Presentation outline

GIRO at a glance
LA Metro's NextGen project
Methodology
Data requirements
Notes on the algorithm
Some results
Conclusion
GIRO at a glance

Established in 1979
Based in Montréal
500+ employees

Integrated software solutions for planning & managing transport-related operations

Public transport (HASTUS & HASTUS-Rail)
On-demand services (HASTUS-OnDemand)
Postal service (GeoRoute)
Our global market presence

300 sites/27 countries
Los Angeles, Montréal, New York, Paris, Stockholm, Singapore, Sydney & more

Global & local organizations
Arriva, Keolis, Transdev & more
LA Metro's NextGen Project

2018, LA Metro decided to redesign & improve its transit network
GIRO involved in partnership to develop a new Pax Assignment Tool

So, what is the NextGen Bus Study?

Metro is designing a modern, more useful bus network. It's time for a better bus system that fits your lifestyle, integrates with all the ways you travel throughout LA County, and gets you where you need and want to go, with flexibility for the future.

The objective of the bus study is to:

• Understand transit market demand in LA County
• Study the agency’s current bus system and how well it serves current and potential customers
• Recommend how best to reimage the system to be more relevant to what people need today
General methodology

Supply
- HASTUS schedules
- GTFS

Demand
- Travel survey
- Smart card
- Location-based services

Census data
- Accessibility measures

Complete timetable
- Planned passing times

Possible paths tree (timetable based)

Trip assignment

Passenger OD version

- Project benefits
- Resource allocation
- PAX experience

Vehicle crowding

Passenger loads

Traveler itineraries
General methodology

Schedule-based simulation of a transit trip

<table>
<thead>
<tr>
<th>Time</th>
<th>07:30</th>
<th>07:34</th>
<th>07:36</th>
<th>07:50</th>
<th>07:53</th>
<th>07:58</th>
<th>08:12</th>
<th>08:18</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Departure</td>
<td>First boarding</td>
<td>First alighting</td>
<td>Second boarding</td>
<td>Second alighting</td>
<td>Arrival</td>
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<tr>
<td>Origin</td>
<td>Transit stop</td>
<td>Vehicle</td>
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<td>Vehicle</td>
<td>Transit stop</td>
<td>Destination</td>
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<td></td>
<td>Initial walk</td>
<td>Initial wait</td>
<td>Transfer walk</td>
<td>Transfer wait</td>
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<td>Egress walk</td>
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Data requirements

Supply (infrastructure & service)
Street network & pedestrian access points at terminals (for walk paths)
Timetables
  • Passing times at each stop for each vehicle trip
  • 2 possible sources: HASTUS schedules or GTFS

Travel demand
Trips between origins & destinations at specific times

Sources of data
Household travel surveys
On-board surveys
Smart cards
Cell phones
...
Data requirements

**Typical patterns of transit travel demand**
- Concentrated in peak periods
- Oriented toward the CBD
Data requirements

Structure of input travel demand can have 2 forms

**Time-sliced OD matrix**
- Requires a zone system (potentially biased)
- Spatially & temporally aggregated
- Cannot be used to simulate trips within same zone
- Inefficient for storing information (more cells than trips!)

**Trip-table**
- Spatially & temporally disaggregate (no zones or time slices)
- Each record is a trip rather than an OD pair
- File size is directly proportional to number of trips
Data requirements

LA Metro case study: raw smart card data vs. aggregated smart card data

**Aggregated (tdxt)** – zone-based matrix for an average day using 6 months of observations (~ 3,000 zones, 20-minute time slices)
- 7,625,260 OD pairs (63,007 intrazonal)  |  859,096 trips (29,707 intrazonal)

**Raw (t3m)** – trip table derived from fare validations on a specific day (no zones, no time slices)
- 258,839 OD pairs  |  542,292 trips
Minimum-(generalized) cost travel times computed from origin to all destination stops (+ egress walk) within a specified maximum (e.g. 60 minutes)

Resulting isochrones can generate accessibility indicators (number of opportunities or characteristics of populations)
Algorithm notes

Calibration parameters

User-specified weights can be applied on:
- Initial wait
- Access & egress walk
- Transfer wait & walk
- In-vehicle time

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Algorithm notes

Other simulation parameters
- Max total trip duration
- Max total transfers per trip
- Max access/egress/transfer walk duration
- Max transfer wait duration
- Calculation of initial wait time (headway or schedule)
- Shortest path time step

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Algorithm notes

**LA Metro case study**

Dimensions of problem:
- 7.6 million OD pairs
- 142 routes
- 901,157 stop times
- 15,968 vehicle trips
- Road network: 624,287 street segments
Example calibration methodology (LA Metro case study)

- Tapcard data (with origin, destination & used route sequence)
- CIS (Passenger assignment)
- Observed paths
- Simulated paths
- Observed ridership
- Simulated ridership
- Path-level calibration
- Rider-level calibration

Criteria version

Calibration
Algorithm notes

LA Metro example result (route-level calibration)

Morning peak period ridership by route (excluding metro routes)

