The Impact Of Emerging Technologies on Freight Transportation and Land Use

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The Webinar...

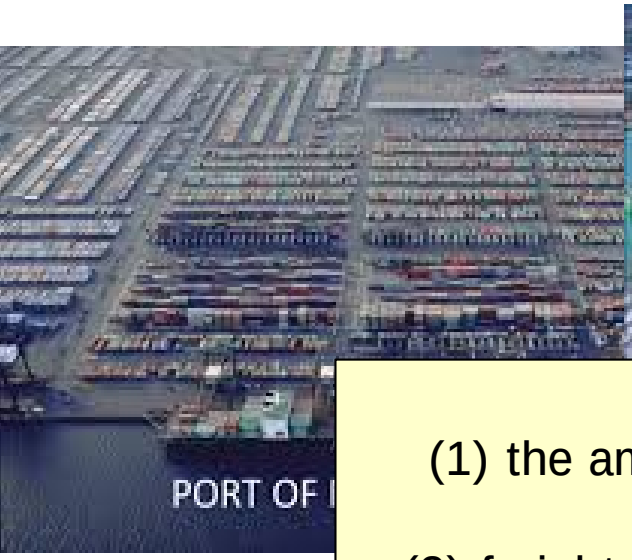
- JHV
  - Metropolitan Economies and Freight Activity
  - Potential Impacts on Land Use
- Kazuya Kawamura
  - What should transportation agencies do ?
- Catherine Lawson
  - What should land use agencies do ?

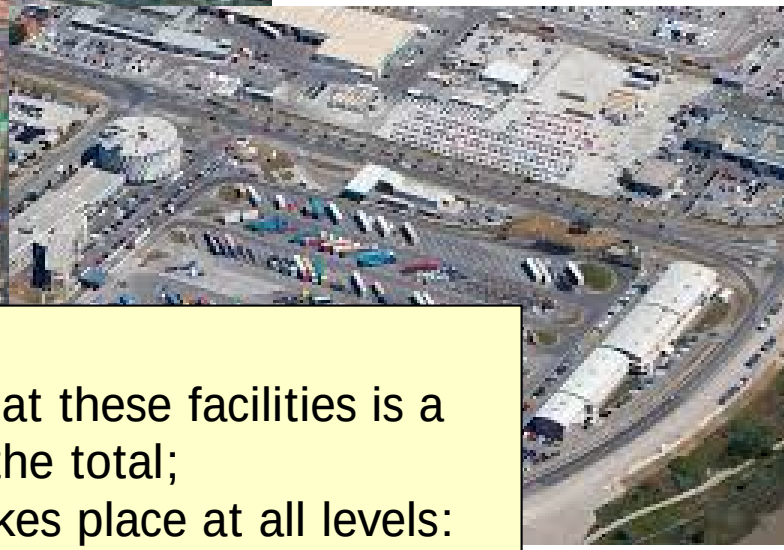
The JHV Principle:
Complex Problems Do Not Have Easy Solutions
Sorry ... There Are No Magic Bullets

About the Freight System and Its Activity

When people think of freight, most think about...

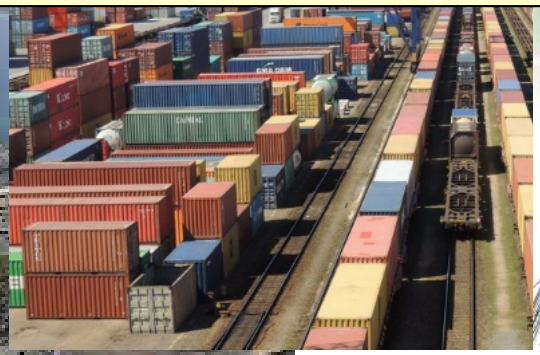
Intermodal terminals





In reality:
(1) the amount of freight activity at these facilities is a minuscule portion of the total;
(2) freight activity takes activity takes place at all levels: global, national/regional, metropolitan/urban, neighborhood, block, household/establishment

and DCs



Metropolitan Economies and Freight Activity

Freight and the metropolitan economies...

- 60% of Global GDP → Produced in top 600 cities
- In the US, metro/micropolitan areas represent:
  - 83% of establishments, 78% of employment, and 76% of the value of manufactures
  - 80% of US cargo transported (top 100 metro areas)
- Statistics about freight transported:
  - USA (entire country) → USA: 114 kg/person-day
  - New York City, USA → 45 kg/person-day
  - Beijing, China → 35 kg/person-day
  - Medellin, Colombia → 25 kg/person-day
  - Port-au-Prince, Haiti → 8 kg/person-day
- Amount of cargo transported increases with income... with rising incomes → Things will get worse

Economic Classification Systems

- Economic Classification Systems (NAICS, SIC, etc.) cluster commercial establishments taking into account the nature of activity

NAICS	Freight-Intensive Sectors (FIS)
11	Agriculture, Forestry, Fishing, Hunting
21	Mining, Quarrying, Oil / Gas…
22	Utilities
23	Construction
31-33	Manufacturing
42	Wholesale Trade
44-45	Retail Trade
48-49	Transportation and Warehousing
72	Accommodation and Food Services

NAICS	Service-Intensive Sectors
51	Information
52	Finance and Insurance
53	Real Estate and Rental and Leasing
54	Professional,Scientific,Tech. Services
55	Management of Companies /
56	Administrative,Support,Waste Manag.
61	Educational Services
62	Health Care and Social Assistance
71	Arts, Entertainment, and Recreation
81	Other Services
92	Public Administration

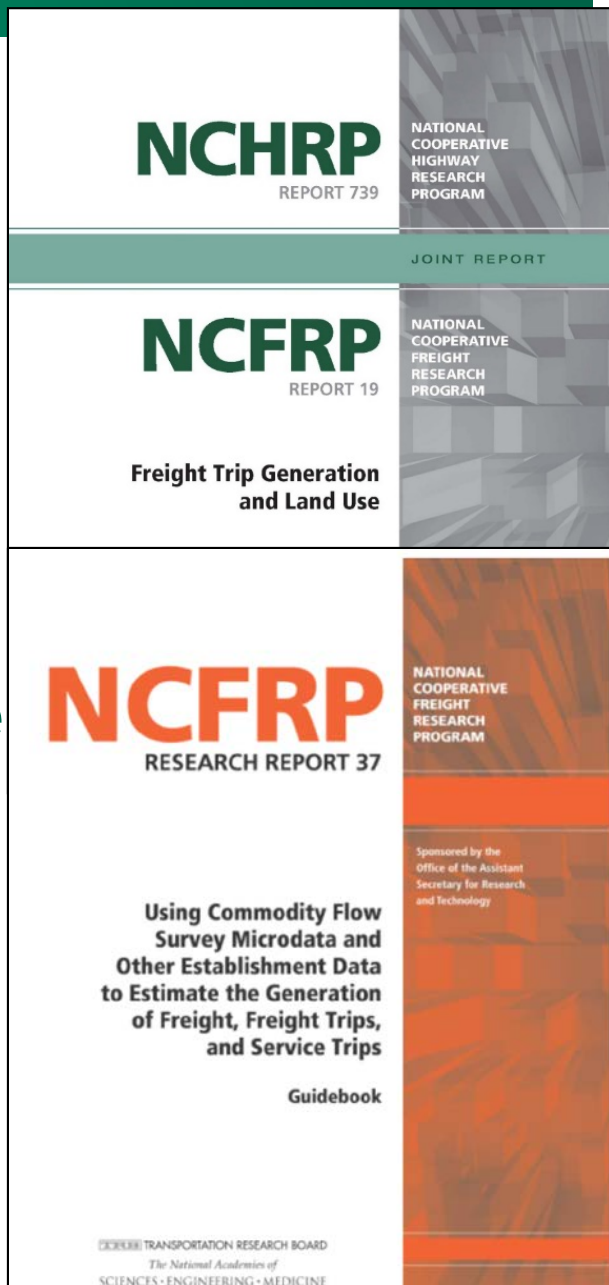
45% of establishments and about half the employment are in FIS

