The Practical Side of Cell Phones as Traffic Probes

The information contained in this document is considered proprietary, and may not be reproduced or redistributed without the consent of Delcan Inc.
Cell Probe Technology

- Part of general trend away from fixed sensors toward vehicle-based information
- Reflects frustration with high costs and slow pace of deployment for traditional sensors
- More than just ITS - a broad management and planning tool (see NCHRP report)
- Characteristics:
  - Low cost
  - Full regional coverage
  - Performance-based, and
  - Self sufficient business model
Cell Probe Technology

- Practical success requires more than cell phones
- Cell phone movement based on cell location and “hand-offs” from one cell to another
- Pattern recognition techniques filter out data from those not on the highway
- Then traffic algorithms generate travel times and speeds on roadway links
- Cell phones need to be turned on, but not necessarily in use
- Full regional systems in place in Baltimore, Antwerp, and Tel Aviv = 4,600 miles
Cell Probe Technology

Cell

Direction of travel

Sample Observer

GSM
Cell Probe Privacy

Cellular network operator

Personal cellular position data

Estimotion sample observer

Estimotion traffic situation

Speeds on road links

ITIS

ITIS publishing systems

Firewall
Path-Finding Drive Tests

(a) 
(b) 
(c) 
(d)
Baltimore MMTIS

- Provides first regional deployment of commercial-quality cellular traffic probes in North America
- Mutually profitable public-private partnership
  - Test commercial markets during project
  - Integrate with existing public data – including transit and E-911
  - Encourage public applications beyond traditional ITS
- Contract signed September 2004; data flow to Maryland DOT began April 2005
Baltimore MMTIS – Private Firms

- Delcan-NET
  - Transportation and technology consultants
  - Fifty plus years in business
  - Profitable every year; staff = 500 plus

- ITIS Holdings
  - Leader in traffic probes; staff = 100
  - Commercial customers – 16 automobile firms, for-profit 511
  - Profitable!
  - Publicly traded on London exchange

- National cellular firms
MARYLAND DOT CAMERAS SHOW ACCURACY OF TRAFFIC INFORMATION BEING CAPTURED USING CELL PROBES

I-695 at HARTFORD ROAD
Monday, June 6th 2005
9:02:18 am
CELL PROBES ACCURATELY UPDATE TRAFFIC CONDITIONS AS CHANGES OCCUR
Travel time residuals relative to floating car data (n=21)

- Loop detectors
- Cellular

Produced by Dr Hillel Bar Gerd, Associate Professor, Ben Gurion Negev University, Israel
Baltimore Comparison with RTMS Data
Analysis Route Overview
This slide gives an overview of the Baltimore ring, and the north-western part which was analysed for this presentation.

a1

alon, 8/19/2005
Baltimore I-695 Weekday Patterns
Baltimore I-695 Saturday Patterns
Travel time comparisons over a common road section
Road section of 1.225 miles on I-695 Baltimore Beltway - junction 22 to 23

04th July public holiday profile - no congestion throughout the day
11th July normal Monday congestion profile - increased travel times at peak times
Travel time comparisons over a common road section
I-695 Baltimore Beltway - junction 22 to 23

04th July public holiday profile - no congestion throughout the day
11th July normal Monday congestion profile - increased travel times at peak
Travel time comparisons on section of the I-695 Baltimore Beltway between junction 22 and junction 23

10th Jun - displays typical Friday peak hour congestion periods
1st Jul - Friday before 4th July holiday displays unusual traffic patterns - no morning peak and several smaller peaks in the afternoon
Beyond Baltimore

- Delcan-NET/ITIS selected to negotiate with Missouri DOT
  - Statewide system -- 5,500 miles
    - St. Louis, Kansas City, all Interstates plus important rural roads
    - Completion within six months
    - Emphasis on performance measures and operations
- Conversations with other DOTS
Possible Applications

- Travel Times
  - For message signs; web sites
- Performance measures
  - Include arterial network
  - “Top 10” routes
  - TTI-type reports
- Operations planning
  - Special events
  - Work zone management
  - Evaluation of actions
- Safety
  - Focus on problem areas and assessments
- Port/intermodal access
- Local/regional web sites
- Statewide coverage
Applications

- General Planning and Management
  - Regional congestion management
  - Archived data supports system analysis, "average day" information, long-range planning
  - Integrated regional or corridor management
  - Plan for “extreme” or special events
  - Homeland security applications – no-notice evacuations
  - Rapid evaluation of alternatives
  - Work zone management
  - Rural planning and operations
  - Traffic volume estimates -- future
Applications (2)

- Performance Measurement
  - System performance in near real time
  - Reliability measures – critical from user’s perspective (travel time index, planning time index, etc.)
  - Performance-based systems – information for operators, users, and the public
  - Congestion management – support for HOT lanes and other finance alternatives
  - Economic value from partnerships with business – the DOT a part of just in time delivery
Applications (3)

- Travel Demand and Air Quality Modeling
  - Today – Validate travel demand and Mobile6 models
  - Tomorrow – origin/destination data
  - Tomorrow – New model development: activity-based and beyond

- Safety
  - Analysis and prediction
  - Targeted deployment of safety personnel

- Communication
  - Public participation – real data on congestion
  - Near real-time data – web, PDA, 511
  - Premium 511 service
Applications (4)

- **Freight Operations**
  - Web- or cell-based distribution of roadway information
  - Individual dynamic routing recommendations based on congestion
  - Travel time prediction to improve asset utilization

- **Freight Analytics**
  - Strategic analysis of freight movement for congestion mitigation
  - Origin/destination data to examine flows and set priorities
  - Support for cost/benefit and alternatives analysis
Appendix

- Safety application
- Some validation results
Safety Example

- Operational tool
  - Assign patrol cars to road segments based on:
    - Average speed – $Z$ percent above speed limit
    - Trigger points – $X$ percent of traffic more than $Y$ percent above speed limit
  - Identify trends and historical patterns
  - Short-term forecasts

- Evaluation tool – near real-time
  - Assess what worked and how well
  - Statistical analysis of patterns
Safety Example

Road # 5

Speed Limit

Km/h

Hours

0 5 10 15 20 25

0 20 40 60 80 100 120

5290 4920 4918

---

Telt Aviv-Yaffo
Distribution of Speeds

Speeds on 4918 Section

- Blue line: Average speed <= 50%
- Yellow line: 30%
- Pink line: 15%
- Light blue line: 5%

Km/h

Hours

0 5 10 15 20 25

Speed Limit
Validation results

- Tel Aviv system – Dr. Hillel Bar Gerd, Associate Professor, Ben Gurion University

“The main conclusion of this experiment is that in most cases all three methods (floating vehicle, loop detectors, and the cellular system) provide very similar travel time estimates. In that respect, the cellular system is a reliable method for travel time measurements, suitable for many practical applications.”
Correlation in travel time measurements (n=25)

- Loop detectors
- Cellular

Produced by Dr. Hillel Bar-Gerd, Associate Professor, Ben Guion Negev University, Israel
## Comparison to GPS

<table>
<thead>
<tr>
<th></th>
<th>CFVD™</th>
<th>Loop detectors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bias</strong></td>
<td>0.49 min</td>
<td>0.90 min</td>
</tr>
<tr>
<td><strong>RMS</strong></td>
<td>1.25 min</td>
<td>1.13 min</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>1.34 min</td>
<td>1.44 min</td>
</tr>
<tr>
<td><strong>SQRT(Bias²+RMS²)</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Produced by Dr. Hillel Bar Gerd, Associate Professor, Ben Guion Negev University, Israel