

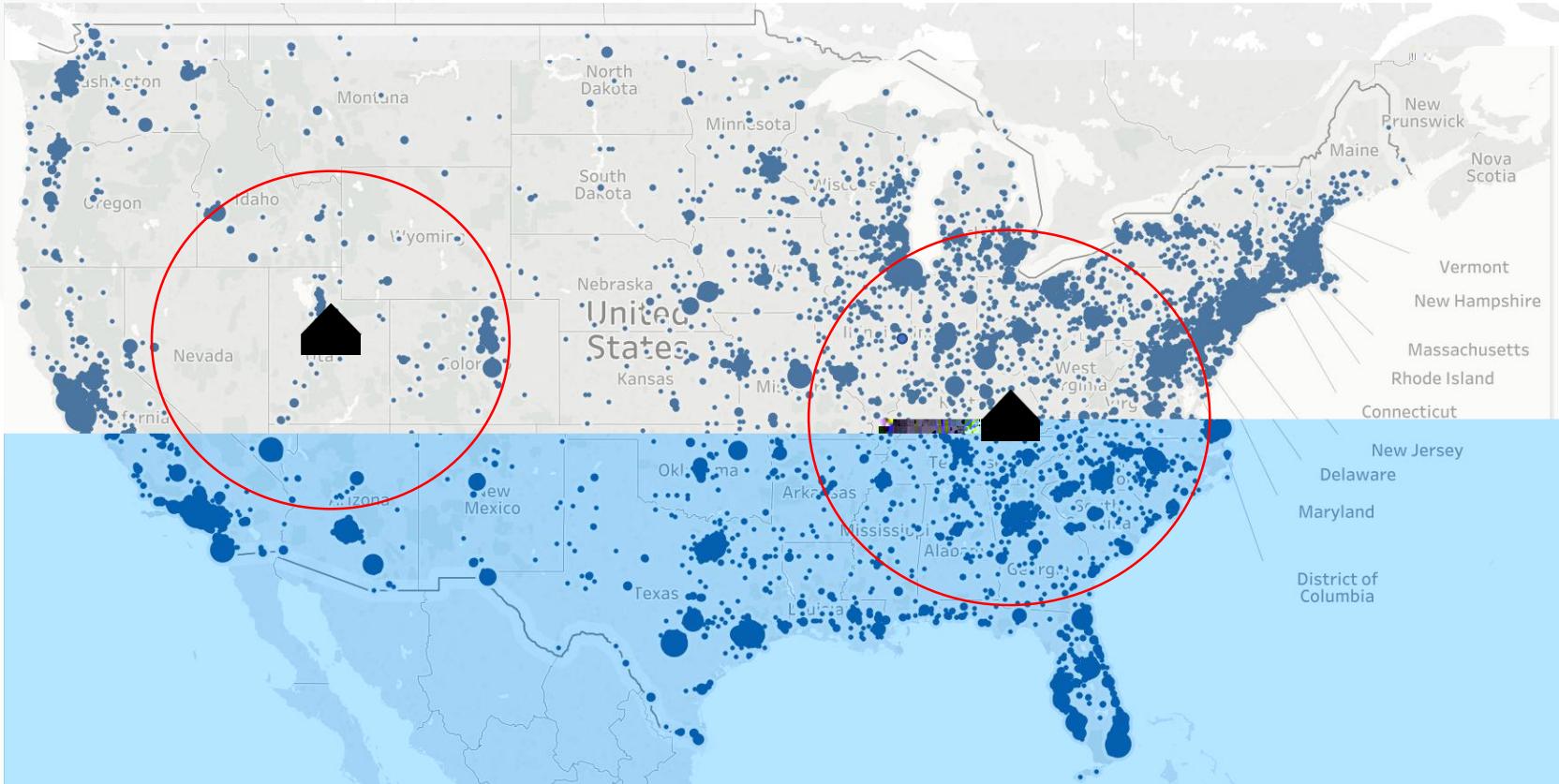


IPIC 2019 | 6th International Physical Internet Conference | London

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Online Order Fulfillment – Changing Business Environment^{[1]-[3]}

