The TopRail System:
Sustainable Transit for Urbanism

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The following is a proposal for a transit system designed to be suspended over city streets and ecologically sensitive habitats via an inverted "T" rail. Dr. Calogero designed the project while analyzing the North Bayshore Precise Plan of Mountain View, California. The system is designed to address the challenge of adding high-throughput transit within existing cities where land-acquisition and entitlement processes have become increasingly difficult.

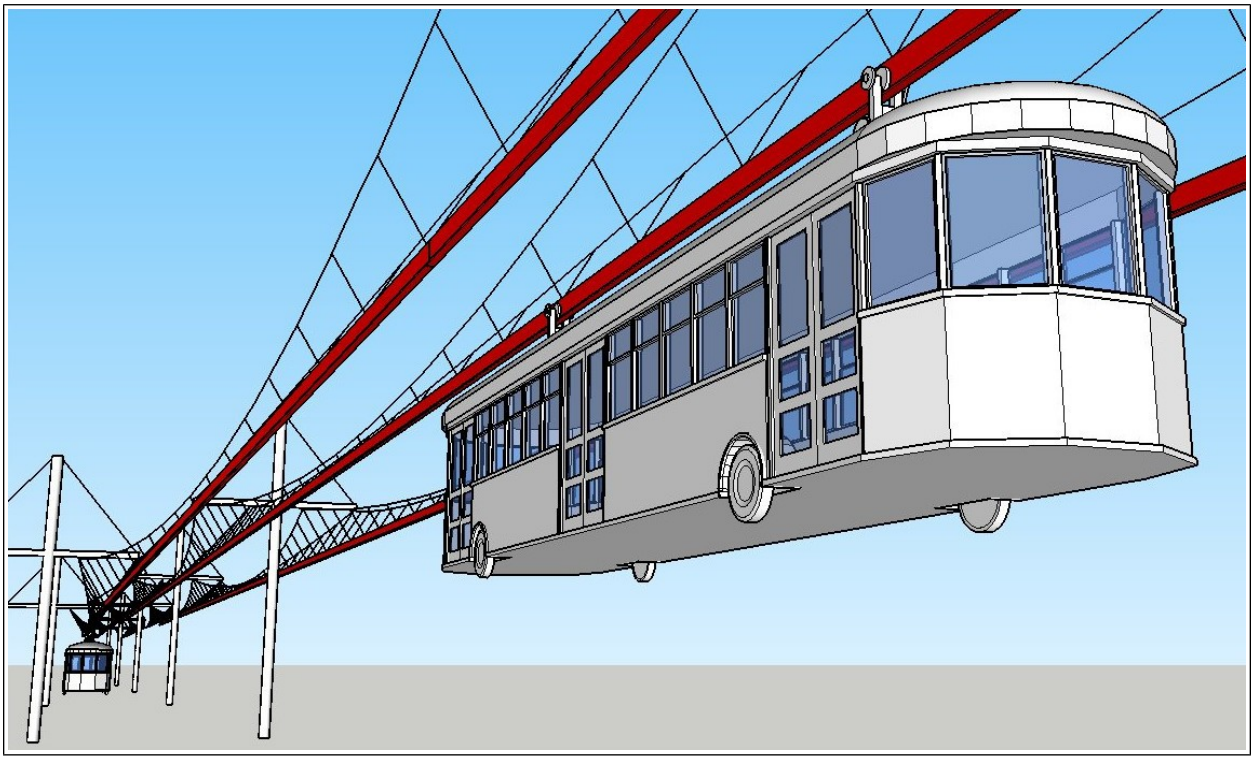

Figure 1. Two TopRail cars: one on main rail and second (in the distance at left) on a 'side drop' station. Three potential types of stations: elevated, side-drop, and off-rail.

High Throughput.

The TopRail System uses 60-passenger cars that can be joined in trains and also spaced very closely together on a grade-separated rail system using LIDAR collision-avoidance. With sufficient feeders and distributors, paired cars could be run ten seconds apart, so that on trunk lines the maximum potential throughput is (60sec/10sec)x(60min)x(120passengers) = 43,200 persons per hour per direction, comparable with heavy rail.
This is only possible when combining the trunk line with multiple feeder-lines to contribute/distribute cars; but this constraint is also the advantage of the system: it branches at both ends of a high-speed trunk-line to multiple local stations.

