Improved Modeling of Network Transportation Flows, Including Land Use-Transportation Interactions: A Research Collaboration between USC (METRANS) and Caltrans District 7 (Office of Advance Planning)

Final Report

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Mayank Mohan, Ph.D. Candidate
Daniel J. Epstein Department of Industrial and Systems Engineering

Mengzhao (Margaret) Hu, Transportation Planner
Parsons Brinckerhoff Quade & Douglas, Inc.

James. E. Moore, II, Professor
Daniel J. Epstein Department of Industrial and Systems Engineering

Peter Gordon, Professor
School of Policy, Planning, and Development

Harry W. Richardson, James Irvine Professor
School of Policy, Planning, and Development, and the Department of Economics

University of Southern California
Los Angeles, CA 90089

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Abstract

Caltrans District 7 manages the highway system of Los Angeles and Ventura counties. As part of their responsibilities, the agency needs to generate planning reports. One such report is the transportation concept report (TCR). It is route specific and needs to be updated periodically. Data for these reports are generated using a network and travel demand model. In the past Caltrans used an in-developed model. However in response to changing resource availability and the need for better collaboration with other regional agencies, Caltrans decided to use a model that had been developed by the Southern California Association of Governments (SCAG). Caltrans found itself struggling to effectively use the SCAG model. Caltrans had long developed modeling and reporting practices around its original model. In this research effort, we helped Caltrans by studying their procedures and recommending possible changes. We also developed a tool which could facilitate the translation of SCAG's results to Caltrans' immediate needs.

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Disclosure

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Acknowledgements

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1. Introduction

Caltrans District 7 is responsible for generating a set of reports referred to as the Transportation Concept Reports (TCR). These are planning reports for each of the highways in the district and are updated periodically. Caltrans was used to a system of modeling and reporting practices which was built around its travel demand and network model. However, with changing resource availability and the need to better collaborate with other regional agencies, Caltrans decided to use the models available at the Southern California Association of Governments (SCAG). Whether it was the lack of foresight or the lack of available options, Caltrans did not realize that SCAG's models were very different from the one that they had been using in the past. There was an urgent need at Caltrans to rethink some of its modeling activities and the way it reported plans. There was also an immediate objective of updating the TCRs, an activity that had been delayed for over a year. This is where the help of the USC based METRANS center was solicited. We helped Caltrans in two ways. First we audited their modeling practices and provided them with an analysis of possible improvement avenues. Second we developed an automated tool, referred to as the correspondence file, to help them meet their immediate and urgent requirement of updating the TCRs.

2. What is a Transportation Concept Report (TCR)?

The Transportation Concept Report (TCR) is an internal Caltrans planning tool intended to provide an initial look at developments within a corridor over the next twenty years. Its primary focus is on identifying need--defined as the difference between forecast demand and capacity. It analyzes this need in three primary ways (Caltrans District 7, 2003):

1. It documents current conditions.
2. It contrasts projected future demand with planned facilities (capacity).
3. It proposes future development alternatives to address the shortfalls between demand and capacity.

Completing the TCR is an initial step in the planning process. Observations and conclusions recorded in a TCR thus serve as a reference for more complex reports such as feasibility studies, corridor studies, and project studies.

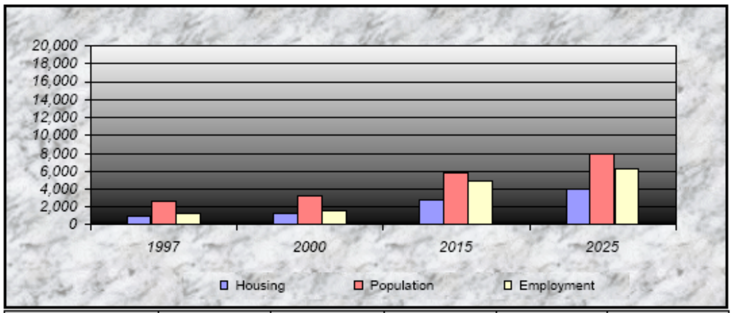
The TCR is composed of a series of proposed alternatives for the development of a corridor. The alternatives are included in the *segment summaries*. The recommended alternative is based on existing plans. These plans are the Southern California Association of Governments' regional transportation plan (SCAG RTP) (SCAG, 2004), the Los Angeles County Metropolitan Transportation Authority (LACMTA) long range and high occupancy vehicle (HOV) plans, and the Caltrans district system management plan (DSMP).

2.1 Content of a TCR:

The transportation concept report divides a route into several segments. Each segment acts as a unit of analysis. The end points of a segment could be either of the following: freeway to freeway interchanges, county lines and end of freeway (Caltrans District 7, 2003).

As identified in the previous section there are three steps of analysis in a TCR:

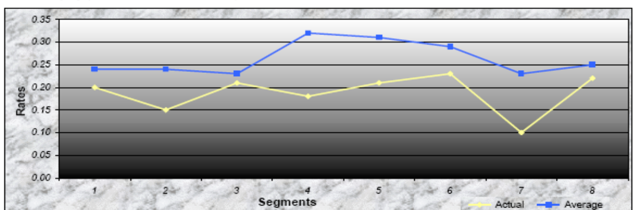
1. TCRs documentation of current conditions:
    a. Route description: This section identifies the classification of the corridor being studied (cahighways.org, 2007), the end points of the route per relevant statutes; and mileage (length) within the state and the district.
    b. Purpose of the route: This identifies the primary usage of the corridor (for example - commuter traffic, goods movement).
    c. Socio-economics: This identifies land use, trip generators, and data on population, employment, and housing trends for the areas that the corridor serves. Refer to figure 1.
    d. Accident rates and safety: This provides data on fatal accidents and injuries per million vehicles for each of the corridor segments. Refer to figure 2.
2. TCRs contrasts projected future demand with planned facilities: Each summary describes a segment's current and projected operating characteristics (for example - free flow speed, congested speed), the base year configuration (for example - number of lanes, types of lanes), projected traffic demand and proposed alternative improvements. Refer to figure 3.
3. TCRs propose future alternatives to address the shortfall: The report then describes the current and future deficiencies in the system. These deficiencies are classified as operating (described as the shortfall in level of service), transit (described as the level of transit service required in the future years to meet the demand) and the availability of the facility for goods movement. Further the TCR identifies the programmed improvement measures and the source of these improvements. Based on this background and the shortfall in level of service as determined in segment summaries, the report outlines an investment scenario which would help meet the projected demand.



	1997	2000	2015	2025	% Change
Housing	985	1,244	2,759	4,015	308%
Population	2,660	3,189	5,736	7,993	200%
Employment	1,268	1,577	4,869	6,301	397%

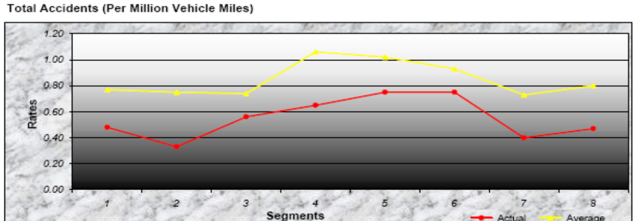
Figure 1: Example of socio-economic data in a TCR (Caltrans District 7, 2003)

Fatal + Injury (Per Million Vehicle Miles)



	1	2	3	4	5	6	7	8
Actual	0.20	0.15	0.21	0.18	0.21	0.23	0.10	0.22
Average	0.24	0.24	0.23	0.32	0.31	0.29	0.23	0.25

Total Accidents (Per Million Vehicle Miles)



	1	2	3	4	5	6	7	8
Actual	0.48	0.33	0.56	0.65	0.75	0.75	0.40	0.47
Average	0.77	0.75	0.74	1.06	1.02	0.93	0.73	0.80

Figure 2: Example of Accident rates for a corridor (Caltrans District 7, 2003)

STATE ROUTE 210 - SEGMENT 1 SUMMARY

DESCRIPTION	
Limits:	Route 5 to Route 118
Post Miles:	R0.00-R5.91

Purpose
Interstate, Interregional, Intraregional, commute and non-commute Travel and Goods Movement.

