Title
Smart Algorithms to Increase Rail Capacity in Congested Areas

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RESEARCH BRIEF

Smart Algorithms to Increase Rail Capacity in Congested Areas

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Issue

Railway has always been an effective mode to transport both people and goods. Freight trains are about four times more fuel efficient than trucks and passenger trains and are popular because of their blend of efficiency, speed and low emissions. According to the Federal Railroad Administration, total U.S. freight shipments will increase 41% from an estimated 18 billion tons in 2015 to 25.3 billion tons in 2045. Increasing rail network capacity, however, can be difficult and expensive. Finding more efficient ways to utilize existing rail network capacity can mitigate the impacts of growing freight demand.

New communication technologies, such as Positive Train Control (PTC), have the potential to improve efficiency and minimize delays in freight and passenger railway operations. PTC enables trains to communicate and share critical information such as speed and location with each other in real time. Previously, train conductors simply followed signals controlled by central dispatchers who monitor all network movements before proceeding on a segment of track (Figure 1). With PTC, trains are controlled to decelerate, accelerate or travel at constant speed based on the real time information they receive (Figure 2). A PTC system enlarges the limited control given by signals. It enables trains to travel with *dynamic* headway (the track segment between two consecutive signals) whereas traditional signals require trains to be operated with *fixed* headway.

Key Research Findings

This research project simulated the complex, busy freight and passenger rail corridor between downtown Los Angeles and Pomona to evaluate the effectiveness of proposed new scheduling and dispatching algorithms using PTC. The area has single-, double-, and triple-tracks with varying speed limits.

Using Positive Train Control can improve the flow of rail traffic on this track. Using the proposed smart algorithms that make

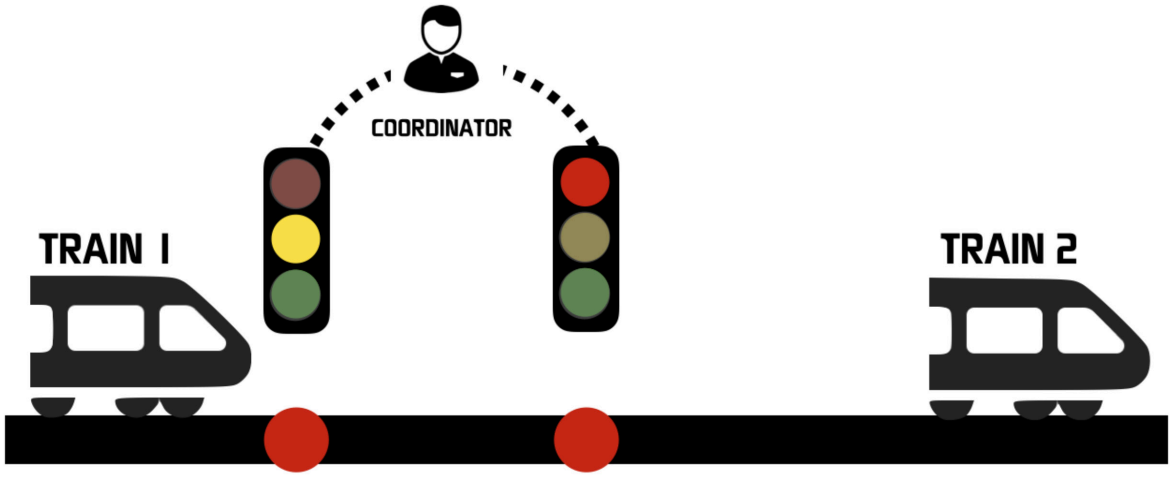

Figure 1. Fixed Headway Model

Figure 2. Dynamic Headway Model

use of PTC with dynamic headway control, the rail capacity could be increased by 20%.

The increased rail capacity allows a significant amount of freight to be shifted from trucks to rail. Shifting freight from trucks to rail could significantly reduce truck traffic in urban centers, helping to ease congestion. The 2015 Urban Mobility report estimates the cost of congestion in the United States to be on the order of $160 billion or $960 per commuter and 7 billion hours in delayed time.

The concepts examined in this study have a broad applicability to other areas such as driverless vehicles. In both applications it is necessary to control and maintain a certain headway between vehicles and other emerging mobility services (e.g., hyperloop).

Further Reading

This policy brief is based on "Integrating Management of Truck and Rail Systems in Los Angeles," a research report from the National Center for Sustainable Transportation, prepared by Maged Dessouky of the University of Southern California. To download the report, visit https://ncst.ucdavis.edu/project/usc-volvo-01/.

Other publications from this project are listed below:

"Models and Algorithms for Dynamic Headway Control for Rail Operations," Computers & Industrial Engineering, 103, 271-281, 2017 (L. Fu, and M. M. Dessouky)

"Algorithms for a Special Class of State-Dependent Shortest Path Problems with an Application to the Train Routing Problem," Journal of Scheduling, 21, 367-386, 2018 (L. Fu, and M. M. Dessouky)

"Joint Optimal Train Regulation and Passenger Flow Control Strategy for High-Frequency Metro Lines," Transportation Research, Part B: Methodological, 99, 113-137, 2017 (S. Li, M. M. Dessouky, L. Yang, and Z. Gao)

"Stochastic Passenger Train Timetabling using a Branch and Bound Approach," Computers & Industrial Engineering, 127, 1223-1240, 2019 (L. Liu, and M. M. Dessouky)

"A Modelling Approach for Dynamic Headway Control," Conference Proceedings of the 14th World Conference on Transport Research, Shanghai, China, 2016 (L. Fu and M. M. Dessouky)

"Control Rules for Dispatching Trains on General Networks with Multiple Train Speeds," Conference Proceedings Transport Research Arena 2014, Paris, France, 2014 (S. Mu, and M. M. Dessouky)

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