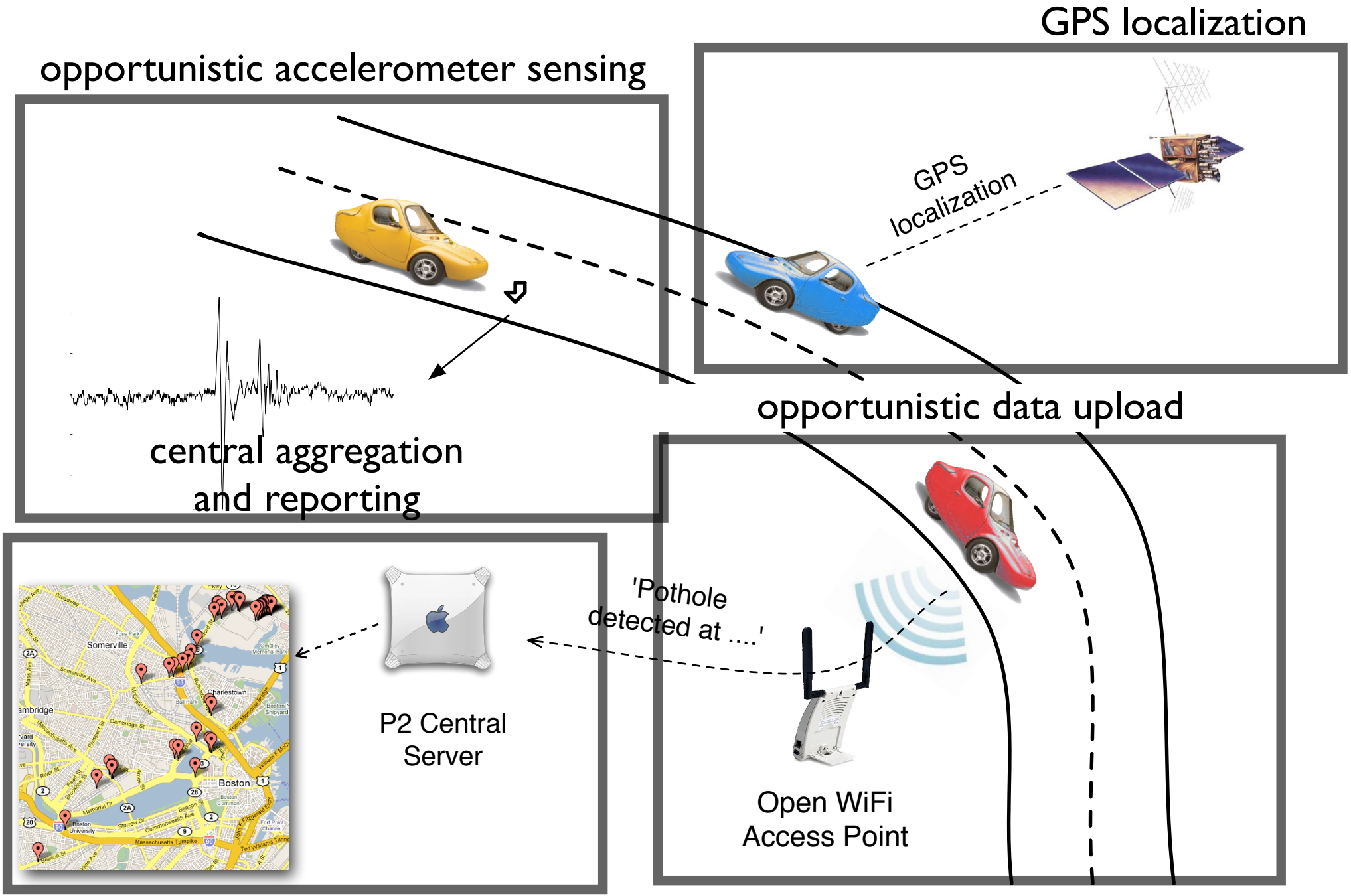
the
Pothole Patrol

6.S062 3/22/2017
Based on Slides from
Jakob Eriksson

- road decay unavoidable, hard to predict
- current monitoring methods costly/ineffective

