Preliminary Investigation: Physical Internet on the Furniture Supply Chain

Jacob Cook
Mohit Goyal

Sponsor Prof. Benoit Montreuil

Agenda

- Introduction
  - Heuristic
  - Case Description
- Generated Data Case Analysis
  - Results
- Conclusions
  - Future Work

Heuristic

Introduction

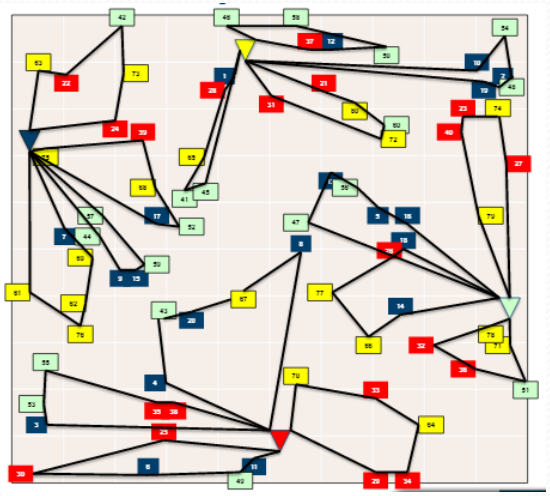
Generated Data

Conclusion

- Vehicle Routing Problem
- Local Neighborhood Search
- Nearest Neighbor

Case Description

Introduction
Generated Data
Conclusion



Case 1 (**Solo** Storage, **Solo** Distribution)

Case 2 (**Shared** Storage, **Solo** Distribution)

Case 3 (**Shared** Storage, **Shared** Distribution)

Case 4 (City **Mobile Cross docks**)

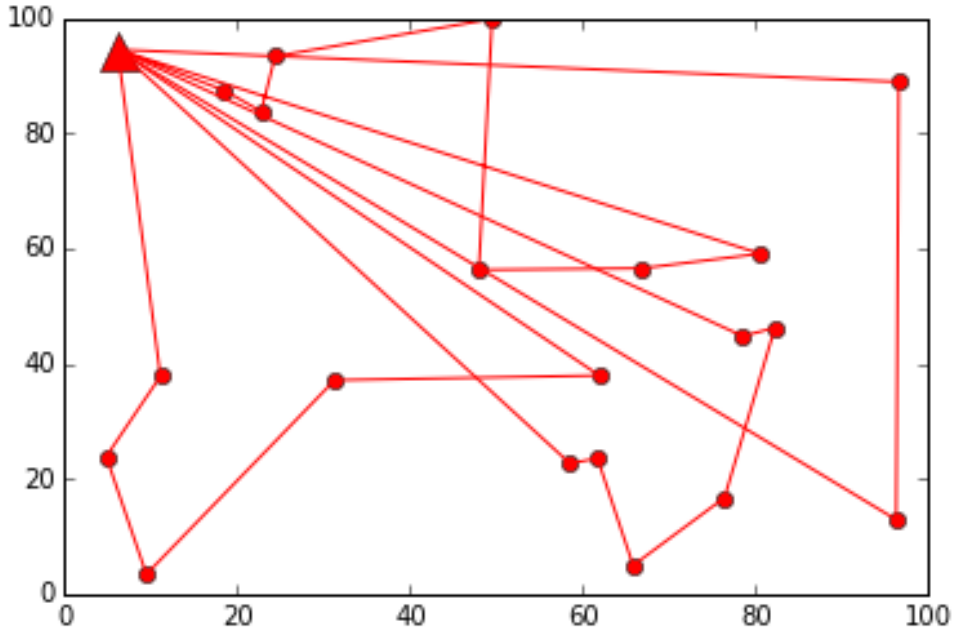
Case 5 (City **Distribution Center**)

Case 6 (**Location Optimization** of DC)

- Optimizing all DCs together
- Optimizing one DC at a time

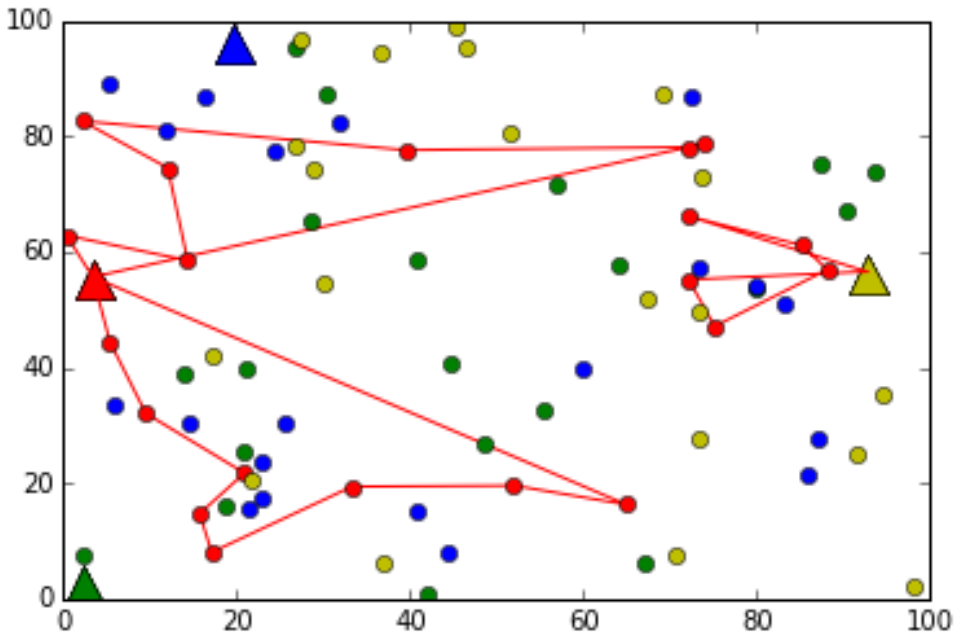
Case 1 (**Solo** Storage, **Solo** Distribution)

- For 1000 Runs
  - Average Distance: 3255 km
  - Average Man Hours: 121 hrs



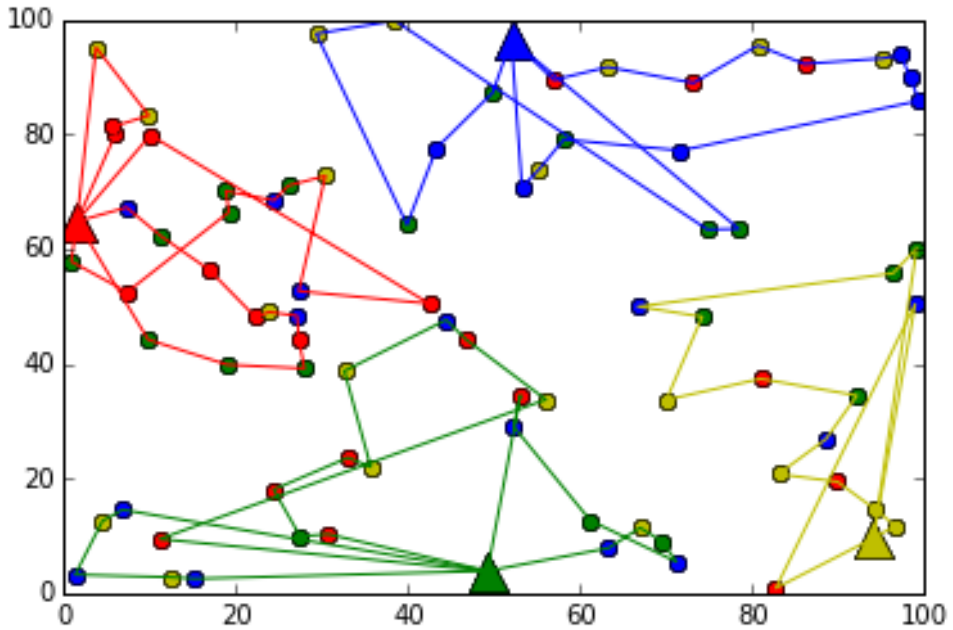
Case 2 (**Shared** Storage, **Solo** Distribution)

- For 1000 Runs
  - Average Distance: 2410 km
  - Average Man Hours: 100 hrs



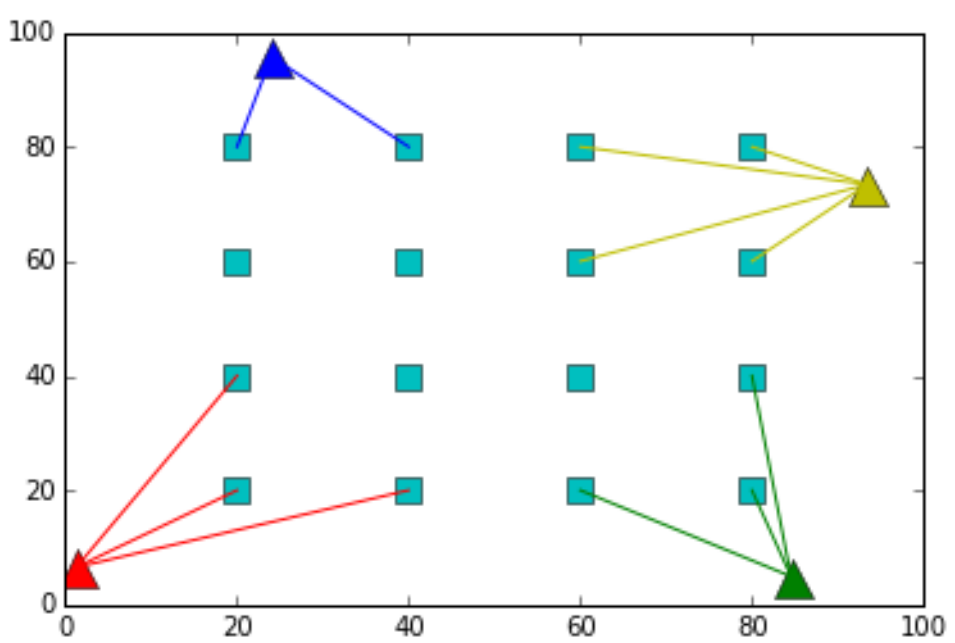
Case 3 (**Shared** Storage, **Shared** Distribution)

- For 1000 Runs
  - Average Distance: 1310 km
  - Average Man Hours: 73 hrs



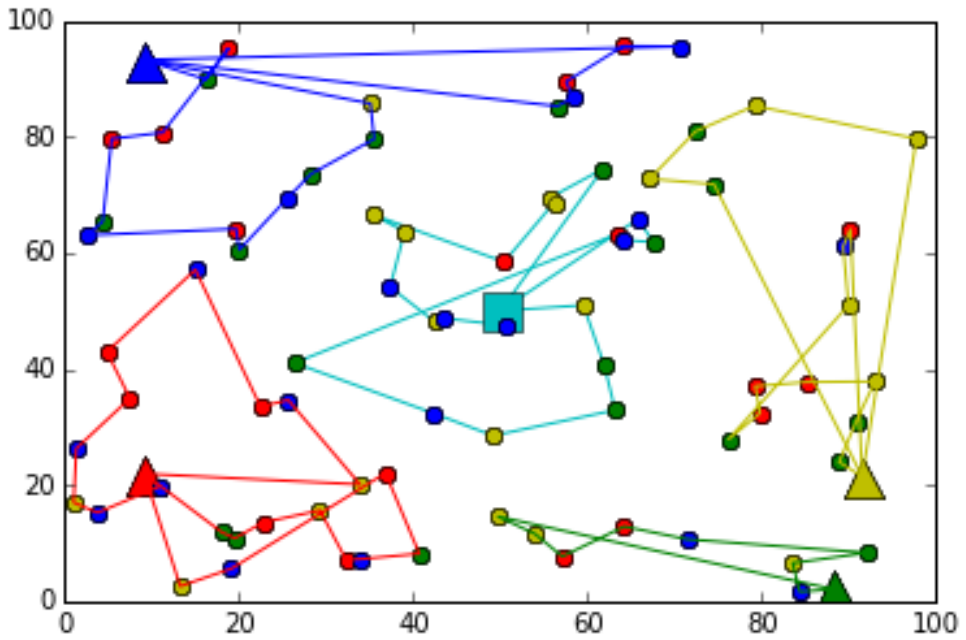
Case 4 (City Mobile Cross docks)

- For 1000 Runs
  - Average Distance:
    - Trucks: 245 km
    - Small Trucks: 1015 km
  - Average Man Hours
    - Truck: 6 hrs
    - Small Truck: 45 hrs



Case 5 (5th Central DC)

