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Challenges and Opportunities in Implementation of the Future California Rail Network

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Abstract

The California High-Speed Rail Authority (CHSRA) adopted a "blended system" at the northern and southern termini of the planned first phase of its high-speed rail line. In this blended operation, the high-speed rail line will share track and other infrastructure with commuter, intercity, and freight rail. However, the lack of common infrastructure among rail modes and the financial and organizational challenges associated with building that common infrastructure and capacity allocation in California present challenges for the implementation of high-speed rail via a blended system in the state. This paper reviews the blended system and discusses the level of cooperation and coordination necessary between host railroads/agencies and the high-speed rail tenant operator. Sharing track comes with challenges for all participating railroad operators and often requires coordination between heterogeneous rail traffic. However, costs can be reduced compared to dedicated track. How blended service is carried out will impact state and local agencies, railroad owners and operators, and customers across the California rail network.

INTRODUCTION

The underlying motivation for this work is to share the challenges and the vision for the implementation of high-speed rail under shared-use conditions in California. In 2012, as a cost-control measure and in response to local opposition in the San Francisco Bay Area, the California High-Speed Rail Authority (CHSRA) adopted a "blended system" at the north and south ends of the planned first phase of its high-speed rail line. In this blended operation, the high-speed rail line will share track and other infrastructure with commuter, intercity, and freight rail on the 50-mile Peninsula Corridor in Northern California and on 50 miles of right-of-way between Burbank, Los Angeles, and Anaheim in Southern California. This paper provides a review of the blended system and discusses the challenges and opportunities associated with the level of cooperation and coordination necessary between host railroads/agencies and the HSR tenant operator.

Though the CHSRA has existed since 1996, the concept of a high-speed link connecting San Diego, Los Angeles, San Francisco, and Sacramento did not significantly move forward until 2008. In that year California voters passed Proposition 1A, which allocated $9.95 billion in bond funds for high-speed rail (90% of funds) and local associated rail improvement projects (10% of funds) across the state *(1)*. Federal funds including American Recovery and Reinvestment Act (ARRA) add approximately $2.5 billion to the project *(2)*. According to the latest business plan issued by the CHSRA, the initial operating segment between Merced, California and Burbank, California will cost $31 billion *(2)*. The first phase of the project, between San Francisco and Los Angeles, to be completed by 2028, will cost $68 billion; to this end, the CHSRA is pursuing private investment that will be partially repaid by fare revenues (ibid).

The high-speed rail system will share right-of-way and often the same track with four right-of-way owners other than the CHSRA itself. They include the BNSF Railway between Anaheim and Los Angeles, the Southern California Regional Rail Authority (SCRRA) between Los Angeles and the San Fernando Valley, the Peninsula Corridor Joint Powers Board (PCJPB) between San Jose and southern San Francisco, and the Transbay Joint Powers Authority (TJPA) for the northernmost 1.3 miles of the system between southern San Francisco and the new downtown San Francisco Transbay Transit Center (See FIGURE 1).

These shared corridors are high-value corridors for both the host railroads and the CHSRA. The PCJPB’s Peninsula Corridor is one of the busiest commuter rail corridors in the country, and the TJPA’s extension into downtown San Francisco will increase ridership on the commuter rail line (Caltrain). In Southern California, the San Fernando Valley to Burbank section of SCRRA’s right-of-way carries two of SCRRA’s commuter rail lines (Metrolink) as well as Amtrak California’s *Pacific Surfliner* and Amtrak’s *Coast Starlight.* Lastly, the San Bernardino subdivision, owned by BNSF Railway, is a vital link between the Los Angeles/Long Beach port complex, BNSF’s Hobart Intermodal Yard, and the railway’s “Southern Transcon” mainline between Southern California and Chicago**.**

