Big (Traffic) Data

Probe Data Analytics and Processing for Traffic Information, Traffic Planning and Traffic Management

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A
B


STIHL


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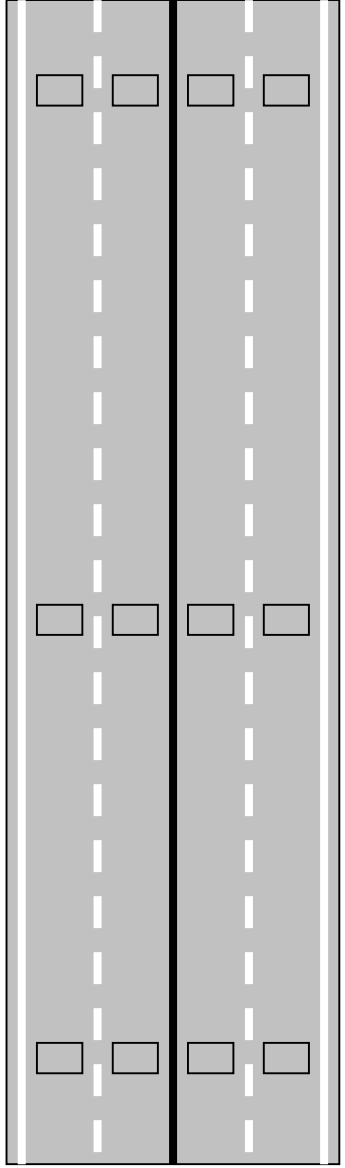
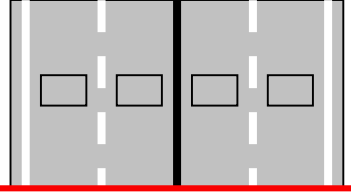
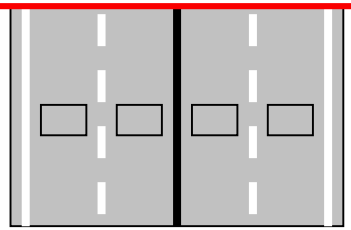




Huge investment and maintenance costs to detect traffic information
Typically every 2 km a loop required to get precise real-time traffic infos

Can we do better?



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Change


LIVE
A316 Richmond
23 min
A314
11 min
A316 Country Way
51 MPH
50 MAX
0.60 MILES
11:22 AM
1:18 HRS
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Change

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Facebook Social Activity Graph (friend interactions)

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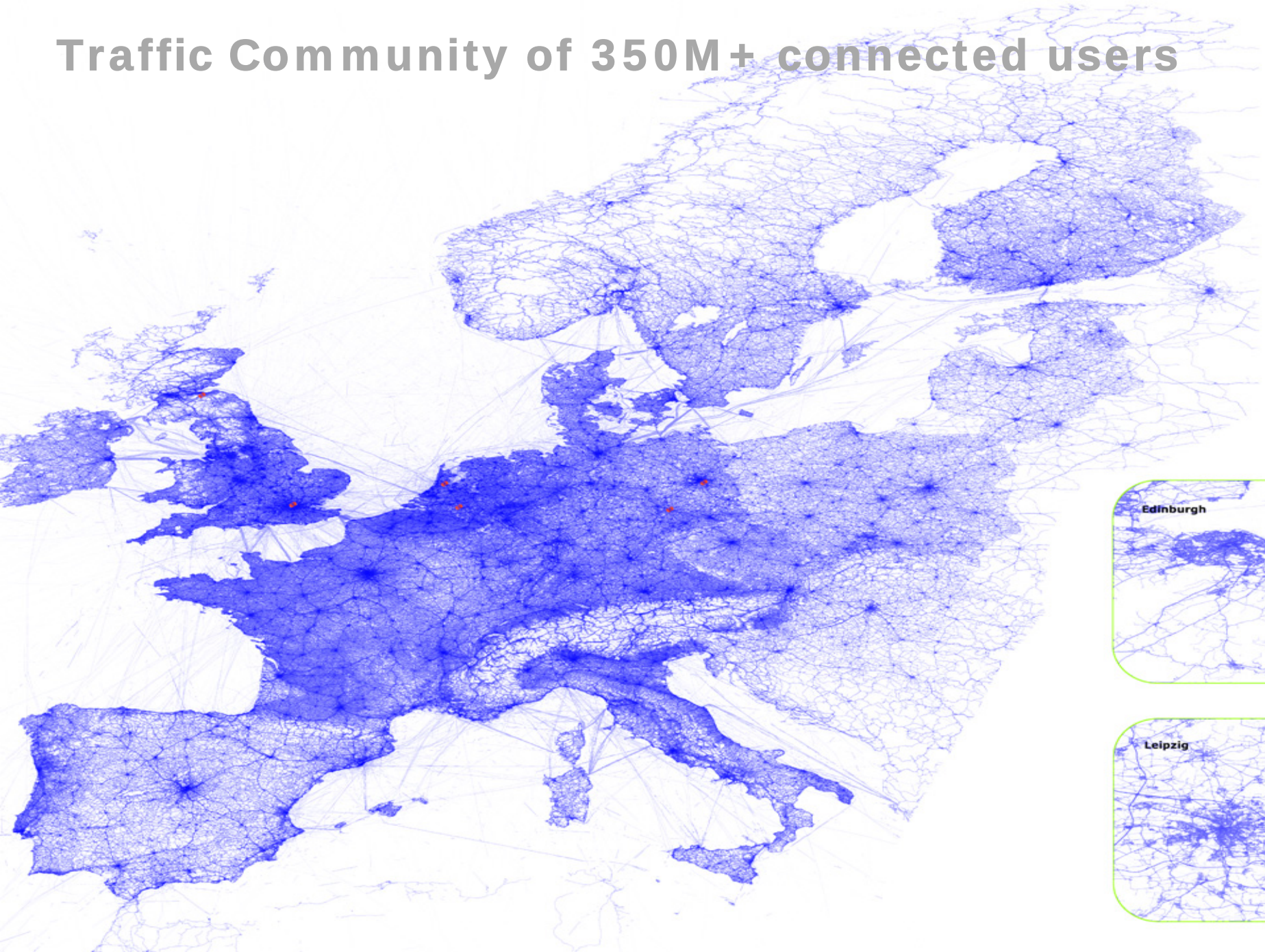
Traffic Community of 350M+ connected users



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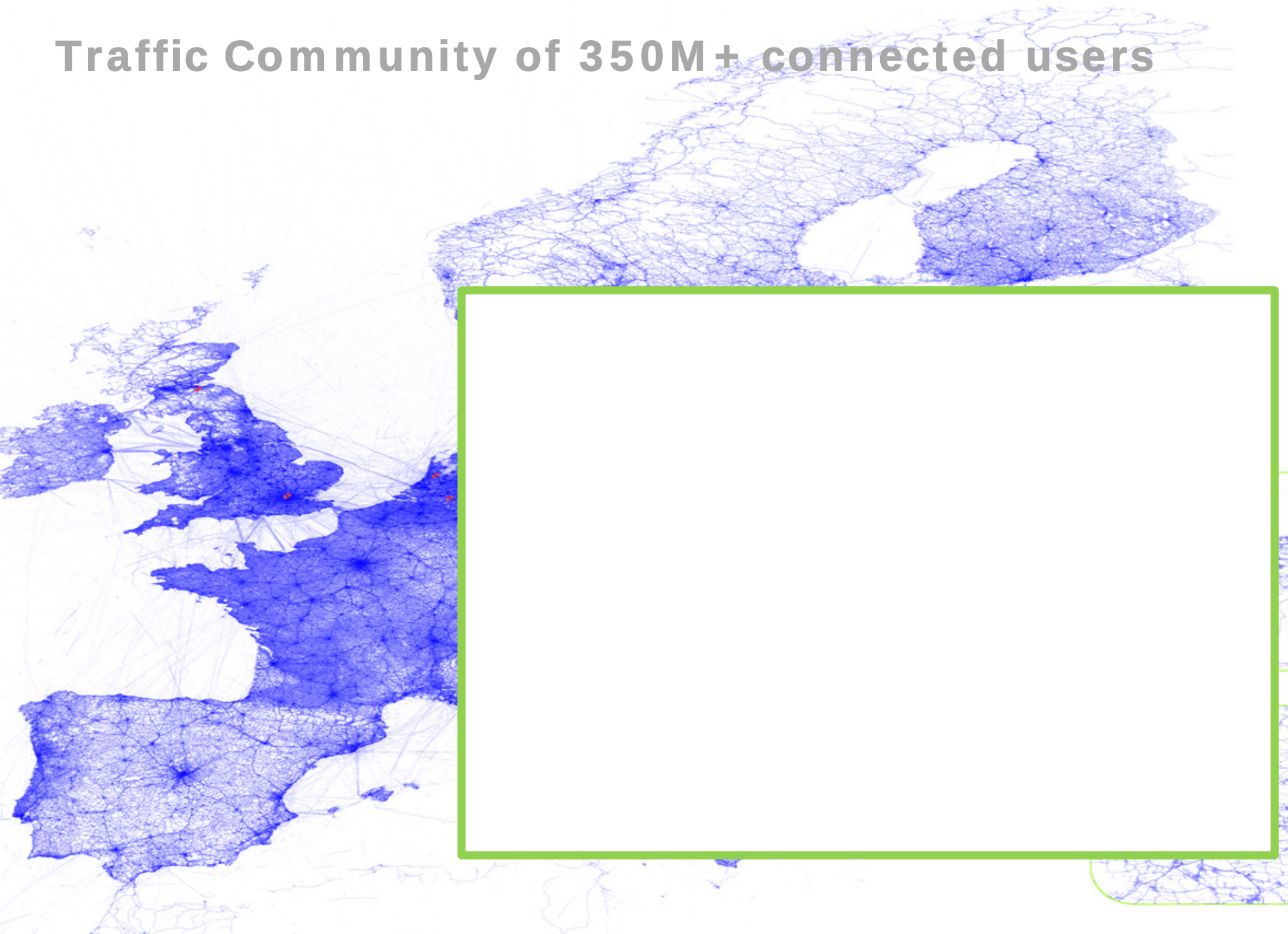

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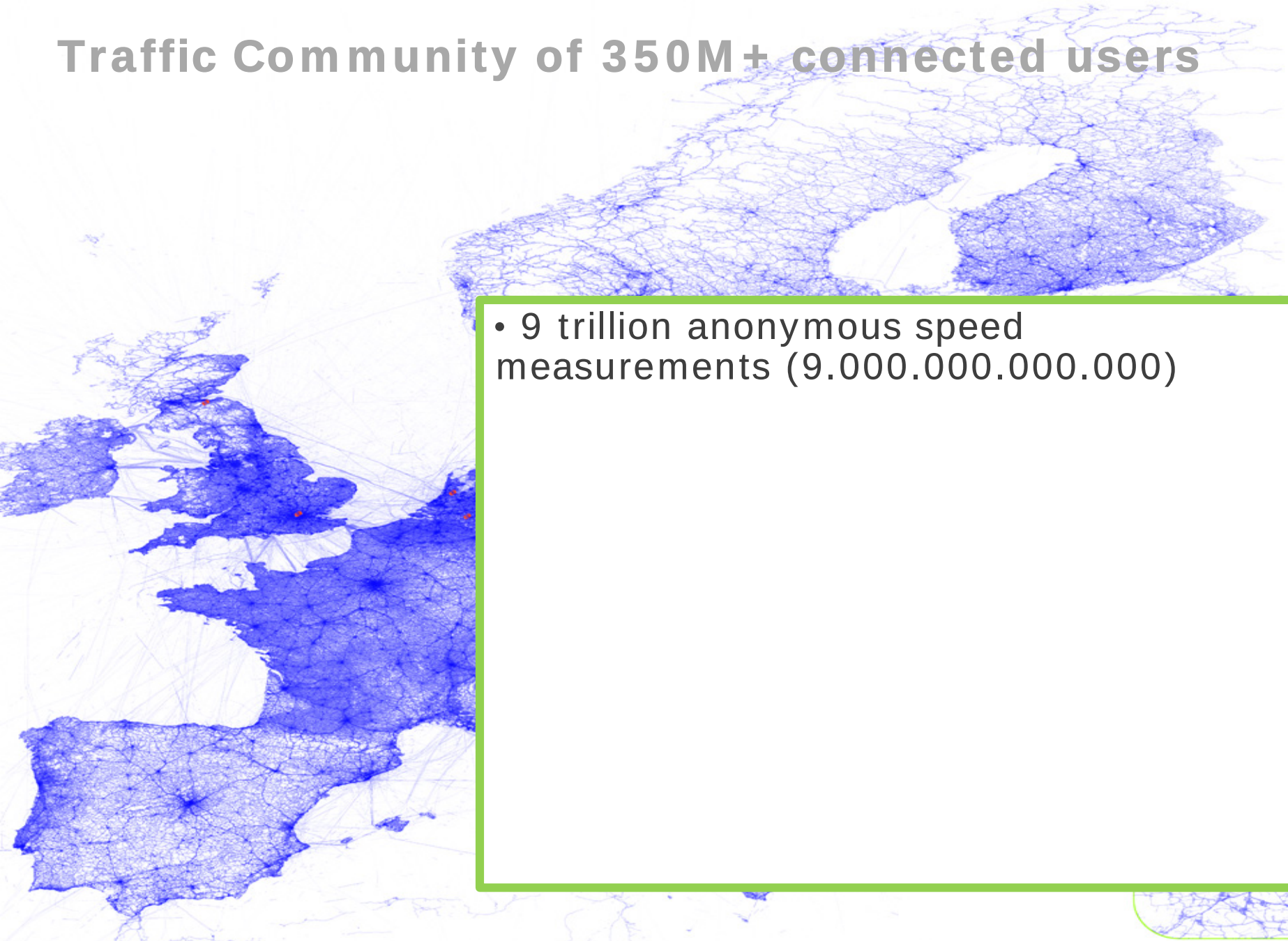
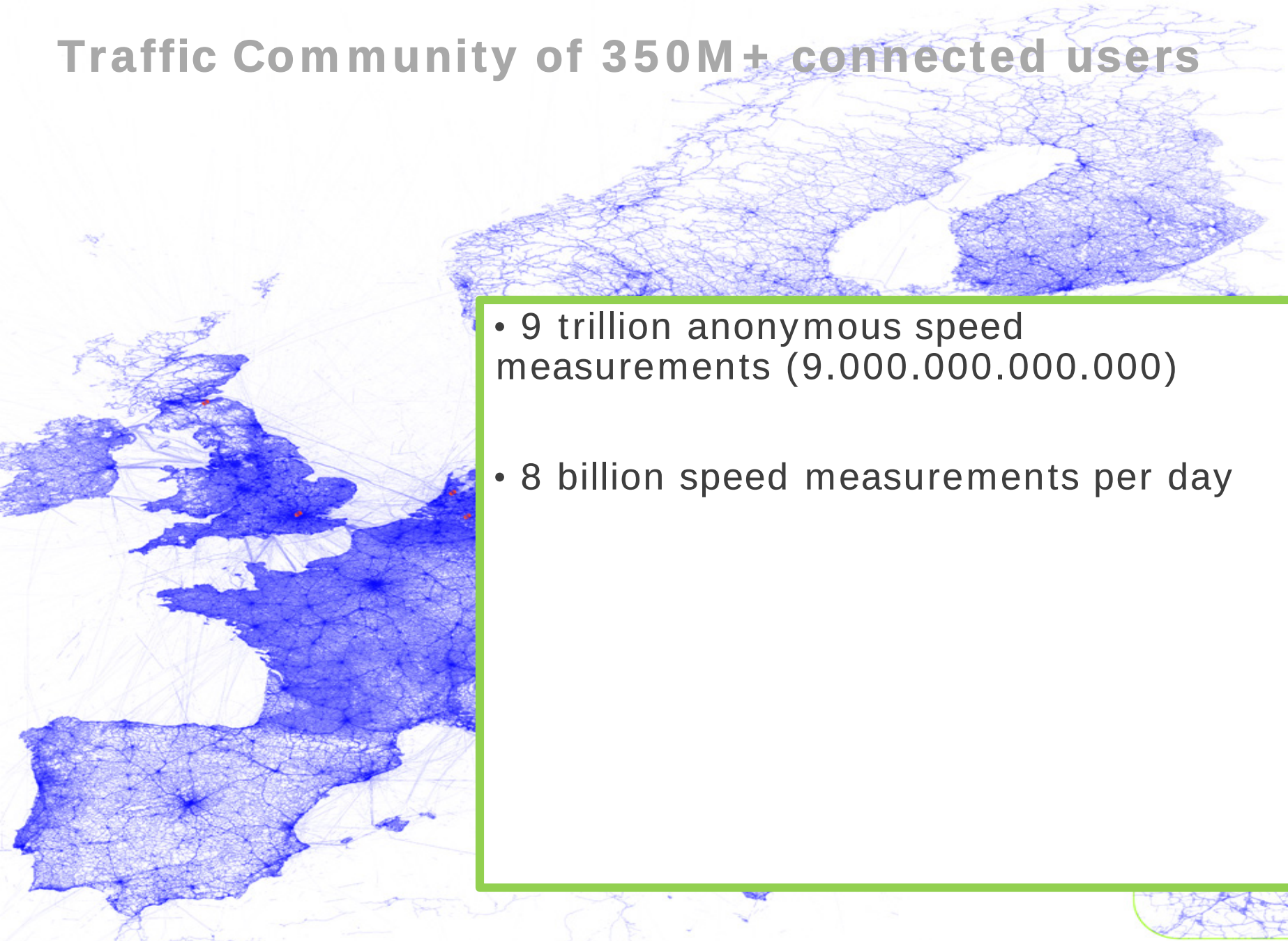