- For 1000 Runs
  - Average Distance: 1270 km
  - Average Man Hours: 72 hrs

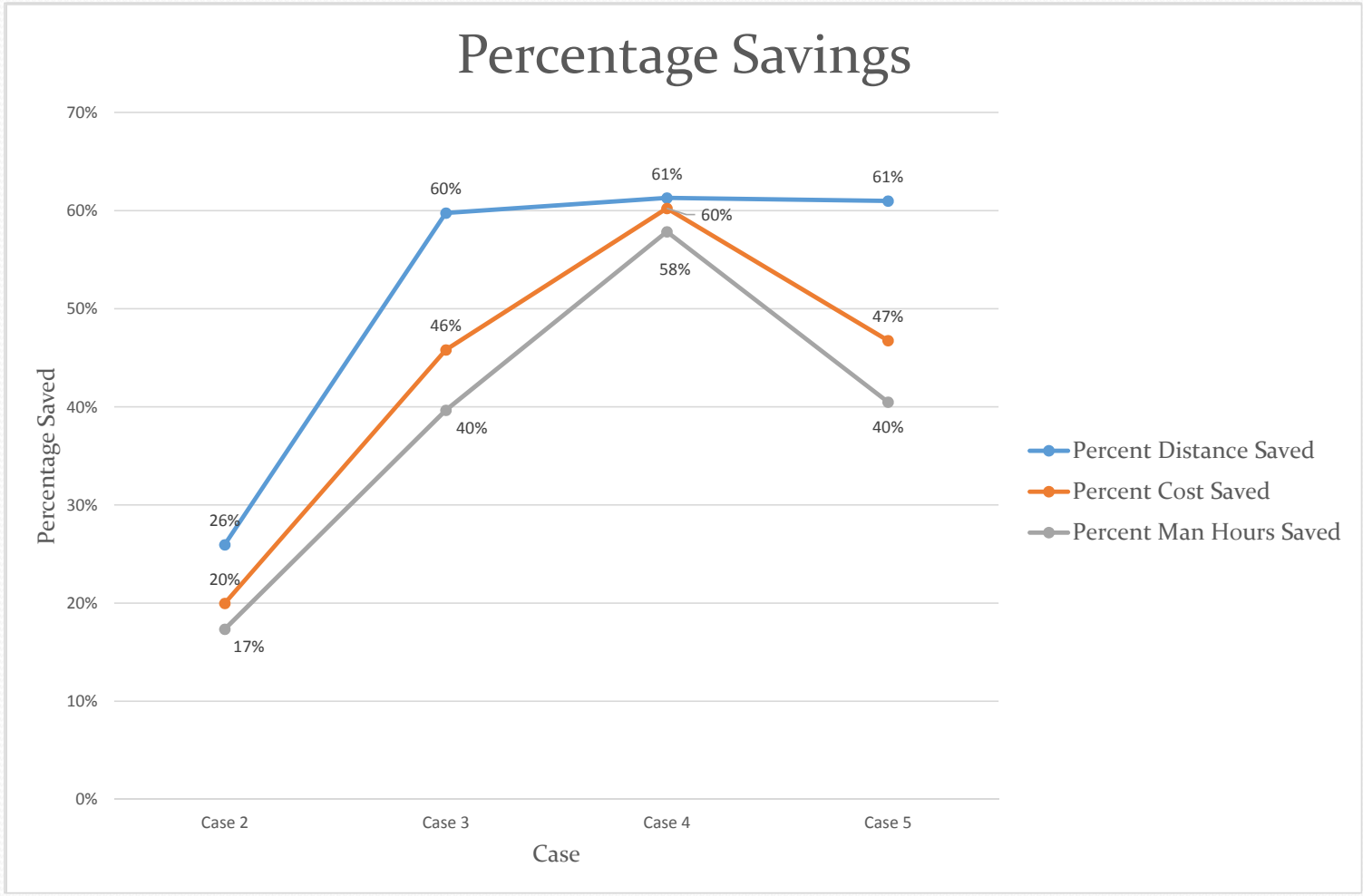


Results

Introduction

Generated Data

Conclusion



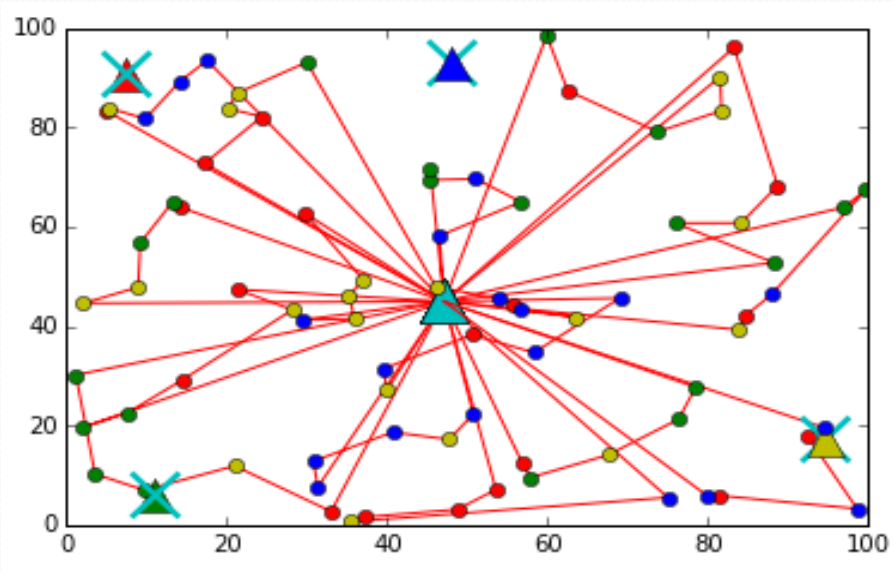
Case 6 (**Location Optimization** of DC)

Introduction

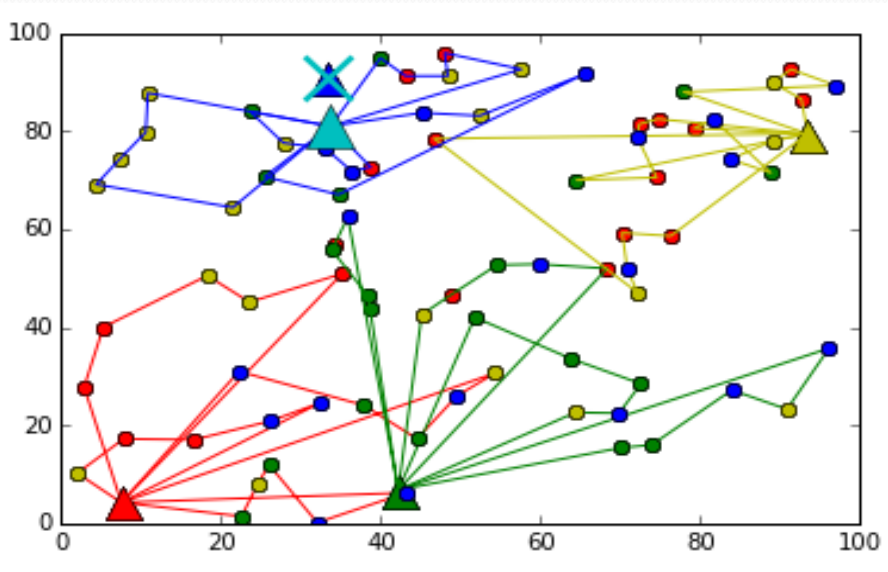
Generated Data

Conclusion

Case 6



Case 6 Special



Case 6 (**Location Optimization** of DC)

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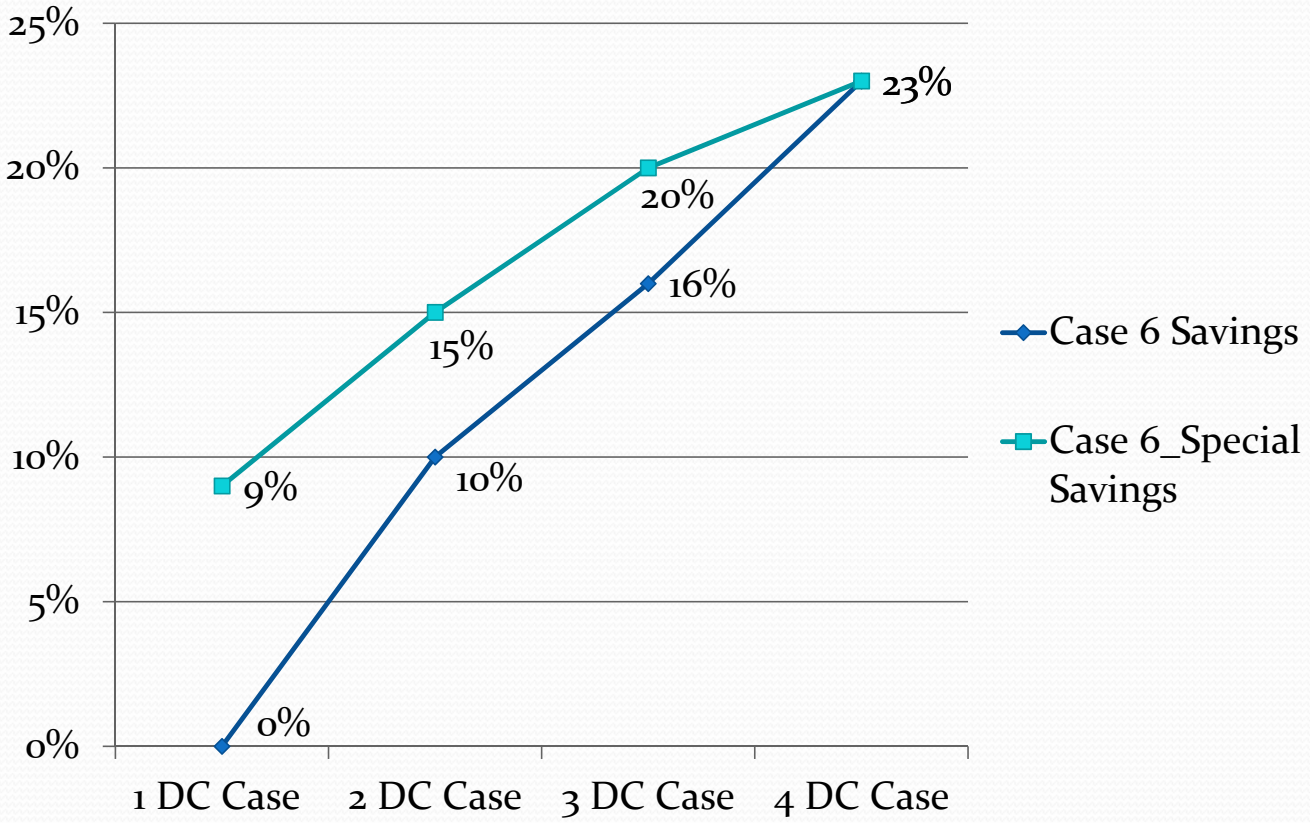


Conclusions

Introduction

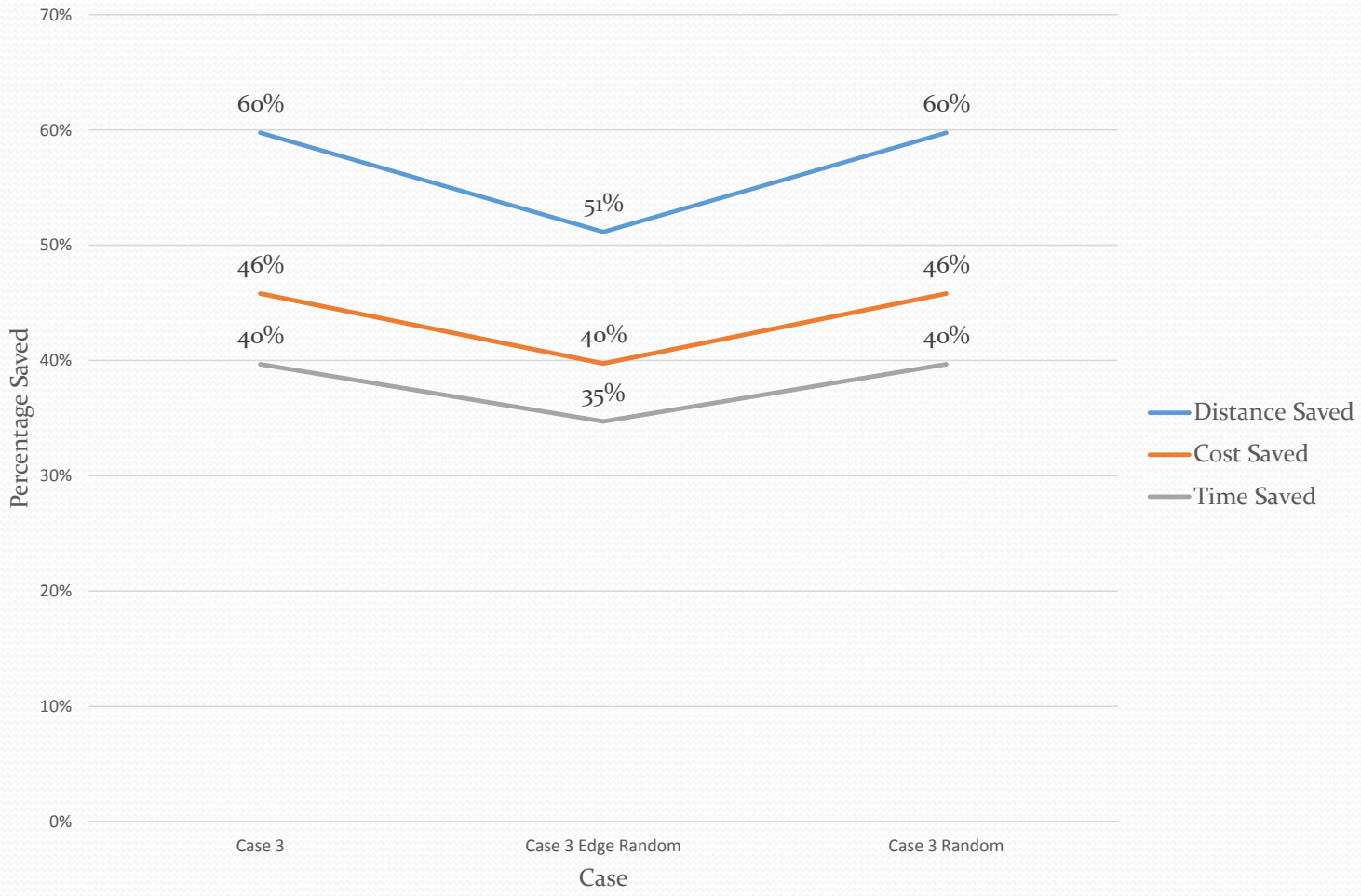
Generated Data

Conclusion

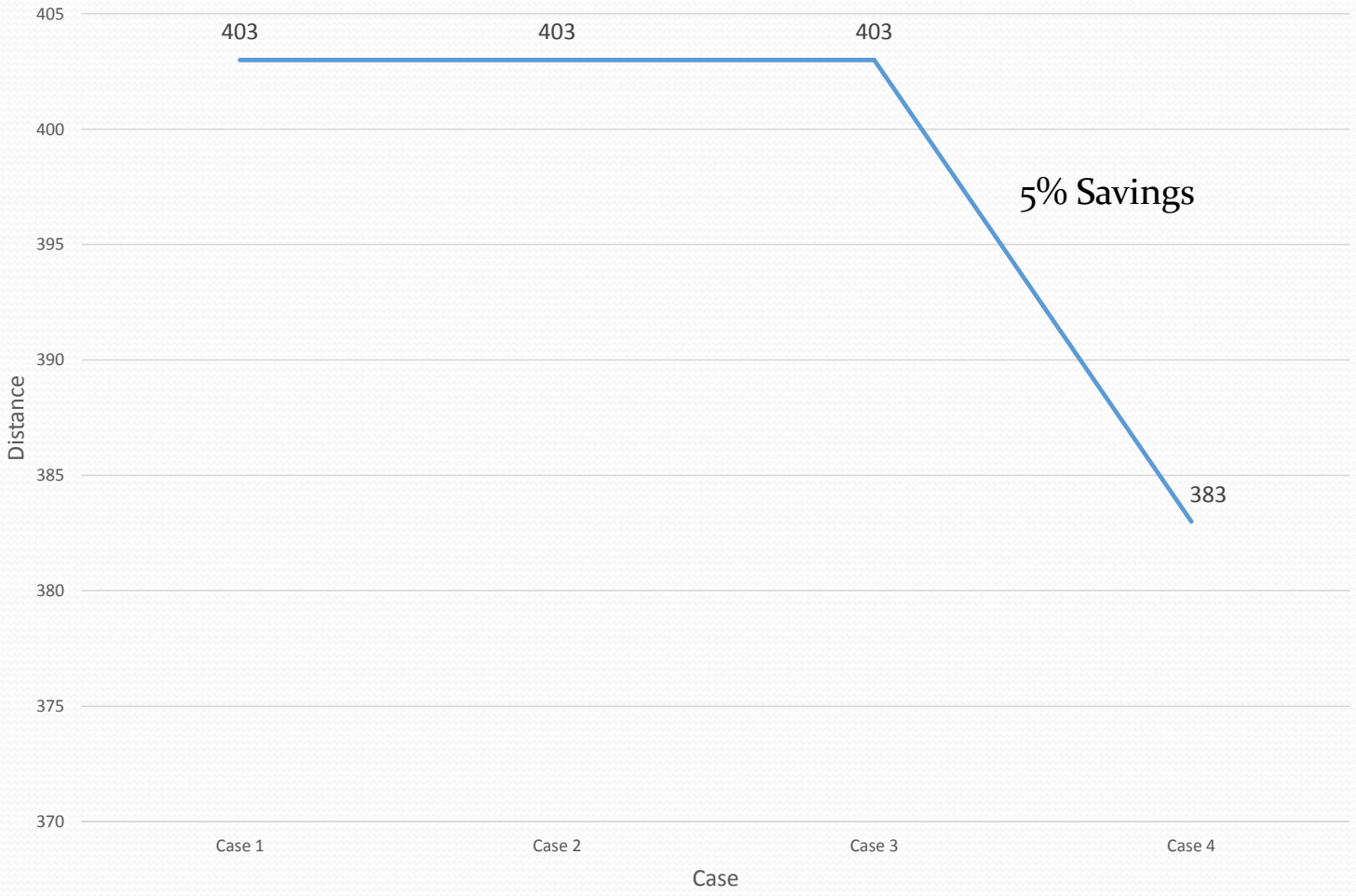
- Move towards inter-connected Supply Chain
- Key Findings: Generated Data Case
- Future Work
  - Increase Scope from Last Mile up to First Mile
  - Analyze Truck Utilization
  - Software for various Scenarios
  - Integrate other Supply Chain Industries