Freight Trip Generation Techniques

- Based on Establishment Surveys
  - Collected data about **deliveries** received and **shipments** sent out
  - Estimated models to predict deliveries and shipments using employment
  - Freight-Trip Generation is estimated from the deliveries and shipments
  - More accurate, flexible, and transferable than any other modeling alternative

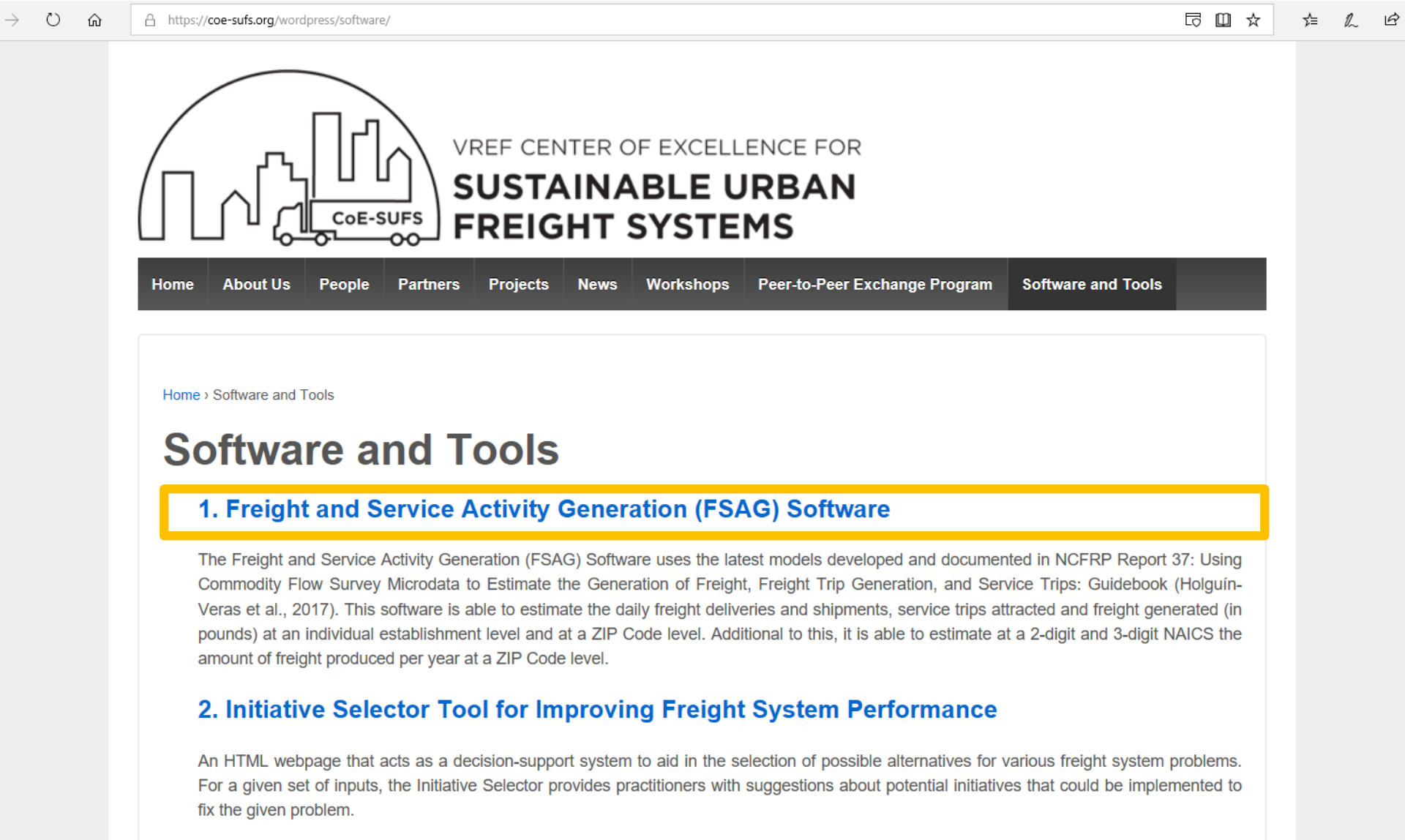
$$FTA = \frac{FD}{CF_{FTA}} = \frac{\text{Deliveries Received}}{\text{Avg. Deliveries per trip}}$$

$$FTP = \frac{FS}{CF_{FTP}} = \frac{\text{Shipments Sent Out}}{\text{Avg. Shipments per trip}}$$