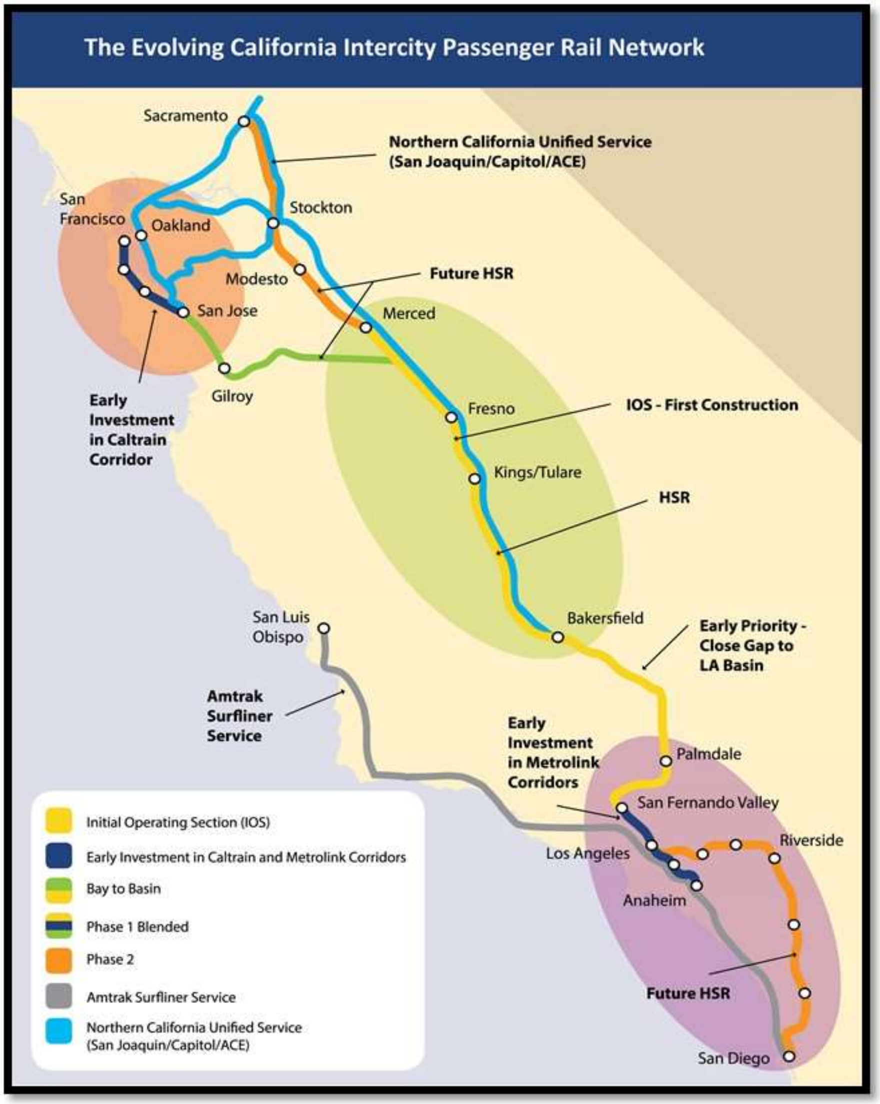


FIGURE 1 California Passenger Rail Network

This paper takes the view that since the high-speed rail line is operating on these shared corridors, and not in a dedicated right-of-way, California needs to take a "top-down" approach to high-speed rail implementation, asking "what do we want as a state and how do we get there?" rather than a bottom-up approach which asks "how does this part of the system need to work for high-speed rail to be successful?" We will discuss how implementation choices will impact agencies, railroad operators, and customers across the California rail network.

LITERATURE REVIEW

In our literature review, we review papers regarding collaboration between transportation agencies which can lead to cross-modal integration, capacity pricing and allocation on shared rail corridors such as the Northeast Corridor (NEC) and California, and finally specific network planning in California.

Collaboration between Transportation Agencies

The body of literature discussing collaboration between transportation agencies is limited. Literature regarding how to achieve collaboration is also underdeveloped *(3)*. Currently, the state of relationships between transportation agencies in California presents challenges for the implementation of high-speed rail in the state.

Collaboration between agencies is critical for the efficient and effective management of transportation systems. However, as funding concerns and litigation slow the process of implementing high-speed rail in California, the level and effectiveness of future multi-jurisdictional and multi-organizational cooperation in the state remains unknown. Meyer et al. define collaboration as a process which "involves understanding the need for collaboration, identifying common goals, putting in place common communication strategies, and using feedback mechanisms that allow for collaboration strategies to be evaluated and modified over time to respond better to changing decision-making demands" *(3)*. Meyer et al. also offer explanations for why collaboration occurs in the transportation sector. Reasons include the need for multimodal or multijurisdictional responses to public needs, the coordination of institutions to maximize the effectiveness of infrastructure investment and transportation system operational efficiency, and the sharing of costs and risks associated with expensive and novel projects.

Meyer et al. present two contexts for collaboration: 1). improving the effectiveness of existing collaborative efforts and 2) understanding the dynamic nature of collaboration and how to influence its evolution (ibid).

In defining collaboration as a process, Meyer et al. outline a detailed, sequential ten-step progression that assesses the quality of the evolution of a collaborative effort at each step with a series of questions that serve to build the foundation necessary to move forward in the process.

Modal integration at the "last-mile"

Effective collaboration between transportation agencies in California directly impacts the quality of service at the point where customers must switch to or from high-speed rail to or from other modes to complete their journeys. Reinhard Clever claims that institutional and regulatory barriers to integration are higher in the United States than in Europe or Asia *(4)*.

In his 2013 TRB paper, Clever develops a "Six Stages of Integration" framework (see Figure 2) that categorizes existing public transportation systems by their level of modal and agency integration in an effort to optimize California high-speed rail.

Integration is important for two reasons, the first being the adverse effect of transfer penalties. The cost a passenger incurs in changing trains substantially reduces the utility of using rail as a transport mode. The second reason integration is important is that ridership falls sharply beyond a 400m radius of a station, a phenomenon Clever refers to as the "quarter mile rule;" and it is based on the willingness of travelers to walk *(4)*.