BACK – UP SLIDES

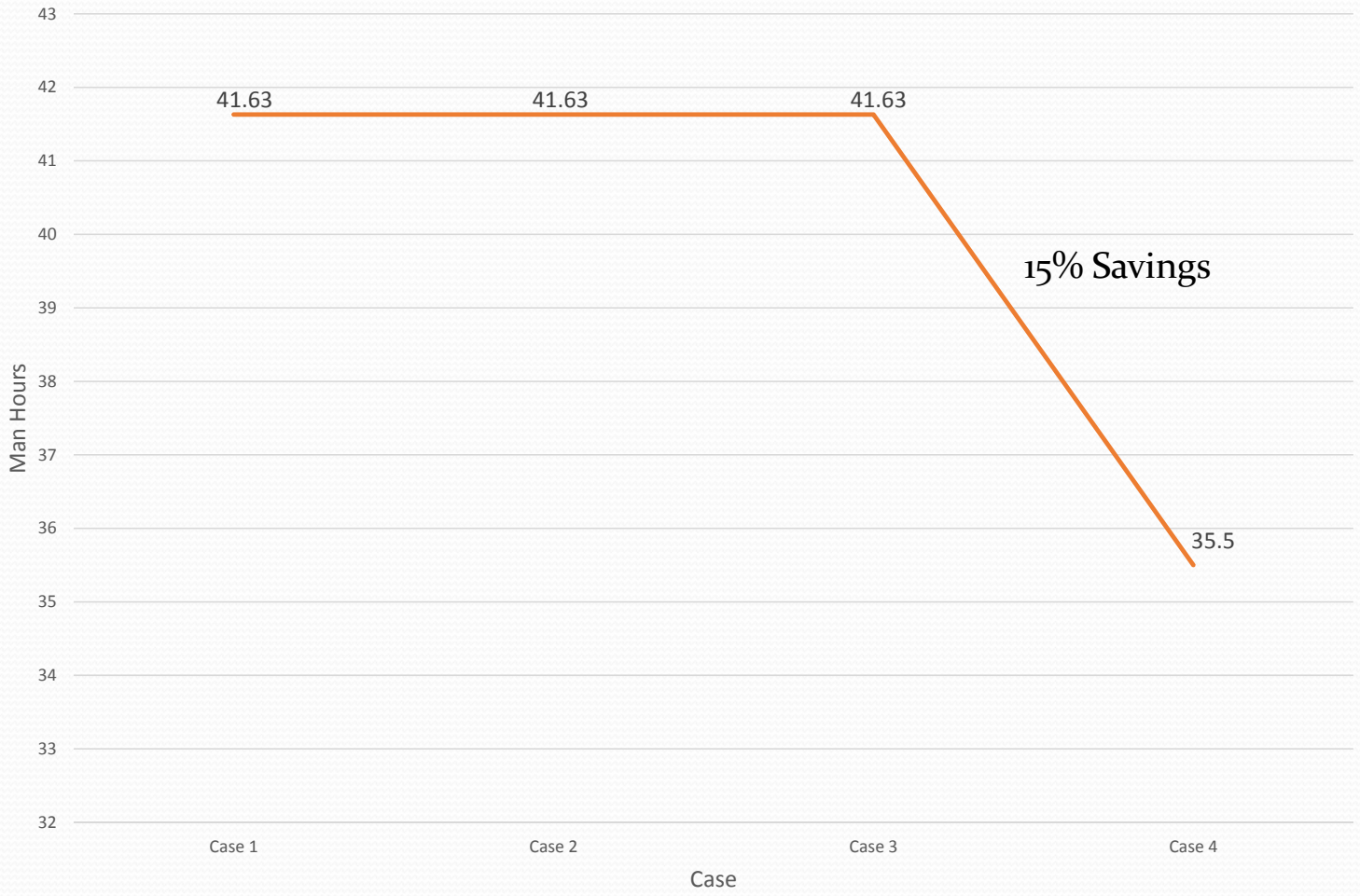
DC Generation Scenarios



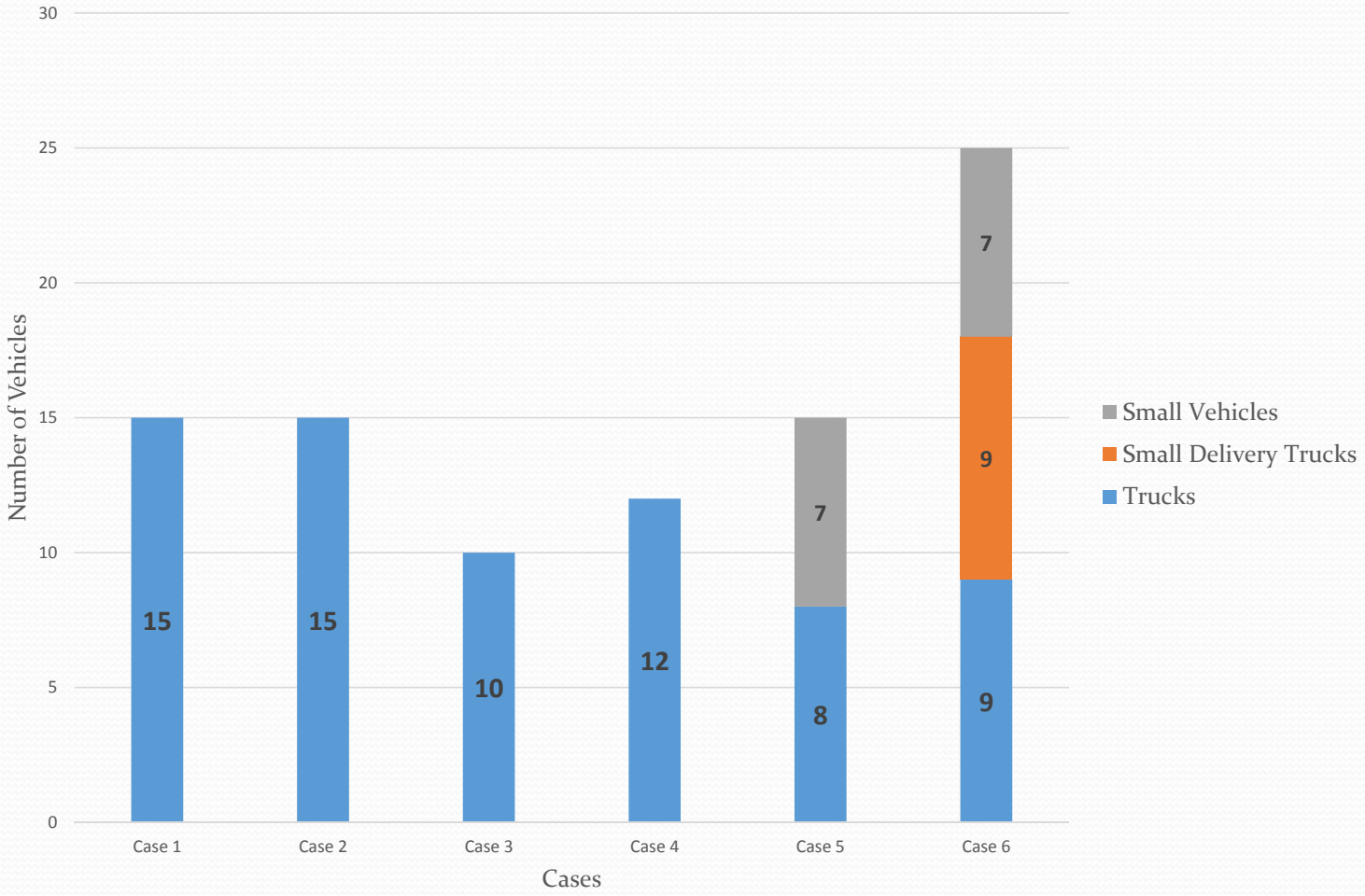
"XXX" Distance



“XXX" Man Hours Scenario



Vehicle Chart



PRELIMINARY INVESTIGATION OF THE IMPACT OF INVENTORY POLICY ON LAST MILE DELIVERY OF FURNITURE AND LARGE APPLIANCE UPON OPEN ASSET SHARING: SIMULATION-BASED APPROACH

NAYEON KIM AND BENOIT MONTREUIL

GEORGIA INSTITUTE OF TECHNOLOGY

3rd International Physical Internet Conference, June 29 – July 1, 2016

Workshop TA1: Hyperconnected Logistics Experiments in Home Fashion, Furniture and Appliance Supply Chains

BACKGROUND

- Last-mile Delivery
  - The most expensive logistic operations
  - Directly related to customer experience
  - Increase with E-commerce
  - Considerable social and environmental impact in urban area e.g. traffic congestion, air pollution

Source: http://amm.clubmetropolitan.ro/structures/auto-draft/

- Furniture and Large Appliances
  - Large, heavy items
  - White-glove services
    - Delivery and install time

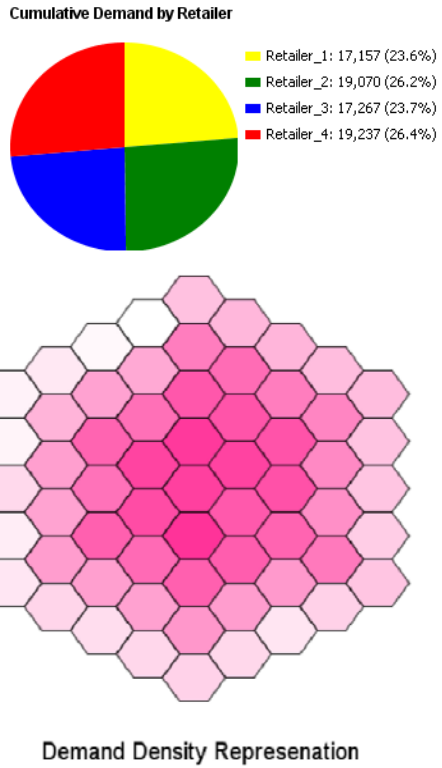
Source: http://lkndelivery.com/ (left)
http://www.ufwinc.com/furniture-delivery-fees-united-furniture-warehouse/ (right)

BACKGROUND: RESEARCH QUESTIONS

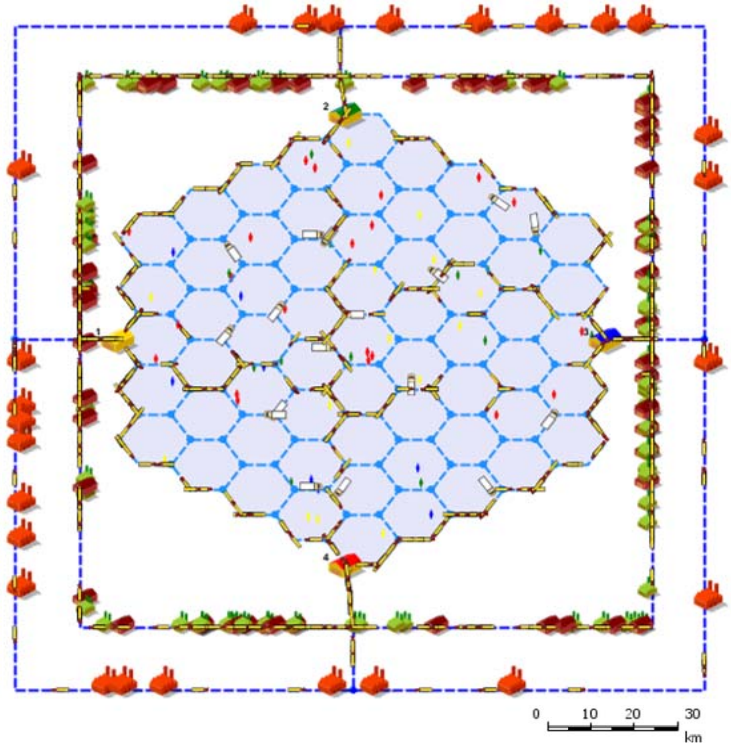
- Is the efficiency of logistics operations when assets are shared affected by the policies of participating companies? If so, how much?

- What would be the potentially best operating policies for companies in the new logistics environment?