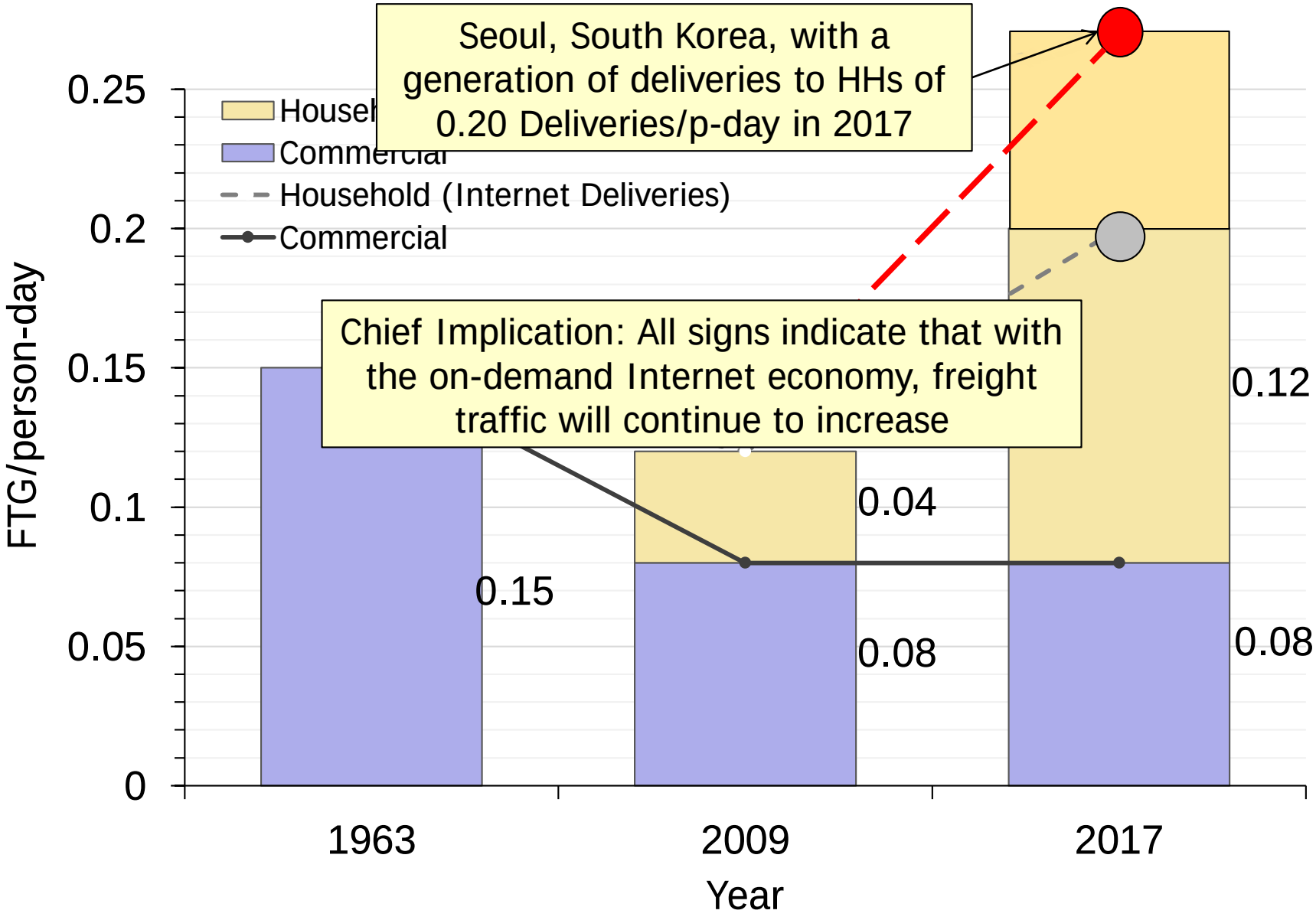


Software Available at COE-SUFS webpage

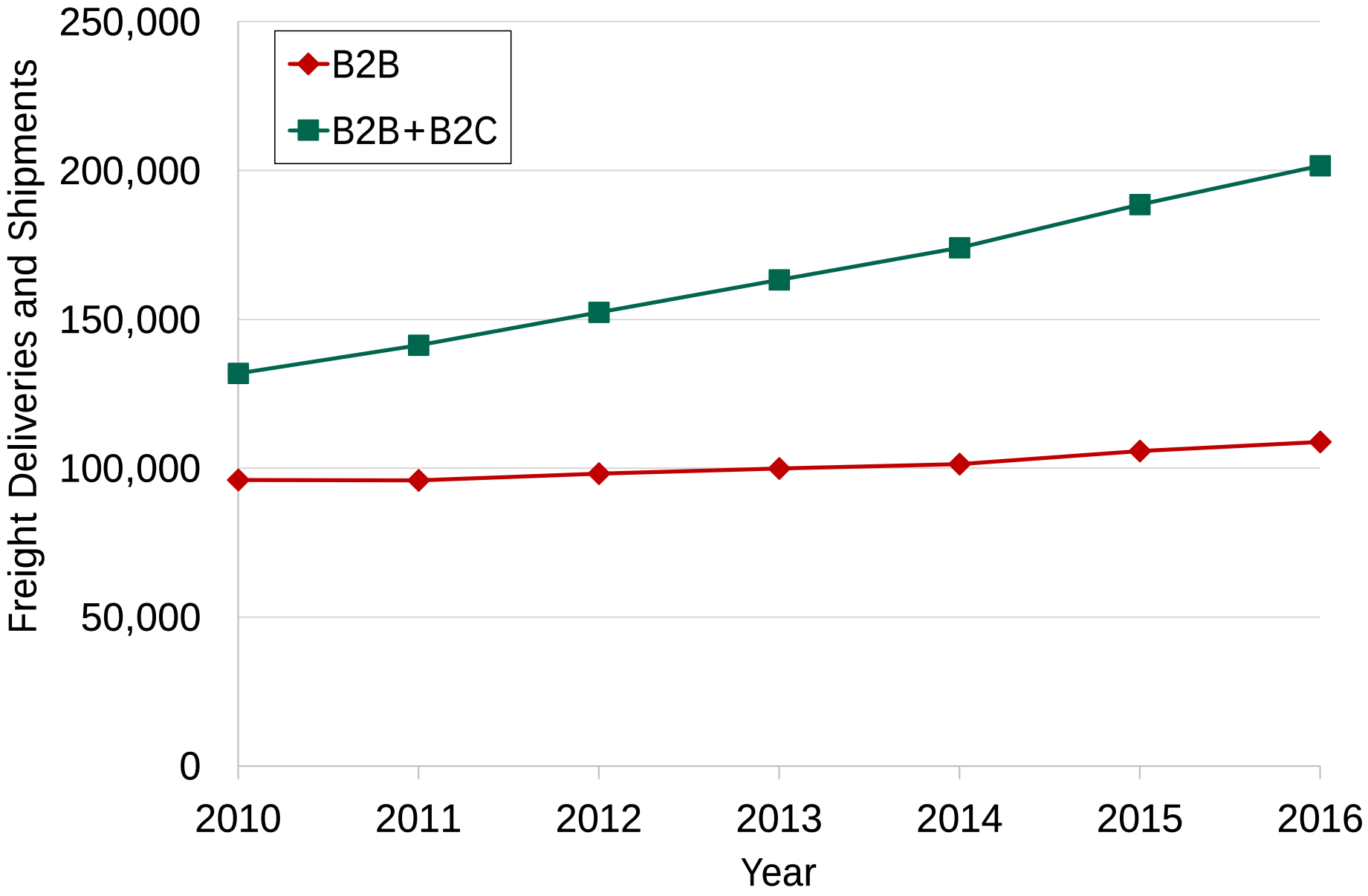
❖ https://coe-sufs.org/wordpress/software/



A Long View of Freight Trip Generation



Estimated Delivery Trends in Charlotte, NC



Freight Activity in the Freight-Intensive Sectors

NAICS	Description	Kansas City, KS	Austin, TX	Colum-bus, OH	San Jose, CA	Seattle, WA	Washin-gton, DC	Boston, MA	New York, NY
44-45	Retail Trade	32.47%	38.58%	38.44%	32.09%	32.90%	35.01%	33.52%	36.17%
72	Accommodation/Food	12.84%	21.01%	18.04%	15.57%	19.59%	40.91%	35.07%	16.06%
42	Wholesale Trade	15.02%	15.63%	14.68%	19.93%	17.05%	10.89%	12.81%	22.27%
31-33	Manufacturing	12.95%	8.21%	10.97%	13.77%	9.27%	1.70%	3.82%	5.24%
48-49	Transportation/Warehouse	11.20%	7.79%	11.75%	7.92%	12.77%	5.89%	11.25%	13.00%
Total FTG in FIS		16,553	106,056	82,096	74,096	107,419	48,065	39,408	802,472
Total FTG for all sectors		17,277	117,216	87,997	80,165	117,681	56,647	43,929	873,380

45-75% of FTG by Retail and Accommodation/Food
(60-85% if Wholesale is included)

28-53% generated by small establishments (less than five employees)
43-68% by less than nine employees...

Key Trends and Technologies

Most Relevant Trends

Economic Trends

- Globalization
- Anti-globalization
- Internet economy
- Sharing economy
- Advanced manufacturing

Technological Trends

- Novel vehicular technologies
  - Unmanned delivery vehicles
  - Connected and autonomous trucks
- Artificial Intelligence and big data
- Internet of Things (IoT)
- Electrification

Societal Trends

- Urbanization

Environmental Trends

- Rising environmental Awareness

In the short and medium-term, the most impactful forces on land use are: Internet Economy and Novel Vehicular Technologies

Levels of Impacts

Trends impact these choices

Individual Decisions

Geographical area
- Local/Urban
- Regional/Metropolitan
- National/Global

Land use choices
- Distance to suppliers or customers
- Establishment size
- Number of establishments

