The Practical Side of Cell Phones as Traffic Probes

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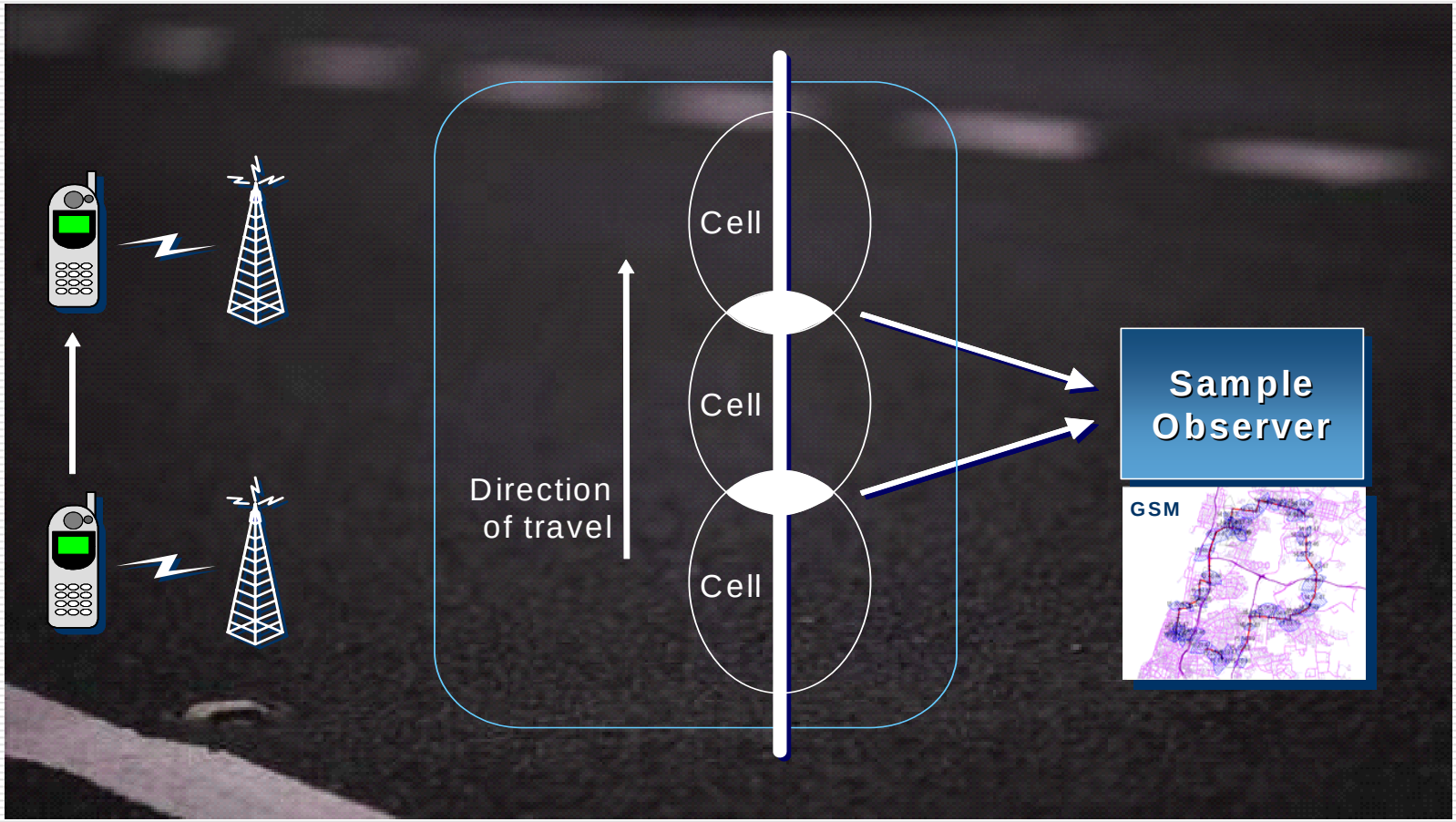
Cell Probe Technology

- 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

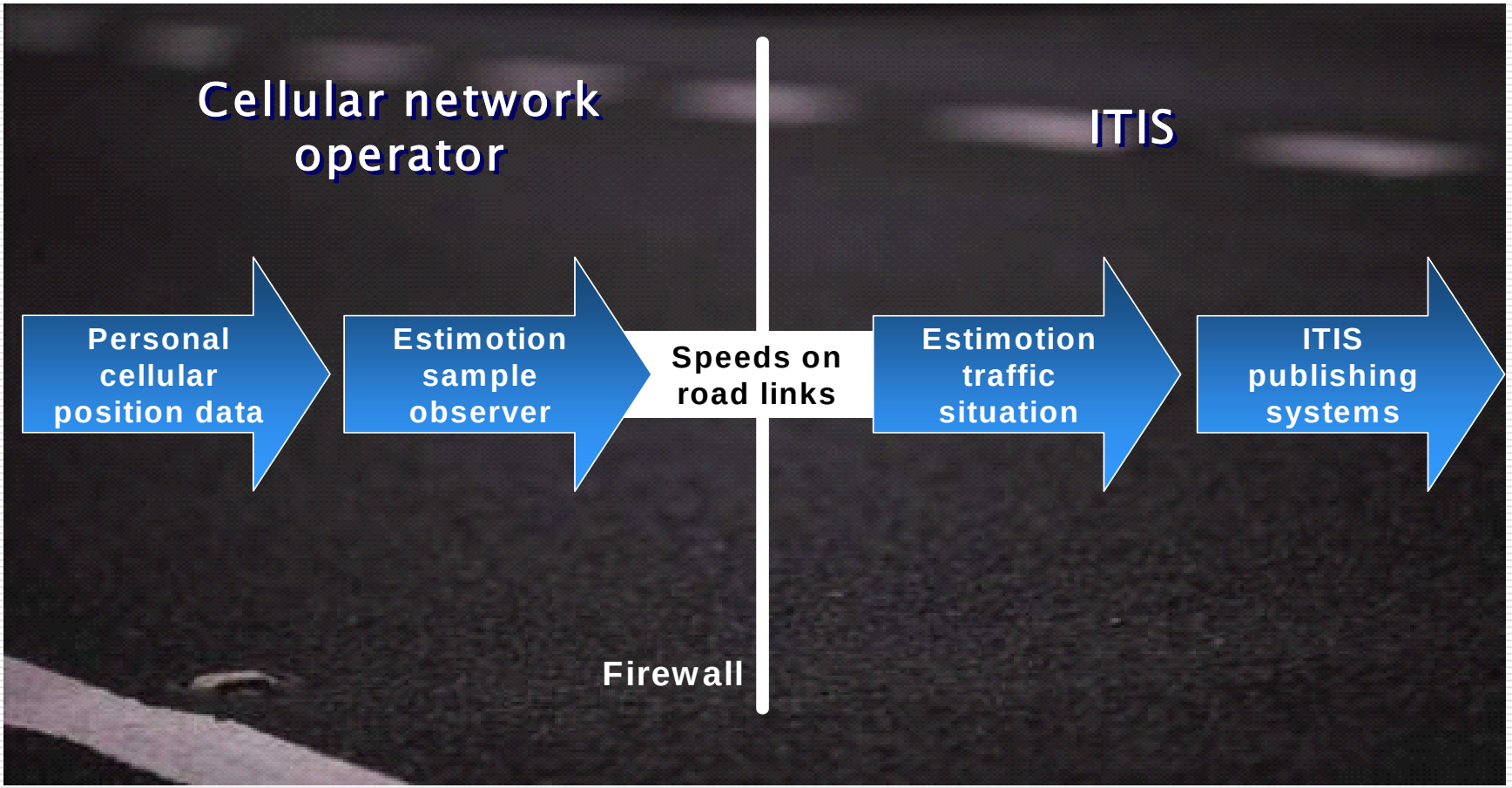
Cell Probe Technology

- 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 Probe Privacy



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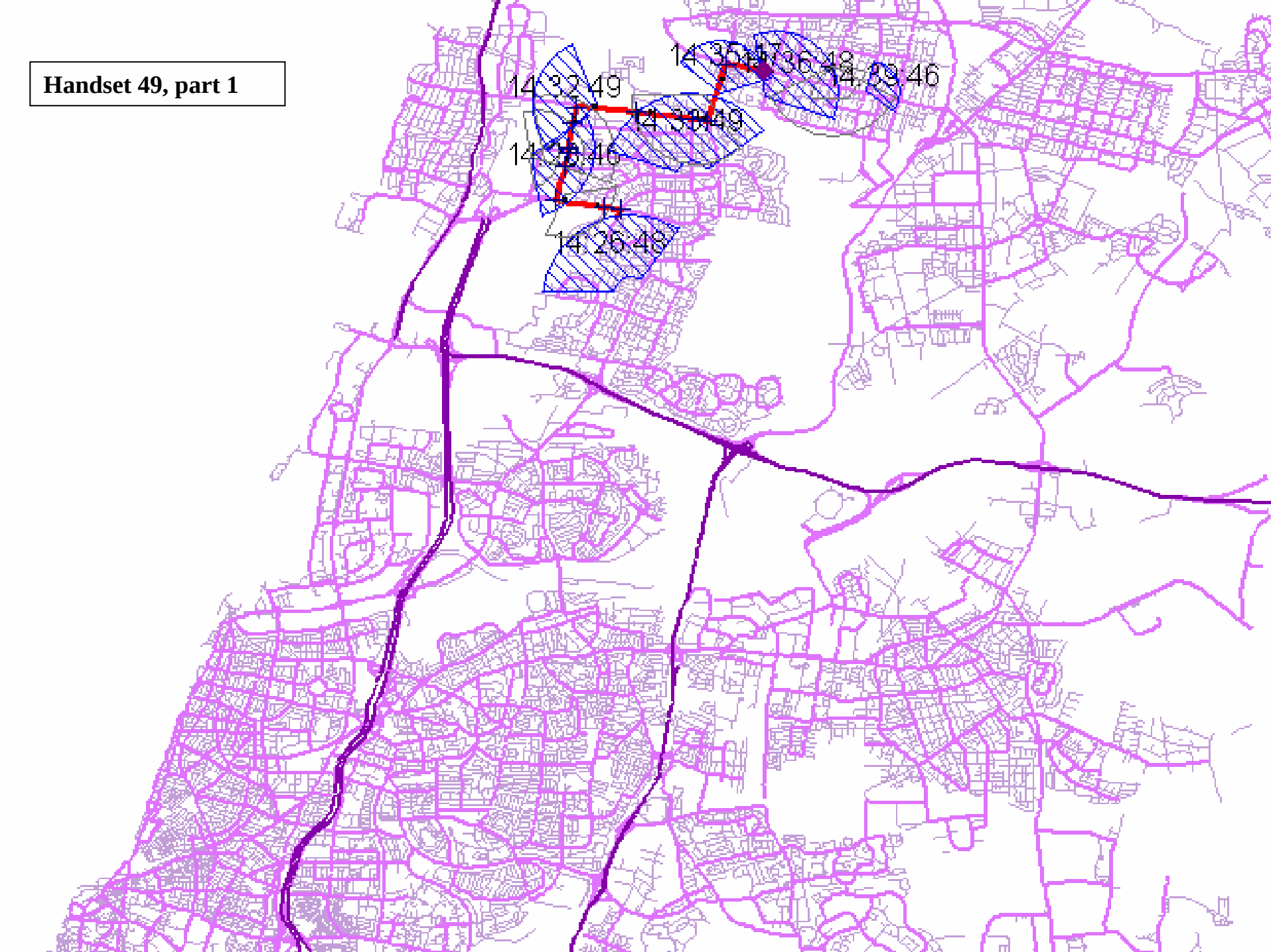
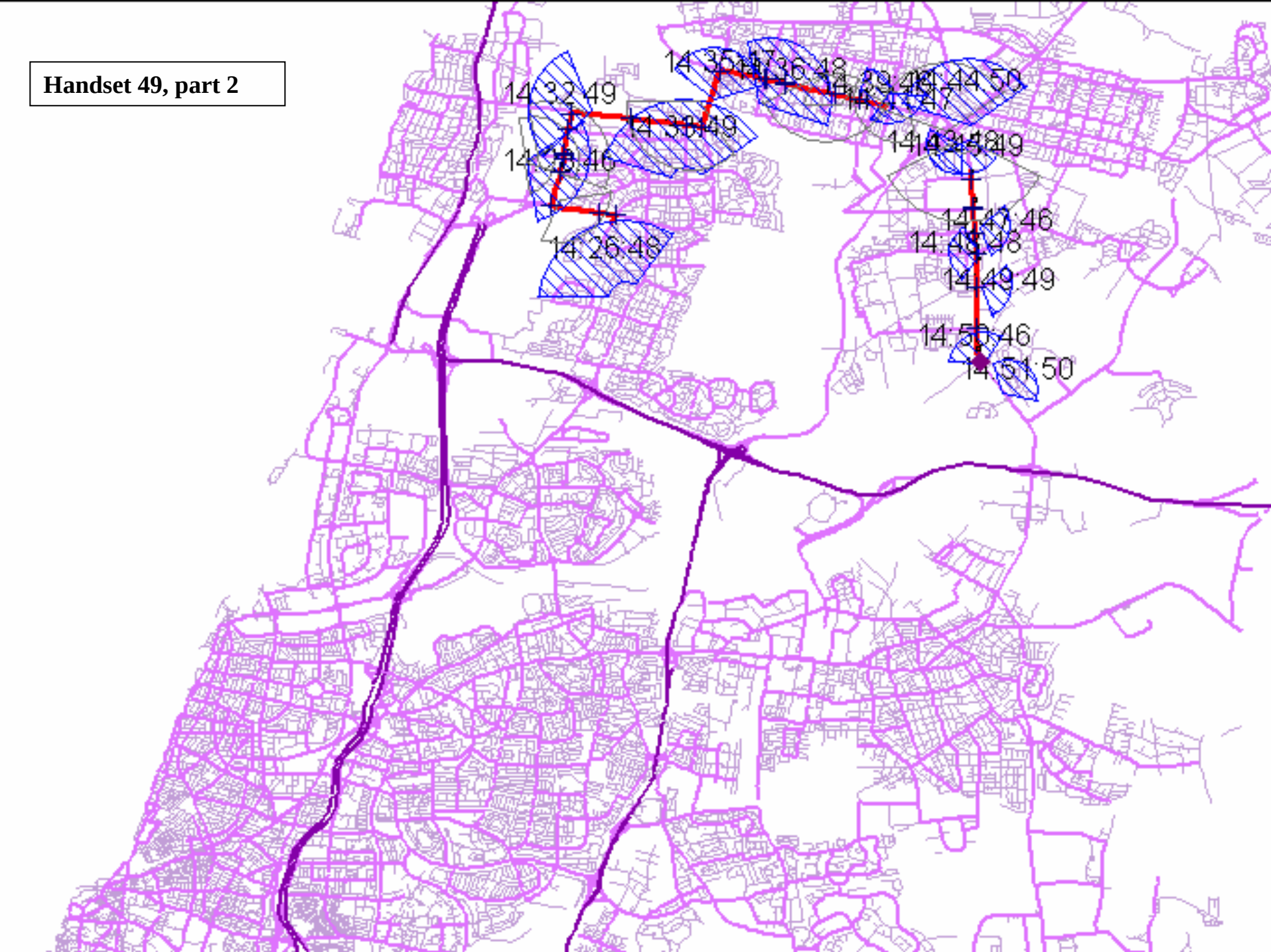
Handset 49, part 1