SIMULATION DESIGN: VIRTUAL CITY



Demand Density Represenation



Manufacturers:

Onshore / Make-to-Stock

Onshore / Make-to-Order

Onshore / Make-to-Order

Delivery Trucks:

Long-haul Delivery Truck

Last-mile Delivery Truck
- 50 km/hr (on main roads)
- 40 km/hr (in a district)

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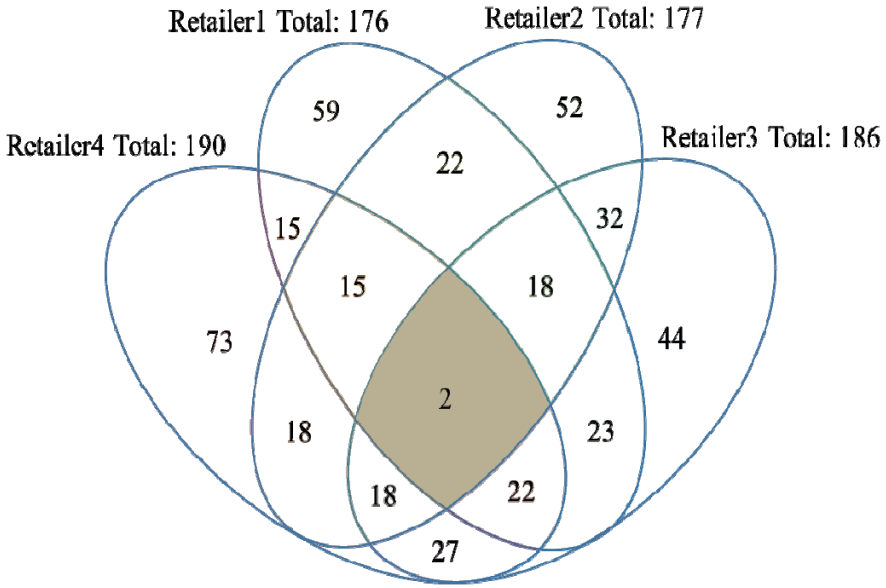
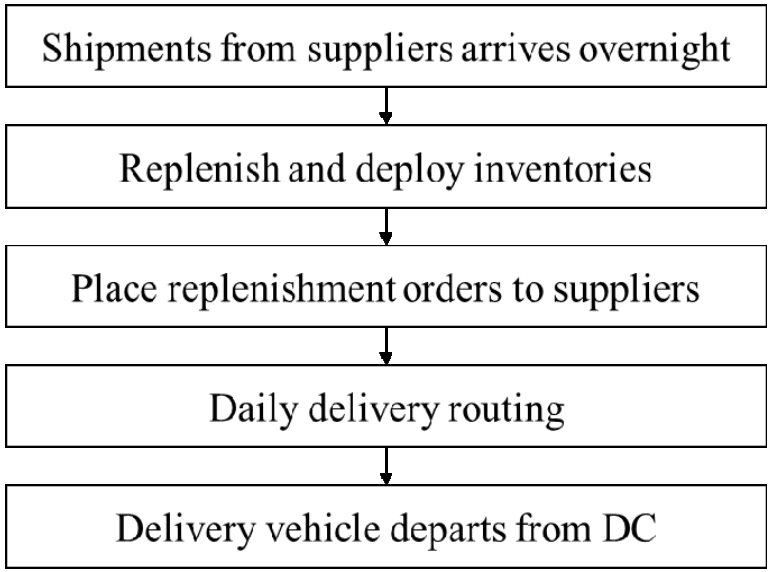
SIMULATION DESIGN: INVENTORY

Product Portfolios (# of products)



Daily Operation Routine of Retailers



- Product lead time (days): 1-7 (Onshore/MTS), 8-29 (Onshore/MTO), 30-90(Offshore/MTO)
- Demand: $\text{Poisson}(\sum \lambda_i = 20)$ per retailer
- Service Level > 0.99

SIMULATION DESIGN: ROUTING HEURISTICS

- Routing Constraints:
  - Inventory, Tour time (8 hours), Volume/Weight capacity (70% of 17ft truck)

- Routing heuristics
  1) **Assign** each customer to DCs with inventory available greedily
     a) Calculate distance to the nearest DC where inventory is available for each remaining customer
     b) Assign a customer with the smallest distance to the DC
     c) Update inventory availability and assigned/remaining customer list
     d) Repeat a-c until all customers are assigned to a DC
  2) Construct route with **CW heuristic** among each group e.g. assigned to the same DC
  3) Improve route with **Intra-route 2-opt and Or-opt, Inter-route Or-opt and SWAP**
     A. For each route, apply 2-opt and Or-opt with best improvement to local optima in sequence
     B. For all routes, apply inter-route Or-opt and SWAP with best improvement to local optima in sequence
     C. Repeat A-B until no improvement is found

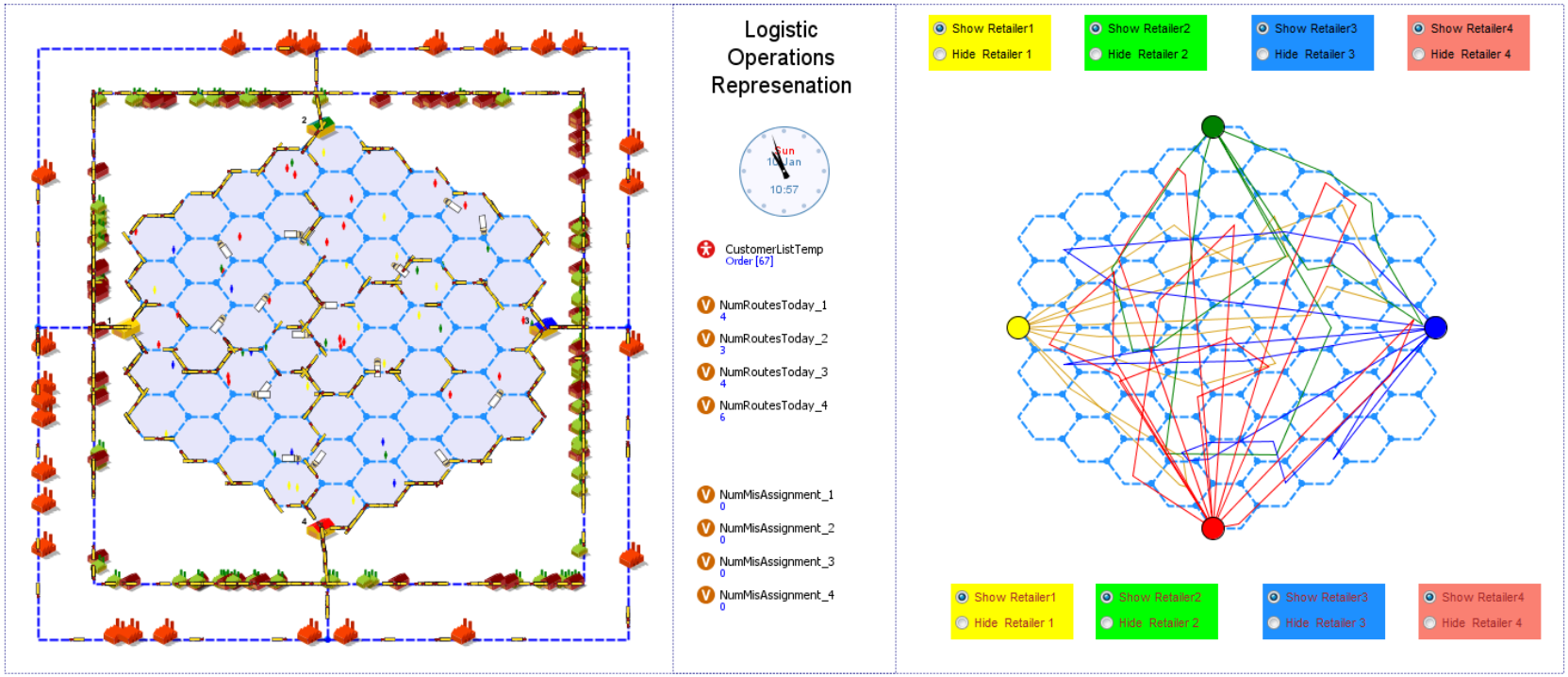
SCENARIO ANALYSIS

Scenario ID	Open Asset Sharing		Inventory Deployment Strategy		Inventory Information Disclosure		Inventory Borrowing
	Storage	Delivery	One-time Placement	Overnight Deployment*	Minimum Disclosure	Selective Disclosure	
1	-	-	-	-	-	-	-
2a	O	-	O	-	-	-	-
2b	O	-	-	O	-	-	-
3a	O	O	O	-	O	-	-
3b	O	O	-	O	O	-	-
4a	O	O	O	-	-	O	-
4b	O	O	-	O	-	O	-
5a	O	O	O	-	-	O	O
5b	O	O	-	O	-	O	O

*** Overnight Deployment stands for forecast-based overnight deployment**

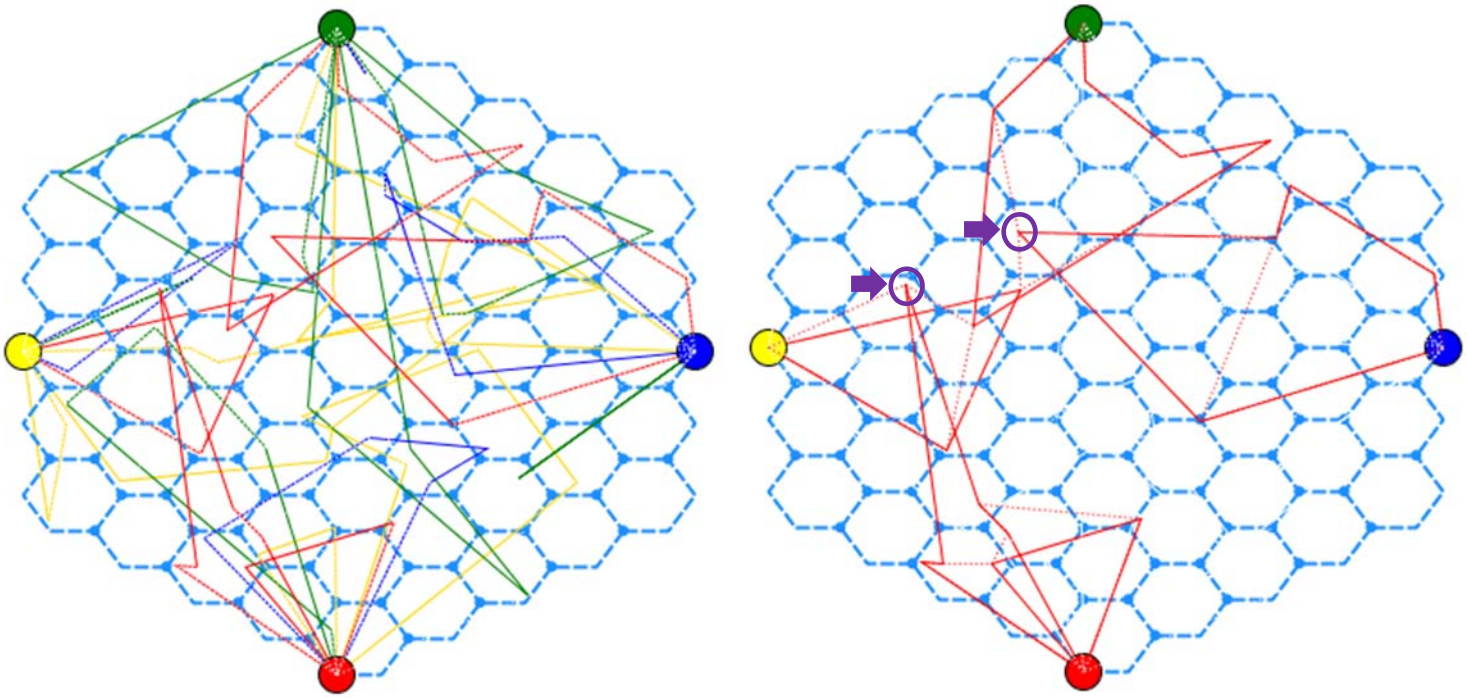
- **Performance measures**: Last-mile delivery travel distance, # of delivery vehicles used
- Simulation run for 2 years (730 days) after 6 months of warm-up period

SCENARIO 1: INDEPENDENT OPERATION



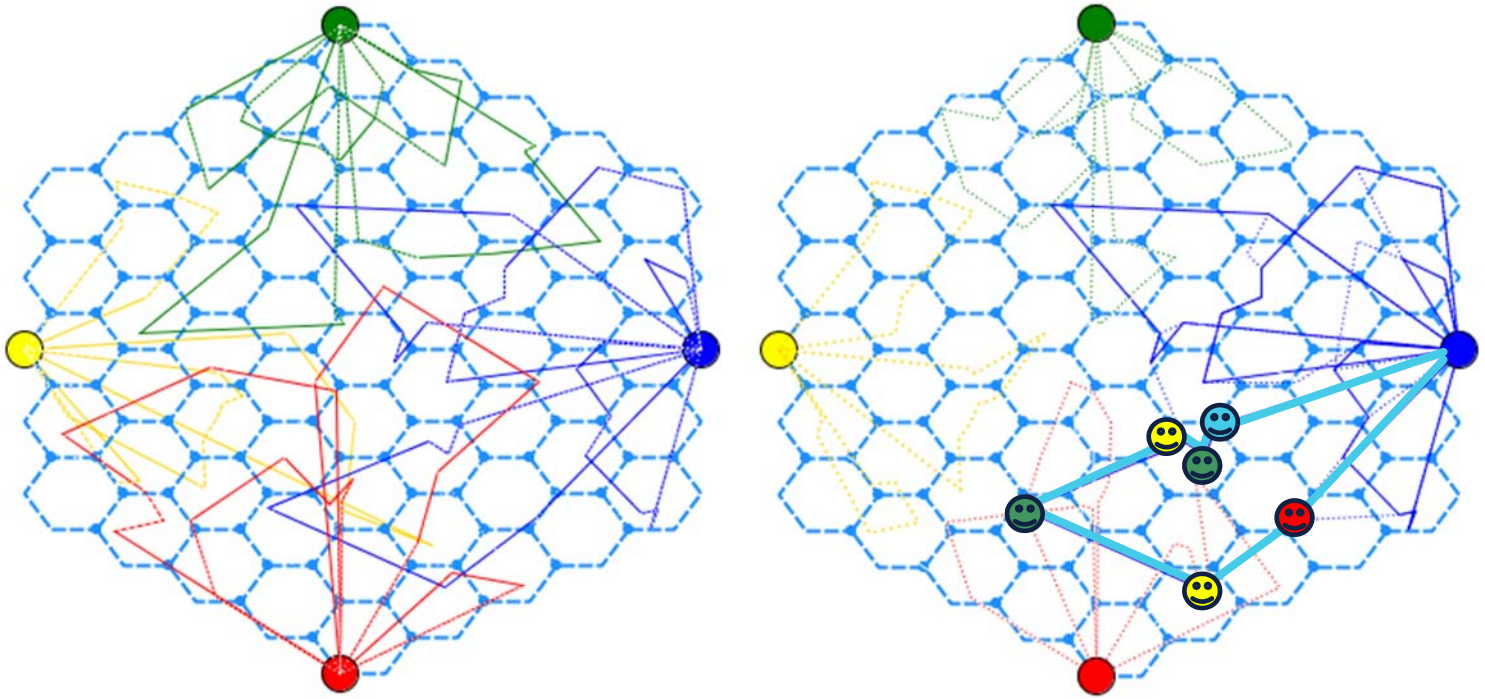
- Routes are colored by retailer

SCENARIO 2: SHARED STORAGE



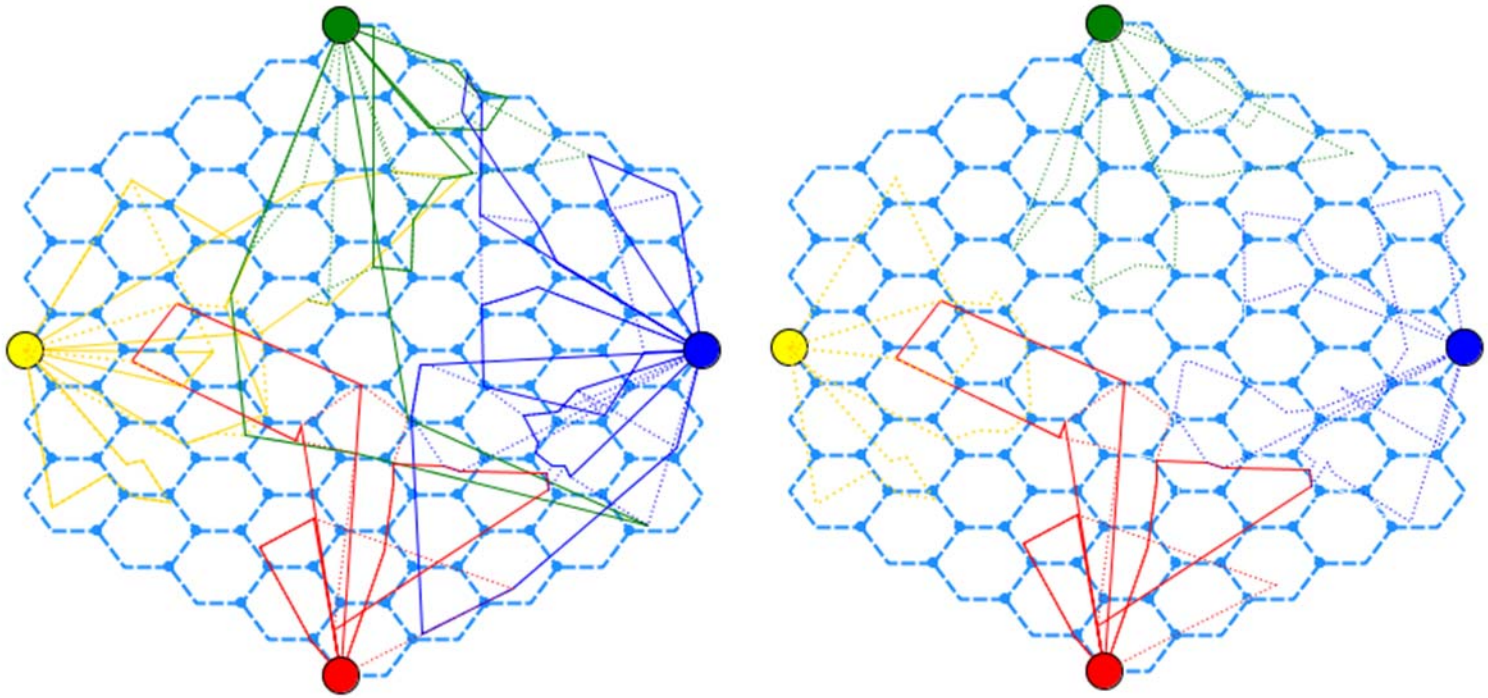
- Routes are colored by retailer
- Solid line for actual routes and dotted line for routes with order-based overnight deployment

