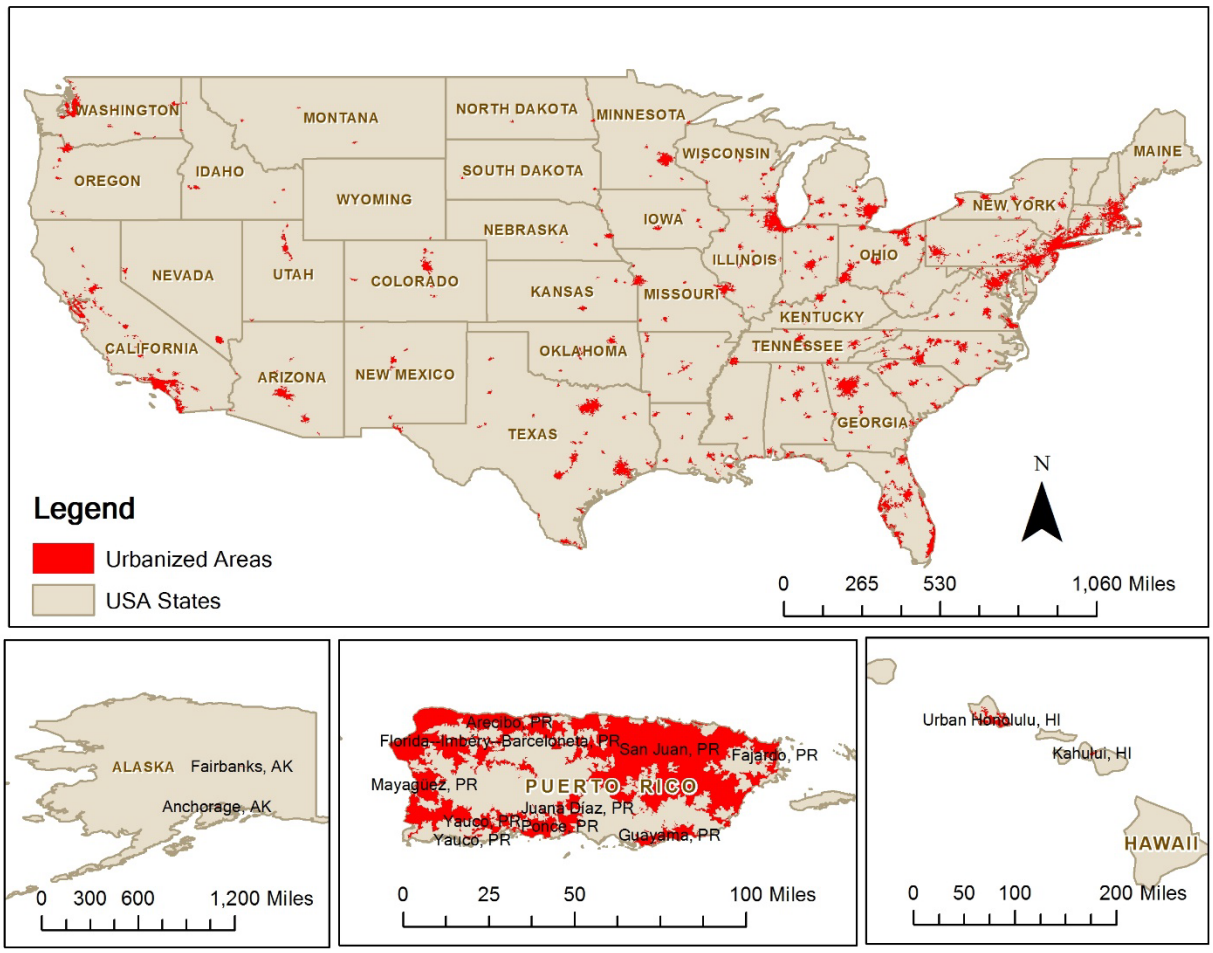

Figure 1: Urbanized areas included in the National Transit Map – United States

MEASURING TRANSIT SERVICES AT THE UZA LEVEL

Because the NTD is designed as a reporting system to help transit agencies submit transit service and safety data, most NTD files are at the agency level. The NTD does have a UZA allocation file in which basic transit service data are summarized to the UZA level. However, the 2013 UZA allocation file only includes total transit service measures and does not include transit service measures by mode or mode presence measures. To generate transit service by mode and mode presence measures, I aggregate agency-level data in the following NTD files to the UZA level.

