

Identifying and Prioritizing Shared Rail Corridor Technical Challenges

Brennan M. Caughron, M. Rapik Saat, Christopher P.L. Barkan

Rail Transportation and Engineering Center (RailTEC), University of Illinois at Urbana-Champaign, Newmark Civil Engineering Laboratory, 205 N. Mathews Ave. Urbana, IL, 61801USA

Email: bcaughr2@illinois.edu, mohdsaat@illinois.edu, cbarkan@illinois.edu

ABSTRACT

Recent proposals for expanded passenger rail service in the United States have ranged from incremental improvements to existing Amtrak service, to plans for new, very high-speed lines on dedicated corridors. Improvement to existing lines aims to accommodate faster, more frequent passenger train operation, generally on trackage owned and operated by freight railroads. New, dedicated high-speed lines may share a common right of way or corridor with other rail lines on some portions of their route. These shared track and corridor operations pose a variety of technical challenges needing solutions in order to assure safe, reliable and efficient passenger and freight service. Track structure and maintenance, rail line capacity, rolling stock design, signaling systems, defect detection and highway grade crossings are just some of the topics needing attention. This paper describes a project sponsored by the FRA to identify, categorize, and prioritize technical challenges that must be overcome to successfully develop mixed passenger and freight rail corridors. The relative importance of different challenges is assessed using different rating criteria, including potential to increase efficiency, effectiveness or safety. An assessment of these criteria for a given challenge is conducted using several methods, including a broad industry survey and interviews with rail industry experts. This paper will summarize and discuss the top technical challenges and research needs. Such knowledge will help freight and passenger railroads, government agencies, rail planners and others better understand how to successfully develop mixed use corridors, while at the same time facilitating continued successful growth of rail freight service.

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INTRODUCTION

The U.S. Department of Transportation is supporting development of substantially expanded and improved passenger rail service on a number of intercity corridors connecting communities across the US. These corridor development projects will range from incremental improvement of existing trackage to new, dedicated high-speed rail (HSR) lines. There will be a corresponding range in the extent and nature of sharing with existing freight and passenger rail lines ranging from extensive sharing of trackage to partially parallel corridor usage. Although such mixed use corridor development and operation is not new, numerous changes in US freight railroad infrastructure, rolling stock and operating practices have resulted in a variety of new questions about how to safely and effectively accommodate new passenger service while sustaining ongoing rail freight transportation efficiency and growth. Furthermore, regulatory requirements continue to evolve in order to ensure both the safety and efficiency of freight and passenger rail development.

The U.S. Federal Railroad Administration defines three types of mixed use corridors as follows: shared trackage, shared right of way and shared corridor (Table 1) (Federal Railway Administration, 2003). Each of these has a different, although in some cases related, set of issues that needs to be resolved. The objective of this project is to develop a technology development path for HSR mixed use corridors in the US by:

1. Identifying and describing shared rail corridor technical challenges
2. Analyzing and prioritizing their importance
3. Identifying previous and on-going research related to the major technical challenges
4. Identifying knowledge gaps and research needs for the major technical challenges

Type of Operation	Dedicated Tracks for Different Traffic Types	Concurrent Operation of Freight and Passenger Traffic	Track Center Spacing (feet)
Shared track	No	Varies	n/a
Shared right-of-way (ROW)	Yes	Yes	< 25'
Shared corridor	Yes	Yes	25 - 200'

Table 1: Types of Mixed Use Rail Corridors

The nature of the mixed use corridor issues that need to be addressed varies across a spectrum of questions and includes, but is not limited to the following categories:

- *Safety* – operational practices, safety technology, infrastructure and rolling stock designs that support very low risk operation of passenger and freight trains on the same corridors
- *Infrastructure and Rolling Stock* - effective and economical design, safety, reliability and maintenance of trackage and equipment
- *Planning and Operations* - capacity and service quality impacts, upgrades to track, train control, scheduling with the potential to mitigate these impacts
- *Economic* – equitable approaches to sharing capital and operating costs for construction and maintenance, maximizing passenger operation profitability and not interfering with current and future capacity and quality of freight services
- *Institutional* – regulatory compliance and possible changes, incentive compensation and penalties, liability and accommodation for growth in either passenger or freight

This paper will focus on the technical issues presented in the safety, infrastructure and rolling stock, planning and operational challenge categories.

METHODOLOGY

The FRA mixed use corridor project has undertaken two main activities related to the identification and prioritization of shared passenger and freight rail corridor technical challenges. On November 10-11, a research symposium was held at the University of Illinois that included over 14 industry representatives from the National Railroad Passenger Corporation (Amtrak), the Class I freight railroad CSX, the U.S. Federal Railroad Administration (FRA), Illinois Department of Transportation (IDOT), the University of Illinois at Urbana Champaign (UIUC), and the Swedish Royal Institute of Technology (KTH). The symposium facilitated the sharing of research challenges and objectives between industry and government representatives. Academics from KTH also interested in mixed use corridor technical challenges attended to learn more about developing solutions that would allow for more efficient freight trains on the European rail network. Discussion over the two day symposium served as framework for further conversations with industry experts about mixed use corridor technical challenges.

In addition to the symposium held in November, the University of Illinois Rail Transportation and Engineering Center (RailTEC) conducted an industry survey between the dates of 9/21/2011 and 01/31/2012. The main objective of the survey was to determine which mixed use corridor challenges to pursue for in-depth literature review. Participation in the survey was solicited from RailTEC's railway industry contacts via email and at conference events such as the 2011 AREMA Conference and Exposition. At the end of the survey, there were 24 total participants from the following sectors of the railway industry.

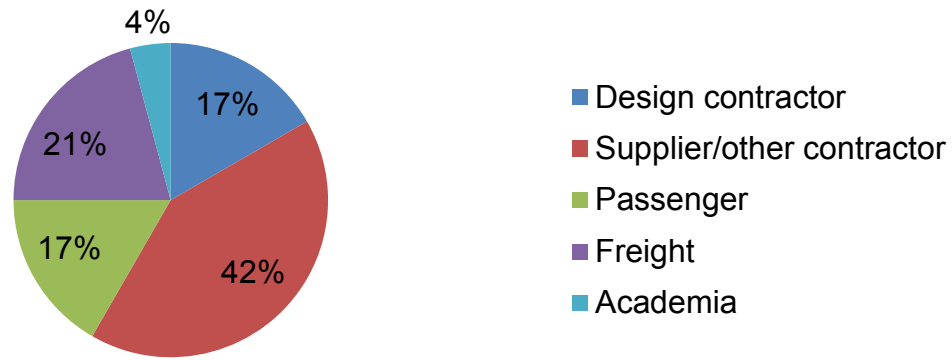


Figure 1: Distribution of Participant Affiliations

Survey participants were permitted to respond to whichever categories they felt sufficiently qualified. For each challenge, participants were asked to rate several criteria on a scale of one to five, with one reflecting high importance or potential for improvement and five being the lowest importance or potential for improvement. The following criteria were included in the survey:

- Potential to increase safety
- Potential to increase corridor effectiveness
- Potential to reduce costs
- Research priority
- Overall importance

The overall importance category was included so that participants could boost the rating of a challenge that was not adequately rated by the other criteria. Some criteria were omitted from certain categories as they were deemed irrelevant to the contained challenges. For example, the potential to increase safety criteria was omitted from the economic challenge category.

Final challenge scores were computed by summing the weighted averages for the criteria scores for each challenge. In the final results, a weight factor of 0.5 (twice as important) was selected for the overall importance criteria. The RailTEC project team sorted the challenge list by increasing scores (lesser importance) to serve as a guide for selecting the prioritized list of technical challenges.

DESCRIPTION OF CHALLENGES

Before embarking on the survey, a list of challenges related to mixed use corridors was generated. The issues presented here were gleaned through a preliminary high level literature review as well as from initial discussion and interviews with representatives from both the passenger and freight sides of the industry.

SAFETY

Loss of shunt problems

Reducing the weight of passenger rail equipment offers a number of benefits, including greater energy efficiency and improved train performance. There is some concern and anecdotal evidence of short light passenger consists exhibiting shunt reliability problems particularly with grade crossing circuits. This problem may be related to the buildup of corrosion on wheel treads that would serve to interfere with reliable electrical contact. The relationship between wheel load and wheel tread condition could be investigated as it relates to track circuit shunt reliability.

Barriers

Barriers have several applications to shared corridors. Barriers may be useful to prevent the intrusion of foreign vehicles onto the railway right of way. To prevent malicious intrusion, barriers should be designed to withstand large trucks or other vehicles that would pose a significant risk to train operations. Barriers may also be useful in mitigating the effects of a derailment. By separating tracks with barriers, the paths of derailed equipment might be channeled or controlled to where they do not threaten adjacent rail operations.