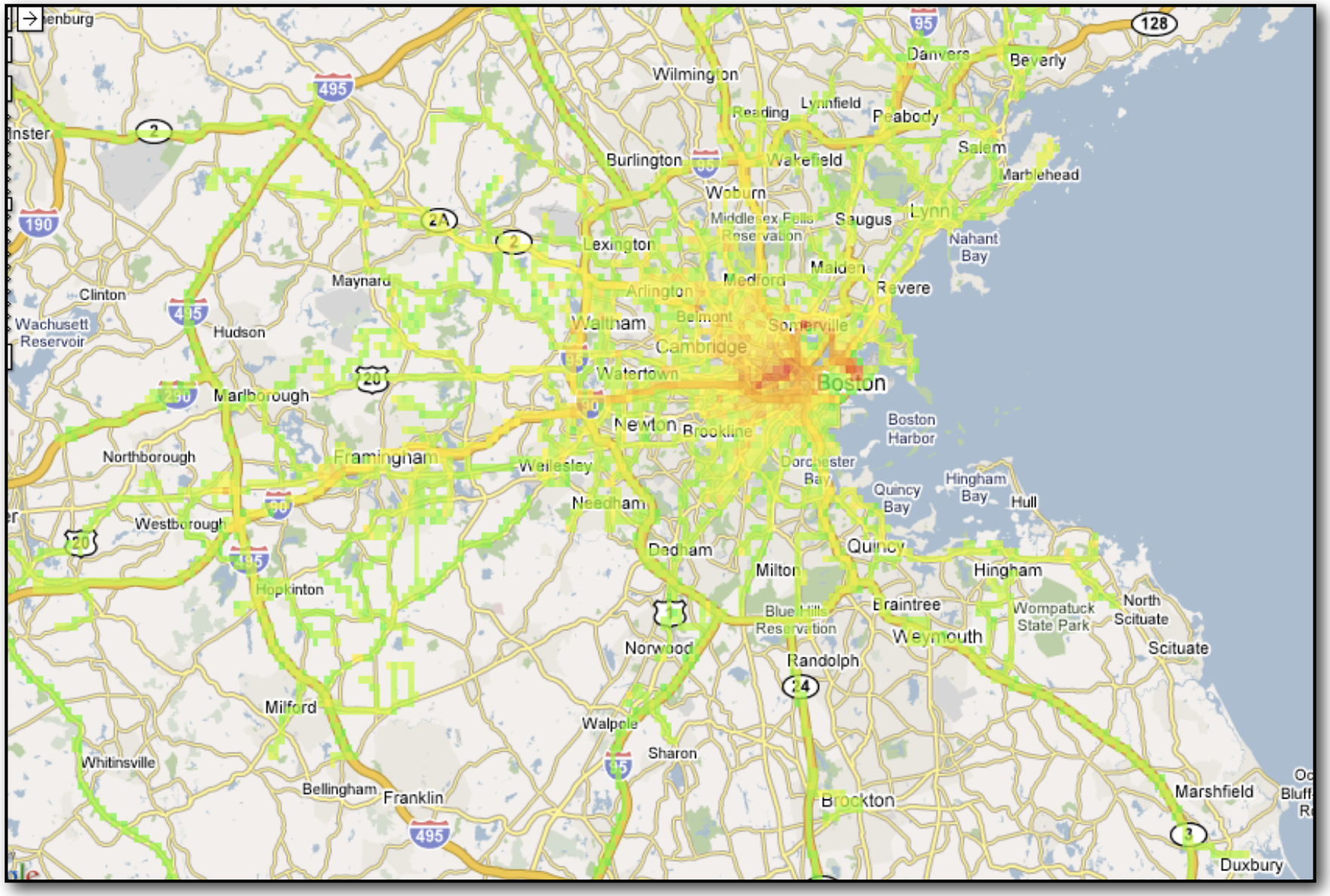
the Pothole Patrol

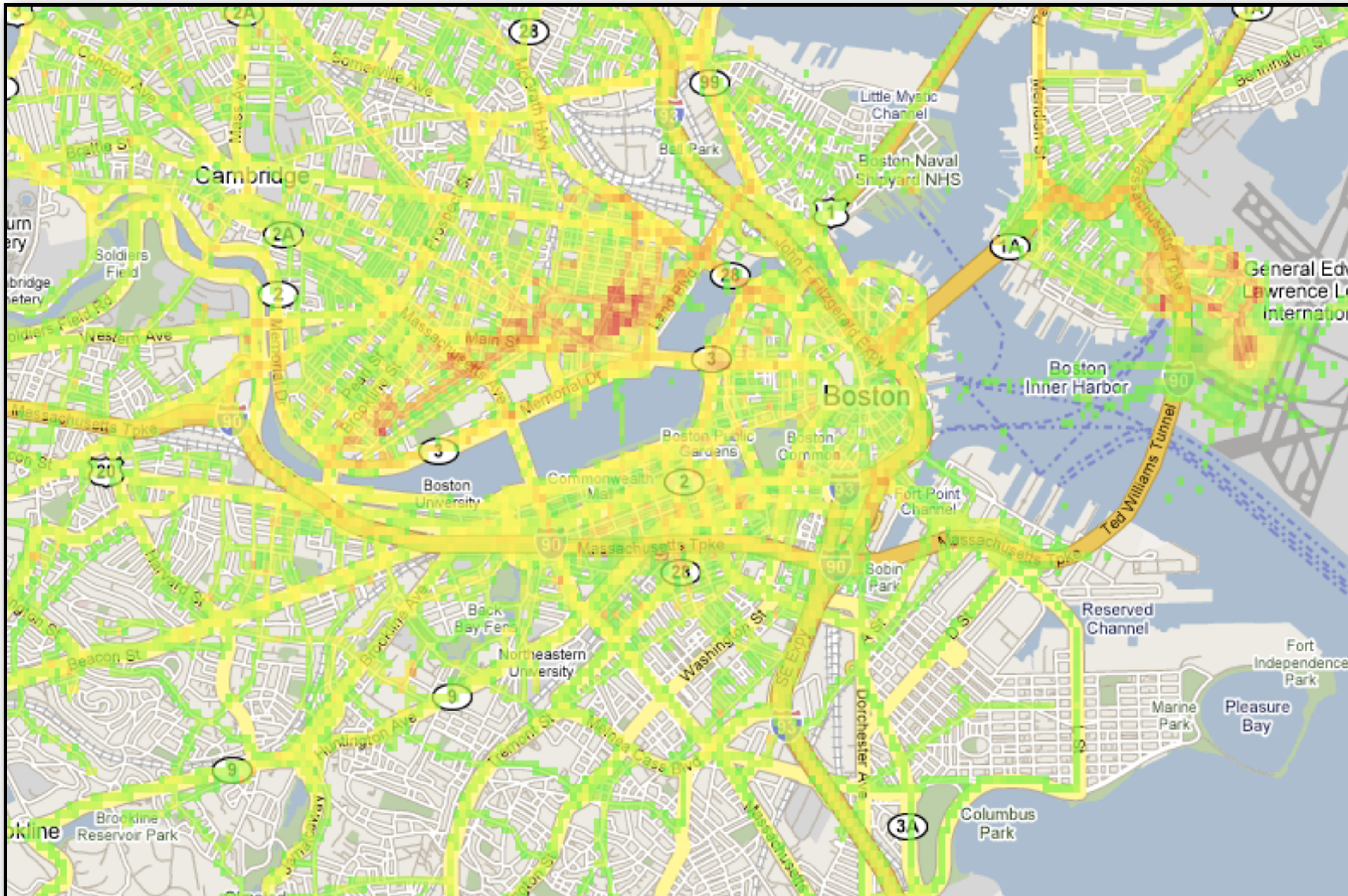


experimental platform

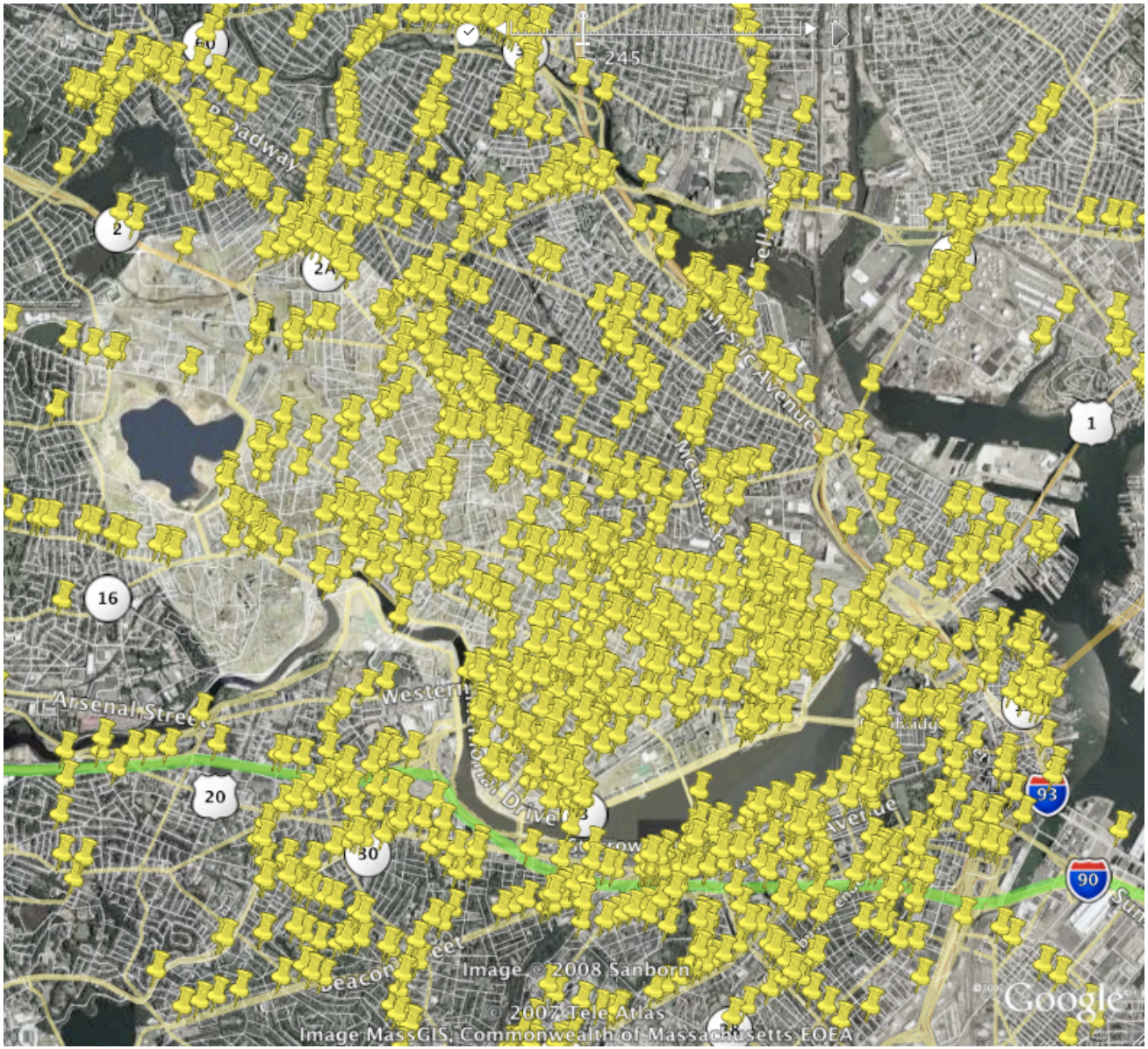
- 7 Boston/Cambridge taxis
- small computer in glove box
- 400 Hz 3-axis accelerometer
- 802.11a/b/g wireless interface
- GPS receiver on roof

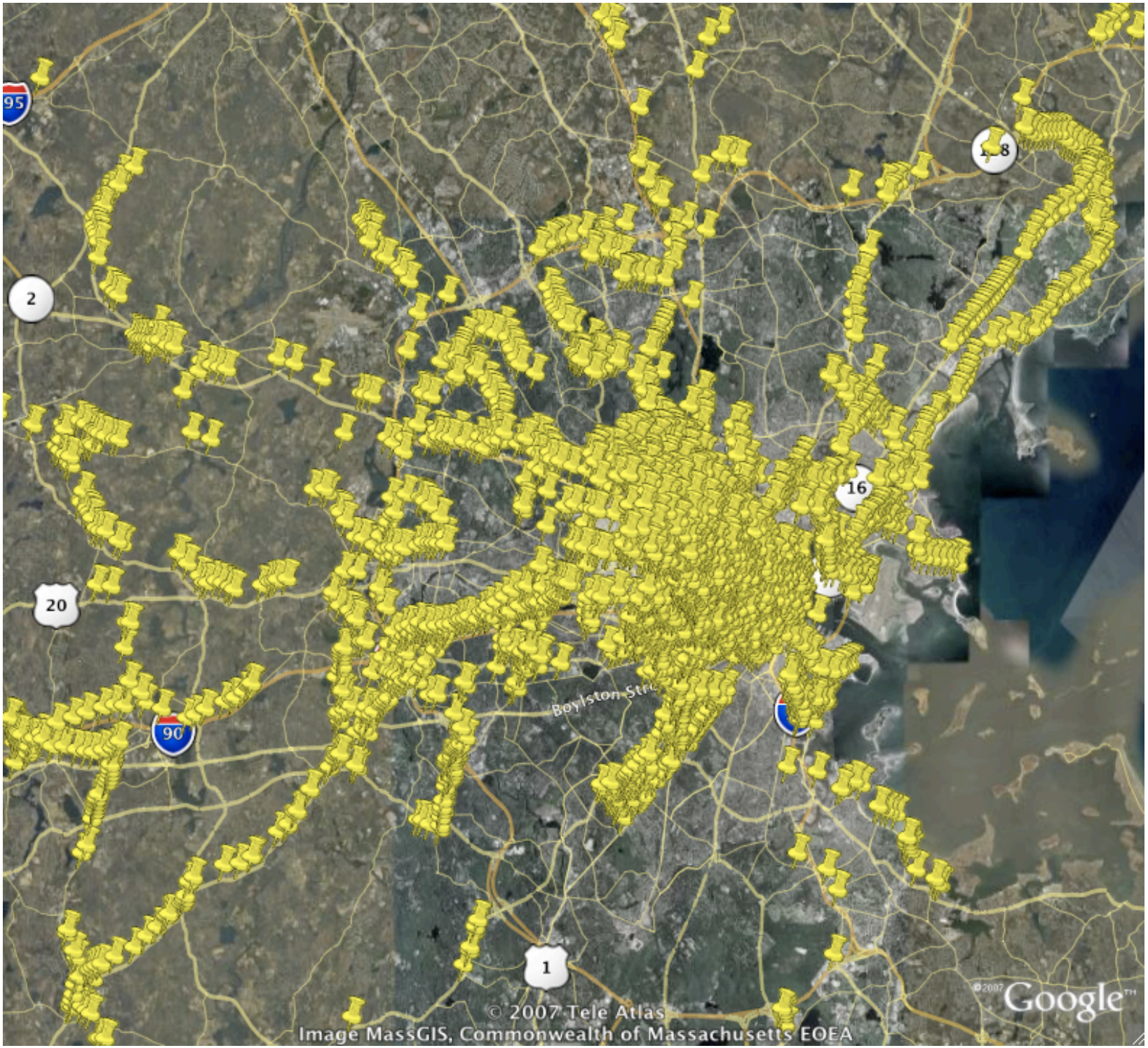
wide-area sensing




Cambridge
Boston
Somerville Ave
Concord Ave
Brattle St
Mass Ave
Soldiers Field
Western Ave
Memorial Dr
Main St
Massachusetts Tpke
Bell Park
Little Mystic Channel
Boston Naval Shipyard NHS
Bennington St
Boston Inner Harbor
Boston Public Gardens
Boston Common
Commonwealth Mall
Boston University
Fort Point Channel
Ted Williams Tunnel
Reserved Channel
Back Bay Fens
Northeastern University
Beacon St
Huntington Ave
Washington St
Dorchester Ave
Fort Independence Park
Marine Park
Pleasure Bay
Columbus Park
Brookline Reservoir Park