- 2013 Agency Information.xls
- 2013 Agency Mode Service.xls
- 2013 Fare Revenue Earned By Mode.xls
- 2013 Service.xls
- 2013 Transit Station.xls

- 2013 Transit Way Mileage.xls

Finding a way to accurately aggregate agency-level service data to the UZA level is challenging. The relationship between agency and UZA is many-to-many. In other words, some agencies serve multiple UZAs, and some UZAs are served by multiple agencies. Luckily, for each agency, NTD asks transit providers to indicate the primary UZA of service operations as their "Primary UZA" along with any secondary UZAs. Each agency is allowed to have only one primary UZA, but more than one agency may have the same primary UZA. This makes a one-to-many relationship between primary UZAs and agencies. Based upon this one-to-many relationship, I summarize and aggregate data from the agencies with the same primary UZA to that primary UZA. Such summarization and aggregation avoids the double-counting problem.

Presence of various transit modes in each UZA

The 2013 NTD includes a total of 19 transit modes, of which 9 are rail and 10 are non-rail. The latest, detailed definition of each of the 19 NTD transit modes can be found in the 2014 NTD Policy Manual, available for download at http://www.ntdprogram.gov/ntdprogram/pubs/PolicyManual/2014/2014_Policy_Manual.pdf.

To efficiently map the presence of various transit modes, the 19 NTD transit modes are combined into 8 broader types, as shown in Table 1 below. The combined mode types include five rail modes (commuter rail, heavy rail, light rail, streetcar, and other rail) and three non-rail modes (bus, bus rapid transit, and other non-rail).

Table 1: Combined transit mode types in relation to NTD transit modes

	Combined mode type	NTD transit mode	Abbreviation
Rail	Commuter rail	Commuter rail	CR
	Heavy rail	Heavy rail	HR
	Light rail	Light rail	LR
	Street car rail	Street car rail	SR
	Other rail	Hybrid rail	YR
		Monorail /automated guideway	MG
		Inclined plane	IP
		Alaska railroad	AR
		Cable car	CC
Non-Rail	Bus	Bus	MB
		Trolleybus	TB
		Commuter bus	CB
	Bus rapid transit	Bus rapid transit	RB
	Other non-rail	Demand response	DR
		Demand response - taxi	DT
		Ferryboat	FB
		Publico	PB
		Vanpool	VP
		Aerial tramway	TR

In the 2013 Agency UZAs.xls, there are a total of 1,700 records describing relationships between agencies and UZAs. Of the 1,700 records, 1,234 are associated with UZAs and 466 are associated with non-UZAs. The 1,234 records that are associated with UZAs come from 856 unique agencies, 483 unique UZAs, and 441 unique primary UZAs (one of the primary UZAs is in the Virgin Islands and is later removed from the list). To derive mode presence data for the 440 unique primary UZAs, I first summarize agency-level mode presence using mode presence data in the 2013 Agency Mode Service.xls, and then summarize UZA-level mode presence using agency-level mode presence indicators and the agency-primary UZA relationships. For example, if a primary UZA is served by Agency A and Agency B, all modes provided by Agency A and Agency B will be considered to be present in this primary UZA.

Using the one-to-many relationship between primary UZAs and agencies to generate UZA-level transit service data has limitations. For example, if an agency serves a primary UZA and a secondary UZA, the method I use does not assign the secondary UZA to any mode service data. This problem has led to 42 UZAs in NTD (42= 483 unique UZAs in NTD – 441 unique primary UZAs in NTD) unassigned to any mode service data despite their existence in NTD. To address this limitation, I manually checked mode presence in the 42 UZAs that appeared in NTD yet were not identified as primary UZAs. Mode presence indicators were added to these 42 UZAs based on manual examination results. The 42 UZAs of which mode presence indicators are manually generated are listed below in Table 2.

