Validation of a Taxi-FCD System by GPS-Testdrives

Elmar Brockfeld, Alexander Sohr and Rüdiger Ebendt
Institute of Transportation Systems, German Aerospace Center (DLR), Berlin

17th ITS World Congress, Busan, Korea, October 2010
FCD – System architecture

Taxi headquarter
Disposition system

digital radio
oder GPRS

FCD-Server
Data processing

Service Provider
Data usage

GPRS, SMS,
RDS-TMC, HTTP

Service Provider
Data usage

Service Provider
Data usage

Service Provider
Data usage
FCD - Database German Aerospace Center

Key figures
- > 10,000 probe vehicles
- Real-time system
- huge raw database since April 2001 (billions of position data)

Key cities with Taxi-FCD system:
- Hamburg: 1700 Taxis
- Berlin: 4300 Taxis
- Brunswick: 160 Taxis
- Nuremberg: 500 Taxis
- Munich: 2700 Taxis
- Stuttgart: 700 Taxis
- Vienna (A): 600 Taxis
- Amsterdam (NL): 700 Taxis
- Copenhagen (DK): 700 Taxis
- Cologne (in planning): 1200 Taxis
- Bonn (in planning): 360 Taxis
Taxi-FCD System – Berlin

- 4300 Taxis (~2500 on the road)
- 30~60s delivering interval
- Continuous generation of a traffic-state map and travel-time information on selected arterial routes
Validation campaign Berlin

- GPS - Testdrives on 3 arterial roads (both directions) of about 12 - 14 km length
- 17th-21th May (5 days), 5am-9pm (16h)
- 2 cars with 1s delivering interval

<table>
<thead>
<tr>
<th>Day</th>
<th>Vehicle-nr</th>
<th>Route-ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Veh 1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Veh 2</td>
<td>1</td>
</tr>
<tr>
<td>Tuesday</td>
<td>Veh 1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Veh 2</td>
<td>1</td>
</tr>
<tr>
<td>Wednesday</td>
<td>Veh 1, Veh 2</td>
<td>3</td>
</tr>
<tr>
<td>Thursday</td>
<td>Veh 1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Veh 2</td>
<td>1</td>
</tr>
<tr>
<td>Friday</td>
<td>Veh 1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Veh 2</td>
<td>1</td>
</tr>
</tbody>
</table>
Results

1. 67 + 63 traces (towards and from city center)
2. 57 + 56 traces (towards and from city center)
3. 34 + 32 traces (towards and from city center)

- In total 309 traces

- Comparing travel times of the test drives with travel time data only of the most current taxi data at the same day

- no “historical” data (days before or same weekdays before) is used
Results – Comparing travel times on Route 1

Route 1 Landsberger Allee - 2010-05-17 - 11.92 km

- In general good match
- Towards center: 19 traces, morning peak from test drives higher
- From center: 19 traces, outlyer at 4 P.M.
Results – Comparing travel times on Route 2

Route 2 Frankfurter Allee - 2010-05-20 - 14.59 km

- In general good match
- Towards center: 18 traces, morning peak from test drives a bit higher
- From center: 17 traces, outlyer at 4 P.M.

Graph showing travel times vs. time of day for Taxi-FCD to/from center and test vehicles to/from center.
Results – Comparing travel times on Route 3

Route 3 Tempelhofer Damm - 2010-05-19 - 11.85 km

- In general good match
- Towards center: 36 traces, morning peak from test drives much higher
- From center: 36 traces, very good match

In general good match
Towards center: 36 traces, morning peak from test drives much higher
From center: 36 traces, very good match
Results – Comparing travel times – Overall Errors

Calculation of the **symmetric mean absolute percentage error** all 309 traces (comparing 15-min intervals)

\[
SMAPE = \frac{1}{N} \sum_{i=1}^{N} \frac{|tt(\text{TEST})_i - tt(\text{FCD})_i|}{(tt(\text{TEST})_i + tt(\text{FCD})_i)/2}
\]

<table>
<thead>
<tr>
<th>ROUTE</th>
<th>SMAPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1 Landsberger Allee to center</td>
<td>11.19 %</td>
</tr>
<tr>
<td>1-2 Landsberger Allee from center</td>
<td>14.38 %</td>
</tr>
<tr>
<td>2-1 Frankfurter Allee to center</td>
<td>7.19 %</td>
</tr>
<tr>
<td>2-2 Frankfurter Allee from center</td>
<td>10.34 %</td>
</tr>
<tr>
<td>3-1 Tempelhofer Damm to center</td>
<td>12.71 %</td>
</tr>
<tr>
<td>3-2 Tempelhofer Damm from center</td>
<td>10.48 %</td>
</tr>
</tbody>
</table>
Results 2 – Comparison of complete traces on Route

- Measuring the „system immanent“ variation of travel times of single vehicle
- Division of Route 3 into six route parts
- Comparison of the test drives with taxis which drove the same complete route parts at the same time
- Detail analysis for one 1.7 km route part
Results 2 – Comparison of complete traces on Route part 3-2

79 % of test vehicles within standard deviation of single taxi drives

15.8 % is the system immanent variation range over all route parts of route 3
Summary & Conclusion

- DLR – FCD system delivers quite good results with errors in travel times of about 11%
- Peak periods are sometimes not that accurate

Future research:
- Supplementation of current taxi data with “historical” data (same weekdays, same daytimes) for badly covered route parts
- More comprehensive comparison of test traces with complete taxi traces
- Deriving quality information by analyzing how many taxi data are available for which time of day
Thank you for your attention!

Contact information:
Alexander Sohr
DLR - Institute of Transportation Systems
Rutherfordstr. 2
12489 Berlin – Germany
alexander.sohr@dlr.de