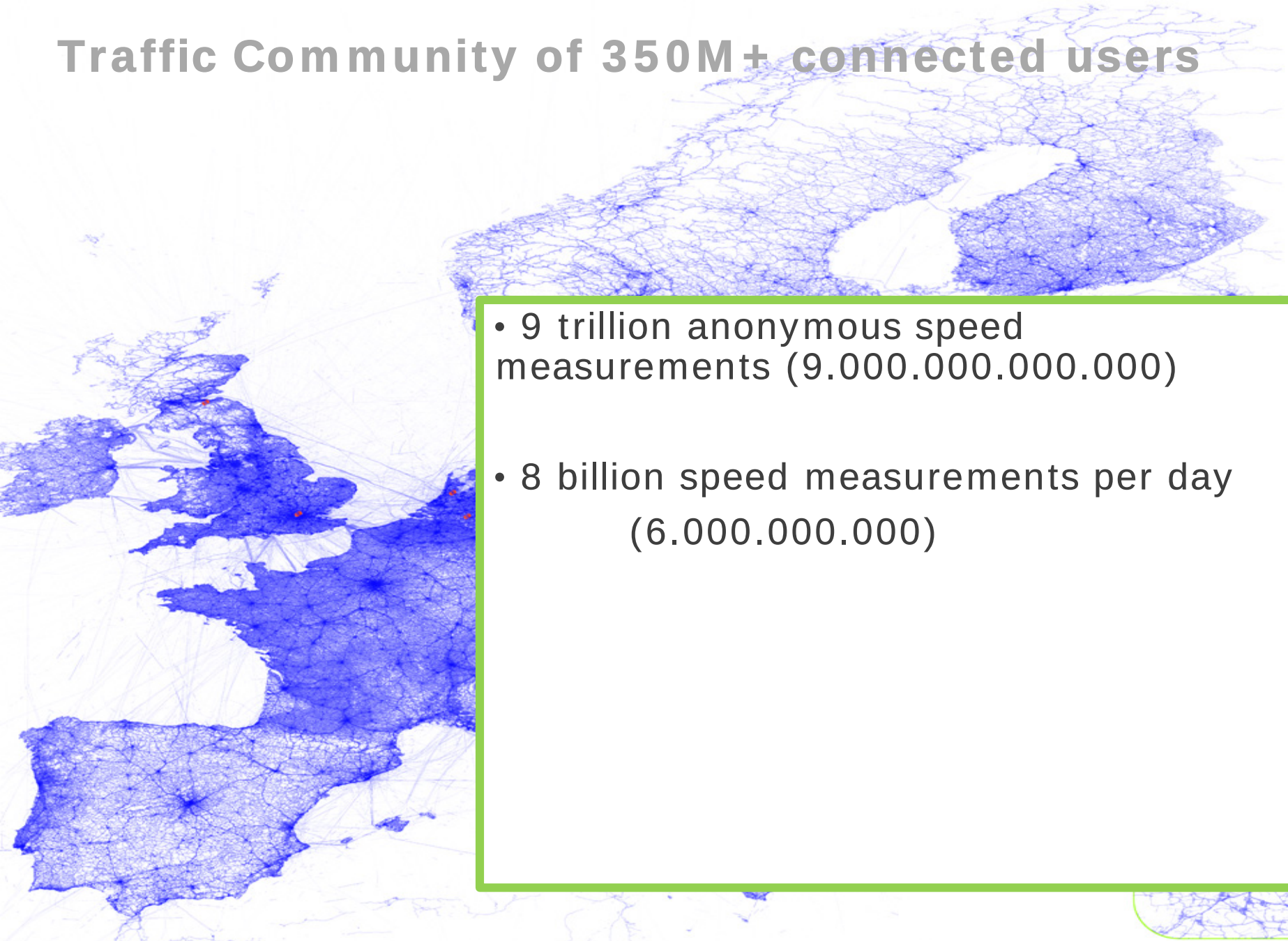
- 9 trillion anonymous speed measurements (9.000.000.000.000)

Traffic Community of 350M+ connected users



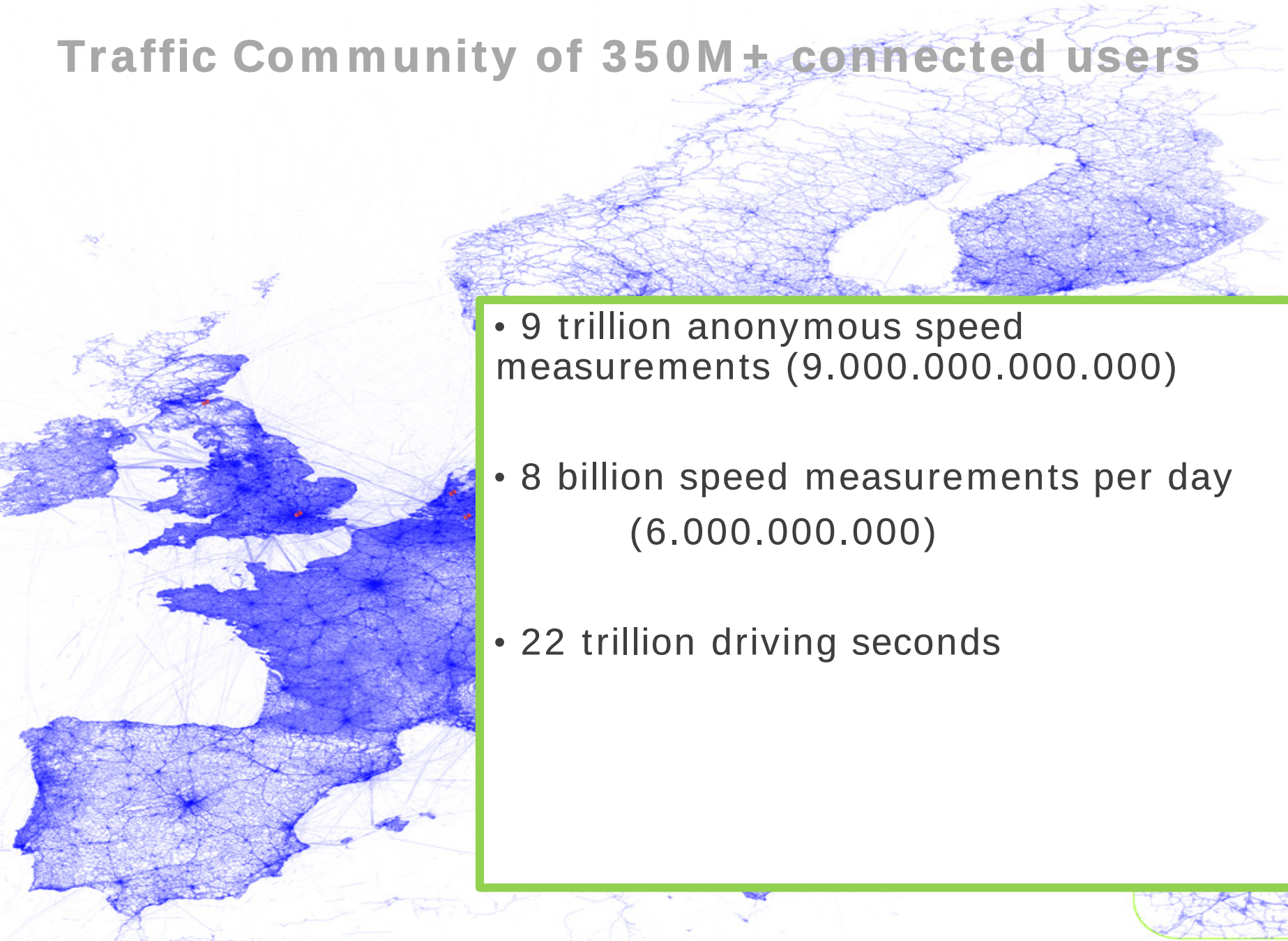
- 9 trillion anonymous speed measurements (9.000.000.000.000)
- 8 billion speed measurements per day

Traffic Community of 350M+ connected users



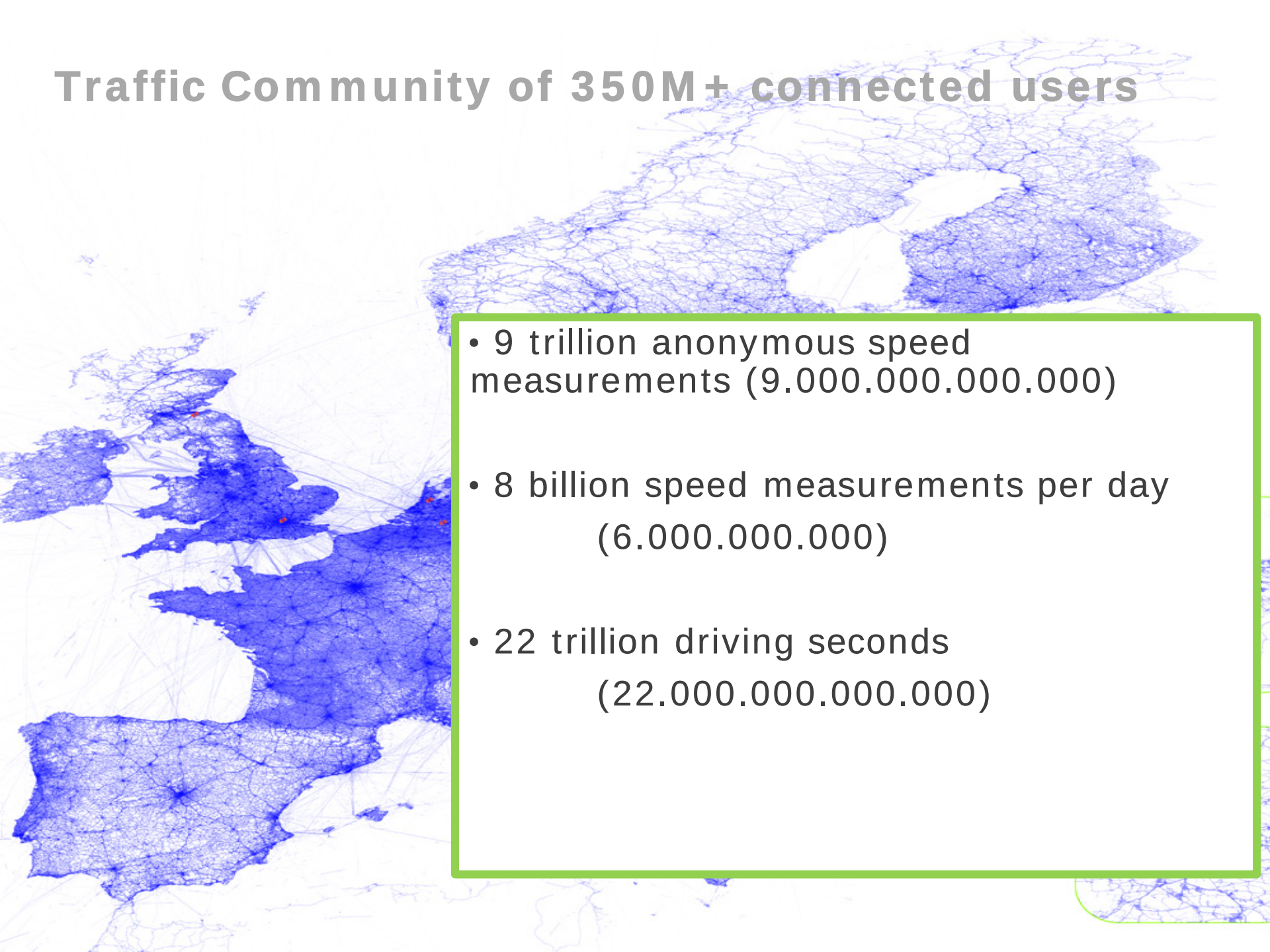
- 9 trillion anonymous speed measurements (9.000.000.000.000)
- 8 billion speed measurements per day (6.000.000.000)

Traffic Community of 350M+ connected users



- 9 trillion anonymous speed measurements (9.000.000.000.000)
- 8 billion speed measurements per day (6.000.000.000)
- 22 trillion driving seconds

Traffic Community of 350M+ connected users



- 9 trillion anonymous speed measurements (9.000.000.000.000)
- 8 billion speed measurements per day (6.000.000.000)
- 22 trillion driving seconds (22.000.000.000.000)

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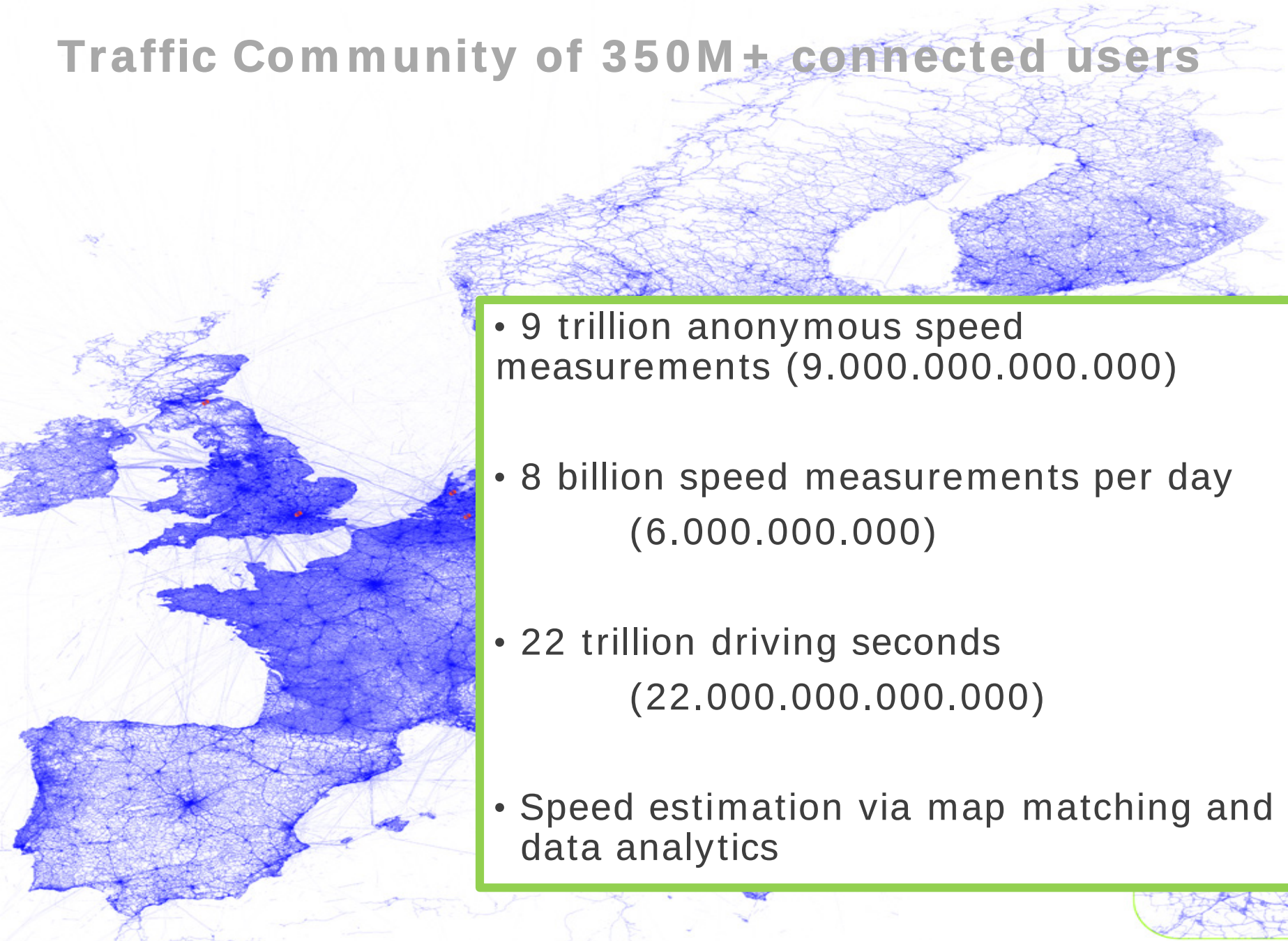