Handset 49, part 2



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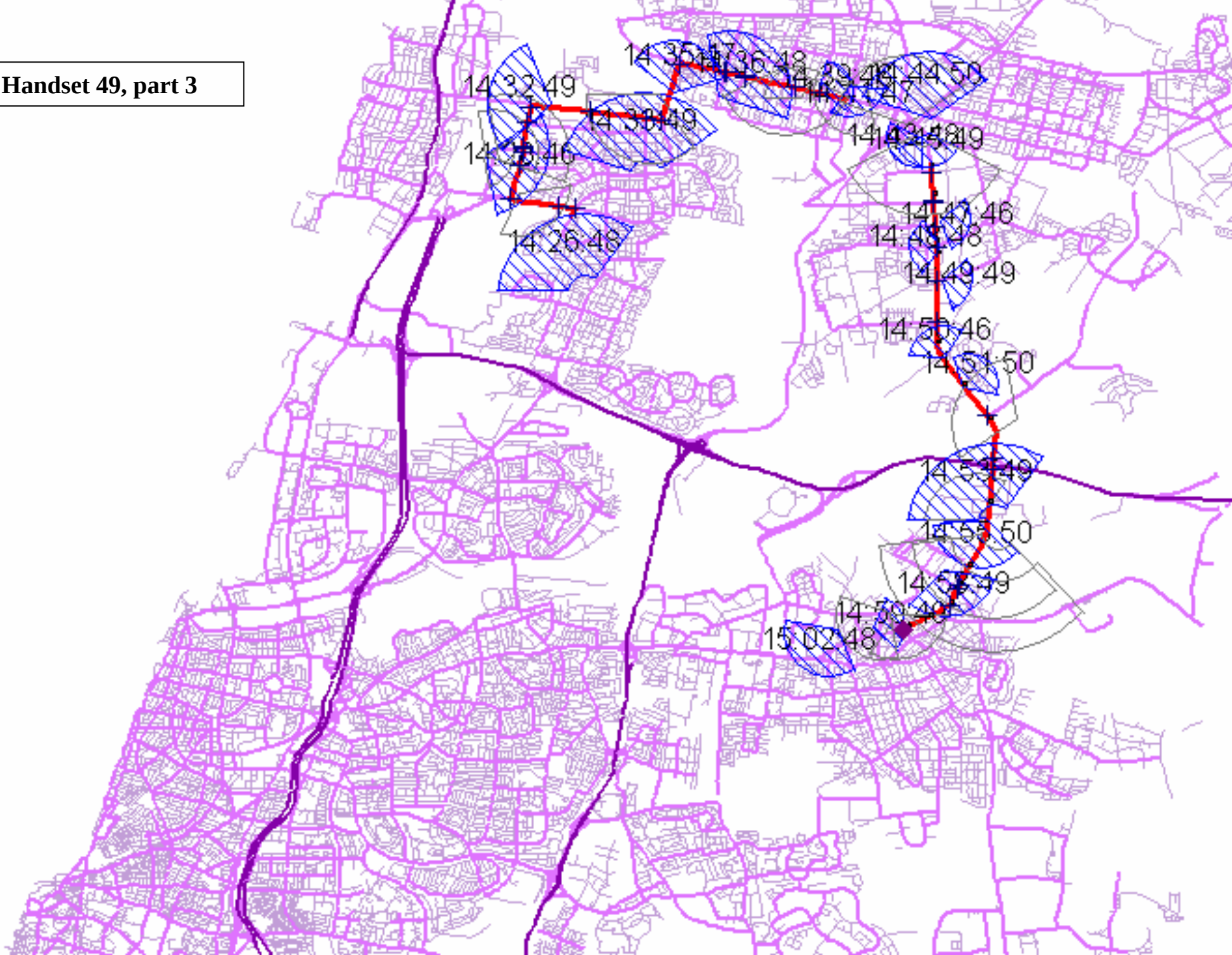

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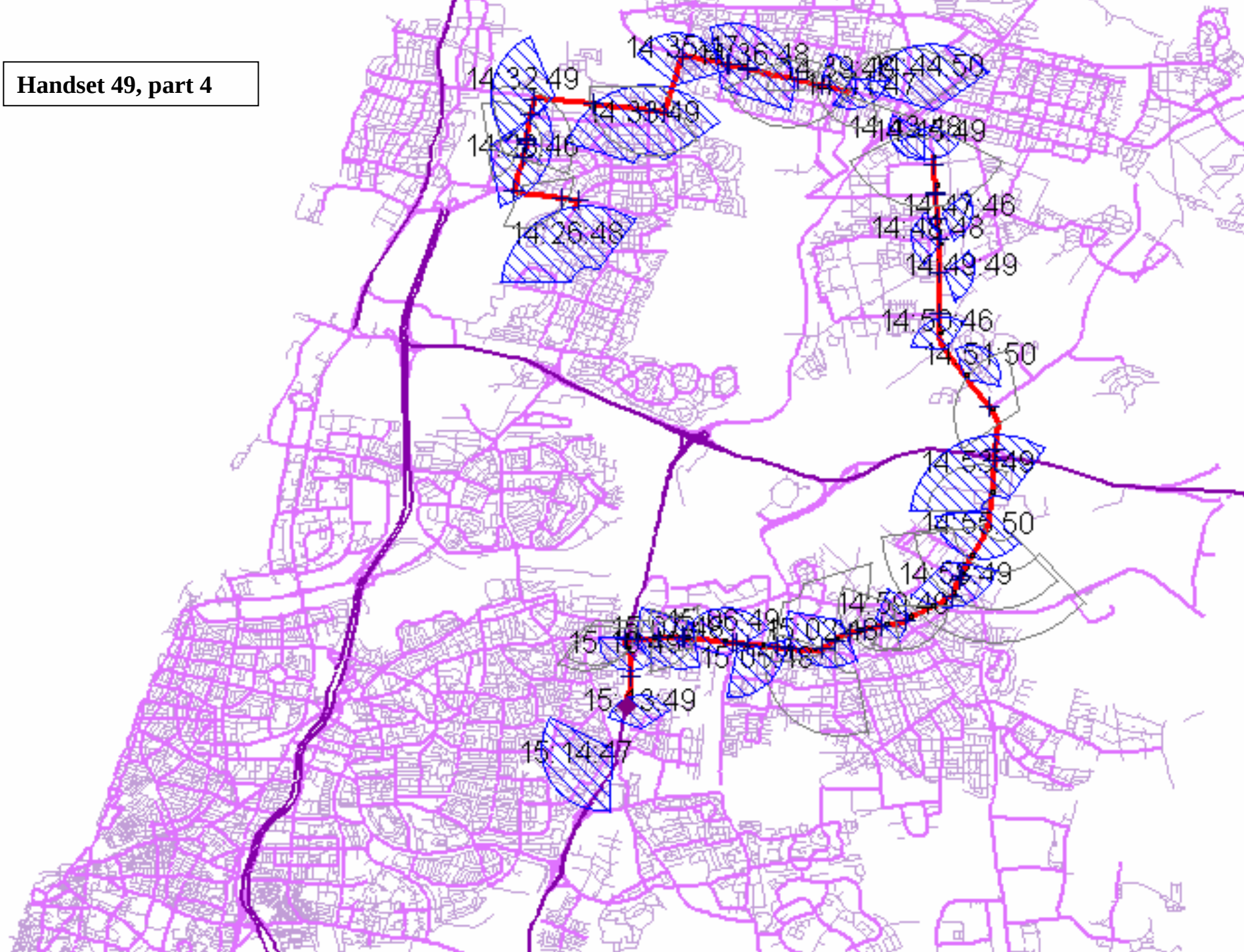

