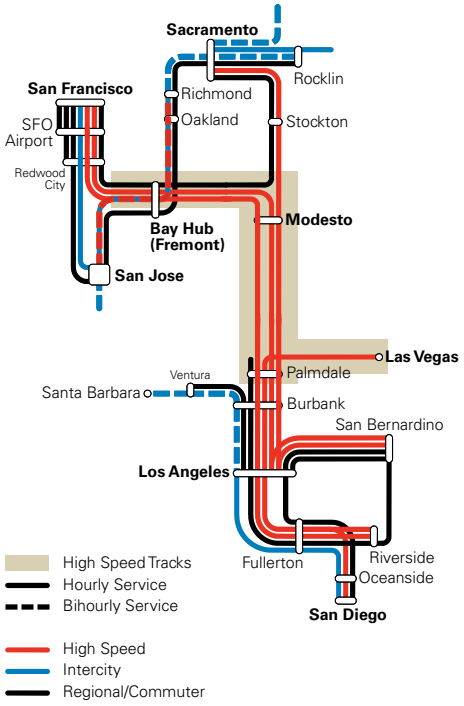
California's planned high speed rail (HSR) system is in serious trouble. Limited funding and strong local opposition mean building the system will not be easy. The proposed dedicated and isolated line has to be built completely at once – or will not be built at all. To prevent the project's failure an alternative plan has to be ready, including shared tracks to minimize impacts in built-up areas and reduce costs.

This thesis for a Californian rail network, commenced in cooperation with the Swiss Federal Institute of Technology and the Berlin Institute of Technology (Germany), applies a lean and rational approach to planning, that is network and schedule-based. A precise computer model is used to test different ideas such as infrastructure layouts or train types. Gradually the schedule is refined and optimized until the required rolling stock and the minimal amount of infrastructure needed to operate all the scheduled trains are determined. The results show that an attractive statewide network is possible with:




- New high speed tracks between San Fernando and Redwood City via Palmdale, Bakersfield, Modesto and the Altamont Pass.
- Using the Dumbarton Rail Corridor and bridge to cross the San Francisco Bay.
- Running direct HSR trains on conventional tracks from a spine high speed line (HSL) to San Francisco, Los Angeles and San Jose, but also to Richmond, Oakland, Sacramento, Stockton, Riverside, Oceanside, San Bernardino, Fullerton and San Diego, much like the French TGV system.
- Travel time from Los Angeles to San Francisco is 3:35 hours, longer than the proposed 2:40 promised today, but faster than air and with the recognition that fast connections are available to many more cities thus creating a real statewide system at much lower cost.
- Construction costs are reduced by building only the minimum infrastructure needed to operate the planned schedule: e.g. the Dumbarton Bridge as well as the tunnels on the Altamont Pass can be built single tracked.
- No additional tracks are required on the Caltrain corridor, where track capacity is sufficient for up to seven Caltrain and two high speed trains per hour and direction.
- Reserving regular schedule slots for freight trains on shared tracks enabling freight railroads to run flexible operations with minimal disturbances by passenger services.
- Possibility of a phased implementation, allowing valuable interim service and spreading of required funding over a longer period of time.
- Detailed calculation of operating costs (fleet, personnel, energy) based on the planned schedule.

**The Problem** Today's high speed plans are likely to fail in an environment of strained budgets and a resentment against government spending. A key criticism is that the planned HSR system would only serve certain cities and the initial segment would be a "train to nowhere". Also, a lack of accuracy concerning construction and operating costs together with the mere amount required for an isolated HSR system provoke criticism that cannot be overcome with today's approach.