Logistical choices
- Total demand
- Shipment frequency
- Shipment size

System-level Impacts

Direct Land-use impact
- Density
- Land value
- Land use diversity

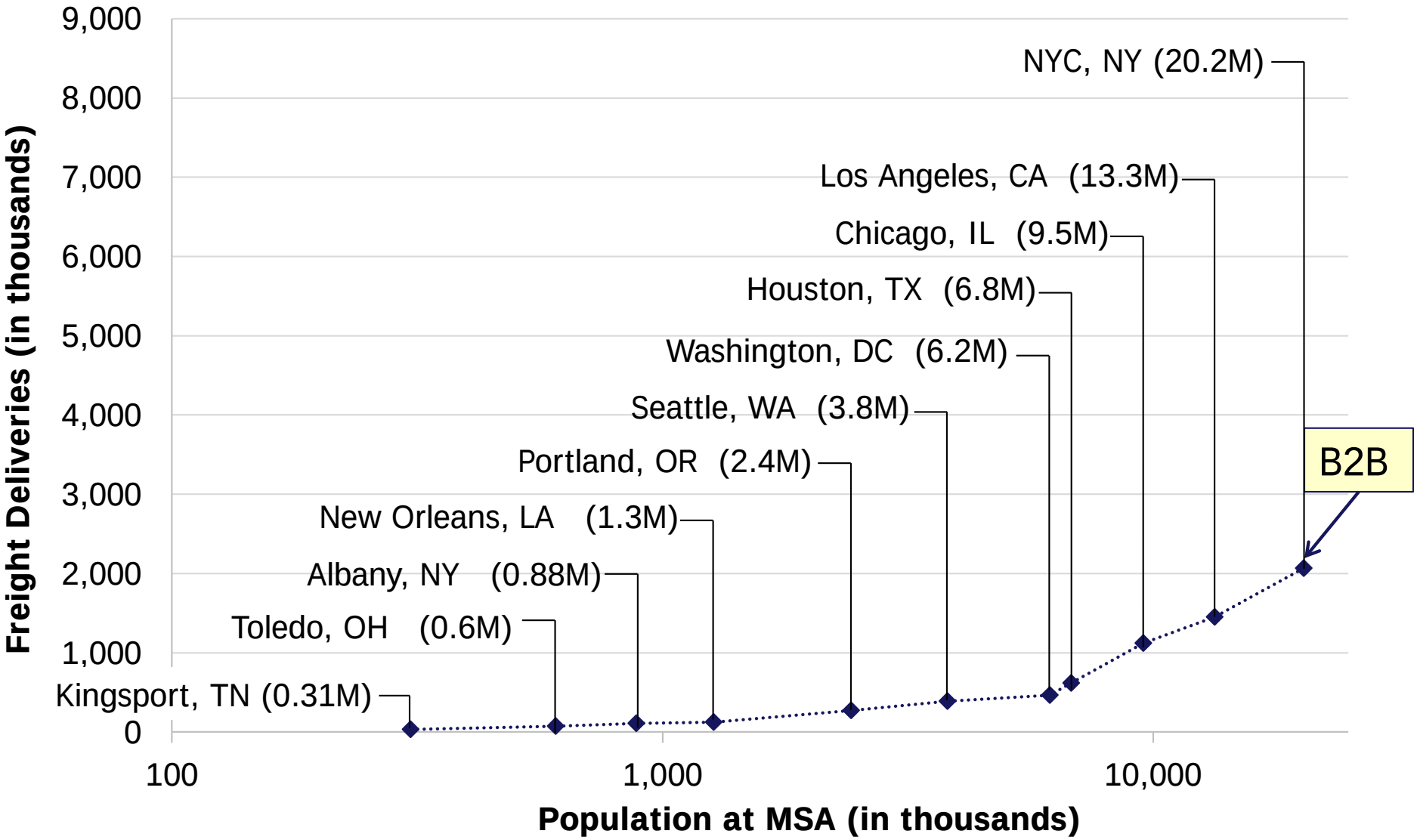
Direct Transportation impact
- Travel time
- Truck VMTs
- Truck trips

Externalities
- Congestion
- Pollution (noise, air)
- Pavement damage

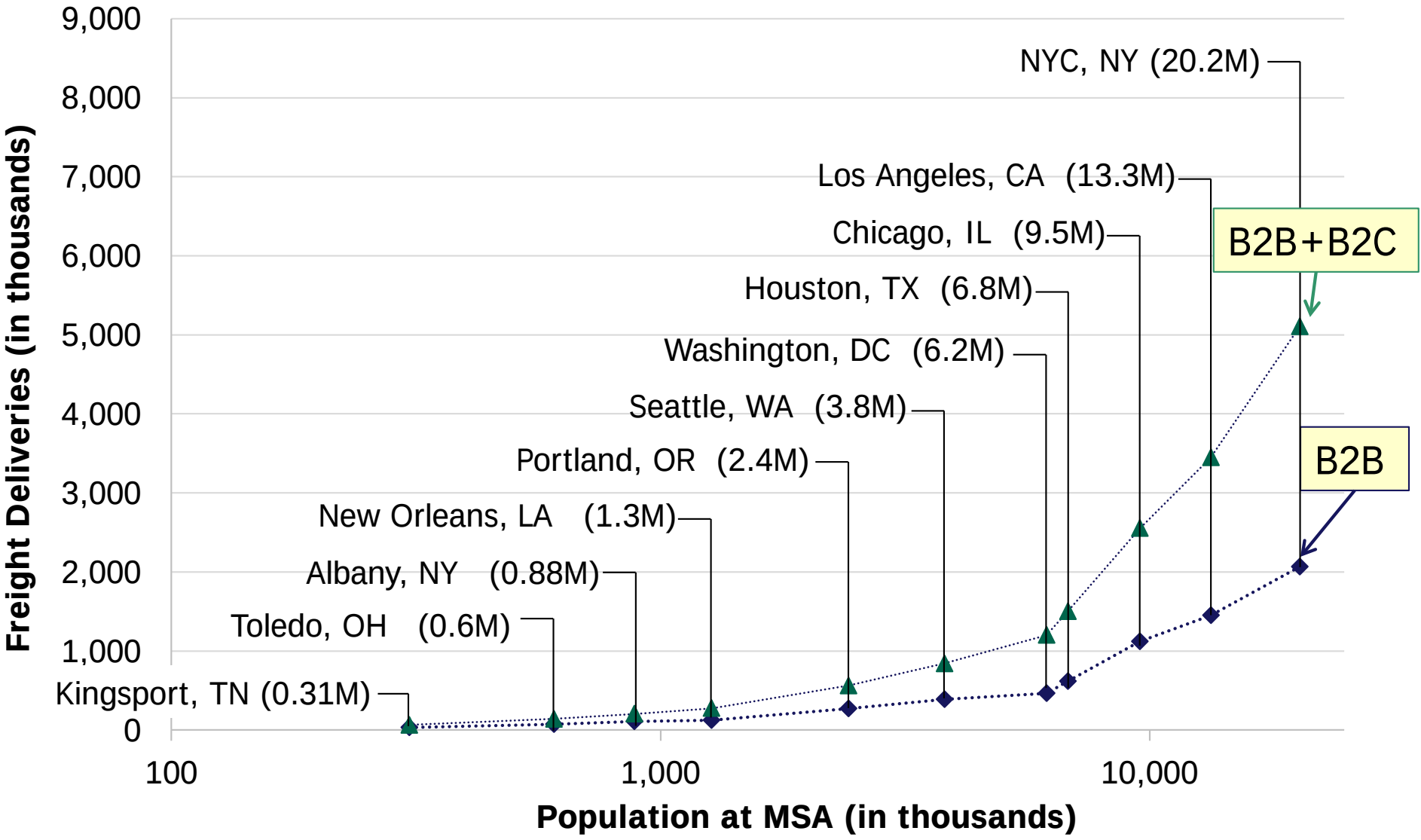
Impacts at the system level will depend on the net effects produced by the counterbalancing forces

