

FINAL REPORT

Ridership Technical Advisory Panel Review of the California High-Speed Rail Ridership and Revenue Forecasting Process

Findings and Recommendations from the March-May 2014 Review Period

September 15, 2014

The Ridership Technical Advisory Panel (RTAP) held its twelfth formal meeting on March 25-26, 2014 at the Parsons Brinckerhoff offices in San Francisco. The Panel also conducted discussions via electronic mail, teleconference, and videoconferencing both before and after this meeting. This report covers their activities and deliberations from March through May 2014. The panelists include:

- Frank S. Koppelman, PhD, Professor Emeritus of Civil Engineering, Northwestern University (chair)
- Kay W. Axhausen, Dr.Ing., Professor, Institute for Transport Planning and Systems, ETH Zurich (Swiss Federal Institute of Technology Zurich)
- Eric Miller, PhD, Professor, Department of Civil Engineering, University of Toronto
- David Ory, PhD, Principal Planner/Analyst, Metropolitan Transportation Commission
- Kenneth A. Small, PhD, Professor Emeritus, Department of Economics, University of California-Irvine

All panelists were present in person for the meeting except for Dr. Axhausen, who attended for part of the time via videoconferencing. Rick Donnelly, PhD, of Parsons Brinckerhoff (PB) served as facilitator and recorder for the Panel. Thierry Prate of PB was invited to attend the meeting as a representative of the program management team. Jeff Morales, executive director of the Authority, briefed the Panel and received input from them on the final morning of the meeting. Jeffrey Buxbaum, Rachel Copperman, David Kurth, and Kimon Proussaloglou from Cambridge Systematics were also invited to attend portions of the meeting. The meeting was otherwise closed to non-members.

1 The context for a Version 3 modeling system

The Panel devoted the majority of the March 2014 meeting to discussion of the Version 3 (V3) modeling system. The requirements and likely uses of the system were discussed, as well as possible approaches. These were informed by discussions with Jeff Morales, Executive Director of the Authority, at the end of the first day of the meeting. There was broad agreement about the need to pursue the Version 3 system in order to take advantage of new data and meet analytical requirements that did not exist at the time that the original modeling system was created.

It is important to note that V3, while based upon a newer modeling paradigm than the existing model, will not "start over from scratch." Rather, it will follow an evolutionary path that largely mirrors the typical transition from aggregate trip-based models to microsimulated tour-based models in metropolitan areas. Here, as in those cases, the individual models will be reused largely in their present form. The software implementation will by necessity change. Minor changes in model form are anticipated, as is limited re-estimation of the models. However, such re-estimation and re-calibration will be required with the introduction of the final 2013-14 RP/SP survey data in any case. Thus, the timing is ideal to begin the transition to V3. The new data, as well as recent availability of the new California Household Travel Survey (CHTS) data and updated metropolitan models, can be used to make incremental changes to the V2 model as well as to enable work to begin on its eventual successor. This will preserve the Authority's investment to date in the forecasting work, while enabling it to move forward with important new capabilities.

Mr. Morales, executive director of the Authority, has instructed the Authority staff to solicit input from potential investors and concessionaires regarding their forecasting needs and expectations. His instructions supported the Panel's concern that a V3 platform be capable of usefully informing their review of the project. While not expected to serve as a substitute for their own due diligence it is felt that information presented in a way most helpful for their uses should be an important V3 design consideration.

2 The imperative for separate model development

The work reviewed by the Panel since the inception in the fall of 2010 has been driven by very tight deadlines imposed for several environmental and business planning documents. This has necessitated a gradual incremental improvement to the original modeling system, for the time and resources required for major changes could not be accommodated within the project schedule. By the time one forecast has been completed and reviewed the CS team has had to gear up for the next. This is not a criticism of the Authority or CS, but rather reflects the stark business and political realities that they are operating under. However, we believe a different approach is now possible, whereby further data and model development are separated from the model's application.

The Panel appreciates the on-going need for concentrated applications of the existing modeling system in support of current planning, environmental, and business studies and reports. The V2 system is suitable to support these activities in the short term, probably to include the 2016 business planning cycle. The retention of institutional knowledge, existing capabilities, and consultant capacity for such intensive applications of the model are essential, and requires a team dedicated to that task. Distracting that team with the V3 development could result in diminished capacity to accomplish either goal. The panel recommends two separate development efforts, possibly within the same organization. A single modeling expert with diverse experience should be appointed to ensure

- Coordination of efforts, particularly for maximizing reuse of and compatibility with as many of the V2 components as possible.
- Smooth eventual transition from V2 to V3 operational use.
- That Authority objectives and needs are being adequately addressed by the work of both teams.