SCENARIO 3:
SHARED DELIVERY / MIN INFO DISCLOSURE



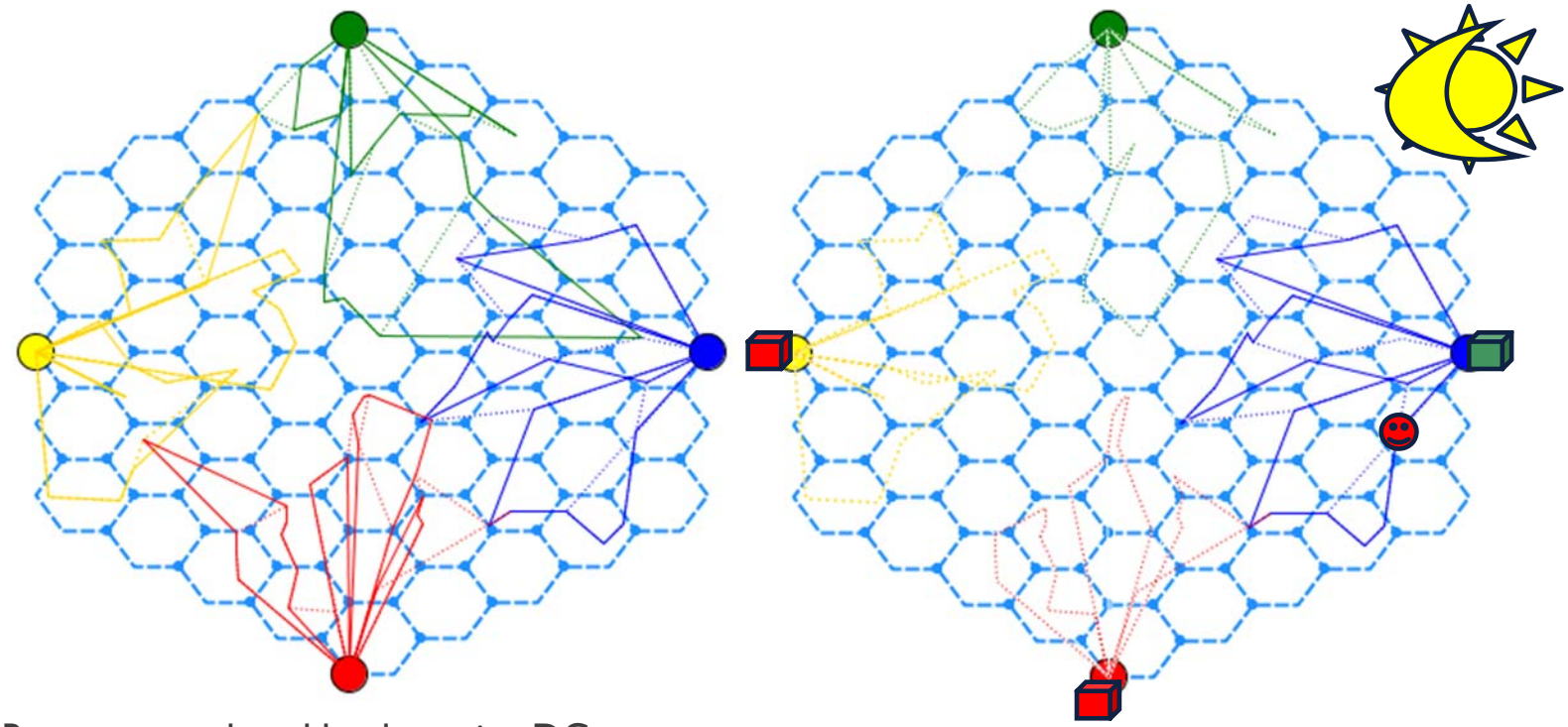
- Routes are colored by departing DC
- Solid line for actual routes and dotted line for routes with order-based overnight deployment

SCENARIO 4:
SHARED DELIVERY / SELECTIVE INFO DISCLOSURE



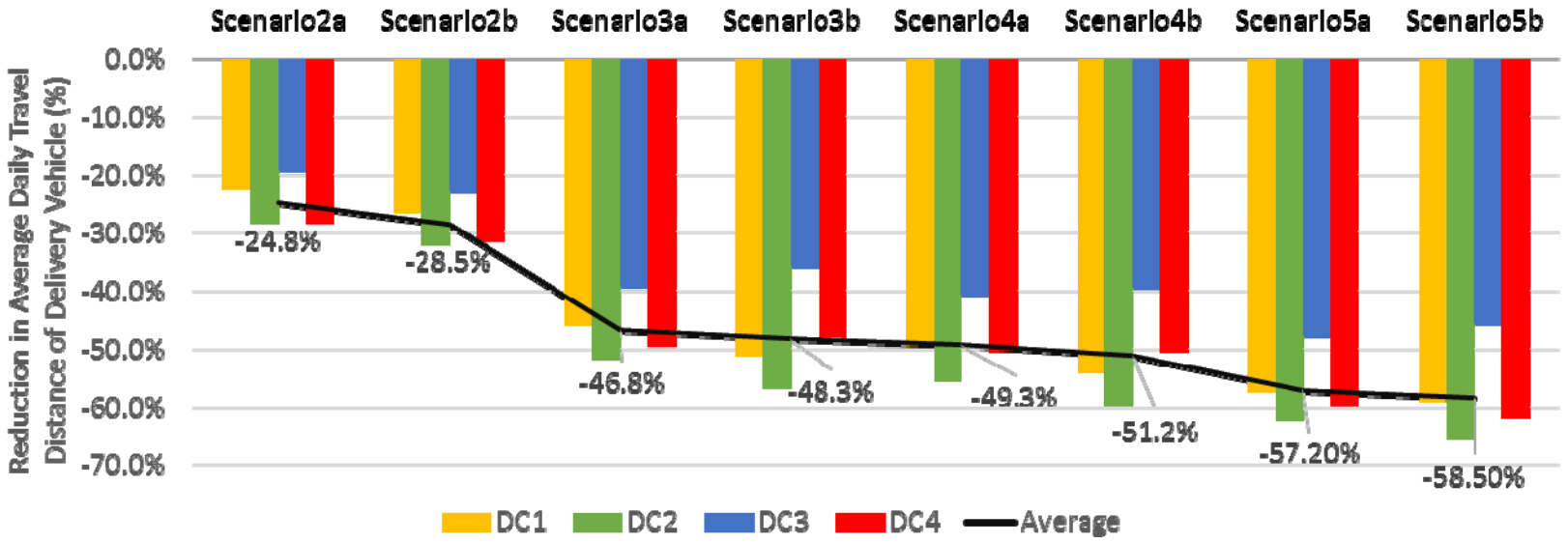
- Routes are colored by departing DC
- Solid line for actual routes and dotted line for routes with order-based overnight deployment

SCENARIO 5: INVENTORY BORROWING



- Routes are colored by departing DC
- Solid line for actual routes and dotted line for routes with order-based overnight deployment

SIMULATION RESULTS: LAST-MILE TRAVEL DISTANCE



- Significant reduction by sharing strategy
- Additional Reduction by deployment strategy

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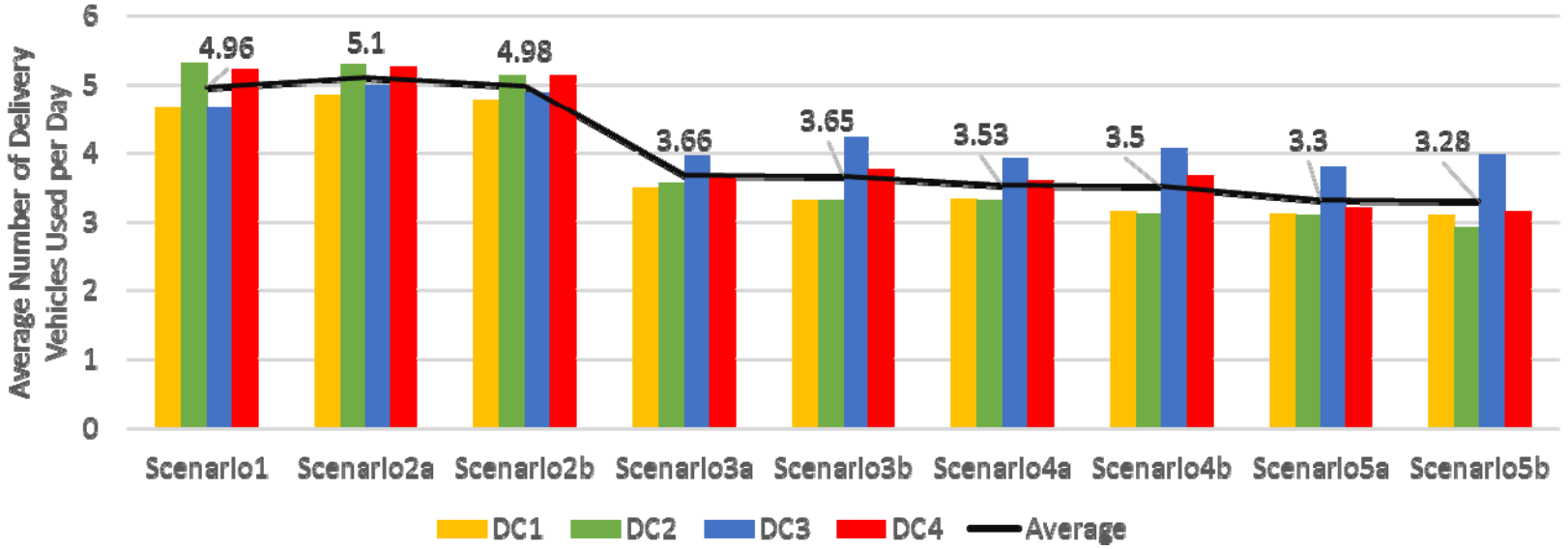
SIMULATION RESULTS: LAST-MILE TRAVEL DISTANCE

Scenario ID	One-time Placement	Forecast-based Overnight Deployment	Order-based Overnight Deployment
1	0%	-	-
2	-25%	-29% (-5%)	**-41% (-17%)**
3	-47%	-48% (-3%)	**-63% (-29%)**
4	-49%	-51% (-4%)	**-64% (-25%)**
5	-57%	-59% (-3%)	**-64% (-13%)**
Average Fraction of Misassignment (Scenario 2-4 / Scenario 5)	**21% / 9%**	**17% / 7%**	**0%**

-5%, -16%, -6%, -15%

- Smart inventory deployment can improve delivery efficiency
  - Up to 29% marginal savings and up to 64% savings compared to baseline
- Disclosing information and borrowing inventory can bring additional improvement

SIMULATION RESULTS: USE OF LAST-MILE DELIVERY VEHICLES



- Number of delivery vehicles used can be reduced significantly by sharing delivery
- Marginal reduction by inventory deployment policy is insignificant
- Preference gap between DCs becomes more visible as routing flexibility increases

LIMITATIONS

- **Cost of inventory deployment** is not counted
- The number and location of DCs can be optimized
- Another type of facilities, e.g. Pi-hubs, can be added
- Different type of products or mixed product types can be investigated

CONCLUSIONS

- Openly sharing logistics assets (storage, delivery) can improve last mile delivery performance e.g. up to 64% reduction in travel distance
- Smart inventory deployment policy can affect the delivery performance in open shared operation environment e.g. up to 29% marginal reduction compared to one-time inventory placement
- Degree of information disclosure affects routing performance
- Sharing inventory between retailers can bring significant improvement under same inventory deployment policy if inventories are not perfectly deployed as in order-based overnight deployment
- Potential imbalance of preference among open assets and different benefits for participants can hinder the efficient utilization of the new system
- Operational protocols must be designed carefully to address different preferences on logistic assets and non-identical gains of participating companies

