Evaluation of Intermodal Marine Container Terminal Gates via Simulation

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Department of Civil Engineering

The Intermodal Freight Transportation Institute (IFTI)
Herff College of Engineering

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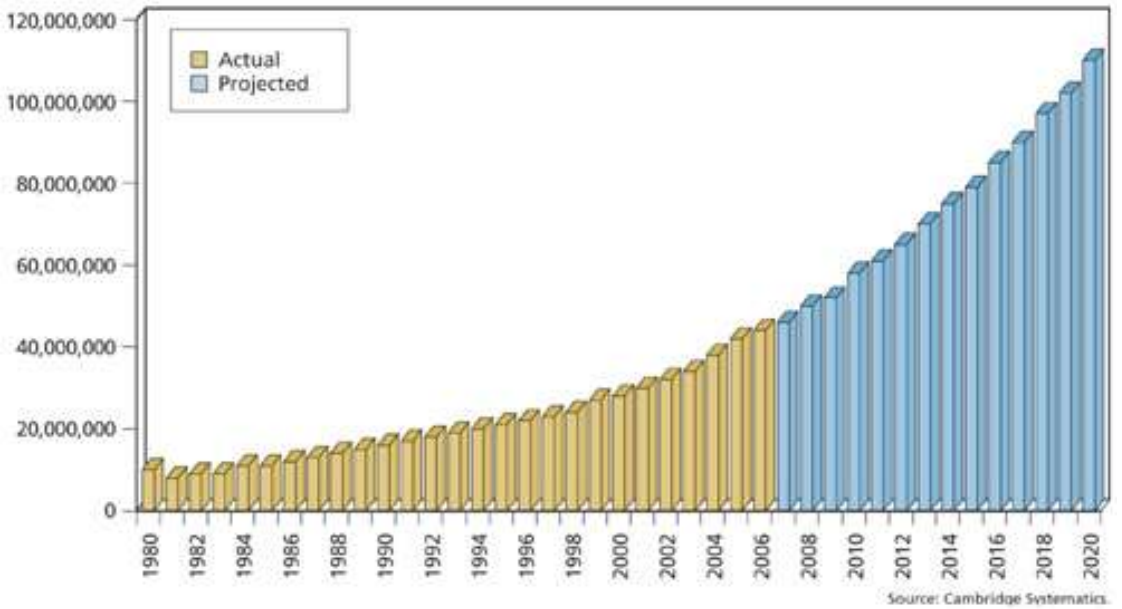
Introduction

- Container volumes are predicted to double over the next 10-15 years
- Volume increases must be met with physical expansion or increases in efficiency



Source: http://www.transportation1.org/tif3report/freight_cont.html

Introduction

- Congestion concerns are coupled with emissions concerns
- Diesel emissions are known to contain carcinogens
- Drayage activities are a major source of emissions at ports

Source: http://global-quote-now.net

Introduction

Drayage: “the movement of containers between a port terminal and an inland distribution point or rail terminal”[2]

Source: http://crossglobegroup.com

- Drivers paid by the move
- Causes “peaking”, especially prior to gates opening in the morning

The Tioga Group, Inc. (2011). *NCFRP Report 11: Truck Drayage Productivity Guide*. Washington, D.C.: Transportation Research Board.

Introduction

In-gate processing is another source of delay for drayage operations. In-gate processing includes:

Source: http://www.ictsi.com

- Identity verification
- Checking container availability
- Equipment inspection
- Dispatching yard equipment
- Typical delay is 4-5 min.

Introduction

Attempts to increase terminal gate efficiency include:

- Installing advanced technology
- Extending gate operation hours
- Appointment systems

Source: http://www.tideworks.com

Objective

Create a **dynamic traffic simulation** model capable of modeling **drayage movements** within an IMCT to **measure** the **effectiveness** of **gate strategies**. The simulation must be able to:

- run for **24 hours** to include **extended** gate hours scenario,
- measure **congestion** via **delays** & **travel** times,
- measure **emissions**.

Literature Review: Gate Strategies

1. Extended gate hours at Port of Los Angeles/Long Beach resulted in **20% shift** of drayage demand to **off-peak** hours
   - Assessed fees to peak-hour moves to offset costs
2. Extended gate hours briefly tried at terminals at the Port of Newark/Elizabeth resulted in no shift
   - No shift to off-peak hours resulted

1. Giuliano, G., O'Brien, T., Clark, A., Linder, A., Rohmer, J., Tan, W., & Zhou, J. (2008). *Evaluation of Extended Gate Operations at the Ports of Los Angeles and Long Beach.* METRANS.
2. Spasovic, L. N., Dimitrijevic, B., & Rowinski, J. (2009). *Extended Hours of Operation at the Port Facilities in New Jersey: A Feasibility Analysis.* Newark: New Jersey Institute of Technology.