It is anticipated that the Panel will likewise continue to review and provide advice on the work of both teams while maintaining primary focus on the V3 system.

3 Vision for V3 design

The process described here is one of many that would lead to a conceptually and practically effective and accurate model system. It is based upon best practice approaches developed for urban and regional environments in the U.S., Canada and Europe. The incremental approach which has been followed in the past is unlikely to lead to a model of similar quality based on a formal conceptual and theoretical structure.

In its various reports, the Panel has articulated an evolving view of what a third generation (V3) modeling system would entail, largely driven by perceptions of current and anticipated analytical needs facing the Authority. The goals for this new modeling system go back to the Panel's first report, where a series of short and long-term recommendations were presented. We are satisfied that the short-term recommendations have been addressed by the additional data and revisions to the original model completed to date. It was acknowledged that many of the long-term recommendations could be addressed only by structural changes in the model that take advantage of methodological advances, experience, and data that were not available when the V2 system was designed and implemented. Moreover, many of the capabilities envisioned for the V3 system were not required for the systems-level planning and environmental analyses undertaken by the Authority to date.

It is envisioned that the V3 system will support finer levels of spatial, temporal, and market analyses than previously required. This will include analyses of specific alignments and facilities, to include their impacts upon the surrounding communities and local transportation system. More detailed revenue analyses will also be required, based upon different fare policies and competitive responses by other transportation providers. Finally, V3 should move the Authority towards an investment-grade forecasting capability. While potential investors are expected to conduct their own due diligence with respect to ridership and revenue, the Authority will still require comparable capabilities to inform its negotiating position with potential investors and to better examine the risk and uncertainty associated with its decisions. The emphasis on increased transparency of the models and underlying data will enable investors to better use them in their own analyses, ensuring comparable analyses to the extent possible and providing a basis for informed discussions of where forecasts might diverge.

A considerable amount of time was devoted to discussing the V3 system with CS during the Panel's most recent meeting. CS provided its own vision of V3 in a document circulated before the meeting, informed by past discussions with the panel and therefore exhibiting a large amount of agreement with the Panel's vision. The CS vision might be characterized as more incremental, adding additional capabilities as an extension of the V2 system. The Panel is more inclined to adopt an approach similar to the so-called activity-based travel models used in urban and statewide travel models. These are typically organized around the concept of tours, which originate and end at the home, and include one or more stops (e.g., work and other daily activities). Almost all of these models are based on microsimulation of synthetic households rather than aggregated households, as used in the V2 system. The California statewide travel model used by Caltrans falls into this category of microsimulation models, and the panel has noted that microsimulation could also be used simply as a computational tool for implementing the existing V2 model. What follows is a description of the Panel's view of a V3 system.

The traditional concept of tours – a sequential chain of two or more trips that usually begin and end at home – can be simplified to that of a *journey*, illustrated in Figure 1, for representing the long-distance travel market in which HSR will compete. A journey differs from a tour in that there is a primary destination, which may also serve as the origin for one or more local tours (i.e., round trips to local destinations beginning at this primary destination or a sequence of trips that, when linked together comprise a journey to home). Detailed modeling of those local tours is not central to the purposes of the Authority, and if needed (for example by MPOs) could be done within the separate MPO models.

It is anticipated that the V3 system will have many of the same components – tour/journey generation, destination choice, and joint models of main, access, and egress mode choice – as the V2 system. It is very important to note that these models will be incorporated into the V3 system, leveraging the Authority's investment in them. Some modification will be required to apply them at the synthetic household rather than traffic analysis zone level, but much of the formulation and structure can remain largely unchanged.