Increasing Levels of Integration

INTEGRATION LEVEL / EXAMPLES		FEATURES
0	**No Integration**	
	New York	separate stub-end terminals throughout the city
	Boston	difficult rail to rail transfers
	Berlin (before 1882)	huge footprint in urban core
1	**Union Station**	
	Washington, DC	single stub end terminal
	Los Angeles	low thru-put per platform track
	Denver	big footprint in urban core
2A	**Intermodal Terminal with Agency Demarcation Lines**	designed for operational convenience
	Millbrae	separate fare collection system
	SF Market Street Stations	long walking distance
2B	**Intermodal Terminal w/o Agency Demarcation Lines**	designed for ease of transfer
	all stations within regional transit federations	common fare collection system
		short walking distance
3A	**Cross-City Line for Suburban Trains**	most downtown work places located within walking distance
	Philadelphia	leverages "Quarter-Mile Rule"
	virtually all Metro Areas in Europe and Southeast Asia	convenient access for reverse commuters
		high capacity using a small footprint
3B	**Cross-City Line for Suburban and Intercity Trains**	most downtown hotels and attractions within walking distance
	Berlin, Hamburg, Brussels	
4 (Best Practices)	**Pulsed Hub System**	
	Switzerland, Austria, Germany	shortest transfer time
5 (Best Practices)	**Convergence**	
	Interurban tram-trains in Karlsruhe	no transfers - one seat rides

FIGURE 2 Clever's Six Stages of Integration; the CHSRA's blended system demands Level 4 (Pulsed Hubbing) or Level 5 (Convergence) Integration.

Clever then defines two types of integration: spatial and temporal. Spatial separation relates to transferring between modes (e.g. HSR and commuter) and temporal integration relates to achieving schedule coordination.

In the United States, the most integrated level of transportation planning is inter-modal terminal with agency demarcation lines. Clever gives four reasons explaining why transportation planning has not moved beyond this level:

- Weak Institutions: Individual transit agencies have the power to demand and obtain approval for their own stub-end terminals and no agency is required to adhere to a common regional fare system; there is no incentive to collaborate and share infrastructure *(4)*.
- Division of Planning: The division of project planning into professional disciplines dealing separately with capital costs, operating costs, and environmental impacts causes one to lose sight of the system as a whole.
- Suboptimization: Project optimization is compromised by political decisions.
- Regulatory Challenges: The prevalence of passive safety measures over active safety measures (e.g. design for accident survivability and crashworthiness as opposed to accident avoidance and positive train control) in North America as regulated by the FRA leads to the need for various waivers to permit high-speed trains to run in the same corridor as other grades of train. Clever also argues that airport-style screening at HSR stations would reduce HSR's ability to "leverage synergies with local and regional transportation, greatly diminishing its potential".

Capacity Allocation and Pricing on Shared Rail Corridors

Sharing track, when done properly, is an attractive option for both passenger rail agencies and freight railroads and increasingly common in the United States. However, sharing track also comes with challenges for all participating railroad operators. Sharing track often requires coordination between non-homogenous rail traffic. Rail capacity is not a fixed quantity; it depends on how the infrastructure is used. A rail line can accommodate much more homogenous traffic (same speed and stopping patterns) than a rail line with heterogeneous traffic.

The National Cooperative High Research Program Report 773 describes the current method of adding service to shared rail corridors: “On corridors they own, freight carriers fully control the technical assessment of the operations for proposed and existing shared-use territories even when the passenger rail sponsor underwrites the cost of such analysis” *(5)*. Freight railroads operate national systems and are often concerned about “network impacts” that extend beyond the reach of passenger rail service on a shared corridor. Sometimes the cost of lost flexibility for freight railroad hosts is greater than the track access fees paid by the commuter rail guest on the line.

In her dissertation, Maite Pena-Alcaraz notes how lack of capacity planning has made modification of Northeast Corridor services an extremely difficult exercise *(6)*. On the Northeast Corridor, there are multiple operators and right-of-way owners, not unlike California. However, long-standing bilateral agreements means that some guest railroads are paying access charges that do not reflect the cost of maintaining infrastructure. Also, these bilateral agreements make it difficult to make service adjustments since train timetables are negotiated on a local level rather than on a corridor- or system-wide basis.

California Rail Network Service Planning

In the spirit of the blended system (in which high-speed rail coexists with conventional services), Ulrich Leister applies what he describes as a “Swiss Approach” to high-speed rail in California by emphasizing a lean construction approach that features a high-speed “trunk” in the middle of the state connecting to major transfer stations that serve the metropolitan areas of San Francisco and Los Angeles *(7)*. Leister proposes an approach that moderately increases travel time between California’s major metropolitan areas, but also (according to Leister’s own estimates), greatly reduces the project’s overall cost. Ross Maxwell, in his 1999 TRB paper, also emphasizes the Swiss strategy of timed transfers and provides a conceptual schedule map for Northern California operations with a San Jose hub *(8)*. Writes Maxwell, “Like the Swiss, North Americans need build only what is needed, but they should build what is truly needed to develop a fully integrated system. To build only to meet the market on a corridor-by-corridor basis runs the risk of underinvesting and thus failing to maximize the public good.” Maxwell and Leister both espouse the importance of cooperation and integration in their service planning for California HSR.

Reinhard Clever presents the San Francisco Peninsula as a case study in the aforementioned integration paper. Clever proposes a rerouting of Caltrain through San

Francisco's Market Street Subway in San Francisco and suggests using underutilized commuter rail tracks to bring HSR directly into San Francisco International Airport. Both of these changes, according to Clever, will free up capacity at the Transbay Transit Center and allow Caltrain access to downtown San Francisco.