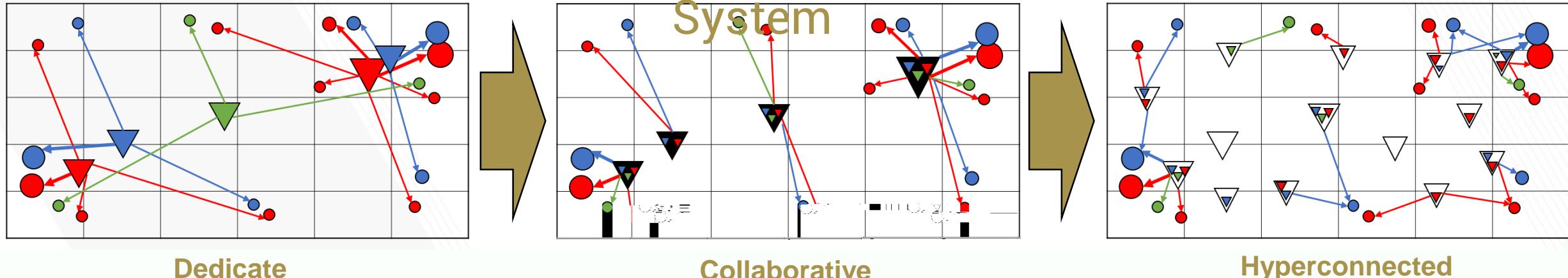


Service incapability causes customer dissatisfaction customer loss

Can hyperconnected fulfillment system be a solution to meet customer needs without tremendous capital investment?

Hyperconnected Distribution/Fulfillment System (HDS/HFS)

Transformation of Distribution/Fulfillment



Three dimensions of transformation to hyperconnected distribution

Resource, Operation, Players

Sourcing/Inventory/Transportation

Dynamic, Flexible
Integrated/Standardized
& Encapsulated

Unrestricted Multi-
player

New Business Model
Service Provider/User



Open
On-demand
Broader



Kim, Montreuil & Klibi, *Physical Internet Enabled Hyperconnected Fulfillment of Delivery Time Sensitive E-Commerce Orders*