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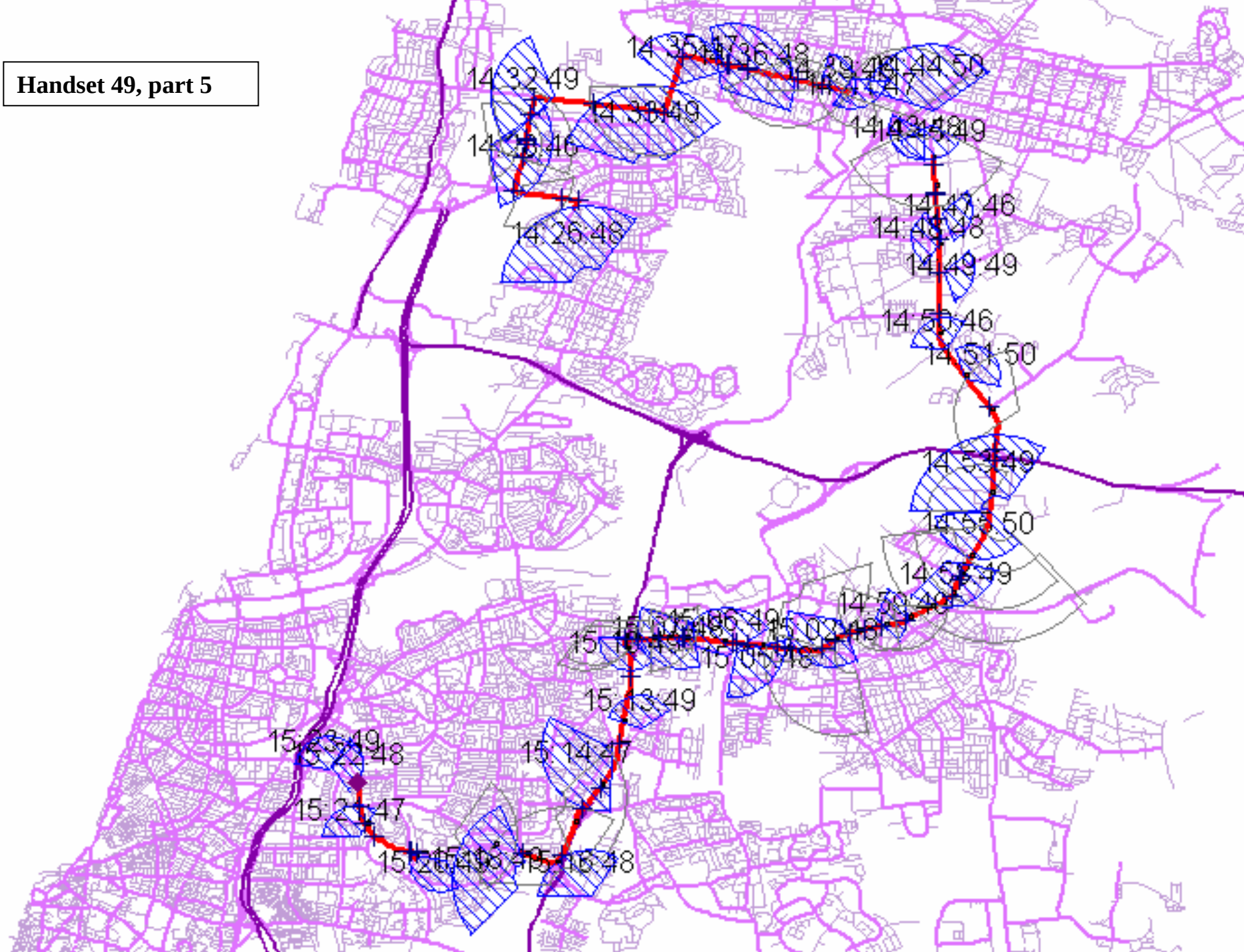
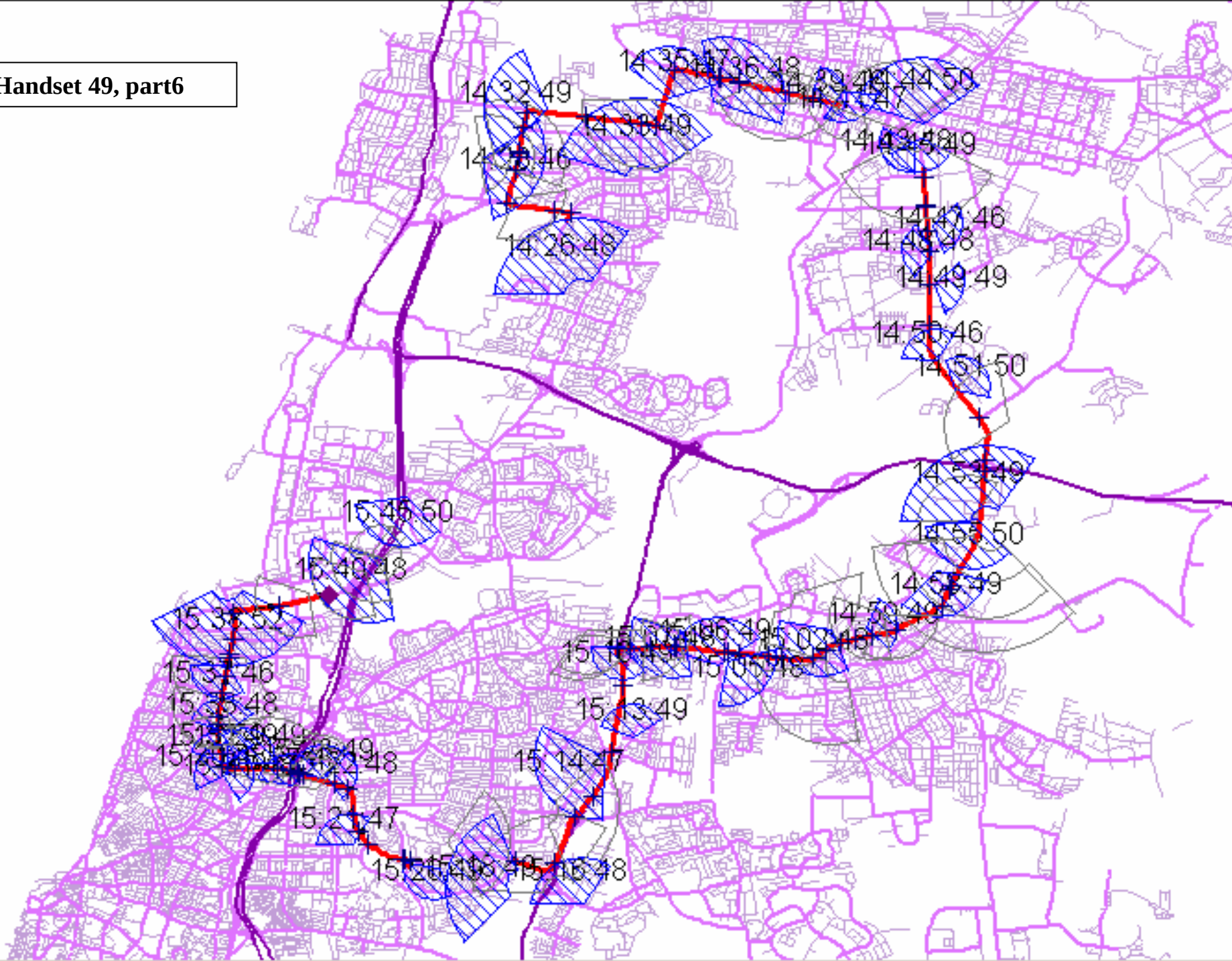
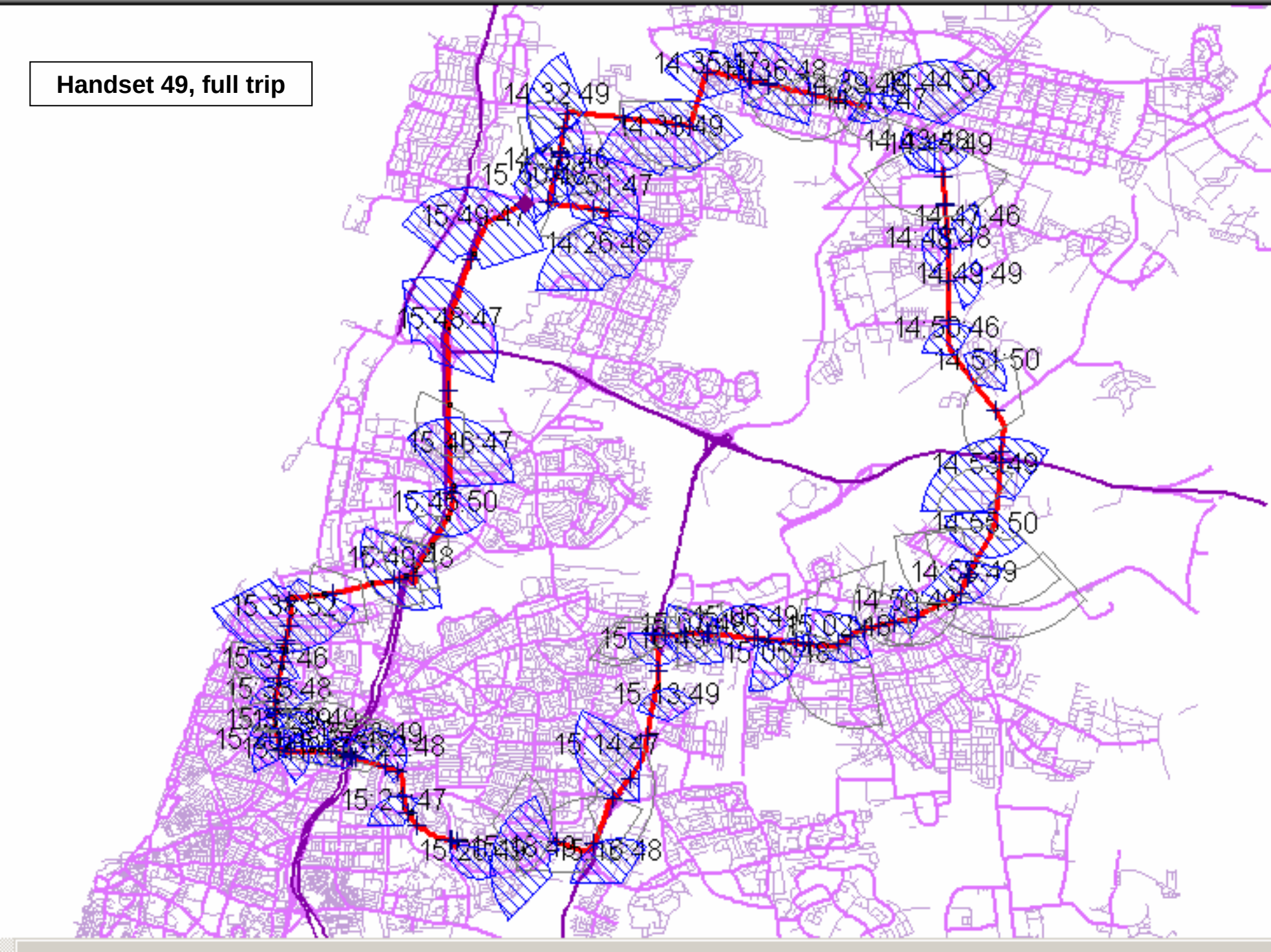
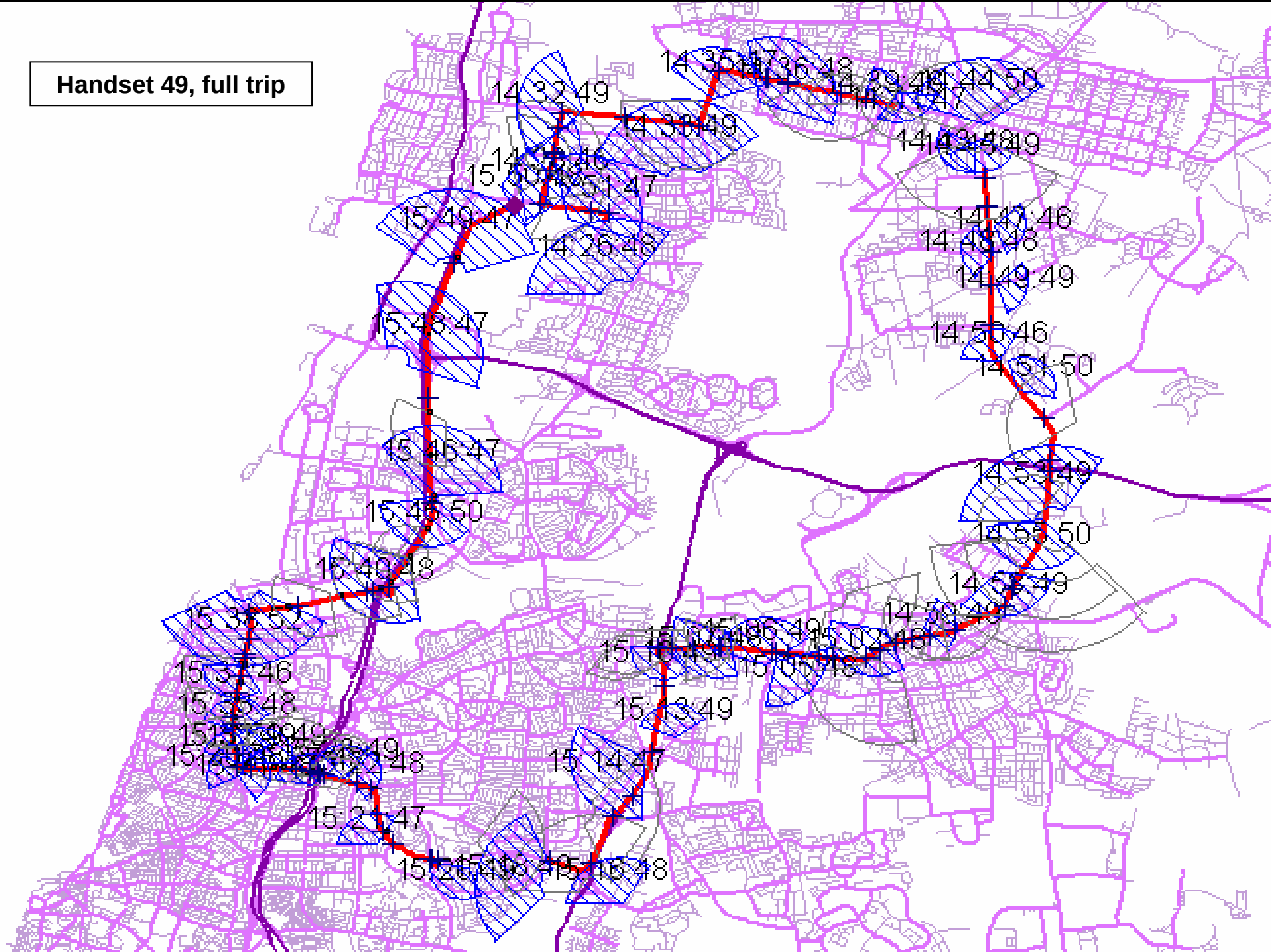