open WiFi connectivity




95
2
20
90
16
1
Boylston St
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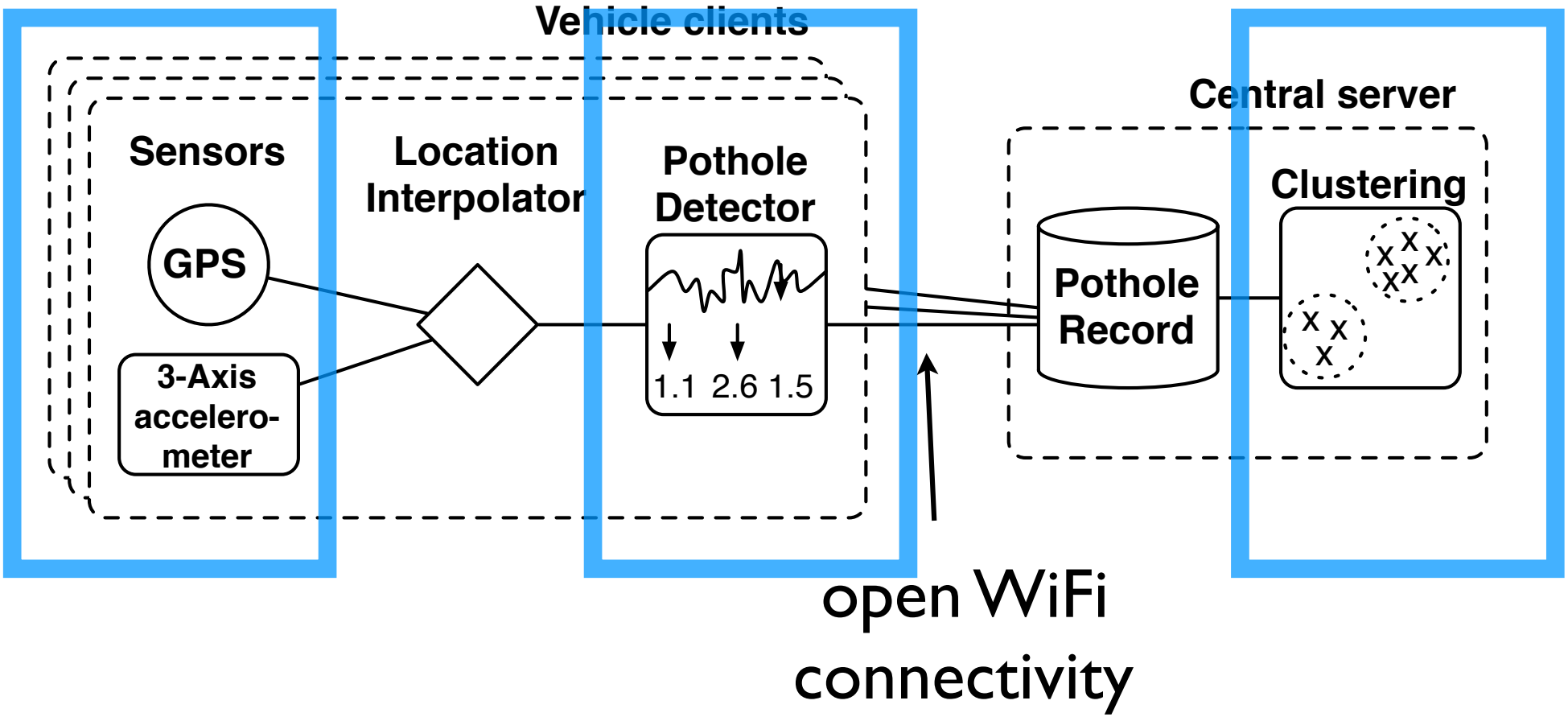
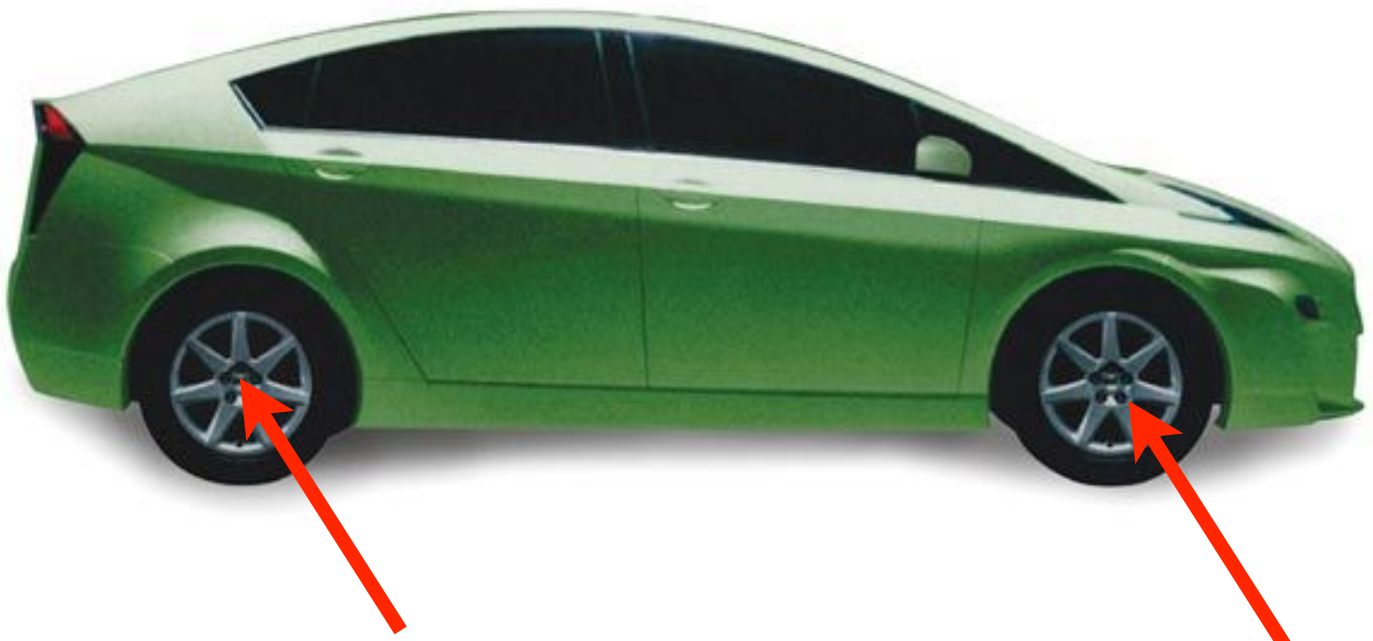
P² architecture



sensor placement

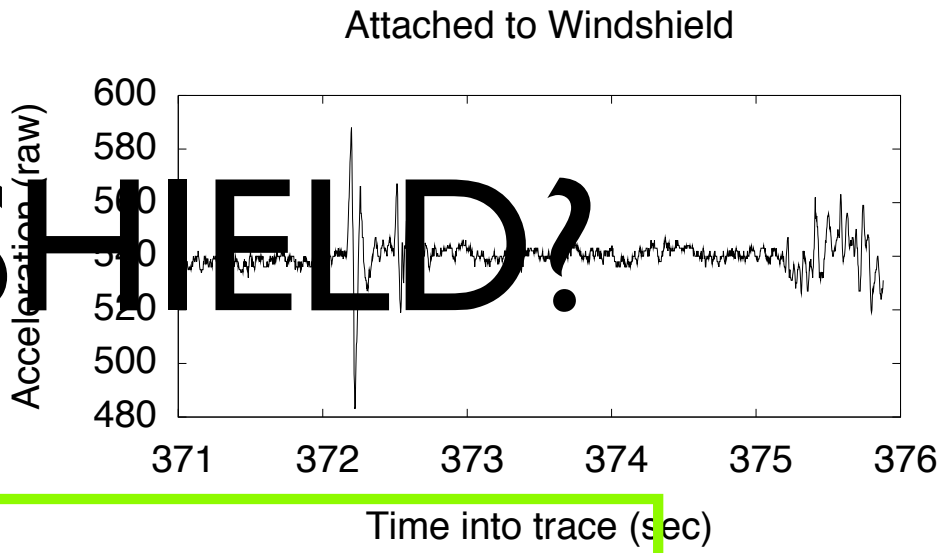


try to stay
inside vehicle

- highly accurate
- difficult mounting
- extreme exposure

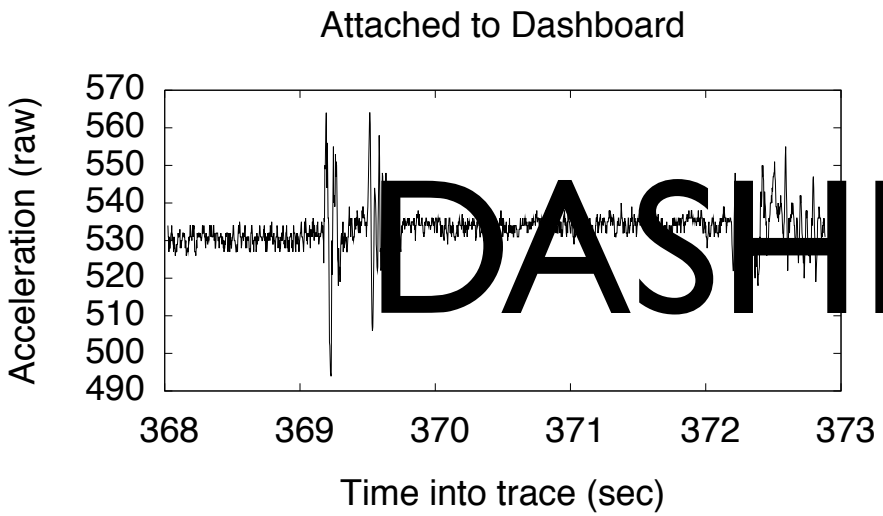
WINDSHIELD?