Classification	
Functional Classification:	P1P
MPAH Designation:	Interstate
Other Systems:	NHS, STAA, Rural and Single Interstate Routing System

Ultimate Concept	
Main Line	HOV Lane(s)
3	2

Physical Characteristics	
Terrain:	Rolling
Mainline R/W	184'
Median / Outside Shoulder:	36'-99'/10'
Design Speed (MPH)	70
Bridge Structures:	

Corridor Characteristics	
Trucks (% of ADT):	8%
Express Transit (lines):	Foothill
Operators:	Foothill
Rail Service:	Metrolink
Park & Ride Lots (Spaces):	None

Accident Rates per Million Vehicle Miles (MVM) (1/98 to 12/00)			
ACTUAL		AVERAGE	
Fatal + Injury	Total	Fatal + Injury	Total
0.20	0.48	0.24	0.77

TRAFFIC DATA

		Base Year (2000)		2020 NULL (w/o Route 710)		2020 NULL (with Route 710)		2020 CONCEPT (Alt1)		2020 CONCEPT (Alt2)	
		Main Line	HOV Lane(s)	Main Line	HOV Lane(s)	Main Line	HOV Lane(s)	Main Line	HOV Lane(s)	Main Line	HOV Lane(s)
Average Daily Traffic (ADT)		72,300		153,000		161,200		124,800	33,200	106,000	34,900
Lanes Configuration (ea. direction)		3		3		3		3	1	3	2
Volume											
AM Peak Hour	E	5,090		11,010		10,710		9,230	2,730	7,620	3,020
AM Peak Hour	W	2,170		2,590		2,810		2,170	380	2,050	380
PM Peak Hour	E	2,730		4,980		5,660		4,170	1,070	3,400	920
PM Peak Hour	W	4,490		10,470		10,320		8,330	3,050	7,150	3,920
Speed (mph)											
AM Average	E	60		22		24		26	36	50	62
AM Average	W	65		65		65		65	65	65	65
PM Average	E	65		63		61		63	65	65	65
PM Average	W	58		26		27		35	27	53	56
Service Characteristics											
Level Of Service, AM	E	D		F3		F3		F3	F2	F0	C
Level Of Service, AM	W	B		C		B		B	A	A	A
Level Of Service, PM	E	B		B		D		C	B	B	A
Level Of Service, PM	W	C		F3		F3		F2	F3	F0	F0
Directional Split (%) AM	E	70%		81%		79%		81%	88%	79%	89%
Directional Split (%) PM	W	38%		32%		35%		33%	26%	32%	19%

NOTES: 2020 Concept Alternates 1 & 2 are both modeled with I-710 gap closure built between I-10 and I-210
Speeds are estimated and are for comparative purposes only

Figure 3: Example of data presented in a segment summary (Caltrans District 7, 2003)

2.1.1 Data found in a TCR

Although a broad overview of the data found in a TCR is described in the above section, we present the data format here since the inability of Caltrans to present the data in the required format was the reason why this project was carried out.

2.2 Need for a TCR

2.2.1 Legislative need

The need for a TCR is derived from a legislative mandate stated as:

"65086 Long-Term System Planning (Added: Statutes of 1987, Chapter 878)

The Department of Transportation shall carry out long-term state highway system planning to identify future highway improvements and new transportation corridor through route concept reports.

The department, in conjunction with transportation planning agencies, shall develop specific project listing for the initiation of project studies reports resulting in project candidates for inclusion in regional transportation plans and the state transportation improvement program as required by Section 14529 (Caltrans District 7, 2003)*."*

2.2.2 Planning need

The alternatives considered in a TCR are starting points for development of a Transportation systems development plan (TSDP) and also used by the other regional transportation planning organizations like the Southern California association of governments (SCAG) and the Los Angeles county metropolitan transportation authority (LACMTA). Based on our discussions with the planning personnel in the three agencies (Caltrans, SCAG and LACMTA) we developed a flowchart. Refer to figure 4 showing the TCR based interactions between these three agencies. Further explanation of regional planning in Southern California can be found in the appendix section 7.1.

There are two types of users of TCR information:

1. Internal Caltrans departments:
    a. Design
    b. Construction

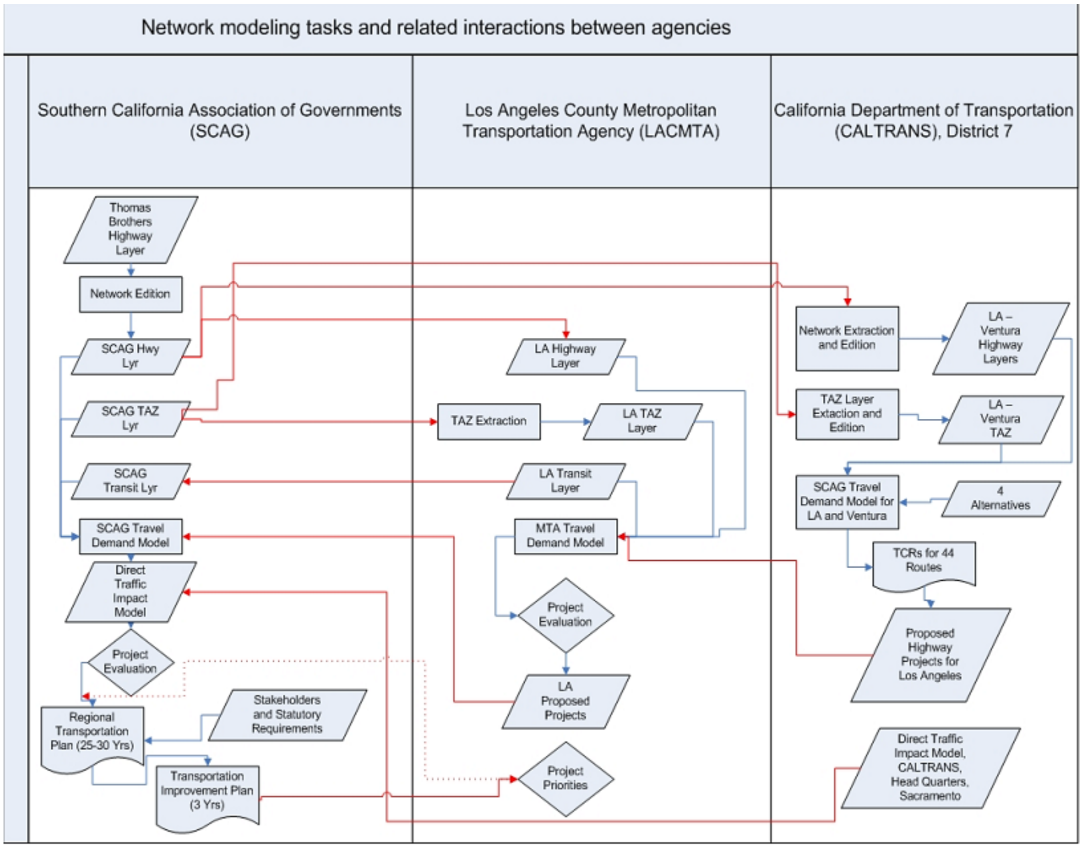


Figure 4: Planning interactions between Caltrans, SCAG and LACMTA

   c. Program project management

   d. Traffic operations

   e. Maintenance

2. External agencies:

   a. SCAG

   b. LACMTA

   c. Ventura county transportation corporation (VCTC)

2.3 TCR development process

Two departments within Caltrans District 7 are responsible for the creation of TCRs. The primary responsibility of developing a TCR is that of the Office of Advance Planning (OAP). OAP personnel lead the development project by initiating the process and by bringing every concerned stakeholder on board. The activities carried out by OAP in TCR development are represented below in figure 5. TCR development activities at OAP are supported by the office of regional planning (ORP). ORP is the division responsible for generating the segment summary data documented in a TCR.