Grade Separated.

Moves independently of surface traffic, so average speed can remain relatively high even if top speed (around 50 mph) is relatively low.
The suspended system also reduces land-acquisition costs and right-of-way entitlement challenges because only the towers and air-rights need to be secured.

Small Ecological Footprint.

This is the lowest-impact design I can imagine to cross San Francisco Bay and other sensitive habitats. The surface-impacts are tower-bases every 200'.
GHG emissions are also minimized. Hybrid/Fuel Cell power is combined with the low rolling friction of rail, regenerative braking, and the aerodynamic efficiency of all-side air passage.

Switchable Tracks; Flexible Routing.

Unlike trams and gondolas, This system can contribute/distribute through overhead track-switching. This enables feeder-lines to converge on a main route.

Mixed Mode.

The cars can be diverted off rail to roll on grade with a lightweight ground suspension system (45 mph top speed). Cars drawn off the TopRail Network can roll through surface streets to multiple stops.

Historic-But-Modern Aesthetics.

I have designed the cars based on the "Peter Witt" design from 1915. As a shape, this is not only historically appealing, but it is a design that has served well for 100 years across the Americas and Eurasia. Several examples of this design, from Milan, operate on the F-Line in San Francisco as the distinctive "orange" cars.
However, TopRail cars will be built out of a mixture aluminum (frame), stainless steel (roof & door jambs), reclaimed wood (detailing), and linoleum (flooring) for the optimal combination of light weight and durability.
TopRail includes a Public Artist program to render the underside of each vehicle in distinctive, unique mural artwork. The Artist program will also maintain ongoing experiments in visual, acoustic, and performing arts on trains and station-areas.

Universal Design built in.

The TopRail System is level-loading at elevated platforms. When rolling on surface streets, the car has a low-floor design 15" above grade, with a "kneeling" suspension lowering the floor to 8" above grade, so that ramp-transitions from adjacent curbs are only 2" of elevation change. TopRail cars use the same flip-ramp design as modern low-floor buses. All doors are 48" net clear width. Three doors per car means rapid level load/offload for all forms of mobility.

- Easy access for wheelchairists, limited-mobility people, stroller-pushers.
- Easy access for bicyclists

21st-Century Safety Features.

In addition to a LIDAR-based collision-avoidance system, TopRail cars are equipped with bottom-side airbags designed for two purposes:
1) in the event of drop from a height, the airbags act as a cushion for ground-impact. (Note: detachment from the top-rail is only possible if a major component actually breaks).
2) in the event of water-landing, the airbags enable the entire vehicle to float.

Institutional Design.

I propose that the first TopRail system be "Clipper TopRail" for the San Francisco Bay Area, governed jointly by a consortium of transit agencies (VTA, AC Transit, CalTrain, SamTrans, SF MUNI, and BART), MTC-ABAG (acting as the Council of Local Governments), and a consortium of tech companies (Google, LinkedIn, Facebook, Apple, Tesla, HP).
Bay Conservation and Development Commission must be included from the beginning; the system is designed specifically to be run through sensitive habitats with minimum impact, and that needs to be verified and recognized.
Payment and transfers will only be through the Clipper Card system. The system will be run as an OpenGov-compliant nonprofit, with specific policies:

- Emphasis on local hiring particularly of historically low-income households and underserved populations
- "Ban-the-Box" hiring regardless of prior conviction status
- Emphasis on professional development of staff (fiscal literacy, educational incentives for staff and staff children)
- Prioritize local manufacturing and maintenance of all components of the system. Northern California, Pacific West, U.S.

Phased Development.

TopRail needs to be developed in a series of institutional and technological phases.

Phase 1: Develop cars to move on surface streets.

- resolve manufacturing processes,
- test partial vehicle systems,
- get NTSB approval, and
- get local transit agency approval.

Phase 2: Develop basic TopRail suspension-system.

- Engineer the TopRail's web depth, suspension-cable catenary depth, and span distance.
- Engineer the suspension/traction assembly on top of the cars.
- Run a basic track within a corporate campus.
- Develop the 'high' station: integrated stair/elevator/platform structure
- Get local-jurisdiction approval to span local streets and install posts on public property.
- Run a basic TopRail line from El Camino Real, to San Antonio Caltrain, to North Bayshore, and back down to Caltrain Mountain View (see Figure 2).

