Thank you Ed...
I want to start off by saying that this conference and this panel session is particularly interesting to me because we’re working in a time when people are thinking about the metrics by which we measure the performance of our transportation system.

This is in part because of the performance-measure requirements in the latest federal transportation-funding bill, MAP-21. As Peter Drucker, the management consultant said, “what gets measured gets managed.” In other words, the metrics that we’re developing and questioning promise to have great impact on the way that we provide transportation.

I want to share with you some concepts for expanding on the method for calculating service coverage.

This work came out of my time as a board member of Ride New Orleans, which is a transit advocacy and outreach organization serving the Greater New Orleans region. I think that service coverage is of particular importance for advocacy groups, since public debate about how to allocate funding for transit often involves tradeoffs between transit coverage and frequency.
In these kinds of debates, advocacy organizations want to be able to contribute independent analysis. However, these groups usually do not have access to highly sophisticated analytical tools.

The work that I am showing you today is an exploration of new methods for analyzing service coverage with minimal resources.

The key to our work is data from the Longitudinal Employer-Household Dynamics program. This program, which many of you are probably aware, is based on federal and state employment-insurance administrative data. Among others, the LEHD program produces an annual data set which provides information about the connections between where people live and where they work.
As with any data set, the LEHD data offers strengths and weaknesses in comparison to other datasets, as you can see on this slide. It offers origin and destination information, it’s free to download and use, and it offers data at the level of the Census Block.

The weaknesses include the fact that the data set provides no trip characteristics, unlike the Census Transportation Planning Package. Also, it excludes some categories of employees, and there are known inaccuracies that sometimes occur in the geographic assignment of work sites.

With these characteristics in mind, however, researchers, including many at this conference, have been using LEHD data for transportation and transit purposes for a few years now.

**Longitudinal Employer-Household Dynamics (LEHD) Data**

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
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<tr>
<td>• Origin and destination</td>
<td>• No trip characteristics.</td>
</tr>
<tr>
<td>• Free of charge</td>
<td>• Excludes some kinds of employment.</td>
</tr>
<tr>
<td>• High degree of geographic detail</td>
<td>• Some known inaccuracies in places of work</td>
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The context for our work is New Orleans, shown on this map in dark grey. New Orleans is a city that, in 2012, was home to approximately 370,000 people.

For those of you who are unfamiliar with the geography, most of the city is wedged between Lake Pontchartrain to the north and the Mississippi River to the south. The densest and oldest parts of the city are those along the river.

By the way, New Orleans is co-terminus with Orleans Parish, and you may hear me use those interchangeably.
At the time of study, The New Orleans Regional Transit Authority or NORTA provided 31 bus lines and four streetcar lines. In 2012, NORTA streetcars and buses served 16.4 million boardings.

Ridership has been increasing rapidly over the past few years as population has returned to the city following Hurricane Katrina, and the system has rebuilt its operations with extensive federal help.
This map describes the RTA system in 2012. Though the city’s streetcars are certainly more famous, you can see from this map that, in terms of miles, most of the system is bus.

Jefferson Transit, which serves the parish to the south and west, has a few routes that serve the central business district, but those are not shown here. The RTA also has one route that serves that City of Kenner, to the west, but which does not serve Orleans Parish.

All routes, except the Riverfront Streetcar, which is the blue line right along the west bank of the Mississippi River, either run in mixed traffic or on rails in the medians of boulevards.
Analysis inputs

DATA
- Census 2010 block-group geography from the New Orleans Regional Planning Commission
- NORTA GTFS from March 12th, 2012
- ESRI StreetMap USA network dataset provided with ArcGIS Desktop 10

SOFTWARE
- ArcGIS Desktop 10, ArcEditor license and Network Analyst Extension
- Microsoft Access 2010
- Microsoft Excel 2010

Here you see the data inputs and software that we used for our analysis. Note that our information about the RTA system comes from the agency’s publicly available general transit feed specification files, which are great to have as a free, public resource.
As many of you know, the *Transit Capacity and Quality of Service Manual*, which I will refer to as the Manual, provides a back-of-the-envelope “Planning Methodology” that, allows an analyst—with a relatively small amount of data and relatively little time—to see how well a transit system covers its service area as a whole and find specific areas where gaps are present.

This kind of tool or method is a good starting point for an advocacy group that wants to quantitatively evaluate a transit system but which doesn’t have extensive technical resources.

Here, I will provide a description of the Manual’s methodology in New Orleans.
In the *Manual*’s planning methodology, we first find the areas in the city that are “transit-supportive” in terms of housing and job density. The manual sets a minimum of four jobs per gross acre and three dwelling units per acre in order to count as transit supportive.

Densities reach as high as 25 dwelling units per acre in the French Quarter, though the city average is 6. The highest job density is 157 jobs per acre in the central business district, while the average is about 3.