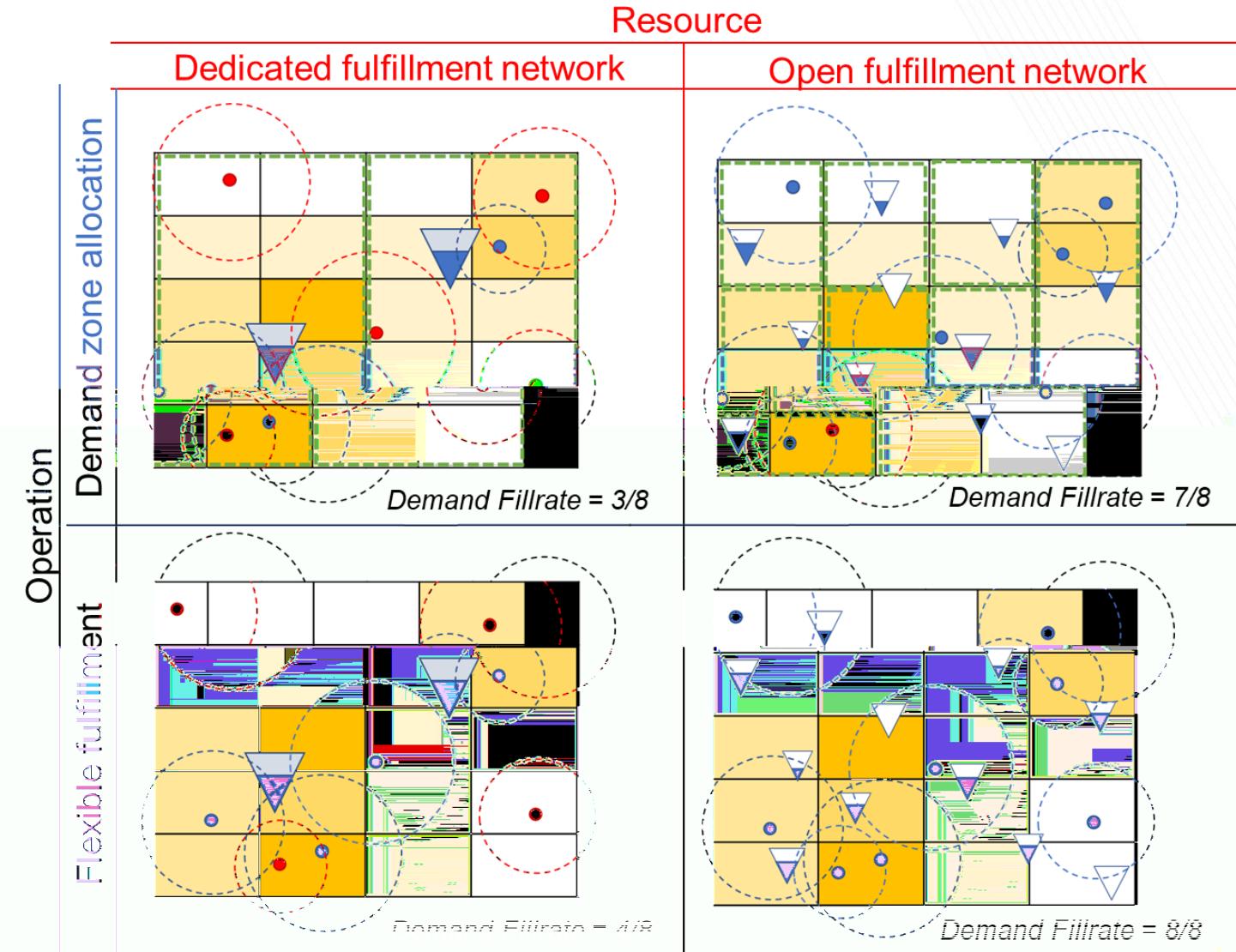
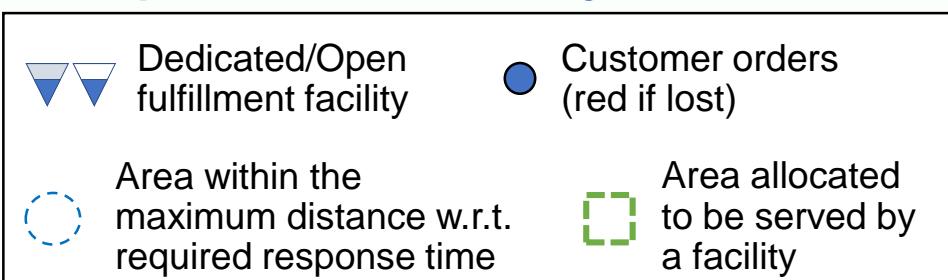
[4] Sohrabi et al., 2012; [5] Sohrabi et al., 2016; [6] Yang et al., 2017a; [7] Yang et al., 2017b, [8] Pan et al.,
6th International Physical Internet Conference (London) 2015