Handset 49, part6

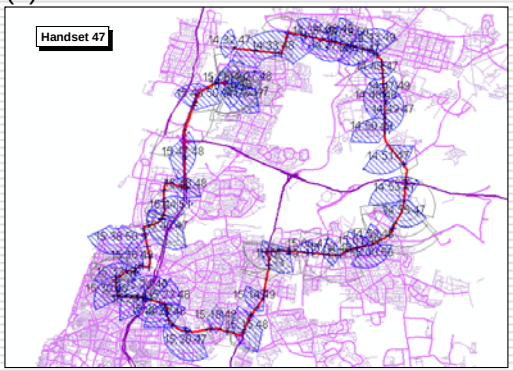



Handset 49, full trip


Handset 49, full trip

Path-Finding Drive Tests

(a)



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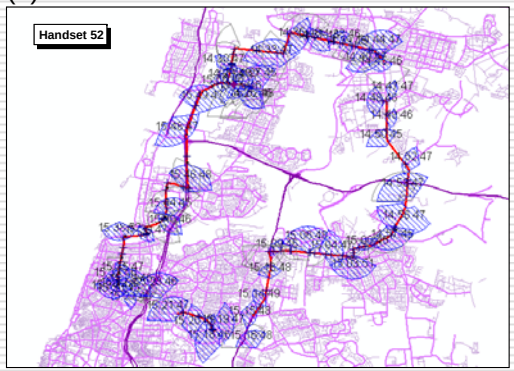

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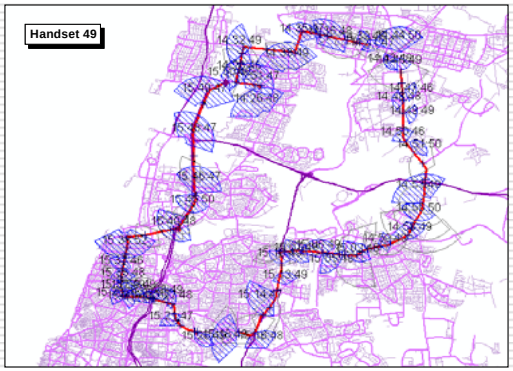
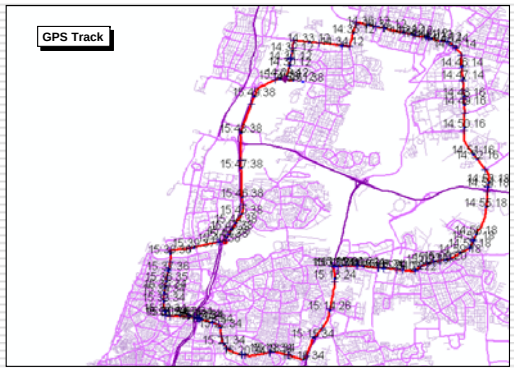


(d)



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

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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

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iTIS Holdings plc

Our Customers

The AA
Bentley
BMW GB Ltd
Co Pilot
DaimlerChrysler
DfT
Ferrari
Ford GB Ltd
Hampshire C.Council
The Highways Agency
Kenwood
Land Rover
Lexus
Maserati
Mini
Navteq
Nissan
O2
Orange
Panasonic
Pioneer
Porsche
Renault
Route 66
Saab GB Ltd
The Scottish Executive
Siemens VDO
Subaru Europe
T-Mobile
Tele Atlas
Tom Tom
Toyota
Transport for London
Vauxhall
Vodafone
Volvo

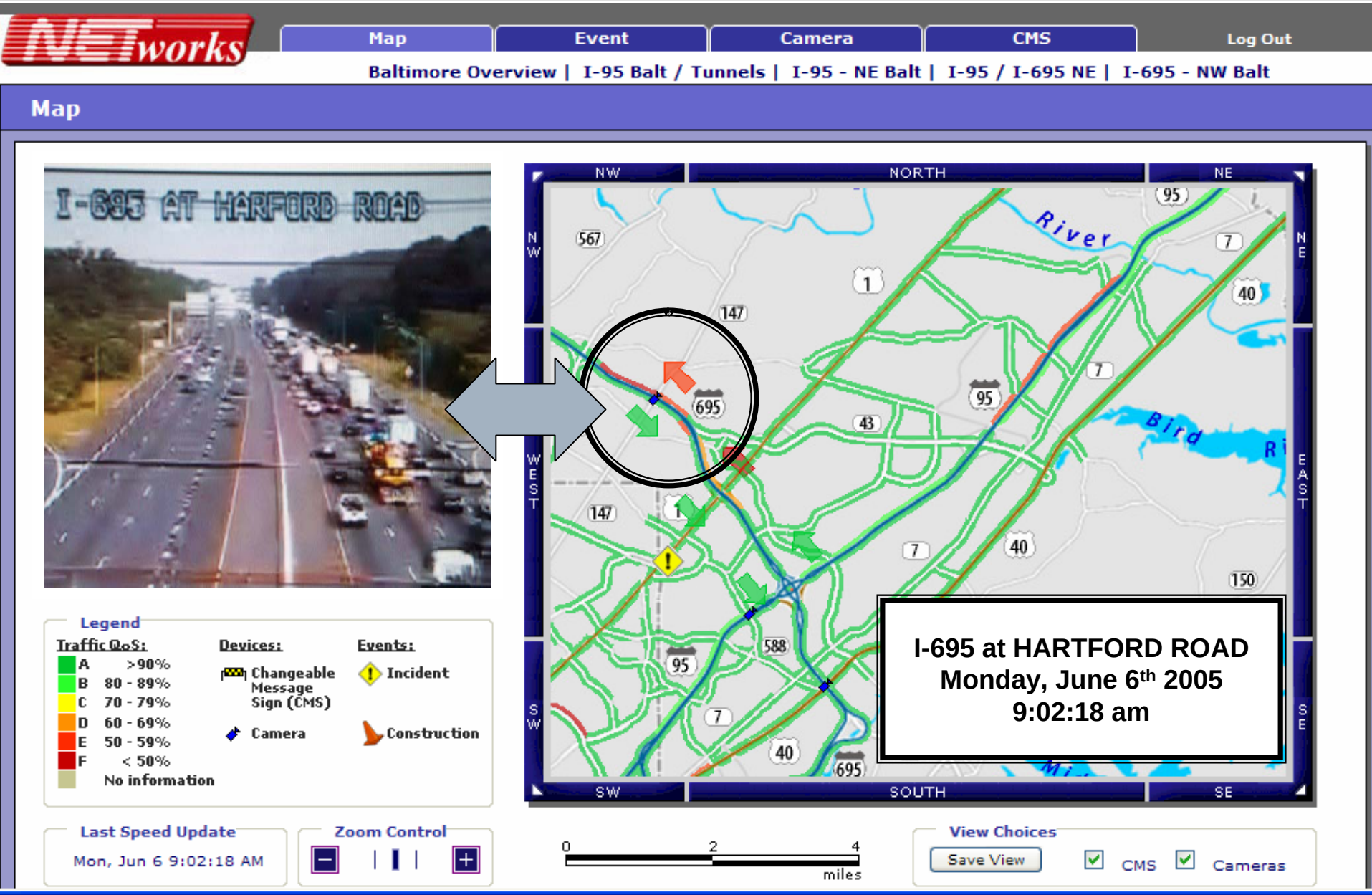
BMW
BENTLEY
Ford Motor Company
TOYOTA
LAND ROVER
MINI
SUBARU
VOLVO
RENAULT
Ferrari
Ford
NISSAN
SAAB
LEXUS
PORSCHE
Mercedes-Benz

T-Mobile
O2
vodafone
orange

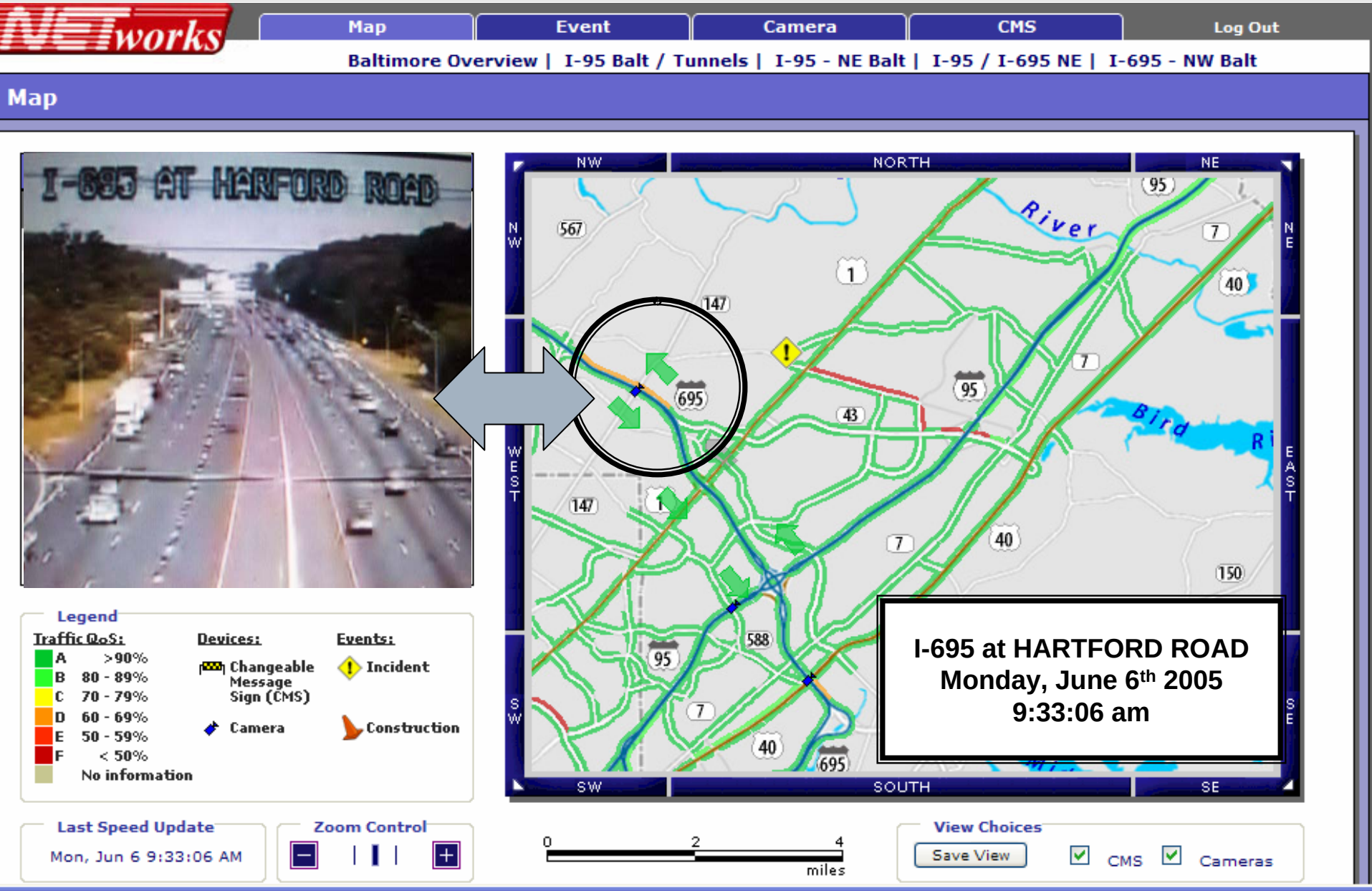
Hampshire County Council
Transport for London
Route 66
SCOTTISH EXECUTIVE
AA
Department for Transport
HIGHWAYS AGENCY