Highway grade crossings

Implementing higher speed passenger service on existing freight corridors may increase risk to the automotive as well as to rail traffic at highway grade crossings. The cost effectiveness of enhanced grade crossing equipment such as median barriers and four quadrant gates should be weighed against the ultimate but often cost prohibitive solution of grade separation.

Pedestrian risk

The occurrence of trespasser-train accidents may have higher frequency on mixed use corridors due to the inherently higher speed of passenger trains. Fencing off an entire ROW might serve to mitigate some of this risk, but would not guarantee against intrusion. Additional signage, selective use of landscaping features and dedicated pedestrian paths may help channel potential trespassers away from tracks. Radar, infrared, and video motion systems also may help detect trespassers on the railroad ROW.

Adjacent track derailments

With higher passenger train speeds, the consequences of a collision of a passenger train with derailed equipment are greater than a lower speed scenario. In all three operating scenarios of mixed use corridors there remains the risk of equipment derailing and interfering with passenger rail traffic. A comprehensive analysis of derailment probability could be undertaken to understand the effect of track center spacing, equipment standards, and train speeds on the mitigation of this risk.

Wayside defect detection

For many years, the use of wayside automated defect detection equipment has helped reduce the frequency of mechanical component caused derailments. To further mitigate the risk of these types of derailments in a mixed use environment, an intensified deployment of this type of equipment could be investigated.

Risk to maintenance of way and train operating employees

Representatives from several Class I railroads have expressed concern about the increased risk to railroad personnel working on and around a HSR mixed use corridor. Faster passenger operations would decrease the time for these workers to visually detect and clear out of the way for a train. The additional risk to these personnel could be studied, especially in areas where high speed shared track configurations already exist in the United States. Track center spacing and train warning technologies could be investigated as possible methods of mitigating this risk.

INFRASTRUCTURE AND EQUIPOMENT

Slab track

Recent research would suggest that slab track offers lower life cycle costs in high speed rail systems. Slab tracks are not widely used on freight lines because the geometry is not adjustable, and the track superstructure is less resilient in the event a derailment. In addition, the first cost of slab track systems is generally higher than ballasted track. However, in a shared corridor environment where capacity is constrained, slab track may offer a benefit of extra capacity due to lower track occupancy for maintenance purposes. The tradeoff point between ballasted and slab track could be investigated for different traffic scenario. In addition, a slab track designed to accommodate both HAL and HSR traffic could be developed.

Ballasted track

On a ballasted track system, the track superstructure must be optimized for the combination of freight and passenger traffic. Ties, fastening systems, and ballast must be selected taking into account the loading characteristics of both train types. On ballasted track with higher track classes, track surfacing activities may be more frequent to maintain track geometry. Engineering a ballasted track that performs well for HAL and HSR traffic is one potential research area.

Special trackwork

Turnouts with higher diverging speeds may be utilized in order to minimize train delay when entering shared track or when passing from one main track to another. New innovations in turnout geometry and components must be designed to accommodate heavy axle as well as high speed wheel loads. In addition, optimizing the diverging route configuration of mainline turnouts may better accommodate certain traffic patterns. Rail crossings with asymmetrical traffic may also benefit from premium frog designs with feature uninterrupted running rails for the predominant route.

Curve superelevation

Curve superelevation is typically set for the predominant traffic speed on a rail line. On freight lines, curves are typically elevated for the balancing speed or slight unbalance for a freight train. Conventional passenger trains may operate at a higher unbalance than freight traffic, but on especially sinuous lines this may lead to numerous speed restrictions that negatively impact the average speed of a passenger train. With heavy-axle freight operation, changing curve elevation to accommodate passenger trains could potentially impact rail life and increase risk of low rail rollover on curves.

Track stiffness transition zones

Highway grade crossings, bridges, tunnels, and areas featuring special trackwork are locations where the vertical stiffness of the track structure typically increases when compared conventional ballasted track. These stiffness transition zones may be problematic when considering track vehicle interaction and track component lifespan. Engineering transition zones to perform well for both HAL and HSR traffic could be one area of further research.

Track surfacing cycles

Increasing the service speed of passenger traffic requires the track geometry to conform to a higher class of federal standards. An increase in track class requires tighter geometric tolerances for alignment, cross-level, warp, and gauge among other criteria. Because geometry degradation is typically driven by the amount of cumulative tonnage over a line, higher track classes will likely require more frequent surfacing operations to maintain track geometry. Any technologies that would reduce the amount of time needed to occupy the track for surfacing could be investigated for application on shared corridors.

Rail wear and defect rate

By increasing superelevation on curves, a railway line can accommodate higher speed traffic for the same degree of curve. Freight traffic traveling at speeds below the balancing speed of the curve will impart higher loads on low curve rails. Increased rail stress can lead to the increased rate of rail defect formation. Rail corrugation and other short wave irregularities can increase

dynamic loads on the track structure. In particular weld geometry can have an impact on higher speed dynamic loads. At higher speeds, these types of defects may have a detrimental effect on passenger ride quality. The impact of weld geometry could be investigated as it relates to ride quality and dynamic track loads.

Electrification

North American clearance profiles are dimensionally larger than is typical in other shared corridors around the world. Electrifying existing freight lines for the introduction of higher speed passenger trains may be technically possible, but existing clearance constraints may dictate changes to bridges and tunnels. In electrified territory, track geometry is subject to the additional constraint of contact wire position. Additional clearance around high voltage wires may also be necessary. The relatively high position of the contact wire may require new pantograph designs and a general optimization of current collection system.

Tilting equipment

On lines where curves restrict the speed of the train to less than the otherwise maximum, tilting equipment may be used to increase speeds without increasing curve elevation. Active or passive tilting equipment may be used to operate passenger trains at higher unbalanced elevations through curves. Despite enhanced passenger comfort, utilizing tilting equipment does not mitigate increased rail stresses brought on by operating at a higher unbalance speed through curves. Overall increases in passenger train speeds may increase stresses on the high rails of curves. Different levels of curve unbalance could be investigated in terms of vehicle dynamics in addition to relation to rail wear.

Level boarding of rolling stock

Station and equipment configurations that allow for level boarding are inherently more time efficient than standard low level boarding equipment. This feature allows for shorter dwell time at stations, improving overall average speed of a schedule and allowing for slightly increased line capacity. High level platforms are generally not utilized on existing freight lines due to

clearance conflicts with freight equipment. Retractable platforms, gauntlet tracks, or rolling stock with retractable walkways are possible methods to allow for level boarding on existing freight lines.

PLANNING AND OPERATIONS

Infrastructure upgrade prioritization

In many recent proposals for improved passenger rail service, an emphasis has been placed on achieving a higher maximum operating speed rather than higher average speeds. Improvements to lower speed terminal areas among other places can often yield a greater marginal trip time reduction than an increase in maximum operating speed. Developing a model that prioritizes infrastructure upgrades could help enhance the efficiency of proposed passenger rail projects.

Rail capacity planning

Rail capacity is a function of the level of service expected for all different train types operating on a line. Planning for increases in rail traffic should take into account present, as well as future desired level of service. Present methods of determining adequate rail capacity include parametric as well as simulation modeling. More research could be undertaken to more accurately quantify the impact of adding higher speed passenger traffic on existing freight lines. The effects of train performance, speed, and priority could be analyzed with the goal of determining the equivalent capacity consumption for different types of rail traffic.

Maintenance of way scheduling

With the addition of passenger service on a shared track line, the time required for infrastructure maintenance is further constrained. On lines with especially high density and little excess capacity, maintenance activities may take place during night hours when passenger traffic does not typically operate. For areas where this technique is not economical, new maintenance window scheduling strategies could be developed to minimize delay to both passenger and freight traffic while at the same time preserving maintenance productivity.

Train scheduling patterns

Different scheduling scenarios can have tremendous impacts on both the ridership and capital costs of a proposed service. Regional intercity passenger trains typically operate during the day, disproportionately adding more demand for infrastructure during certain time periods.

Accommodating this traffic may require extra infrastructure that would otherwise not be needed if the service was scheduled more uniformly throughout the day. Different scheduling patterns could be assessed for their efficiency in utilizing new infrastructure, as well as their impact to delay for both freight and passenger traffic. In addition, grouping train types with more similar performance characteristics, for an example, intermodal and passenger trains, may hold some opportunity for reducing delay. The impact of speed and priority differential between train types could be investigated as it relates to different traffic levels and infrastructure characteristics.

Train schedule reliability

Many contemporary intercity passenger rail services use a fixed percentage of minimum run time applied as slack time to the end terminal to help enhance reliability of train services. Slack time is not typically adjusted for expected rail traffic or even infrastructure characteristics. It is possible there are better methods of enhancing train reliability through schedule slack based on specific rail traffic conflicts or track configurations expected for the passenger service. In addition, distributing slack time to different points in the schedule based delay statistics could help make for a more robust schedule. Investigating these different methods and developing a model that could be applied to existing and future service would serve to increase the reliability of passenger services.