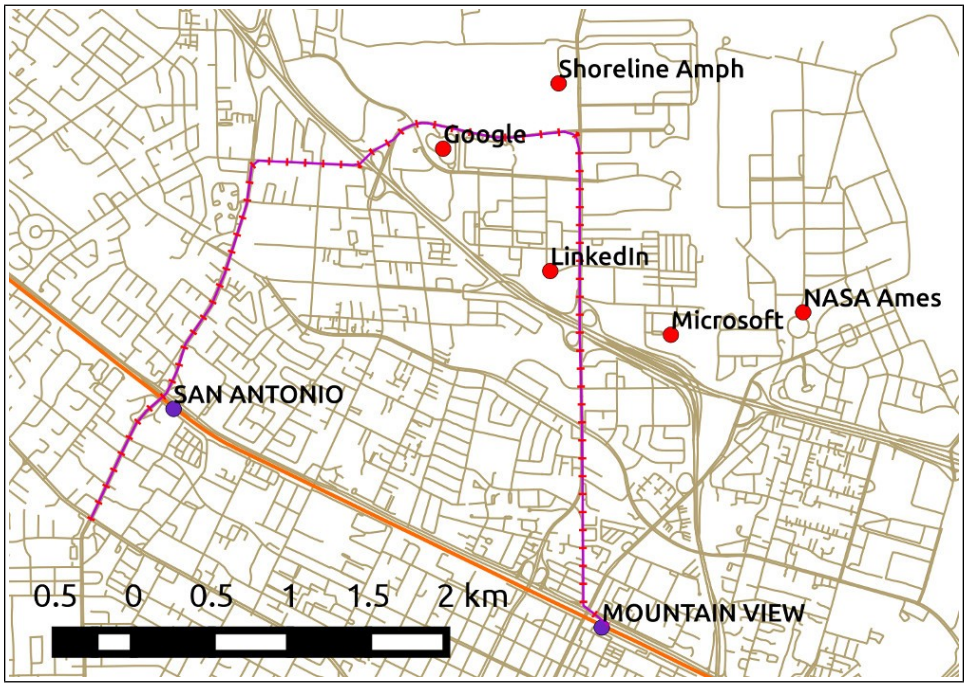

Figure 2: Phase 2 of TopRail: suspension system linking North Bayshore with Caltrain. Caltrain line shown in orange; stops in blue.

Phase 3: Develop switching and "side-drop" stops.

- Secure regional transit approvals and integration into the regional network.
- Incorporate into the Clipper Card fee system.
- Develop a descent/ascent side track for surface stops. This includes track-switching mechanism and signaling.

Once these phases are resolved, the TopRail system can be used to address a major regional transit problem (see Figure 3):

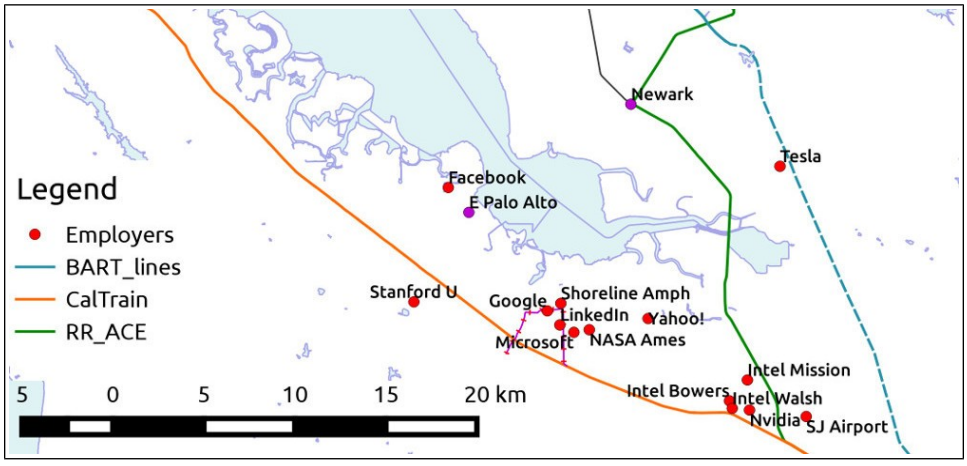

Figure 3. The problem: regional transit systems do not connect well to Silicon Valley, with the

exception of Caltrain. Northeast/Southwest alignments are especially poor.