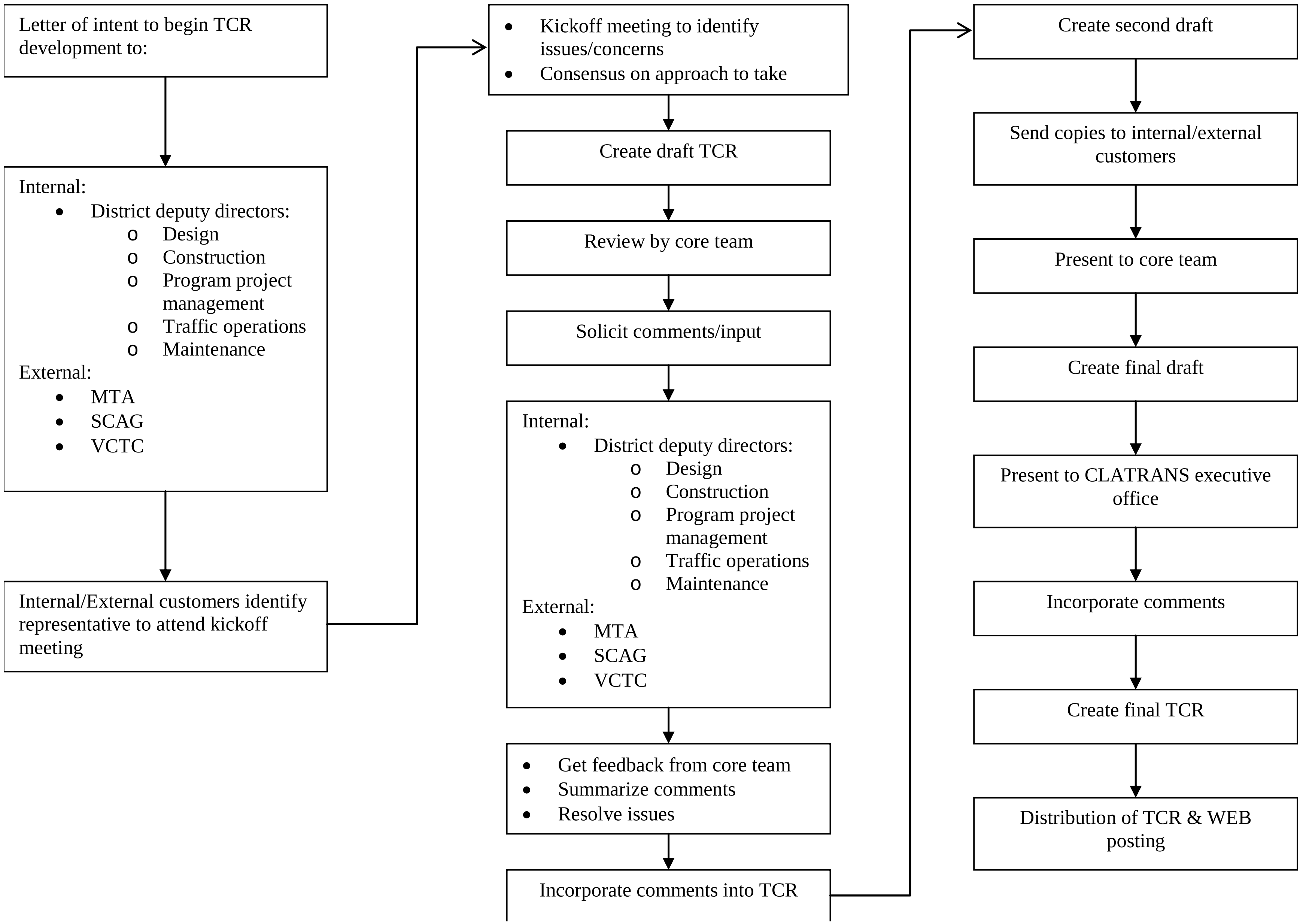


Figure 5: TCR development activities

3. Problems that Caltrans District 7 reported in developing TCRs

As of September 2003, Caltrans district 7 had been struggling for over a year to generate data for updating the TCRs. Updating the TCRs is mandated by the state legislature and is also important from the regional planning perspective. Any delay in TCRs would thus imply delay for the regional planning process, or the use of non – updated information from prior years' TCRs.

3.1 Summary of reasons

TCRs are developed as a collaborative effort between OAP and ORP. OAP is responsible for collecting data from previous TCRs and other regional plans to develop scenario definitions for TCR updates. This was a step that the OAP staff stated, they had completed. The delay in updating the TCRs was in the activities for which ORP was responsible. Both the groups agreed that the delay was a result of staff reduction at ORP during the past two years (at the time this project was initiated). However ORP personnel also stated that more significant than understaffing was the change in the network model. ORP had been asked to collaborate with SCAG to make joint use of the SCAG network model. Figure 6 below represents the factors that complicated tasks for ORP.

The reasons presented in figure 6 are correlated. For example, undocumented procedures add to the functional division between OAP and ORP where staff in one division does not know about the activities carried out by staff on the other division. We arrived at the reasons in figure 6 based on our analysis of Caltrans District 7 work flows, and having worked on creating automated tools for data analysis and formatting.

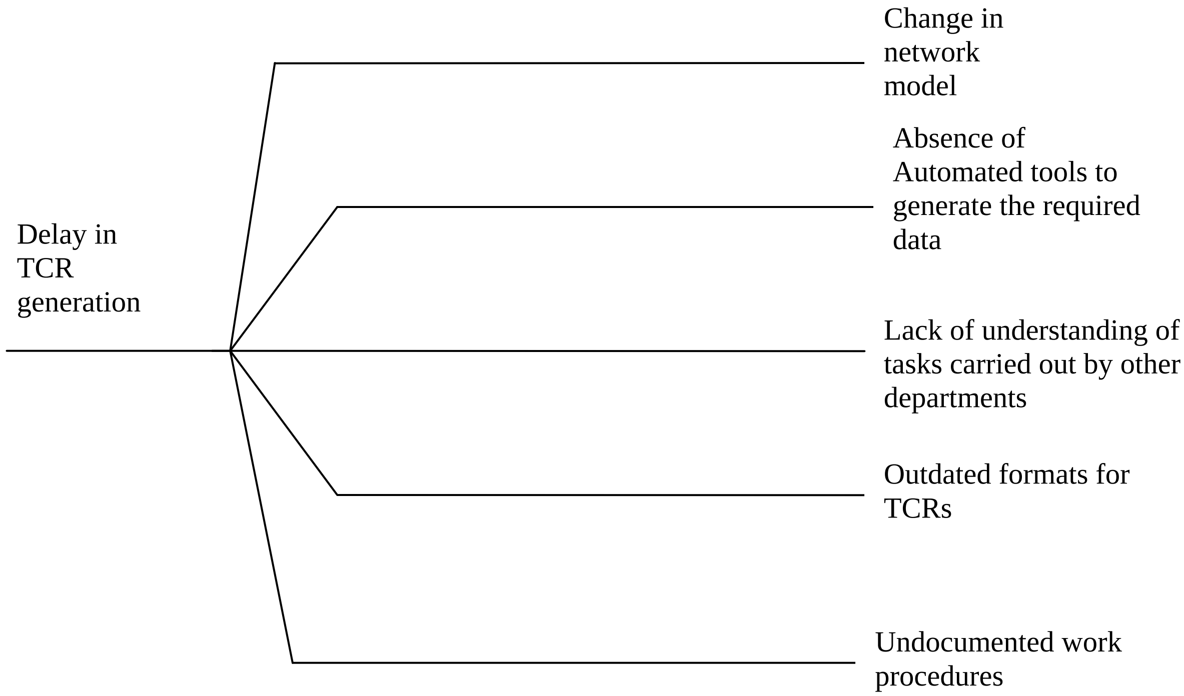


Figure 6: Reasons for delay in TCR generation

3.2 Explanation of reasons

3.2.1. Reason 1: Change in the network model

Until the late 1990s Caltrans District 7 had been using a network model based on the Los Angeles Regional Transportation Study (LARTS), which was conducted in late 1960s and early 1970s. The representation of the transportation network in this model was simplistic, for example a physical two way road link was represented by a single bi-directional link on the model; all intersections were represented by a single node on the network; freeway ramps were not considered and links did not consider gradients. Caltrans did use the traffic analysis zones (TAZs) and socio-economic data from SCAG to produce results that were consistent over the region. SCAG, however, developed a more elaborate network model that included complexities mentioned above – A physical two way road link was represented by two uni-directional links. Intersections could have up to four nodes. Freeway ramps were included and the links could be specified with a gradient. Some of these changes are represented in Figure 7. Whether such additions to a simple network model improve the model results was a question that Caltrans staff raised on several occasions and answering this question requires further research. Since the LARTS network model was old and needed an update, Caltrans District 7 decided to work with the SCAG network model. This posed a problem for the ORP staff since they had developed their work processes around the LARTS model.