Table 2: UZAs in NTD but not identified as primary UZAs by any transit agencies

UZA IDs in NTD	Name
77	Ogden-Layton, UT
82	Provo-Orem, UT
87	Murrieta-Temecula-Menifee, CA
117	Kissimmee, FL
130	Round Lake Beach-McHenry-Grayslake, IL-WI
181	Avondale-Goodyear, AZ
188	Salinas, CA
190	Deltona, FL
205	Hemet, CA
216	Nampa, ID
237	Harlingen, TX
263	San Germ¨¢n-Cabo Rojo-Sabana Grande, PR
265	Midland, TX
274	Boulder, CO
277	Kailua (Honolulu County)-Kaneohe, HI
279	Lady Lake-The Villages, FL
280	Dover, DE
303	Gilroy-Morgan Hill, CA
310	Vineland, NJ
320	Longmont, CO
323	Temple, TX
327	Mandeville-Covington, LA
340	Lee's Summit, MO
343	Alton, IL-MO
351	Livermore, CA
356	Juana Díaz, PR
358	Guayama, PR
361	Lafayette-Louisville-Erie, CO
373	Lake Jackson-Angleton, TX
378	Watsonville, CA
415	Zephyrhills, FL
416	Hanover, PA
427	Saratoga Springs, NY
433	Los Lunas, NM
453	Middletown, NY
465	Woodland, CA
470	Titusville, FL
472	East Stroudsburg, PA-NJ
481	Cartersville, GA

482	Arroyo Grande-Grover Beach, CA
490	Monroe, MI
497	Pascagoula, MS

An additional issue about generating mode presence indicators at the UZA level comes from the inconsistency between agencies in reporting their mode services. Some agencies chose not to report any mode services that were not in operation at the time of reporting, yet some agencies chose to report mode services under construction at the time of reporting. For example, agencies in both San Jose, CA, and Urban Honolulu, HI reported having heavy-rail services, yet neither UZA had heavy-rail services in operation in 2013. This problem is illustrated by the fact that some UZAs indicate mode presence in certain categories but have zero values in these categories in terms of transit service measures such as number of transit vehicles operated at maximum service (VOMS), number of transit stations, and transit way mileage. These problematic cases are listed below:

- Urbanized areas indicating BRT presence in 2013 NTD yet having zero values in BRT-related transit services measures:
    - Austin, TX
    - Grand Rapids, MI
    - Lansing, MI
    - Portland, OR-WA
    - Riverside-San Bernardino, CA
    - Salt Lake City-West Valley City, UT
    - San Francisco-Oakland, CA
    - Washington, DC-VA-MD

- Urbanized areas indicating heavy-rail presence in 2013 NTD yet having zero values in heavy-rail-related transit services measures:
    - San Jose, CA
    - Urban Honolulu, HI

- Urbanized areas indicating light-rail presence in 2013 NTD yet having zero values in light-rail-related transit services measures:
    - Tucson, AZ

- Urbanized areas indicating streetcar presence in 2013 NTD yet having zero values in streetcar-related transit services measures:
    - Atlanta, GA
    - Detroit, MI
    - Oklahoma City, OK
    - San Antonio, TX

Levels of transit services in each UZA

Besides the eight mode presence indicators described above, the National Transit Map – United States (U.S.) includes three types of transit facility measures in each UZA: number of transit vehicles operated at maximum service (VOMS), number of transit stations, and transit way mileage. These measures include both the total amount as well as the amounts across the eight mode categories. See Table 3 for the specific measures and data files in the 2013 NTD that were used to generate these measures. Measure definitions are below:

- Vehicles operated in maximum service (VOMS): VOMS is the revenue vehicle count taken during a transit agency's maximum season of the year, on the day of the week that this maximum occurs. It is not taken on a day when a special event or other extreme set of circumstances would cause the resulting tally to represent a onetime event rather than a recurring maximum service requirement.
- Transit Way Mileage: The length of the transit way system. NTD's transit way mileage include all fixed-route and fixed-schedule modes (i.e., track mileage for rail modes and lane/route miles for fixed-route and fixed-schedule non-rail modes).
- Number of Transit stations: The passenger station information is only reported for fixed-route, fixed scheduled services (includes rail modes, bus, commuter bus, bus rapid transit, trolleybus, and ferryboat). More specifically, all rail passenger facilities are stations (except light rail and cable car); all light rail and cable car passenger facilities in a separate right-of-way (ROW) that have platforms are stations; all bus and trolleybus passenger facilities in a separate ROW that have an enclosed structure for passengers for such items as ticketing, information, restrooms, concessions, and telephones are stations; and stops on-street or in medians without separate, enclosed buildings are not stations.