Georgia Tech
CREATING THE FUTURE

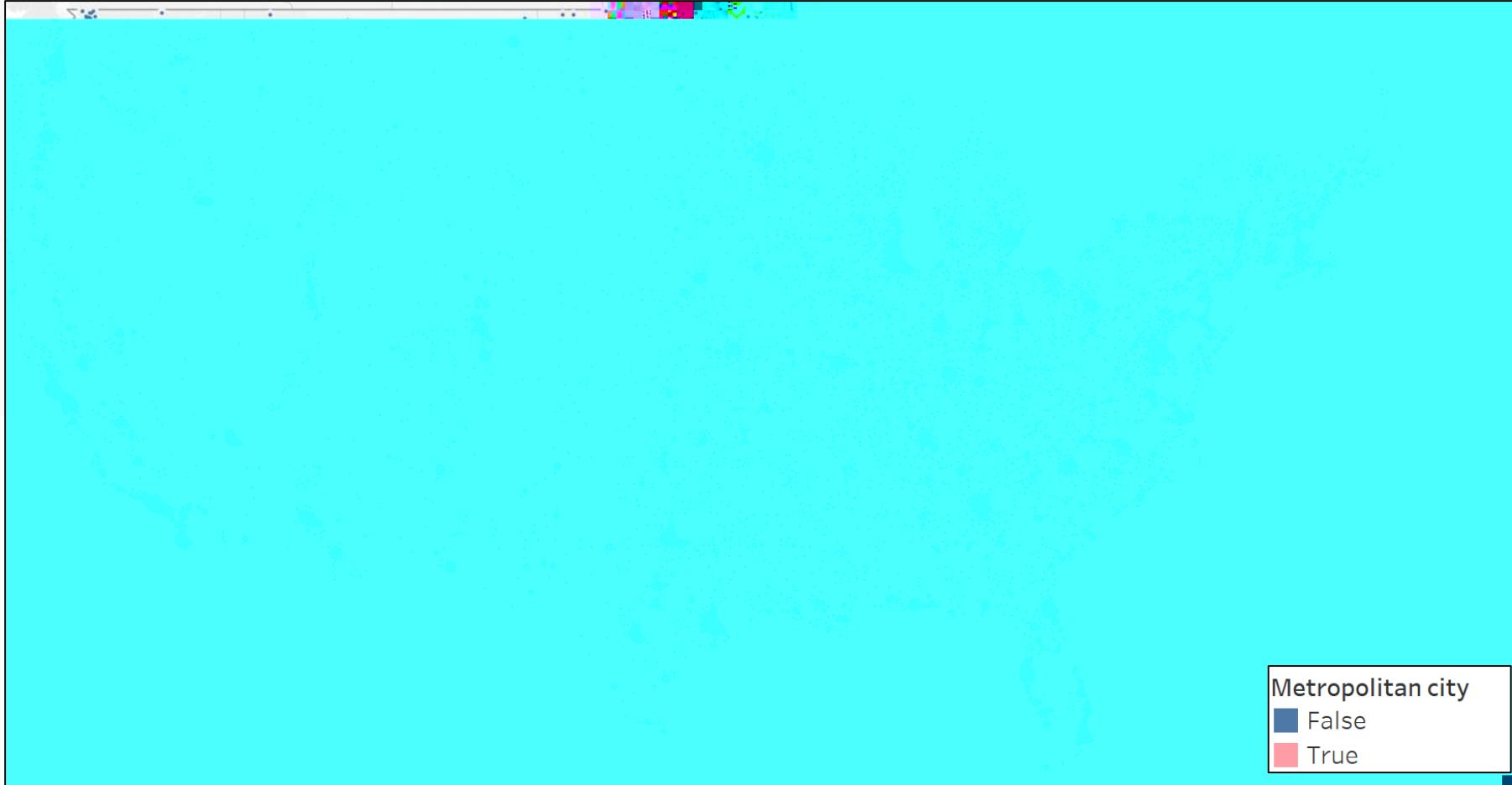
Hyperconnected Fulfillment System (HFS)

- Resource
 - Dedicated vs. Open FC network
- Operation (Sourcing)
 - Demand zone allocation vs. Flexible fulfillment

Demand fillrate can potentially be improved by increased **customer proximity** and flexible fulfillment from **pooled inventory**



Case Study: E-Commerce Manufacturer in USA Market



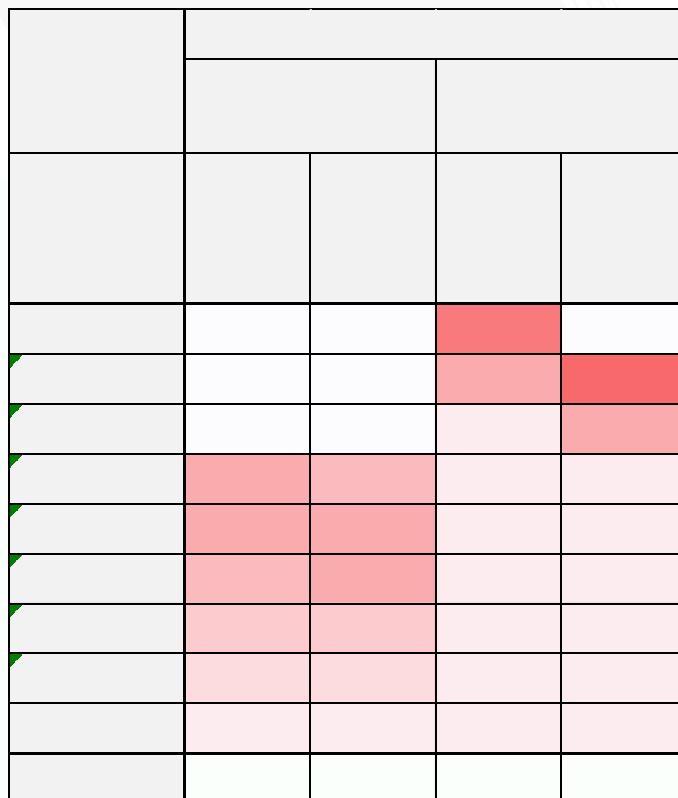
Assume customer require certain delivery lead time sensitive to area.