This map describes all of the Census block groups that meet the definition of transit-supportive. The block groups in yellow are neighborhoods where housing meets the “transit-supportive” density threshold. The red areas are where jobs meet the density threshold. And the blue areas are where both housing and job density meet the density threshold.

It is these neighborhoods that are of concern for us in the *Manual*’s planning methodology.
This map describes the second step of the Manual’s planning methodology. Here, in green, we have the areas of Orleans Parish that are within a quarter-mile of a transit stop. What we want to know is how much of the transit-supportive block groups from the last map fall within the transit access sheds seen here.

Note that we used quarter-mile buffers for the RTA streetcar network, even though the Manual recommends a half-mile distance for rail stops. We did this because the New Orleans streetcar system has design and operating characteristics that make it more like a local bus than a rail rapid-transit system. We included only the RTA system, primarily because Jefferson Transit did not offer a GTFS feed at the time of our analysis, and because the system is limited in Orleans Parish.
When we put the two maps together, we see that the transit sheds do cover the majority of transit-supportive block groups in Orleans Parish, which should result in a very high service-coverage rating for RTA service in Orleans Parish.
When we divide the land area of the transit-supportive block groups, seen in the second column, by the area of those block groups that fall under the transit sheds, seen in the third column, we find that the New Orleans Regional Transit Authority (RTA) provides coverage to nearly 89.8% of the land in Orleans Parish that the Manual deems “transit-supportive,” as seen in the fourth column.
As you can see in this first table, the 89.8% figure gives the RTA a high “B” service-coverage LOS on the Manual’s A-to-F scale.

In the second table, we also have the rating that the RTA system would get based on the new, third Edition Manual. The third edition gives a rating both from the perspective of the passenger and the transit operator.

So as I said, these calculations are relatively easy to produce. Especially with the availability of LEHD data for providing job density values and GTFS feeds, which can quickly provide us with the locations of stops and routes for measuring coverage.

Yet this method is not based on actual trip demand. It is based on land use, and it takes for granted that covering transit-supportive neighborhoods actually serves the travel needs of the population.
Here, we present a method that uses LEHD and GTFS data that determines service coverage not based on jobs or housing density, but on the home and work locations of individuals. This diagram explains that method graphically.

As you see here, we can use the same transit access sheds, shown in green, and lay them on top of commute origins and destinations. On the left side, we see a case where the transit shed touches both the commute origin and commute destination. Here we can say that the commute is covered by the transit system. On the right-hand side, we can see that transit shed touches only the origin or home location, not the destination or workplace location. Therefore, this commute is not covered.
When we overlay the same transit sheds that I showed you a few slides ago on top of the commute origin-destination pairs from the LEHD data, we find that the RTA system covers a large share of commutes in Orleans Parish.

As you see here, the green RTA transit sheds connect nearly 55,000 of the commutes between home and work locations within Orleans Parish. That’s 81.2% of all commutes.

If we limit ourselves to commutes between transit-supportive home and work locations, the block groups in yellow, red and blue from the earlier slide, we find that the transit sheds connect nearly 47,000 or 89.7% of commutes.

Now it is interesting that the share of transit-supportive land covered by RTA service, 89.8%, that we found with the Manual’s planning methodology is numerically similar to the 89.7% of commutes covered or connected according to the calculation seen here. However, this is not enough to conclude that the two methods are more-or-less equivalent.

What I think we can conclude, however, is that the RTA system provides a high level of service coverage.

This is valuable information to have in New Orleans, because it verifies what the RTA has
been saying publicly about the system in Orleans Parish, which is that service covers pretty much every part of the city.

As an advocacy group, Ride New Orleans can take this information to public meetings and discussions with neighborhood groups, in order to focus conversation on prioritizing new investment towards service frequency instead of service coverage.
We also wanted to explore how we might use the LEHD data to create a service-coverage methodology that connects transit sheds not only to home and work locations, but also routes between home and work.

This diagram again explains our method graphically. We compare the transit sheds, in green, to the purple routes between origin and destination pairs. On the left-hand side, we see a path that falls completely within the service shed. This means that the route is covered by transit. On the right-hand side, we see a path that only partially falls under the transit shed, so it is not covered.

Now, given that the LODES dataset does not contain information about the routes taken to travel between home and work, this method relies on paths generated through network analysis that searches for the shortest (in terms of travel time) route on the road network.

Such a method adds a new dimension to service coverage calculations by adding information about the efficiency or directness with which transit service is able to carry travelers from home to work.
In this map, the purple lines are the shortest paths between each home origin and work destination described in the LEHD data set for Orleans Parish. There are nearly 25,000 unique routes that each connect between 1 and 438 commutes.