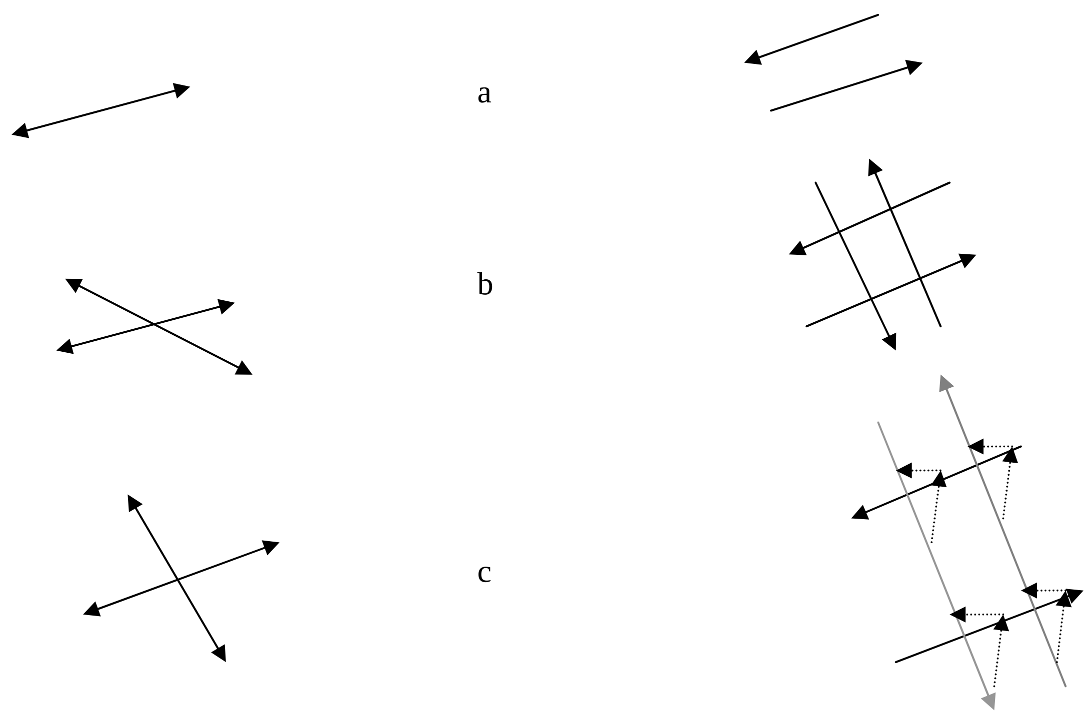


Figure 7: Examples of changes in the network model. Figures on the right represent the LARTS network model and those on the left represent the SCAG network model. 7a - shows representation of a two way road link. 7b – shows an intersection. 7c – shows the representation of a freeway/highway intersection with a two way road link.

Formatting the model output data to match the TCR requirement was the most difficult part of the problem. This was so because a TCR consists of segment summaries. Segments are defined as a set of links on a route between any combination of an interchange and a county line. On a TCR the segment end points are identified by name of interchange or the county line. In the model output results, traffic volume, are represented for all links on the network. A link is identified by its starting node (a unique number) and its ending node (a unique number). The problem then is to assign a set of links to a segment and generate the segment summary. In the past, with the LARTS network, it was easy to assign a link to a segment. However with the increase in network complexity the number of links that would have be assigned to segments increased from a few hundreds to several thousands. The task could still be completed manually, but it would require so much more effort that completing it using a single staff member would take several months. It was thus necessary to develop an automated tool to assign links to a segment or hire (even temporarily) a person to complete the task for Caltrans.

3.2.2. Reason 2: Absence of automated tools to generate the required data

As stated above, ORP staff used to generate the required data by manually assigning links to segments. Although it can be argued that any such tool would be specific to the network model, we believe that prior experience would have been helpful. We developed an implemented one such tool that could transfer the data from the model to the required format of the TCRs. The model development and implementation is described in the later sections of this report.

3.2.3. Reason 3: Lack of understanding of tasks carried out by other departments

During our meetings with the staff at OAP, ORP, SCAG and LACMTA we found that departments had an understanding how their work interacted. Departments did not know if their work could be presented in a manner to reduce the workload of those using it. Consider for example a division (called B) requires a set of data from another division (called A). Division B requests the data and division A provides it in a format that they think is best. Division B now has to spend several hours (say x) to bringing the entire data set to a format that would fit the requirements of their computer program. If, division B had outlined the format in which they needed the data division A could have formatted the data and saved x hours for the organization. It may be argued that division A may need to spend more than x hours to provide division B with data in the required format. However in the instances that we came across, data are created by a data entry step. Thus the format in which these data are entered does not make significant difference in the time it takes to complete the step. The case of a dataset called the segment definition table provides an example. This dataset is provided by OAP to the ORP and contains segment related information. The table identifies segment endpoints by post-miles and not by intersecting facility name. ORP staff had to look up the road maps to identify the facility names and add them to the dataset. It would be much less time consuming for OAP to add the names of the intersecting facilities since segments by definition are from intersection to intersection and this information, should be readily available with OAP.

3.2.4. Reason 4. Outdated TCR format

The TCR process entails some outdated procedures that though beyond the scope of this project, are worth recognizing and addressing. TCRs were, by their very design, simplistic, easily-read reports with a small number of transportation scenarios and investments. However, in today's world of high-level computing, software programs can model much many more scenarios *and* take into account the relationship between the scenarios. Currently, a TCR may, for example, address a question such as "How do 20-year projections of population growth and planned investments on the I-405 affect traffic on the I-405 in Los Angeles?" but completely ignore a slightly similar question: "How do 20-year projections of population growth and planned investments on the I-405 affect traffic on the **I-10** in Los Angeles?" The TCR format fails to consider the effects of highways on each other.

The problem is represented below in Figure 8. Examining number of possible roads produces n possible TCR scenarios. However, considering the cross-effects of pairwise conditions of road projects

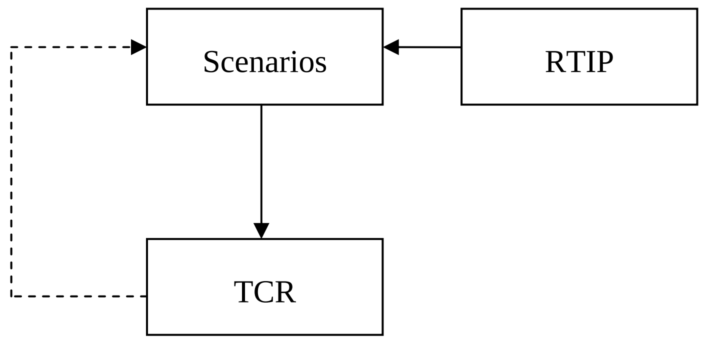


Figure 8 a: The missing link in scenario development (the dashed arrow)