THANK YOU ☺

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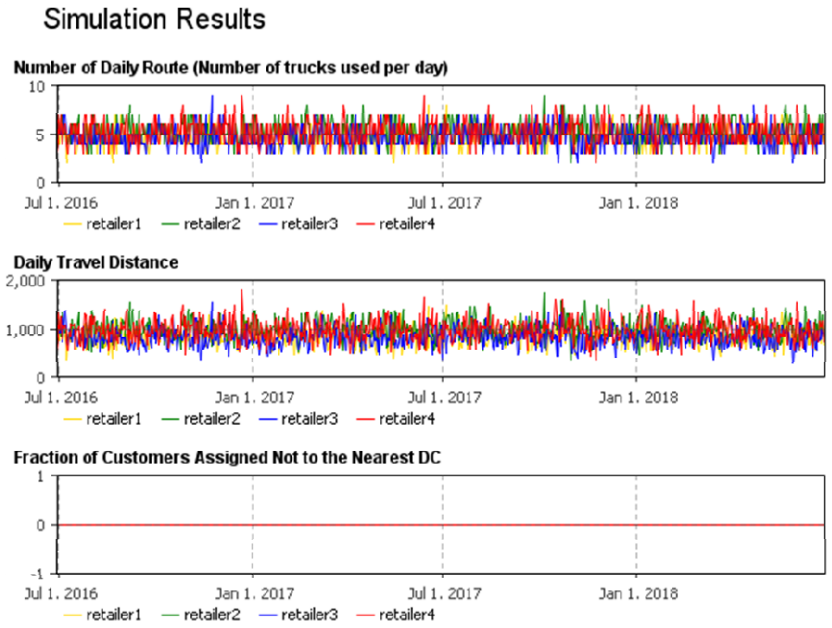
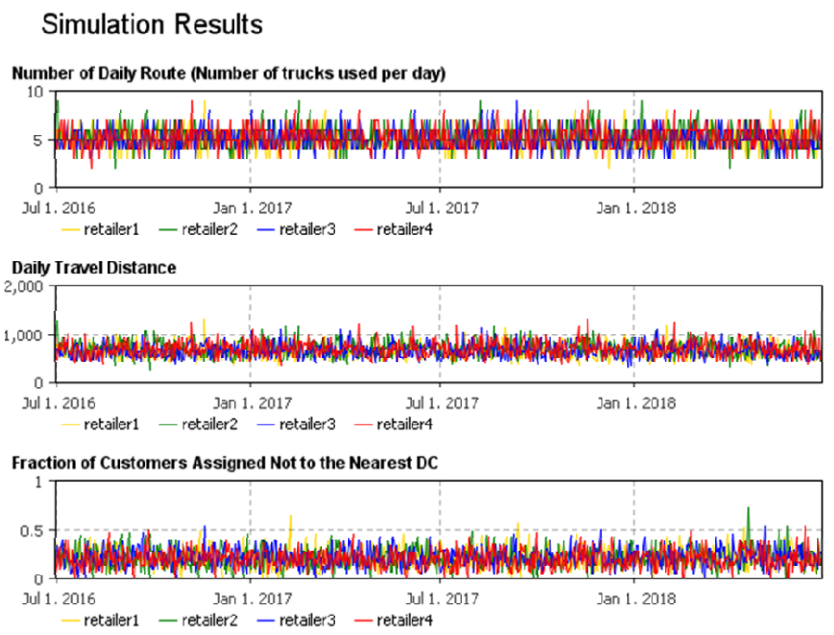
- Simulation Design
- Scenario Analysis
- Results
- Conclusion

SIMULATION RESULTS





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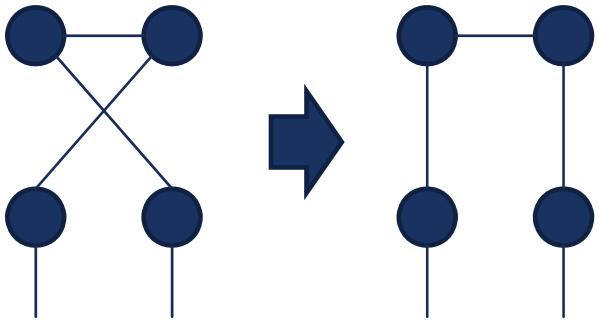
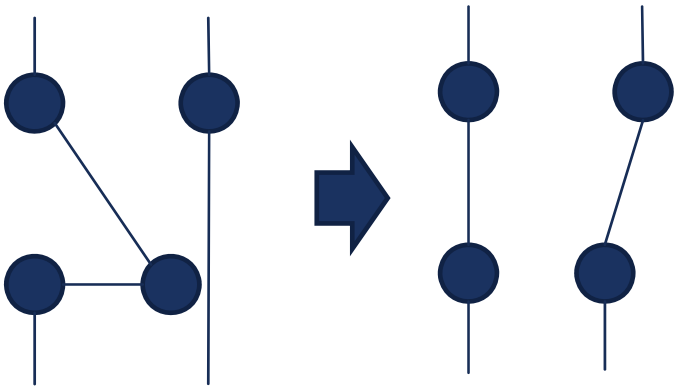
SIMULATION DESIGN: ROUTING HEURISTICS

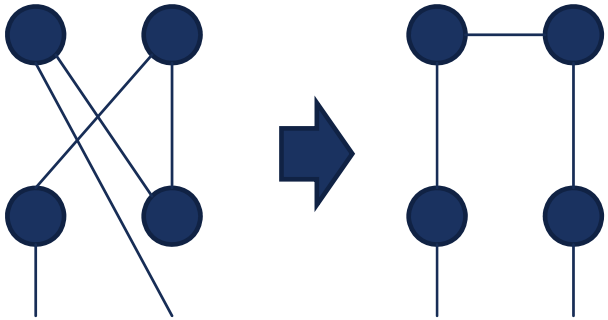
- Intra-route 2-opt



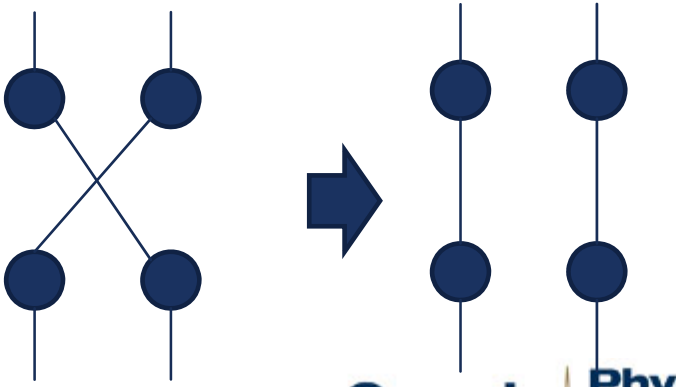
- Inter-route Or-opt



- Intra-route Or-opt



- Inter-route SWAP



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International Physical Internet Conference Atlanta 2016

Daniel Pronovost

Daniel Pronovost

- Director Home Delivery Operations Sears Canada Inc.

- 20 yrs experience big ticket retail
  - Sales
  - Operations
  - Supply Chain
  - Logistics
  - Customer Service

- Large national retailers such as Hudson Bay Company and Sears Canada Inc.

- Regional retailers such as Appliance Canada, Corbeil and Wise Buy Home

Who is Sears Canada?

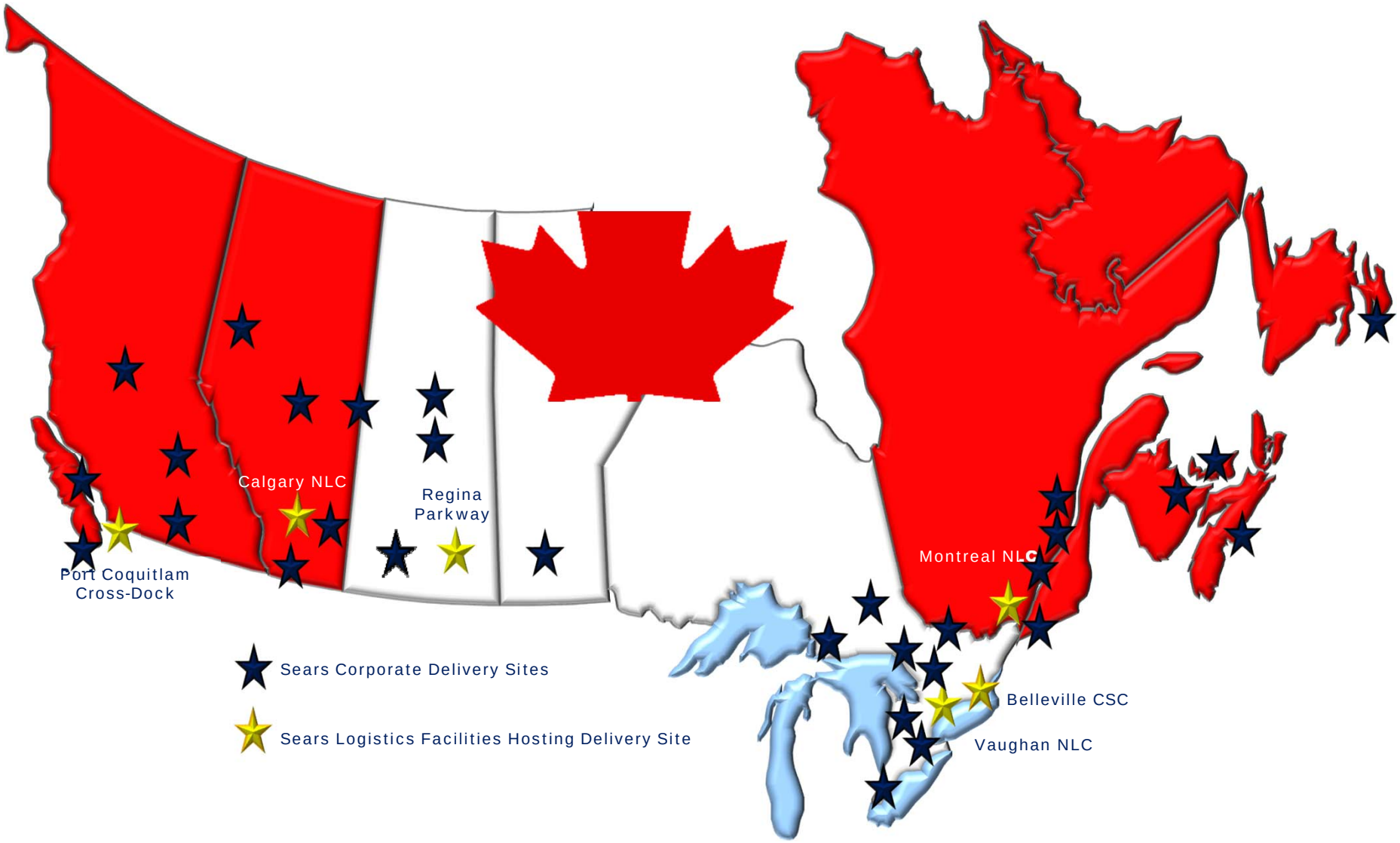
- Sears Line Haul (SLH) provides the bulk of our 1st mile and replenishment needs
  - 700 power units
  - 2700 trailers

- DC's
  - 4 main sites (Vancouver, Calgary, Toronto and Montreal)

- Retail stores, dealer stores, catalogue sites and E-commerce
  - Comprising of 700,000 2 man white glove home delivery stops per year

- 46 home delivery sites
  - 4 hubs (DC's)
  - 42 spokes
  - Service over 90% of Canadian postal codes

Who is Sears Canada?



Canada big ticket challenges

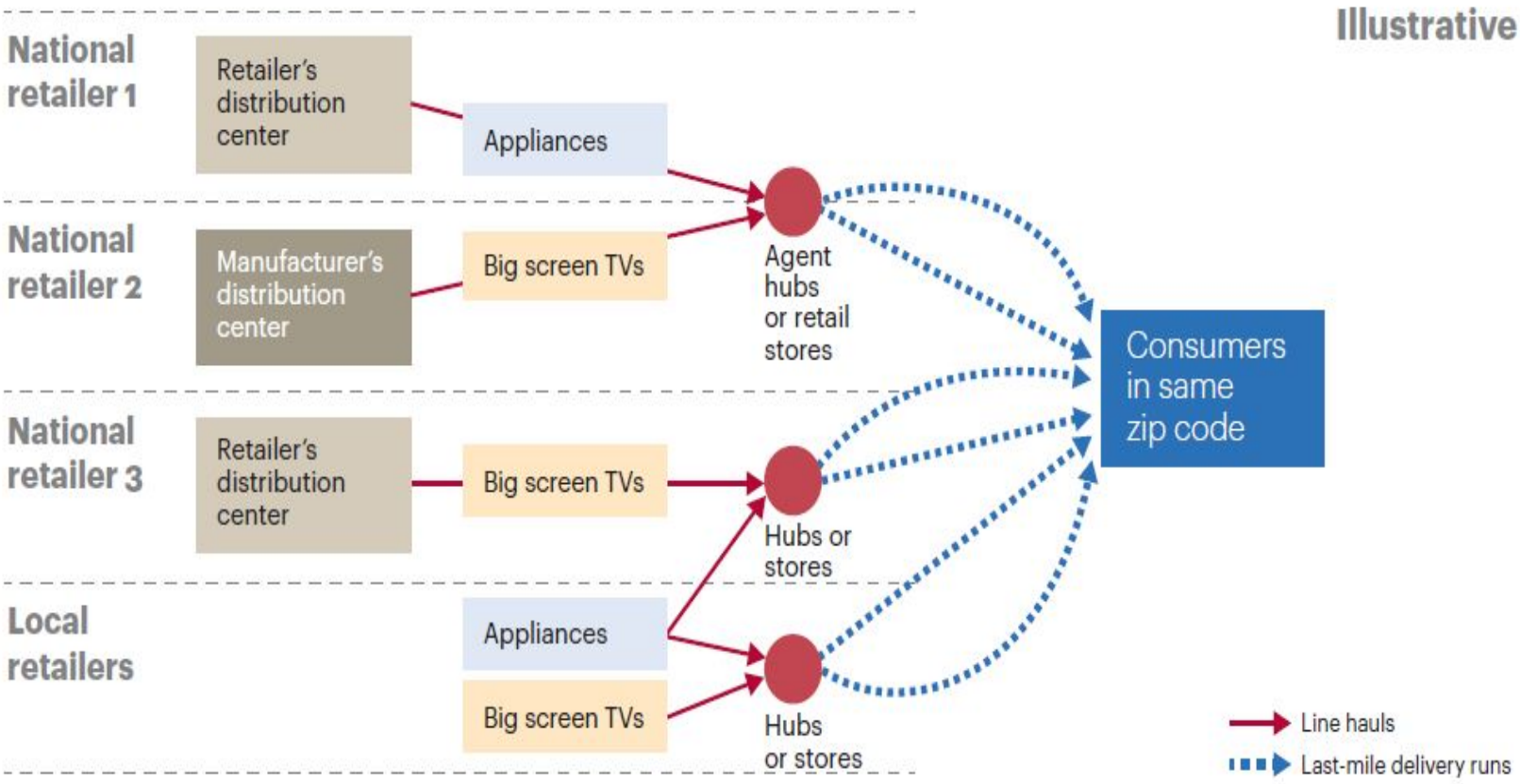
- Fragmented volumes
  - Multiple channels servicing the same market
  - Inefficient use of transportation
  - Utilizing multiple final mile carriers to service the same PC's
  - Acting independently has continued to drive up costs
  - Supplier and retailer very protective of their information and networks

- Customer has more choice and channels to purchase from
  - The rise of E-tailing (Omni channel and Market Place)
  - Specialty regionalized retailers (ELTE Mkt, Appliance Canada)

- Bottom Line
  - Decreased volume
  - Making decisions that impact customer negatively (decreased service days)
  - Increased cost per item/delivery
  - **Lack of critical mass**