SURVEY RESULTS

The technical challenges previously described were included in the industry survey. After closing the survey, the weighted scores from various participants were considered to calculate an average score for each challenge. The top priority challenges were selected primarily from the

survey results. In each category, challenges with lower scores indicated greater importance. For scenarios where several challenges were grouped near the top of the priority list, the RailTEC team relied on its own domain knowledge as well as information gathered from interviews with industry experts to serve as tiebreaking criteria. The top challenges selected for the next phase of the project for further analysis are presented in Table 2.

Safety	Infrastructure and Equipment	Planning and Operations
Adjacent track derailments	Special trackwork	Train scheduling and effects on delay
Highway grade crossings	Optimized ballasted track	Maintenance window scheduling
MOW and train operating employee safety	Track stiffness transitions	Capacity planning methodologies

Table 2: Top Challenges

CONCLUSIONS AND FUTURE WORK

In summary, top technical challenges needing further research were identified through a research symposium, industry interviews, and an open industry survey. In the safety category, assessing the risk of adjacent track derailments, furthering the understanding of highway grade crossing risk mitigation, and assessing the risk to railroad employees on and about the ROW were identified as top challenges. In infrastructure, special trackwork, ballasted track, and track transition optimization were identified as top challenges. In planning and operations, train scheduling, maintenance window scheduling, and capacity planning methodology challenges were identified as top challenges.

The next step of the project is to conduct an extensive literature review for the identified top challenges. In this review process, the relevance of the different challenges to different types of mixed use corridors will be assessed. In addition, existing research, knowledge gaps and future research needs in each of the top challenges will be identified.

ACKNOWLEDGEMENTS

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REFERENCES

Federal Railway Administration. (2003). *Catalog of "Common Use" Rail Corridors*. Washington, DC: U.S. Department of Transportation.

LIST OF TABLES AND FIGURES

Figure 1: Distribution of Participant Affiliations

Table 1: Types of Mixed Use Rail Corridors

Table 2: Top Challenges



Identifying and Prioritizing Shared Corridor Technical Challenges

Brennan M. Caughron
Graduate Research Assistant
Rail Transportation and Engineering Center
(RailTEC)
University of Illinois at Urbana-Champaign

INVESTIGATING TECHNICAL CHALLENGES AND RESEARCH NEEDS RELATED TO SHARED CORRIDORS FOR HIGH-SPEED PASSENGER AND RAILROAD FREIGHT OPERATIONS

RAILTEC
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN



Project Description:

- New high speed rail (HSR) developments in the U.S. need to address technical challenges of shared rail corridors in the North America rail environment
- The objectives of this project are to **identify shared rail corridor technical challenges, existing and on-going research, knowledge gaps and research needs**

Impact on the Railroad Industry:

- Reducing the operational and program deployment risks associated with shared rail corridors
- Identification of critical areas to address in planning new HSR systems
- Expediting the process of developing efficient and safe HSR shared corridors with better prioritization in planning

Research Sponsor:



U.S. Department of Transportation

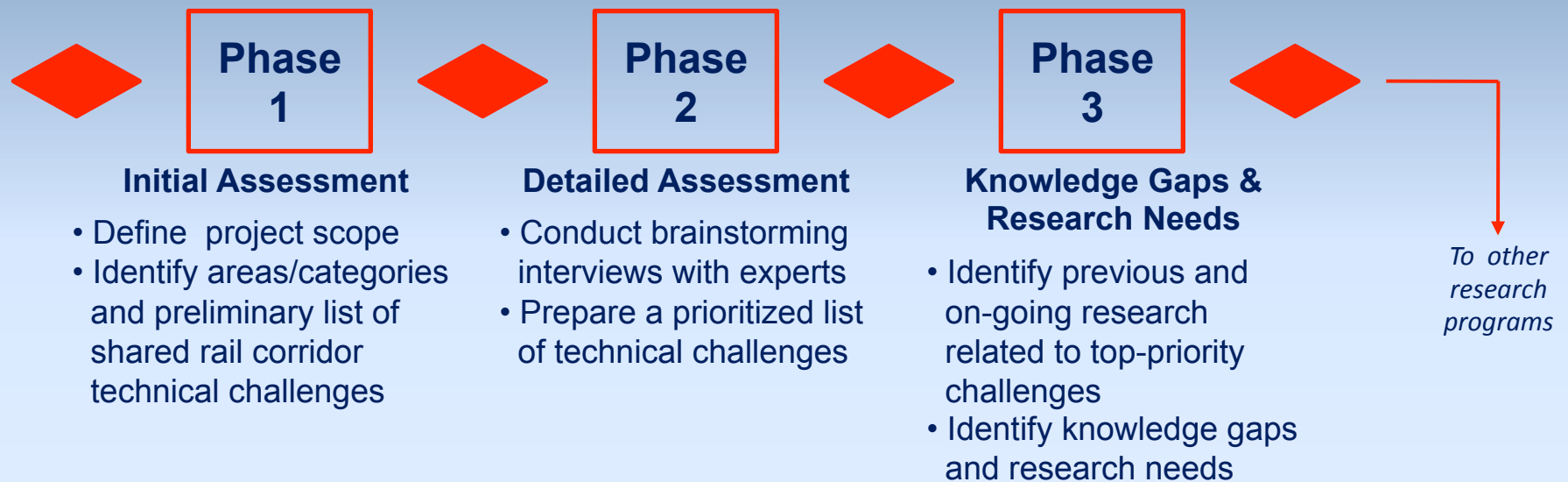
Federal Railroad Administration

BROAD AGENCY ANNOUNCEMENT

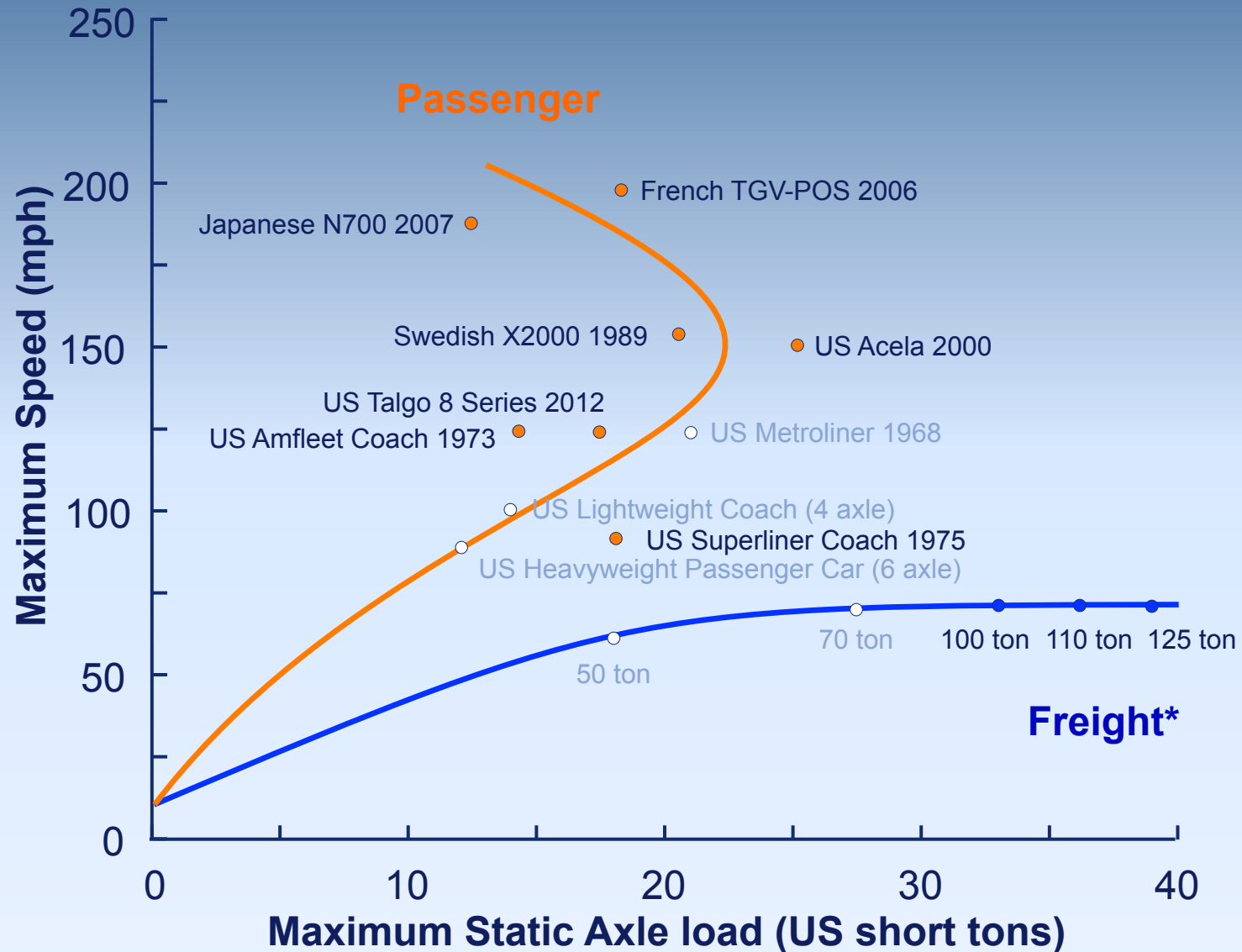
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*Research and Demonstration Projects Supporting
the Development of High Speed and Intercity
Passenger Rail Service*