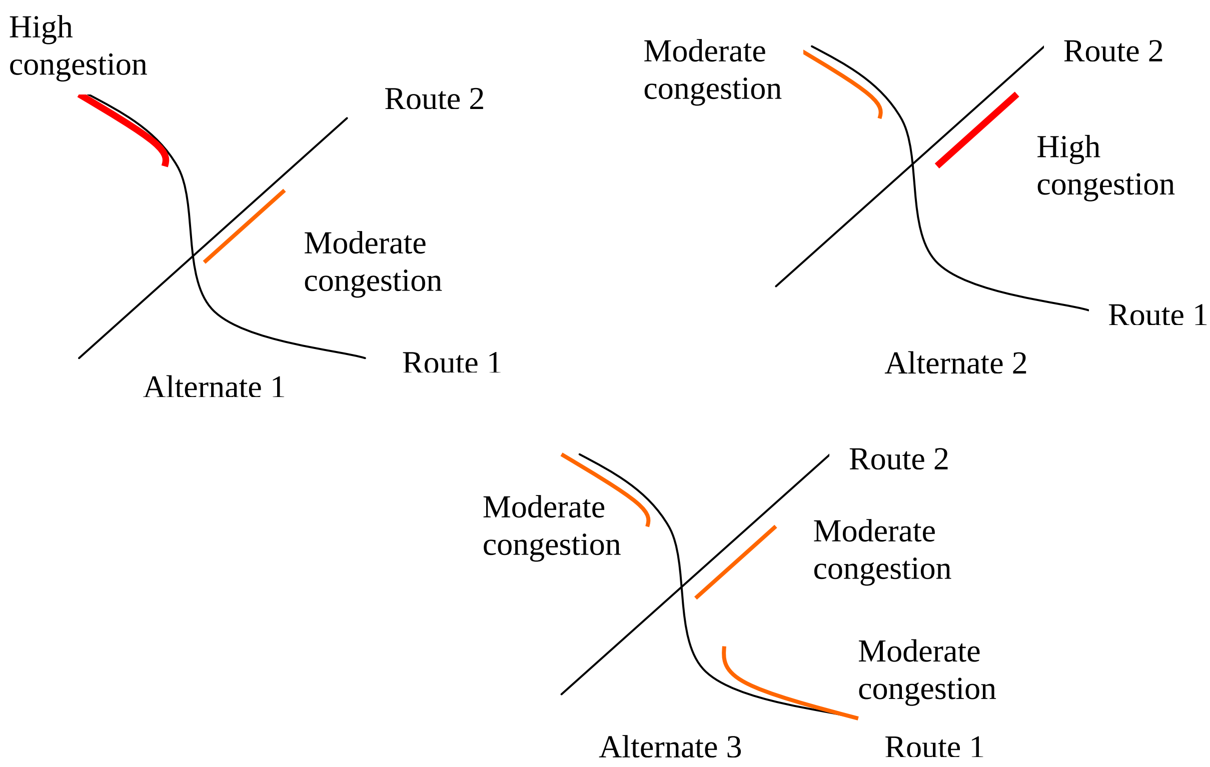


Figure 8 b – Represents two routes with possible investment alternatives 1, 2 and 3 for route 1. Each alternative produces under different congestion levels for each of the routes 1 and 2. Which is the preferred alternative? Per the TCR approach, the alternative which has the lowest congestion for route 1 is the preferred alternative.

on each other, the number of scenarios grows to

$$\binom{n}{2} = \frac{n!}{(2)!(n-2)!} = \frac{n(n-1)}{2} . \qquad (1.)$$

This quantity grows very quickly with n. This is only an under estimator of possible scenarios, of course, as we could also examine the effect of two highways on a third, or three highways on a fourth. It is common for researchers at Caltrans to use software to calculate a multitude of these different scenarios during the course of their assignments, so what makes TCRs different? Its readability cannot be overstated, but possibly even more important is its audience. TCRs are meant to single out a specific set of possible projects and their importance, rather than overwhelming the reader with multitudes of scenarios.

3.2.5. Reason 5: Undocumented work procedures

The work procedures that were followed to create at least the TCRs are undocumented. Which department is to do what, who is the responsible person within the division for each of the work elements, the standard time to process a work element and similar information was not documented. This lack of documentation made it more difficult to communicate requirements and made accountability difficult. This report provides a first step in the documentation of work procedure.

4. How could METRANS help?

The previous section documents the problems that affect Caltrans modeling activities. It is clear that the delay in TCR generation is not a problem in itself. Problems exist within the modeling system that led to the delays. It was not feasible within the scope of this project to correct any of the problems we identified. However, it was possible for us to develop tools that could help Caltrans meet its immediate objective of generating the TCRs. In this section we describe the procedure to develop and implement the tool we developed for this purpose. This tool is a bridge that enables connecting the data obtained from the *new* model to the format of a TCR. We call this tool a correspondence file. See figure 9.

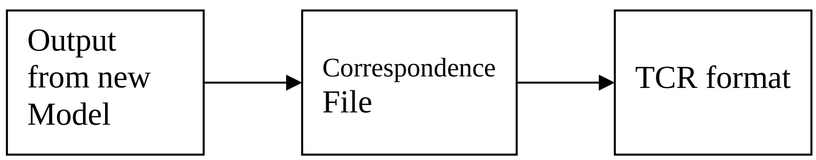


Figure 9: Correspondence file facilitates conversion of data from one format to another

4.1 Development of the correspondence file

Writing the TCRs requires data in the form of segment summaries. The data from the SCAG model output is organized by links (a segment contains several links) and does not contain segment information. In the LARTS network model, assigning the links to a segment was easy and could be accomplished manually. However the SCAG network had a considerably larger set of links and assigning links to segments was too difficult to be handled manually. The correspondence file is an automated way to assign links to segments.

4.1.1 Network representation:

We exploited properties of the network and the output data to develop the correspondence file. The SCAG network consisted of nodes and links. Nodes represented intersections and Traffic Analysis Zone (TAZ) centroids. Each node was associated with a unique number and its (X, Y) coordinates with respect to the origin of the network. Nodes were joined by links. So each link had two nodes – a starting node and an ending node determined by the direction of traffic flow. Each link had several attributes but the important one for our purpose was the "assignment group." This attribute was used to determine the facility type of the link. For example a mixed flow freeway link had an assignment group number of "1". There were several other assignment groups that identified facility types, including – centroid connector, high occupancy vehicle (HOV) link, truck only link, primary arterial and secondary arterial amongst others.

An interesting and important property of the freeway links was that one node of the link could be joined with only one other freeway link. One node of a High Occupancy Vehicle (HOV) link could be joined with only one other HOV link. This is represented in the figure 10. This property was important in the algorithm for development of a correspondence file. It is important to note that this property was not exhibited by the arterial (non- freeway) links. That is, an arterial link node could be joined with more than two arterial links.

4.1.2 Model output

The model output consisted of volume data for each link. Associated with each link were several other attributes – starting node number, ending node number, assignment group, gradient, area type where the link exists, volume, free flow speed and others. The next section explains the algorithm we used for assigning links to a segment.

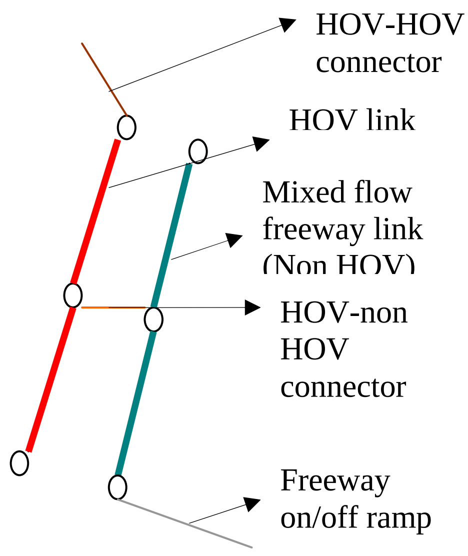


Figure 10: Representation of freeway links in the network.

4.1.3 Algorithm for creating the correspondence file

Suppose we know the start node (A) and the end node (B) of a segment (S). We also know the end node of the first link on the segment (B'). The algorithm starts by assigning the first link of the segment (AB') to segment S. The assignment group (G) of this link is also stored. This is stored in a separate file. Now the node B' becomes the starting node for the next link in the segment (A=B'). If more than 2 links emanate from the node B', check which one has the same assignment group (G). If more than two links have the same assignment group, prompt the user to enter the right choice of link and assign it to segment S. If there is only one other link with the same assignment group, assign this link to segment S and make the end node of this link the start node for the next link. Continue until the end node = B.

This algorithm is presented below in a pseudo-code format. The associated flow chart appears in figure 11.