The Impacts of the Internet Economy

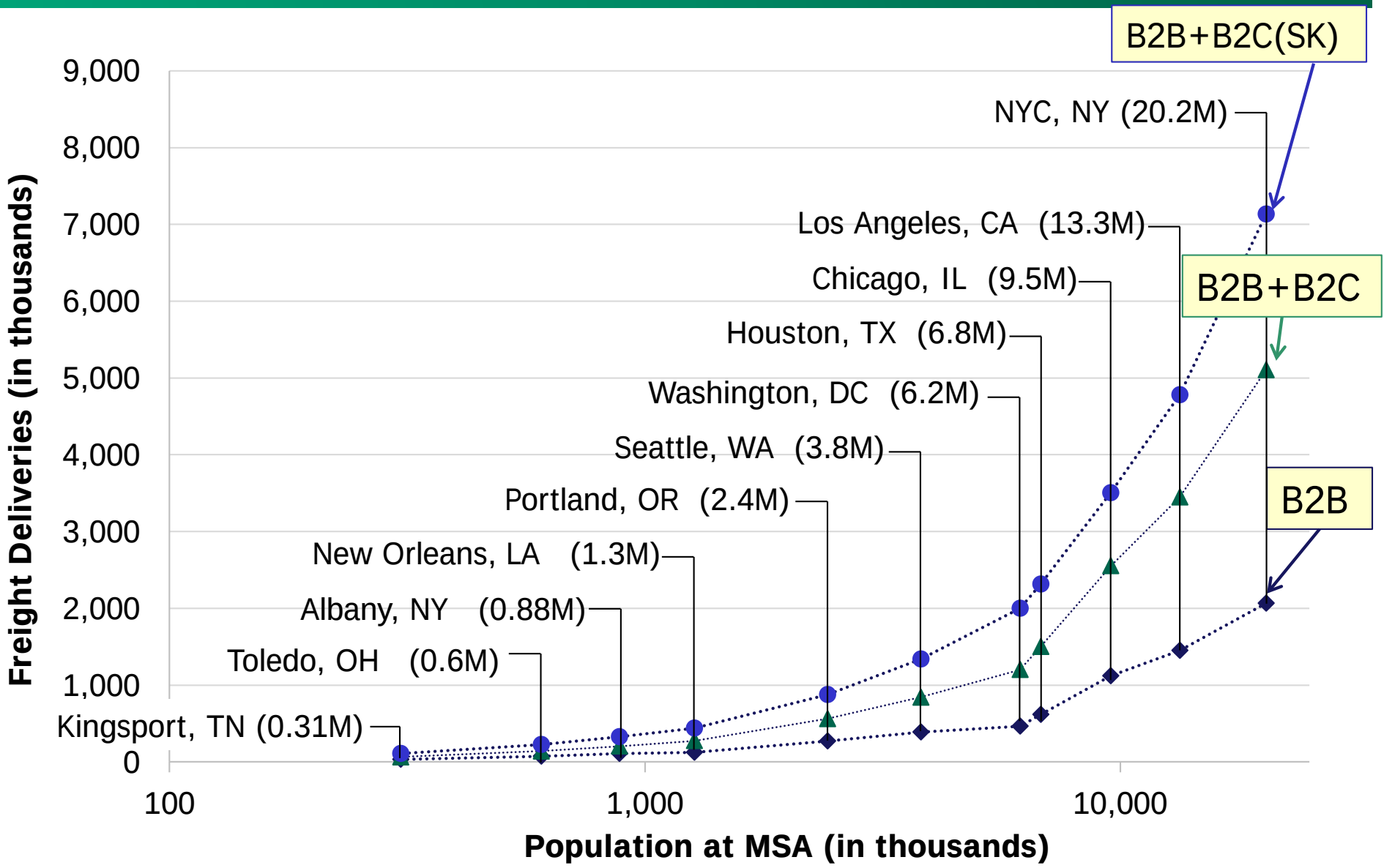
Base Activity (B2B)



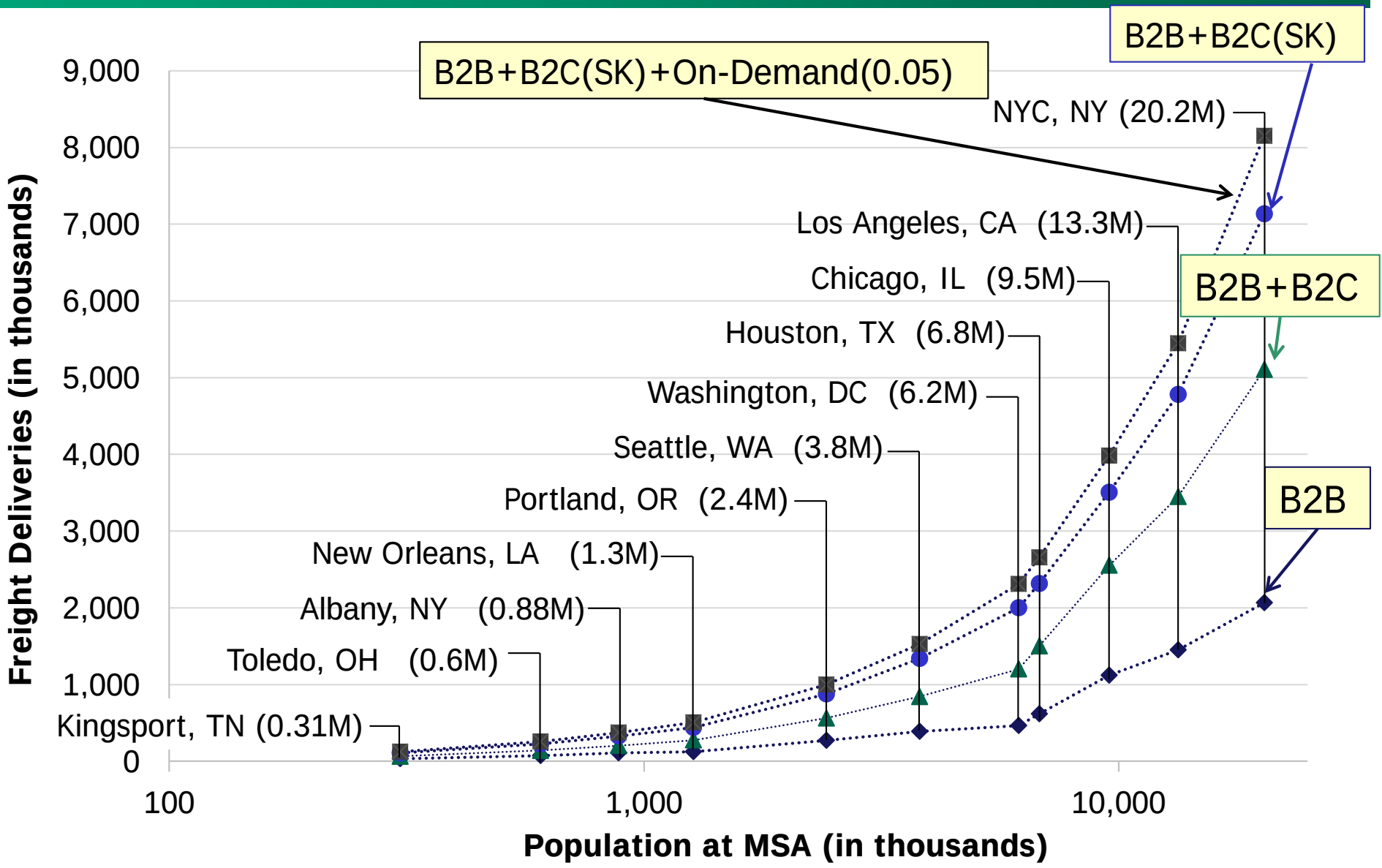
B2B + Internet Deliveries (B2C)



B2B + B2C @ South Korea's Rate, B2C(SK)

