Wabtec Project Summary

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Topic - Route Optimization using Autonomous Railcars

Why do we need Autonomous Railcars-

Freight rail is a critical piece of the world's supply chain.
Each year in the US alone, goods worth $700 billion are moved by 1.6 million railcars.
However, each day almost a million railcars do not move at all.
And on each leg of a loaded railcar's journey, it sits idle for an average of 24.6 hours waiting to be picked up by a locomotive.
Rail's inefficiencies push many shipments to trucking, which is bad for society.
Trucks emit 9x more GHGs per ton-mile than rail, add congestion to our roads, and contribute to deadly accidents.
Intramodev is a startup which is creating a world where no railcar sits idle, and not a gallon of fossil fuel is used to move them.

Problem Statement:

The problem statement we chose is route optimization through autonomous railcars. The goal is to drop the cargo on individual Parallel Systems vehicles(autonomous railcars) and have them moved without waiting for the whole train to be unloaded. This will create a demand for the usage of a route optimization technique for the smooth movement of these railcars. This is the problem which we are going to tackle.

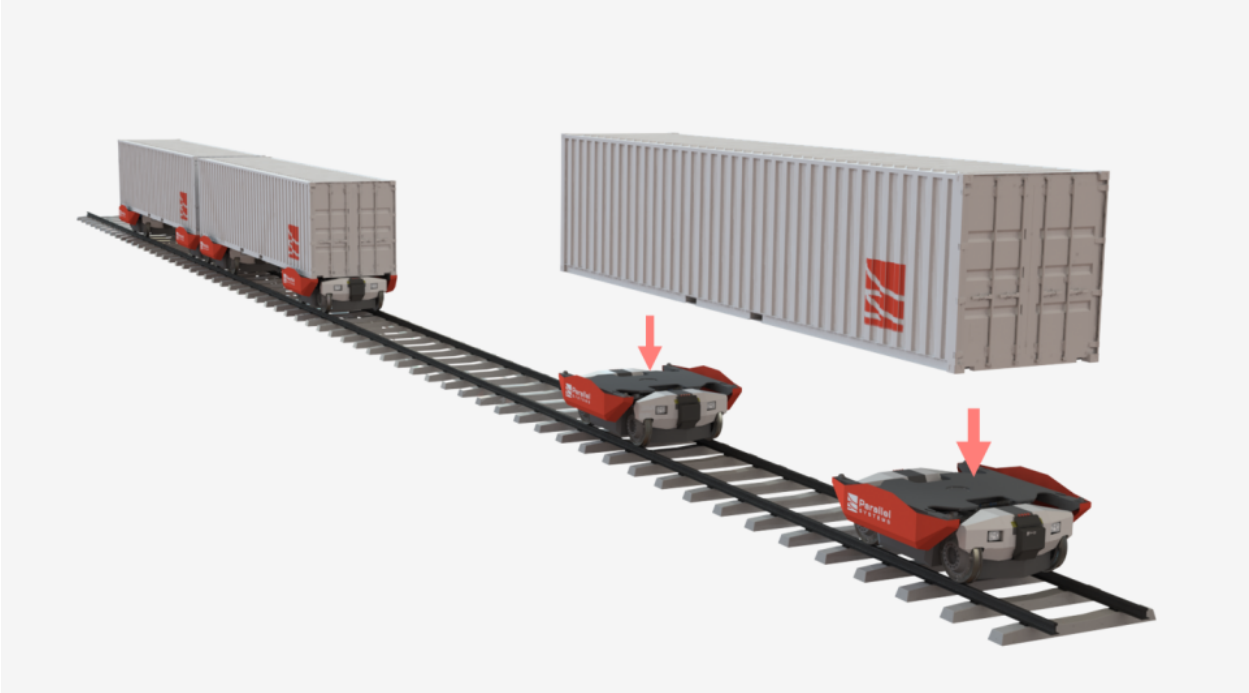
Proposed solution:

There are various aspects which need to be addressed for the usage of these railcars, such as terrain, congestion control, collision avoidance,etc. Taking all of these aspects into consideration, we have to form a graph where each node is a station or a loading/unloading point for the railcar, and weights between nodes will be determined by taking into consideration the attributes mentioned above. Instead of making the weight distance, we consider this as time.

Before moving on, we need to remember that each container can move individually for up to 500 miles or band together to become more efficient. First the delivery points are identified. Then k such delivery points are grouped together and the centroid for the same is calculated. The station nearest to the centroid is labelled as a destination station. The banded railcars will travel till this point and then few of the rail cars will disband from the main chain and travel to their respective delivery points. A route optimization technique will be used for the chain of railcars to reach all the destination points.

How do autonomous vehicles work?

Parallel's vehicle architecture combines innovative software and hardware with the historic rail industry to increase the utilisation of the rails. The autonomous battery-electric rail vehicles load and transport standard shipping containers as a single or double-stacked load. **The railcars, which are individually powered, can join together to form "platoons" or split off to multiple destinations while en route.** The platooning technology is currently pending for a patent. According to the company, the railroad's closed network is ideal for the safe and early commercialisation of autonomous technology due to limited track access and centralised traffic control.



Parallel Platoon Architecture. Source: Parallel Systems

The rail vehicles are more flexible than traditional trains. According to Parallel Systems, the platoons do not need to accumulate large quantities of freight to make service economical, unlike conventional freight trains. The system can support service at a range of distances, from across a city to across the country. This enables more flexible service and a wider range of routes, reducing the waiting times associated with loading trains that are miles long. It also means that waiting times for other traffic at level crossings is diminished because the vehicles can separate if they are blocking traffic.

Additionally, Parallel's architecture will also bypass congested switching yards, used to manually sort and reassemble freight onto secondary trains, which could save hours, or even days, of transit time, says the company. The 'near-continuous flow of containers' through terminals should result in faster delivery times and higher quality of service

Vehicle Routing Problem-

Using a type of VRP called PDVRP(Pickup and Delivery Vehicle Routing Problem). A common case is on-demand transportation – supplying services in direct response to customer requests in accordance to his/her needs. Associated with origin and destination, routing results in paired pickup and delivery points.Here each railcar picks up items at different given sources and drops them off at different given locations.Taking various aspects into consideration(constraints) like such as terrain, congestion control, collision avoidance , we find the optimal route for each

railcar by considering weights as time from respective source nodes to respective destination nodes and for each intermediate nodes between the them.The railcars may detach from its collection or attach to its collection based on the type and quantity of goods it delivers. We are finding the optimum route each railcar and its collections should travel along these paths, a route that gives the minimum cost with respect to the weights considered above , to ensure quick,efficient delivery of goods and parallel unloading of all such railcars. We do this inorder to ensure smooth and efficient functioning of railcars as a whole.