Shuichi Kasuya, in his 2005 master's thesis, also discusses the opportunity for California HSR to act as a commuter service at those major metropolitan areas *(9)*. He suggests that the low cost of rolling stock relative to the total cost of the infrastructure means that sharing rolling stock for intercity and commuter service is "essential for efficient rail transportation." Kasuya performs a case study of Metrolink's Antelope Commuter Rail Line in the Los Angeles basin and concludes that for little additional cost, the HSR operator can increase profits by acting as a commuter service and commuters can benefit up to a 50% travel time-savings.

As far as research regarding the current plan for the blended system, the authors have not been able to find any further academic work. LTK Consulting produced a short feasibility study of the blended system in 2012 and concluded that the system is in fact feasible; however, we contend that the report did not fully explore the implications of the blended system that we will explore later in this paper.

SPECIFIC CALIFORNIA INFRASTRUCTURE OWNER IMPLENTATION CHALLENGES

In this section, we examine the specific challenges facing each agency and the infrastructure that they own and will share with California HSR. Figure 3 shows a schematic of the HSR corridor, the various right-of-way owners, and the tenant operator railroads on each part of the corridor.

Station or Junction	HSR Milepost	Segment Length	ROW Owner	Non-HSR Operators
San Francisco Tranbay Transit Center	0			
		1.3 miles	TJPA	Caltrain
San Francisco 4th and King Station	1.3			
		42.7 miles	PCJPB*	Caltrain, Freight**
UP Coast Line Junction	44			
		7 miles	PCJPB*	Caltrain, Freight**, Amtrak, ACE
San Jose Diridon Station	51			
		385 miles	CHSRA	(None)
Burbank Station	436			
		13 miles	SCRRA*	Metrolink, Freight**
Los Angeles Union Station	449			
		22 miles	BNSF	Metrolink, Freight**
Fullerton Junction	471			
		5 miles	SCRRA*	Metrolink, Freight**
Anaheim Regional Transit Center	476			

*PCJPB operates Caltrain, SCRRA operates Metrolink
**Freight includes BNSF and/or Union Pacific RR

FIGURE 3 HSR Corridor Owners and Operators; HSR will be a "tenant" nearly 20% of the Phase 1 line

Peninsula Corridor Joint Powers Board

The 51.5-mile Peninsula Corridor between San Francisco and San Jose is poised to become the West Coast's premier example of a shared-use corridor. Five operators already use the corridor—Caltrain, Union Pacific, Amtrak, Amtrak California's *Capitol Corridor*, and the Altamont Commuter Express (ACE). In 2012, the PCJPB and the CHSRA announced that the corridor, with minimal new construction of track-miles, would serve both high-speed rail and Caltrain commuter rail services when high-speed rail comes on-line in 2028 *(2)*.

An improving Bay Area economy coupled with "Baby Bullet" limited-stop service that debuted in 2004 and cut travel times between San Francisco and San Jose to less than 60 minutes has fueled a Caltrain ridership boom in the last decade. The PCJPB's electrification project—partially funded by the CHSRA--will allow trains to accelerate and decelerate faster than the current diesel fleet; this will enable Caltrain to serve more stations with the same commute time. Per the environmental impact report and the authors' calculations, service to local (non-Baby Bullet) stations will increase 50% while Baby Bullet stations will see increases of 33% *(10)*. By reducing last-mile connections, this service plan should relieve some of Caltrain's bicycle crowding challenges, but could also drive overall ridership demand. Caltrain has the highest on-board bicycle usage of any transit agency in the United States; 83% of the bicyclists use a Baby Bullet stop as part of their commute *(10)*. This has led to Caltrain trading seats for bike capacity to ameliorate some of the "bumping" that occurs when there is no space for bicyclists on board. There may be bike-averse riders who have been driving their cars between San Francisco and their Peninsula destinations; with rail service that brings riders "close enough" to their origins or destinations, it is probable that a certain degree of mode-shift to Caltrain will occur.

In 2012, the PCJPB commissioned a feasibility study regarding blended Caltrain and high-speed rail service. The study, performed by LTK Engineering, concluded that, while the system is feasible, Caltrain service quality deteriorates quickly with the addition of one HSR train to the line (see Figure 3). Furthermore, Caltrain has, in the past, expressed a desire to run up to 10 trains per hour on its line, but according to LTK, HSR would limit Caltrain to six trains per hour *(11)*.