Literature Review: Gate Strategies

1. Port of New Orleans found **appointment system improved** traffic **flow** and increased terminal **throughput**
2. Port of Los Angeles/Long Beach found **appointment system** to be **ineffective**
   - Implemented alongside extended gate hours
   - System was imposed from outside

1. U.S. Environmental Protection Agency. (2006). *A Glance at Clean Freight Strategies: Terminal Appointment Systems for Drayage.*
2. Giuliano, G., Hayden, S., Dell'aquila, P., & O'Brien, T. (2008). *Evaluation of the Terminal Gate Appointment System at the Los Angeles/Long Beach Ports.* METRANS Project 04-06.

Literature Review: Simulations

Authors	Software	Port	Entrance Gates	Terminal Yard	Exit Gates	IMCT Road Network
Huynh & Walton (2005)	Arena	Houston	no	yes	yes	no
Fischer et al. (2006)	QuickTrip	LA/Long Beach	no	no	no	no
Moini (2010)	Arena	generic	yes	yes	yes	no
Lee et al. (2011)	Paramics	Singapore	no	yes	no	yes
Dougherty (2010)	Vissim	Newark/ Elizabeth	no	no	no	yes

Vehicle Types

"Other"

Source:
http://www.autocreditfinancing.com/

Container Trucks

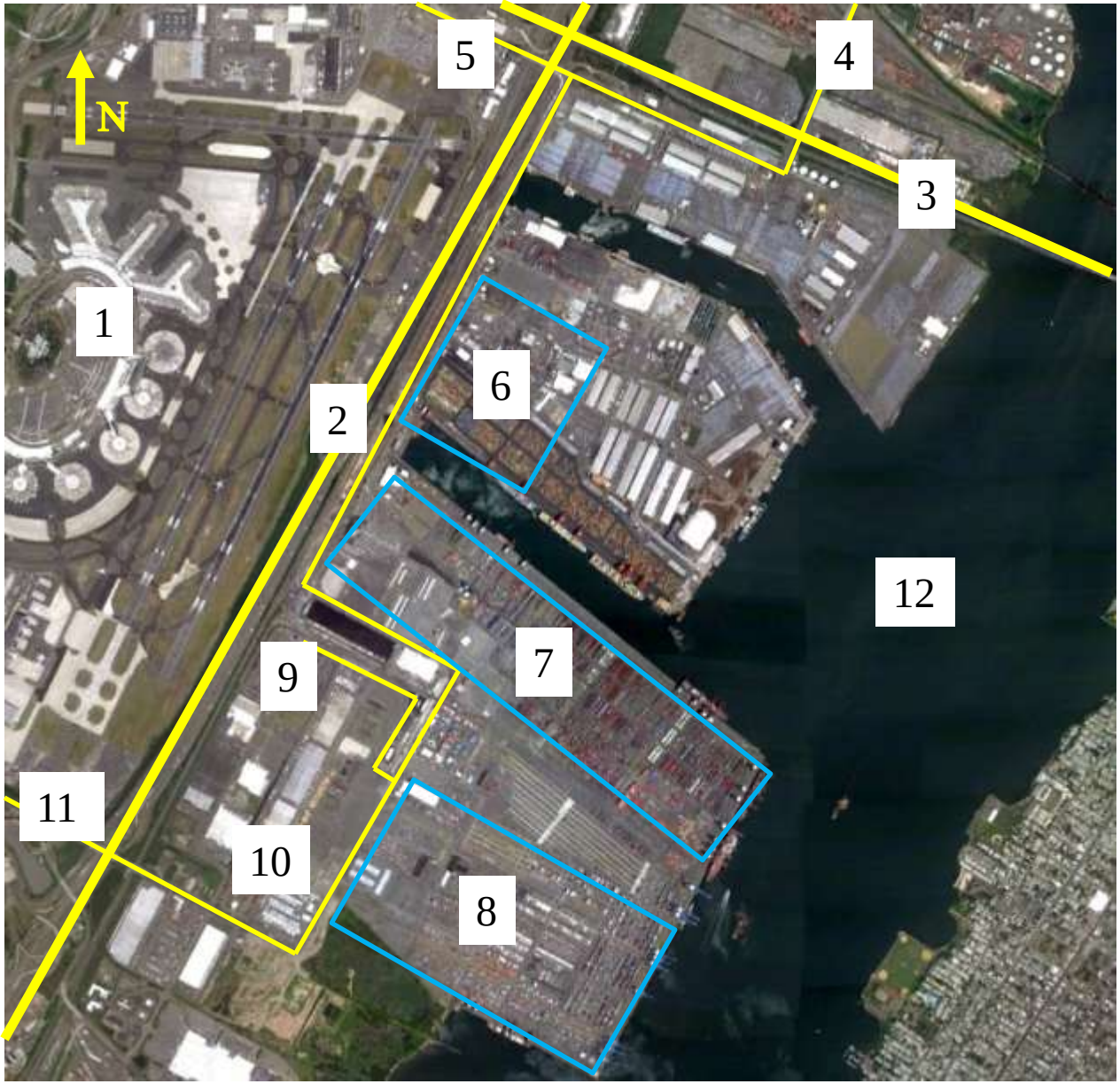
Source: http://ehtrucking.com/

Chassis Trucks

Source: http://blog.logisticsgriffin.com

Bobtail Trucks

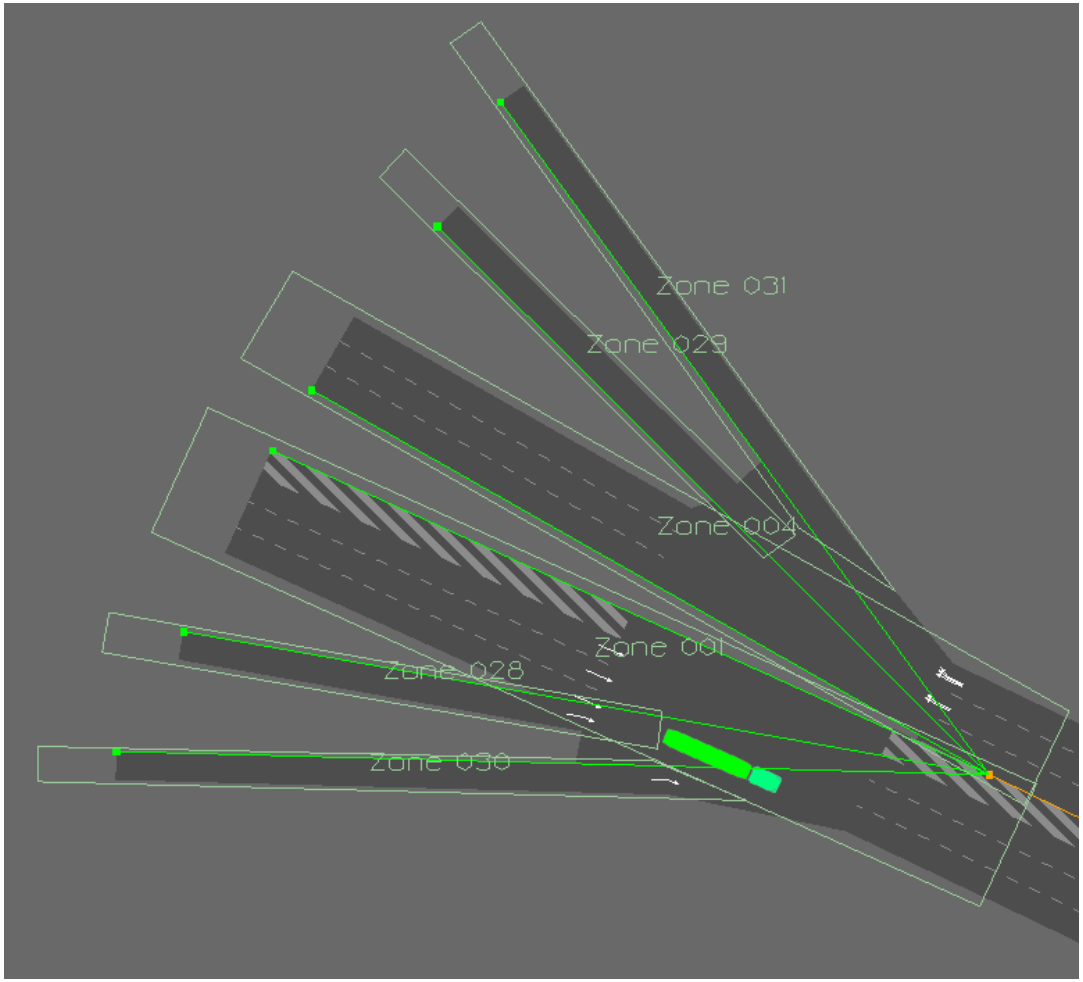
Source: http://ehtrucking.com/



1. Newark Liberty Int'l Airport
2. I-95
3. I-78
4. Doremus Ave.
5. Port St.
6. PNCT Terminal
7. Maher Terminal
8. APM Terminal
9. Maher chassis depot
10. PNCT chassis depot
11. North Ave.
12. Newark Bay