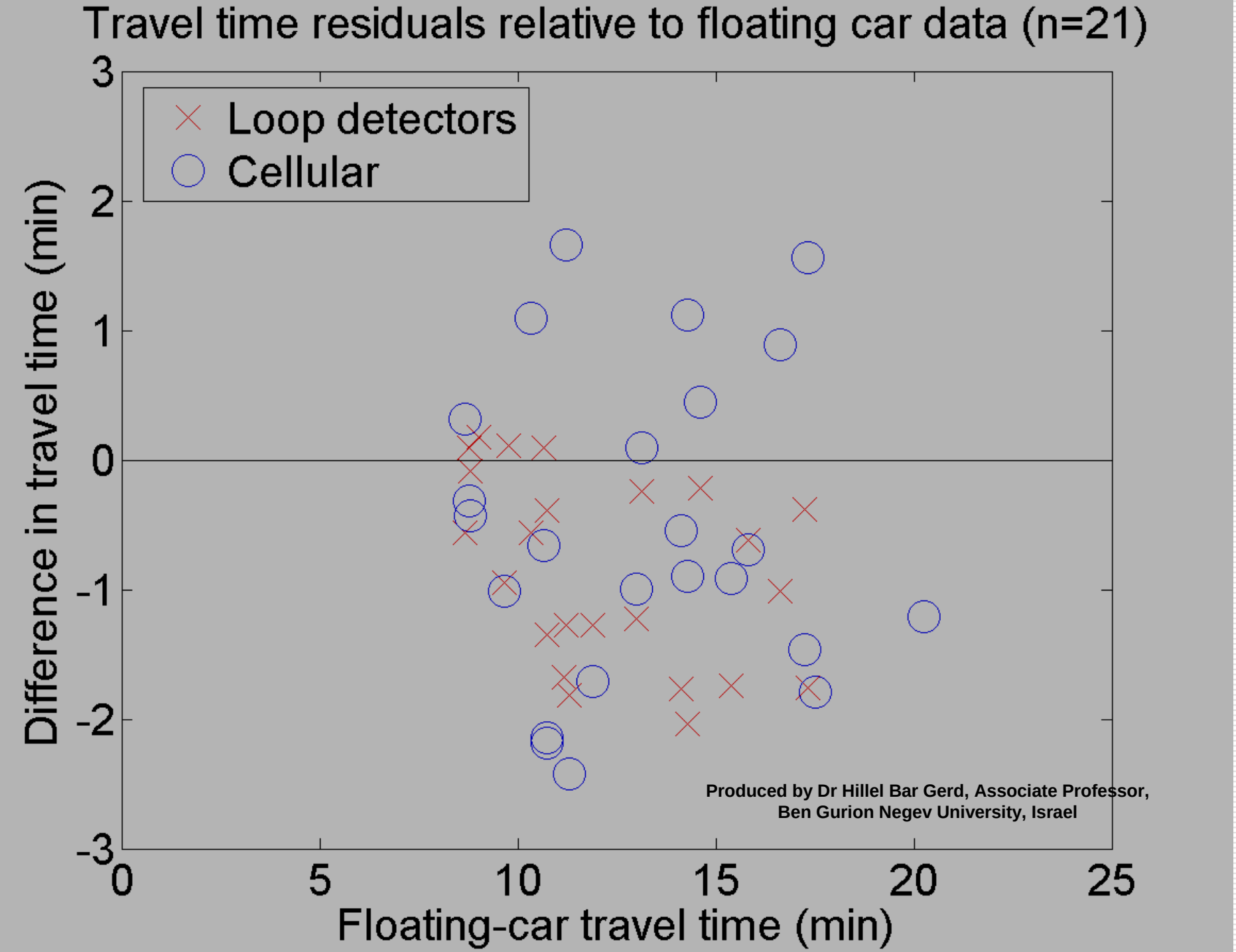
KENWOOD
SIEMENS VDO Automotive
CoPilot live
Panasonic
tomtom
Tele Atlas
NAVTEQ
Pioneer

MARYLAND DOT CAMERAS SHOW ACCURACY OF TRAFFIC INFORMATION BEING CAPTURED USING CELL PROBES

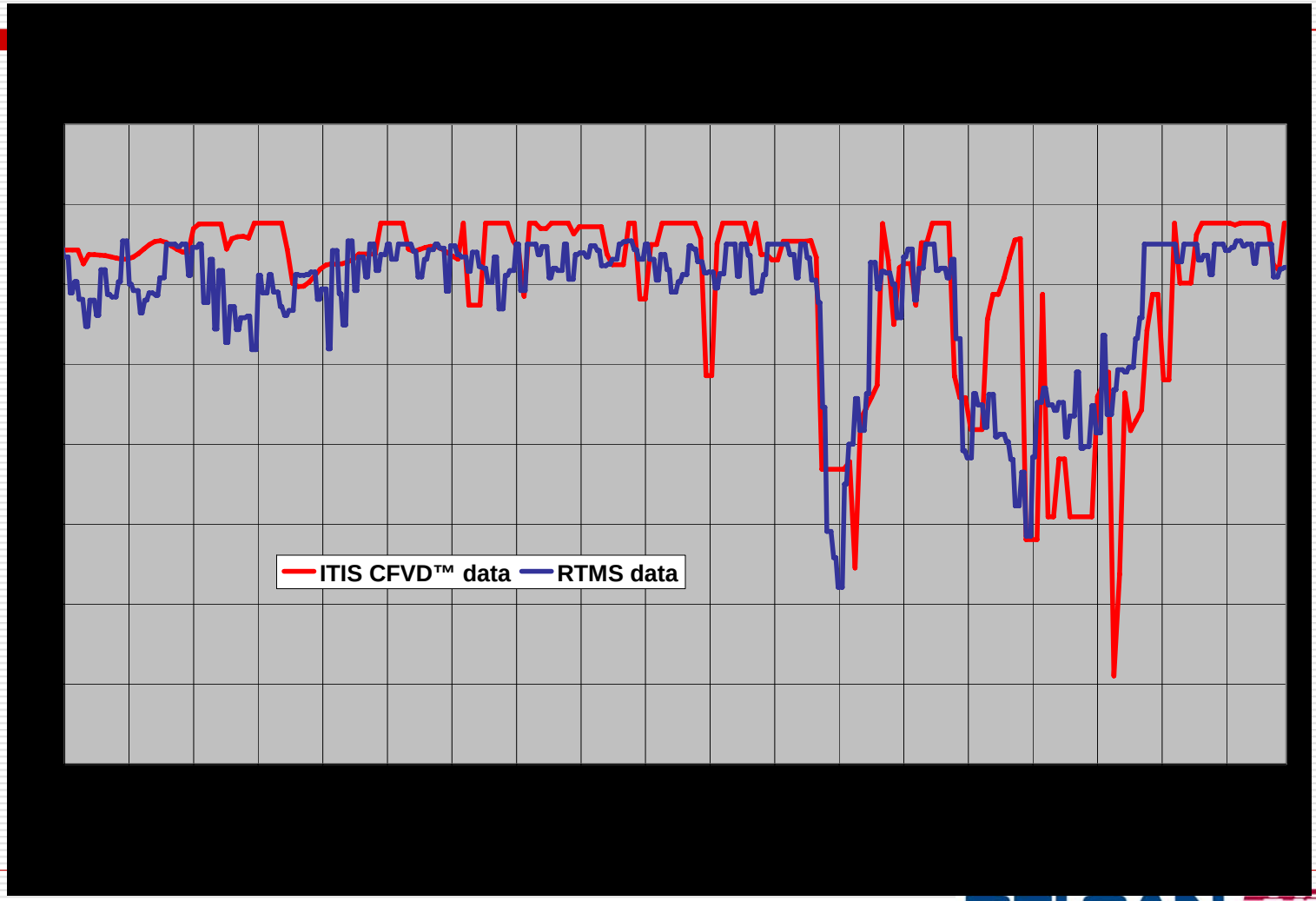


CELL PROBES ACCURATELY UPDATE TRAFFIC CONDITIONS AS CHANGES OCCUR

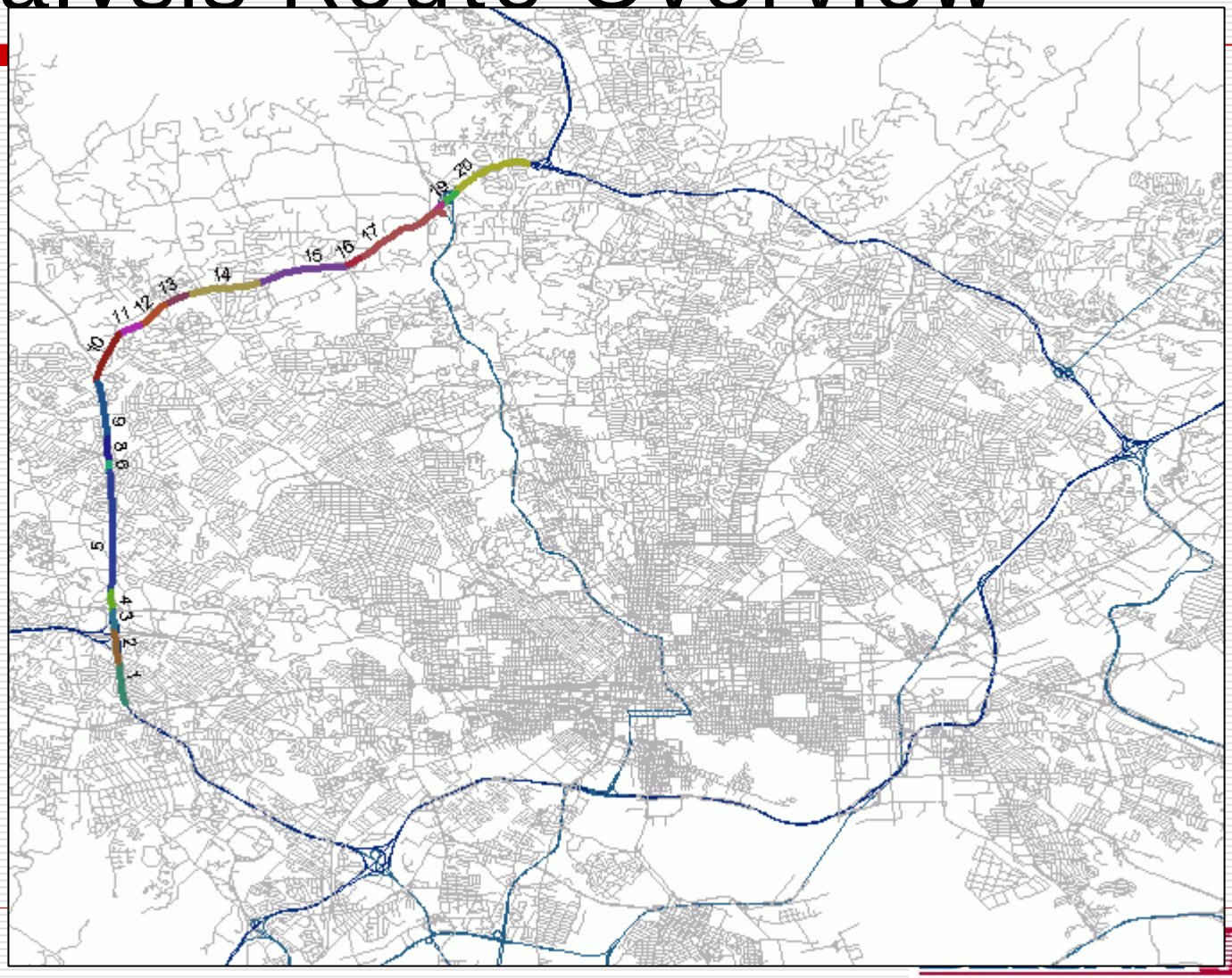



Travel time residuals relative to floating car data (n=21)
Loop detectors
Cellular
Difference in travel time (min)
Floating-car travel time (min)
3
2
1
0
-1
-2
-3
0
5
10
15
20
25
Produced by Dr Hillel Bar Gerd, Associate Professor,
Ben Gurion Negev University, Israel