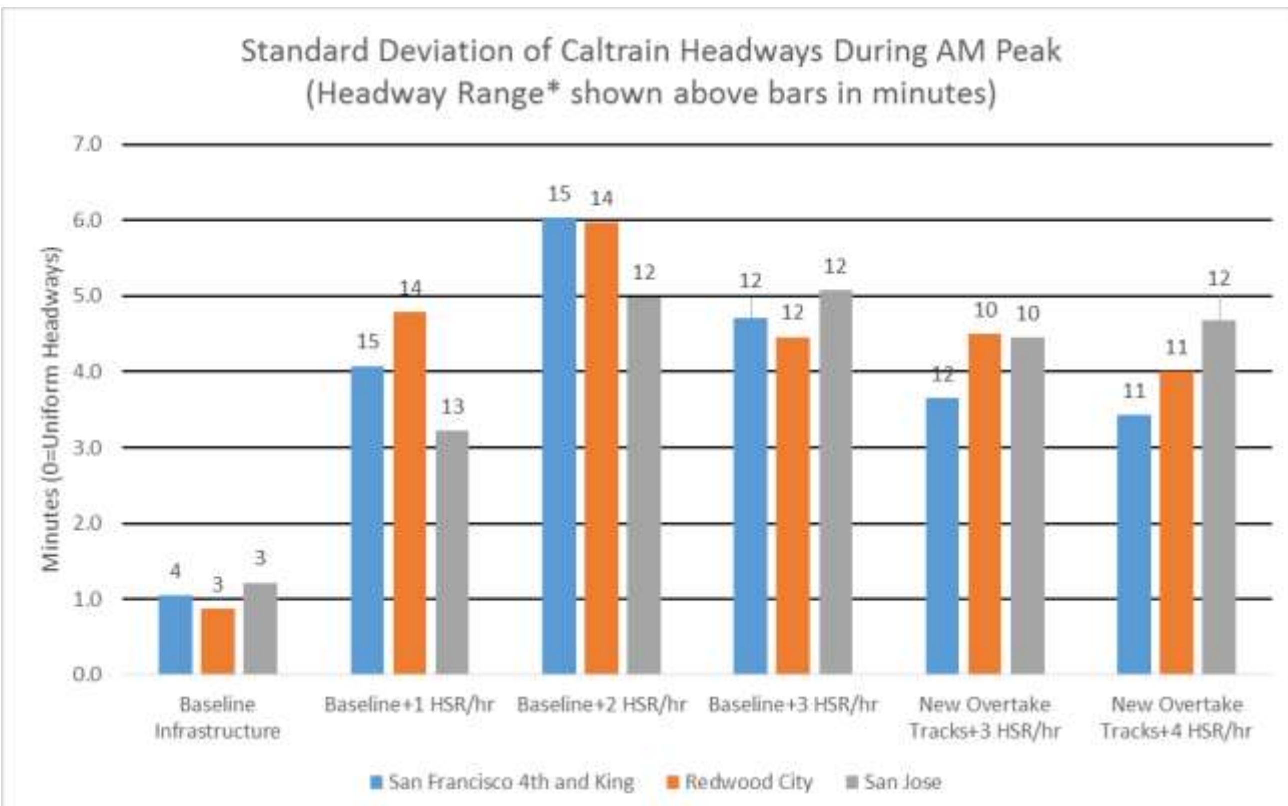


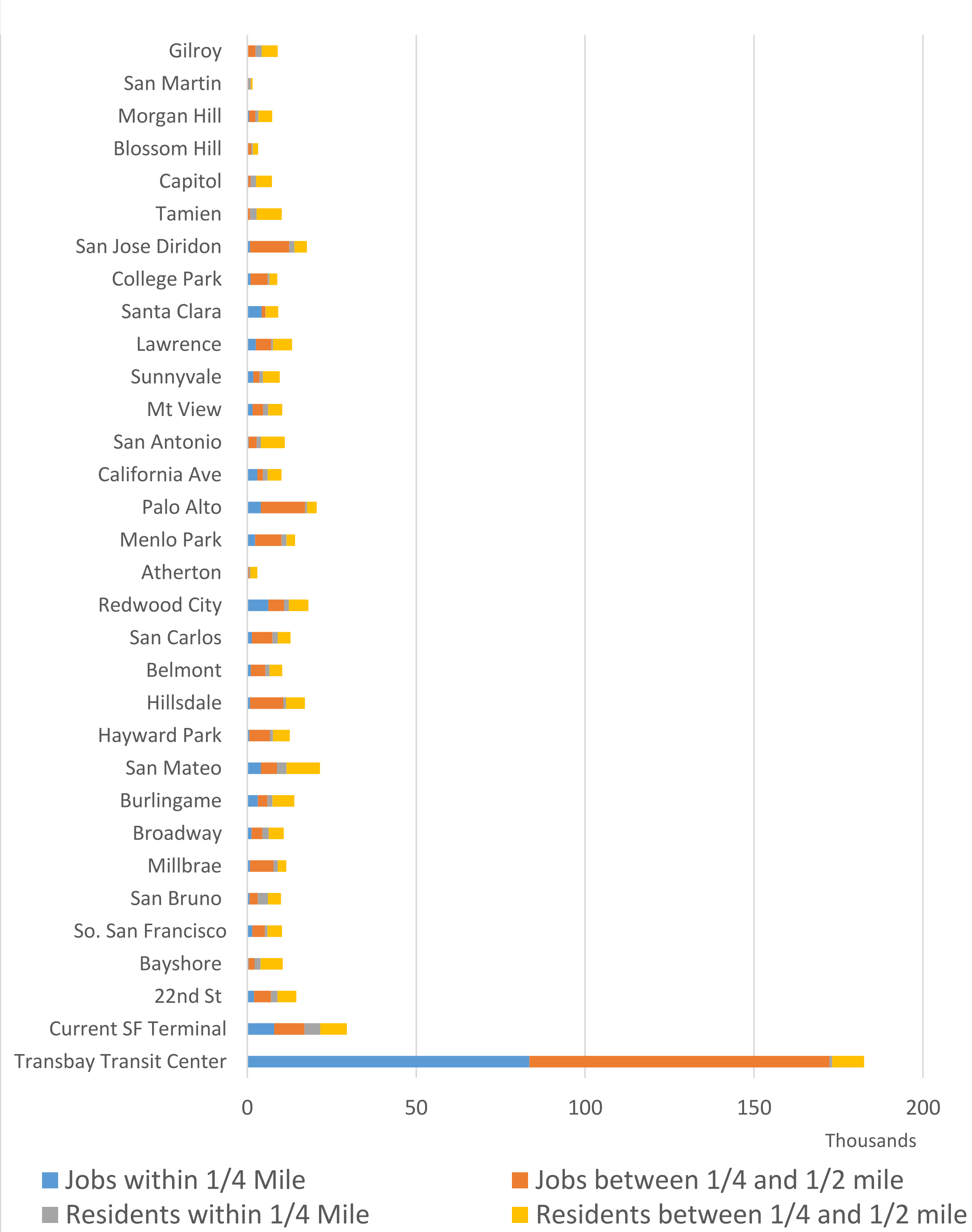
FIGURE 4 Impact of Blended Service on the Peninsula. Caltrain headway range is defined as the difference between maximum and minimum scheduled headways