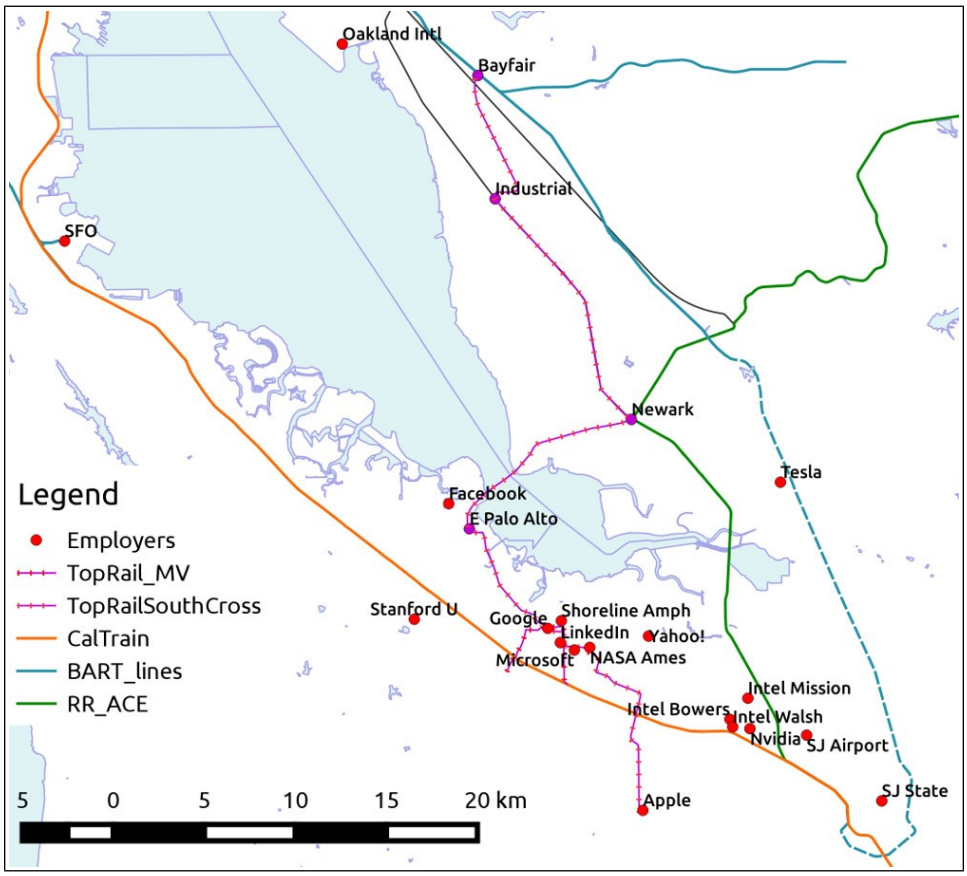

Figure 4. The solution: the Southern Crossing. This alignment connects tech campuses to Bayfair BART via East Palo Alto, the abandoned rail alignment, and a Newark station that links to the ACE train.

Phase 4: Develop "Southern Crossing" express route.

The major advantage of the TopRail system is that it can be run as a very local system, comparable to light rail, and as an express rail comparable to interurban heavy rail. The Southern Crossing shown in Figure 4 has only four stops once it leaves North Bayshore: 1) the East Palo Alto stop, which can serve Facebook, Palo Alto, and Stanford;
2) Newark, which links with the ACE train;
3) Industrial, which would link with a future SFO-OAK "AirLink" line;
4) and the BayFair BART station, which is a driect link to both the Fremont-Richmond and Dublin-Pleasanton lines.
This line can cross the bay along the alignment of the old pier, between the Dumbarton Rail Bridge and the Highway 84 Bridge.

Because of the elevated geometry of the system, it will not conflict with the proposed Dumbarton Rail Corridor alignment. See: http://www.bayrailalliance.org/dumbarton_rail

Phase 5: develop local & express lines to complement regional network.