1. Input the segment start node ← A

2. Input the segment end node ← B
3. Input the end node of the first link in the segment ← B’
4. if B is not equal to B’ continue else stop
5. Store link AB’ in Segment S, store assignment group of link ← G
6. A= B’
7. Search for links which have starting node = A
8. If more than one link with same G has starting node = A, ask user to input the correct end node for the link = B’
9. If not, B’= end node of the link
10. Go to step d

This algorithm requires two sets of inputs:

1. Network data – the start and end nodes for all the links in the network
2. The start and end nodes for all the segments and the end node for the first link in each segment

It also requires user information for the case of arterial segments. For the freeway segments it can function without any user intervention because freeway segments have only one link that has the same assignment group as the predecessor, and has the end node of the predecessor as its start node. Upon running this algorithm with the required inputs we obtained a table that contained the links (identified by start and end node) and the segment to which each belonged.

4.2 Implementation of the correspondence file

Once the table from the algorithm implementation is generated we can use it to extract the required information from the model output. To achieve this, we used a commercially available database system (Microsoft – Access). The correspondence file used three tables:

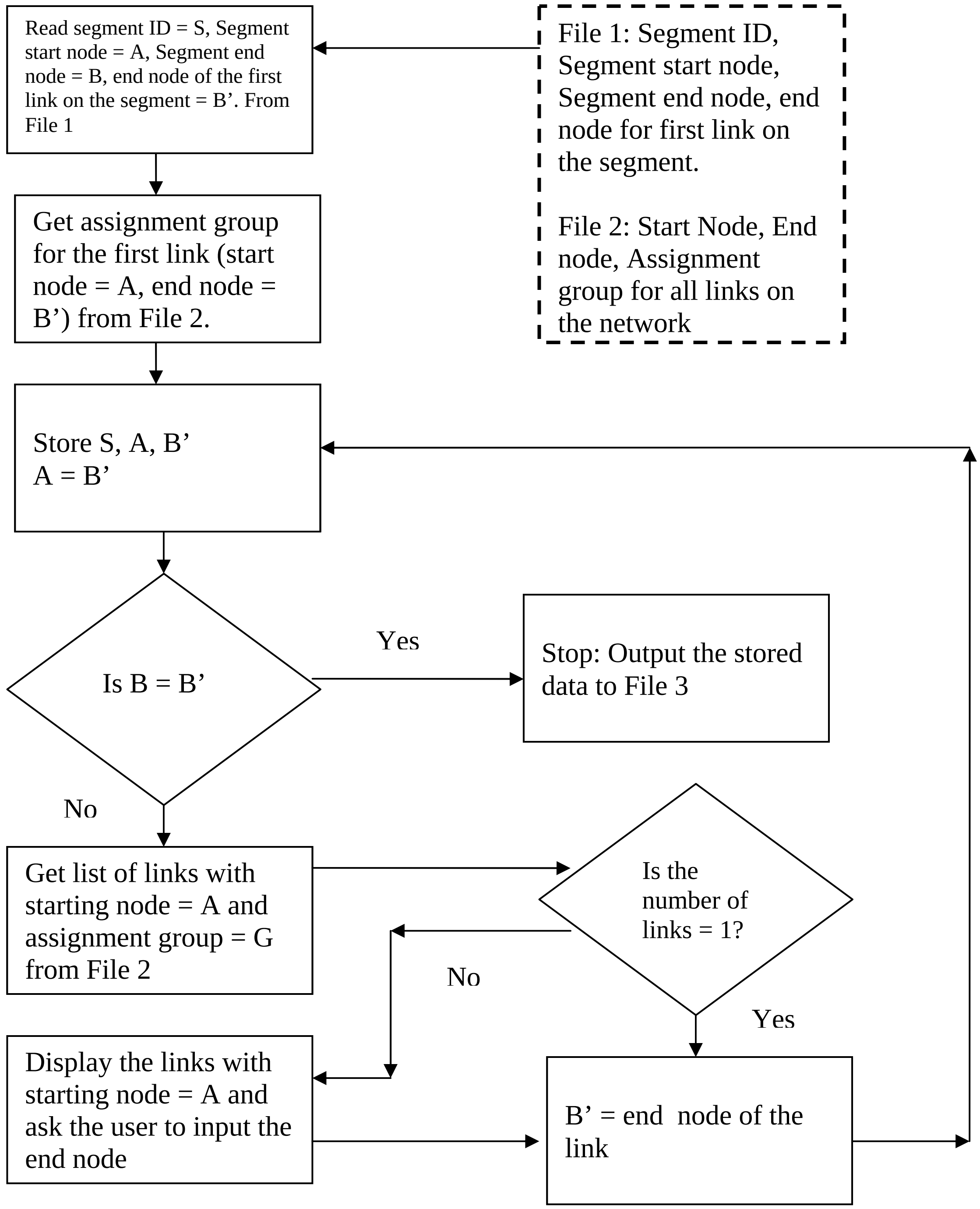


Figure 11: Flowchart for the algorithm that creates the correspondence file

1. Routes and segments for each of the forty four routes.

2. Segments and their links (generated from the algorithm).

3. Link data (generated from the model output).

The user creates a query on the database system using the first table (routes and segments), and – enters the route number and the segment number (referred as segment ID). The query is directed to the second table (segments and their links). This generates an auto – query for the data on all the links in the segment. This query is directed to the third table (link data). A spreadsheet containing all the links in the segment and their associated volume data is generated by the database system. The schematic representation of the correspondence file is shown in figure 12.

The segment definition table contains the route and segment ID information. The user creates a query using the route number and segment ID. This query is directed to the core table. The Core table contains data on segment ID and its associated links. Using the link information a query to the network output table is generated. This query then extracts the links' data for the segment queried. The data is reported in a spread sheet.