- 9 trillion anonymous speed measurements (9.000.000.000.000)
- 8 billion speed measurements per day (6.000.000.000)
- 22 trillion driving seconds (22.000.000.000.000)
- Speed estimation via map matching and data analytics

GPS PROBE DATA

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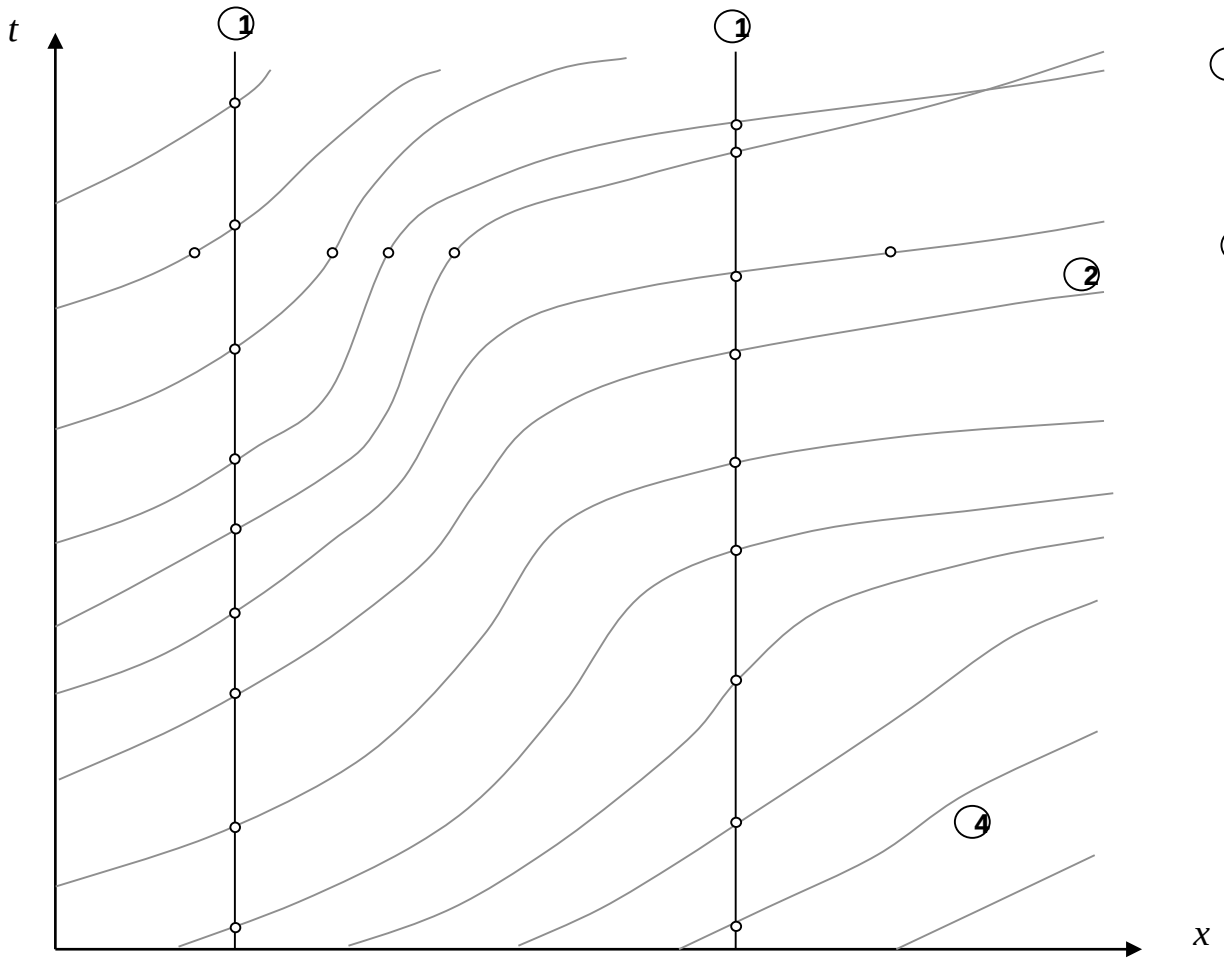
Time-Space Characteristics

Time-Space Characteristics

Probe vehicle
(e.g. GPS)

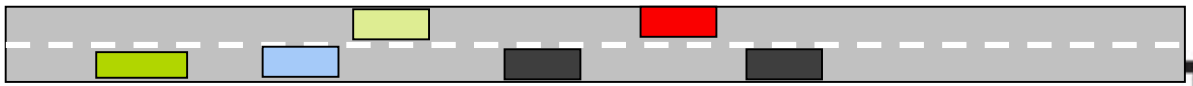
Time-Space Characteristics



1 Local detection (loops)

2

Probe vehicle (e.g. GPS)



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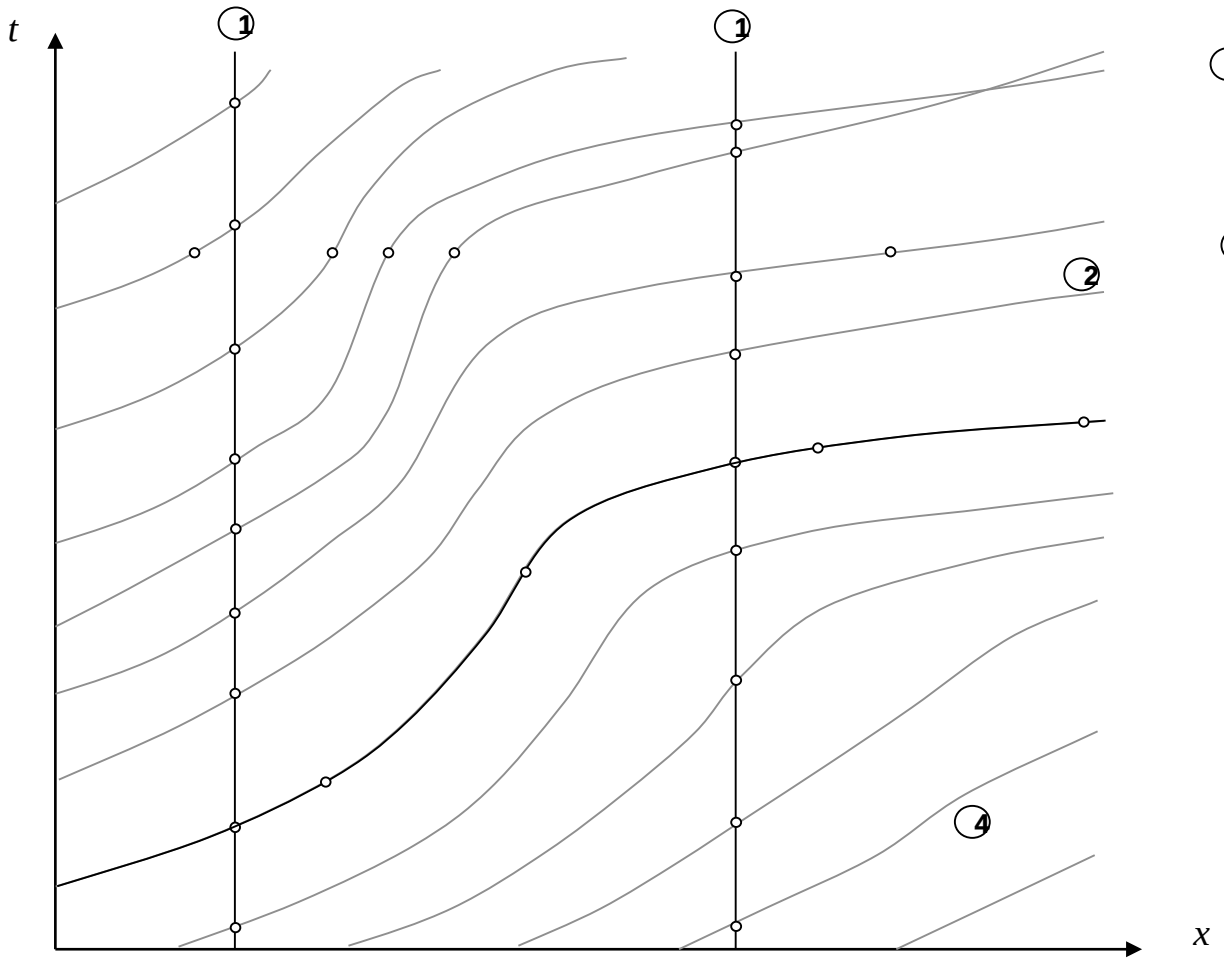
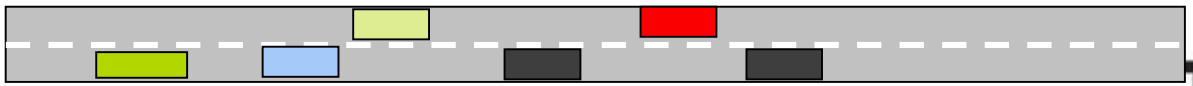
Time-Space Characteristics



1 Local detection (loops)

2 Moving Detection Floating Car

Probe vehicle (e.g. GPS)



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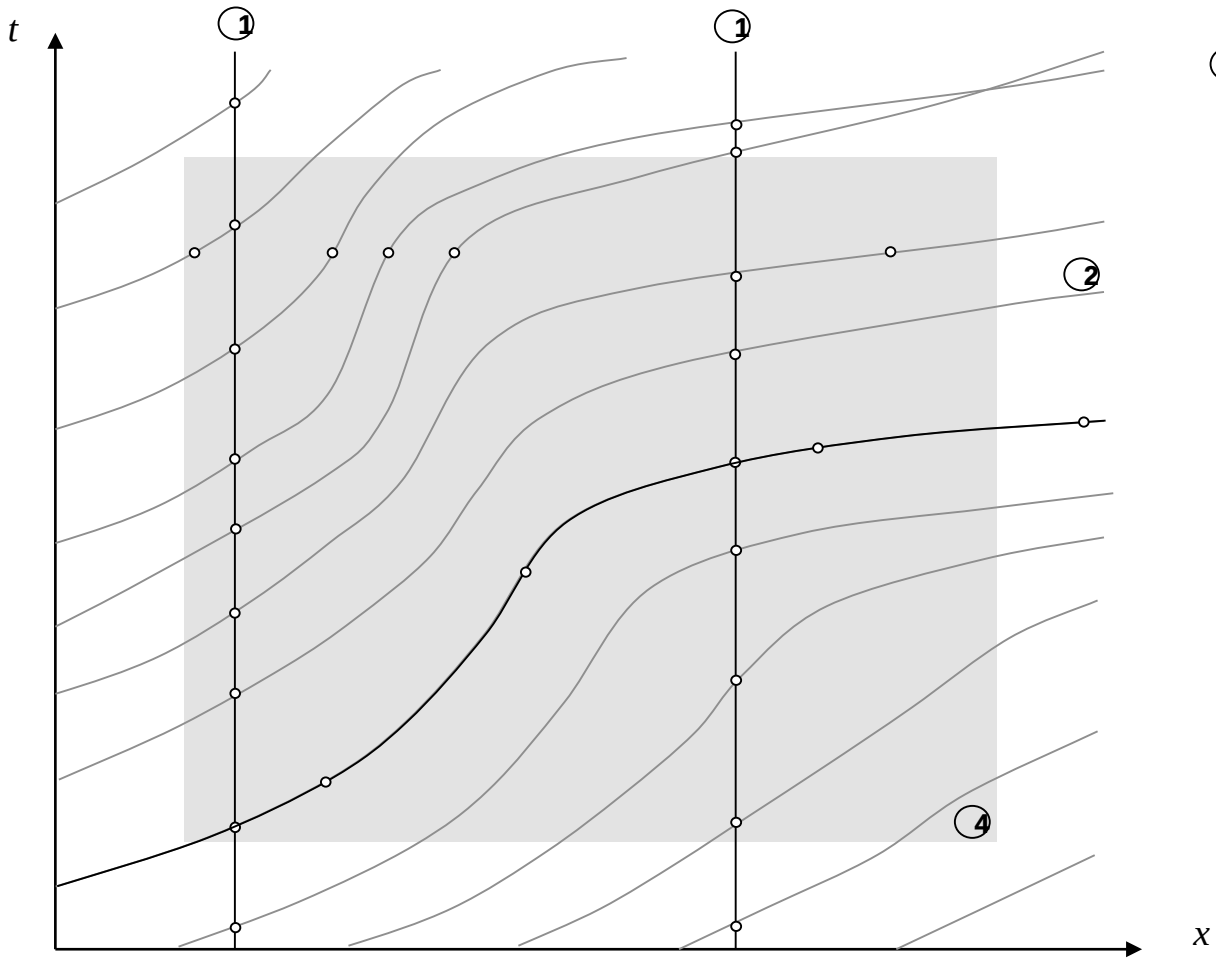

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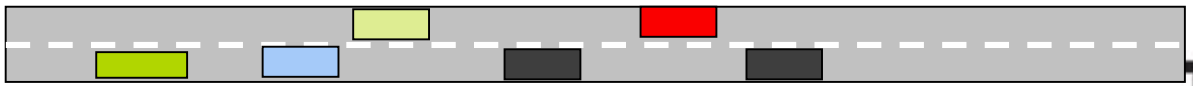