Source: Google Earth

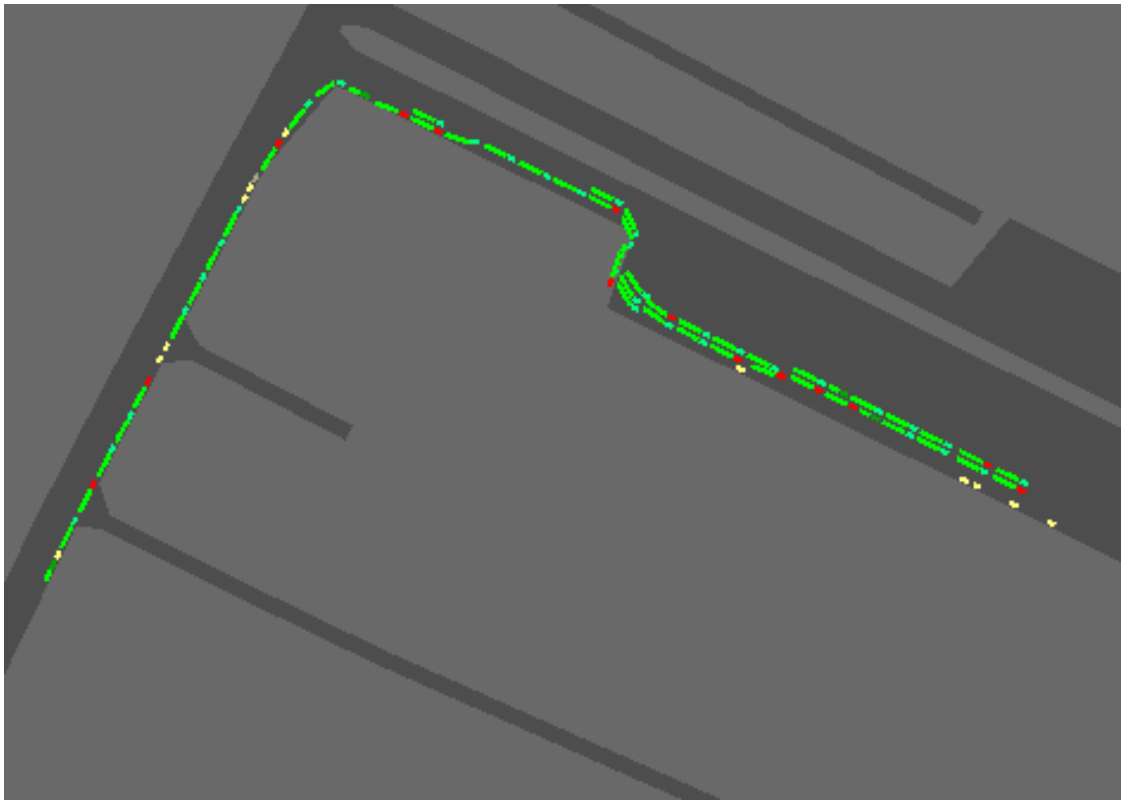
Simulation Considerations: Don't Lose the Truck!!



- Multiple zones at each entrance
- Allows for the creation of **waypoint routes**
- Zone type allows vehicles to enter simulation at link speed

Simulation Considerations: Realistic Queue Formation

- Trucks do not utilize lanes without adjustment to behavioral logic
- Each terminal used a **combination** of:
  - Lane restrictions
  - Route choice rules
  - Nextlanes rules