Freight service still has a small, yet significant presence on the Peninsula Corridor. Together, the ports of Redwood City and San Francisco are working with the local freight trade group, the Seaport Industrial Association, to ensure continued freight rail service between San Francisco and San Jose *(12)*. A 1991 agreement between Union Pacific and PCJPB helps to secure this continued use: Union Pacific "reserves the perpetual right of access to and from and use" of the corridor *(13)*. Furthermore, Union Pacific is guaranteed one 30-minute window between 10:00 A.M. and 3:00 P.M. each day to run freight trains on each of the northbound and southbound tracks (ibid). Between midnight and 5:00 A.M., one main track is reserved for freight use. Union Pacific will likely be reluctant to abandon their rights on the corridor and the planned high-speed rail headways will likely interfere with the freight railroad's right to the track. Whether or not high-speed rail and Caltrain find a way to co-exist with Union Pacific, freight service on the Peninsula will play an important role in the corridor's future.

Transbay Joint Powers Authority

If an electrified corridor draws commuters to Caltrain because of its more comprehensive coverage for last-mile commuters, then the Downtown Extension (DTX) to the Transbay Transit Center (TTC) project should draw even more riders to the rail system. Though the project is delayed due to a current funding gap, the most recent scheduled date of completion (scheduled as of 2014) was in 2024, well ahead of high-speed rail's expected arrival in 2029. While the current Caltrain San Francisco terminal is well connected to transit, it is over a mile from the city's downtown financial district. Whether riders make their terminal-to-workplace connections via transit, bicycle, or on foot, the transfer requires a non-trivial amount of time (Transbay 2001). We conducted a GIS buffer analysis and concluded that there are more jobs located within ¼ mile of the Transbay Transit Center than all other Caltrain stations combined (See Table 1).

TABLE 1: Residents and Jobs within 1/4 mile and 1/2 mile of Caltrain stations



1 **Source: Author's GIS Analysis, 2010 US Census Data**

The ability of California HSR to attract business travelers and commuters will depend, not only on its travel speed, but also its frequency. Ryan Westrom, in his 2014 thesis, finds that "The combination of high-speed and appropriate frequency will result in a service that is most advantageous, and thus competitive, for a trip of the right distance" *(14)*. For high-speed rail service, much like the airline sector, frequency helps reduce schedule displacement between trains. Schedule displacement is the perceived "wait time"; for example, a traveler that ideally would depart at noon, but instead departs on a 12:45pm plane or train has a schedule displacement of 45 minutes. Herein lies HSR's competitive advantage. Because the marginal cost of adding rail service is much less than the marginal cost of an additional flight (rail's fixed costs are higher than those of airlines), rail can support much higher frequencies than air even if railcars are not as full (in general, rail can run profitably with a lower load factor, that is, percent of seats occupied). Furthermore, in short-haul markets like California, frequency is more important than it would be in long-haul markets because the ratio of passenger wait time to travel time is much higher. Given its competitive conditions, California high-speed rail will divert business travelers from air and be successful only if it can provide reliable frequency into and out of its San Francisco and Los Angeles termini during peak travel times.

On the Peninsula Corridor, San Francisco should be a very lucrative hub for a high-speed rail operator given its attractiveness to high-yielding business traffic. The Transbay Transit Center will be located in a dense downtown core with excellent transit connections to Oakland and the East Bay via BART as well as Marin County via frequent express bus service across the Golden Gate Bridge. In his thesis, Westrom states that "any city, regardless of its distance from a metropolitan area, can move into the commutable realm of a central city if the travel time resulting from a HSR improvement moves to below one hour" *(14)*. Because of the Transbay Transit Center's central location within San Francisco, cities like Gilroy and Merced (79 miles and 130 miles from San Francisco, respectively) become reasonable commutes for commuters living and working in San Francisco. San Francisco's six-track HSR and Caltrain terminal will mean that the operators will be competing both temporally and spatially at peak times for high-value infrastructure; a significant challenge from a capacity pricing and allocation perspective.

At the time of this writing, according to the authors' conversations with CHSRA, the TJPA will retain ownership of the Transbay Transit Center and Downtown Railroad Extension (or the private partner should the project proceed as a public-private partnership). This is essentially a vertically separated railway system in which the infrastructure owner (the TJPA) is separate from the railway operators (Caltrain and high-speed rail). Using the same methodology from the author's past TRB paper, *Analyzing the Financial Relationship between Railway Industry Players in Shared Railway Systems: The Train Operator's Perspective,* we find that the HSR operator will likely have a much higher willingness to pay for access to the terminal than Caltrain, not to mention a state's worth of stakeholders rather than the three counties that Caltrain serves *(15)*. However, the high-speed operator will need access to PCJPB's (Caltrain's) Peninsula Corridor in order to access the Transbay Transit Center.