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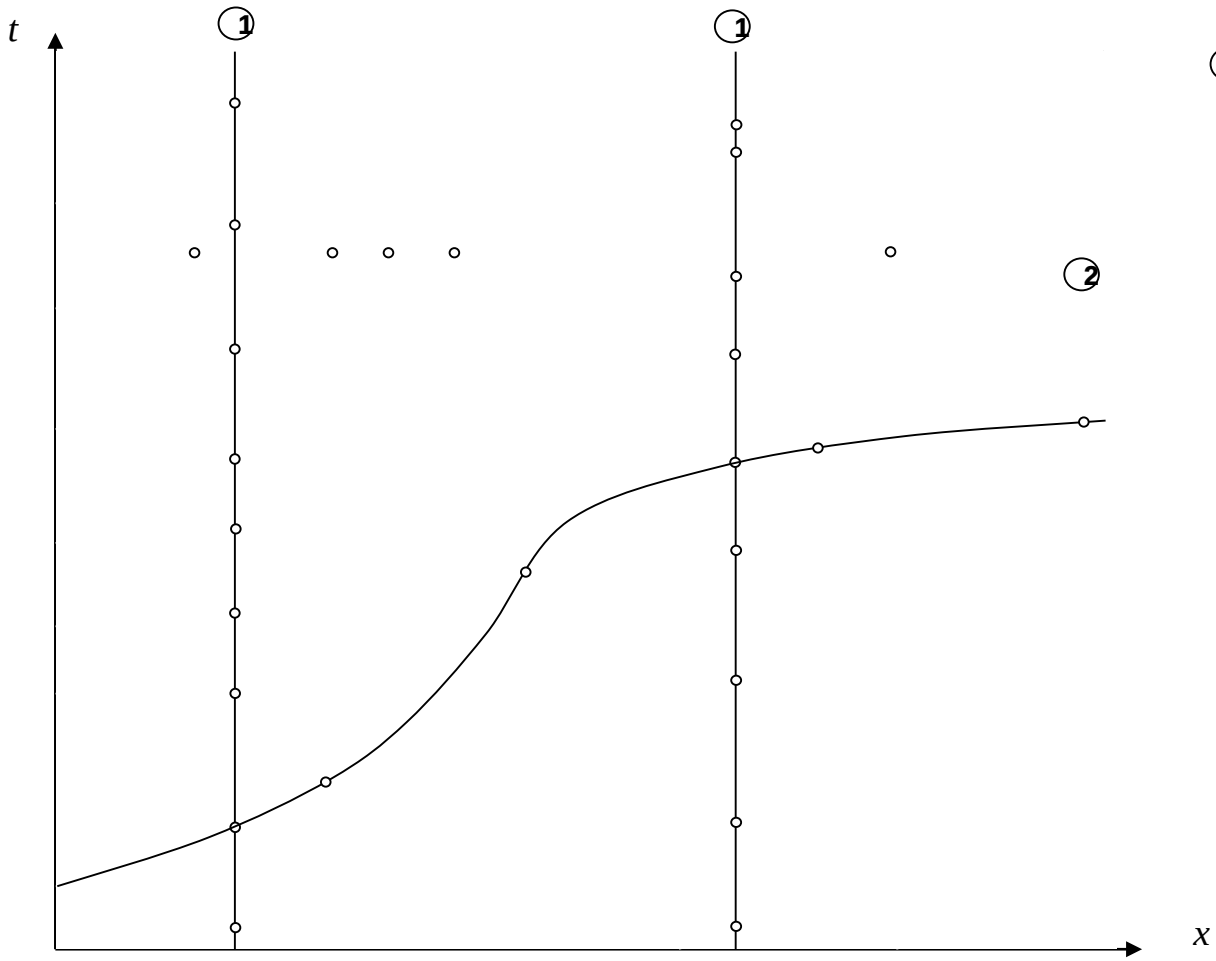

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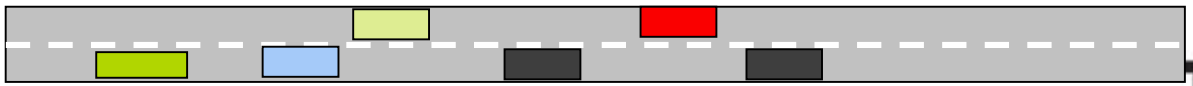
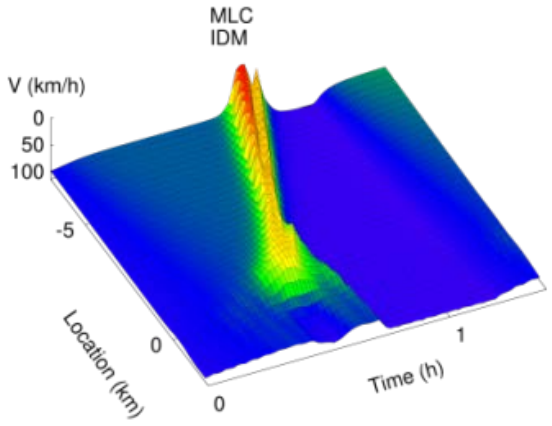
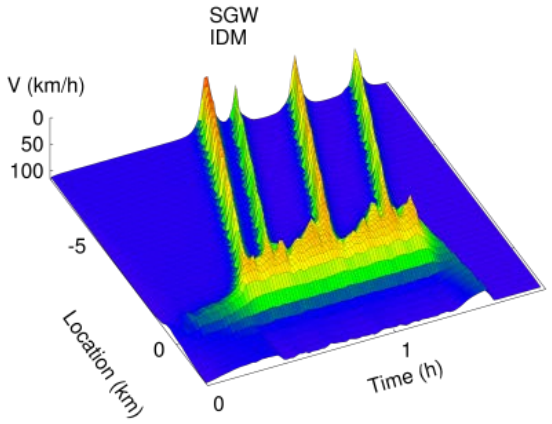


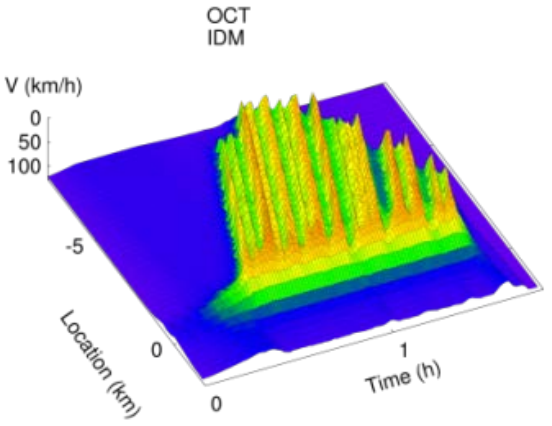
From Modeling to Measuring

Classical tools for observing traffic flow: Simulation and Data from Loop-Detectors

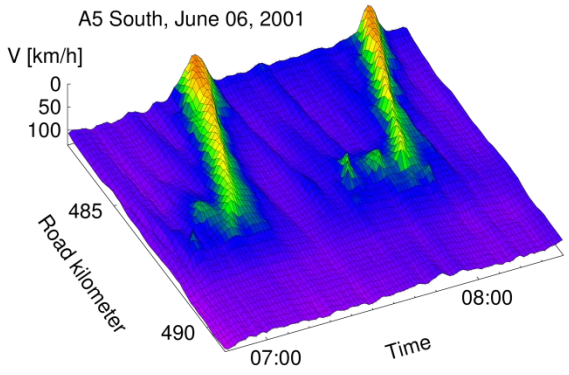
Simulated elementary traffic jam patterns:

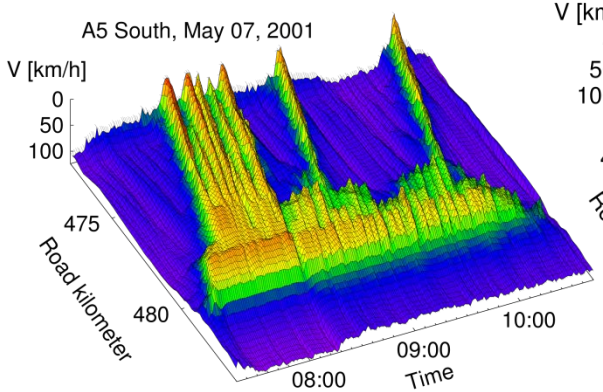


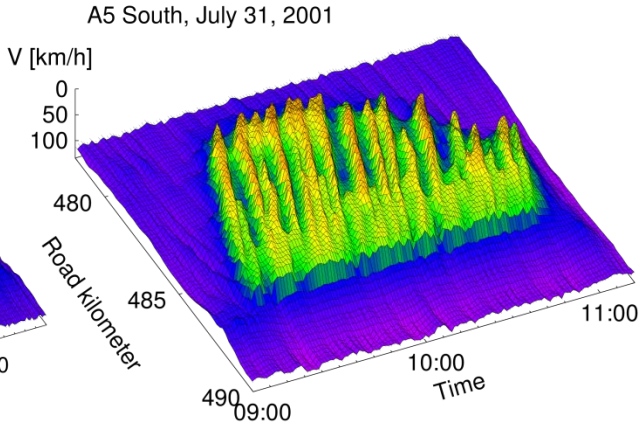




Interpolated and smoothed data from loop detectors:







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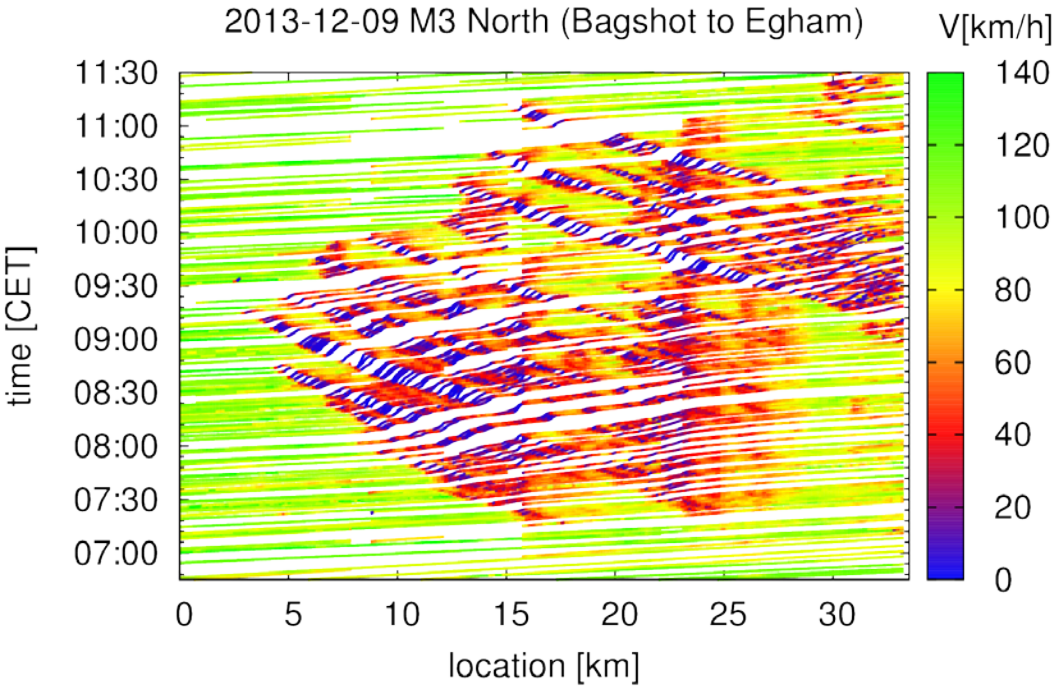
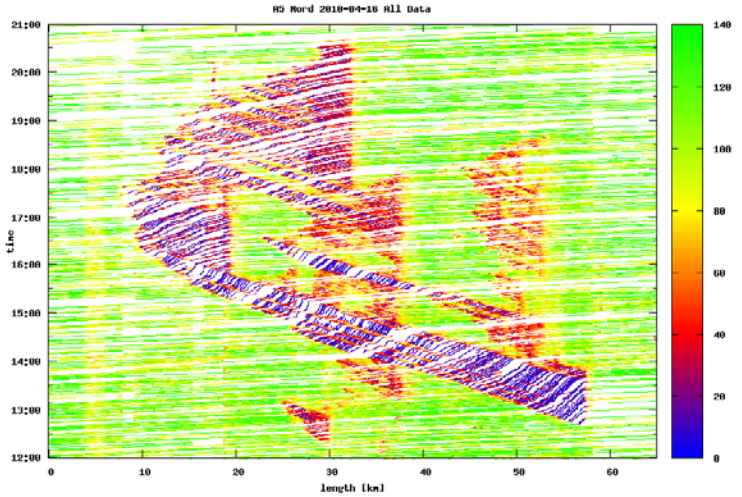
From Modeling to Measuring

Direct speeds observations with GPS probe data



- GPS data allows traffic observation everywhere
- Independent from stationary devices
- Sampling rate sufficient for real-time traffic information



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TomTom Congestion Index Europe (Q3 2013)

Traveltime delays compared to free flow situation at night hours

http://www.tomtom.com/congestionindex

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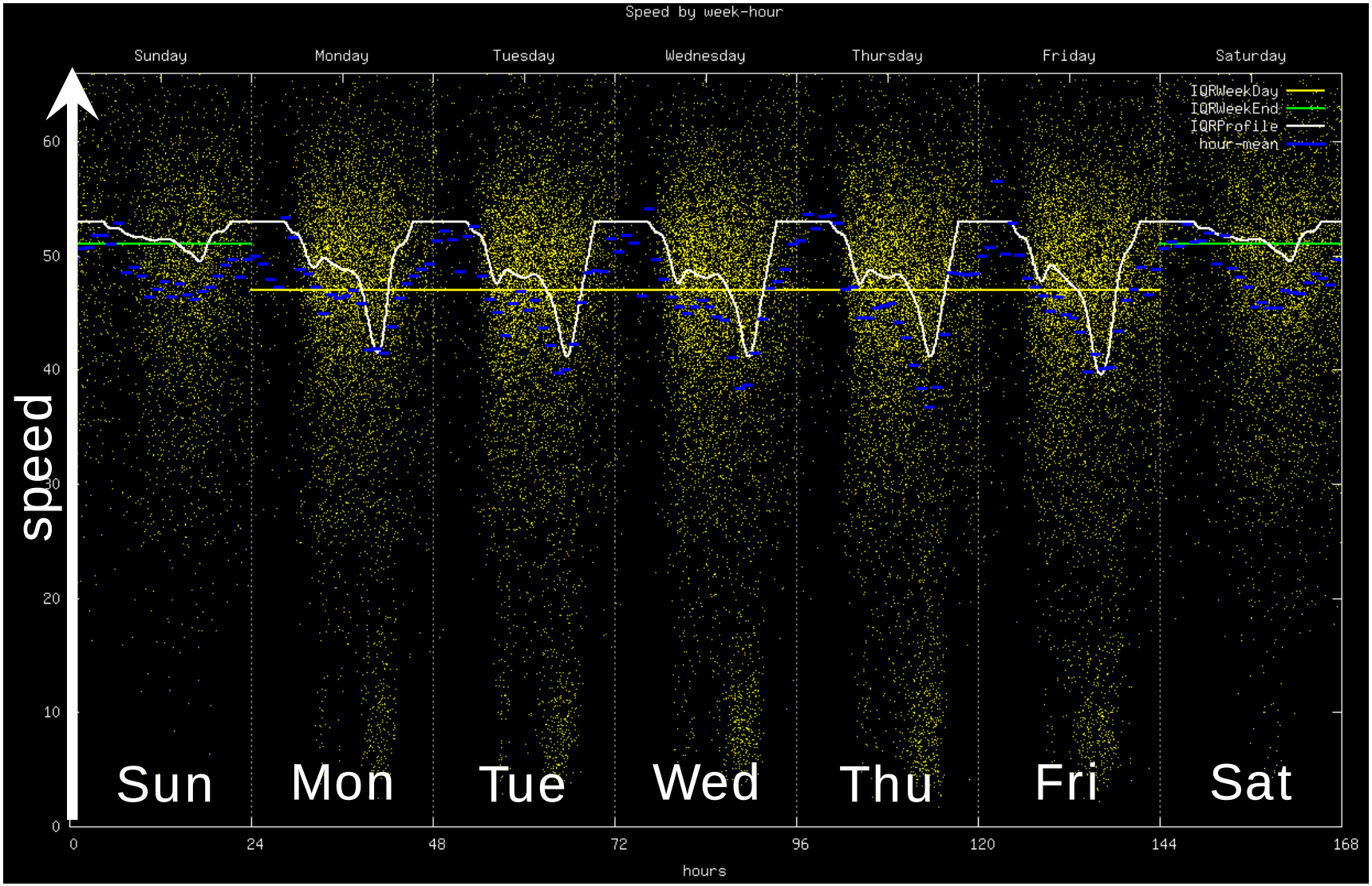
Europe congestion level