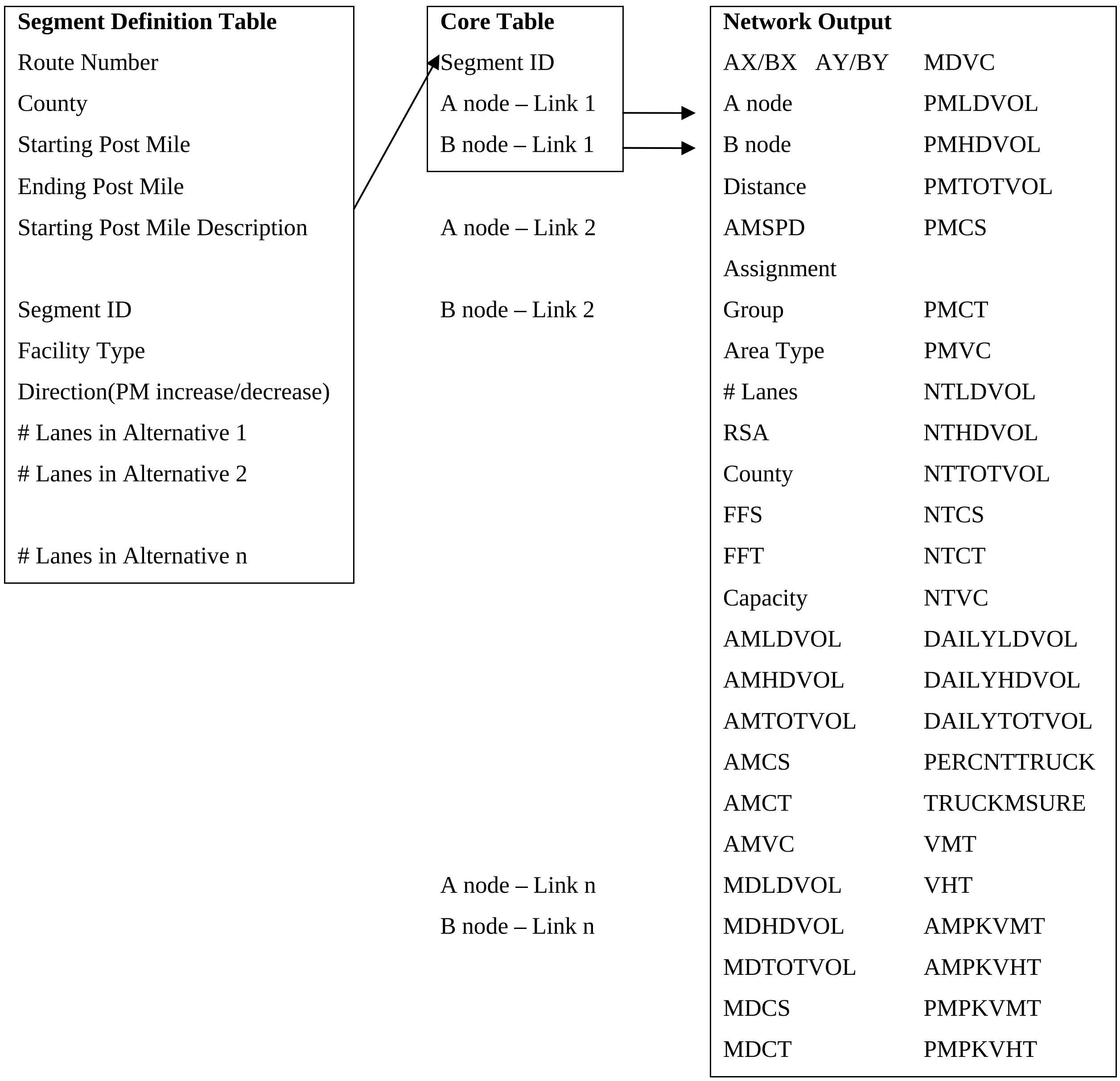


Figure 12: Schematic representation of correspondence file

5. Conclusions

This study demonstrated an example of change management. Change management has long been an issue of research in the field of management, and has got increasing attention with the advent of software systems based management. Implementation of a single new practice affects all activities related to the one that has been changed. New roles are created for employees and everyone is expected to cope with the transition costs.

Our research effort, however, was limited in objective. We conducted an audit of Caltrans' original activities and provided a feedback on what could be changed, given the adoption of SCAG's model. The largest focus of our effort was directed towards helping Caltrans develop its TCRs. The delay in TCR generation was unacceptable and required immediate attention. We were successful in overcoming that problem.

However, this research does open avenues for further exploration. We have questioned the bases for some of the key modeling activities that Caltrans engages in. How each activity adds value or could add value if done differently is a question that is interesting not only for Caltrans but other regional planning organizations as well. An important question relating to the collaboration between agencies is how much each organization contributes towards the objective of generating a TCR and whether their contribution justifies their own need for a TCR. How can we objectively evaluate contribution and need? Answers to some of these questions would determine the future course of action for collaborative efforts, and change requirements at transportation planning agencies.

6. Implementation of this research

Based on the description and the algorithm for the correspondence file in section 4.1.3, we developed a computer code. This code was implemented in C++ and was used to generate the core table described in section 4.1.4. The code is contained in the appendix of this report. Once we had the data on segments and its associated links, we developed a Microsoft-Access based database system. This system was provided to Caltrans for use in their work. The working of the database system was validated and verified and was found to conform to the requirements.

Another outcome from our research was the analysis of Caltrans' work procedures. Our findings of the analysis were presented in section 3. The delay in publishing of the TCRs was the result of several problems. How these problems can be corrected require further deliberation at Caltrans and from a scientific point of view.

7. Appendices

7.1 Regional transportation planning in Los Angeles

Regional transportation planning for Los Angeles County is the responsibility of Caltrans district 7, Southern California Association of Government (SCAG) and Los Angeles Country Metropolitan Transportation Authority (LACMTA). SCAG is the agency responsible for modeling activities for the southern California region. Caltrans and LACMTA cooperate with SCAG in establishing the model and use it per their requirements with relevant modifications.

7.1.1 Southern California Association of Governments (SCAG)

SCAG functions as the Metropolitan Planning Organization (MPO) for six counties: Los Angeles, Orange, San Bernardino, Riverside, Ventura and Imperial. The region is inhabited by over 15 million people and extends to an area of more than 38,000 square miles. One of the main tasks of SCAG is to maintain a continuous, comprehensive, and coordinated planning process resulting in a Regional Transportation Plan (RTP) and a Regional Transportation Improvement Program (RTIP).

At SCAG, the Data & Monitoring division develops and maintains the transportation and air quality data. Computer models are the responsibility of SCAG's modeling and GIS division. The SCAG models have been developed and applied over the last three decades to forecast travel demand necessary for planning activities such as the RTP, Air Quality Management Plan, and the Regional Transportation Improvement Program RTIP. The transportation model is the four steps travel demand forecast model. SCAG uses Direct Travel Impact Model (DTIM), developed by Caltrans to estimate source emissions. The model results are provided to South Coast Air Quality Management District (SCAQMD) for inclusion in their own air quality model.

7.1.2 Caltrans District 7

Caltrans is responsible for the design, construction, maintenance, and operation of the California State highway system, as well as that portion of the Interstate Highway System within the state's boundaries. Caltrans District 7 is the local office for the Los Angeles and Ventura Counties. The office of regional planning at Caltrans District 7 uses a travel demand model to offer technical assistance to the creation of Transportation Concept Reports (TCR), a Caltrans internal planning document that describes the department's basic approach to the development of a given route.

7.1.3 Los Angeles Country Metropolitan Transportation Authority (LACMTA)

Los Angeles Country Metropolitan Transportation Authority manages 100% of federal and 75% of state transportation funding. Besides operating over 2,000 peak-hour buses on an average weekday as well as building and operating 73.1 miles of Metro Rail service, LACMTA funds a wide array of transportation projects including bikeways and pedestrian facilities, improvements of local roads and highways, movements of goods, Metrolink, and the popular Freeway Service Patrol and Call Boxes.

The LACMTA travel demand model of is developed by its office of Systems Analysis and Research. The model focuses on the area of Los Angeles County, which is the most populous county among the six counties comprising SCAG. More than 9 million people - one-third of California's residents - live, work, and play within its 1,433-square-mile service area.

7.1.4 Collaboration between Caltrans, LACMTA and SCAG

The current SCAG travel demand model has three main layers: Transportation Analysis Zones (TAZ) layer, the Highway layer and the Transit layer. The TAZ layer of the six counties is created, maintained and updated by SCAG. The transit layer is developed by the Metropolitan Transportation Authorities of each of the six counties. The highway layer is created using a geographic information system (GIS) layer from Thomas Brothers Maps Inc. SCAG makes revisions on this layer to incorporate planned facilities. Commercially available transportation planning packages are used in development of these GIS layers.

The modeling group at Caltrans district 7 uses the SCAG highway network and TAZs of Los Angeles and Ventura Counties. To prepare the TCRs for each of the 44 routes, the travel demand model is run for the four alternatives for each route. Using the 44 TCRs as reference, Caltrans district 7 proposes relevant projects to LACMTA for its consideration.

LACMTA develops its own travel demand model. For the region within Los Angeles county LACMTA uses smaller TAZs and more detailed data to improve forecasting accuracy. For modeling the region outside Los Angeles county LACMTA uses the same TAZs as SCAG. As the operator of public transit in Los Angeles County, LACMTA develops the Los Angeles transit layer both for its own model and as an input to the SCAG transit layer. LACMTA uses the model to evaluate the highway projects proposed by Caltrans District 7, combined with some other transportation projects in Los Angeles. Model output aids the LACMTA prioritization of projects. These are then submitted to SCAG as the candidate projects for Regional Transportation Report (RTP).

The Metropolitan Transportation Authorities of all the six counties submit a list of projects in their respective counties. All of these projects compete for being included in the RTP. SCAG incorporates these proposals to its SCAG Travel Demand Model which includes other proposed projects which are of regional significance.

SCAG also uses Direct Travel Impact Model (DTIM), which is developed by Caltrans, to estimate source emissions. The model results are provided to South Coast Air Quality Management District (SCAQMD) for inclusion in their own air quality model. The SCAG Travel Demand Model and Direct Travel Impact Model are run at different scenarios to determine what combination of proposals, minimize the congestion and pollution effects. These proposals are included in the RTP and become eligible for federal and state transportation funding. Inclusion in RTP does not guarantee funding.