Again, the advantage of TopRail is that it can be built as a local, existing corridor system that complements existing bus and rail transit alignments, such as on El Camino Real. At the same time, it can be configured as an express service, such as an AirLink route that parallels the San Mateo Bridge and connects SFO to OAK with only a single intermediary stop at Industrial, to link to the Southern Crossing line.

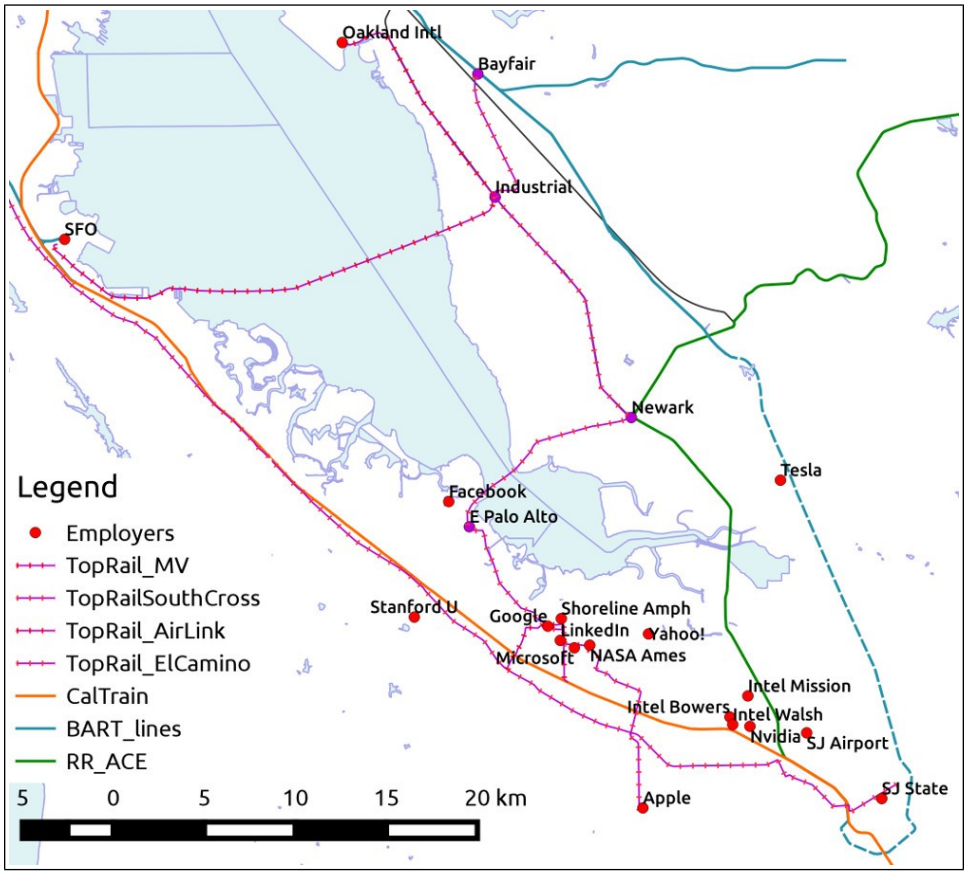

Figure 5: A fuller development of the TopRail system, complementary to existing Bay Area Transit systems. The AirLink parallels the San Mateo Bridge; the El Camino line complements the CalTrain with a more local service.

Similar arterial corridor lines could be extended to east San Jose, and in the East Bay along San Pablo Avenue and International/Mission Boulevard from Rodeo to Hayward. However, these alignments are beyond the scope of this initial proposal.

References and sources

Bay Rail Alliance, Dumbarton Rail Corridor Project: www.bayrailalliance.org/dumbarton_rail

California Department of Transportation GIS Data Library: http://www.dot.ca.gov/hq/tsip/gis/datalibrary/

Census Bureau, TIGER/Line shapefiles (for SF Bay shoreline in this case): https://www.census.gov/cgi-bin/geo/shapefiles2013/main

Cervero, Robert (1998). *The Transit Metropolis - A Global Inquiry*. Island Press. ISBN 1-55963-591-6.

Open StreetMap, linked through QGIS to locate major employers and BART to San Jose alignment. https://www.openstreetmap.org/#map=17/37.41755/-122.08200 and http://qgis.org/en/site/