Demand will be lost if the lead time cannot be met.

Case Study: Scenario Design

Market Environment

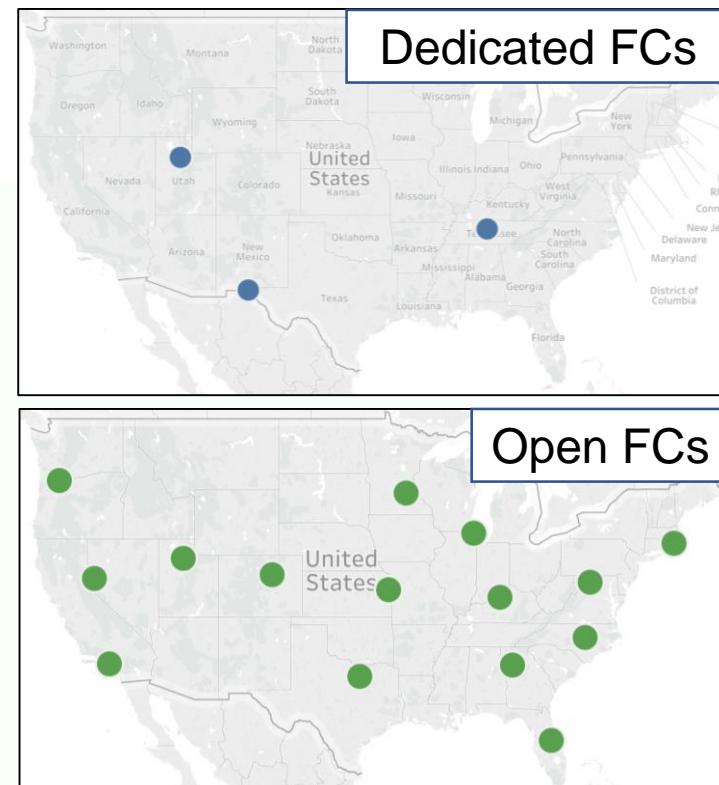
Customer requested delivery leadtime Fast vs. Slow



Resource

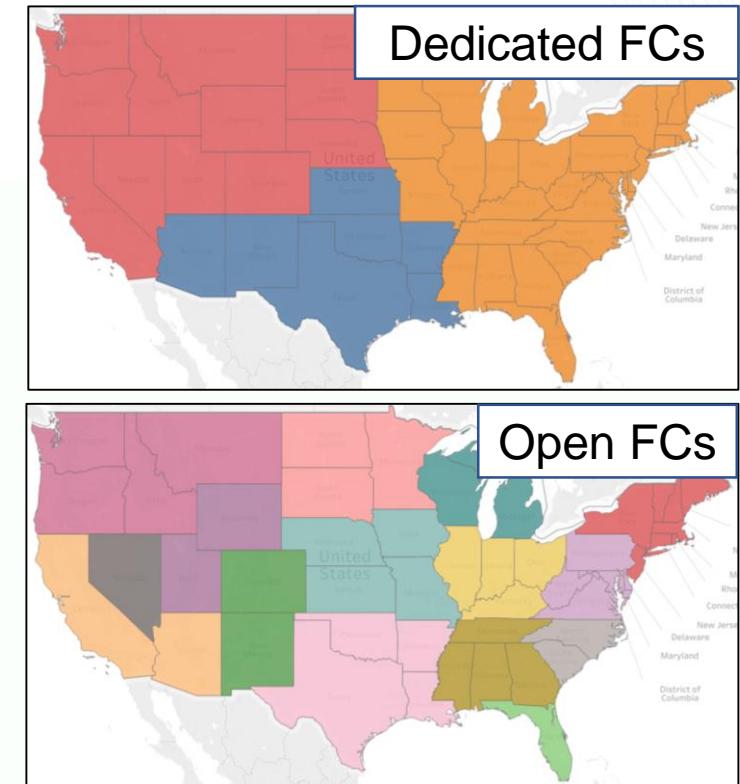
Fulfillment center network

Dedicated FCs vs. Open FCs



Operation

Sourcing (Zone allocation)
Single vs. Flexible sourcing
Inventory policy (level)
Low vs. Lean vs. High