Rank	CI change	City	Country	Congestion	Morning peak	Evening peak	Highways	Non-Highways
1	▼	Moscow	Russia	65%	114%	133%	63%	66%
2	---	Istanbul	Turkey	57%	81%	127%	59%	55%
3	▼	Warsaw	Poland	44%	89%	95%	40%	49%
4	---	Palermo	Italy	40%	65%	67%	32%	47%
5	▼	Marseille	France	40%	74%	81%	25%	50%
6	▲	Rome	Italy	36%	84%	67%	28%	40%
7	▲	Paris	France	36%	77%	72%	35%	36%
8	▲	Stockholm	Sweden	36%	75%	85%	34%	38%
9	▲	Brussels	Belgium	34%	71%	92%	30%	37%
10	▲	Lyon	France	31%	66%	66%	27%	38%
11	▲	Nice	France	31%	49%	65%	21%	37%
12	▼	Stuttgart	Germany	30%	54%	67%	28%	34%
13	▼	Hamburg	Germany	29%	50%	56%	22%	36%
14	▲	London	United Kingdom	29%	57%	60%	19%	36%
15	▲	Berlin	Germany	28%	44%	53%	23%	33%
16	▼	Vienna	Austria	27%	49%	57%	19%	34%
17	▲	Budapest	Hungary	27%	57%	49%	6%	38%
18	▲	Oslo	Norway	27%	70%	90%	23%	32%
19	▲	Luxembourg	Luxembourg	26%	56%	66%	19%	39%
20	---	Prague	Czech Republic	26%	68%	44%	21%	31%
21	---	Toulouse	France	26%	69%	63%	21%	34%
22	▼	Leeds-Bradford	United Kingdom	26%	48%	56%	22%	30%
23	▼	Dublin	Ireland	25%	61%	58%	18%	37%
24	▼	Milan	Italy	25%	73%	56%	20%	29%
25	▲	Strasbourg	France	24%	44%	76%	20%	32%
26	---	Munich	Germany	24%	53%	46%	17%	34%
27	▼	Naples	Italy	23%	42%	42%	12%	36%

Speeds Over Time (City, e.g. Berlin)



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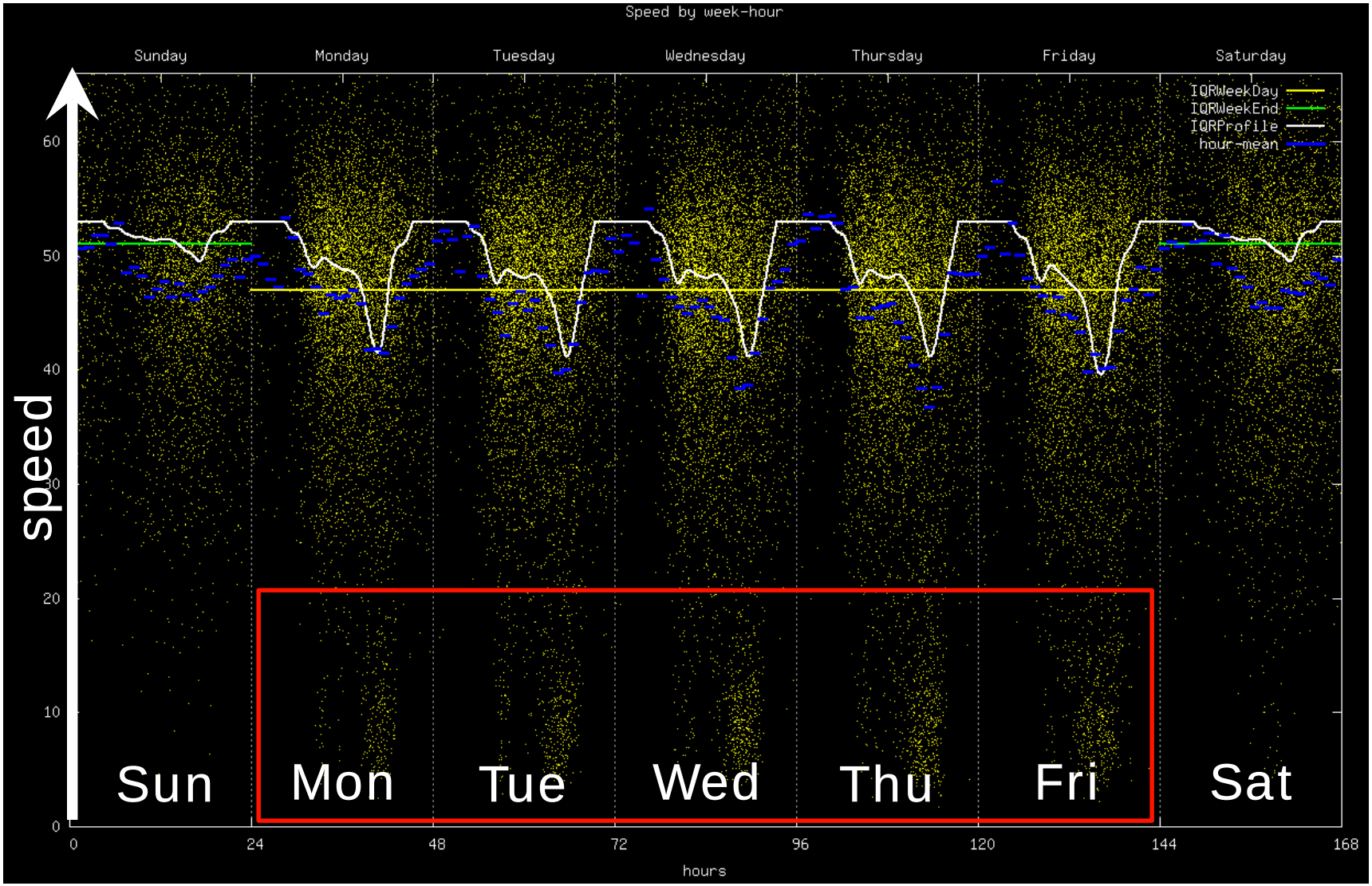

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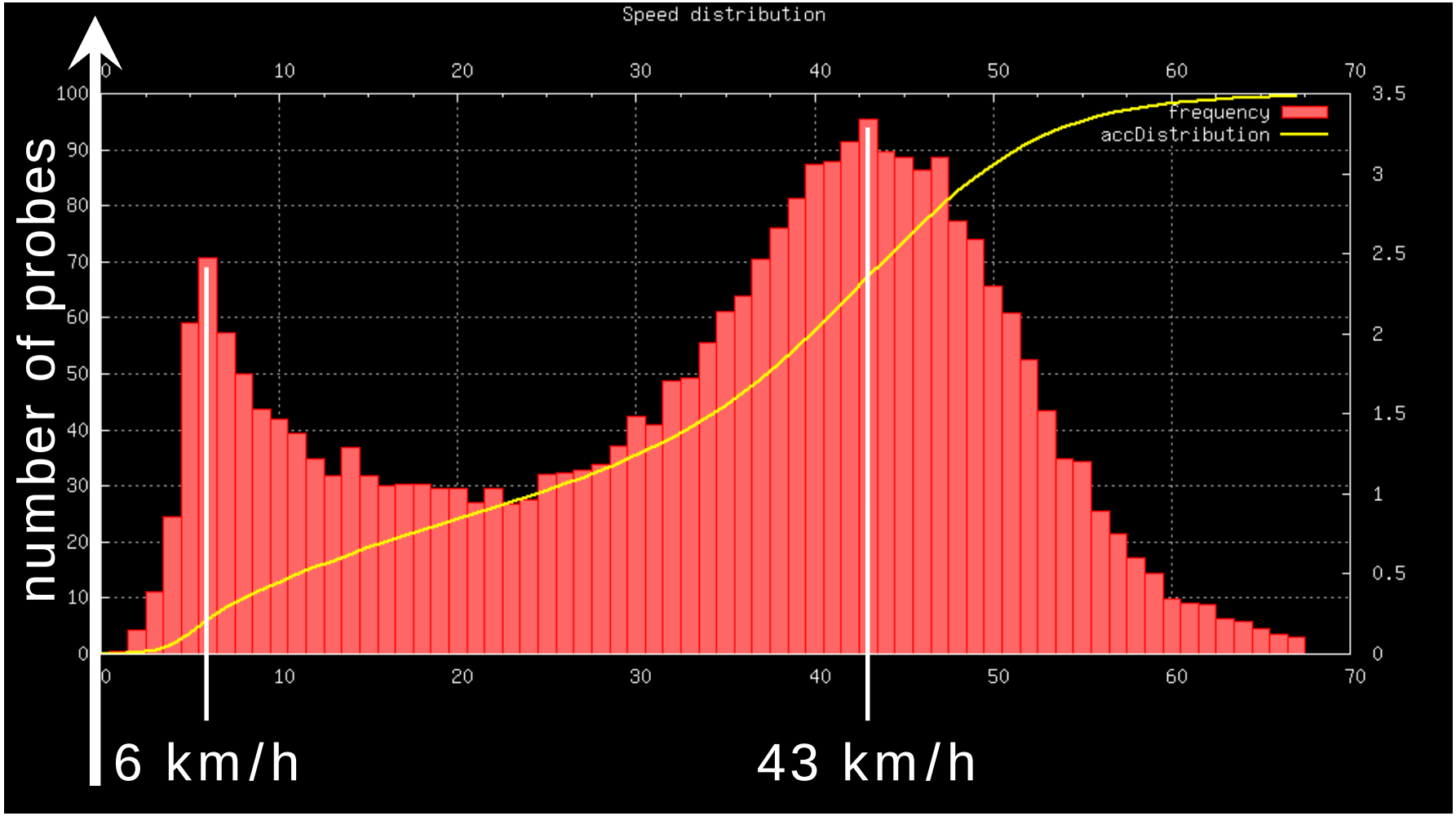
Speed Frequencies Weekdays (City e.g. Berlin)



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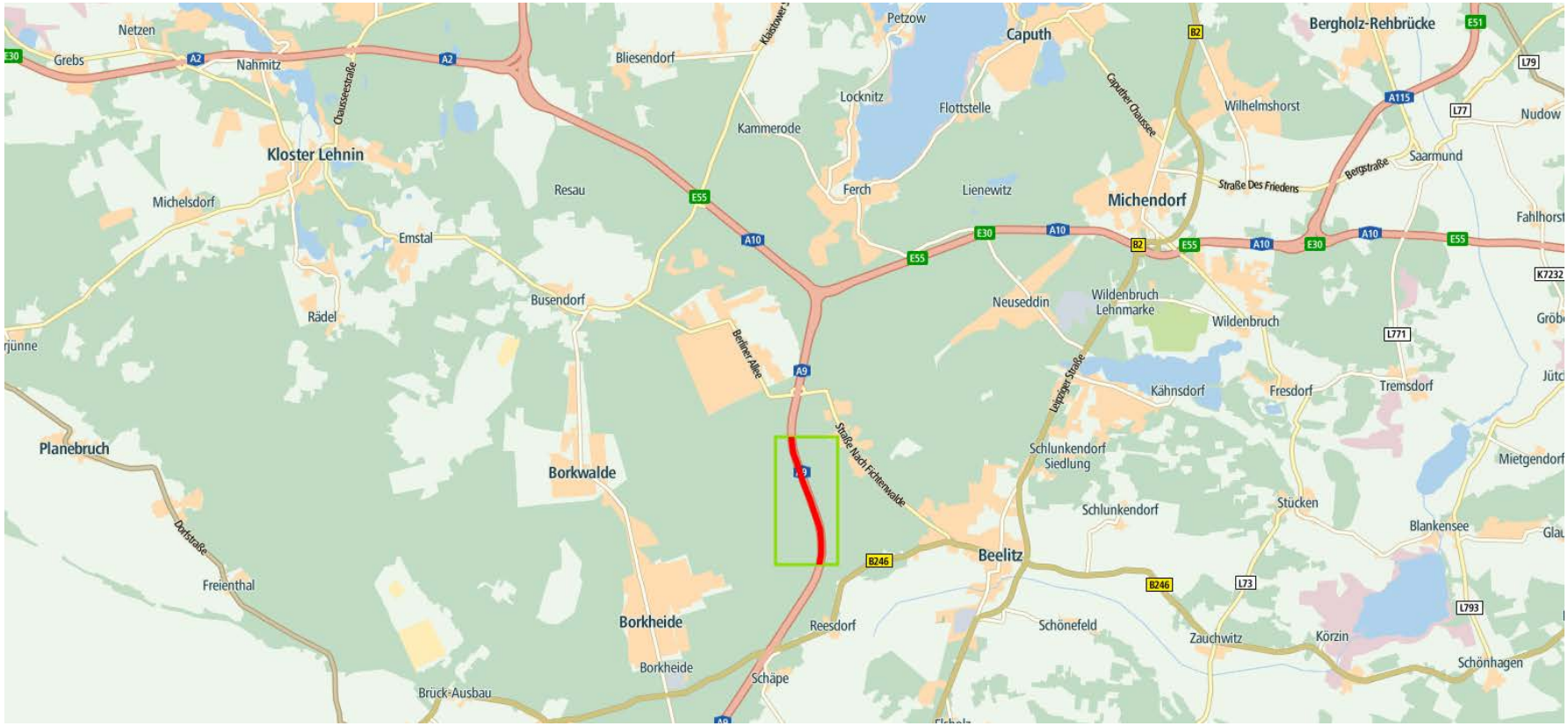
Speed Probe Data (Freeway, e.g. A9 south of Berlin)



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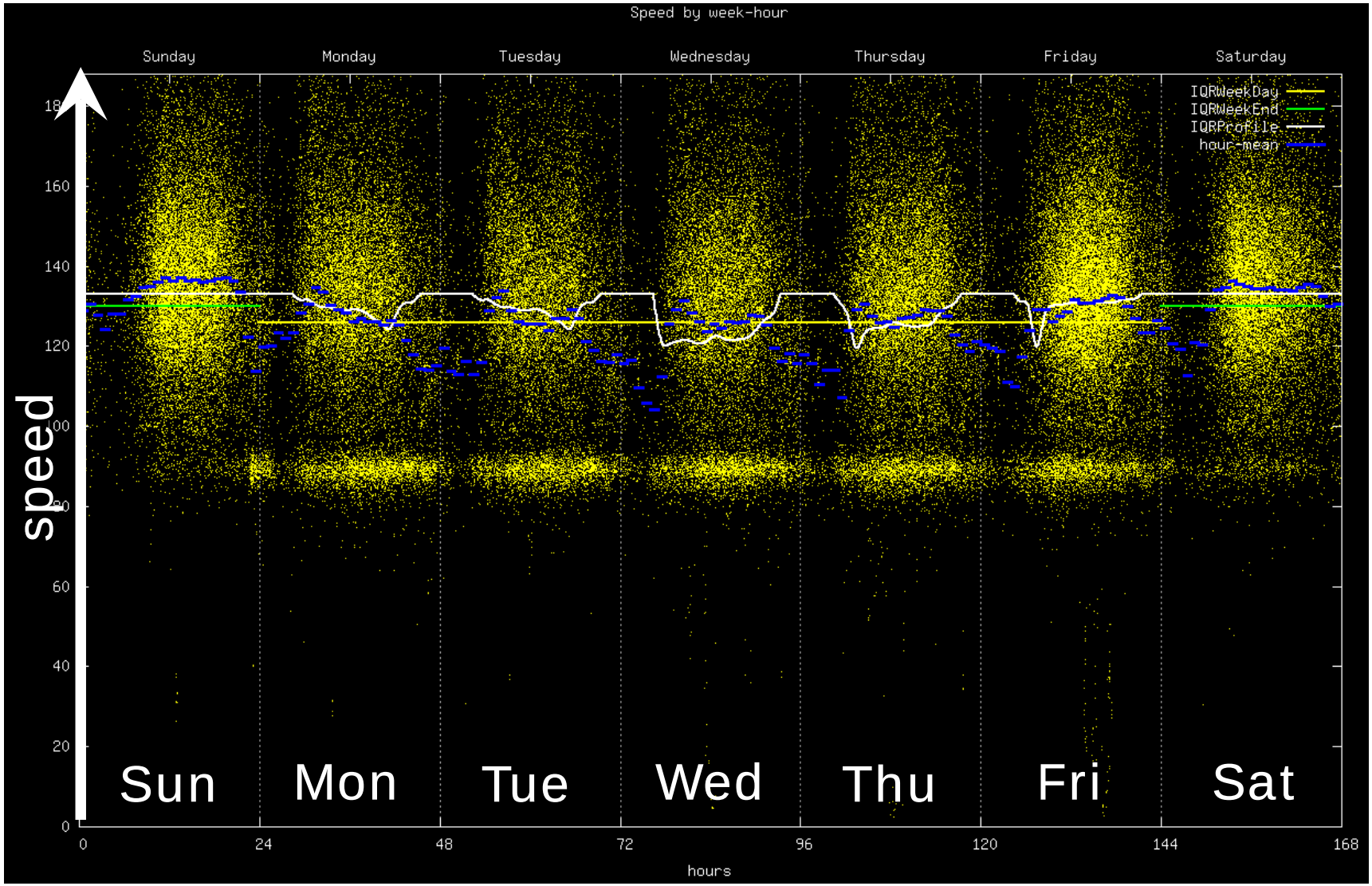
Speeds Over Time (Freeway , e.g. A9 south of Berlin)