- very clean signal
- ‘gold standard’
- difficult to mount



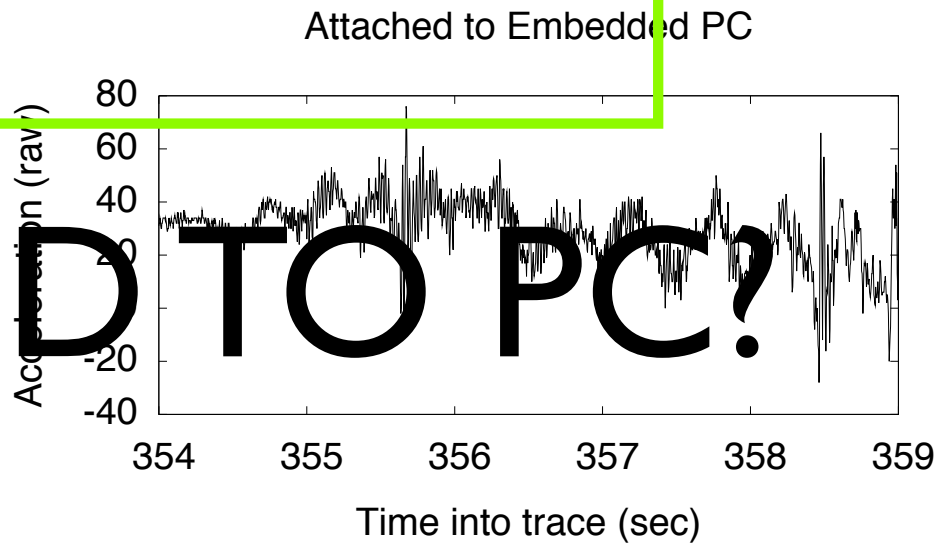
DASHBOARD?

- good signal
- easy to mount?
- out of the way



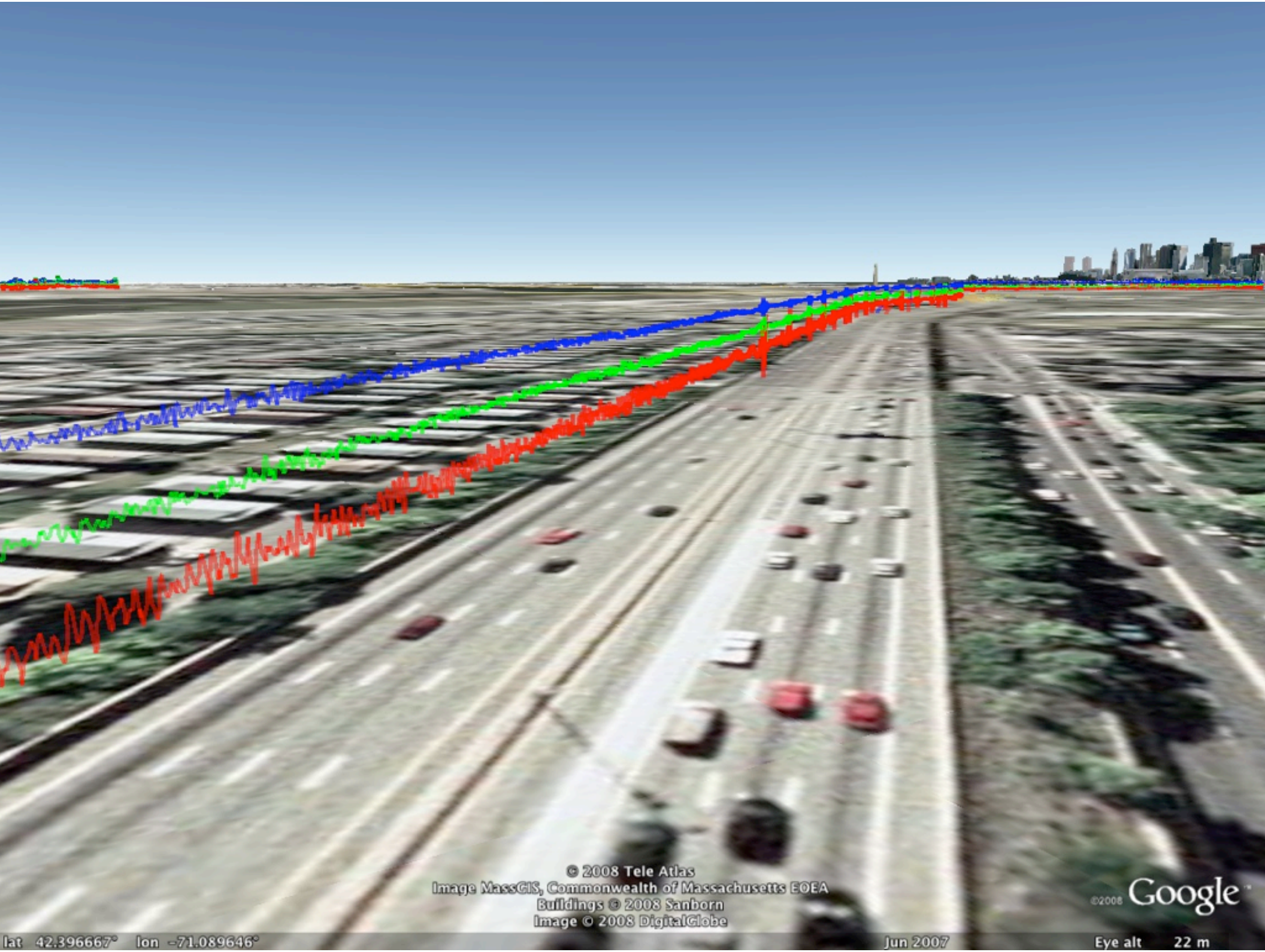
ATTACHED TO PC?