AM Peak Period Ridership (excluding Metro)
OD pairs can be colored based on the CIS results

Example of a OD pairs colored by best path duration

<table>
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<tr>
<th>Count</th>
<th>Paed total real dur</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>[0h10.0h15]</td>
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<tr>
<td>1</td>
<td>[0h20.0h25]</td>
</tr>
<tr>
<td>1</td>
<td>[0h30.0h35]</td>
</tr>
<tr>
<td>2</td>
<td>[0h40.0h45]</td>
</tr>
<tr>
<td>1</td>
<td>[0h50.0h55]</td>
</tr>
<tr>
<td>3</td>
<td>[1h05.1h10]</td>
</tr>
<tr>
<td>1</td>
<td>[1h20.1h25]</td>
</tr>
<tr>
<td>1</td>
<td>[1h25.1h30]</td>
</tr>
<tr>
<td>6</td>
<td>[1h30.1h35]</td>
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</table>
Passenger loads on each route segment can be visualized within HASTUS.
Planners can compare forecasted ridership to planned service levels & detect routes that may experience overloads – By route segment
Planners can compare forecasted ridership to planned service levels & detect routes that may experience overloads – By vehicle trip

Example of a route crowding view, in HASTUS
Detailed load profiles can be generated in Excel directly from HASTUS.
Output results

Animation of boardings in Excel using an automatically-generated text file
Output results

**BI Dashboards**

Provide metrics & visuals to facilitate comparisons between scenarios

**Customer Impact Simulator (CIS) - Overview**

- **Total Pax**: 856,534
- **Assigned**: 789,946
  - 599,537 Not impacted
  - 187,719 Impacted
  - 2,690 Newly covered
- **Unassigned**: 66,588
  - 30,444 Lost passenger
  - 36,144 Always unassigned

**Total demand per period**

- **Total Pax**: 8,525
- **Early AM**: 31,755
- **AM peak**: 193,367
- **Midday**: 269,176
- **PM peak**: 272,915
- **PM peak**: 80,795

**Passenger distribution by category and period**

**Demand by origin region**

**Demand by destination region**
Output results

**BI Dashboards**

Provide metrics & visuals to facilitate comparisons between scenarios

**Customer Impact Simulator (CIS) - Travel time impact**

Origin Region:
- 84,123 Advantaged
- 2,206,727 Total min gained
- 26 Min / Advantaged

Destination Region:
- 103,596 Penalized
- 4,415,658 Total min lost
- 43 Min / Penalized

Passenger distribution by travel time impact (in minutes):
- 9,112 (6.85%)
- 6,655 (26.32%)
- 11,364 (6.05%)
- 29,356 (15.64%)
- 29,441 (15.68%)
- 29,794 (13.65%)

Total Impacted: 187,719

Passenger distribution by time period and travel time impact (in minutes):
- [0-5](Min) - [5-10](Min) - [10-15](Min) - [15-20](Min) - [20-25](Min) - [25-30](Min)
BI Dashboards
Provide metrics & visuals to facilitate comparisons between scenarios

Customer Impact Simulation (CIS) - Regional distribution of impact by travel step

Select a travel step and travel time impact bracket(s) to view geographic distribution of impacted passengers. OR select an origin or a destination region to view the impacted passengers by travel step for that region. Note that passengers are accounted for in each travel step used and more than one travel time impact bracket in the travel step can be selected simultaneously.
Output results

BI Dashboards
Provide metrics & visuals to facilitate comparisons between scenarios

Customer Impact Simulation (CIS) - Travel time impact by travel step and time of day

- Average travel time impact by origin area
- Average travel time impact by destination area

<table>
<thead>
<tr>
<th>Travel step</th>
<th>O Bus</th>
<th>O Initial wait</th>
<th>O Initial walk</th>
<th>O Metro</th>
<th>O Other wait</th>
<th>O Other walk</th>
<th>O Total</th>
<th>O Train</th>
<th>O Tram</th>
</tr>
</thead>
</table>

- Assigned who's taking the selected travel step
  - 2,232 Advantaged
  - 55,848 Total min gained

- Impacted passengers
  - 5,458 Penalized
  - 333,506 Total min lost

- Most advantaged for total duration
  - CO Key: 101, 126, 160, 195, 230, 265
  - Scenario duration: 10, 11, 12, 13, 14, 15
  - Diff duration: 1, 2, 3, 4, 5, 6
  - Impacted: 0.001, 0.002, 0.003, 0.004, 0.005, 0.006
  - Weighted Impact: 0.007, 0.008, 0.009, 0.010, 0.011, 0.012

- Most penalized for total duration
  - CO Key: 101, 126, 160, 195, 230, 265
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Conclusions & future work

Data can help improve transit planning
- Demand can be extracted from AFC & cellular data
- AFC data can help pax assignment calibration

Once a model has been calibrated
- Different scenarios can be simulated & evaluated

Integration with a scheduling software is valuable
- Operating costs can be taken into account

Thanks to LA Metro
Thanks

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Always moving forward - together