Again, measures at the UZA level are calculated based upon agency-level measures and the one-to-many relationship between primary UZA and agencies. To avoid double counting, all mode services associated with an agency are assigned to the agency's primary UZA only. This leads to the 42 UZAs that appeared in NTD yet were not identified as primary UZAs having zero values on transit facility measures. No manual allocations were used to allocate transit facilities to these 42 UZAs because there are no reliable data or information to make manual allocations. As such, for these 42 UZAs, the National Transit Map will show mode presence but not the amount of transit facilities in these UZAs.

Table 3: Measures on the amount of transit facilities in each UZA and data sources

Measure Types	Measures	Data Sources
# of vehicles operated at maximum services (VOMS)	VOMS_BUS	2013 Agency Mode Service.xls
	VOMS_BRT	
	VOMS_CommuterRail	
	VOMS_HeavyRail	
	VOMS_LightRail	
	VOMS_Streetcar	
	VOMS_OtherRail	
	VOMS_OtherNonRail	
	VOMS_TOTAL	
# of stations	TS_BUS	2013 Transit Station.xls
	TS_BRT	
	TS_CommuterRail	
	TS_HeavyRail	
	TS_LightRail	
	TS_Streetcar	
	TS_OtherRail	
	TS_OtherNonRail	
	TS_TOTAL	
Transit Way Mileage	TWM_BUS	2013 Transit Way Mileage.xls
	TWM_BRT	
	TWM_CommuterRail	
	TWM_HeavyRail	
	TWM_LightRail	
	TWM_Streetcar	
	TWM_OtherRail	
	TWM_OtherNonRail	
	TWM_TOTAL	

Annual performance of transit services in each UZA

The annual preference measures of transit services in the National Transit Map – United States (U.S.) include annual fare revenue earned, annual vehicle revenue miles, and annual unlinked passenger trips. These measures include both the total amount as well as the amounts across the eight mode categories. See Table 4 for the specific measures and data files in the 2013 NTD that were used to generate these measures. Measure definitions are below:

- Fare Revenue Earned: All income received directly from passengers, paid either in cash or through pre-paid tickets, passes, etc. It includes donations from those passengers who donate money on the vehicle. It includes the reduced fares paid by passengers in a user-side subsidy arrangement.
- Vehicle Revenue Miles: The miles that vehicles travel while in revenue service. The measure excludes miles that vehicles travel for deadhead services (leaving or returning to the garage or yard facility, changing routes, or when there is no expectation of carrying

revenue passengers), operator training, maintenance testing, and school bus and charter services.

- Unlinked Passenger Trips: The number of passengers who board public transportation vehicles. Passengers are counted each time they board vehicles no matter how many vehicles they use to travel from their origin to their destination.

Table 4: Measures on the annual performance of transit services in each UZA and data sources

Measure Types	Measures	Data Sources
Fare Revenues Earned ($)	FRE_BUS	2013 Fare Revenue Earned By Mode.xls
	FRE_BRT	
	FRE_CommuterRail	
	FRE_HeavyRail	
	FRE_LightRail	
	FRE_Streetcar	
	FRE_OtherRail	
	FRE_OtherNonRail	
	FRE_TOTAL	
Vehicle Revenue Miles	VRM_BUS	2013 Service.xls
	VRM_BRT	
	VRM_CommuterRail	
	VRM_HeavyRail	
	VRM_LightRail	
	VRM_Streetcar	
	VRM_OtherRail	
	VRM_OtherNonRail	
	VRM_TOTAL	
Unlinked Passenger Trips	UPT_BUS	2013 Service.xls
	UPT_BRT	
	UPT_CommuterRail	
	UPT_HeavyRail	
	UPT_LightRail	
	UPT_Streetcar	
	UPT_OtherRail	
	UPT_OtherNonRail	
	UPT_TOTAL	

Again, measures at the UZA level are calculated based upon agency-level measures and the one-to-many relationship between primary UZA and agencies. Similar to measures of transit facilities, no manual allocations were used to allocate annual performance data to the 42 UZAs that appeared in NTD but were not identified as primary UZAs by any transit agencies.