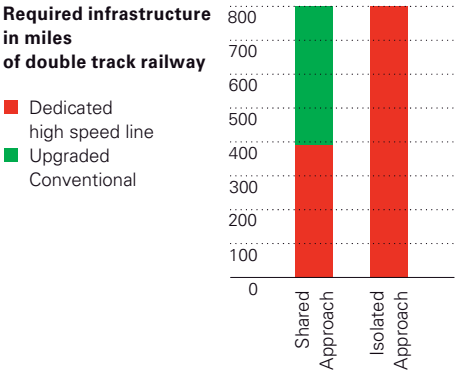
**The Solution** The existing plan's shortcomings have to be directly addressed by an alternative solution. It has to consist of shared tracks, phased implementation, service-centered planning and lean infrastructure design. Shared tracks will calm opposition of neighboring communities, as new or widened corridors are avoided by modernizing existing tracks. Track capacity on shared tracks is managed by a planning that starts with the required schedule. This service-centered approach helps to squeeze out all available capacity and makes a lean infrastructure design possible. New speed and capacity upgrades are derived from the actual and precise service intention in an iterative process. Implementation can be phased, concentrating on the most promising and effective measures first. With this comprehensive information on the planned network, operating costs are calculated precisely from the beginning. Project benefits beyond the high speed corridor can be explained easily by showing the network schedule.

**The Results** The thesis gives an impression of the outcome of such a planning approach. New high speed infrastructure is required between San Fernando (North Valley, 22mi from Los Angeles) and Redwood City (Peninsula, 26mi from San Francisco) via Palmdale, Bakersfield, Modesto and the Altamont Pass. The Bay is crossed between Fremont and Redwood City by reactivating the Dumbarton Rail Corridor and bridge. Beyond the high speed infrastructure the trains run on existing, conventional tracks to access the downtowns of San Francisco, Los Angeles and San Jose, but also Richmond, Oakland, Sacramento, Stockton, Riverside, Oceanside, San Bernardino, Fullerton and San Diego. Journeys between Los Angeles and San Francisco take longer than the 2:40h promised today, but fast connections are available to many more cities and a real statewide system is formed with much less high speed lines (just around 390mi, excluding the Las Vegas HSL). Frequent service on the network is realized by implementing hub stations of which the most important is located at Fremont to provide rapid and frequent access of the Bay Area. A hub offers convenient timed transfers and thereby multiplies the number of available connections to the customers without increasing operating costs. Construction costs are cut down by reducing the infrastructure to the effectively required: e.g. the

**Number of trains per hour and offered travel time between selected city pairs**

| | Las Vegas | Los Angeles | Sacramento | San Diego | San Francisco |
|---|---|---|---|---|---|
| San Bernardino | 1 | 4 | 1 | 2 | 2 |
| Riverside | 1 | 3 | 1 | 2 | 2 |
| Los Angeles | 1 | | 1 | 2 | 2 |
| Sacramento | 1 | 1 | | 1 | – |
| San Diego | 1 | 2 | 1 | | 2 |
| San Francisco | 1 | 2 | – | 2 | |
| Richmond | 1 | 1 | 1 | 1 | – |
| San Jose | 1 | 1 | 1 | 1 | 4 |
| Bakersfield | 1 | 1 | 1 | 1 | 1 |

Travel Time
- less than 4 hours
- 4 to 6 hours
- More than 6 hours




Dumbarton Bridge as well as the tunnels on the Altamont Pass can be built single tracked. This is possible, because the later schedule is known and excess capacity can be identified. Also no additional tracks are required on the Caltrain corridor, where track capacity is sufficient for an increased number of seven Caltrain services and two high speed services per hour and direction. A sufficient number of seats is provided by using long, double-deck trains. This cost effective approach requires less track capacity, energy and personnel than running multiple trains during a short time span to meet demand. Coordination of freight and passenger trains on shared tracks is ensured by systematic high quality slots which are reserved for freight trains throughout the day in regular intervals, allowing freight railroads to run flexible operations on shared tracks with minimal disturbances by passenger services. Capacity bottlenecks are identified by the methodology and appropriate infrastructure measures implemented. This approach is successfully employed on the lines crossing the Swiss alps, which are at capacity and carry significant amounts of passenger and freight traffic.

The results are preliminary, more detailed study is needed, but it's an idea that deserves to be taken seriously by California!

If you are interested in the detailed report please send a message to
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