Methodology



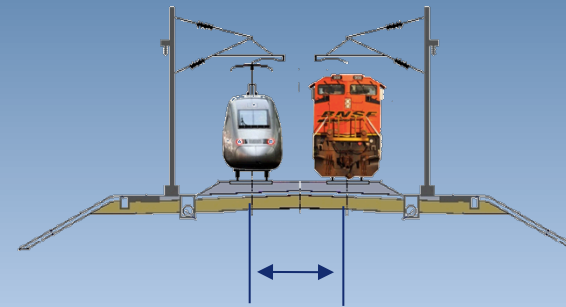
Divergence of HAL and HSR



Shared-Use Corridor Operating Configurations

Shared track & shared ROW

- **Shared track:** tracks shared between passenger and freight or other service.
- **Shared right of way (ROW):** dedicated high-speed passenger tracks separated from freight or other service tracks up to 25'
- **Shared corridor:** dedicated high-speed passenger tracks separated from freight or other service tracks by 25-200'

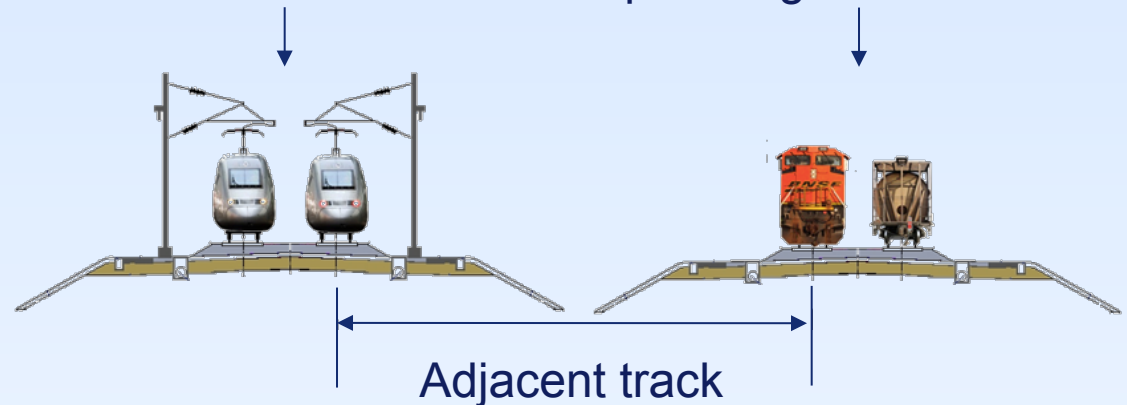


Adjacent track centers $\leq 25'$

Shared corridor

High-speed rail service

Freight or conventional passenger rail service



Adjacent track centers $>25' \leq 200'$

Shared Rail Corridors: SAFETY

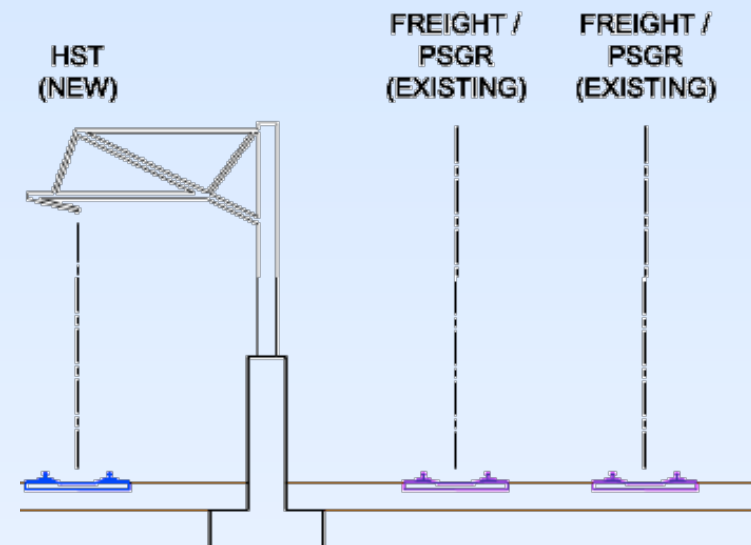
Track Center Spacing

- Track center spacing has risk exposure implications
- Typical spacing on freight lines is around 14 feet, but can be as low as 11' and in areas with no ROW constraints as high as 25'
- Areas of concern include:
 - Adjacent track derailments
 - Safety of maintenance of way (MOW) and train operating (TY&E) employees
 - Capacity effects of maintenance on adjacent tracks
 - Aerodynamic effects of higher speed trains



Adjacent Track Derailments

- Higher speed of proposed passenger rail services increases risk posed by derailed trains on adjacent tracks
- Warning of a derailed train fouling tracks may not always arrive soon enough to prevent collision of other trains with debris on affected tracks
- Use of derailment barriers suggested as a method of mitigation for adjacent tracks but these can create access problems for maintenance
- Holistic risk management including accident prevention as well as accident mitigation is needed



Wayside Defect Detection

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- Wayside detectors can identify problems with rolling stock
- Can be reactive or predictive
 - Dragging equipment
 - Shifted loads
 - Wheel bearing condition
 - Wheel contour
 - Brake condition
- Numerous technologies
 - Acoustic
 - Thermal
 - Machine vision
- Potential risk management strategy on shared corridors
 - More stringent standards to mitigate derailment risk

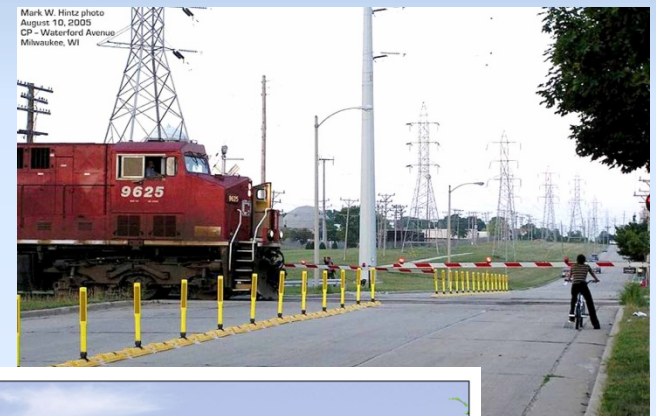


Highway Grade Crossings

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Operating Speed	Requirement
< 110 MPH	States and railroads cooperate to determine the needed warning devices
110 – 125 MPH	"Impenetrable barrier" must block highway traffic when train approaches.
>125 MPH	Level crossing not permitted

- Types of enhancements
 - Long-arm gates
 - Median barriers
 - Four quadrant gates
 - Incursion detection
- Grade separation or crossing closure required above 125 MPH
 - Closures inconvenient and unpopular
 - Bridges expensive
 - May disrupt nearby residents and business

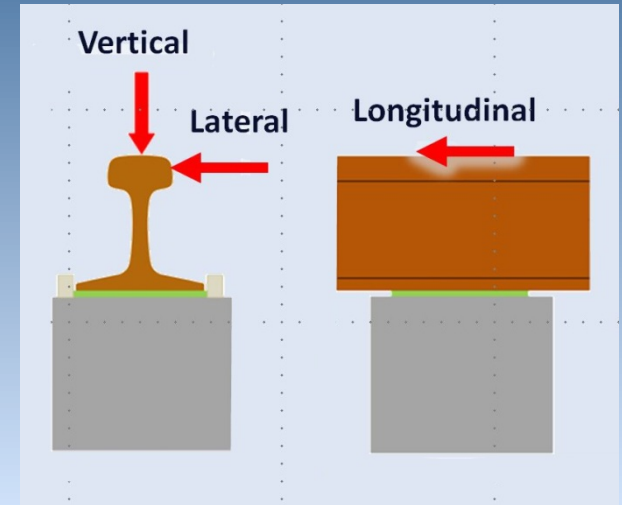


Shared Rail Corridors: INFRASTRUCTURE & ROLLING STOCK

Traffic Loading

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Traffic Type	Speed (MPH)	Static Load (tons)	Dynamic & Impact Load (95 th percentile, tons)
Passenger	125	25.9	31.0
Freight	35	36.3	49.8