Case Study Result: Lost Demand – Slow Delivery

Low Inventory

		Resource		
		Dedicated FC network	Open FC network	Market Gain (%)
Operation	Single sourcing			
	Flexible sourcing			
	Market Gain (%)			

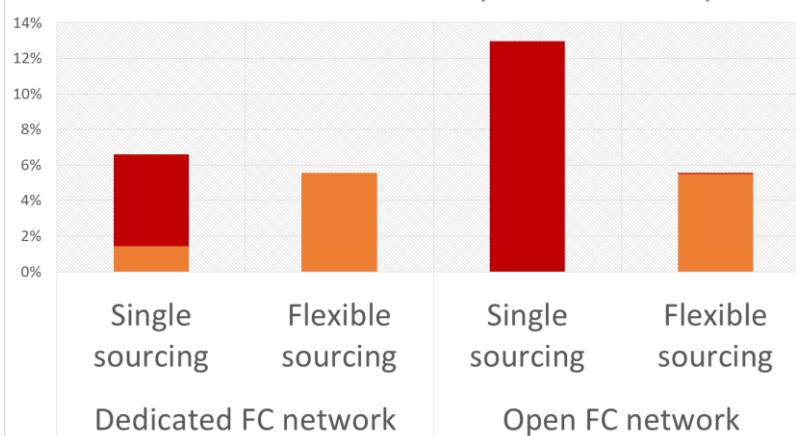
Lean Inventory

		Resource		
		Dedicated FC network	Open FC network	Market Gain (%)
Operation	Single sourcing			
	Flexible sourcing			
	Market Gain (%)			

High Inventory

		Resource		
		Dedicated FC network	Open FC network	Market Gain (%)
Operation	Single sourcing			
	Flexible sourcing			
	Market Gain (%)			

Demand Loss - Slow Delivery & Low Inventory



- Demand lost rate due to inventory shortage
- Demand lost rate due to service capability

- When inventory is low, open FC network with single sourcing (zone allocation) performs worse than dedicated FC network with single sourcing;
Smarter inventory allocation strategy is needed
- With flexible sourcing, only inventory shortage itself becomes bottleneck
- With slow delivery, the advantage of hyperconnected fulfillment for basic service capability is not seen

Case Study Result: Lost Demand – Fast Delivery

Low Inventory

		Resource		
		Dedicated FC network	Open FC network	Market Gain (%)
Operation	Single sourcing			
	Flexible sourcing			
	Market Gain (%)			

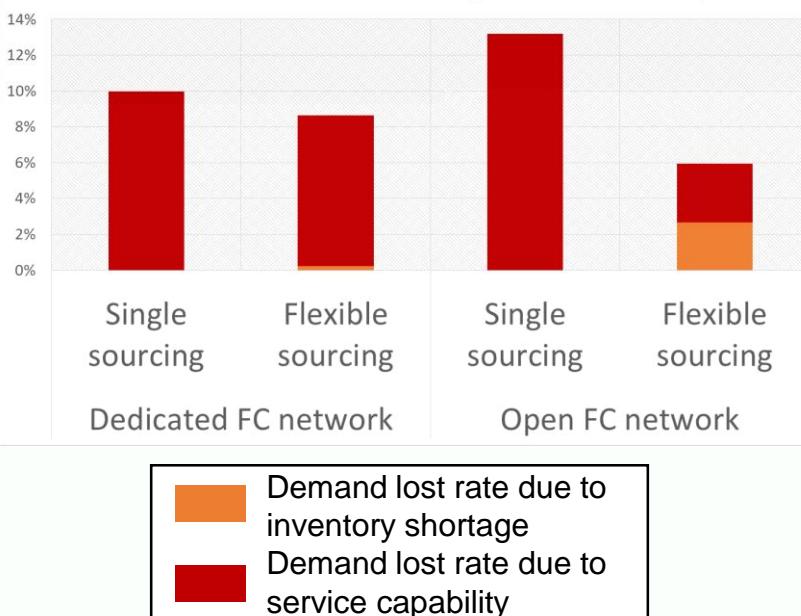
Lean Inventory

		Resource		
		Dedicated FC network	Open FC network	Market Gain (%)
Operation	Single sourcing			
	Flexible sourcing			
	Market Gain (%)			