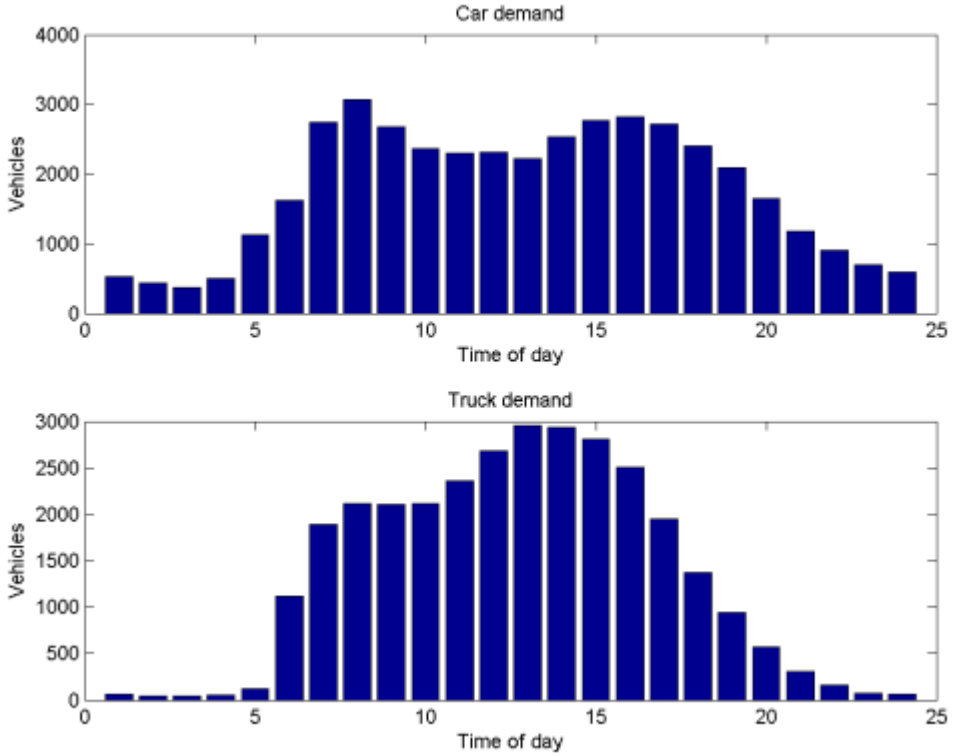
Simulation Considerations: Delays at Gates

- Terminal gates were modeled using **toll feature**
  - Allowed for **discrete uniform** delays from 0-200 s.
  - Each terminal gate was set up as a series of **3 tolls** to **approximate normal distribution**
- **Mean delays**:
  - Container 4.5 min.
  - Chassis 2.25 min.
  - Bobtail 1.125 min.
  - Appointment 50% reduction in delays

OD Development

- Used data made available by Dougherty (2010) and Spasovic (2009) was used to create OD

- Hourly entering/exiting demand
- Entrance demands for peak hours, split by entering/exiting & vehicle type
- Peak hour terminal demands
- Peak hour turn counts



OD Development

- Five appointment scenarios were created
  - Each scenario increased the demand for the appointment lanes by 10%
  - All scenarios had 30% of the lanes at the entrance and exit gates converted to appointment lanes
- The only appointment scenario that outperformed the base case was the scenario in which 30% of the demand was assigned to the appointment lanes

Scenarios

1. Base Scenario (2006)
2. Extended Hours (2006)
3. Appointment (2006)

Each scenario was run for 15 iterations. The results are the average values.