- very poor signal
- no mounting necessary



crowd-pleasing graphics

CONTINUE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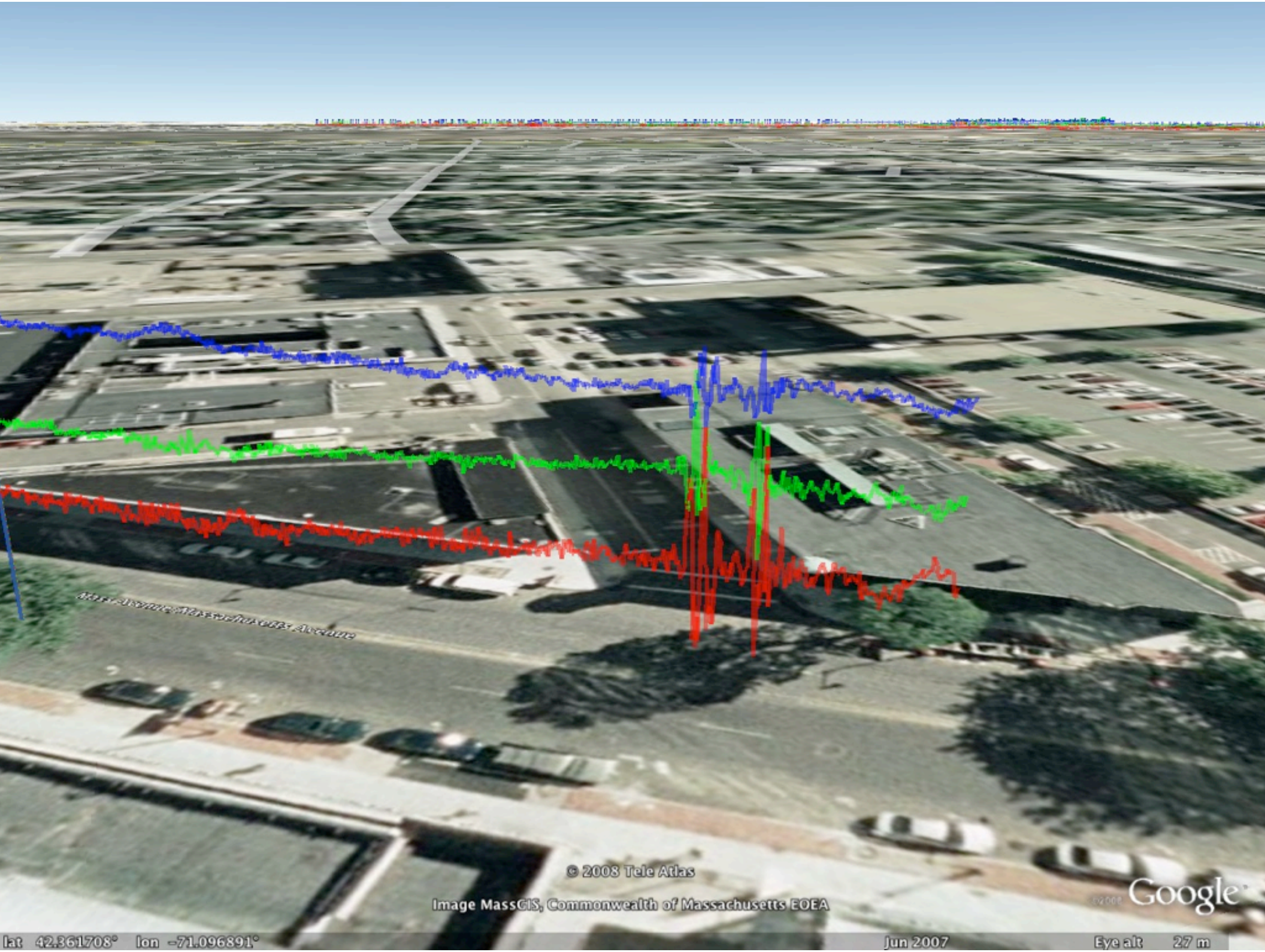
Buildings © 2008 Sanborn
Image © 2008 DigitalGlobe
©2008 Google
lat 42.396667° lon -71.089646°
Jun 2007
Eye alt 22 m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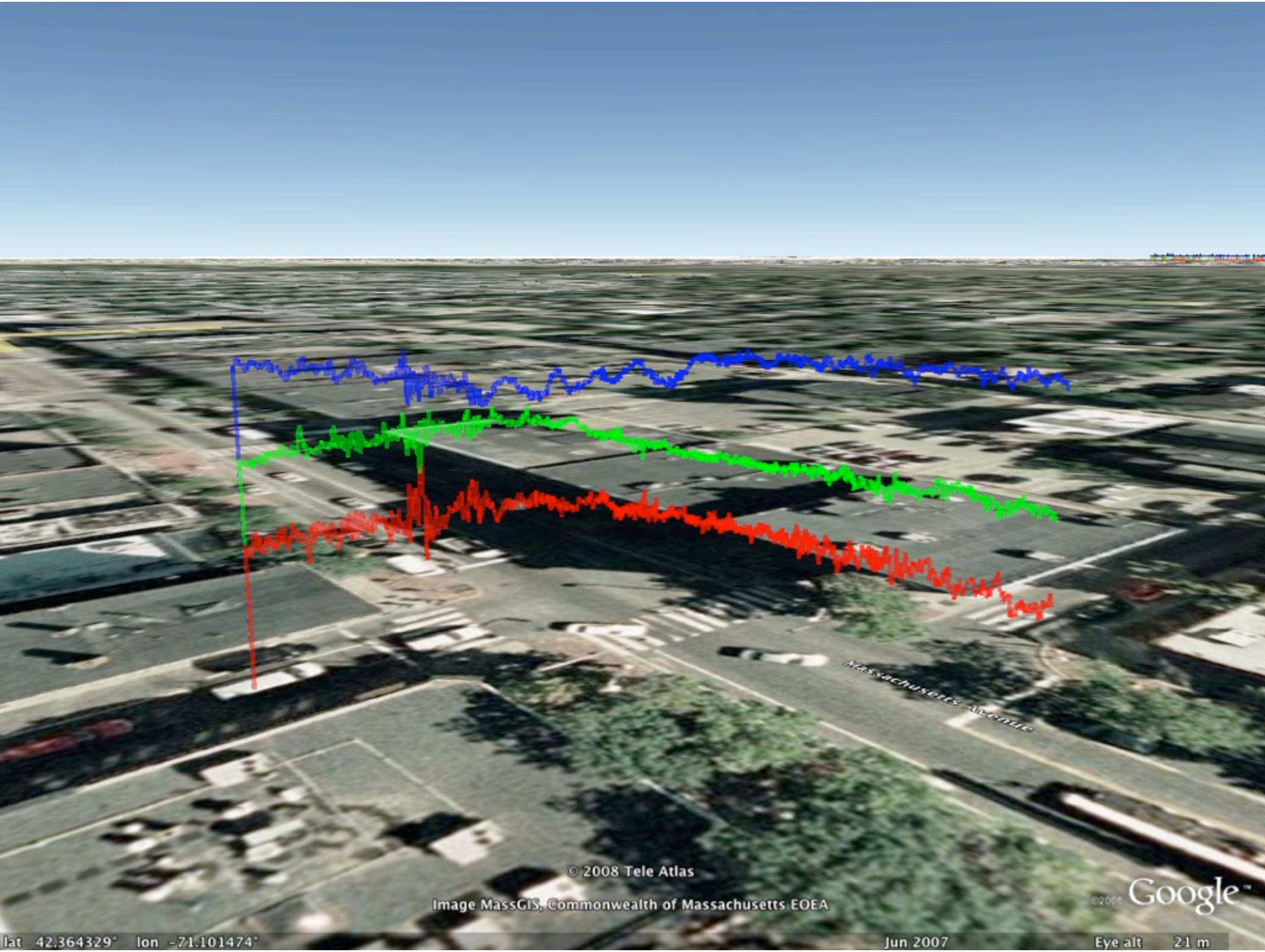
Jun 2007
Eye alt 27 m