Based on the RTP, SCAG develops a RTIP. Proposals that are included in the RTIP are queued for funding. However, due to fiscal constraints, not all projects in the RTIP receive immediate funding and thus a current RTIP includes projects from prior years' RTIP which are yet to be funded. Figure 13 represents the modeling process across the three agencies.

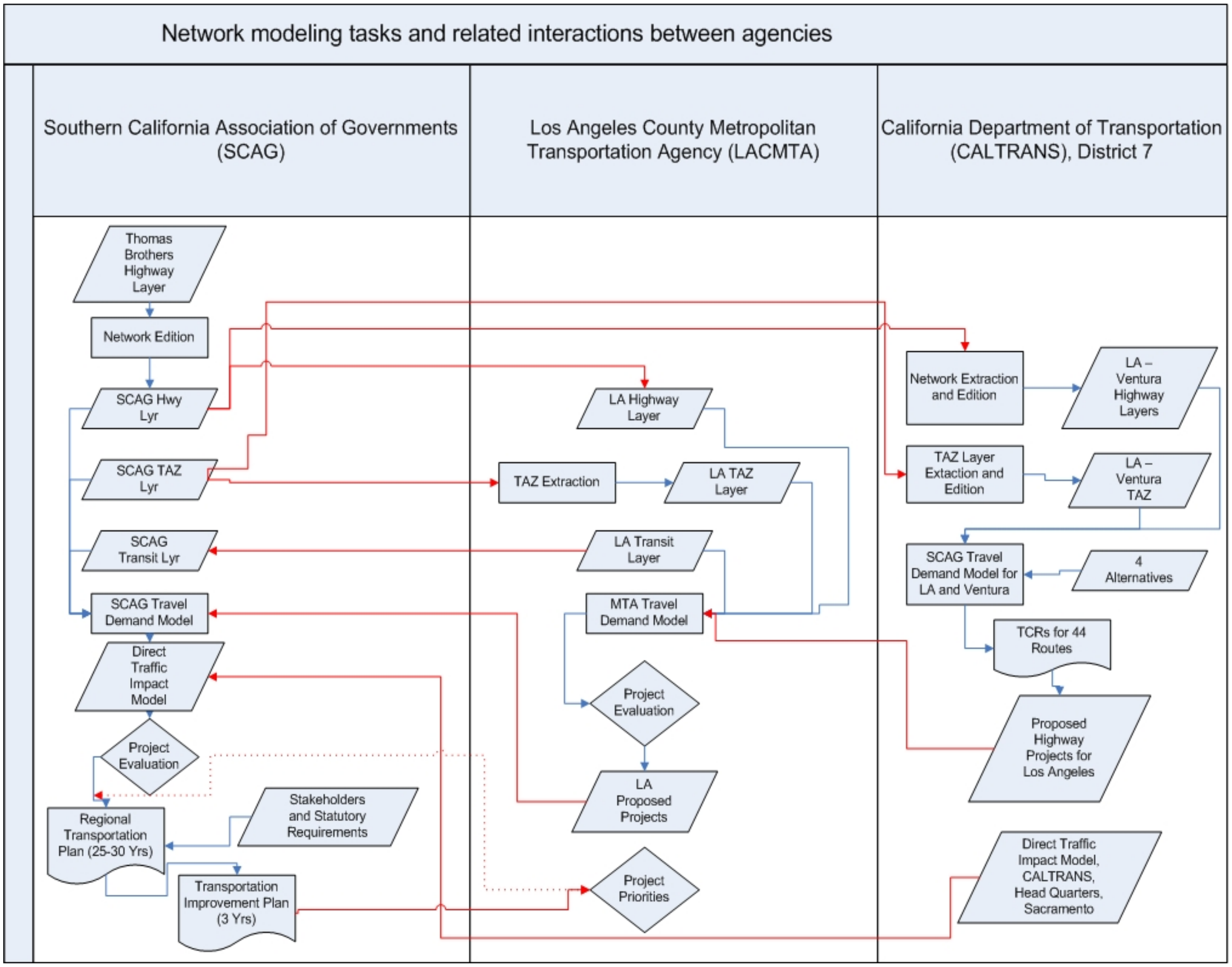


Figure 13: Regional transportation planning activities among Caltrans, LACMTA and SCAG

7.2 Computer code for the algorithm that creates the correspondence file

```
#include<fstream.h>
#include<iostream.h>
#include<cmath>
#include<stdio.h>
using namespace std;
long chtoint(int,char[10]);
int main()
{

 long matrix[70000][2];
 char a[10],b[10]; // the 3 fields
 int flag=1;
 // char seg[10];
 long A,B,A1,Seg;
 int multi[5];
 flag=0;
 char re1;
 long matrix1[200][3];
 ifstream in("abnode.txt");   // open the file.. change the file name

do
 {
  in>>a>>b;   // retrieve the 3 nos.
  matrix[flag][1]=chtoint(4,a);matrix[flag][2]=chtoint(4,b);
  flag++;
 }
 while(!in.eof());
 in.close();
 int x = flag;
 cout <<"\n its here.."<<endl; getchar();
 flag=1;
 ifstream din("segid.txt");   // open the file.. change the file name

 do
 {
  din>>seg>>a>>b;   // retrieve the 3 nos.

 matrix1[flag][1]=chtoint(9,seg);matrix1[flag][2]=chtoint(4,a);matrix1[flag][3]=chtoint(4,b);
 flag++;
 }
 while(!din.eof());
 din.close();
int x1;
x1=flag;
```

```
ofstream outfile("seg.txt",ios::app );

for(int w=1;w<flag+1;w++)
{
Seg=matrix1[w][1];
cout<< "Seg:" << Seg <<endl;getchar();                    33
A=matrix1[w][2];
B=matrix1[w][3];
 //char resp ='y';
//do
  //{
    //cout<< " Enter the value of A:";
    //cin>>A;
    //cout <<" Enter the value of B:";
    //cin >>B;
    //cout << " Enter Segment ID:";
    //cin>>Seg;
 do
 {
  flag=0;
  for(int i3=1;i3< x+1;i3++)                // a sequential search
  {
   if (A==matrix[i3][1])
   {
    flag++;multi[flag]=i3;
}
}


  if(flag>=1)
    {
   if(flag==1)
   {                            // UNIQUE CASE
     outfile << A <<'\t'<<matrix[multi[flag]][2]<<'\t'<<Seg<<'\n';
A=matrix[multi[flag]][2];
   }
   if(flag>1)
   {
    for(int j3=1;j3<=flag;j3++)
    {
      cout<<matrix[multi[j3]][1]<<'\t'<<matrix[multi[j3]][2]<<endl;
      cout <<multi[j3]<<endl;
      cout << "is this the correct value of B? (y/n)" << endl;
      cin >> re1;cout << endl;
      cout << re1 << endl;
      if (re1 == 'y')
            {
             A1 = matrix[multi[j3]][2];
             outfile << A << '\t' << A1 << '\t' << Seg << '\n';
```

```
            A=A1;
            A1=0;
            j3=flag+1;
           }
    }
   }                                                    34
    }
  if(flag<1){cout << "A node doesnt exist"<<A<<endl;A=B;}
 }
 while(A!=B);
 //cout << "/n Another segment?(y/n)";
 //cin >> resp;
 //}
 //while (resp =='y');
cout <<"\n process complete press a key to end:" <<endl;
getchar();
return 0;
}

long chtoint(int i1,char a1[10])
{

  long c=0,p=0,d=0;
  for (int i = i1;i>=0;i--)
    {
      if(a1[i]<48 || a1[i]>57)
         d++;
    }
  //cout <<"d :" << d << endl;
  for(int j1 =i1 -d;j1>=0;j1--)
    {
      c=a1[j1]-48;
    //  cout << "c: " << c << endl;
      p=p+static_cast<long>(c*pow(10,((i1 - d)-j1)));
    }
  //cout << "p: " << p << endl;
  return p;
}
```

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