High Inventory

		Resource		
		Dedicated FC network	Open FC network	Market Gain (%)
Operation	Single sourcing			
	Flexible sourcing			
	Market Gain (%)			

Demand Loss - Fast Delivery & Low Inventory



- Service capability becomes critical factor of demand loss
- With lean/high inventory, all demand loss is caused by service incapability and from metropolitan area
- 0.8% demand loss under open FC network and flexible sourcing with lean/high inventory can only be captured with additional FCs located closer to metro area

Case Study Result: Average Travel Miles Per Order

Slow Delivery

Low Inventory

		Resource		
		Dedicated FC network	Open FC network	Reduction Rate (%)
Operation	Single sourcing			
	Flexible sourcing			
	Reduction Rate (%)			

Lean Inventory

		Resource		
		Dedicated FC network	Open FC network	Reduction Rate (%)
Operation	Single sourcing			
	Flexible sourcing			
	Reduction Rate (%)			

High Inventory

		Resource		
		Dedicated FC network	Open FC network	Reduction Rate (%)
Operation	Single sourcing			
	Flexible sourcing			
	Reduction Rate (%)			

Fast Delivery

		Resource		
		Dedicated FC network	Open FC network	Reduction Rate (%)
Operation	Single sourcing			
	Flexible sourcing			
	Reduction Rate (%)			

		Resource		
		Dedicated FC network	Open FC network	Reduction Rate (%)
Operation	Single sourcing			
	Flexible sourcing			
	Reduction Rate (%)			

		Resource		
		Dedicated FC network	Open FC network	Reduction Rate (%)
Operation	Single sourcing			
	Flexible sourcing			
	Reduction Rate (%)			

- In most cases, average travel miles per order is reduced by about 70% by utilizing open FC network and flexible sourcing
- With single stop shipping, the travel miles directly represents proximity to customers

Conclusion and Future Research

Overall, ~6% of market gain and 73% delivery mile reduction potentials are shown with open FC network and flexible sourcing under tight delivery time constraints

- Measure the impact of hyperconnected fulfillment on cost, profit, and service considering deployment, distribution, and production
- Examine impact of transportation e.g. routing
- Optimal network selection:
select which open FC to use and how much and when to store or redeploy
- Extend to multi-product and/or multi-player operation

Thank you

- [1] Agatz, N. A., Fleischmann, M., & Van Nunen, J. A. (2008). E-fulfillment and multi-channel distribution—A review. *European journal of operational research*, 187(2), 339-356.
- [2] Lang, G., & Bressolles, G. (2013, January). Economic performance and customer expectation in e-fulfillment systems: a multi-channel retailer perspective. In *Supply Chain Forum: An International Journal* (Vol. 14, No. 1, pp. 16-26). Taylor & Francis.
- [3] Jie, Y. U., Subramanian, N., Ning, K., & Edwards, D. (2015). Product delivery service provider selection and customer satisfaction in the era of internet of things: A Chinese e-retailers' perspective. *International Journal of Production Economics*, 159, 104-116.
- [4] Sohrabi, H., Montreuil, B., & Klibi, W. (2016). On comparing dedicated and hyperconnected distribution systems: an optimization-based approach. In *International Conference on Information Systems, Logistics and Supply Chain (ILS2016)*. Bordeaux, France.
- [5] Sohrabi, H., Klibi, W., & Montreuil, B. (2012). Modeling scenario-based distribution network design in a Physical Internet-enabled open Logistics Web. In *International conference on information systems, logistics and supply chain*.
- [6] Yang, Y., Pan, S., & Ballot, E. (2017a). Innovative vendor-managed inventory strategy exploiting interconnected logistics services in the Physical Internet. *International Journal of Production Research*, 55(9), 2685-2702.
- [7] Yang, Y., Pan, S., & Ballot, E. (2017b). Mitigating supply chain disruptions through interconnected logistics services in the physical internet. *International Journal of Production Research*, 55(14):3970–3983.
- [8] Pan, S., Nigrelli, M., Ballot, E., Sarraj, R., & Yang, Y. (2015). Perspectives of inventory control models in the physical internet: A simulation study. *Computers & Industrial Engineering*, 84:122–132.