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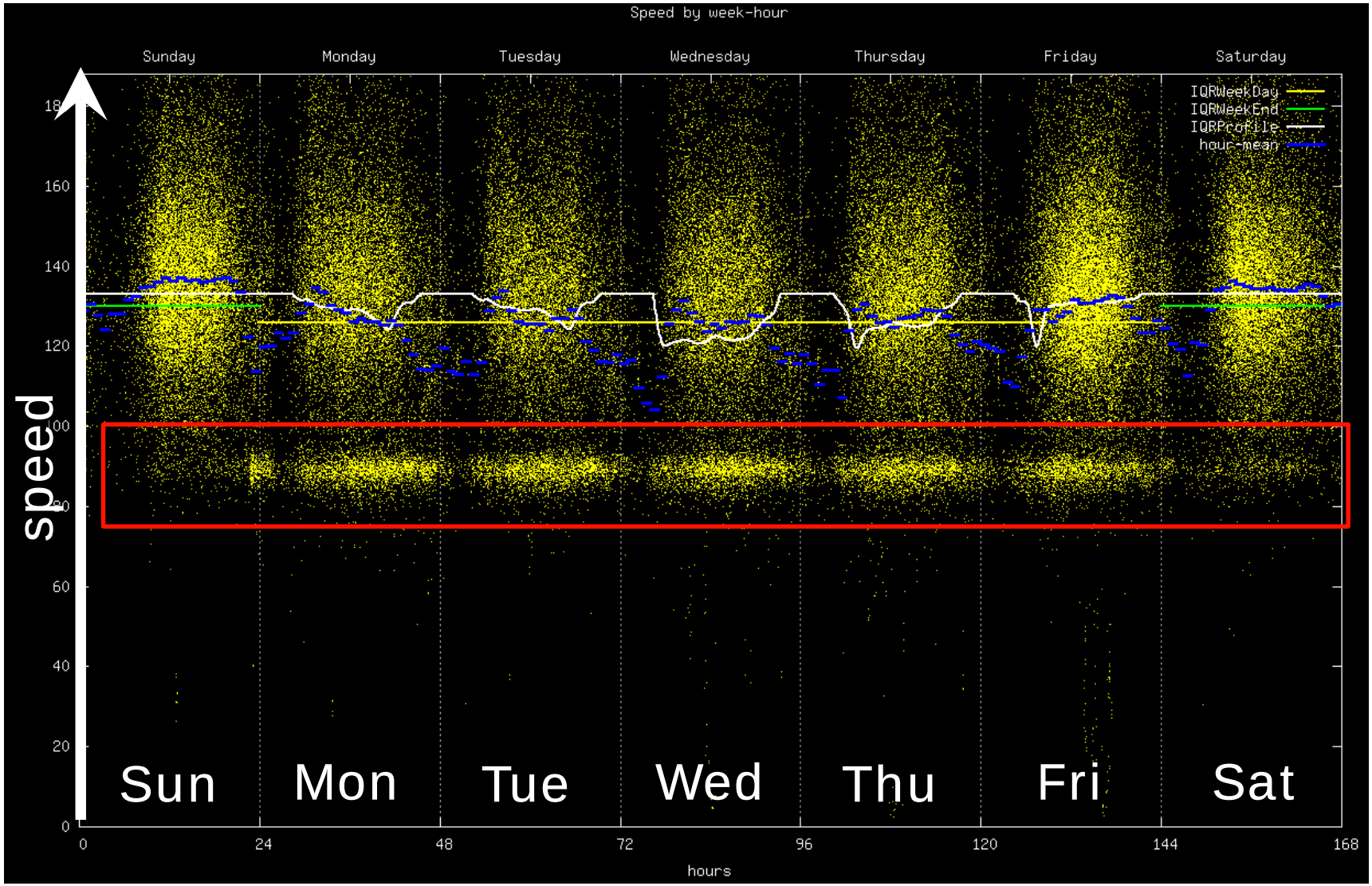

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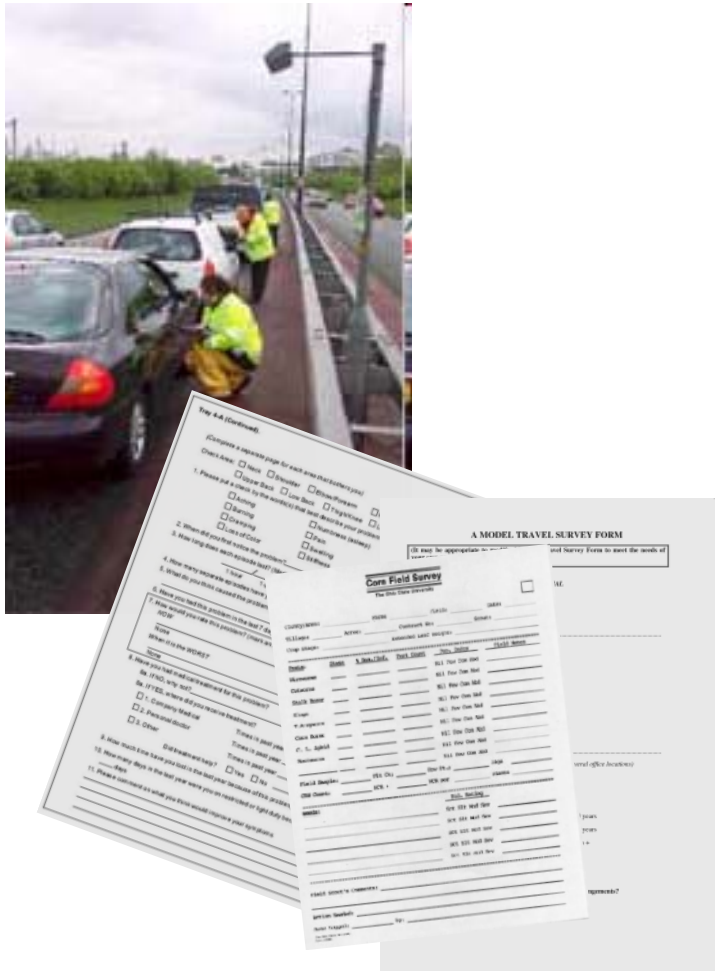
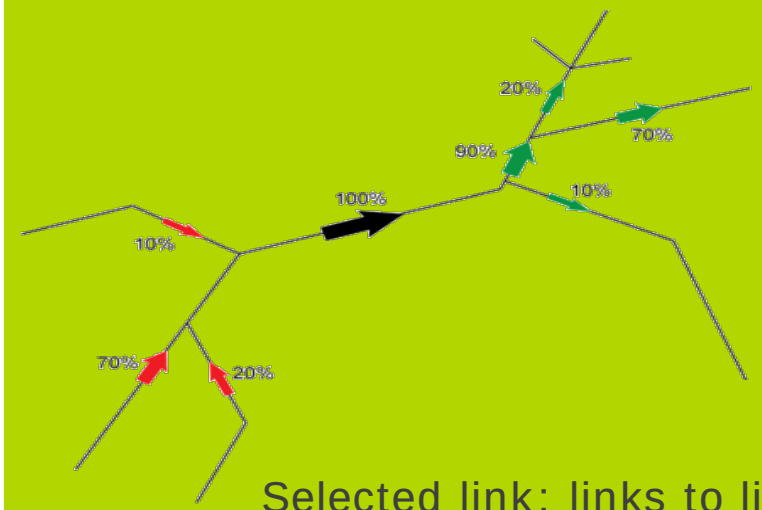
ORIGIN-DESTINATION ZONE ANALYSIS



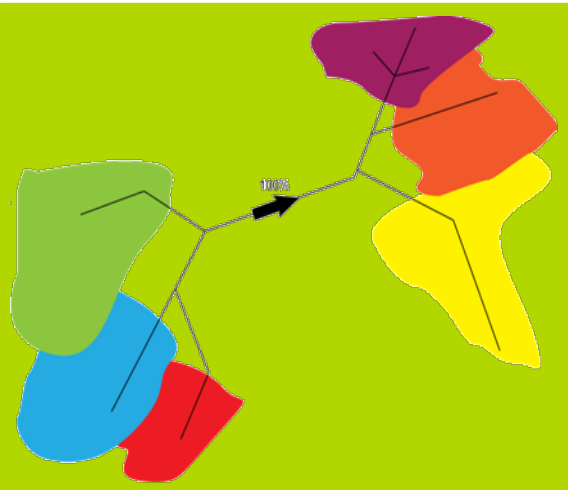
Data collection of origin-destination data is difficult

Current techniques include

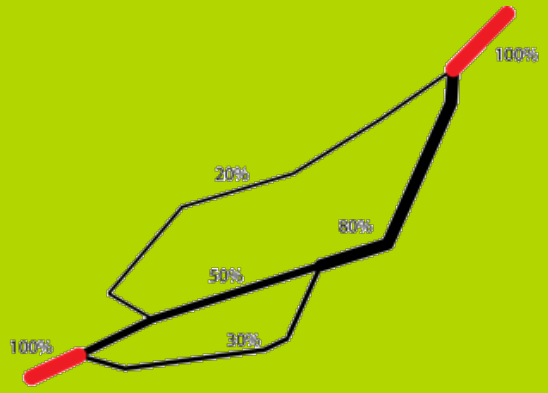
- **Stop cars:** road side interviews
- Get address from **license plate** and send survey
- **Telephone** interview
- Panel fills in a **diary** of their movements
- **Point to point** tracking: license plates (full) or bluetooth (sample)