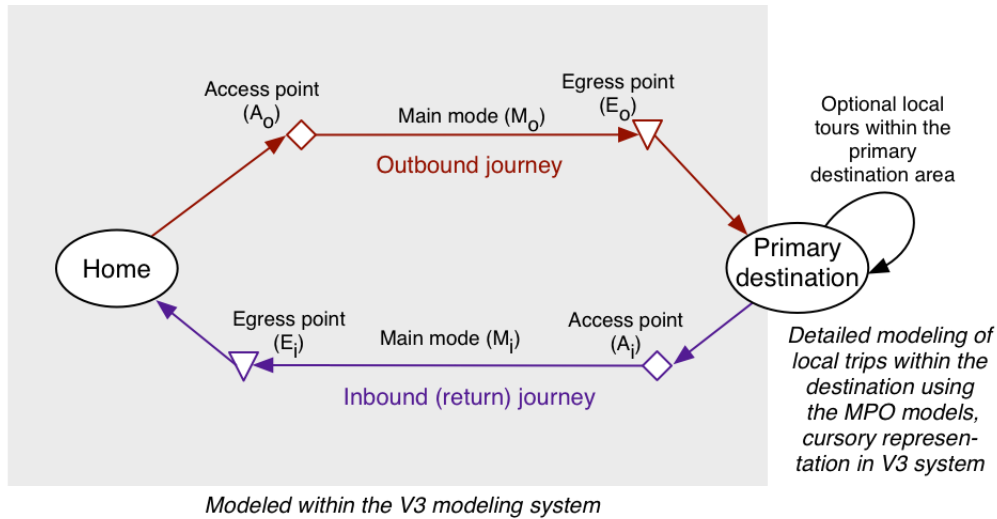


Figure 1: Long-distance journey representation

The V3 system should also use as much of the Caltrans statewide model as practical, such as synthetic households, zone systems, networks, and other components. Because the model will evolve from its current form and the data that underlies it the Panel does not believe that the overall ridership forecasts will be affected, given the same assumptions and inputs. The model should be appropriately responsive to changes in major assumptions and socioeconomic data, an expectation that would be appropriate for any modeling system.

The detailed specification of the V3 system should be driven by the analytical requirements described above. We provide further detail in the following two sections.

3.1 Analytical requirements

The V3 system will retain the existing modeling components of the V2 system. The several major new features described below are extensions dictated by the changing requirements of more detailed planning and operational studies expected to be undertaken, as well as emerging best practices in travel modeling. These include:

- *Station choice:* Explicit modeling of station choice should be included in the V3 system. This should incorporate station capacity, local transit connectivity, and access and egress modes available. This will enable the model to better represent different combinations of multimodal long-distance travel. Even though the HSR stations are likely to be far apart, we believe that enough of the travel market will have more than one viable choice to

make this investment worthwhile. Further, this will provide a basis for sizing station and parking lot size.

- *Fare classes:* The ability to test different fare class structures has been identified as a highly desired capability. The typical distinction between premium and regular fare riders is important, as is differential pricing for both groups by time of day, trip frequency, etc.
- *Time of day:* The time of day of travel will influence many other modeled choices, including access and egress modes, destination and main mode choice, and fares by mode. The effect, extent, and duration of congestion will be important considerations for all travel markets (trip and traveler characteristics), as will different service levels by time of day.
- *Journey duration:* The journey duration is probably a highly influential factor in intercity mode choice. The length of the entire journey should be modeled.
- *Non-resident travel:* The V2 system represents the travel choices of California residents. The V3 system should explicitly include visitors, for they are a large potential market for the California system. There were 14.1 million international visitors to California in 2011, and an estimated 48.1 million domestic person trips made by residents of other states.¹ This is a significant market that the Authority will need to understand, particularly if a separately planned HSR service between Southern California and Las Vegas should begin operation. A separate but parallel set of demand models will likely be required for nonresident travel, since the needs of such travelers are different from those of California residents.
- *Seasonality and day of week:* The evidence from Europe suggests that HSR traffic differs significantly by day of week and season of the year. Such trends are likely evident in travel statistics compiled for other travel modes including auto travelers. A microsimulation framework will facilitate incorporating this factor.

3.2 Platform requirements

A scalable, computationally efficient, and transparent software implementation of the model and its supporting data systems will be required. This implies a new modeling platform, for the existing system was designed to support a more aggregate level of analysis. The V3 platform should include several important characteristics, including:

- Be based on open source software stored in a publicly accessible repository (e.g., GitHub) with version control.
- Support micro-simulation, i.e. representation of individual household travel choices through a real or synthetic sample to which the estimated behavioral equations are applied, followed by aggregation.
- Build upon the investment already made in the Caltrans statewide model to the maximum extent possible. For example, synthetic households, networks, and some existing sub-models can be adapted from the statewide model.
- Include inline documentation and user's guide in wiki format, both of which should be publicly accessible.

¹ <http://industry.visitcalifornia.com/Find-Research/California-Statistics-Trends/>

The design of the model should be modular, extensible, and flexible enough to allow it to be implemented in standalone workstations, computer clusters, and cloud computing environments. This will facilitate quickly running scores of scenarios in parallel, which will support the risk and uncertainty analyses of the forecasts.

3.3 Next steps

The development of the V3 system should follow a careful and deliberate path, for example:

- A *high-level design* document that describes the analytical requirements and required functionality would be prepared. Stakeholder input, as described in Section 5 below, would inform it. It would also describe the system and its components in conceptual form, as well as the data systems required to build and use it. This document would be prepared by or carefully reviewed by the Authority and the Panel before proceeding to the next steps.
- A *detailed model specification* would be created that describes the system and its components in sufficient detail to permit cost estimation and for developers to begin work. The specification would describe the conceptual basis, mathematical or algorithmic form, anticipated parameters, data requirements, calibration targets, and implementation process
- A *schedule and budget* based on the specifications would outline milestones and major deliverables over a multi-year time frame.
- *Model development* would be monitored by the Authority, with technical reviews at major milestones by the Panel, and perhaps other outside experts.