CONCLUDING REMARKS

The purpose of developing the National Transit Map – United States (U.S.) is to make the NTD data more accessible to researcher communities and the public. Spatial visualization of transit service measures by UZA also helps people understand geographic disparities in transit services across the U.S. As shown in Figure 2 below, people who are interested in knowing mode-specific transit service availability and performance can explore the map in various way to examine the geographic patterns.

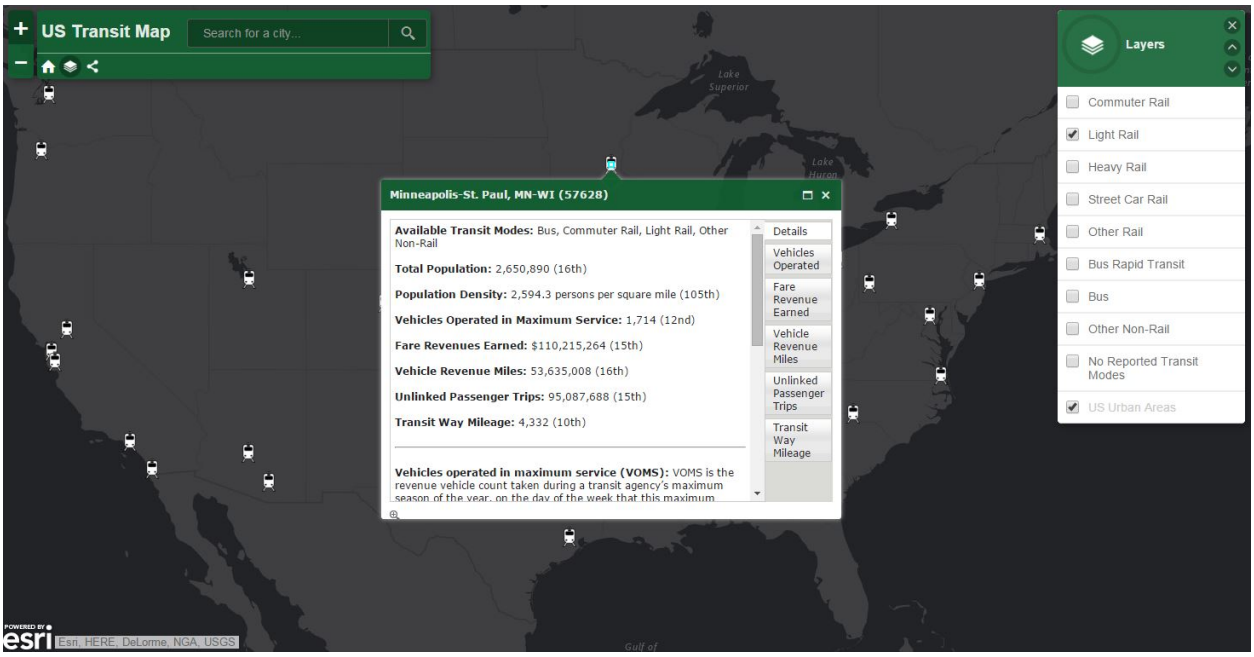

Figure 2: A screenshot of the National Transit Map – United States (U.S.) indicating UZAs with light rail services and indicating transit service measures in the Minneapolis-St. Paul area

Along with the National Transit Map – United States (U.S.), this mapping project makes available the compiled dataset that describes UZA-level transit mode availability and service performance. This dataset and the associated data dictionary are available for download at http://gti.umn.edu/data/.

The dataset can be further used by researcher communities and the public to understand relationships between UZA characteristics and transit service attributes. For example, Figure 3 below illustrates a positive relationship between UZA population size and the presence of rail transit services. In addition, Figure 3 provides information on cities that are exceptions to this general positive relationship. Detroit, MI, Tampa, FL, and Salt Lake City, UT, are three extreme cases: Detroit and Tampa both have a large population size yet relatively small percentage of rail services; Salt Lake City has a moderate population size yet relatively large percentage of rail services. The type of data and visualization are likely to stimulate and renew interest in identifying underlying factors at the UZA level that influence transit service availability and performance.