The Southern California Regional Rail Authority

The Southern California Regional Rail Authority (SCRRA), another California joint powers authority, is responsible for the planning, design, and operation of Metrolink, the largest commuter rail service in Southern California. Governed by representatives from the six counties in which it operates—Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura, SCRRA operates Metrolink services on a 512-mile network. However, Caltrain continues to have higher annual ridership on its Peninsula Corridor, which is 1/10 of the size of the Metrolink network [2]. Metrolink carries fewer passengers for several reasons. First, jobs and housing in the region are not as concentrated around stations as they are on the Peninsula; last-mile transit connections are a challenge for many riders. Secondly, Metrolink's schedules provide less service frequency than Caltrain—its relatively minimal "reverse commute" service makes it an unattractive service for commuters travelling away from downtown Los Angeles in the morning. Finally, because Metrolink runs a majority of its trains on a network owned by freight railroads (a significant portion of which is single-tracked), delays create reliability challenges.

As part of their new business plan in 2012, the CHSRA chose to pursue a blended system in Southern California as well *(2)*. As in Northern California, freight rail will remain on the corridor. At the time of this writing, this blended system runs approximately 50 miles from Burbank through to Los Angeles Union Station and on to Anaheim's newly-built Anaheim Regional Transportation Intermodal Center (ARTIC) *(2)*. Currently, electrification in Southern California is solely for high-speed rail. Metrolink and Amtrak California have no plans to electrify their systems. From 2022 to 2028, riders would transfer from high-speed rail at Burbank to diesel-powered trains for the ride southward to Los Angeles and Anaheim. When the CHSRA completes Phase 1 in 2028, HSR trains would share tracks, but not stations, with Metrolink and the Pacific Surfliner south through Los Angeles and onwards towards ARTIC. Metrolink and the Surfliner, though, would continue conventional rail operation, though possibly at higher speeds than today *(2)*.

The BNSF Railway

Southern California is a rail transportation hub for both freight and passenger services. Because of the importance of the Ports of Los Angeles and Long Beach, both BNSF and Union Pacific have large rail yards and intermodal facilities in the region. Unlike in Northern California, where freight is a tenant, in Southern California, between Los Angeles and Anaheim, the freight operator—specifically BNSF—is an owner. Furthermore, this subdivision is vital to BNSF as it is a link between the Ports of Los Angeles/Long Beach and its sprawling Hobart Intermodal Yard. Before any kind of blended service expansion gets implemented in Southern California, the needs of the BNSF Railway will have to be addressed.

IMPLICATIONS OF IMPLEMENTATION CHALLENGES

Cost considerations mandate the Blended System on the Peninsula, but it is currently infeasible to operate

The 2012 CHSRA Business Plan suggests a different system than the one put forth in the 2008 bond measure—with travel time of 30 minutes between San Francisco and San Jose as well as 5-minute headways. The HSR operator and Caltrain will be competing for track access and access to the downtown San Francisco terminal. The blended operations feasibility analysis performed by LTK shows that Caltrain will likely have limited access to its most important station and that the HSR operations create uneven headways on the corridor. Furthermore, without constructing passing tracks on the mid-peninsula section, CHSRA can only operate two trains per hour, per direction into the terminal. Separate stations for HSR up and down the Peninsula will make it difficult for passengers to “interline” or use both systems as envisioned in the 2012 CHSRA Business Plan describing blended service.

Caltrain has shared aspirations of 10 trains per hour, per direction on the corridor, while the CHSRA has planned in the past service frequency as high as eight trains per hour per direction *(16)*. The LTK engineering study reported that six Caltrain trains per hour was feasible and four HSR trains was possible only with significant construction. Constructing the passing tracks for Baby Bullet service required weekend shutdowns of the Caltrain system for two years. This means that once a high-speed operator is running revenue service along with increased Caltrain service, performing track construction to expand capacity on the line or in the Transbay Transit Center will pose significant challenges. However, a renewed dedication to blended operations is beginning to develop with the current discussion on Caltrain’s new electric equipment; CHSRA and Caltrain need to keep this momentum while moving towards a shared system.

The phased approach at Burbank has system-wide consequences

The CHRSA’s plan of terminating service at Burbank from 2022 to 2028 before extending service to Anaheim and Los Angeles poses a risk. Transferring to conventional diesel service from Burbank to Los Angeles and Anaheim will add a non-trivial amount of time in addition to a perceived “transfer penalty” (See Table 2). There are also costs associated with operating a temporary terminal station. Maintenance and baggage transfer facilities will be necessary, and because a Burbank station has low transit connectivity, there is potential for transit-averse land-use patterns such as large parking structures. Furthermore, the relative lack of access from the southern portion of the Los Angeles Basin might initially crimp ridership and revenue. Either a private investor or the CHSRA (i.e. the State) itself will have to fund the cost of additional time for ridership and revenue to materialize after completion of the section between Anaheim and Los Angeles (planned for 2028).