Current state

The web of home delivery operating models is overly complex



At Kerney Heavy Lifting required July 2013

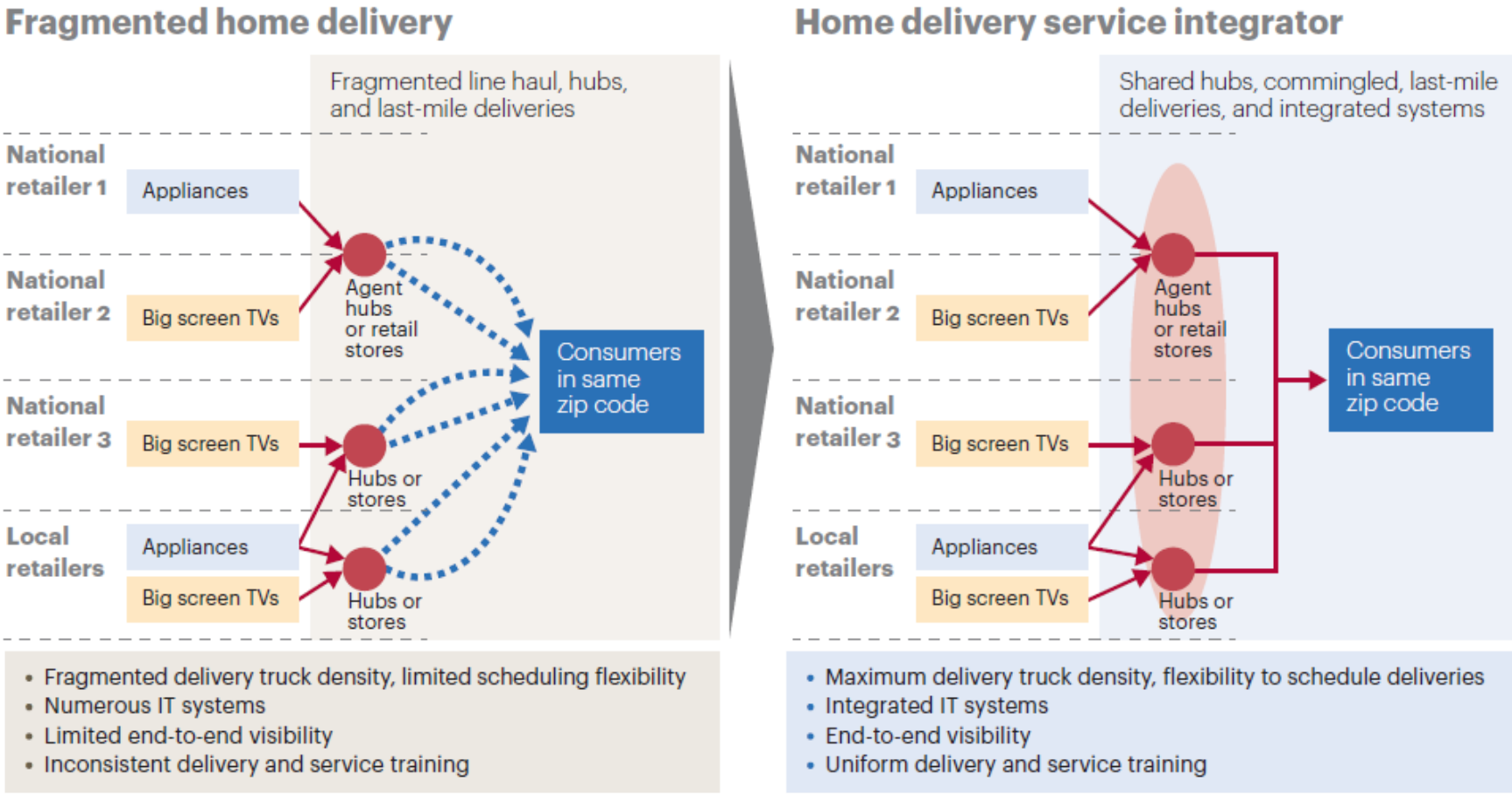
How to increase critical mass

- Sourcing 3rd party retailers and manufacturers to support their entire logistics and supply chain needs
  - LG Canada (drop ship and final mile for Costco.ca Canada)
  - US Mattress manufacturer (warehousing, inventory management and final mile for Costco)
- Providing system solutions to increase track and trace
  - Real time visibility all the time for manufacturers, retailers and customers
  - Cost savings and customer experience far out way the concern to protect information
- Enhanced customer experience
  - Multiple items delivered on the same day from multiple sources
  - Visibility and constant communication
- Combining volume to drive down CPC and CPS
  - Increased volume reduces miles between stops
    - attracts better driver teams

Future state

A home delivery service integrator could transform the industry

CL1



At Kerney Heavy Lifting required July 2013

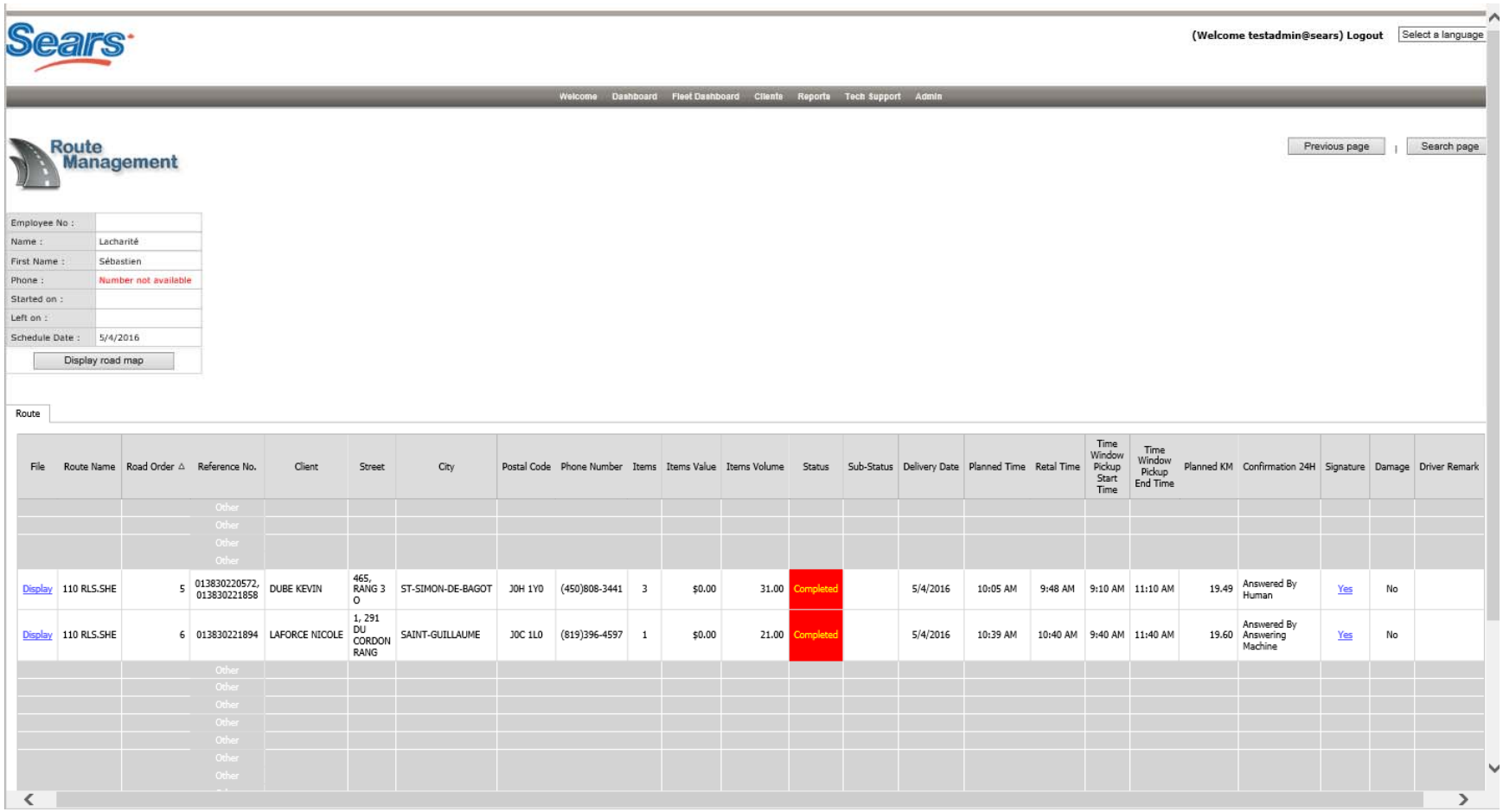
Slide 8

CL1 Christian Lafrance, 6/29/2016

Beyond the physical network

- Finding the right software to support this complex business requirement
  - Seamlessly integrated at every point
  - Provides real time visibility
  - Network optimization,
    - point of origin
    - 1st mile
    - drop ship
    - final mile
    - direct to home
  - Detailed reporting
  - Inventory integrity……and the list goes on!
- Ship to Home
  - From point of origin to customer

Optimized cube



Sears

(Welcome testadmin@sears) Logout | Select a language

Welcome | Dashboard | Fleet Dashboard | Clients | Reports | Tech Support | Admin

Route Management

Previous page | Search page

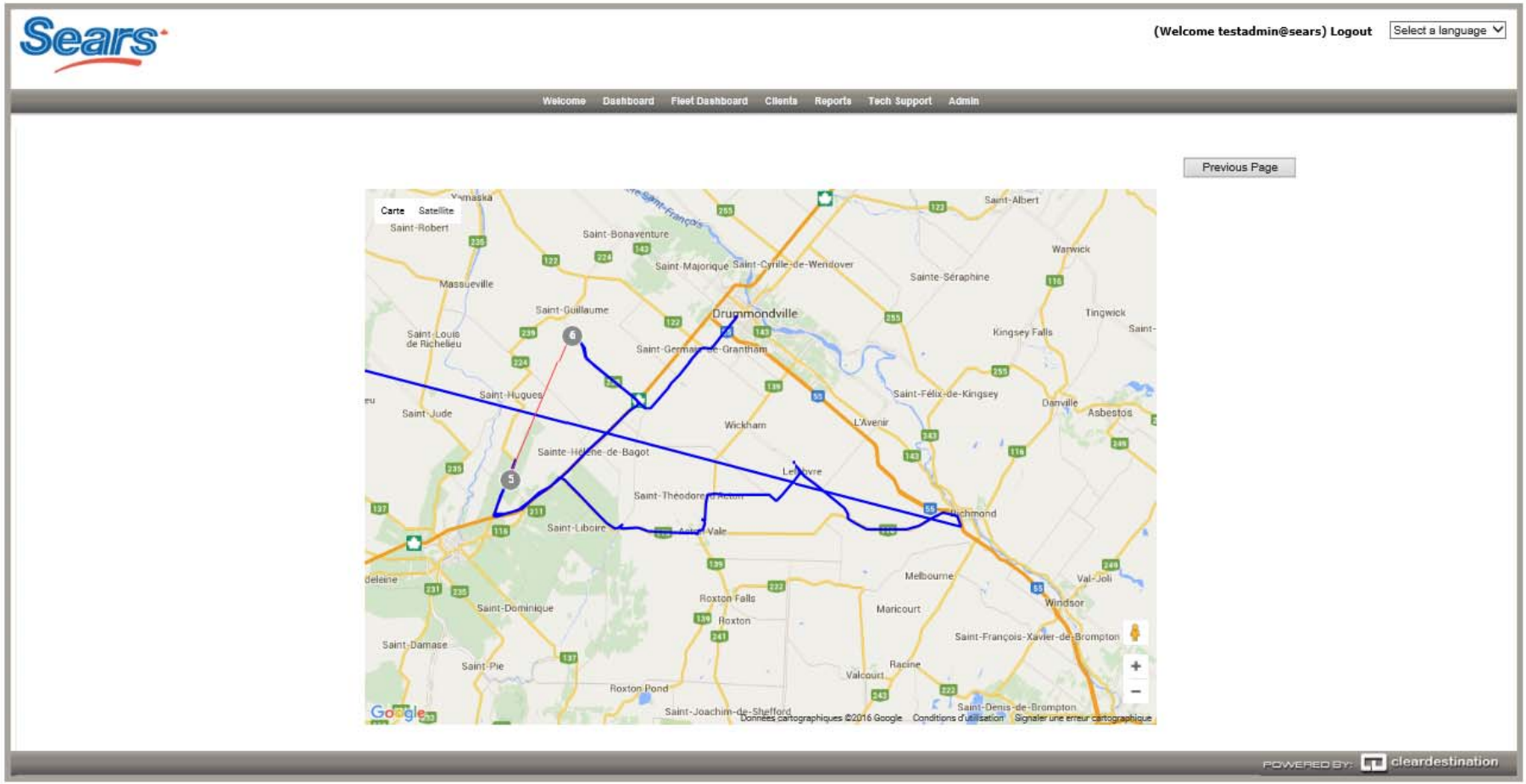
Employee No :	
Name :	Lacharité
First Name :	Sébastien
Phone :	Number not available
Started on :	
Left on :	
Schedule Date :	5/4/2016

Display road map

Route

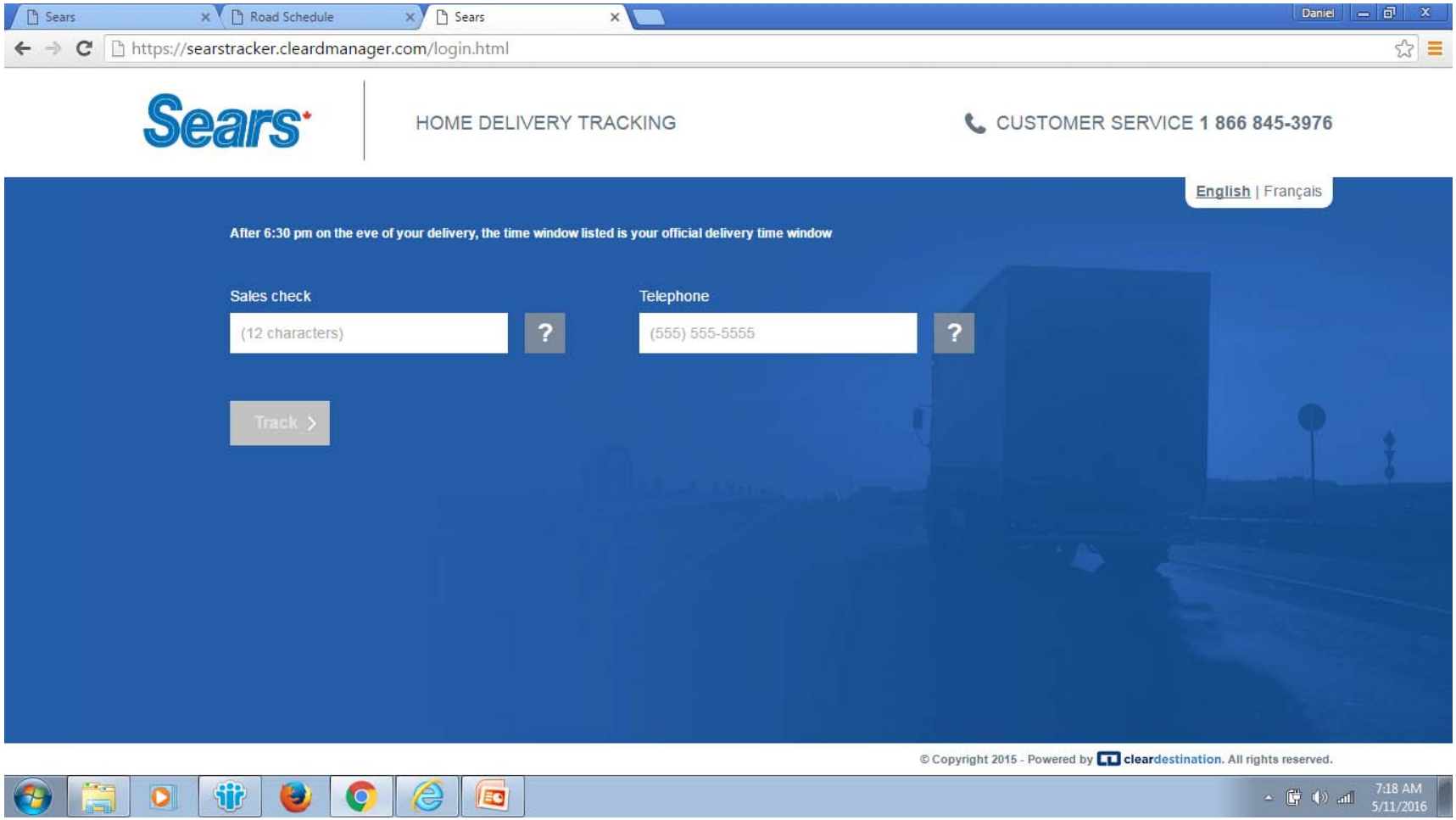
File	Route Name	Road Order	Reference No.	Client	Street	City	Postal Code	Phone Number	Items	Items Value	Items Volume	Status	Sub-Status	Delivery Date	Planned Time	Retal Time	Time Window Pickup Start Time	Time Window Pickup End Time	Planned KM	Confirmation 24H	Signature	Damage	Driver Remark
			Other																				
			Other																				
			Other																				
			Other																				
Display	110 RLS.SHE	5	013830220572, 013830221858	DUBE KEVIN	465, RANG 3 O	ST-SIMON-DE-BAGOT	J0H 1Y0	(450)808-3441	3	$0.00	31.00	Completed		5/4/2016	10:05 AM	9:48 AM	9:10 AM	11:10 AM	19.49	Answered By Human	Yes	No	
Display	110 RLS.SHE	6	013830221894	LAFORCE NICOLE	1, 291 DU CORDON RANG	SAINT-GUILLAUME	J0C 1L0	(819)396-4597	1	$0.00	21.00	Completed		5/4/2016	10:39 AM	10:40 AM	9:40 AM	11:40 AM	19.60	Answered By Answering Machine	Yes	No	
			Other																				
			Other																				
			Other																				
			Other																				
			Other																				
			Other																				
			Other																				

