

Network Design for Two-Day E-Commerce Fulfillment

Motivation

14% E-commerce vs retail	E-commerce represents 14% of total retail sales in the US in 2020 and expected to reach 19.2% by 2024
34% Amazon market share	The Amazon Effect has given consumers the expectation that deliveries for online purchases should be free and quick
39% Want fast delivery	39% of shoppers in the US expect companies to offer free two-day shipping for online purchases
2x Spend increase	Two-day delivery can lead to 2x shipping costs increase for small and medium-sized businesses (SMBs) that ship from one or two origins
3PLs as a solution	Third-party logistics providers (3PLs) represent an effective option for SMBs to build a network to afford short delivery time

Key Question

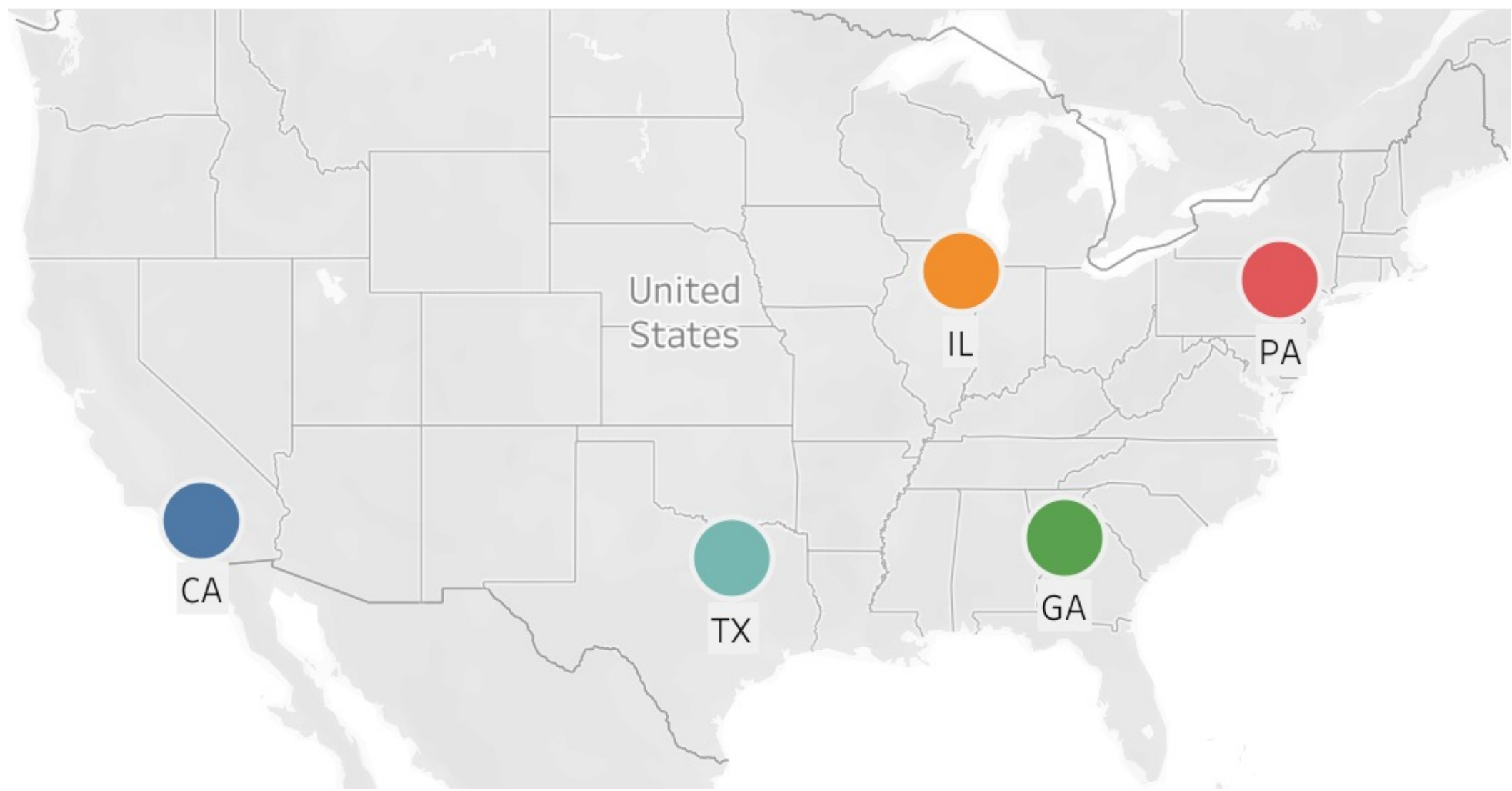
What is the optimal network solution for delivering online orders within a two-day window while minimizing cost and maintaining an on-time service level of at least 95%?

Relevant Literature

- Ballou, R. H. (2005). Expressing inventory control policy in the turnover curve. Journal of Business Logistics
- Croxton, K. L., & Zinn, W. (2005). Inventory considerations in network design. Journal of Business Logistics
- Croxton, K. L., Gendron, B., & Magnanti, T. L. (2003). A Comparison of Mixed-Integer Programming Models for Nonconvex Piecewise Linear Cost Minimization Problems. Management Science

