Functional Design of Physical Internet Facilities: A Road-Based Transit Center

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Objective

In their 2010 IMHRC paper, Montreuil, Meller and Ballot proposed a set of facility types ("π-nodes") that would be necessary to operate a Physical Internet. This paper is part of a three-paper series for the 2012 IMHRC where the authors provide functional designs of three π-nodes.

The subject of this paper is a road-based transit center, or road-based π-transit. The mission of a π-transit node is to enable the transfer of π-carriers from their inbound to outbound destinations.

The objective of the paper is to illustrate the design and its components, as well as the design process.

Background

The Physical Internet (PI) was presented by Montreuil (2009, 2011) as a response to what he termed the *Global Logistics Sustainability Grand Challenge*.

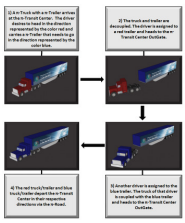
This grand challenge covers three aspects of sustainability:
•economic,
•environmental and
•social.

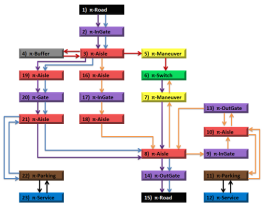
The PI is defined as an open global logistics system founded on physical, digital and operational interconnectivity through encapsulation, interfaces and protocols. The PI enables an efficient and sustainable logistics web that is both adaptable and resilient.

Physical Internet
Efficient Sustainable Logistics

Methodology

The mission of a road-based π-transit is to efficiently and sustainably transfer trailers from one truck to another to serve two purposes:
1.to enable the trailer to move from its origin to its destination to facilitate delivery within its delivery time window;
2.to enable a truck to pick up a trailer that will put the driver closer to his/her target destination at the end of his/her workday.





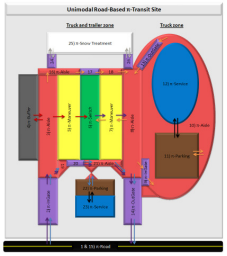
The first part of our methodology was to translate the mission of the facility into its major flows.

We followed a linear design process, sizing the gates first, then the switch zone and finally associated buffer areas.

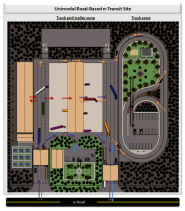
We used rules of thumb and simulation, but developed a preliminary queueing model as well.

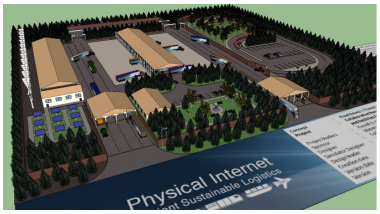
Our design goal was to enable trucks and trailers to enter and leave within 30 minutes without excessive queueing delays.

We used other KPIs from the customer and operator perspectives to evaluate our design and an alternative design that doubled the number of switch bays and eliminated the need for queueing bays.



Results





KPI	Value
Customer	
Average Throughput Time (Truck)	30.73 minutes
Average Throughput Time (Trailer)	32.76 minutes
Average Percentage Departing in Preferred Direction (Truck)	79.84%
Average Percentage Expedited Assignments	0.84%
Operator	
Area of Transit Center	50,625 m^2 (544,923 ft^2)
Number of Gates (In)	4
Number of Gates (Out)	4
Number of Switch Bays	24
Number of Parking Bays (Trucks/Trailers)	24
Number of Parking Bays (Trucks)	24
Average Percentage of Declined Trucks/Trailers	1.23%

Conclusions

Our goal was not to produce the optimal functional design of a π-transit center.

Our primary goal was to produce a functional design that performed at an acceptable level in terms of KPIs related to efficiency and sustainability.

Our secondary goal was to establish what details are needed to provide when one provides a functional design going forward. Please see our detailed paper.

We hope others are motivated to develop alternative functional designs of a PI transit center!

Future Work

Examination of our work will hopefully lead to future research on three fronts:

1)We hope that additional π-transit center functional designs will be developed. Having a suite of functional designs to choose from will aid future facility operators.

1)We used simulation as a means to evaluate our designs. However, simulation is a cumbersome process. We presented a possible analytical model for the π-switch zone, but other analytical queueing models would be helpful in terms of evaluating the performance of sub-systems of the facility.

2)The design process itself. We used a linear, sequential design process to allocate resources initially, and then used simulation of the total system in an attempt to fine-tune those resource allocations. More complex design processes may not only reduce and streamline the design realization efforts, but also improve the designs that result.

Acknowledgments

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