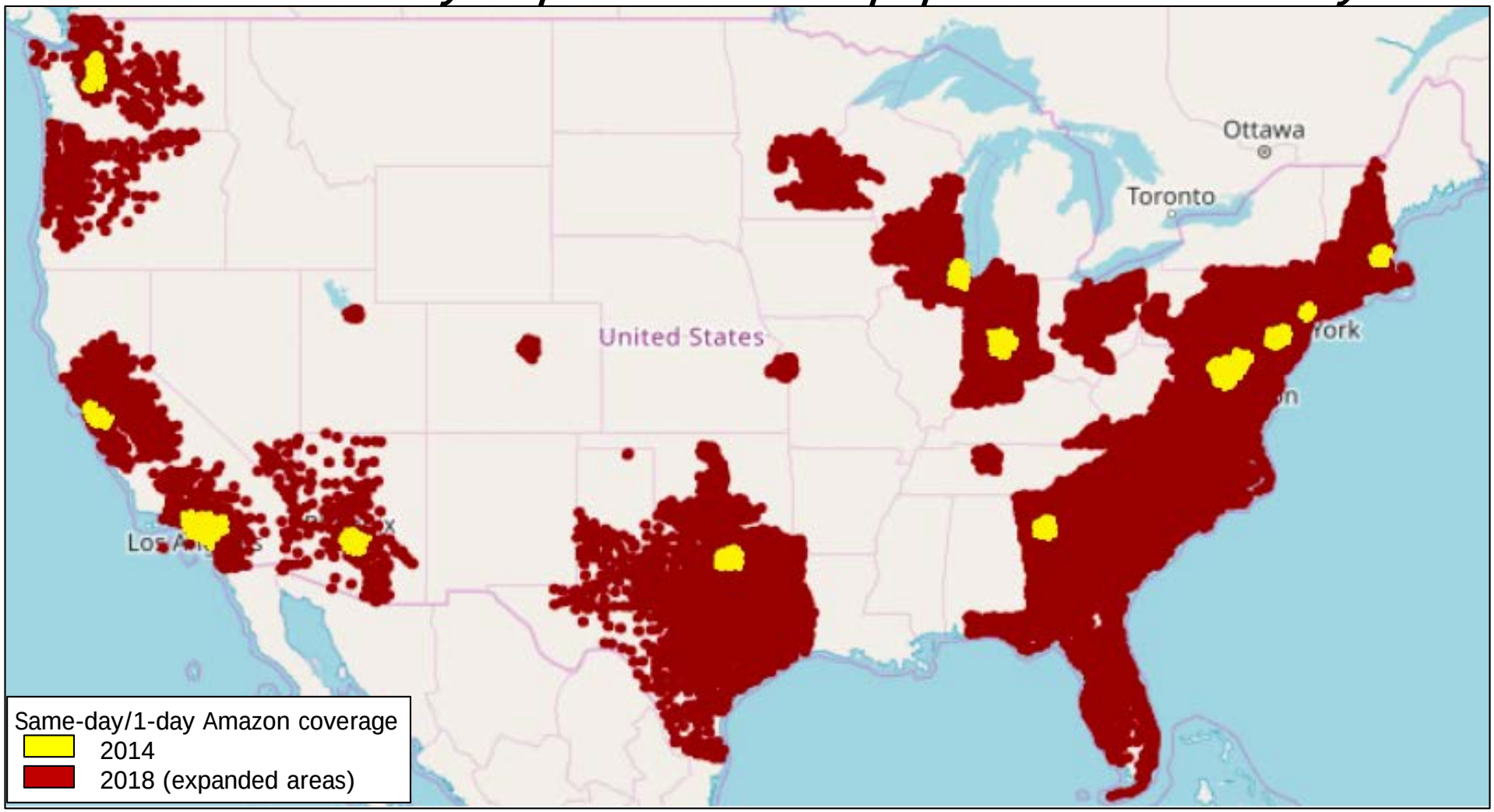


B2B + B2C(SK) + On-Demand Deliveries @ 0.05



Ecommerce Impacts on Land Use

"Amazon can already ship to 72% of US population within a day..."



Source: CNBC (2019)

Novel Vehicular Technologies

History (and the EOQ model) shows

- Reductions in generalized transportation costs
  - → Decreases shipment sizes
  - → Increases shipment frequencies
  - → Increases the separation between economic units
- Reductions in shipment sizes
  - → Leads to the use of the smaller vehicles and modes
  - → Since the amount of cargo per-capita increases or stay the same, the total VMT increases

A Tsunami of New Technologies...

Truck Platooning / Connected and Autonomous Trucks

Delivery Drones

Truck / Delivery Drone Systems

Delivery Robots (Bots)

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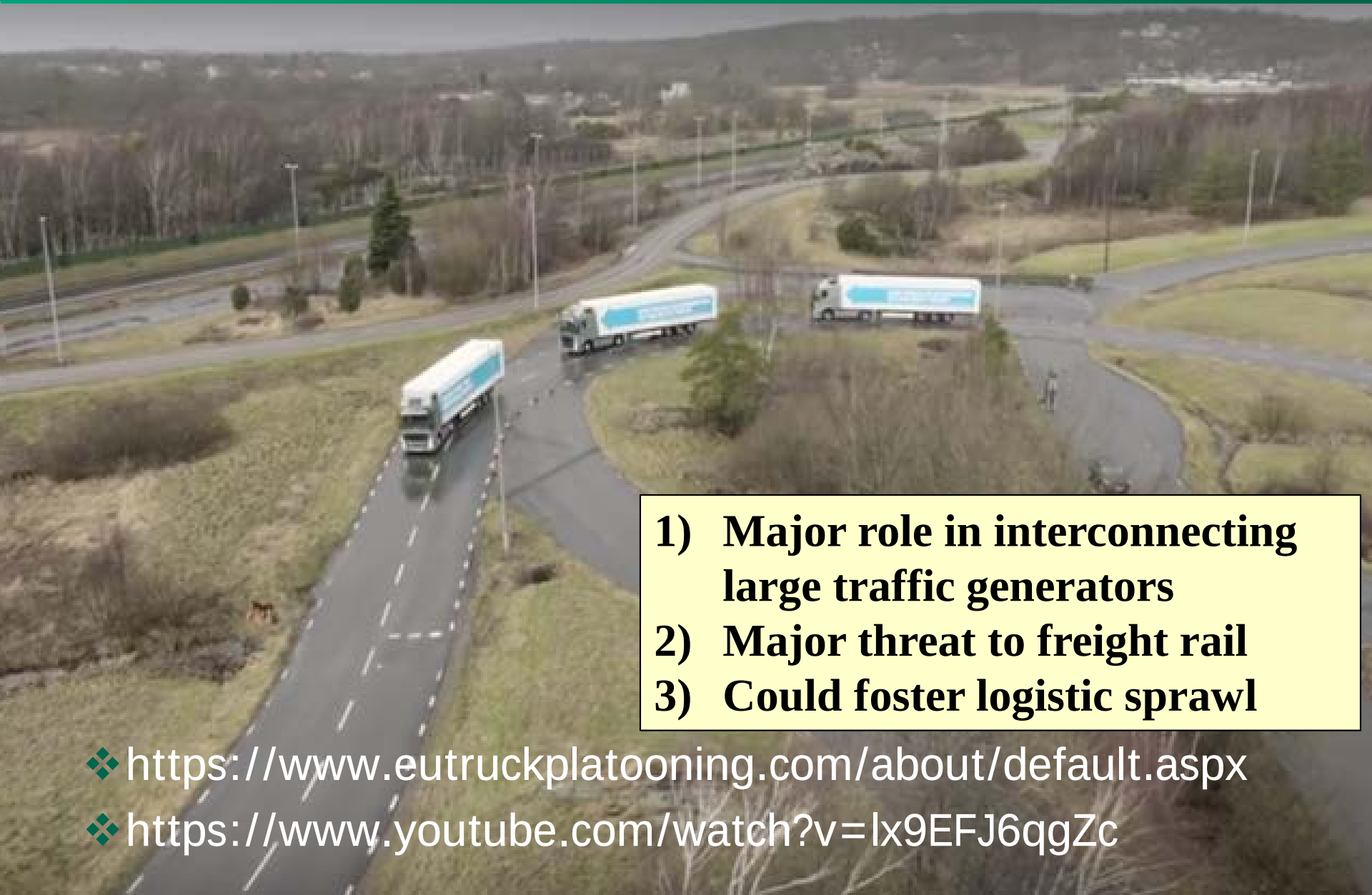
CoE-SUFS
VREF CENTER OF EXCELLENCE FOR
SUSTAINABLE URBAN FREIGHT SYSTEMS