Massachusetts Avenue
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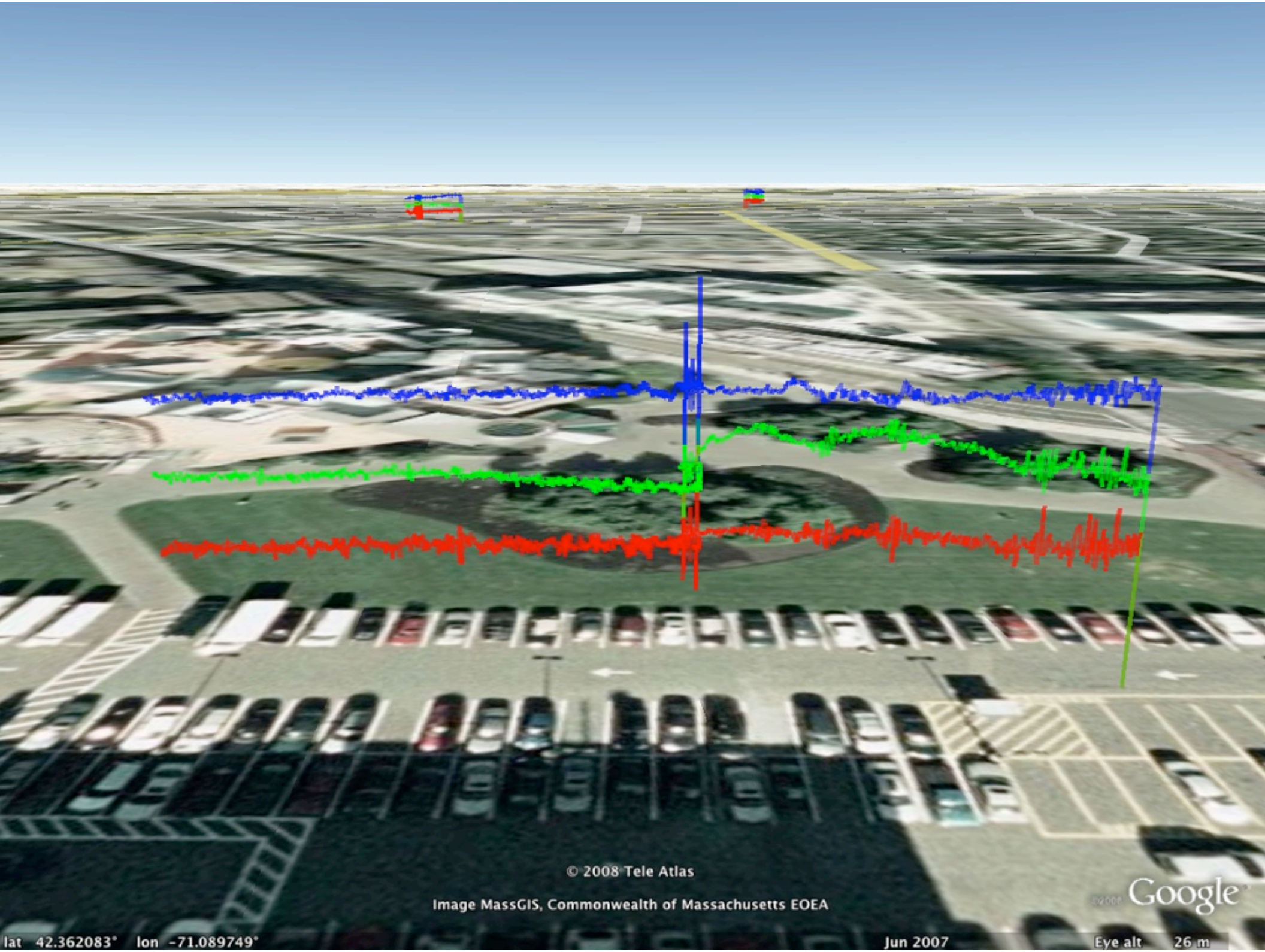
Google
lat 42.364329° lon -71.101474°
Jun 2007
Eye alt 21 m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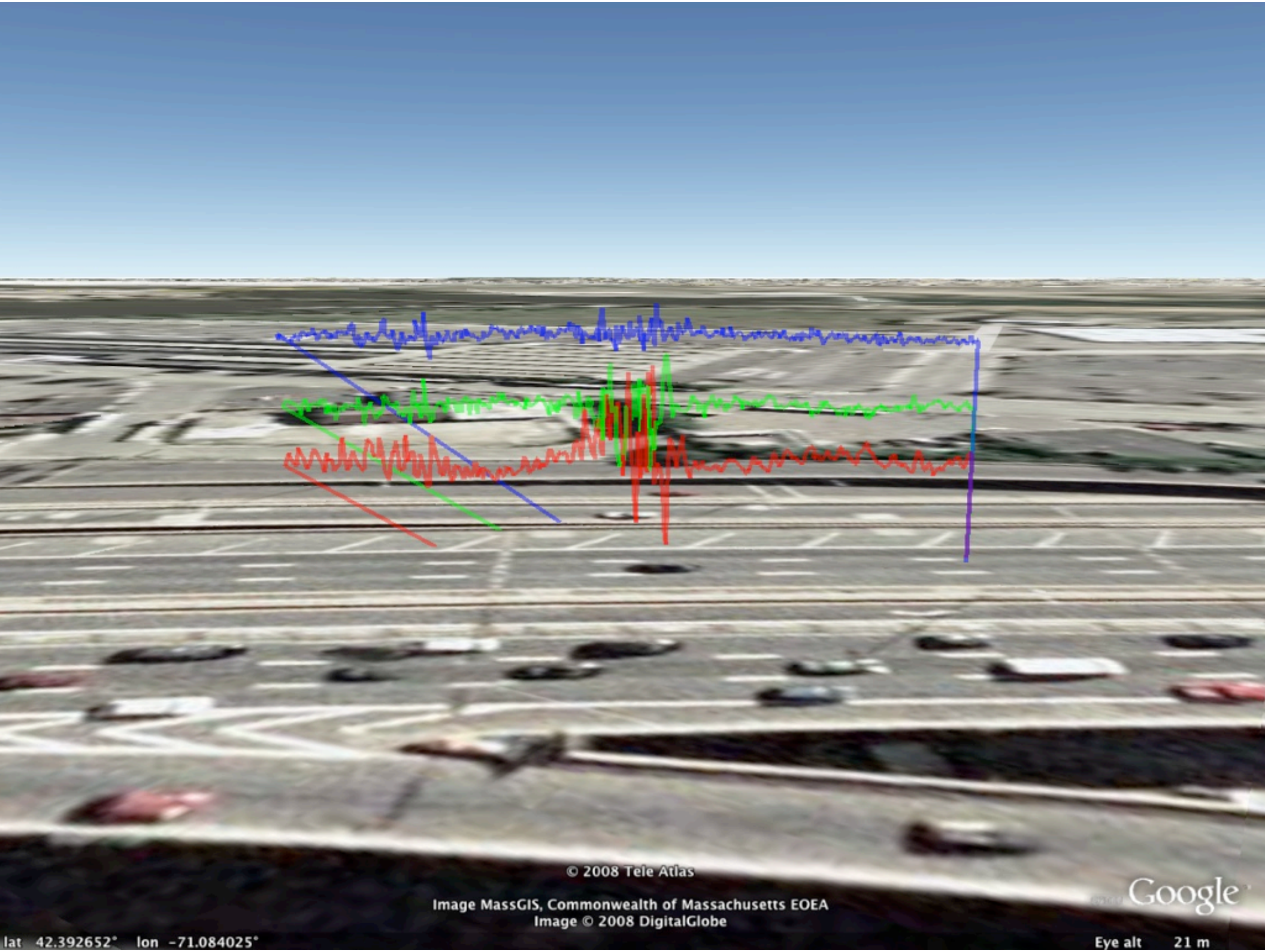
Jun 2007
Eye alt 26 m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Google
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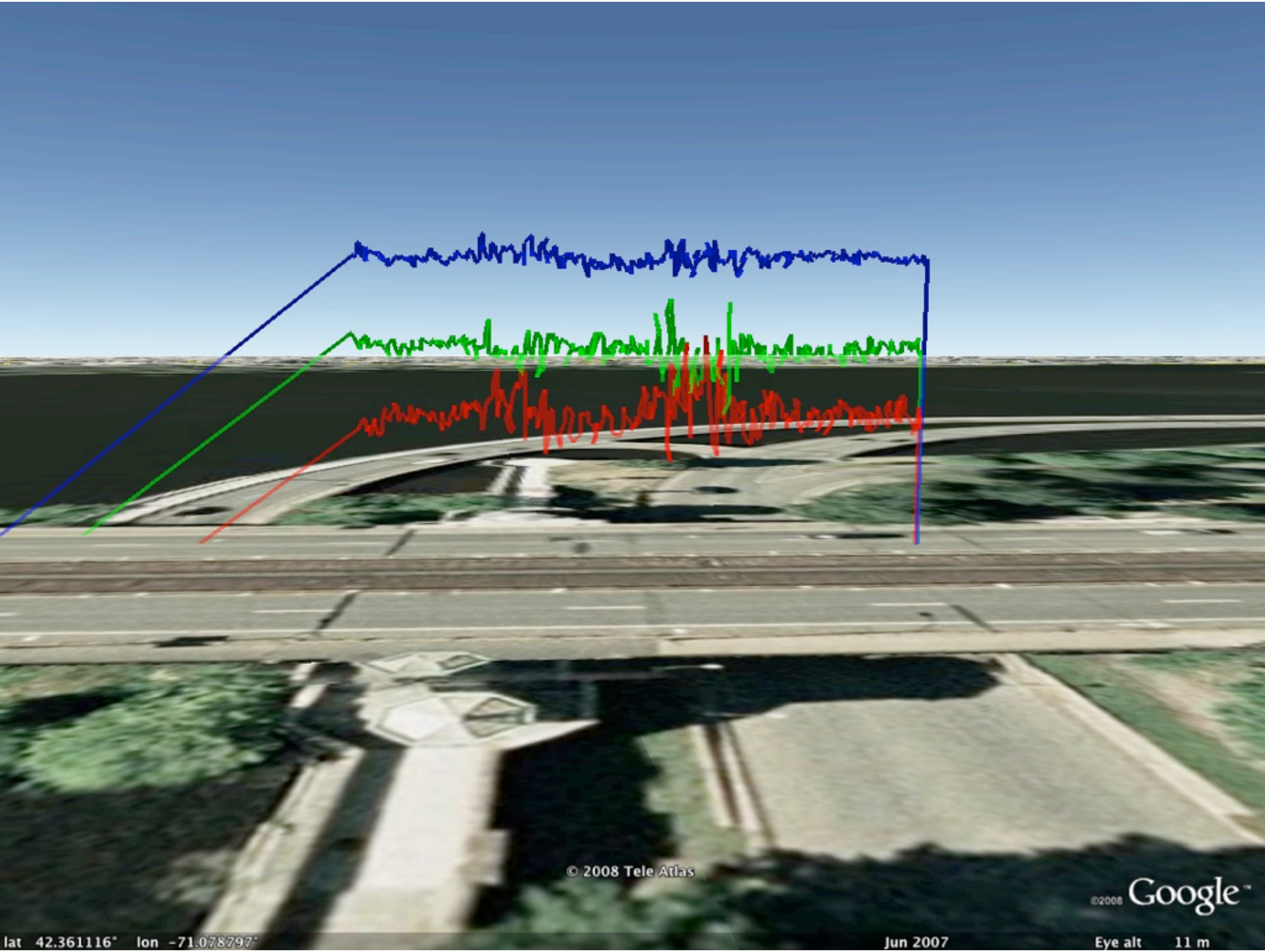
Eye alt 21 m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lat 42.361116° lon -71.078797°
Jun 2007
Eye alt 11 m

P^2 detector

need threshold parameters

256-sample windows →

training the detector

- manually label training samples

Type	Count	Percentage
Smooth road (SM)	64	23%
Potholes (PH)	63	23%
Manholes (MH)	59	21%
Railroad Crossing (RC)	18	6%
Crosswalk/Exp. Joint (CWEJ)	76	27%