It is anticipated that these activities will be carried out independent of further development and application of the V2 model or variants thereof.

4 Continuous data collection and performance monitoring

Travel behavior and the likely response to the introduction of HSR in California have changed considerably since the original 2005 surveys, as revealed by the preliminary results of the 2013-14 survey, and will likely continue to change over the coming years. Moreover, the data currently used are for California residents, but the visitor (i.e., non-resident) population needs to be equally well understood. To that end the Panel recommends that the Authority continue to invest in data development for the foreseeable future. As a goal, we suggest that on-going data collection and monitoring account for 20 percent of the total funds allocated for modeling and forecasting activities. Specific elements of this on-going data collection program may include:

- Continued attempts to collect additional long distance surveys from respondents of the CHTS who indicated a willingness to be contacted for further surveys, as well as new households recruited into the sampling frame.
- Administering the 2013-14 RP/SP survey instrument to additional samples of individuals, in order to freshen it with more recent data, target market segments not well captured in previous efforts, field new experiments, etc.
- A visitor data collection program.

- Passive travel data, such as origin-destination matrices for major markets (e.g., intercity travel by California residents versus non-residents) derived from cellular tracking data, can be used to validate the current model, help synthesize parts for which data are lacking, and spot aggregate trends before they become apparent in travel survey findings.
- Continuous monitoring of data on intercity bus, air, and rail flows within California, to include temporal and seasonality patterns.

This information would become part of the Authority's marketing and operating data once HSR service begins. A program well informed by current data will be best positioned to quickly respond to changes in markets and traveler behavior. Indeed, robust forecasting models that are responsive to the Authority's needs are only possible with data of equally high quality and coverage.

5 Dialogue with the investment community

An important capability of the V3 system will be its ability to inform investment decisions and negotiations. It is expected that investors will conduct due diligence with respect to ridership and revenue forecasts. However, the Authority's forecasts will provide information to investors, as well as provide the Authority with their own information upon which to evaluate and negotiate proposals.

The relatively open approach used to date by the Authority is unusual among HSR projects worldwide. For example, even in Version 1 the specifications for and aggregate results of the modeling system were easily accessible on the Authority's website. Continuing this practice enables potential investors and other interested parties to understand the methodology used in forecasting, including its strengths and weaknesses. This will reduce the cost of outside investor analyses and improve consistency in the data and assumptions underlying the forecasts.

The Panel endorses the desire of the Authority to obtain input from potential investors about how the V3 model and data, and forecasts developed using them, can be most useful to them. As noted earlier, their input will provide important design guidance for the V3 system. One way to gain that input would be a workshop devoted to the topic of their ridership and revenue information needs. This could be a one-day event, where potential investors are invited to share their views with the RTAP and Authority on their information needs. It could take the form of the Industry Forum recently held in conjunction with the Construction Package 2-3 rollout. A structured program is envisioned that would summarize the current and planned model improvements, risk and uncertainty analyses, and available data. A facilitated discussion about how this information can be useful to potential investors would then follow. A set of findings from that discussion would be presented near the end of the workshop, and refined as appropriate. These findings will play an important role in the design of the V3 system.

An alternative to hosting a formal workshop is a series of discussions with prominent investors and forecasters. A series of pre-recorded video presentations about the current and planned models, data, and forecasting processes (to include risk and uncertainty analyses) can be used to brief the experts. An interview by one or more panelists or staff members can be used to elicit their responses. A synthesis of the findings can be created to inform the V3 specifications. This approach does not have the advantage of allowing full discussion and interaction among all participants, and will likely take longer to complete. However, it solves the problem of finding a

date that works for all participants and reduces the burden and cost of their participation. Either approach is seen as superior to proceeding with the V3 design and specification without their input

6 Conclusion

The work to date on the V2 system has improved it considerably, making it a suitable platform for near-term uses by the Authority while the V3 system is developed, tested, and implemented. The Panel has reviewed the estimation and calibration results and provided comments to CS previously. The quality and scope of the work completed under tight deadlines is commendable. However, the Panel believes that further major refinements to this platform are not cost-effective. Rather, a new platform for implementing the models that provides greater flexibility to meet current and anticipated needs, as well as taking advantage of recent methodological advances, is highly recommended. The Panel strongly recommends that the Authority pursue its development as quickly as possible, using a development effort separate from the activities required for producing forecasts for ongoing updates of the Business Plan.