Preliminary analysis by Brandon Van Dyk based on NEC WILD data

Wheel loads

Type

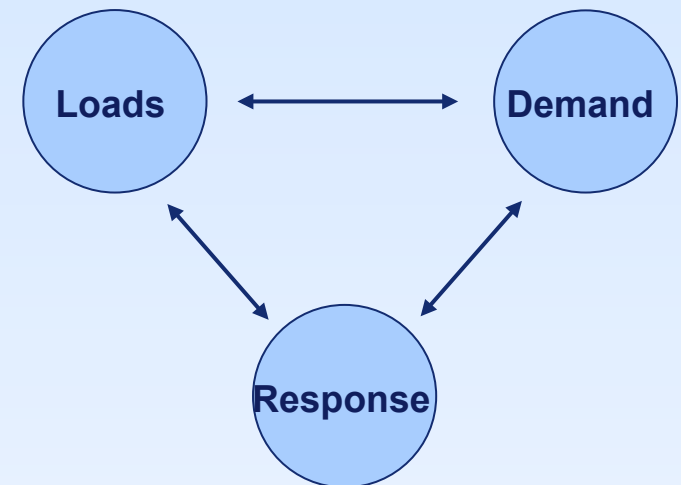
- Static
- Dynamic (track deflection, curving)
- Impact (flat wheels, frog gaps)

Characteristics

- Magnitude
- Frequency
- Cycles

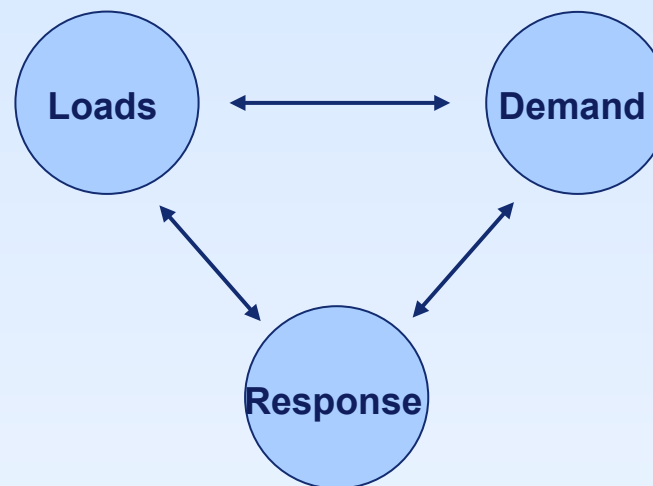
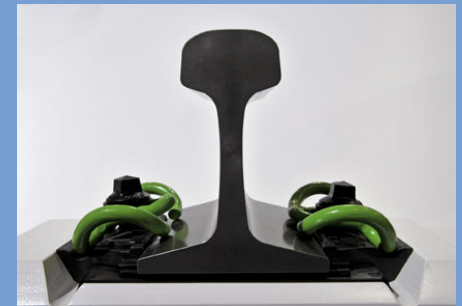
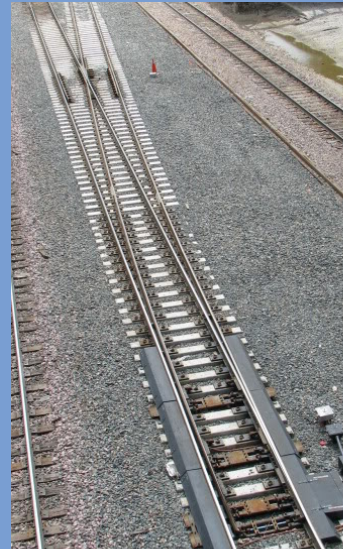
Response - elastic or plastic

Demand - varies with speed and type of traffic



Track Structure Design

- Superstructure
 - Rail
 - Fasteners
 - Insulators
 - Pads
 - Crossties
- Substructure
 - Ballast
 - Subgrade
- Special trackwork
 - Turnouts
 - Crossings
- Track transitions

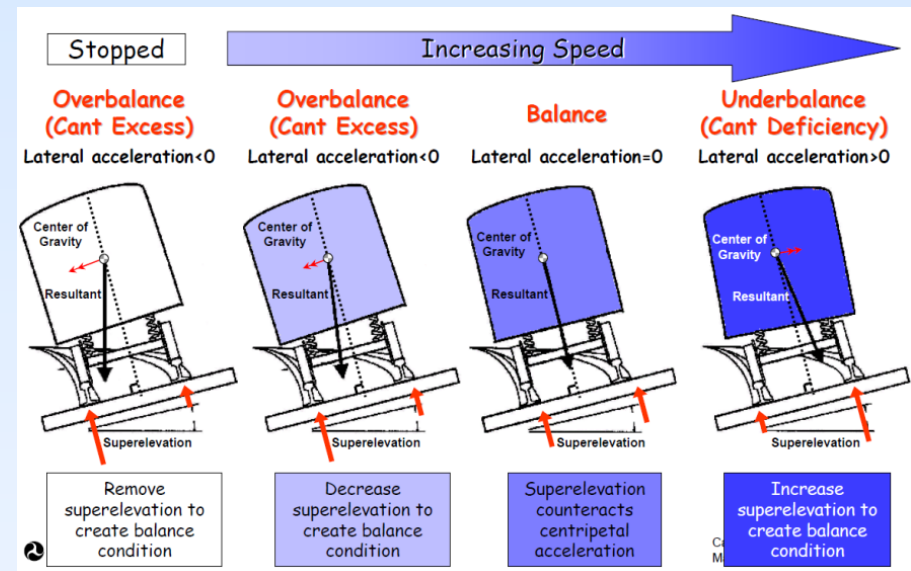


Track Geometry

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- US FRA regulates track geometry based on maximum train speed
- Higher speeds require more stringent geometry and more frequent inspection and maintenance
- Optimizing track geometry for mixed traffic is a challenge
- Curve super-elevation allows for higher speed passenger traffic but causes problems for lower speed freight traffic
- Better performing trucks allow for higher cant deficiency operation. Tilting equipment allows passengers' on-board safety and comfort to be preserved, while traveling at higher speed on under-balanced curves

Track class	Max speed (MPH)	Gauge (mm)	Alignm ent (mm) over 18.9m chord	Profile (mm) over 18.9m chord	Warp (mm) over 18.9m chord
3	60	-12.6, +31.6	44.2	56.8	50.5
5	90	-12.6, +25.3	18.9	31.6	37.9
7	125	-12.6, +18.9	12.6	25.3	37.9
9	200	-6.3, +18.9	12.6	18.9	37.9



Special Trackwork

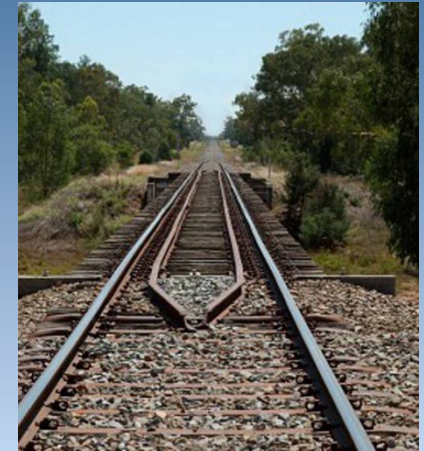
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- High impact loads and ride quality at high speed may require extra attention to special trackwork
- Turnout geometry
 - Higher diverging speeds
 - Reduced component wear
- Frog types
 - Moveable point (swing nose)
 - Vertical lift frog
 - Spring rail frog
- Optimization of diverging route configuration for turnouts
 - Train speed requirements
 - Traffic damage per train type
 - Traffic damage differential diverging vs. straight route



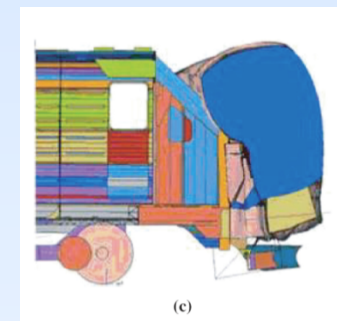
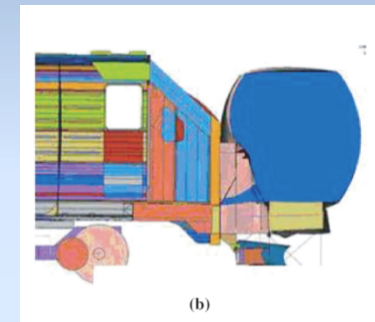
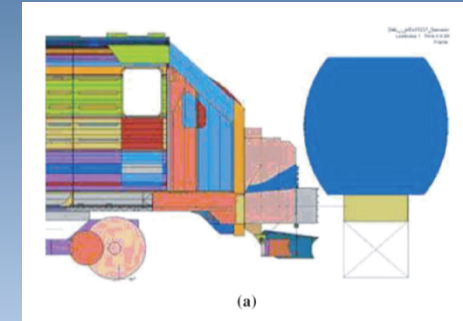
Track Transitions