TABLE 2 Travel time via conventional rail (Source: SCRRA, Author’s Calculations)

Burbank to:	Distance	Best Travel Time	Avg. Speed	% trip time increase on top of a 158-minute San Jose-Burbank HSR trip[b]	% trip time increase on top of a 62-minute Fresno-Burbank HSR trip[c]
Los Angeles	13 miles	27 minutes	35mph	17%	44%
Anaheim	44 miles	65 minutes[a]	44mph	41%	105%

(a)Author used best time of Pacific Surfliner and Metrolink and subtracted lay-over time at Union Station under assumption that run-through tracks would reduce this layover to 1-2 minutes.

(b) Using travel times from all-stop HSR train in 2014 Business Plan, Author assumes five-minute transfer at Burbank and 100% on-time departures from Burbank

(c) In the 2014 Business Plan, the CHSRA schedules approximately 10 minutes travel time between Burbank and Los Angeles after Phase 1 is complete

Freight will continue to be a key stakeholder in the north and south

Freight has a large presence in Southern California, and with the large port complex of Los Angeles and Long Beach coupled with the low cost of long-distance rail freight transportation, rail freight volumes in the region continue to grow. The blended corridor in Southern California will run across the BNSF's San Bernardino Subdivision from Hobart Yard near Union Station to Fullerton. This corridor saw 45 freight trains per day in 2010 and is projected to see 90 freight trains per day in 2035 *(17)*. The line from Burbank to Union Station is owned by SCRRA, but Union Pacific also operates about 10 trains per day on that section of track enabled by trackage rights as it is the link between Los Angeles and the Central California coast (ibid).

The CHSRA's relationship with freight railroads will be important across the state, but it is on these blended corridors that it is critical. On the Peninsula, freight operating windows will become increasingly valuable as the CHSRA tries to thread services into the corridor timetable. In Southern California, rail goods movement is a vital part of the regional economy and high-speed rail will operate on freight-owned infrastructure. Any decisions made regarding service on the blended corridor in Southern California will need to have Union Pacific and BNSF at the negotiating table. Negotiations for capacity with freight railroads can become contentious when freight railroads feel that they are losing flexibility to run trains efficiently through their network when necessary. However, if passenger rail can use freight infrastructure in a way that does not impede freight trains from operating efficiently, freight railroads would stand to benefit financially from increased access charges.

CONCLUSIONS AND FURTHER RESEARCH

Rail capacity in California is already a scarce asset and the blended approach of the CHSRA demands that capacity be used even more carefully than today. A "buffet" approach to capacity in which operators schedule services unilaterally, or even bilaterally, is infeasible. In order to avoid a situation similar to that on the Northeast Corridor, with complex bilateral agreements constraining a system-optimal timetable, California must devise a network-wide capacity allocation mechanism. A top-down approach to service planning should dictate infrastructure improvements to ensure quality system-wide performance for the commuter, interregional traveler, high-speed passenger, and freight customer. Research that evaluated the feasibility and likelihood of cooperation based on characteristics of each entity in California would be beneficial as it would identify less-than-obvious institutional synergies. Currently, MIT's Regional Transportation/High-speed Rail group is researching stakeholder analysis on the Northeast Corridor. This research could be expanded into a broad evaluation tool for stakeholder willingness to cooperate. Another potential avenue of research would look at how the Japanese model could be exported to California. Unlike California, Japan's institutional structure is fully integrated. Each of the four "JR" companies that operate high-speed service, operate commuter rail service as well. Timed transfers are commonplace and on-time performance is high, and operations on the system level are profitable. This would reduce the complexity of capacity allocation as well as challenges associated with revenue sharing interlining and platform compatibility. However, it would require local authorities to cede control to a state agency; some politicians and constituents might be wary of this prospect.

The high-speed line from San Francisco to Los Angeles has a price tag of $68 billion. The CHSRA's business model depends on over half of that money—$37 billion—coming from a private operator bidding for a concession contract after the initial operating section from Merced to Burbank operates profitably. To that end, a strong commuter rail network is essential for an effective HSR network. One of the challenges with a blended system is passenger fare revenue sharing, especially between a private operator and a public agency. For example, if Caltrain transports a high-speed rail passenger who came from Fresno between San Jose and San Francisco, what share of that total fare revenue should Caltrain receive? The degree of complexity that the CHSRA is discussing in terms of interlining and through-ticketing does not yet exist in the U.S. rail market. Airlines already practice some form of fare proration between operators in offering code share flights, but this is between two private companies. Research that identifies some of the institutional and regulatory challenges of cooperating with a private for-profit operator would be useful and valuable for both the CHSRA and its public agency partners. Vehicle floor height compatibility and interline-ticketing can alleviate some capacity issues, but most importantly, coordination is necessary to integrate operations on both a spatial and temporal level.

Finally, the choice to use a blended approach stemmed from the fact that the CHSRA faced a budget constraint. Should the current planned levels of rail capacity prove insufficient, the California agencies, need to ensure a path for capacity improvements. A private investor will demand that the voters of the state subsidize these risks. To this end, the CHSRA and local commuter rail agencies should collectively plan for future capacity improvements including land purchase and division of future capital expenditures. Capacity constraints at one end of the line impact the performance of the entire California rail network. It is a classic systems issue, balancing suboptimization and political and cost realities.

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