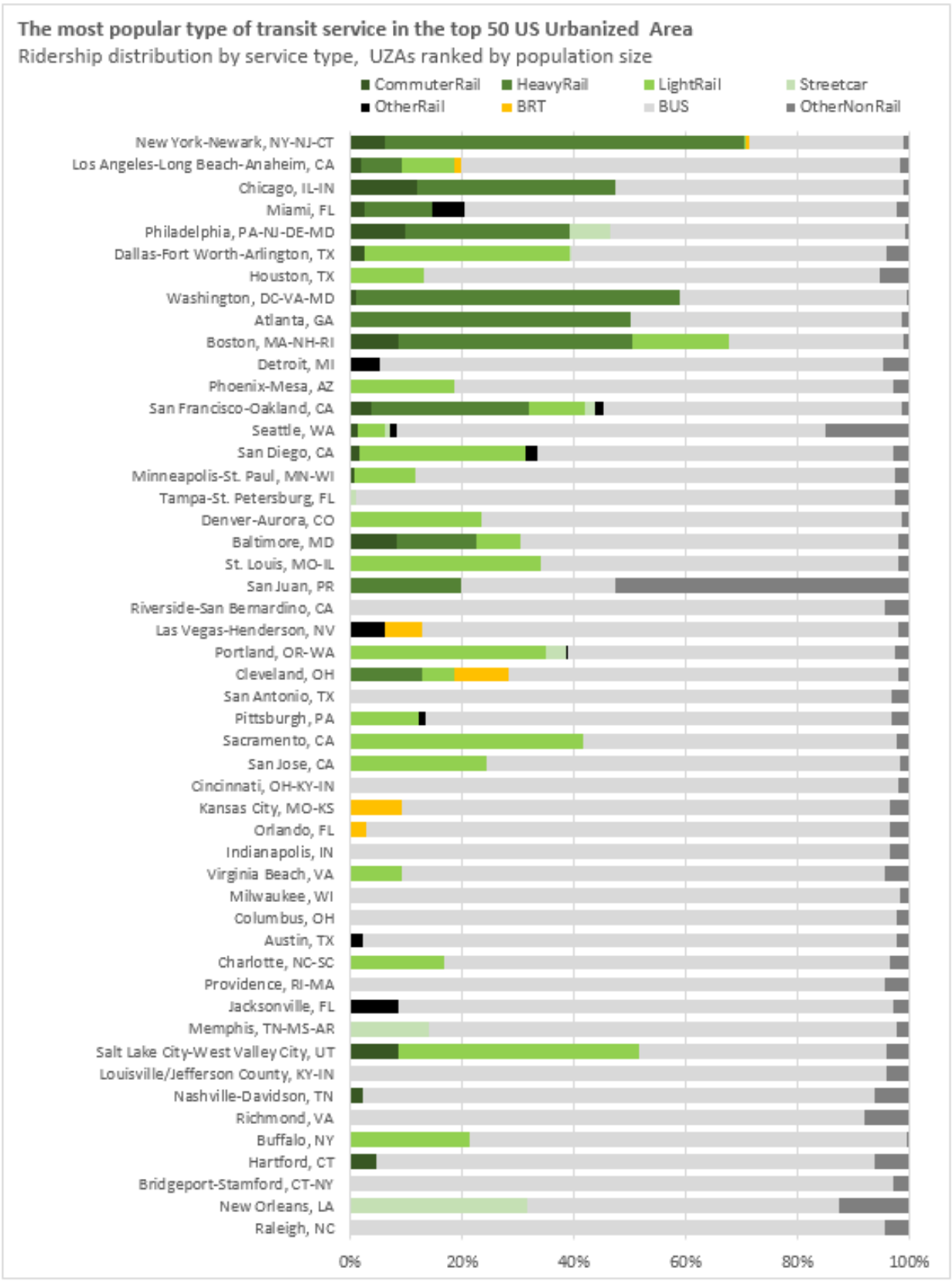

Figure 3: Ridership distribution by transit mode in top 50 U.S. urbanized areas