Baltimore Comparison with RTMS Data



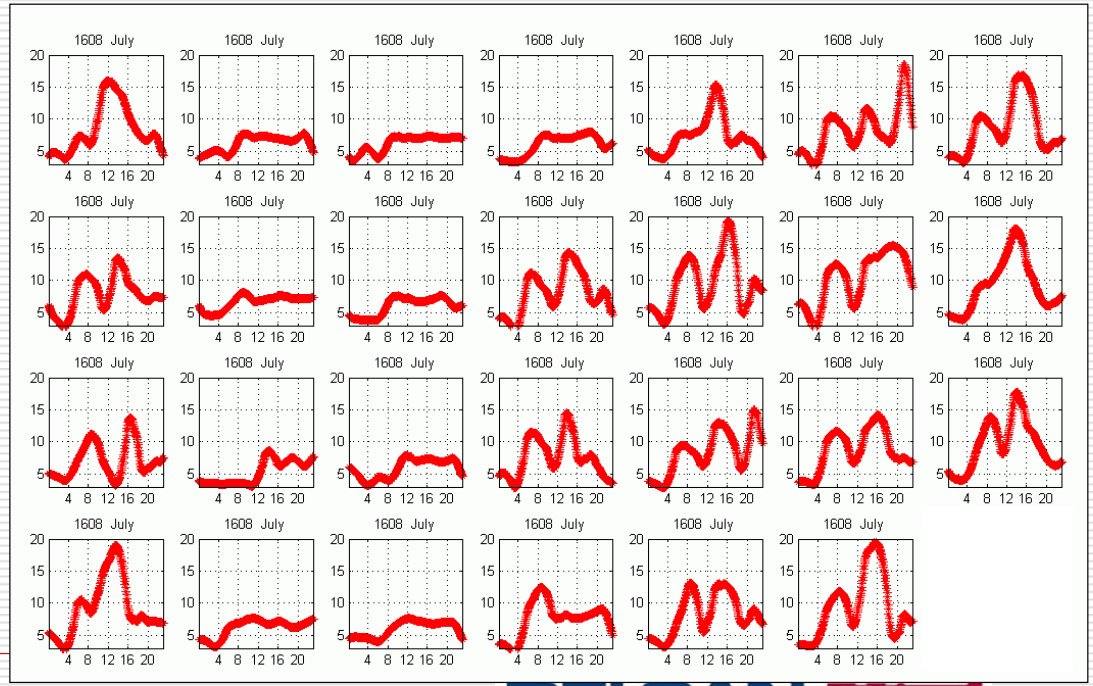
Analysis Route Overview



Slide 22

a1 This slide gives an overview of the Baltimore ring, and the north-western part which was analysed for this presentation
alon, 8/19/2005

Performance data I-695 – July 2005



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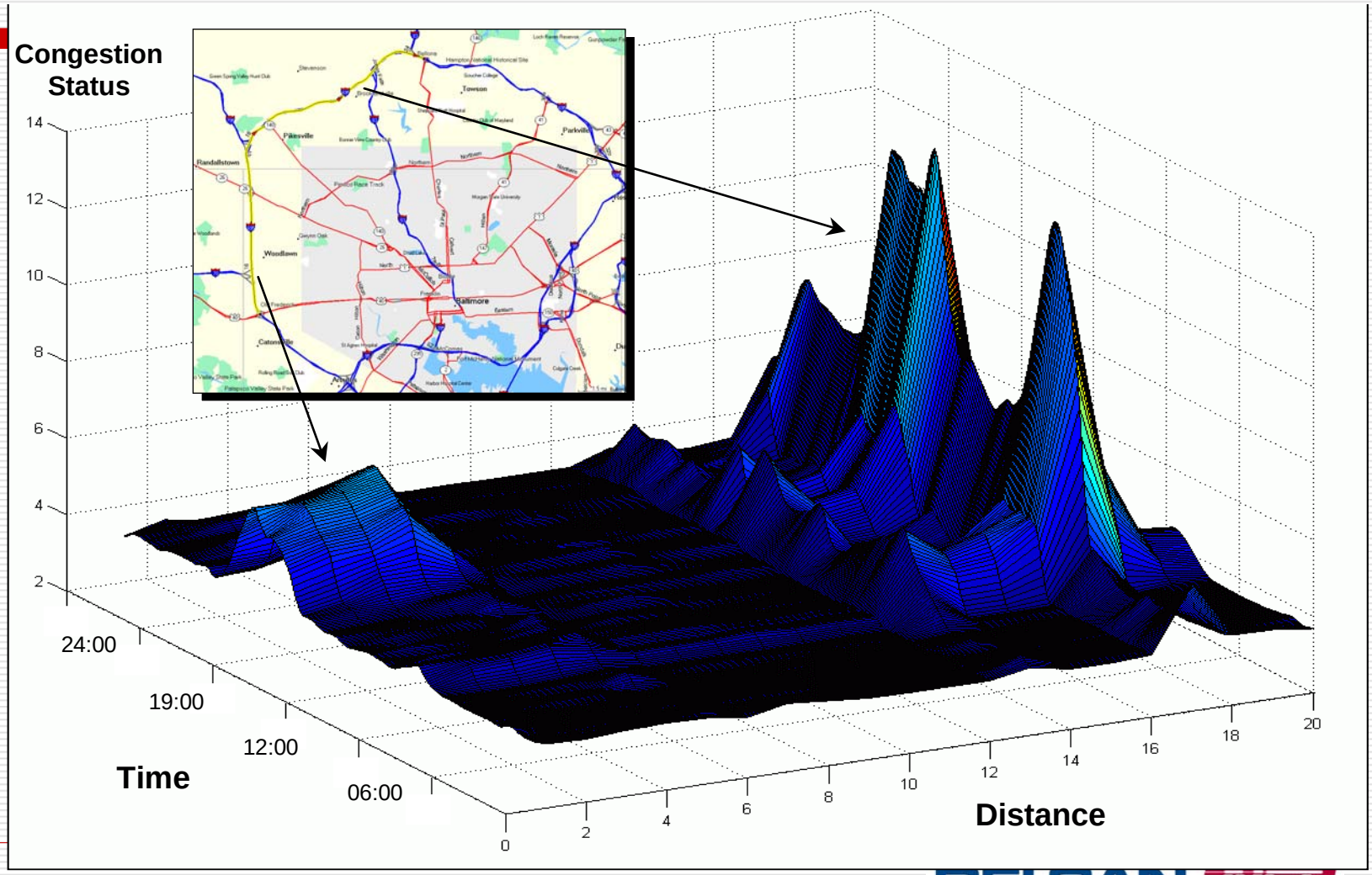
Baltimore I-695 Weekday Patterns



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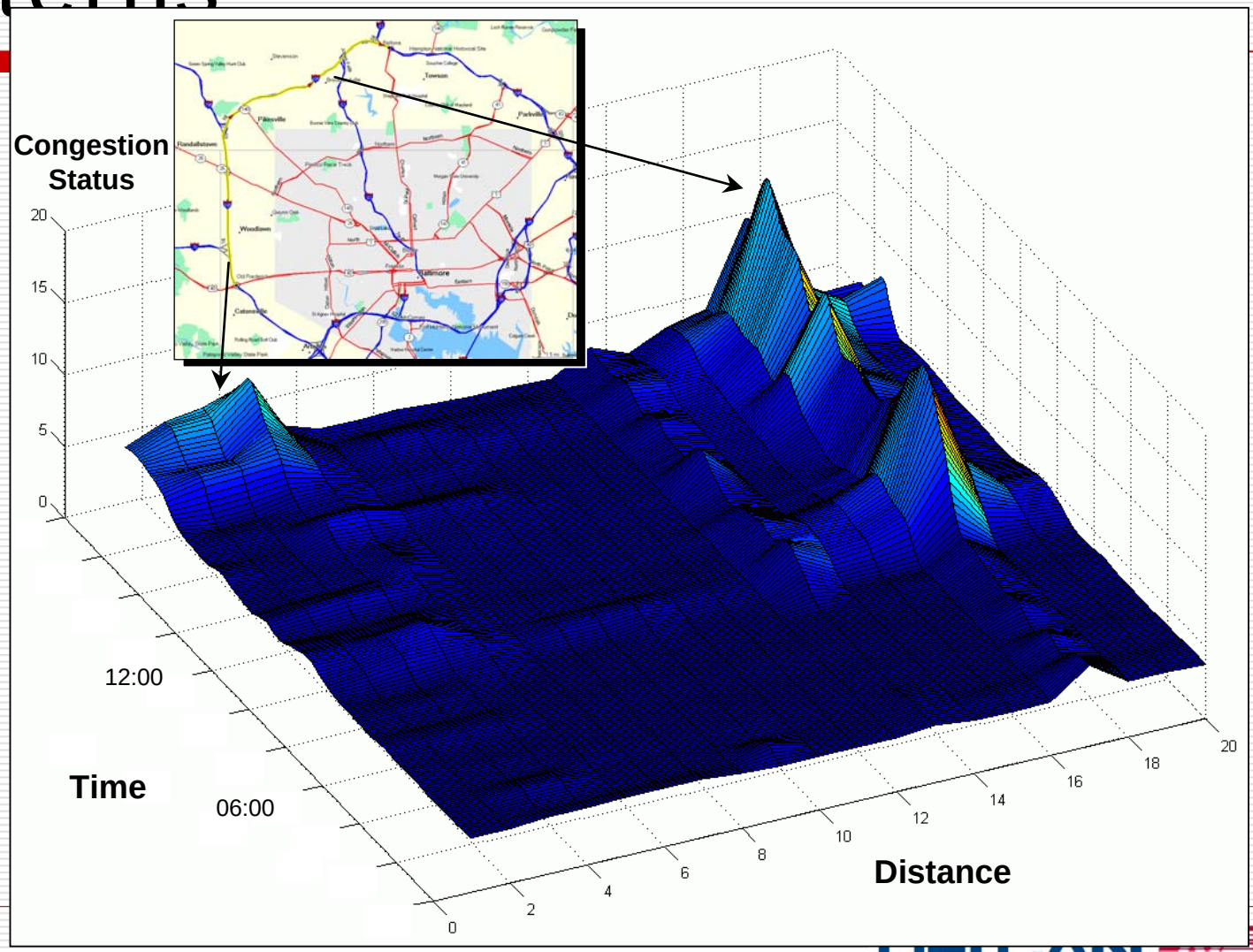
Baltimore I-695 Saturday Patterns



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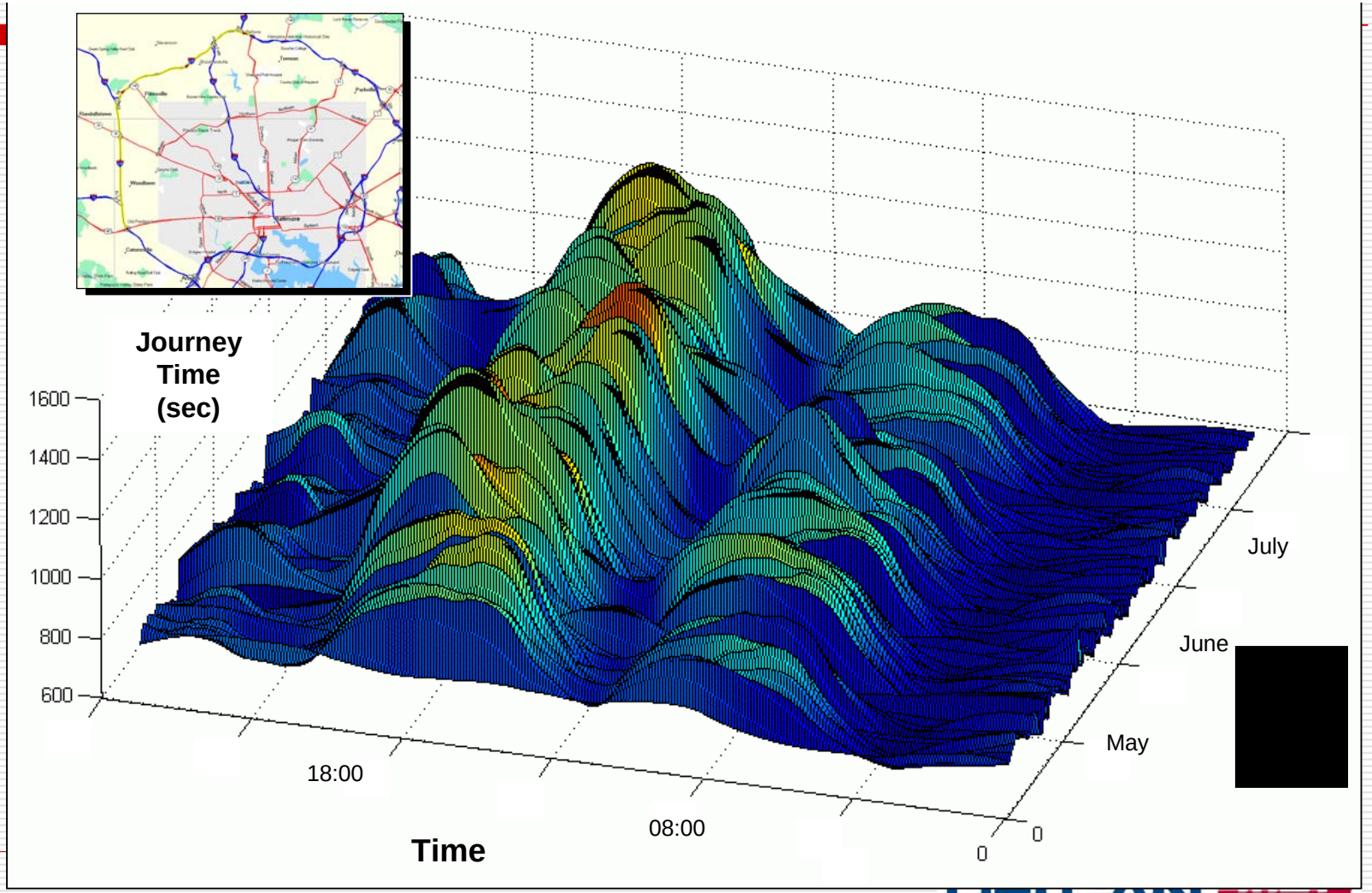
Baltimore I-695 Route Travel Time