Truck Platooning, Driverless Trucks

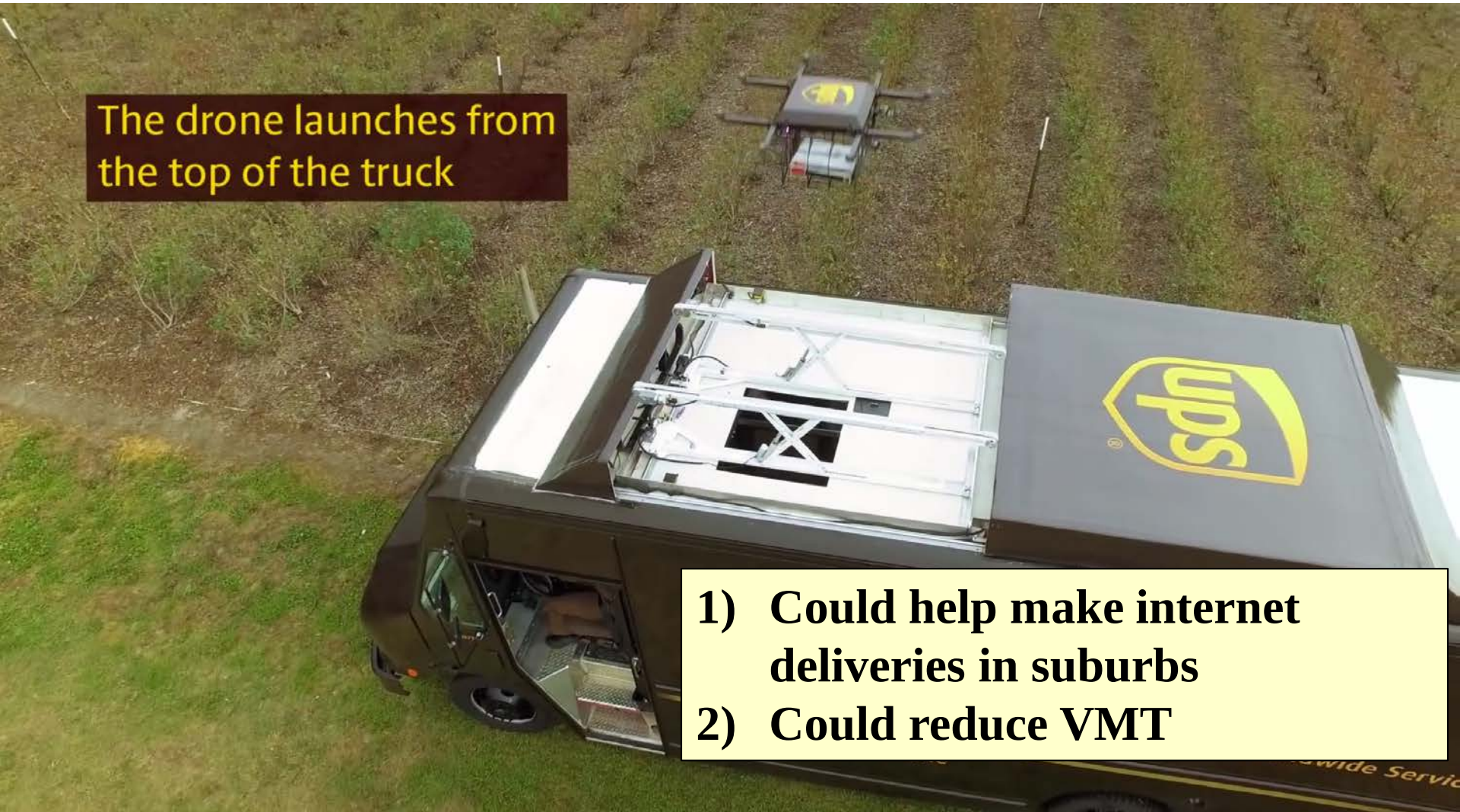


1) **Major role in interconnecting large traffic generators**
2) **Major threat to freight rail**
3) **Could foster logistic sprawl**

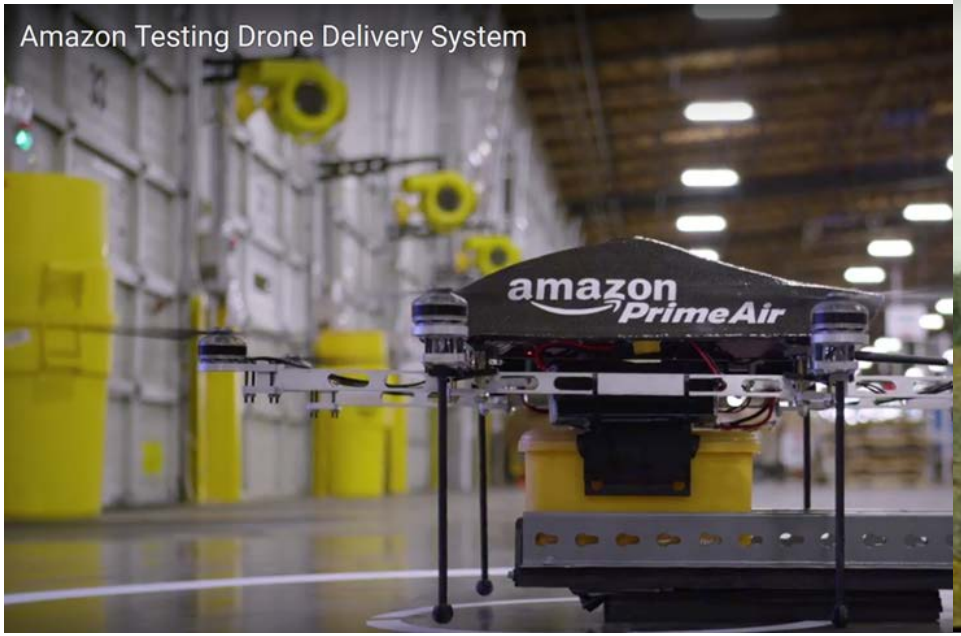
- https://www.eutruckplatooning.com/about/default.aspx
- https://www.youtube.com/watch?v=lx9EFJ6qgZc