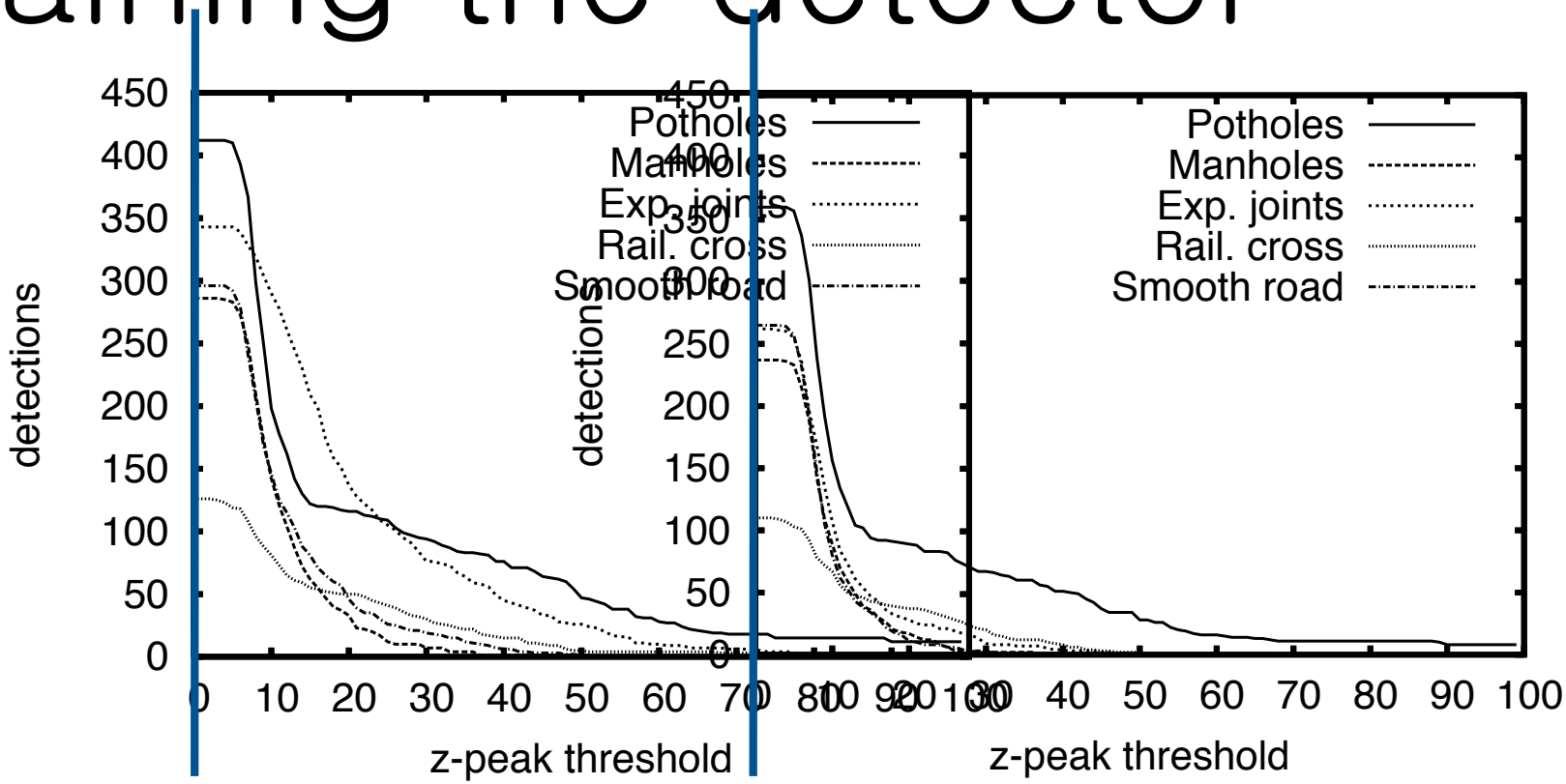
training the detector

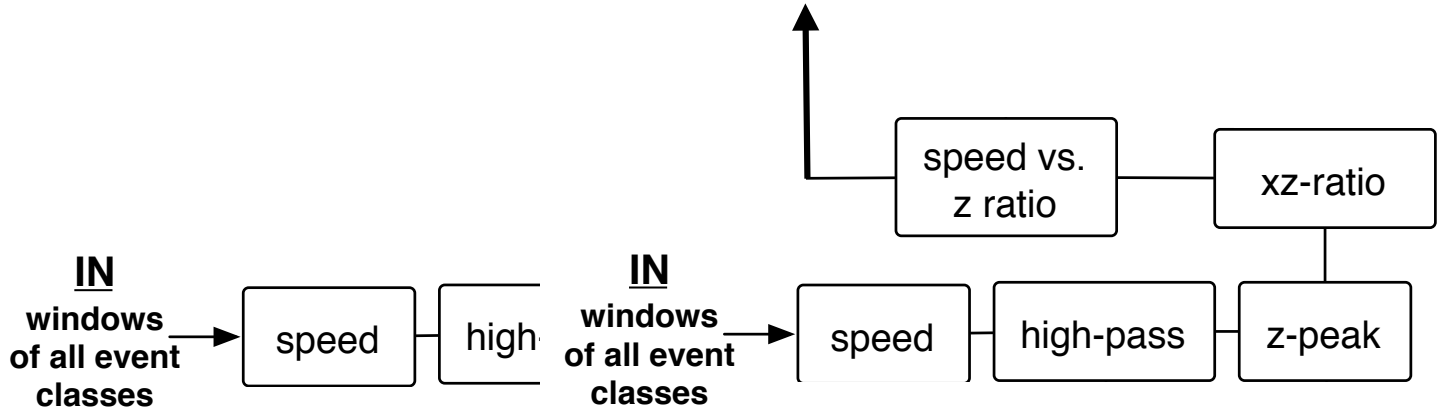
- pick an objective function

$$s(\mathbf{t}) = corr - incorr^2$$

- optimize over 3 threshold parameters
  - z-peak
  - xy-ratio
  - speed vs. z-ratio

training the detector

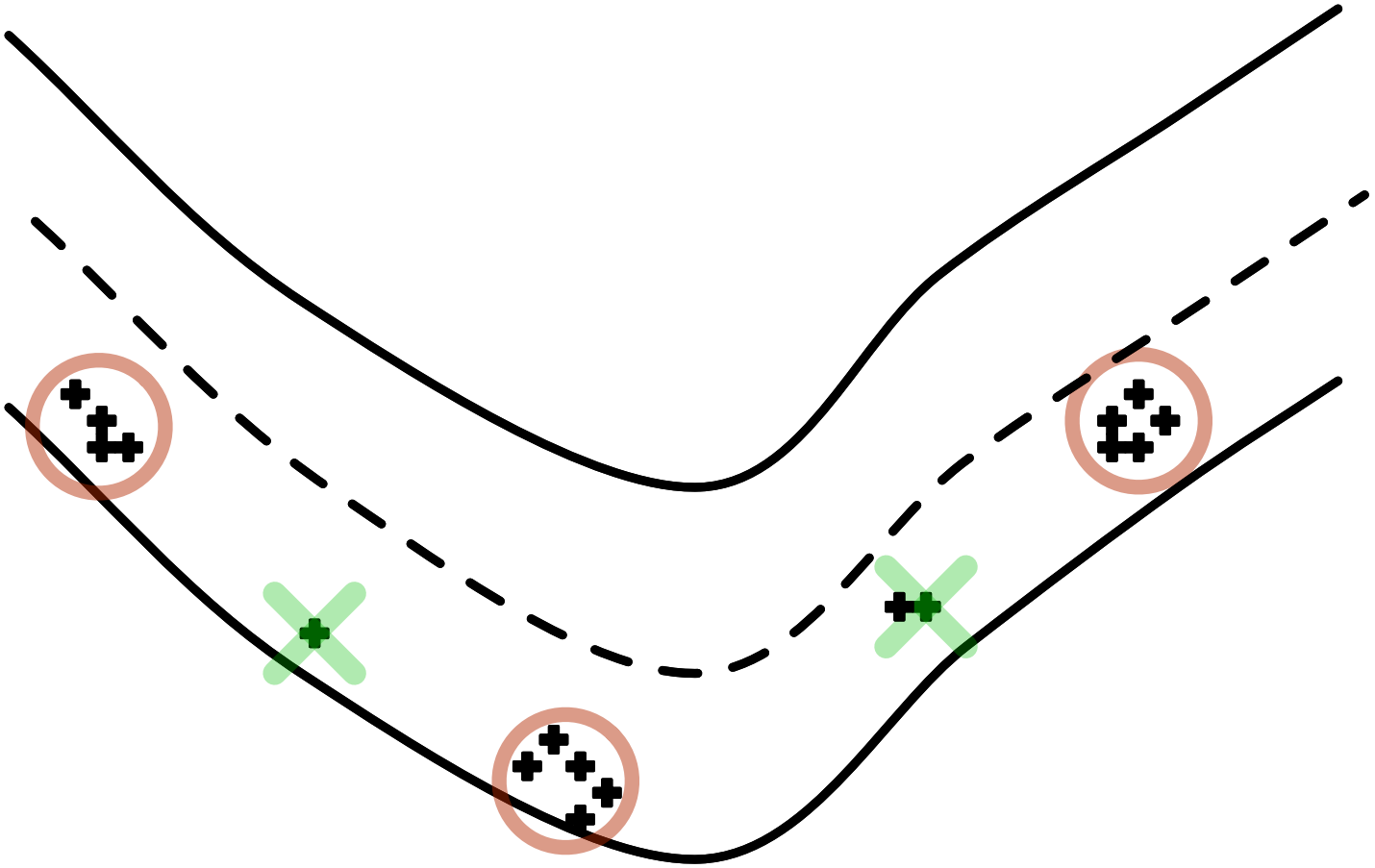




detector performance

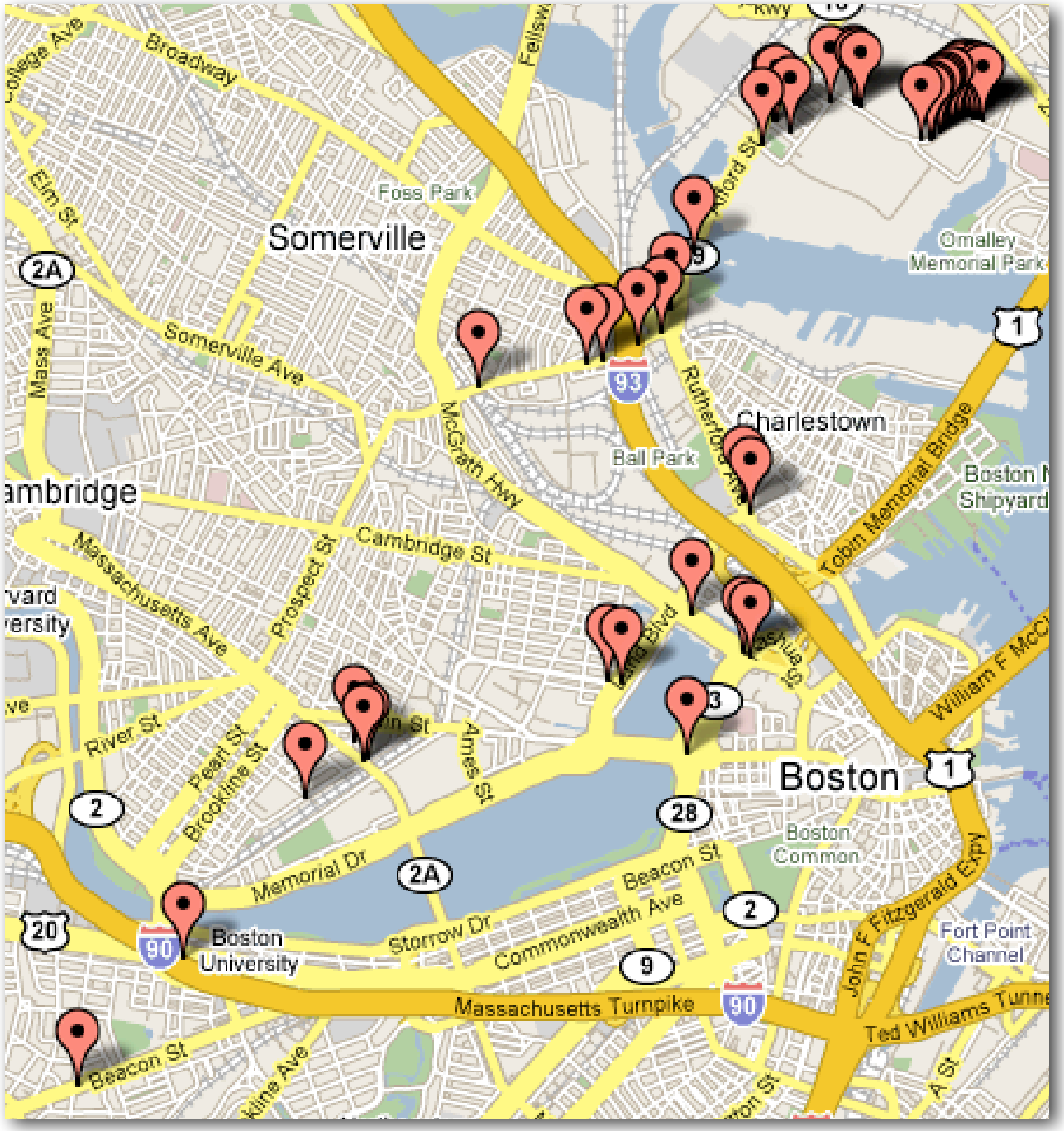
Road	# potholes	#win	#det.	rate
Storrow Dr.	few	1865	3	0.16%
Memorial Dr.	few	1781	2	0.12%
Hwy I-93	few	2877	5	0.17%