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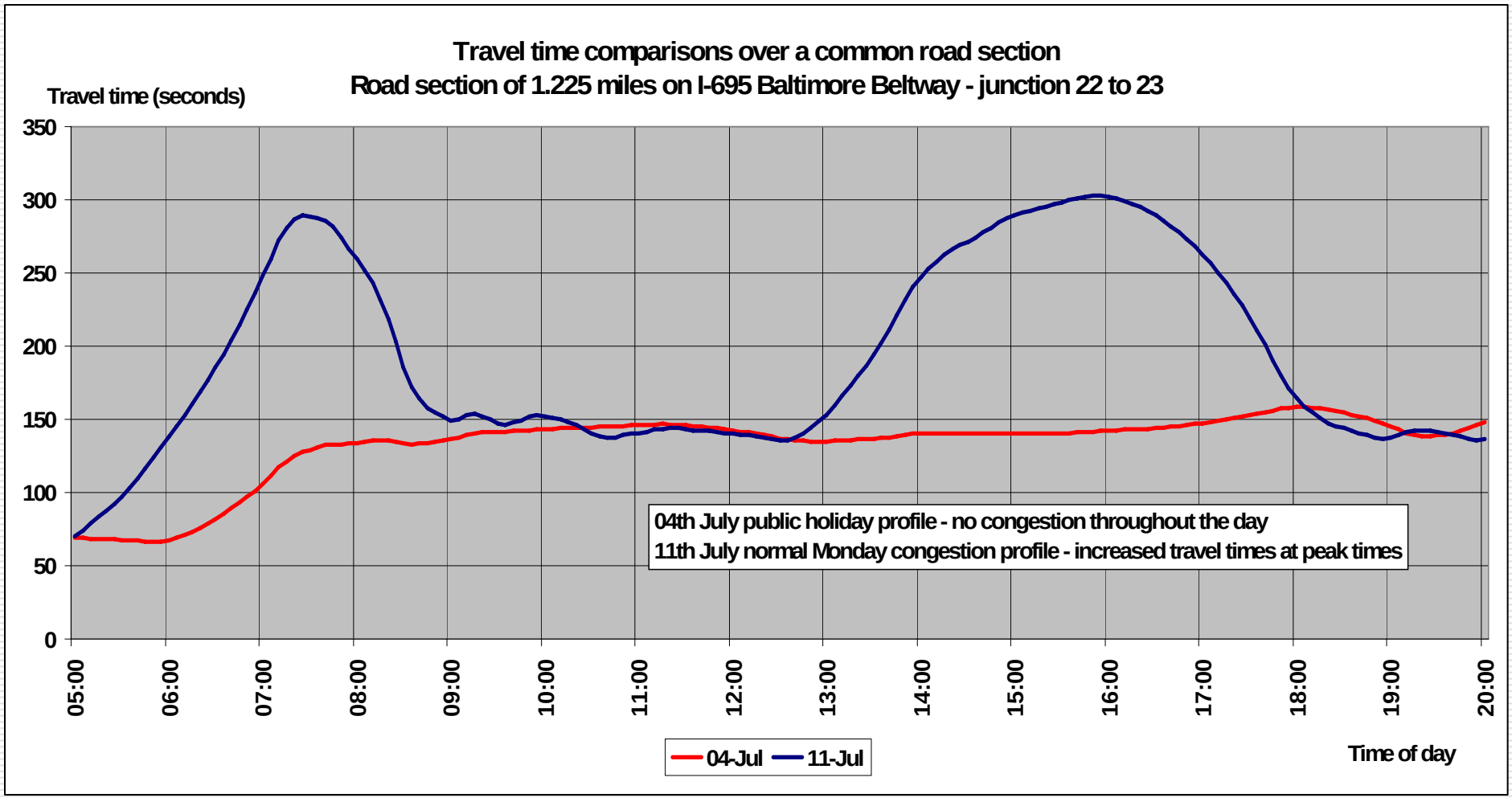

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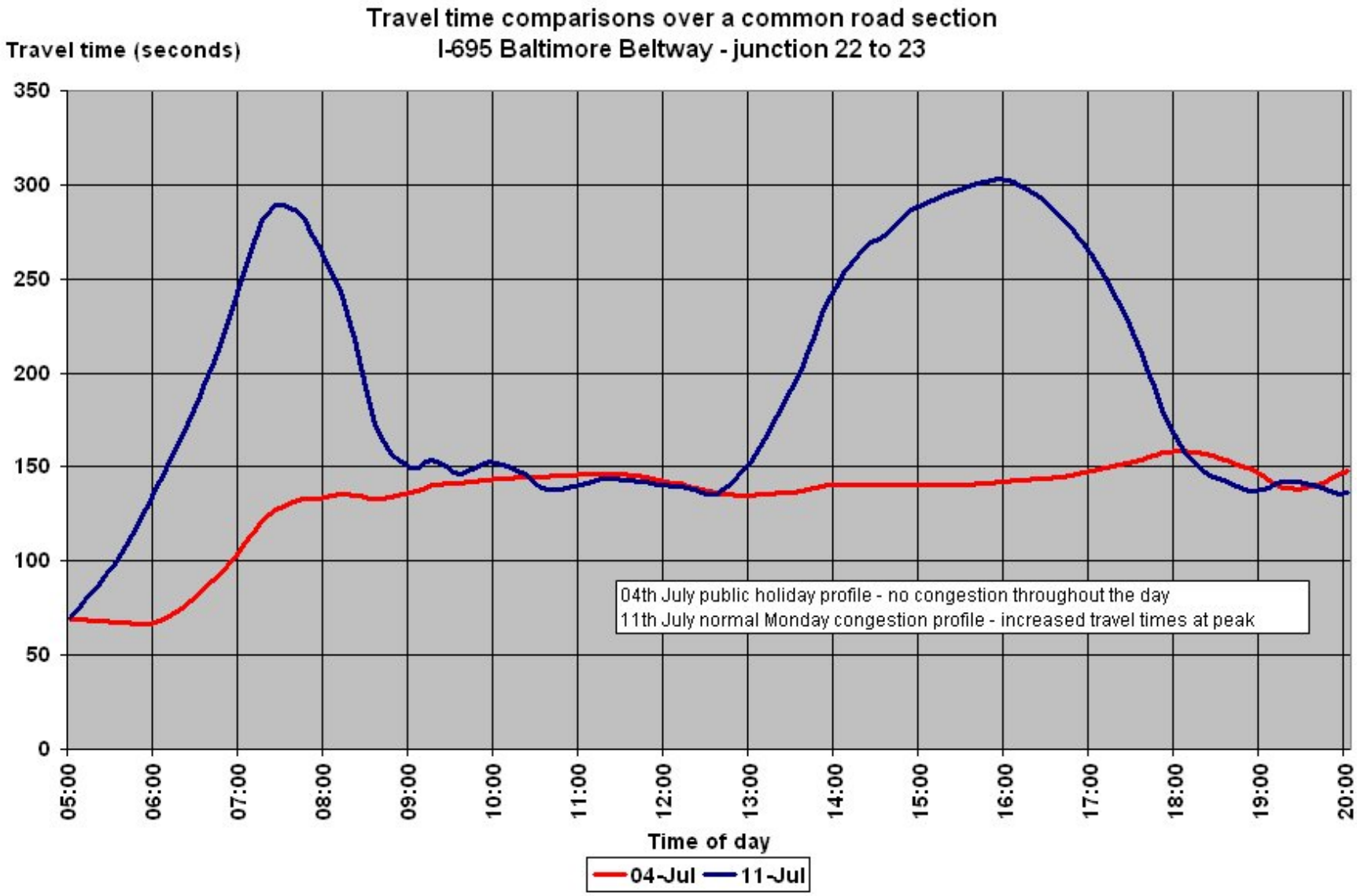
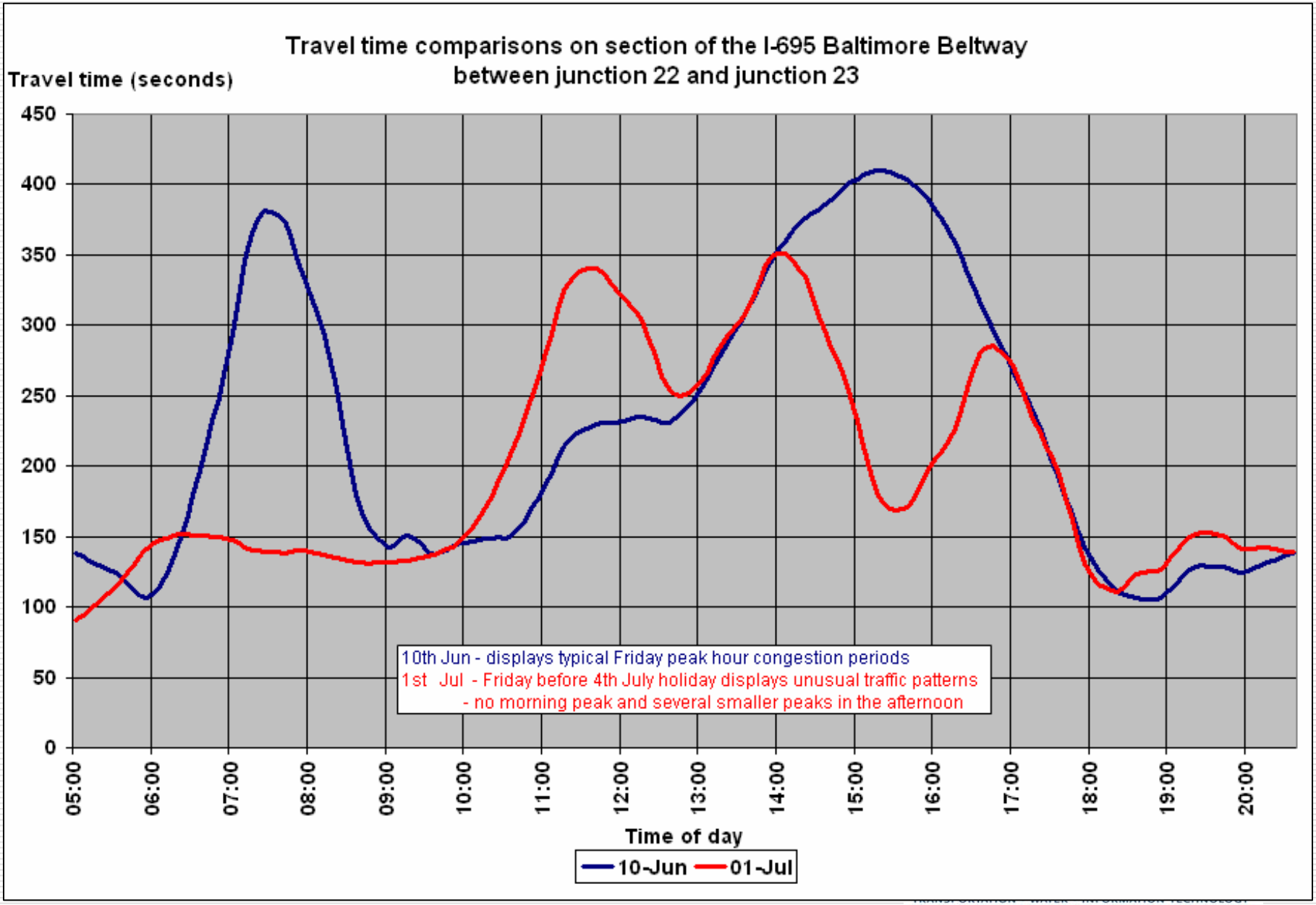