Optimized route



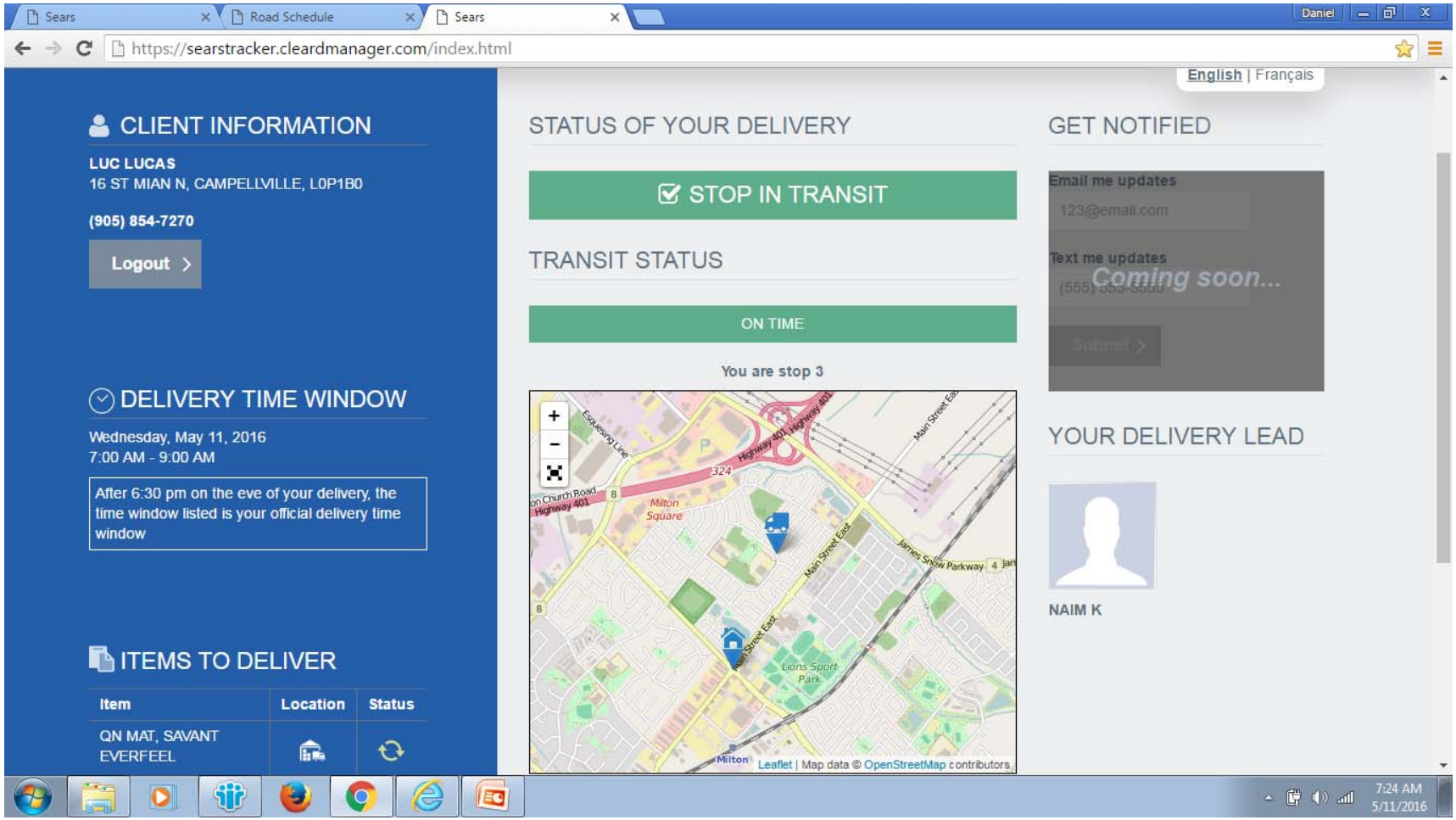
Online tracking tool

•customizable to the needs of the manufacturer or retailer (LG portal)



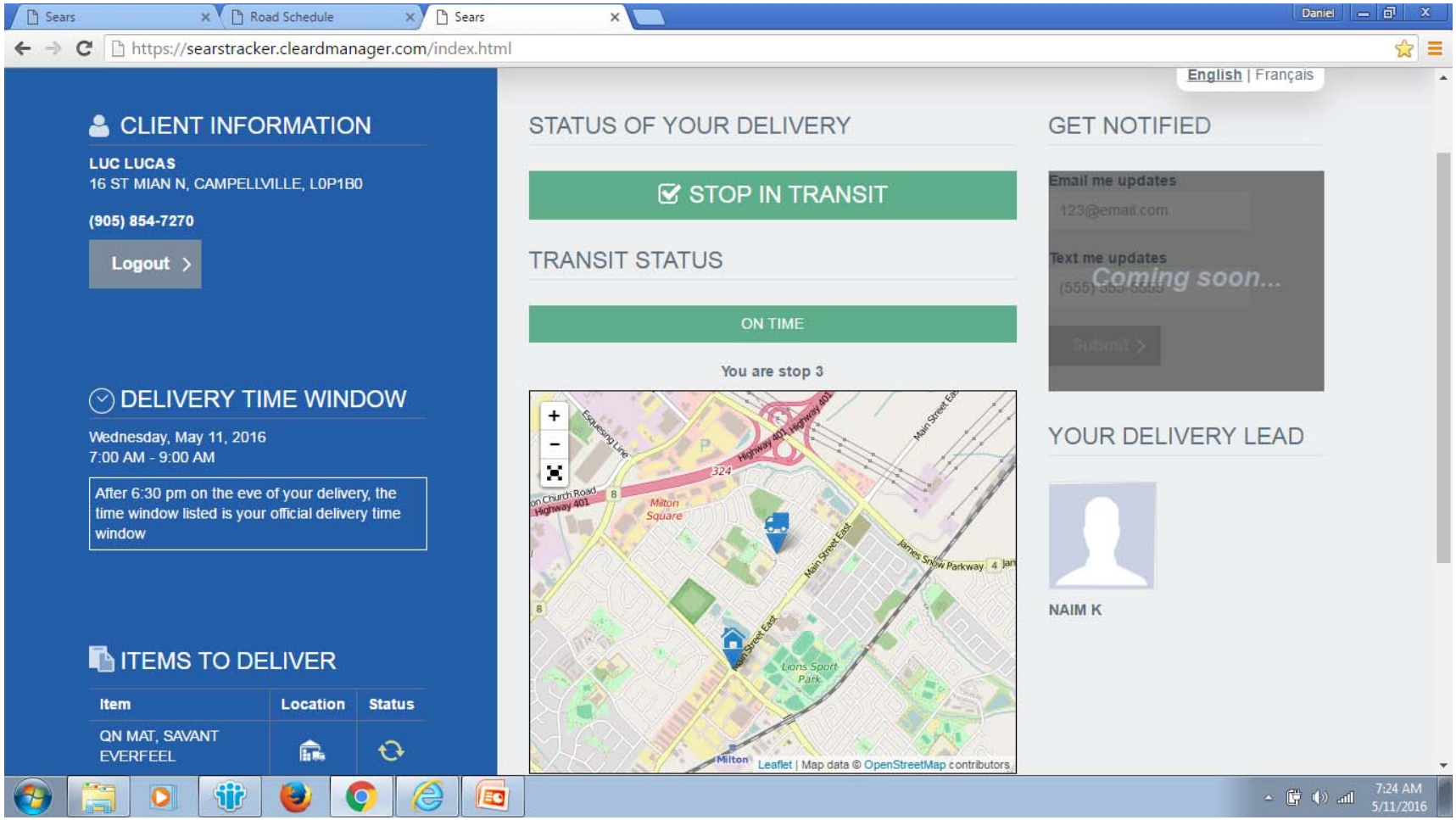
Online tracking tool

•real time visibility for customer……avoid the costly “not at home”



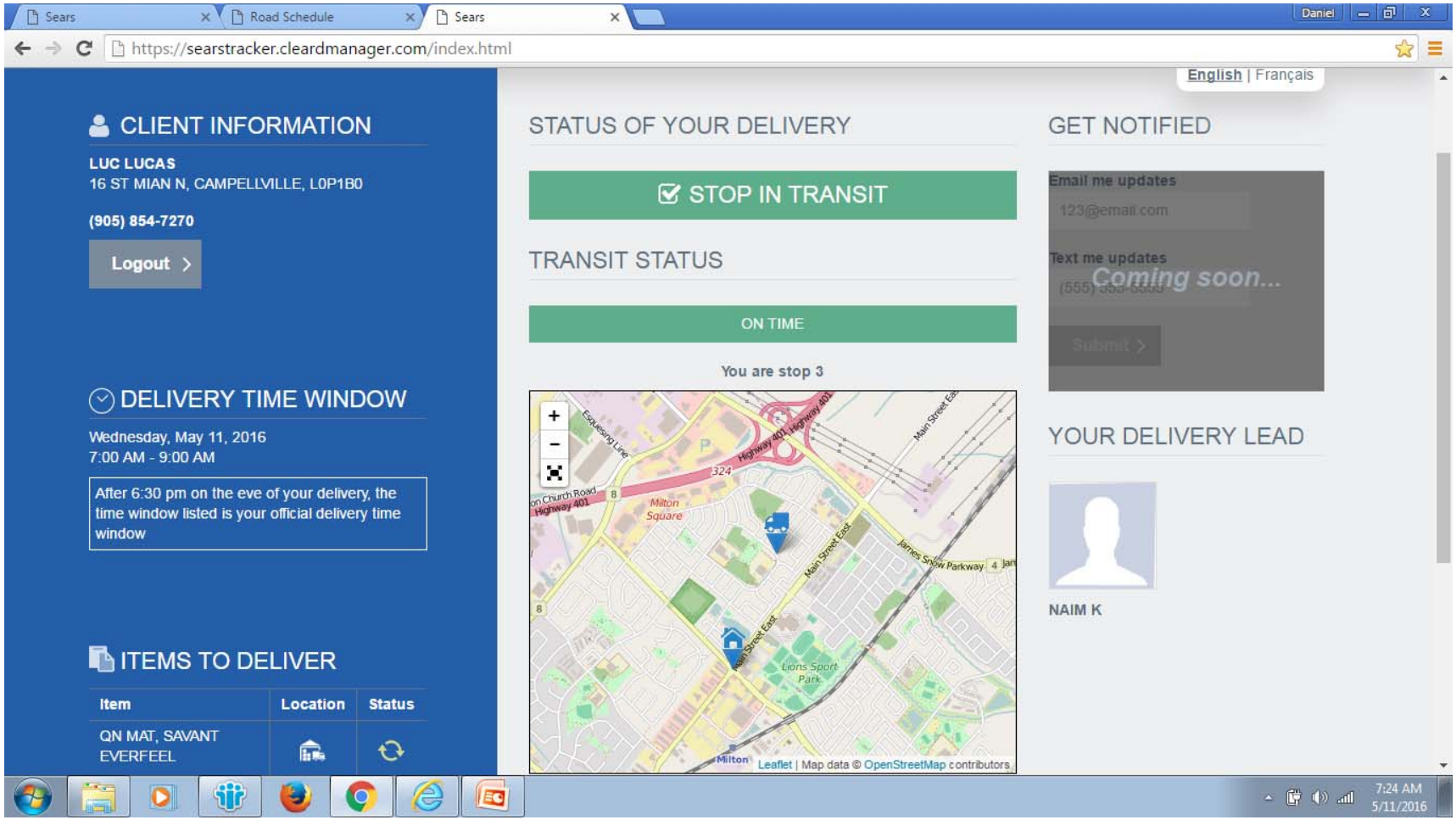
Online tracking tool

•customizable consumer communication



Online tracking tool

•off setting fraud and security risk by adding identifiable carrier information



Ship to Home benefits - bigger picture

- Ship to Home solution
  - Leveraging manufacturers inventory from multiple sources direct to consumer
  - Streamlined tools to manage the origin to consumer process
  - Optimizing the efficiency of freight movement
    - point of origin tracking
    - 1st mile
    - drop ship
    - final mile

- Real time alerts focused on maximizing cubage
  - Not important who you are it's about where you are

- Faster and reduced delivery cycles

Ship to Home benefits

- Reduced operational costs
- Reduced capital expenditures
- Reduced carbon footprint
- And ultimately
  - Improved customer experience
  - Improved sales platform

Conclusion

- Ship to home with support and input from Sears Canada is working towards changing collaborative to hyperconnected supply chain

- Ship to Home and Sears Canada have teamed up to lower costs associated to transportation at Sears Canada – proven success

- The Ship to Home program will benefit all retailers and product suppliers by reducing costs and increasing customer experience.

- Maximum collaboration equals maximum savings