Analyzing Capacity Pricing and Allocation Mechanisms in Shared Railway Systems


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Motivation

New pieces of legislation such as PRIIA (2008) or EU directives 91-440 and 2007-58 promote the use of **shared systems**

Shared railway systems are systems in which different railway operators may use the same infrastructure.

It allows for **efficient use of the infrastructure**, which is expensive: represents 60-80% of total rail transportation costs.

It **requires coordination**: when different operators request access to the infrastructure the regulator should decide who gets access, when, and at what price.

Research Question and Objectives

Research Question

How do different **mechanisms** for capacity pricing and capacity allocation affect the **performance** of shared railway systems?

Objectives

1. Identify representative mechanism for shared railway systems, and
2. Understand implications of these mechanisms for the infrastructure manager, the operators, and the users, in system like the Northeast Corridor (NEC) in the U.S.

Capacity Pricing and Allocation Mechanisms

Rules for deciding what trains to schedule, when, and at what prices

This research analyzes:
1. Auctions
2. Cost allocation methods + priority rules

Infrastructure

Railway capacity is constrained by the infrastructure (signaling systems, topology, etc.).

Users demand

Initially, shared railway systems are designed to accommodate different types of services in the same infrastructure. As a consequence, the transportation demand consists of intercity passenger demand (including high-speed rail), commuter passenger demand, and freight demand.

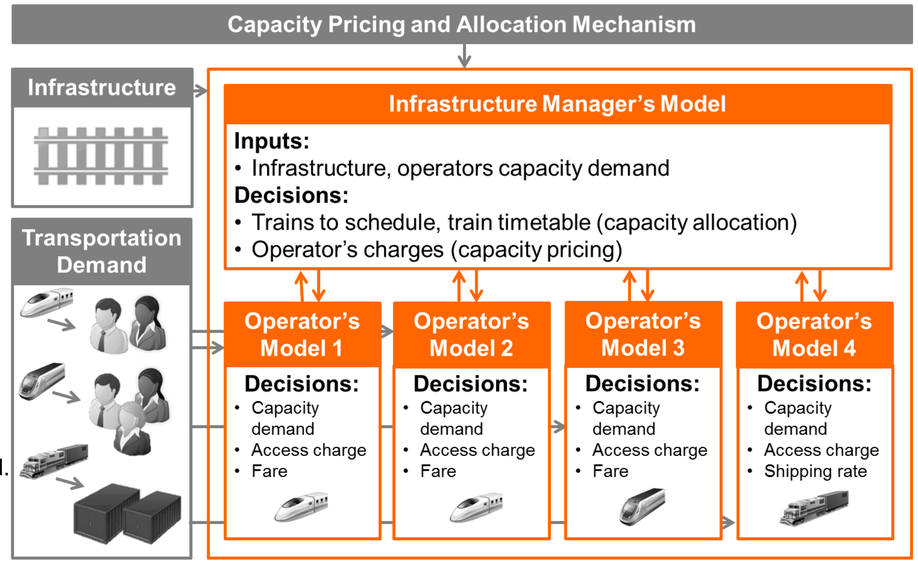
Performance

The performance is measured using multiple criteria:
1. Infrastructure manager: cost recovered, use of capacity
2. Train operators: track-access charges, barriers to entry
3. Users: level of service, demand served

Capacity Allocation ⟷ Capacity Pricing

Decision of which trains get access to the infrastructure and when

Decision of the access fee that each train scheduled should pay to the infrastructure manager



Infrastructure Manager Model

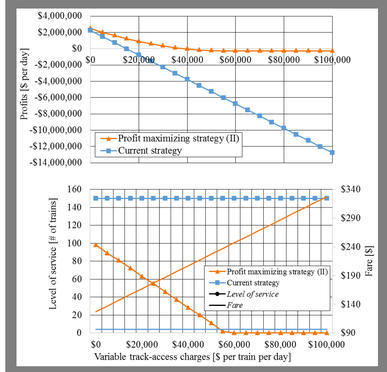
Replicates the infrastructure manager and designs the best possible timetable to accommodate the demand to schedule train in the existing infrastructure (optimization model) The inputs of the model are the desired train operator timetables, the train operator willingness to pay to access infrastructure and the infrastructure. The main decision variables are the trains to schedule, the final timetable, and the track-access charges.

Train Operator Model

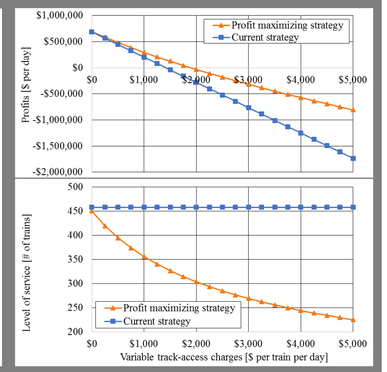
Simulates the behavior of the operators and its impact on the users (behavioral economic model).

The main decision variables for the train operators are the number of trains to operate (level of service), the fare or service rate charged to the users, and the willingness to pay to access the infrastructure.

Preliminary Results: NEC Train Operators



Amtrak



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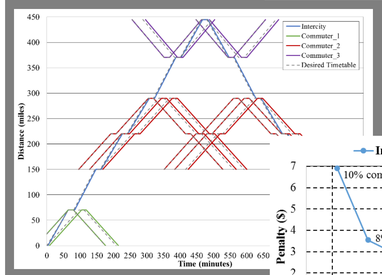
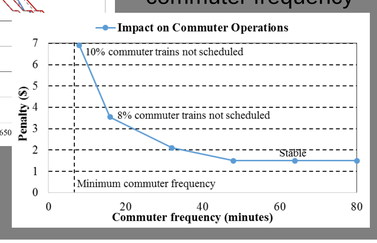
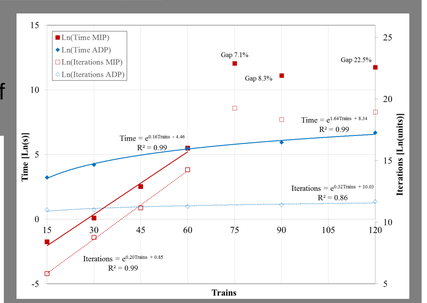
Results: NEC Infrastructure Manager



Sample Timetable

Intercity access charges as a function of commuter frequency





Computational Results
Effectiveness of Algorithm Developed

Acknowledgements

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References

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Gomez-Ibanez, J.A. (2003). Regulating Infrastructure: monopoly, contracts, and discretion. Harvard University Press.

Future Work and Expected Contributions

Future work:

1. Integrate the infrastructure manager and the train operator model
2. Analyze the implications of alternative capacity pricing and allocation mechanisms for the Northeast Corridor (NEC) in the U.S.

Expected contributions:

1. Increase the understanding of alternative capacity pricing and allocation mechanisms,
2. Provide a framework to evaluate the implications of these mechanisms for the infrastructure manager, the train operators, and the users,
3. Analyze the implications for regulating different shared railway systems.