Travel time comparisons over a common road section
I-695 Baltimore Beltway - junction 22 to 23
Travel time (seconds)
350
300
250
200
150
100
50
0
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
Time of day
04th July public holiday profile - no congestion throughout the day
11th July normal Monday congestion profile - increased travel times at peak
04-Jul
11-Jul


Travel time comparisons on section of the I-695 Baltimore Beltway between junction 22 and junction 23
Travel time (seconds)
450
400
350
300
250
200
150
100
50
0
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
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
Time of day
10-Jun
01-Jul

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

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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

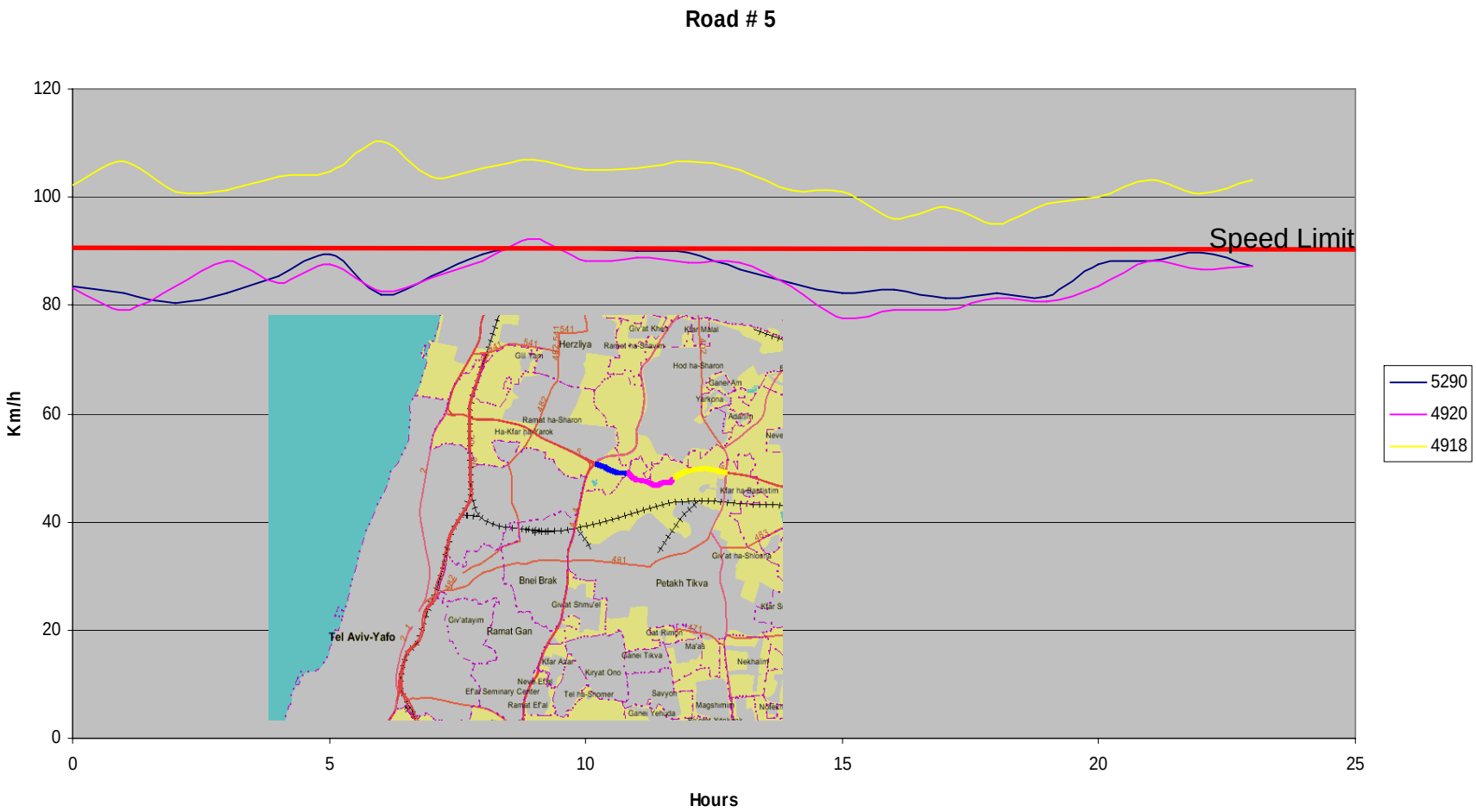
Appendix

- 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



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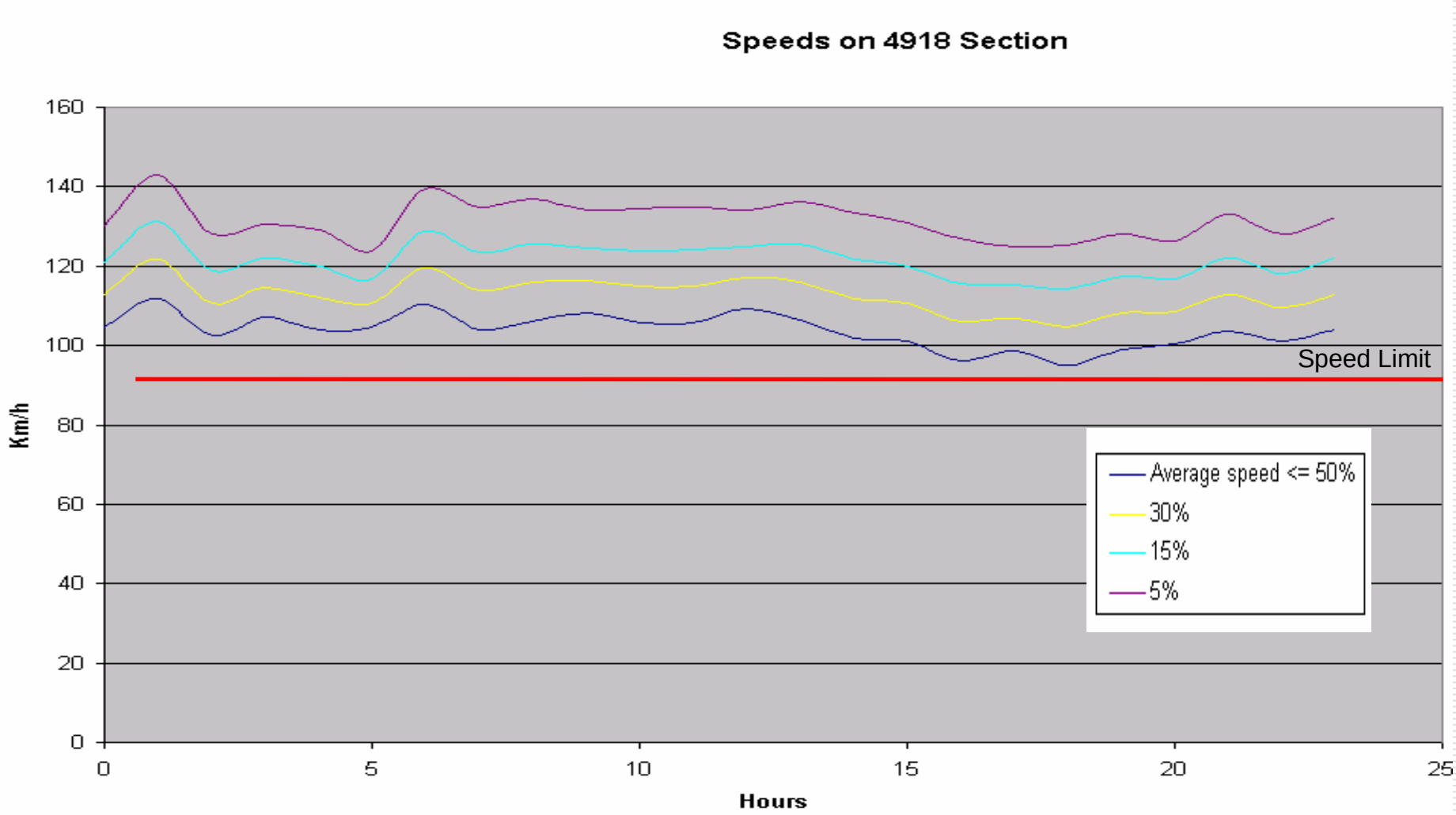
Distribution of Speeds



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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."

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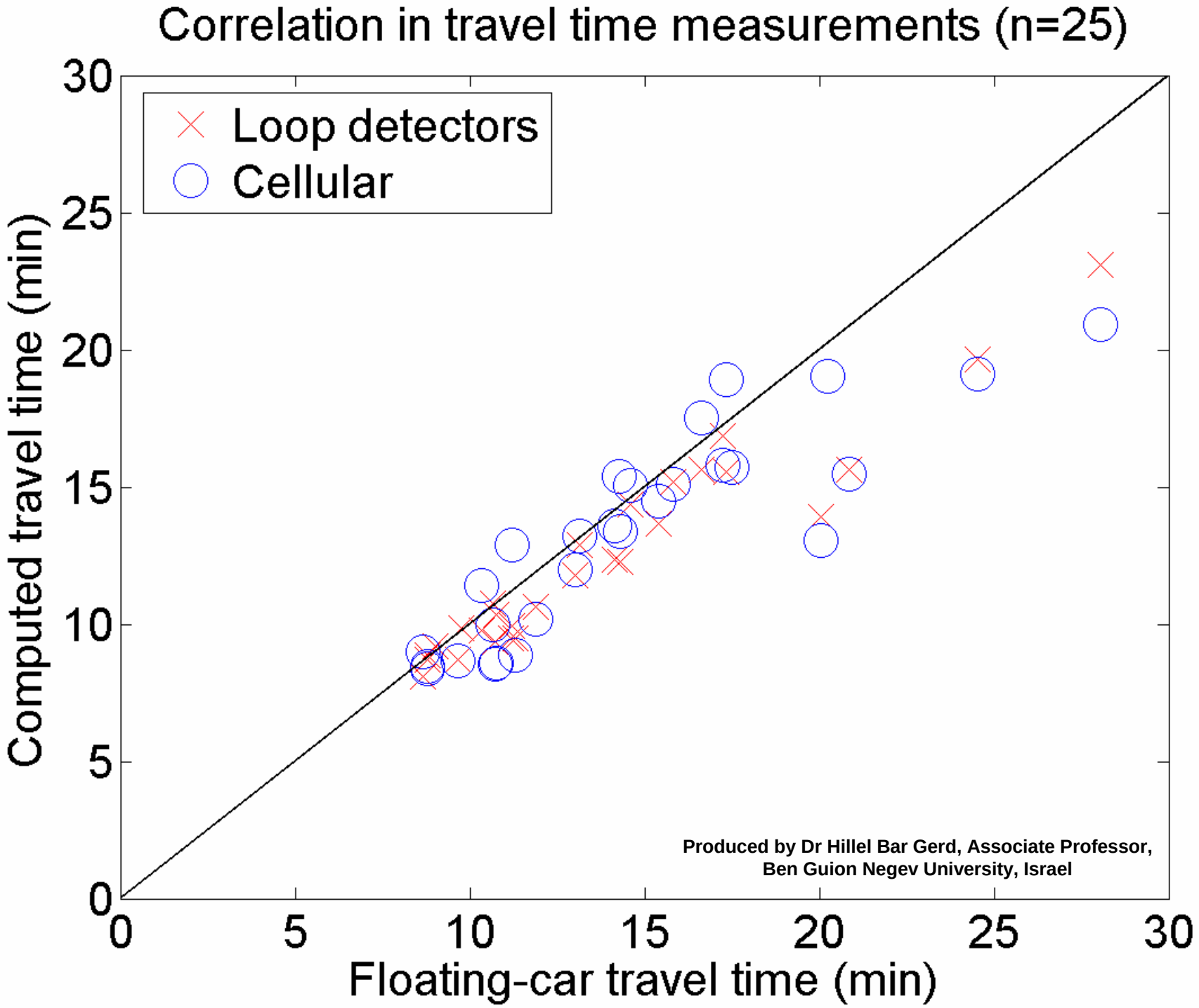
Correlation in travel time measurements (n=25)
Loop detectors
Cellular
Computed travel time (min)
Floating-car travel time (min)
0
5
10
15
20
25
30
Produced by Dr Hillel Bar Gerd, Associate Professor,
Ben Guion Negev University, Israel

Comparison to GPS

	CFVD™	*Loop detectors*
Bias	0.49 min	0.90 min
RMS	1.25 min	1.13 min
Accuracy SQRT($Bias^2+RMS^2$)	1.34 min	1.44 min