- Controlling changes in track stiffness or modulus may be more important on shared corridors
- Problem of ballast degradation and subgrade settlement (pumping, mud spots)
- High maintenance cost
- Potential ride quality and vehicle response problem with higher speed trains
- Problem areas:
 - Concrete to timber crossties
 - Ends of bridges
 - Highway grade crossings
 - Turnouts and special track-work
 - Tunnels



FRA Passenger Equipment Safety Standards

- **Tier I** - For passenger equipment with a maximum operating speed less than 125 MPH
 - Conventional intercity and commuter equipment
- **Tier II** – For equipment with maximum speeds of greater than 125 MPH but less than 150 MPH
 - Developed for Acela, adopted as FRA regulations
 - Additional strength requirements
 - Crash-energy management requirement
- ***Tier III** – Will allow speeds of up to 220 MPH on dedicated line
 - Interoperable with other equipment below 125MPH
 - Some standards may be less stringent than Tier II because of restrictions on operating environment

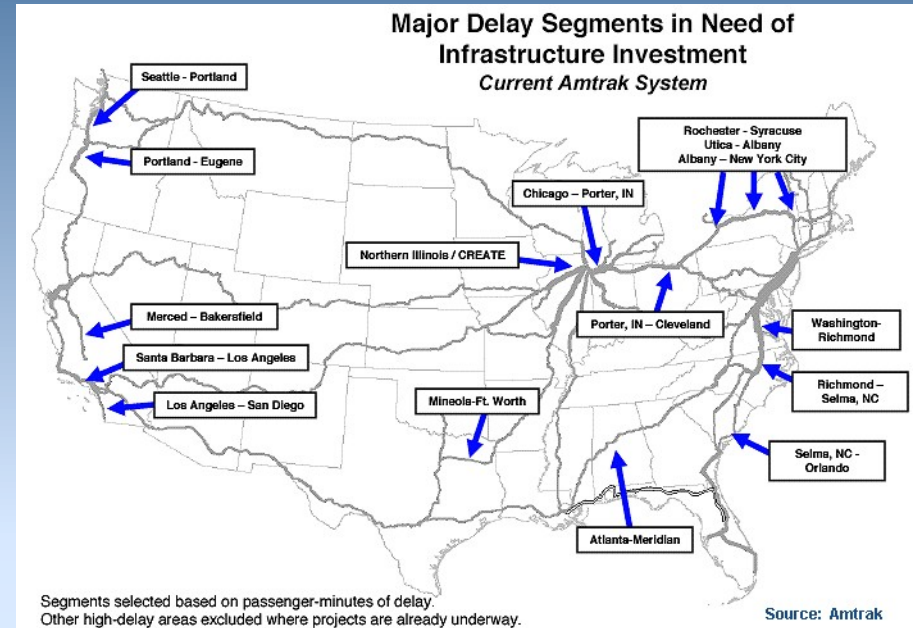


Drawings from: Siemens (in DiBrito et al 2011)

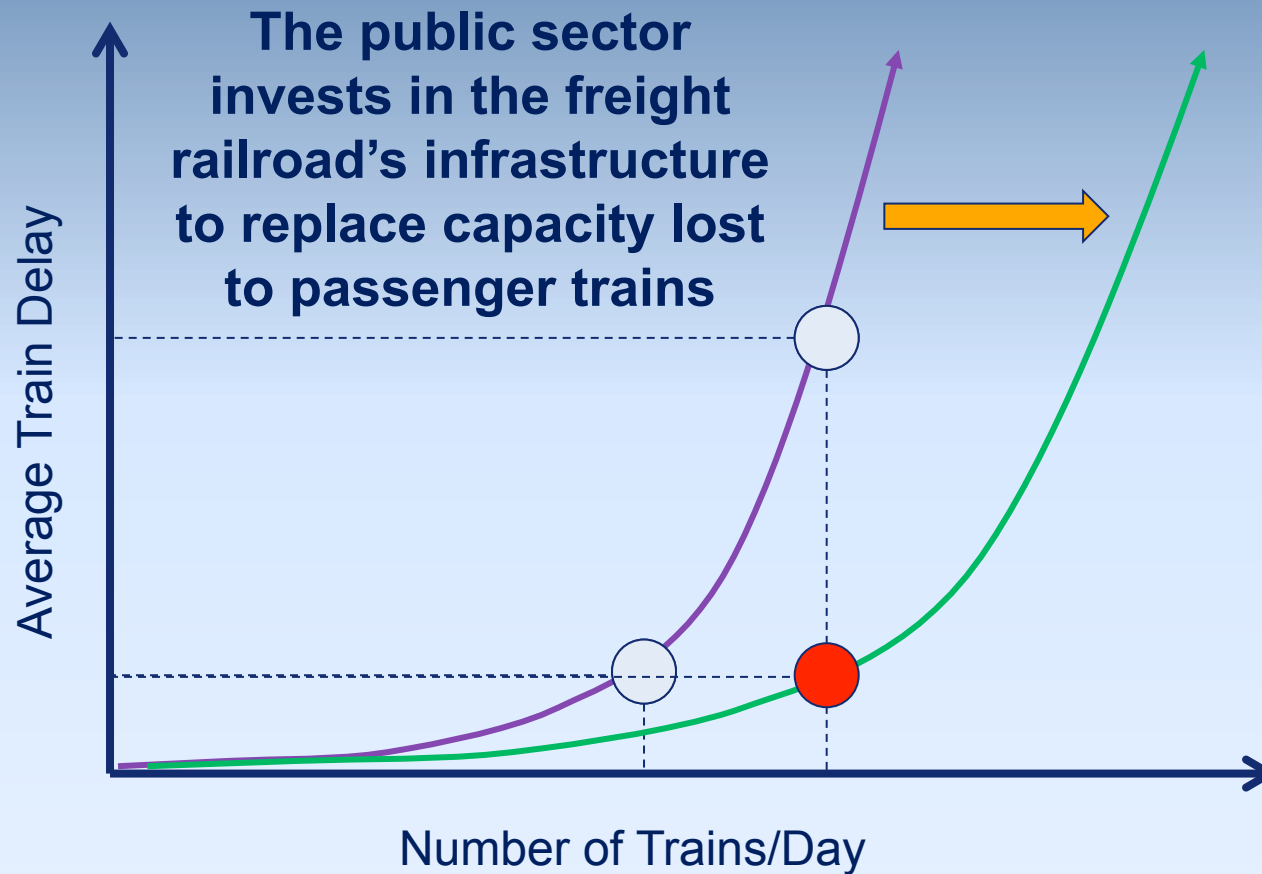
Shared Rail Corridors: PLANNING AND OPERATIONS

Operational Interference and Incompatibility

- Heterogeneous operating characteristics such as speed and especially priority, disproportionately consume rail line capacity and introduce delay
- Dedicated tracks for each reduces this impact but increases cost
- New passenger operation is likely to require additional rail capacity, such as:
 - Siding upgrades
 - Additional main track
 - Improved turnouts
 - Signal upgrades



Adding Passenger Trains to a Freight Line



RailTEC Simulation Modeling

Software: Rail Traffic Controller

- Developed by Eric Wilson from Berkeley Simulation Software
- Emulates a dispatcher controlling train movements across a network based on train priority
- Integrated train performance calculator
- Inputs: track, signals, trains, and schedule
- Output: delay, average velocity, on time performance