clustering



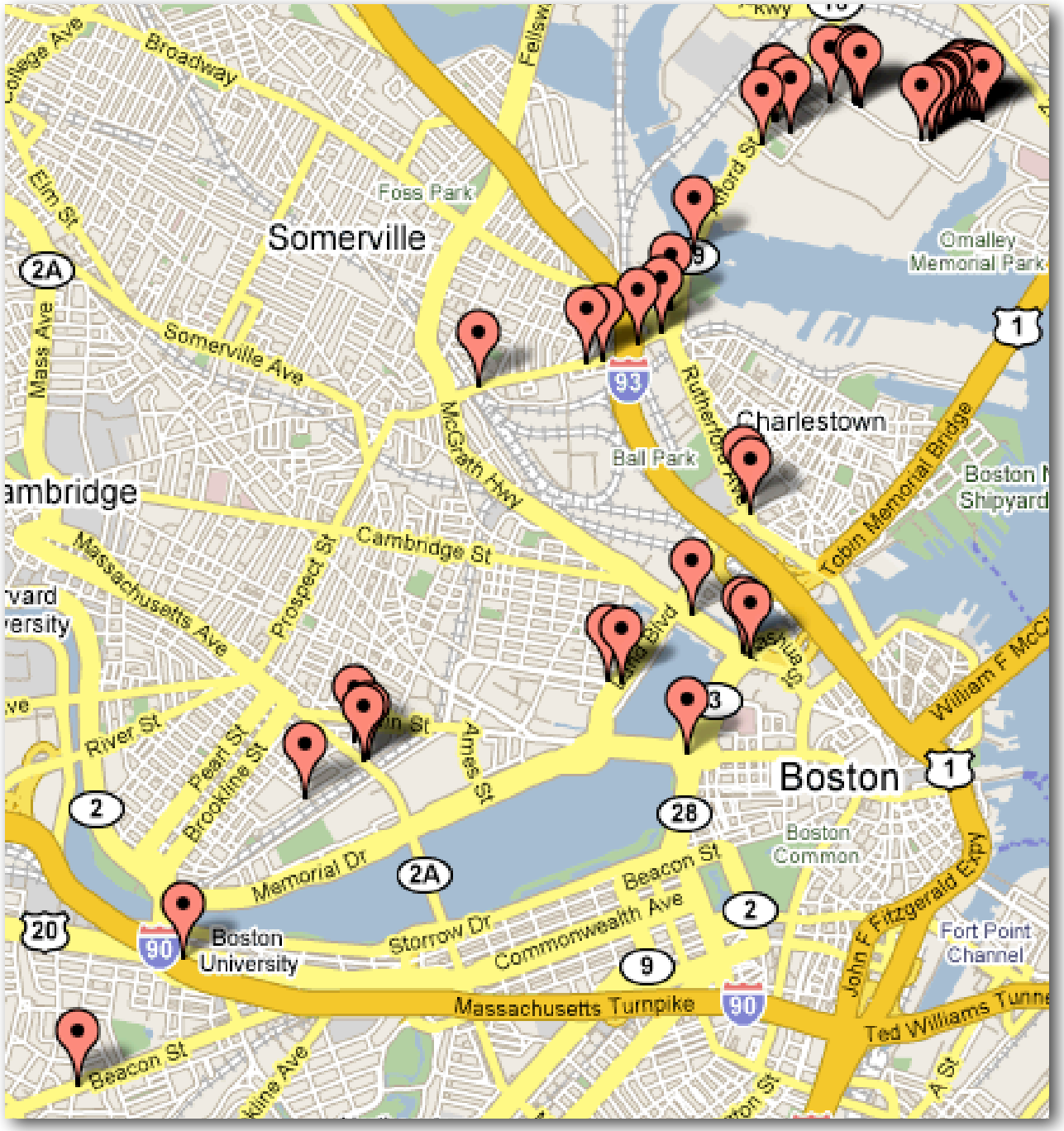
- 1.4 million sample windows
- 2500 unique km of road covered
- 4131 detections in 2709 locations

impact of cluster size


Somerville
Foss Park
Broadway
Somerville Ave
Mass Ave
Elm St
2A
93
Ball Park
Charlestown
Rutherford Ave
McGrath Hwy
Cambridge St
Prospect St
Massachusetts Ave
River St
Pearl St
Brookline St
Ames St
Memorial Dr
2
20
90
Boston University
Storrow Dr
Commonwealth Ave
Beacon St
Massachusetts Turnpike
Boston
Boston Common
28
9
3
1
Tobin Memorial Bridge
William F McC
John F Fitzgerald Expy
Fort Point Channel
Ted Williams Tunne
O'malley Memorial Park
Shipyard

48 spot-checks

potholes	39
sunk-in manholes	3
railways and exp. joints	4
undetermined	2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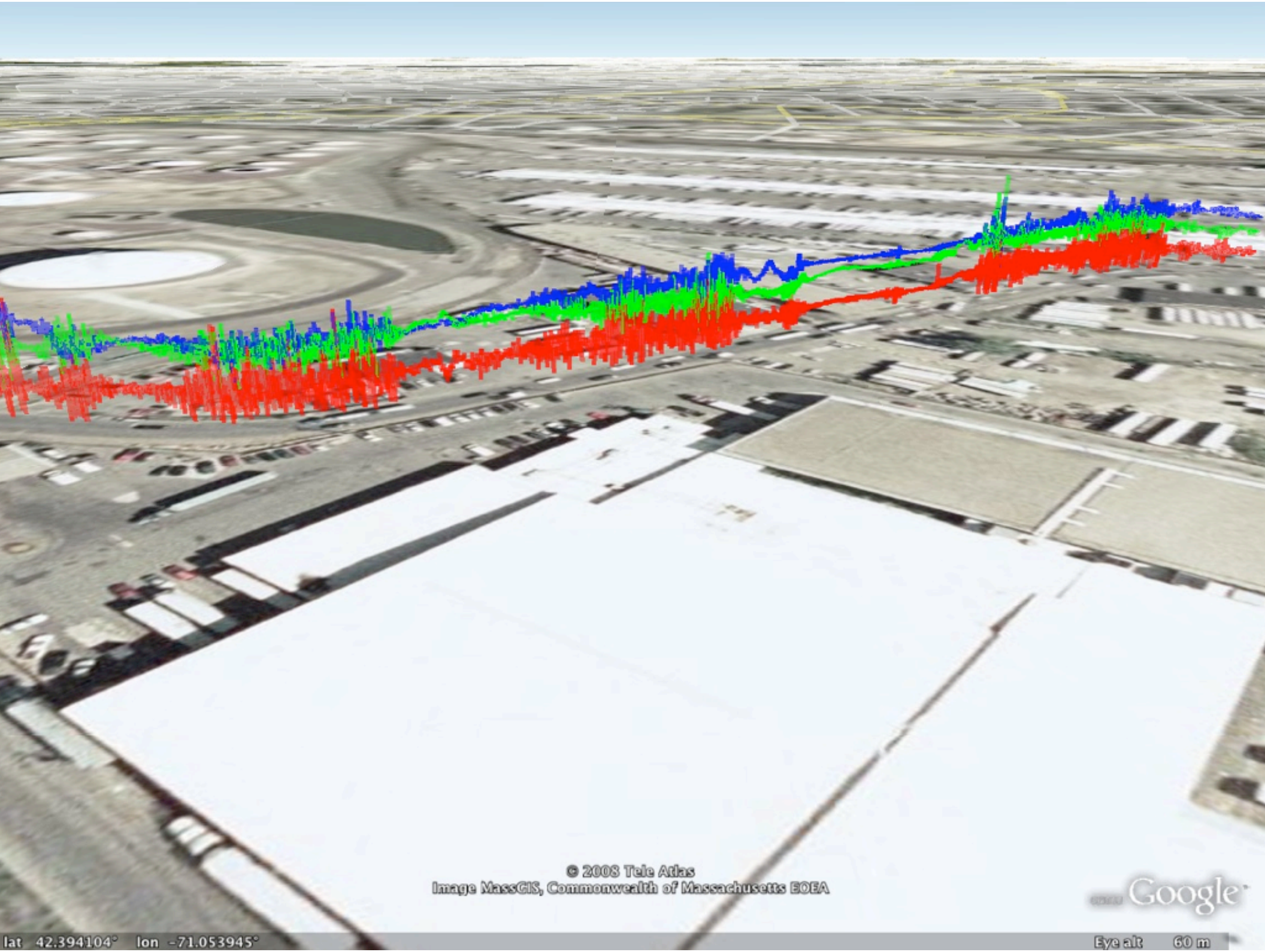
McGrath Hwy
Rutherford Ave
Charlestown
Ball Park
Tobin Memorial Bridge
Boston
Shipyard
O'malley
Memorial Park
1
Cambridge St
Massachusetts Ave
Prospect St
River St
Pearl St
Brookline St
Ames St
2
28
Memorial Dr
2A
Boston
University
20
90
Storrow Dr
Commonwealth Ave
Beacon St
Boston
Common
Fort Point
Channel
John F Fitzgerald Expy
9
Massachusetts Turnpike
Ted Williams Tunnel
Beacon St
William F McC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lat 42.394104° lon -71.053945°
Eye alt 60 m

P^2: the Pothole Patrol

- automatic wide-area road quality monitoring
- use of opportunistic mobility
  - mobile sensing
  - delay-tolerant communication
- low-cost approach to help solve a costly problem