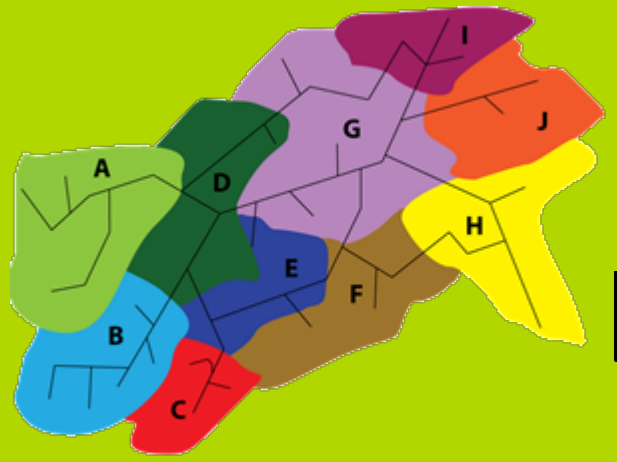
Selected link: links to links



Selected link: zones to zones



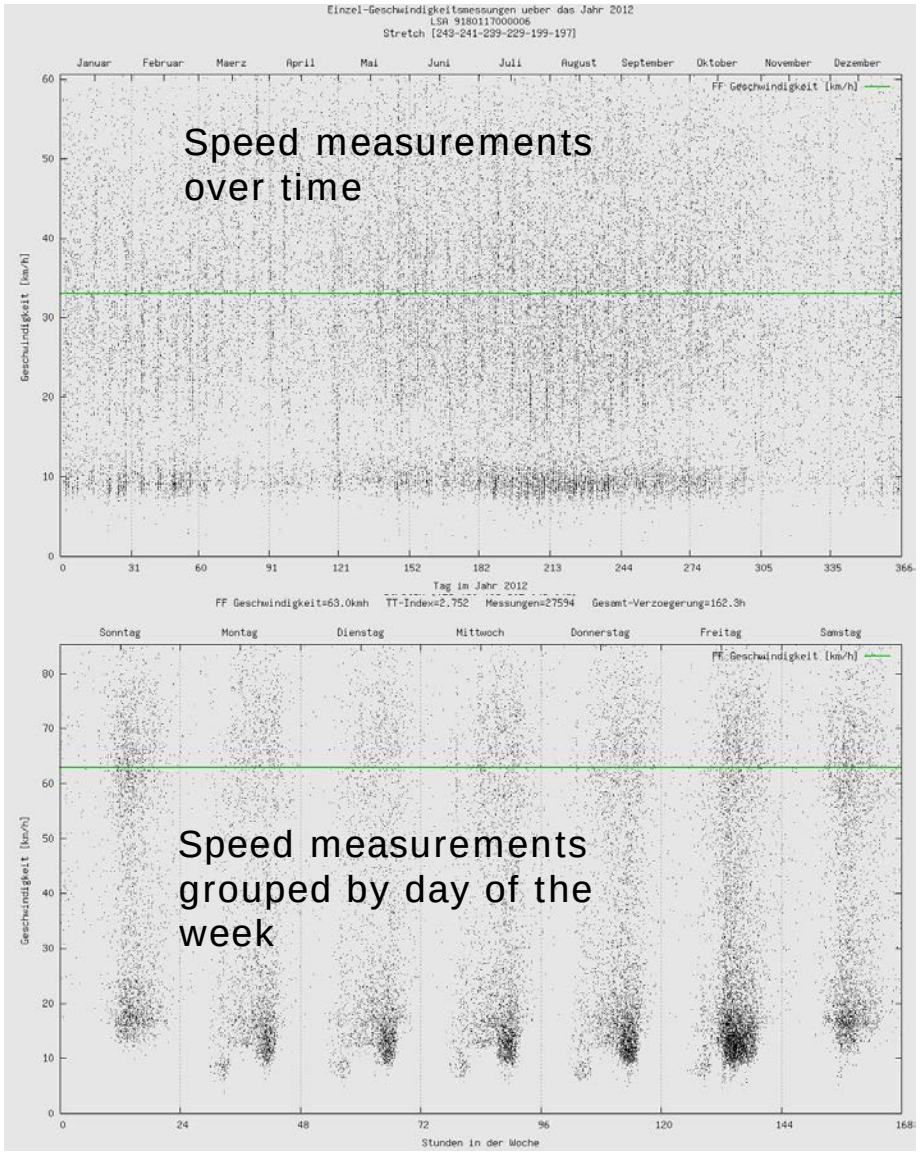
Route choice

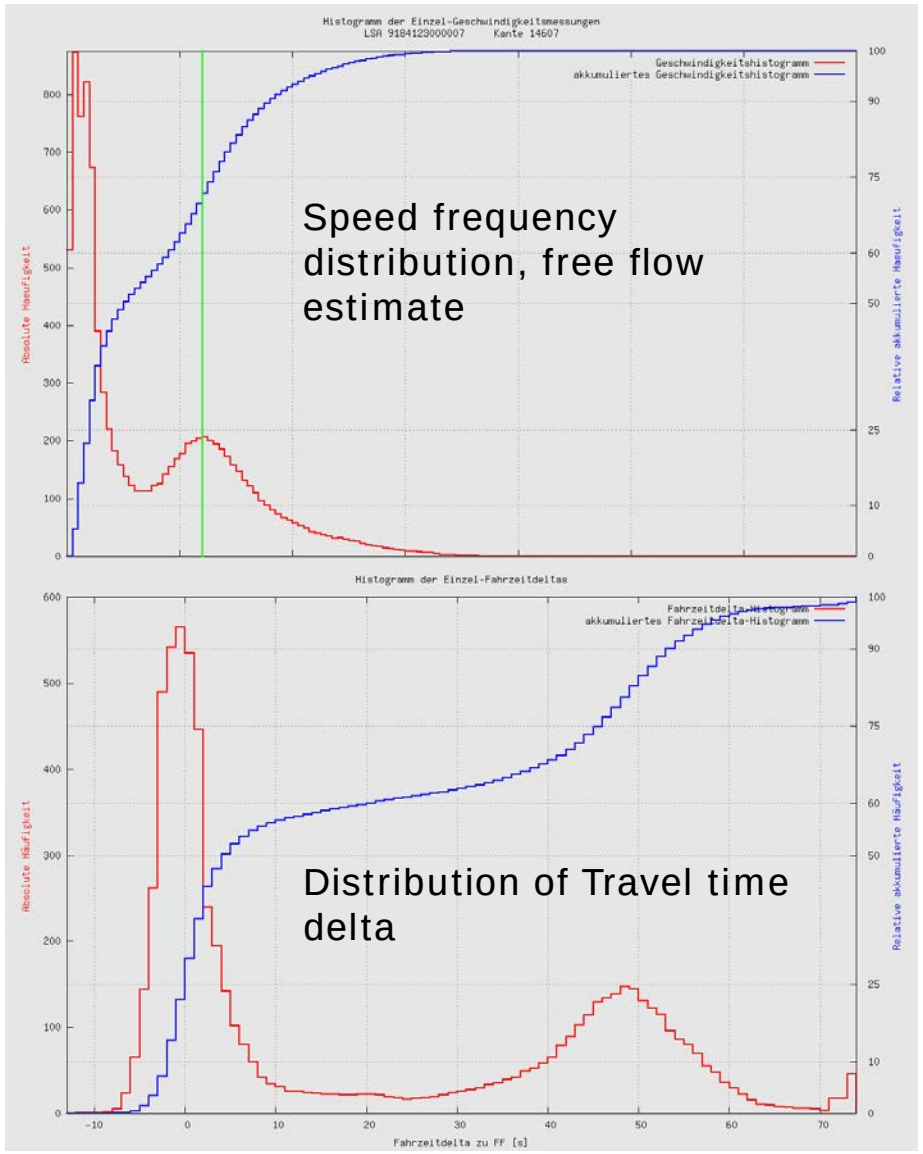


	A	B
A	30	5
B	10	20

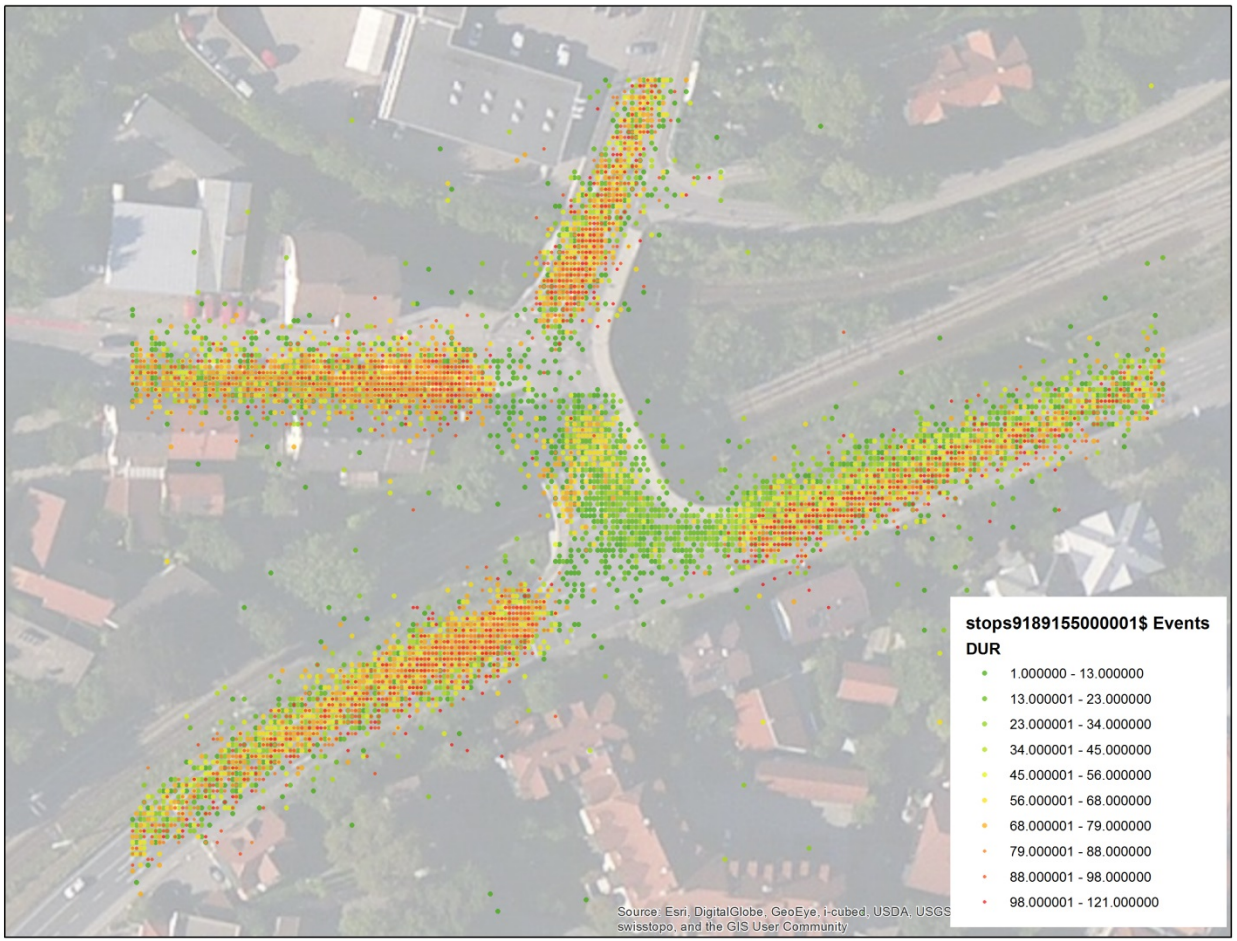
OD Matrix

Detailed junction analysis per path





Junction Stop Characteristics



Number of average stops per traversal

Average stop time per traversal

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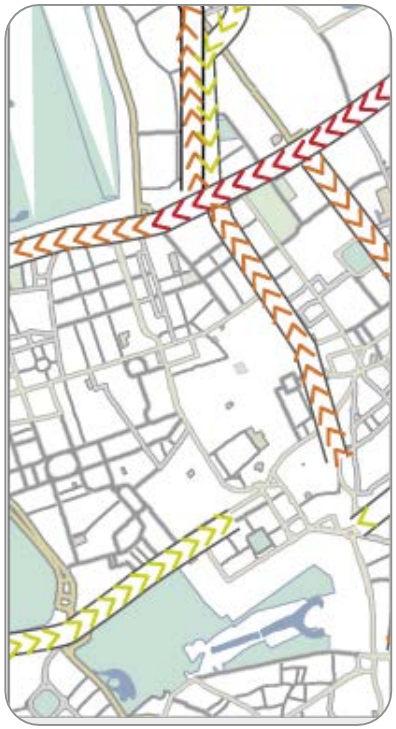
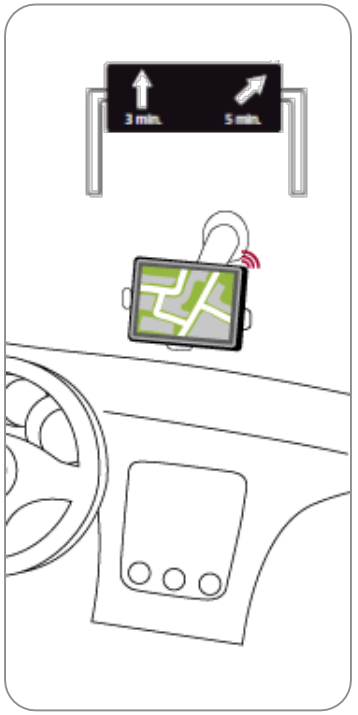
REAL-TIME TRAFFIC INFO FROM USERS TO USERS

Various input sources

Data fusion



Send to users



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Probe Data Example of Traffic Incident

GPS and GSM input sources and incident output message

- Example from Dec 13, 2011
- Near Stuttgart, Germany

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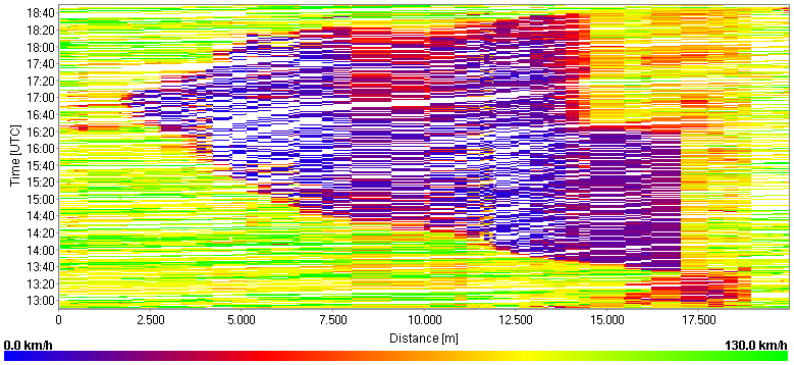
Probe Data Example of Traffic Incident

GPS and GSM input sources and incident output message

- GPS data from floating cars
- Speed data matched to road elements



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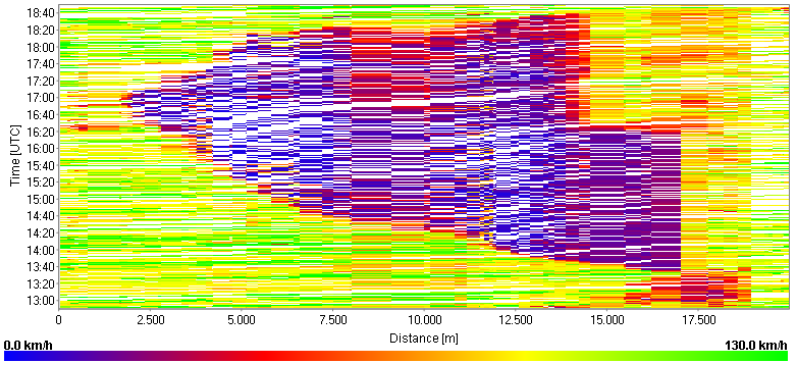
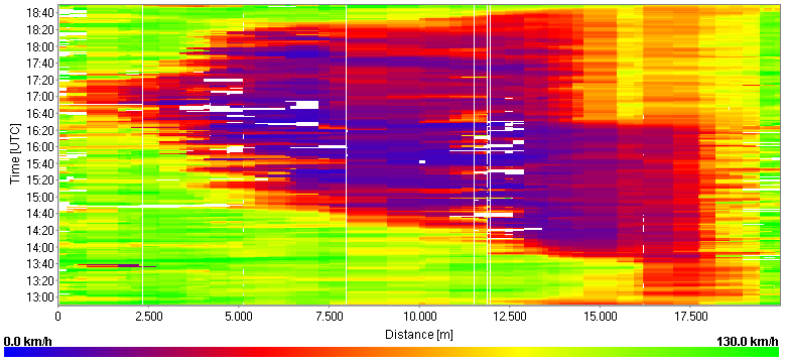


- GSM data from mobile phone calls
- Sophisticated algorithm



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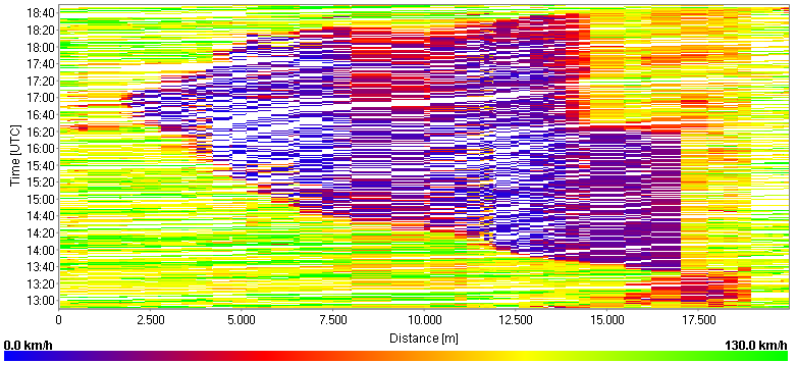
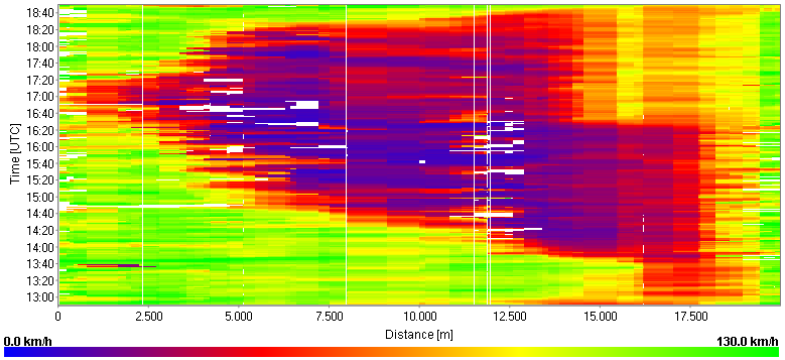
Probe Data Example of Traffic Incident

GPS and GSM input sources and incident output message

- GPS data from floating cars
- Speed data matched to road elements

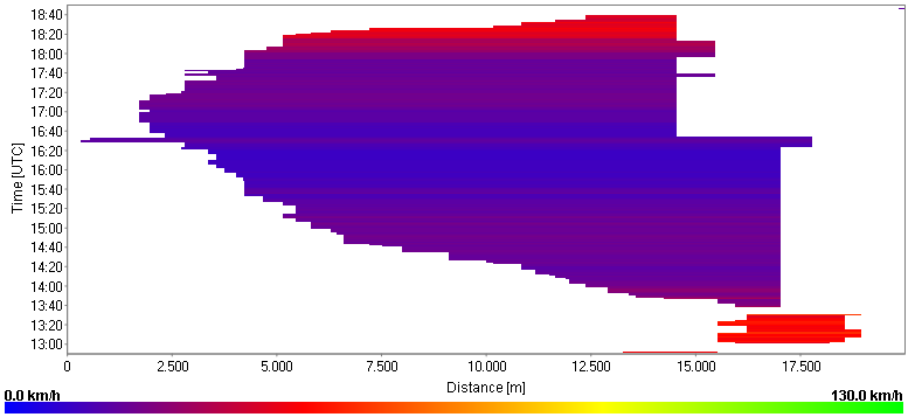


- GSM data from mobile phone calls
- Sophisticated algorithm



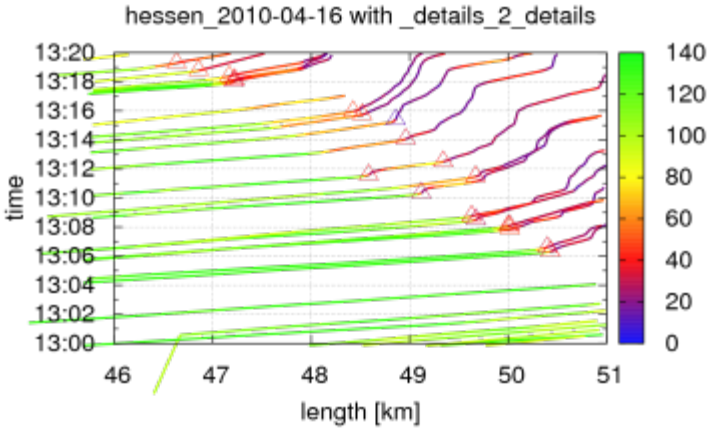
- Example from Dec 13, 2011
- Near Stuttgart, Germany

- After fusion and incident detection
- Live incident output to PND



JAM TAIL WARNINGS

Detection of jam tails for a safety warning in the navigation unit



- Over 35% of drivers have admitted to experiencing an accident caused by sudden or unexpected traffic holdups
- Jam ahead warning messages in traffic output can be used to create these safety messages with great accuracy