Route information

1. Single track with 15 mi between siding centers

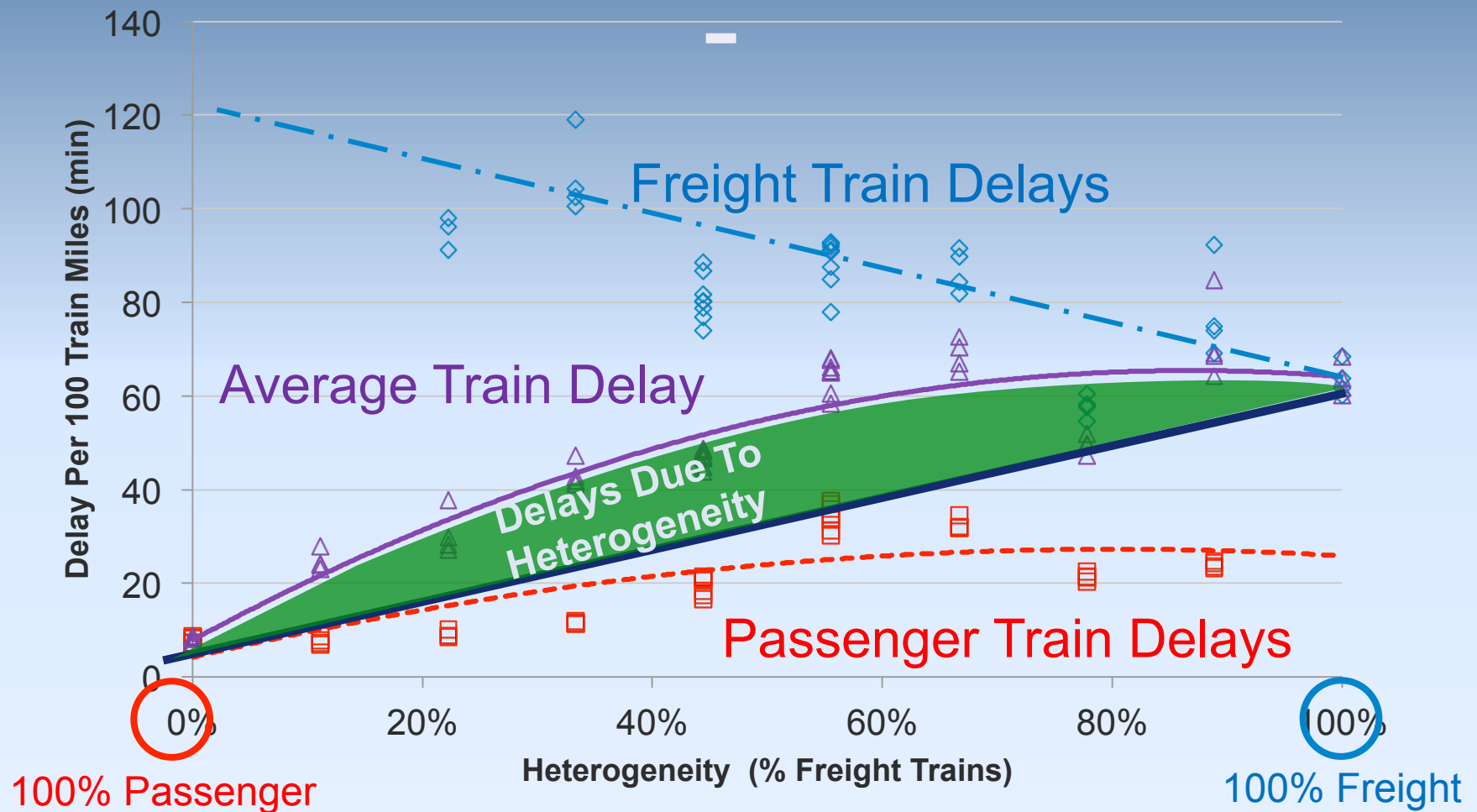
2. Double track with 15 mi between universal crossovers

Both routes 260 mi long

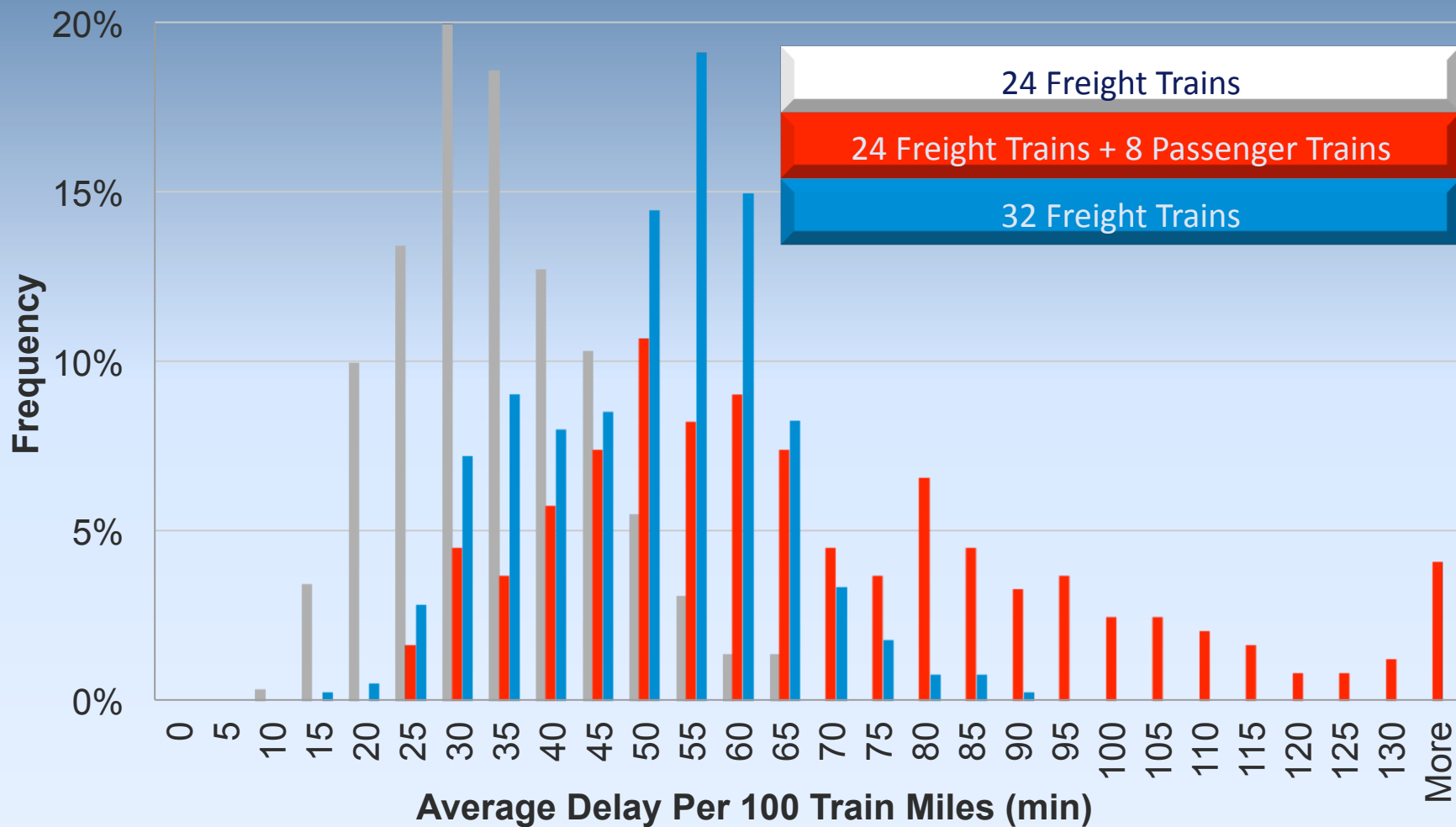
Train information	Unit Freight Train	Passenger Train
Length (ft)	6,323	500
Weight (tons)	16,450	500
Max. Speed (MPH)	50	80,90,110