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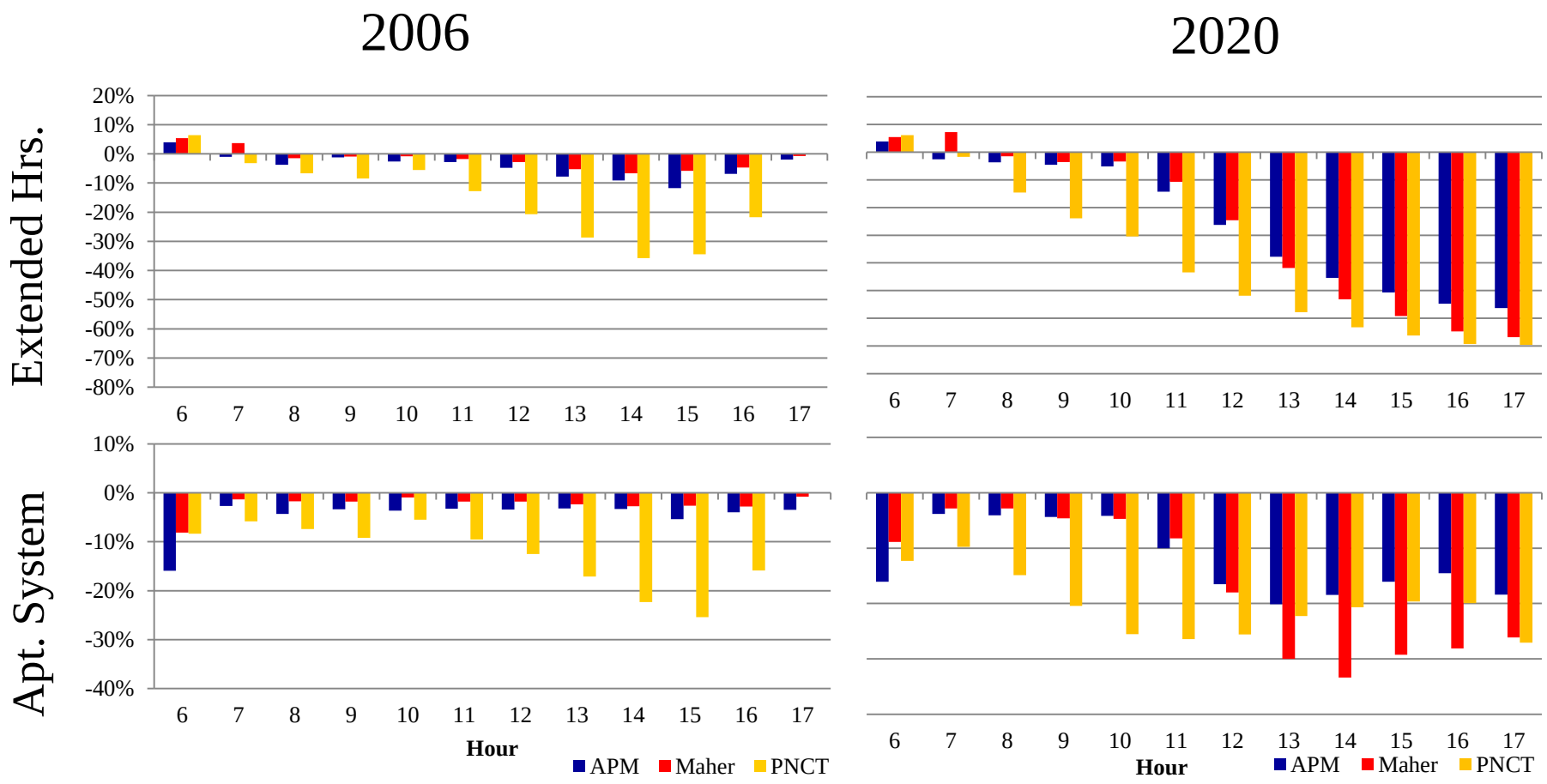
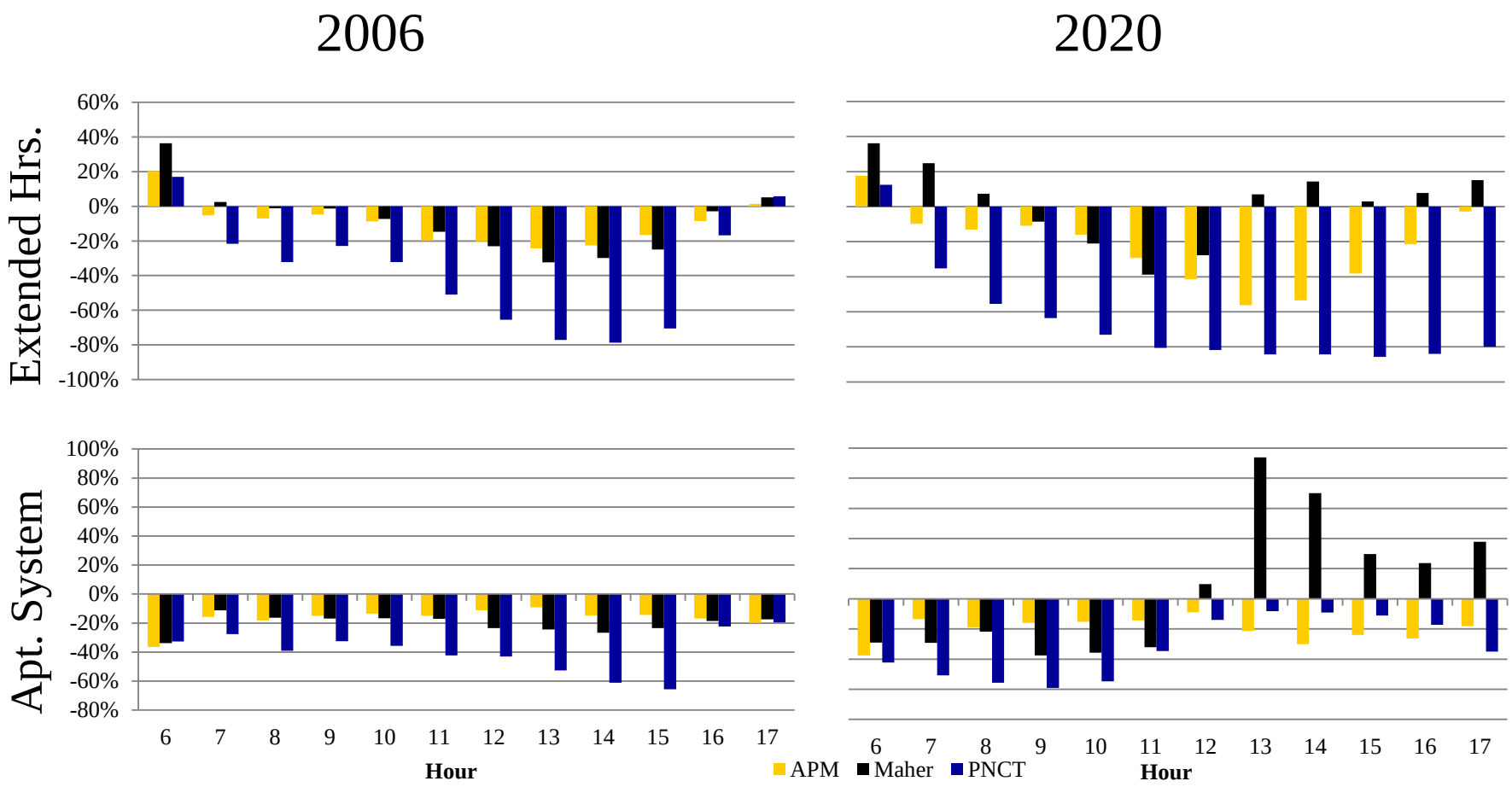
4. Base Scenario (2020)
5. Extended Hours (2020)
6. Appointment (2020)

