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Introduction

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Project Background

- Kaiser uses ArclInfo Network Analysis to evaluate member access to clinical services, and to optimize the location of new facilities.
- Network analyses at Kaiser were being done using impedances developed from 1997 Caltrans floating-car rush travel time reports.
- Travel times had changed substantially over 8 years, and new roads had been built.
- Kaiser needed to update its road data, and engaged Baker as partner in the development of a new California Road Network.
**Project Overview**

- **Project Goals**
  - Update Road Network Geometry
  - Gather Real-Time Speed Data
  - Develop Drive Time Data Models
Network Geometry

- Network Geometry Update
  - Old ETAK Geometry outdated
  - Purchase Up-to-Date TeleAtlas Geometry

- Network Attribution
  - Expanded road classifications
  - Assigned Speed Limit Values
Real Time Speed Data

- Availability of Sensor Data
  - Public systems
    - PeMS
  - Commercial Data
    - SpeedInfo
Real Time Speed Data

• Sensor Data Processing
  - Data Collection Period
    • Synchronizing available data sets to 3 month period
  - Time of Day Driving Variability
    • Rush Peak times : 7-9 AM / 4-6 PM
    • Mid Day : 10AM to 2PM
    • Off Peak : 8 PM to 5 AM
Real Time Speed Data

- Geo-Coding Sensor Locations

- Linear Sensor Expansion
Derived Drive Time Data

• Previous Kaiser Speed Estimation Model

Speed Limit (45 mph) X Stop Factor (0.7) = Normal Speed (31 mph)

Speed Limit (45 mph) X Stop Factor (0.70) X Rush Factor (0.70) = Rush Speed (22 mph)

Segment Length = .5 mi.

Drive Time in Minutes = Segment Length (.5) / Speed X 60

Normal Drive Time = 1.15 minutes
Rush Drive Time = 1.28 minutes
• Improved Speed Estimation Model
  – Urban Density Classification – Used to create travel times dependent upon both road class and population density
  – Freeway Speed Model - Based on real time speed data
  – Major Road Speed Model - Developed from data gathered in the Road Field Study

• Speed Modeling Factors
  • Speed Limit
  • Time of Day
  • Urban Rural Density
  • Stop Resistance
  • Special considerations
Urban Rural Density Class

- Developed from census data and polygon geometry (populated places, block groups)
- Places were classified into 6 groups based on population density per square mile:

<table>
<thead>
<tr>
<th>Class</th>
<th>Population per sq mi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense Urban</td>
<td>&gt; 15,000 (San Francisco)</td>
</tr>
<tr>
<td>Urban</td>
<td>8,000 to 15,000 (Oakland)</td>
</tr>
<tr>
<td>Dense Suburban</td>
<td>4,500 to 8,000 (Fremont)</td>
</tr>
<tr>
<td>Suburban</td>
<td>2,000 to 4,500 (Livermore)</td>
</tr>
<tr>
<td>Small Town</td>
<td>&lt; 2,000 (Sunol)</td>
</tr>
<tr>
<td>Rural</td>
<td>Outside populated place boundaries</td>
</tr>
</tbody>
</table>
Urban Rural Density Class

Bay Area Urban Rural Density Areas

Urban Rural Density
- Dense Urban
- Urban
- Dense Suburban
- Suburban
- Small City
- Rural

5 0 5 10 Miles

Mapping To Manage™
• Real time speeds were applied to the network for roads with sensors.
• A speed model was developed for freeways without sensors:

  \[ \text{Speed} = \text{Speed Limit} \times \text{Time of Day Factor (density specific)} \]

• A speed limit of 65 MPH was assumed (with a few exceptions)
• Factors for Caltrans District 8 (Los Angeles) were somewhat different from other areas of California
Major Road Study

- Major Road Study – Provided empirical data for developing the major road speed model:

  \[
  \text{Speed} = \text{Density Specific} \times (\text{Speed Limit} \times \text{Stop Factor} \times \text{Time of Day Factor})
  \]

- Data collection method:
  - Data gathered by road segment
  - Type of road (divided or unseparated)
  - Urban rural density of road
  - Segment Speed Limit
  - Road segment distance
  - Road segment travel time
Bay Area and Southern California area routes were mapped
- Each route was about 175 miles
- Routes sampled a cross-section of density areas and road types