Delay Increases Due to Heterogeneity in Train Type

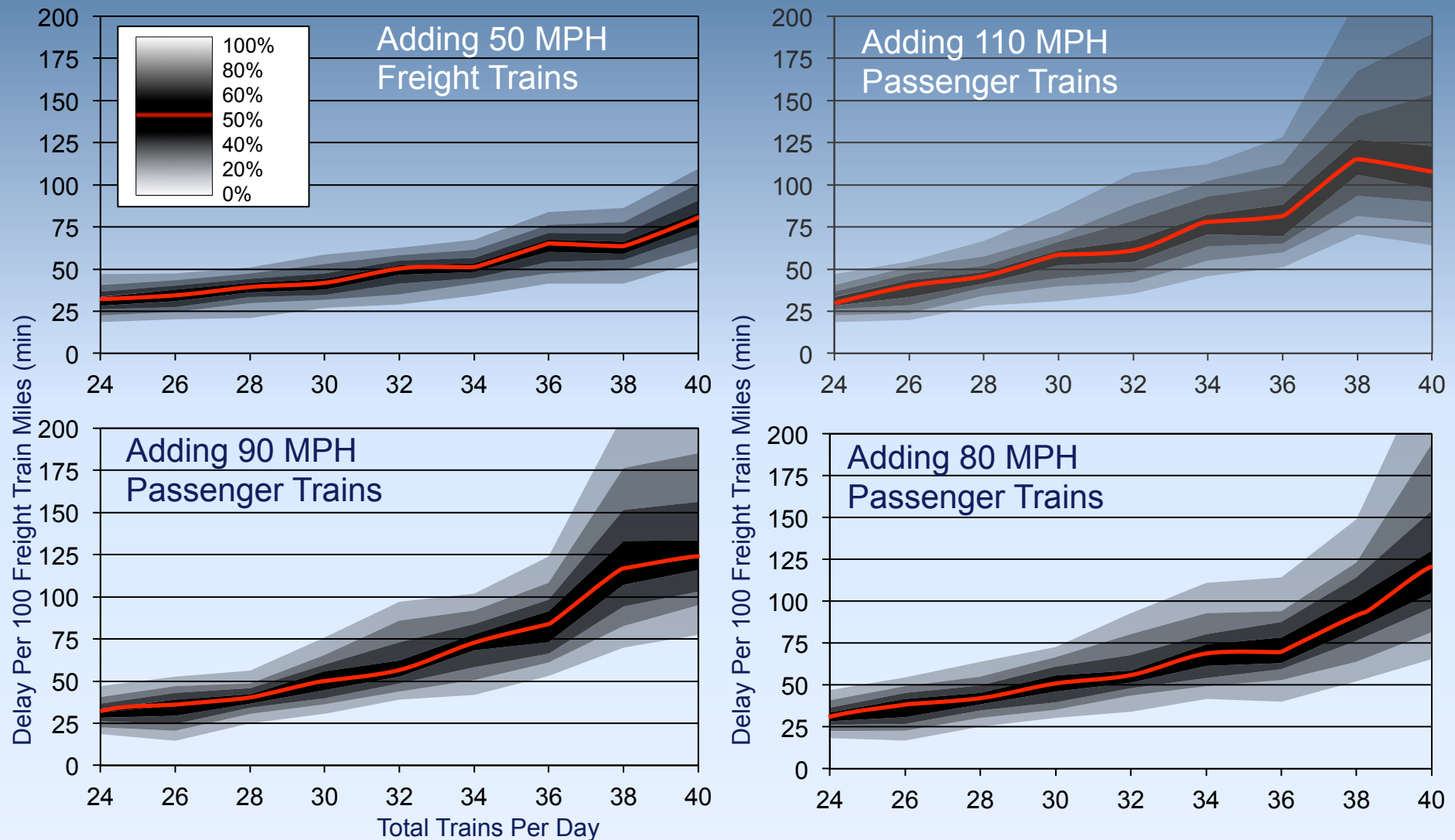
36 Trains Per Day



Distribution of Delays

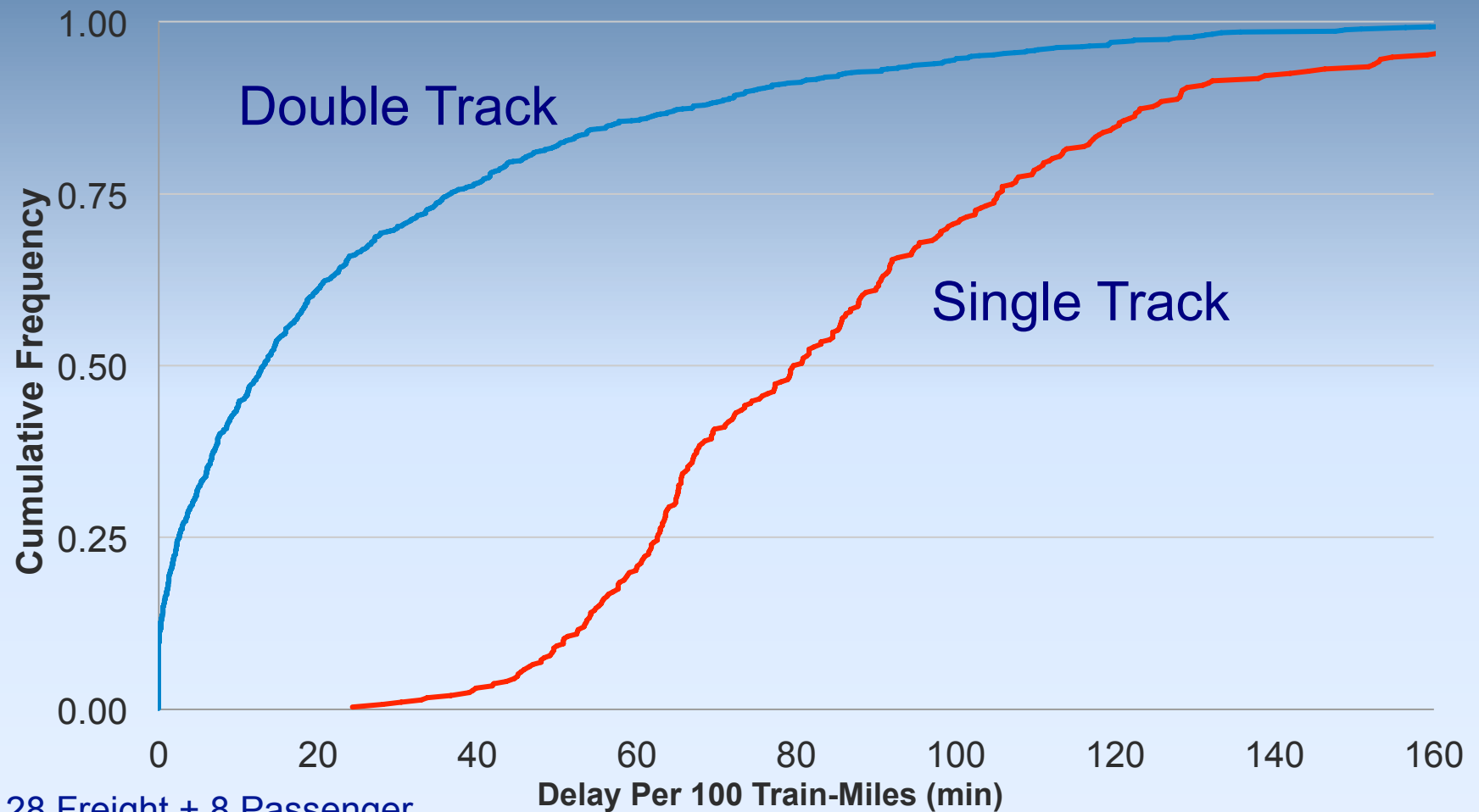


The Effect of Passenger Speed on Freight Delay



Sogin, S.; Barkan, C.P.L.; Saat, M.R.; , "Simulating the effects of higher speed passenger trains in single track freight networks," *Simulation Conference (WSC), Proceedings of the 2011 Winter*, vol., no., pp.3679-3687, 11-14 Dec. 2011

Distribution of Freight Delays on Single & Double Track



- (1) 28 Freight + 8 Passenger
- (2) 40 Freight + 24 Passenger

Marginal Cost of Capacity

- Rail capacity investments may be “lumpy”, that is they require a single, large expenditure
- Marginal cost of capacity is an increasing function
- How should the cost of capacity be shared among different users?
- Some freight railroads concerned that new passenger services are taking advantage of “cheap” capacity upgrades



Accommodating more traffic requires a second bridge. Who pays?

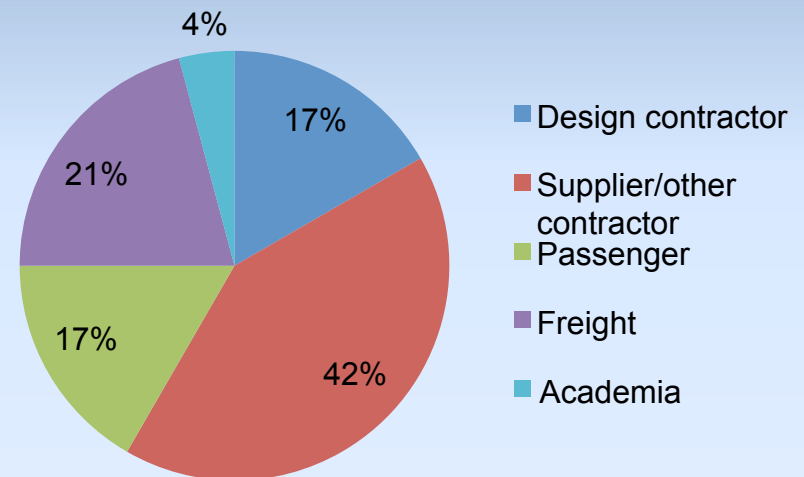
Industry Survey

Rating Criteria

- Criteria assessed on a scale from 1 (*high*) to 5 (*low*)
- Potential to increase safety - incident severity, frequency
- Potential to increase corridor effectiveness - tonnage, speed, ridership, reliability
- Potential to reduce costs - initial costs, maintenance and operating costs, lifecycle costs
- Research priority
- Overall importance (2x)

Survey Participation

24 total participants



Top Rated Challenges

Safety

- Adjacent track derailments
- Roadway worker safety
- Highway grade crossings

Infrastructure

- Special trackwork
- Ballasted track optimization
- Track transitions

Planning & Ops.

- Traffic scheduling patterns
- Maintenance of way scheduling
- Capacity planning methodologies

Questions?

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Samuel L. Sogin
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Assistant UIUC

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Graduate Research
Assistant UIUC



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Contact Information

Christopher P.L. Barkan
Professor
Director of Railroad Engineering
Program
George Krambles Faculty Fellow
UIUC
<cbarkan> at illinois.edu

M. Rapik Saat
Research Assistant Professor UIUC
E-Mail: <mohdsaat> at illinois.edu

Brennan M. Caughron
Graduate Research Assistant UIUC
E-Mail: <bcaughr2> at illinois.edu