Optimizing the Network: Taking Precision Scheduled Railroading to the Next Level

Ken Kenjale and Dharma Acharya
Network Optimization and Logistics, Wabtec Corporation

Presentation to Railway Application Section, INFORMS

August 26, 2020
Wabtec overview

Freight segment

Equipment

>20%

Of the world’s rail freight is moved by a Wabtec locomotive

Services

2.5M

Messages monitored daily on Wabtec locomotives

Components

> 30%

Of content on a Freight car capable of being Wabtec

Digital Electronics

> 30%

Of North American freight moved through ports managed by Wabtec software

Transit segment

Transit

>15%

Rail passenger cars equipped with Wabtec safety critical components

Wabtec Confidential
A quick primer on terminology …

• **Block**: A group of railcars (loads and empties) moving to a same intermediate destination on a train. A block is defined by its’ origin and destination locations

• **Block-to-train assignment**: Which block will be moved by which train

• **Train Schedule**: Itinerary or timetable of train departure and arrival times from train origin to train destinations including intermediate activity locations where block pickups/setoffs and crew changes are performed

• **Operating Plan**: Blocking and block-to-train assignment plans and train schedules for the entire rail network to move all shipments from origin to destination

• **Meet/Pass Plan**: A detailed plan of train movements on track segments specifying which train will take which track (e.g., siding vs. main track) when moving trains towards destination

• **Traffic Mix**: Composition of freight and passenger trains
Introduction: Ripped from the headlines …

Railroads Post PSR
Precision Scheduled Railroading (PSR) is an operating strategy, largely attributed to railroading legend the late Hunter Harrison, designed to make rail operations more efficient and thereby more profitable. But with new economic and technological challenges of the ‘20s, what’s next for railroads?

Union Pacific CEO: PSR is dead. Long live PSR
Supply Chain Drive, Jan 16, 2020

Hunter Harrison’s Train Overhaul Starts Running Out of Steam
Wall Street Journal, Aug 23, 2019

Executives insist Precision Scheduled Railroading is about growth, not shrinking the railroad industry
Trains, Nov 26, 2019

More Railroads Implemented PSR to Enhance Efficiency
Market Realist, 2019
Why optimize the network?

Network: *Integrated* system
- Tracks & Terminals: Topology
- Locomotives
- Railcars
- Workers / Crew
- Operating Plan

**Increase network fluidity** through improvements to the operating plan and automatic detection and resolution of conflicts across the entire network.

**Improve on-time performance** through increase in network velocity, reduced train miles, fewer unplanned events.

**Reduce costs** through reduction in expired crews, increased asset utilization, and efficient operating plan.

**Expand market share** through improved service and performance.
Wabtec’s Network Optimization & Automation Playbook

- **Service Design**: Create optimal operating plan, integrated with day of operations.
- **Real Time Visibility**: Identify potential train conflicts several hours in advance.
- **Real Time Optimization**: Automatically resolve conflicts for entire network.
- **Train Dispatch**: Centralized traffic control: Monitor, plan events, and resolve exceptions.
- **Prediction**: Predict likelihood of unplanned events, drive into operating plan.
Step 1: Service Design

Current Challenges

• Resource needs calculated using spreadsheets
• Car blocks determined manually or with ad-hoc tools
• Adding/removing trains without knowing network impact
• Dynamically changing conditions not factored into plans
• Unexpected train delays and resource waste
Step 1: Service Design

Future State / Opportunity

- Forecast based on history, economic indicators, other factors
- Forecast empty traffic moves based on loaded moves
- Create optimized car blocking plan based on terminal capacities
- Optimized block-to-train assignment
- Optimize train schedule generation
- Minimize resource needs based on train plan
Step 1: Service Design
Models & Algorithms

- **A. Commercial Traffic Demand Forecasting** (or Historical Waybills)
- **B. Empty Movement Forecast**
- **C. Blocking Optimization**
- **D. Yard Capacity Planning**
- **E. Unit Train Optimization** (No Blocks)
- **F. Scheduled Train Optimization** Block-to-train assignment Schedule generation
- **G. Corridor Capacity Planning** – Long-term and Tactical
- **H. Loco Fleet**
- **I. Car Fleet**
- **J. Crew Requirement**
- **K. Track Resource**
- **L. Terminal Resource**
- **M. Financial Planning**
Current Challenges

- String line diagrams created manually or not created at all
- Laborious effort to factor in multitude of data
- Detailed plans don’t exist
- Difficult to predict 8-12 hours out
- Reactive communications

Step 2:
Real Time Visibility
Future State / Opportunity

- Visualize real time train status across network
- Identify potential train conflicts up to 12 hours in advance
- Predict train ETA
- Perform physical simulation of start-to-end train trips
- Improve decision making on train meets and passes
- Frequent ingestion of latest state of the network and generation of a new plan
- Instantly share latest plan with all stakeholders
Step 3: Real Time Optimization

Current Challenges

- Goals may not be communicated across divisions
- A good decision for one territory may not be optimal for adjacent territories
Step 3: Real Time Optimization

Future State / Opportunity

• Automatic conflict detection and resolution for entire network
• Decisions optimized across the enterprise
• Frequent ingestion of latest state of the network and generation of new plan every 2 minutes
• Decisions communicated to dispatch systems for automatic route setting
• Instantly share latest plan
Wabtec Example: Integrated Movement Planner System

Train Control Platform
- Dispatching System
  - Field Status
  - MIS Updates

Movement Planner
- Autorouter
- Published Plan
- Movement Planner
- TDMS
- Master Database

Published Plan

TDMS

Master Database

Dispatching System

Field Status

MIS Updates
Step 3: Real Time Optimization

Demo Video
Step 4: Train Dispatch

Current State

- Different territories each with unique characteristics
- Challenges managing multiple trains at the same time → fatigue, stress
- Variation between dispatchers
- Train visibility, not network visibility
- Need for better network fluidity
Future State / Opportunity

- Auto routing to enable the visual plan to be requested through the dispatching system without manual action
- Automatic translation of the movement plan into route requests
- Integrated traffic control and dark territory control from a single unified interface
- Moving blocks for improved throughput
- Train trip visibility to the dispatcher, enhancing situational awareness
- Proactive monitoring of subsystems
- Information propagation to other users
Step 5: Prediction

Current Challenges

- Lots of data, not a lot of predictive insights
- Primary focus is on responding to unplanned events
- Challenges pulling together disparate data across the enterprise
Step 5: Prediction

Future State / Opportunity

• Using data and analytics to see the likelihood of unplanned events downstream. For example, terminal congestion, line of road congestion, locomotive failures, crew delays, weather impacts, etc.

• Driving predictive insights into the plan

• What-if analysis
Take the next step

Service Design ➔ Real Time Visibility ➔ Real Time Optimization ➔ Train Dispatch ➔ Prediction

- Service Design: Create optimal operating plan, integrated with day of operations
- Real Time Visibility: Identify potential train conflicts several hours in advance
- Real Time Optimization: Automatically resolve conflicts for entire network
- Train Dispatch: Centralized traffic control: Monitor, plan events, and resolve exceptions
- Prediction: Predict likelihood of unplanned events, drive into operating plan

Contact us to continue the journey:
- Ken.Kenjale@Wabtec.com
- Dharma.Acharya@Wabtec.com
Accelerating the future of transportation