Sample Study Data

<table>
<thead>
<tr>
<th>Route Directions</th>
<th>Road</th>
<th>Rd Type</th>
<th>Density</th>
<th>Dist</th>
<th>Travel Time</th>
<th>Speed Limit</th>
<th>Actual Speed</th>
<th>Speed Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn right on</td>
<td>Victory Pl</td>
<td>Unseparated</td>
<td>Dense Suburb</td>
<td>2.3</td>
<td>7.43</td>
<td>35</td>
<td>19</td>
<td>0.53</td>
</tr>
<tr>
<td>Turn right on</td>
<td>Glenoaks Blvd</td>
<td>Divided</td>
<td>Urban</td>
<td>3.5</td>
<td>9.67</td>
<td>38</td>
<td>22</td>
<td>0.57</td>
</tr>
<tr>
<td>Turn left on</td>
<td>Colorado St</td>
<td>Unseparated</td>
<td>Urban</td>
<td>1.7</td>
<td>7.03</td>
<td>35</td>
<td>15</td>
<td>0.41</td>
</tr>
<tr>
<td>Continue straight on</td>
<td>Colorado Blvd</td>
<td>Divided</td>
<td>Urban</td>
<td>1.3</td>
<td>3.23</td>
<td>35</td>
<td>24</td>
<td>0.69</td>
</tr>
<tr>
<td>Bear left on</td>
<td>La Loma Rd (becomes Colorado)</td>
<td>Unseparated</td>
<td>Dense Suburb</td>
<td>2.6</td>
<td>7.55</td>
<td>32</td>
<td>21</td>
<td>0.65</td>
</tr>
<tr>
<td>Turn right on</td>
<td>Colorado Blvd</td>
<td>Unseparated</td>
<td>Dense Suburb</td>
<td>5.2</td>
<td>12.03</td>
<td>34</td>
<td>26</td>
<td>0.75</td>
</tr>
<tr>
<td>Turn left on</td>
<td>Huntington Dr (becomes Foothill)</td>
<td>Divided</td>
<td>Dense Suburb</td>
<td>8.1</td>
<td>18.75</td>
<td>37</td>
<td>26</td>
<td>0.70</td>
</tr>
<tr>
<td>Bear right on</td>
<td>Alosta Ave (becomes Route 66)</td>
<td>Divided</td>
<td>Suburb</td>
<td>3.9</td>
<td>10.68</td>
<td>43</td>
<td>22</td>
<td>0.51</td>
</tr>
<tr>
<td>Turn right on</td>
<td>Lone Hill Ave</td>
<td>Divided</td>
<td>Suburb</td>
<td>1.6</td>
<td>4.85</td>
<td>40</td>
<td>20</td>
<td>0.49</td>
</tr>
<tr>
<td>Turn left on</td>
<td>Arrow Hwy</td>
<td>Divided</td>
<td>Suburb</td>
<td>3.8</td>
<td>8.53</td>
<td>43</td>
<td>27</td>
<td>0.62</td>
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<tr>
<td>Turn right on</td>
<td>White Ave</td>
<td>Divided</td>
<td>Dense Suburb</td>
<td>1.2</td>
<td>1.67</td>
<td>45</td>
<td>43</td>
<td>0.96</td>
</tr>
<tr>
<td>Bear left on</td>
<td>McKinley Ave</td>
<td>Unseparated</td>
<td>Dense Suburb</td>
<td>1.1</td>
<td>3.27</td>
<td>35</td>
<td>20</td>
<td>0.58</td>
</tr>
</tbody>
</table>
Major Road Study
# Speed Model Factors

## Speed Limits

**A10 HIGHWAY SPEEDS**

65 MPH except for 70 MPH for roads specified by CalTrans

## A20 ROAD SPEEDS

<table>
<thead>
<tr>
<th>Road Type</th>
<th>KP_UCC DENSITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divided</td>
<td>30 35 40 45 45 50</td>
</tr>
<tr>
<td>Unseparated</td>
<td>30 35 35 40 45 50</td>
</tr>
</tbody>
</table>

## A30 MAJOR ROAD SPEEDS - FROM MAJOR ROADS STUDY

<table>
<thead>
<tr>
<th>Road Type</th>
<th>KP_UCC DENSITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divided</td>
<td>30 35 40 45 45 50</td>
</tr>
<tr>
<td>Unseparated</td>
<td>30 35 35 40 45 50</td>
</tr>
</tbody>
</table>

## A40 LOCAL ROAD SPEEDS

<table>
<thead>
<tr>
<th>Road Type</th>
<th>KP_UCC DENSITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divided</td>
<td>25 25 25 25 25 35</td>
</tr>
<tr>
<td>Unseparated</td>
<td>25 25 25 25 25 35</td>
</tr>
</tbody>
</table>

## Stop Factors

### A10 HIGHWAY STOP FACTOR

No stop resistance

### A20 and A30 MAJOR ROAD STOP FACTORS

<table>
<thead>
<tr>
<th>KP_UCC DENSITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>0.55 0.60 0.65 0.70 0.80 0.90</td>
</tr>
</tbody>
</table>

### A40 LOCAL ROAD STOP FACTORS

Use same factors as for major roads.

<table>
<thead>
<tr>
<th>KP_UCC DENSITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>0.55 0.60 0.65 0.70 0.80 0.90</td>
</tr>
</tbody>
</table>
# Speed Model Factors

## Time of Day Factors

### A10 Highway Rush and Mid-Day Factors

#### Rush Factors

<table>
<thead>
<tr>
<th>District</th>
<th>District Name</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>LA</td>
<td>0.65</td>
<td>0.75</td>
<td>0.80</td>
<td>0.85</td>
<td>0.85</td>
<td>0.95</td>
</tr>
<tr>
<td>NOT LA</td>
<td>NOT LA</td>
<td>0.80</td>
<td>0.80</td>
<td>0.85</td>
<td>0.85</td>
<td>0.90</td>
<td>0.95</td>
</tr>
</tbody>
</table>

#### Mid-Day Factors

<table>
<thead>
<tr>
<th>District</th>
<th>District Name</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>LA</td>
<td>0.90</td>
<td>0.90</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
</tr>
<tr>
<td>NOT LA</td>
<td>NOT LA</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

### A30 and A20 Major Roads Rush and Mid-Day Factors

#### Rush Factors

<table>
<thead>
<tr>
<th>District</th>
<th>District Name</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>ALL</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.95</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

#### Mid-Day Factors

<table>
<thead>
<tr>
<th>District</th>
<th>District Name</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>ALL</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

### A40 Local Road Rush and Mid-Day Factors

No Time of Day Difference
Special Considerations

- **70 MPH Highways**
  - Listed on Caltrans website

- **Bay Area Bridges**
  - Not in “populated places”
  - Used Dense Urban factors - assuming maximum time of day differences

- **I-205 through Tracy**
  - Specific information about the impact of major road work was incorporated
Database Model Integration
Questions

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Oakland