Project Scope

Fulfillment Centers of the 3PL



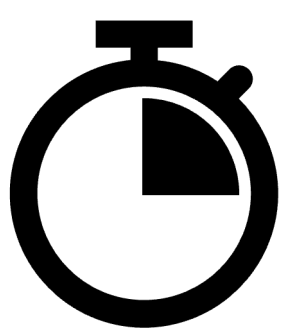
Parcel Carriers



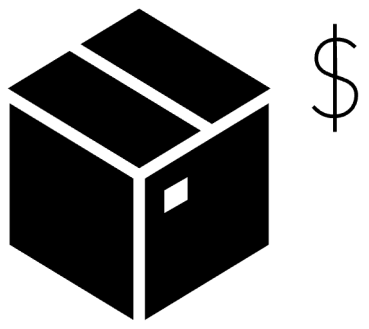
Parcel Modes

UPS Ground
UPS 2nd Day Air
FedEx Ground
FedEx 2Day
USPS Priority
USPS Express

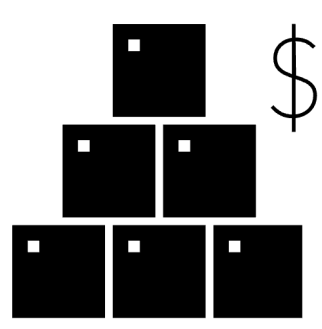
The Problem



Delivery within
Two-Days



Minimize
Delivery Cost



Minimize
Inventory Cost



Use Reliable
Carriers Only



Use FTL for
Inbound

Methodology



Modeling



Optimization



Analysis

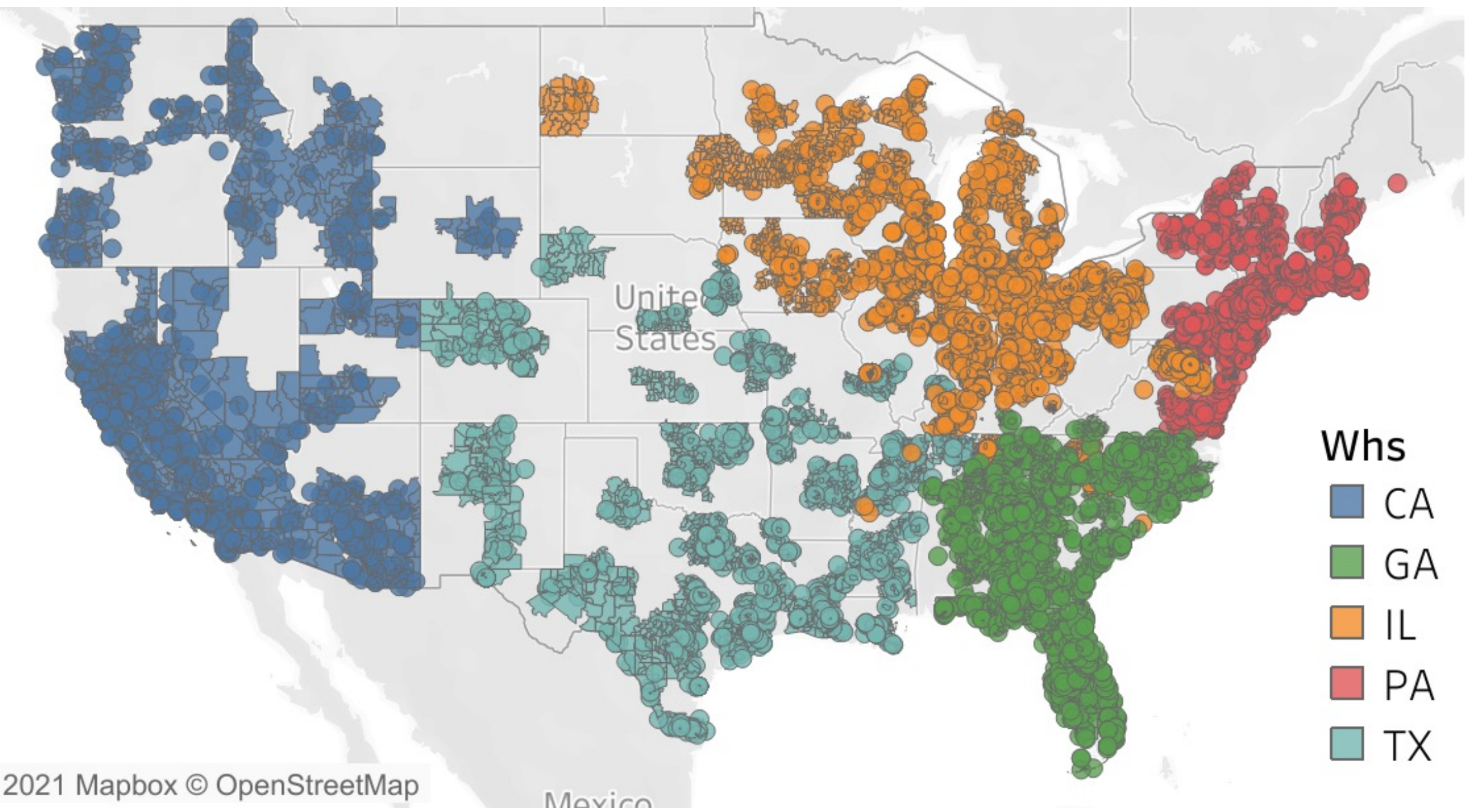
- Inventory Turnover Curves
- Parcel Rates
- FTL Rates

- Square Root Law
- MILP Model
- Gurobi Implementation

- Current vs. Optimal
- Inventory Policy Scenarios
- Delivery Time Scenarios

Results

Design of the network for one client (beverage company)



2021 Mapbox © OpenStreetMap

vs. Current		Impact	
- 12%	 Outbound Transportation	84	-8% Annual Savings
+ 10%	 Inbound Transportation	13	
+ 29%	 Inventory Holding	3	

Expected Contribution

- To create an integrated model to minimize the total logistics cost for two-day e-commerce fulfillment
- To allow 3PL providers to offer competitive solutions based on an optimized network
- To assist 3PL providers in assessing the cost impact of a client's inventory policy and in making recommendations for more efficient replenishment strategies

Ryan Wilson



Cosmo Valentino