2020 scenarios were created by increasing the volumes of the ODs by 25%.

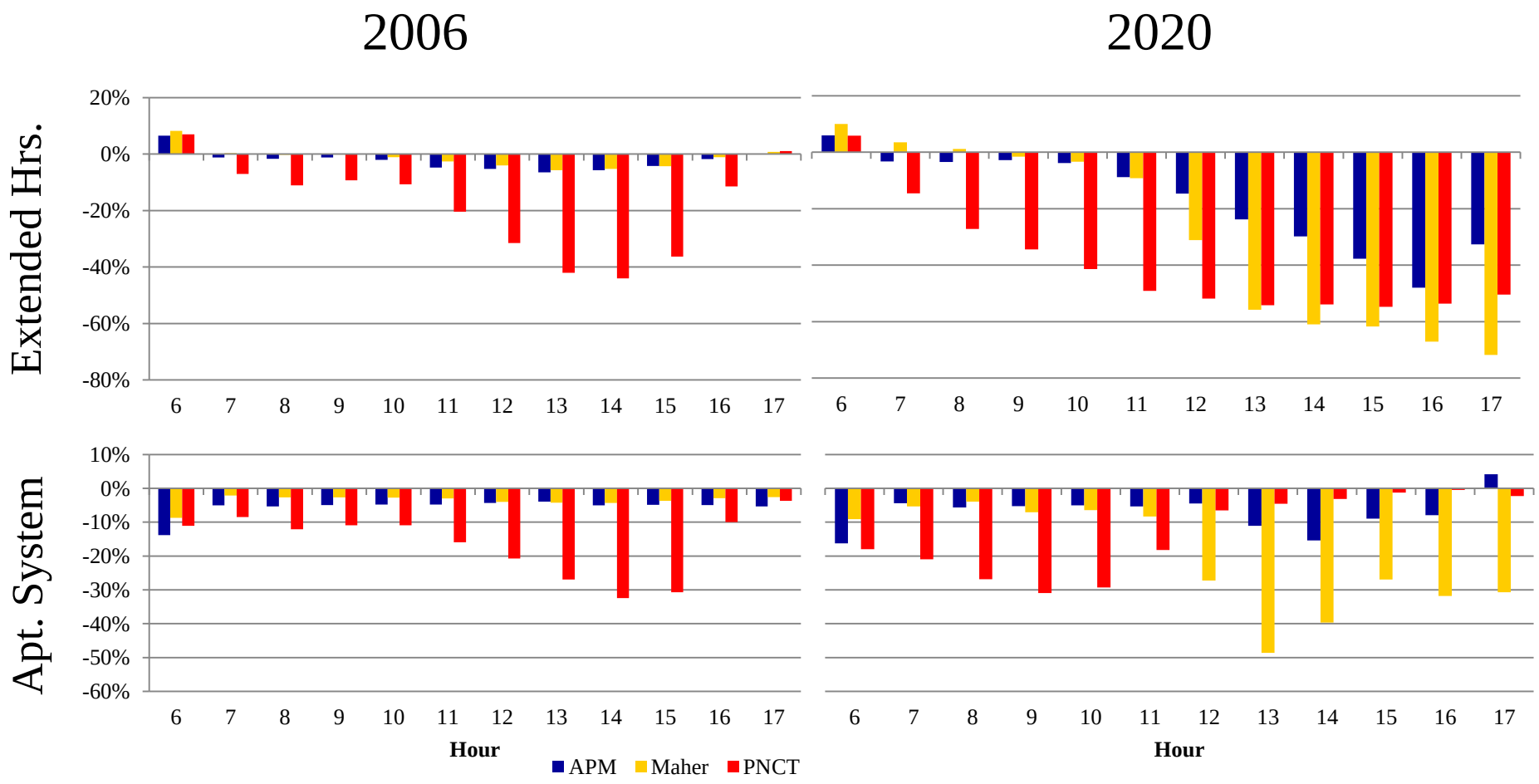
Travel Time: % of Base Case



Delays at Gates: % of Base Case

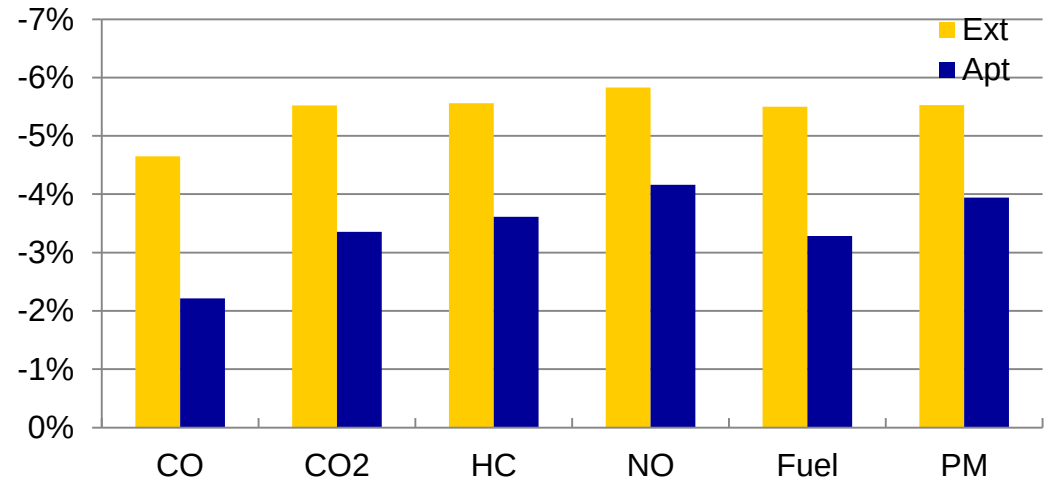


Time in terminal (incl. gates)

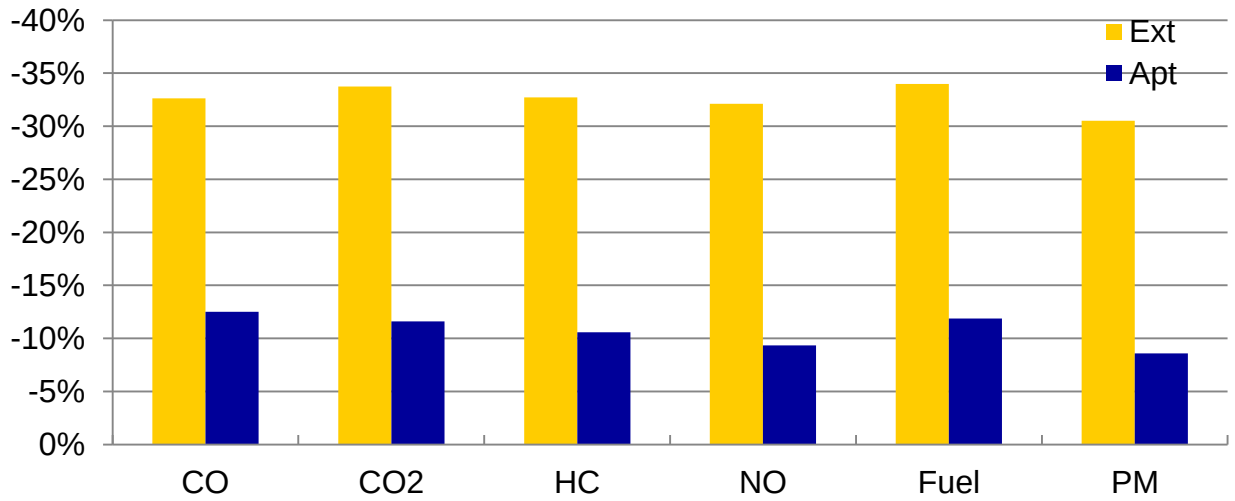


Emissions

2006



2020



Conclusion

- The results show that extended hours outperforms appointment lanes under heavy congestion
- Results also indicate that a simulation that does not include the entire roadway network of an IMCT will miss interactions critical to assessing the viability of implementing gate strategies

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