From here, our method overlays the green access sheds on top of the routes to determine how many commute routes fall within the RTA access shed.

Unfortunately, we quickly discovered that we need to further refine this method before we can use it as a robust measure of service coverage.
To see what I mean, let’s look at this example. The Block Group shown here in pink has a density of close to 4.2 jobs per gross acre, which is near the minimum for qualification as “transit-supportive.”

It is the origin and destination of 847 commutes that extend across Orleans Parish, as shown as the lines in purple.
As this slide illustrates, though a large portion of the Block Group itself is not within the green quarter-mile RTA buffer, most of the commute routes appear to be.

However, when we applied the selection method to these routes, none were found to be completely within the RTA service area. Why is that?
The network analysis that we used to create our commute routes calculates paths from the centroids of each Block Group. The centroid of this block group is the black dot in the middle of the screen.

In order to create paths, ArcGIS Network Analyst must first assign the centroid to a position on the network. Based on our input parameters, the software simply located the centroid at the point along the street network that is closest to the object. Which I’ve illustrated here with the arrow that points west towards Jourdan Road.

This section of Jourdan Road is outside of the RTA service-area buffer, in green here again. As such, it was impossible for Network Analyst to generate any routes that would have been completely within the service buffer.

Now, in theory, if all of the jobs and homes in this Census Block were located along Jourdan Road, then it would be realistic to say that none of the commutes in and out of this Block Group should be counted as covered by the RTA system.
Yet a quick look at satellite imagery of the area indicates that the jobs and homes in this Block Group are not located at that point on Jourdan Road. You can see the majority of buildings are at the northern end of the block group, and that the homes are to the southwest.
Future Work

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<thead>
<tr>
<th>Fixes to Route-Based Method</th>
<th>Other Issues</th>
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<tr>
<td>• Smaller geographies.</td>
<td>• Relationship between the TCQSM method and the origin-destination-based method.</td>
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<tr>
<td>• Use Block-level geography to define weighted centroids.</td>
<td>• Utility of our alternative methods.</td>
</tr>
<tr>
<td>• Run multiple iterations of the method based on random points within each Block Group.</td>
<td>• Comparing subway/other transit service with paths on the surface street network?</td>
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There are a few technical solutions that immediately come to mind for fixing the problems encountered with our second method, which I have listed here. We could use smaller geographies. The LEHD origin-destination data is available at the Census Block level, and by reducing the extent of each geographic unit, we could maximize the chance that a given area’s centroid would be close to the actual location of the housing or jobs.

Alternatively, we could use Block-level data to find centroids within each block group that are weighted by the concentration of housing and jobs.

Finally, we could run multiple iterations of the method based on random points created within each Block Group. Without knowing more about the location of jobs or housing within each Block Group, any point within the Block Group is equally valid for describing the Block Group’s location on the street network. Therefore, we could generate, say, ten random points within each Block Group and then conduct our method on the resulting 100 combinations for each OD pair; we could then select the mean values of routes and commutes covered from all combinations of points for each origin-destination pair. The major drawback to this method is the extra processing time required.
There are other areas for research that come out of what I have shown you here today, which I’ve listed on the right.

We would like to assess the relationship between the results of the *Manual’s* land-density-based service coverage method, and our method that used origin-destination pairs to evaluate coverage.

As we saw, the results of the two methods were numerically similar, but we would like to look at other cities or transit-service areas, and across time periods in order to see how the two methods track with each other.

If they track together neatly, then we could say that the original land-use-density method does an excellent job of capturing commute coverage on its own, without resorting to data on origins and destinations.

However, even if they do track together, there are unique uses for our origin-destination method that we would like to explore. For example, we could use the LEHD data to explore equity issues in transit service coverage. The dataset contains information on monthly income for each OD pair, and one could quickly compare, using our methods, the coverage of a transit system for commutes made by low-income people with coverage of commutes made by high-income people.

The data also has information about the age of commuters, and so we could evaluate differences in service coverage between different age groups.

Finally, even with the fixes to our route-based methodology that I’ve listed on the left, we would need to consider how such a method might be used in other cities, where transit service is provided below ground or in completely separated rights of way. Would it be possible or meaningful to compare this kind of transit service with shortest-distance paths on the surface-street network?
With that, I will conclude and say that I am happy to share these experiments with you and to participate in ongoing discussions of how we can advance system-performance measures for transit. I encourage all of us to engage with the advocacy community in our work as well, because I believe that they are interested in participating in these conversations.

I also want to thank our partners on this work. Particularly the executive director of Ride New Orleans, Rachel Heiligman. The University of New Orleans Transportation Institute for funding this work, the Greater New Orleans Community Data Center for providing feedback on drafts, and for my current employer, Mobility Lab, which made it possible for me to be here today.

I look forward to your questions.