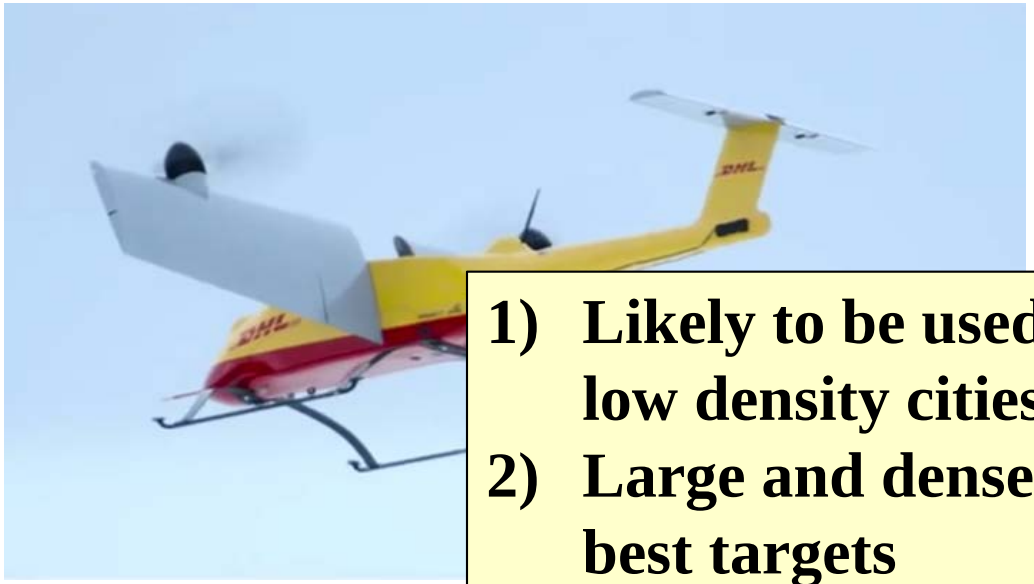
Truck-drone combinations

- https://www.youtube.com/watch?v=xx9_6OyjJrQ



Drones

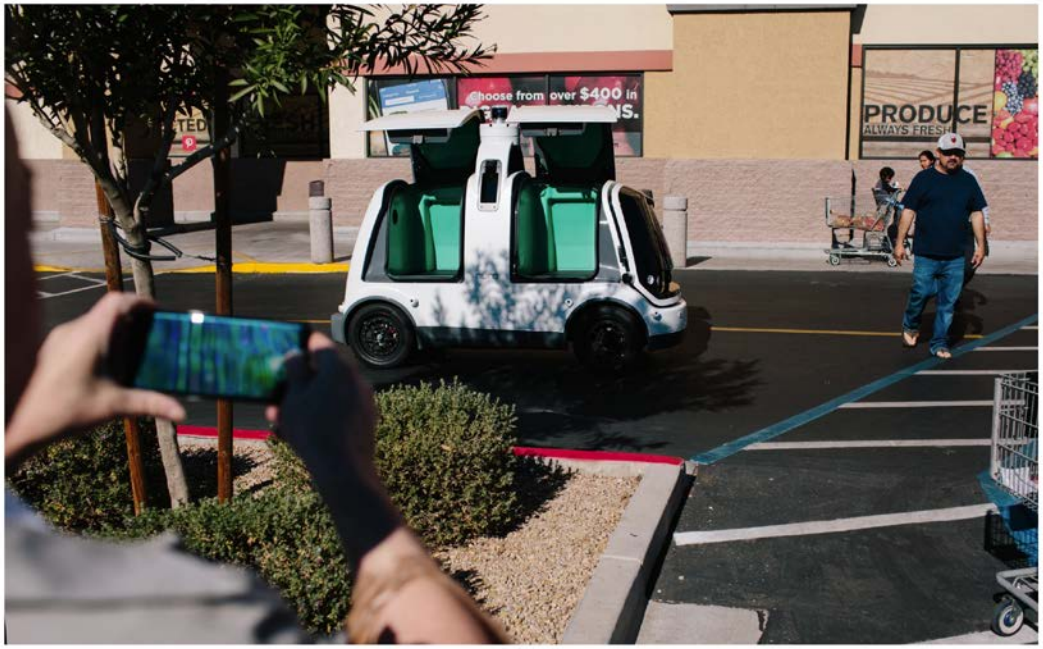




1) **Likely to be used in suburbs, low density cities**
2) **Large and dense cities not the best targets**

Delivery robots

A Toaster on Wheels to Deliver Groceries? Self-Driving Tech Tests Practical Uses



Starting this week, two small self-driving cars made by Nuro, a start-up, will chug along at no faster than 25 miles an hour to deliver groceries in Scottsdale, Ariz. Caitlin O'Hara for The New York Times

Postmates has created a robot to automate its deliveries

It can carry 50 pounds of cargo, and travel 30 miles on a single charge

By Jon Porter | @JonPorty | Dec 13, 2018, 12:12pm EST

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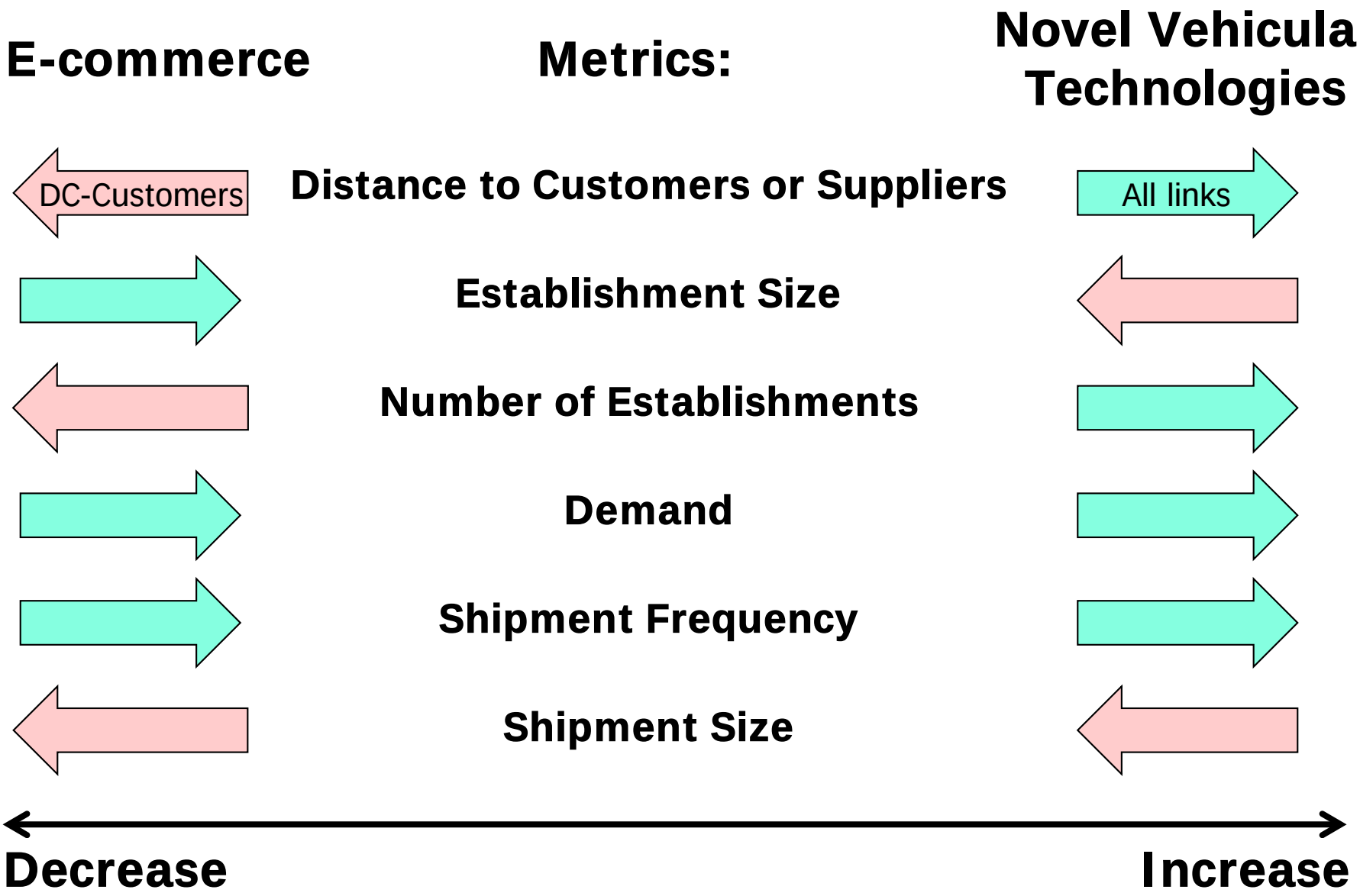
1) **Will necessitate major changes in curbside / sidewalks**
2) **Conflicts with pedestrians**

Net Effects ?

Net Effects


E-commerce
Metrics:
Novel Vehicular Technologies
DC-Customers
Distance to Customers or Suppliers
All links
Establishment Size
Number of Establishments
Demand
Shipment Frequency
Shipment Size
Decrease
Increase

Key Insights

Key Insights

- This is an era defined by social, economic, and technological transformation
- The various trends are producing, and will continue to produce counterbalancing effects
- The net effects will be determined by the balance of these forces
- The Internet economy and the development of novel vehicular technologies stand out for their impacts
- More than ever before, transportation and land use decision makers must frequently update policy procedures in these changing times

Remarks

- History shows that there are no magic bullets
- In most cases, new technologies solve some problems ... and create others...
- Comprehensive approaches are needed to:
  - Maximize beneficial impacts
  - Mitigate/Eliminate negative effects

Thanks!

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