TOMTOM TRAFFIC

Real-time road speed data

Enable traffic information and traffic management

- Measured speed on each road segment
- On all important roads
- Without the need of road-side equipment
- By using Floating Car Data
- Updated every minute

Traffic Flow

Flow conditions (speed) on all roads

The TomTom Traffic Manifesto

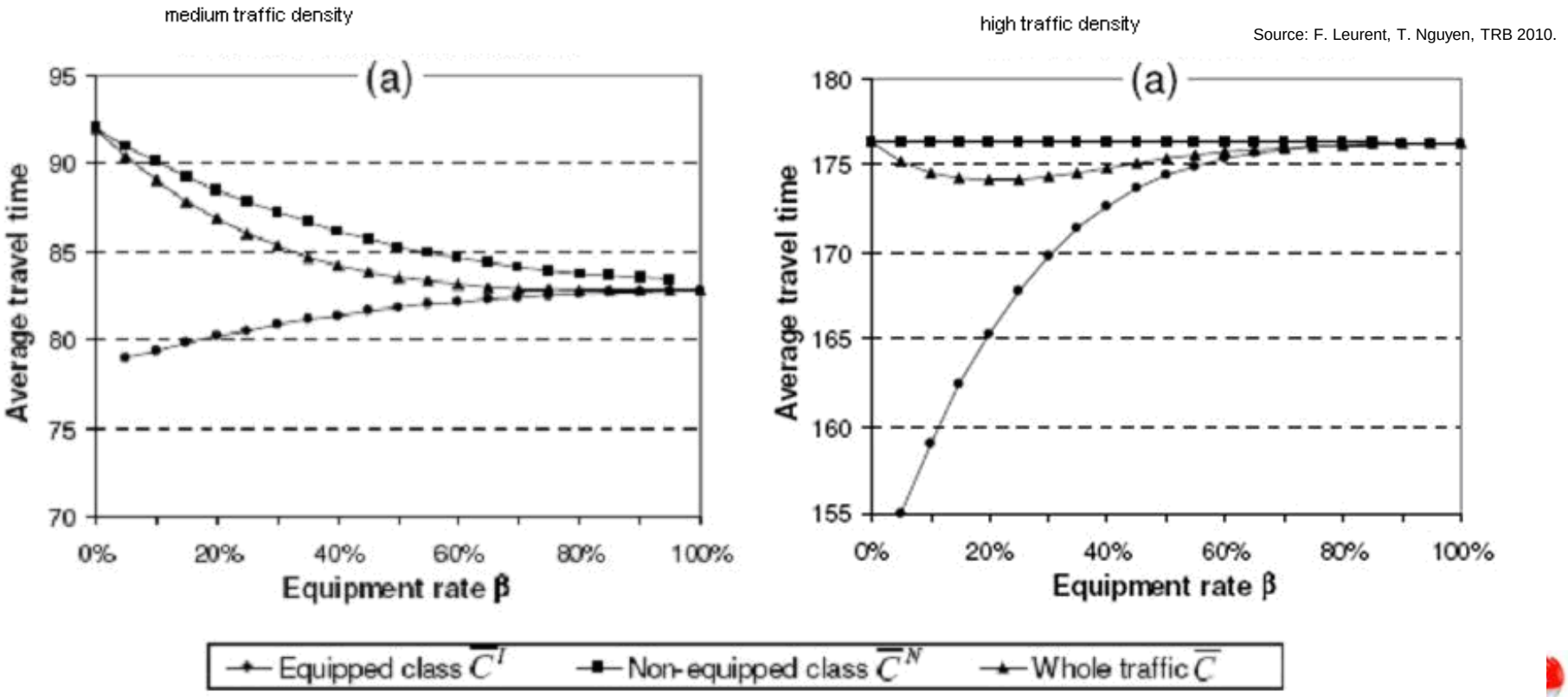
http://www.tomtom.com/trafficmanifesto

If 10% of the road drivers use HD Traffic guided navigation in conurbations there is a

1. Individual journey time reduction for informed users by up to 15%
2. A collective journey time reduction for ALL by up to 5%

How to estimate the journey time reduction claims in the TomTom Manifesto?

Use of traffic modelling and simulation in a simplified road network
Assume a share of equipped navigation users (e.g. traffic guided drivers)
Assume high acceptance rate for detour choices when approaching a traffic jam!
Results from simulation below for medium and high traffic flow



Source: F. Leurent, T. Nguyen, TRB 2010.

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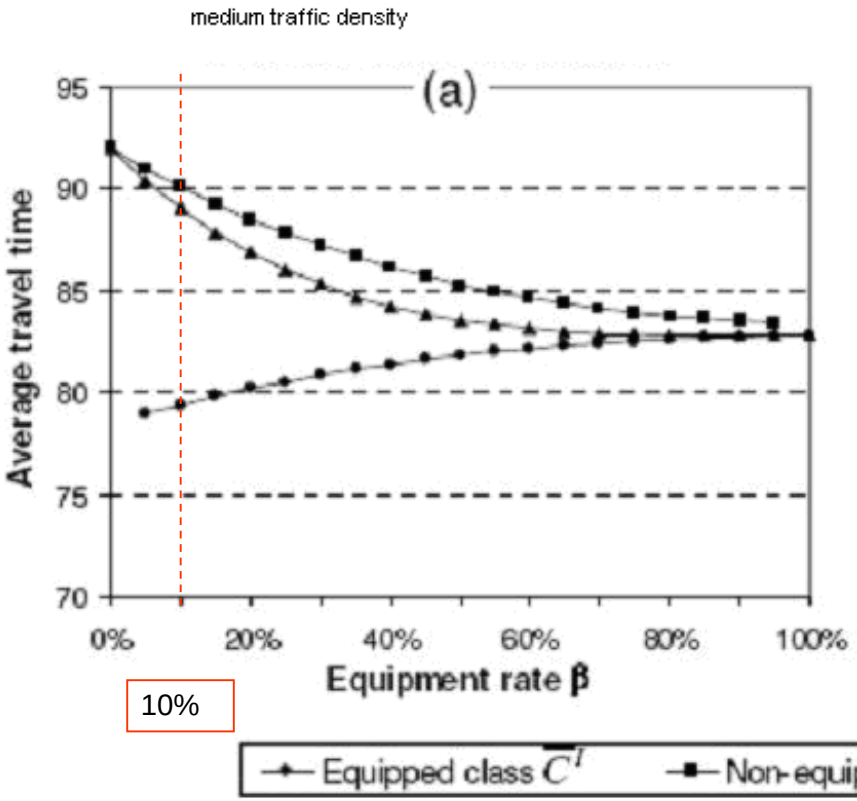
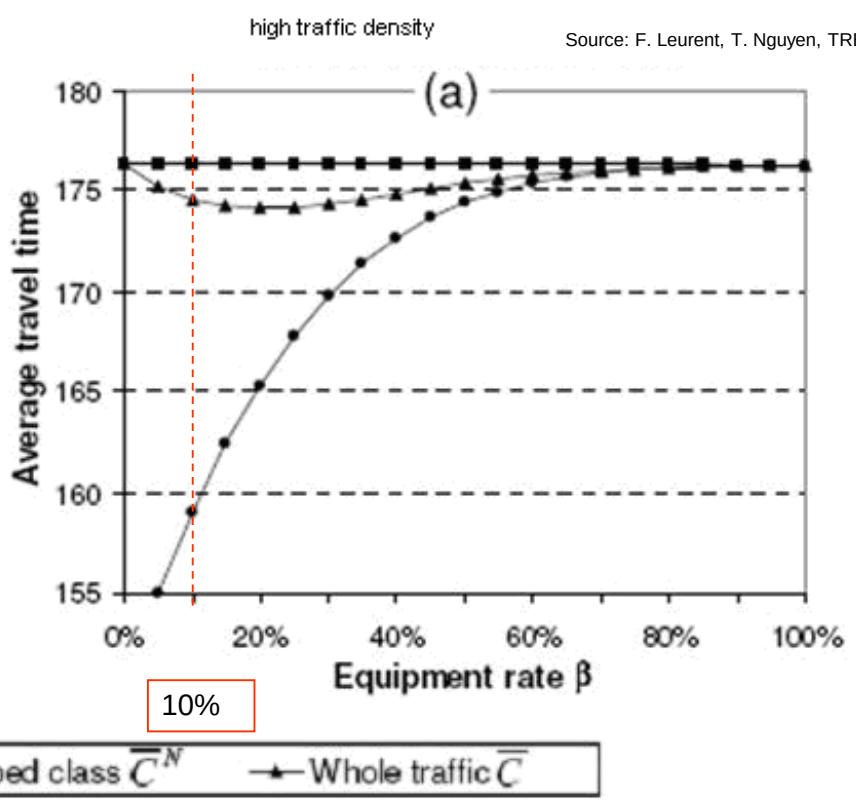


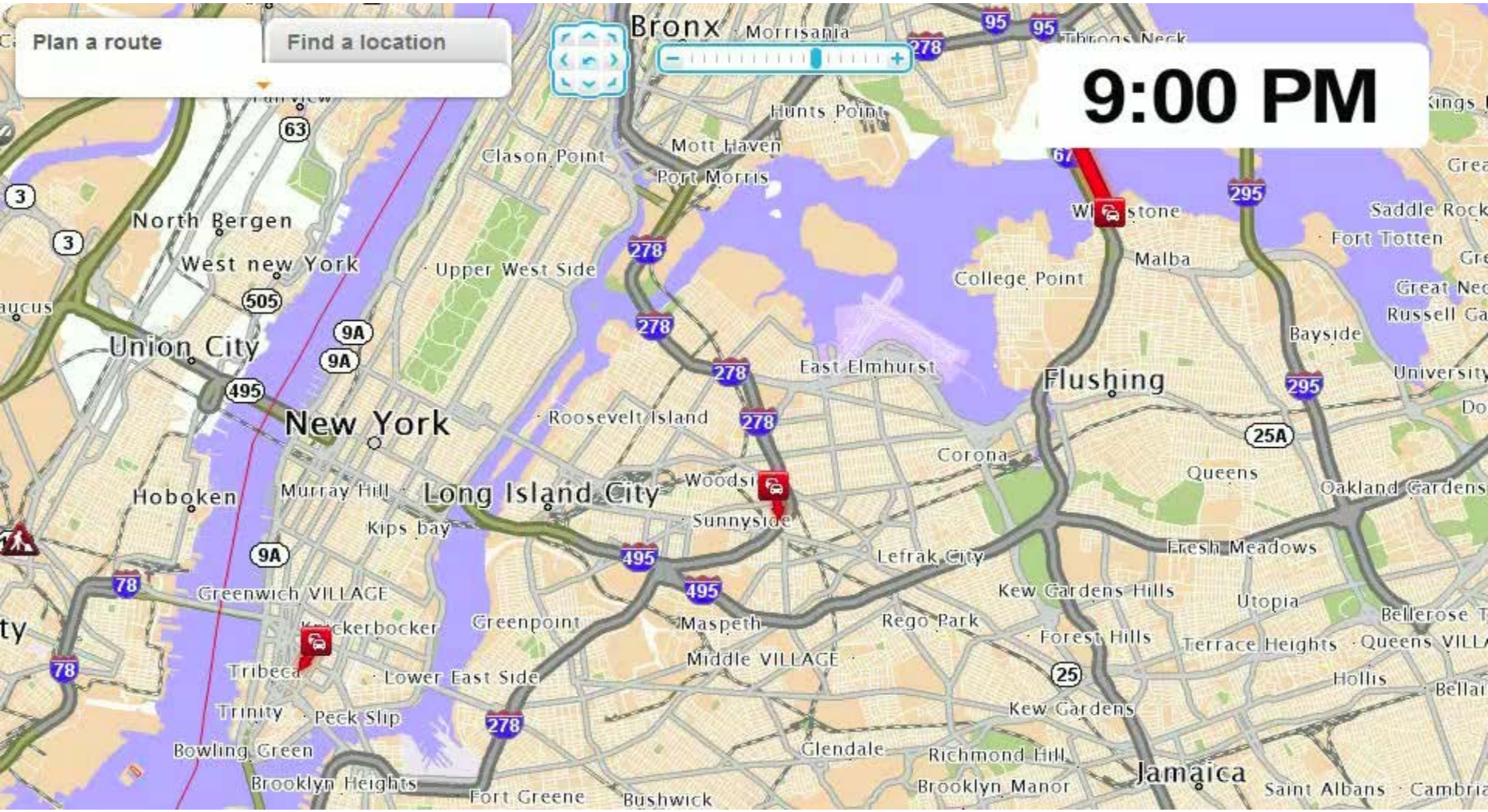


Source: F. Leurent, T. Nguyen, TRB 2010.

Equipped class $\overline{C}^I$ — Non-equipped class $\overline{C}^N$ — Whole traffic $\overline{C}$

Dynamic Navigation for personal and collective benefits

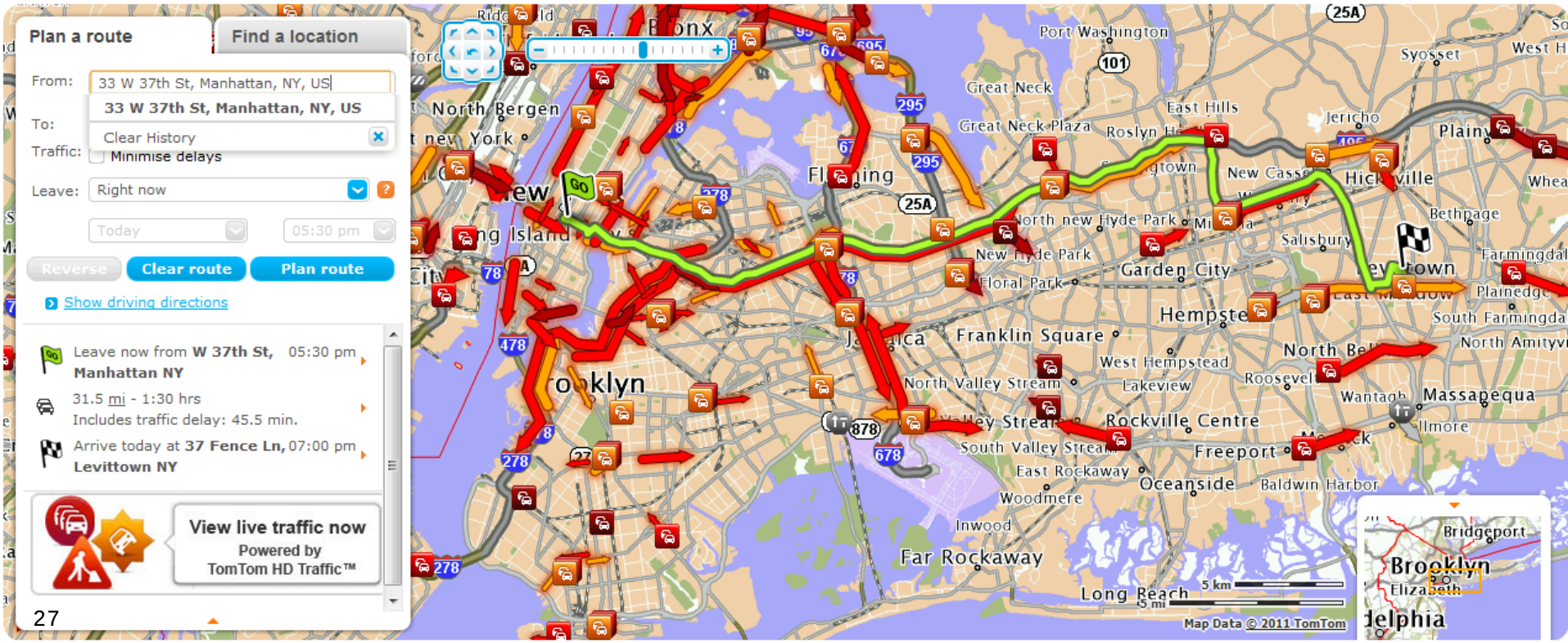
24 Hour Time Lapse – NYC



5 day historical– NYC

5 day historical– NYC

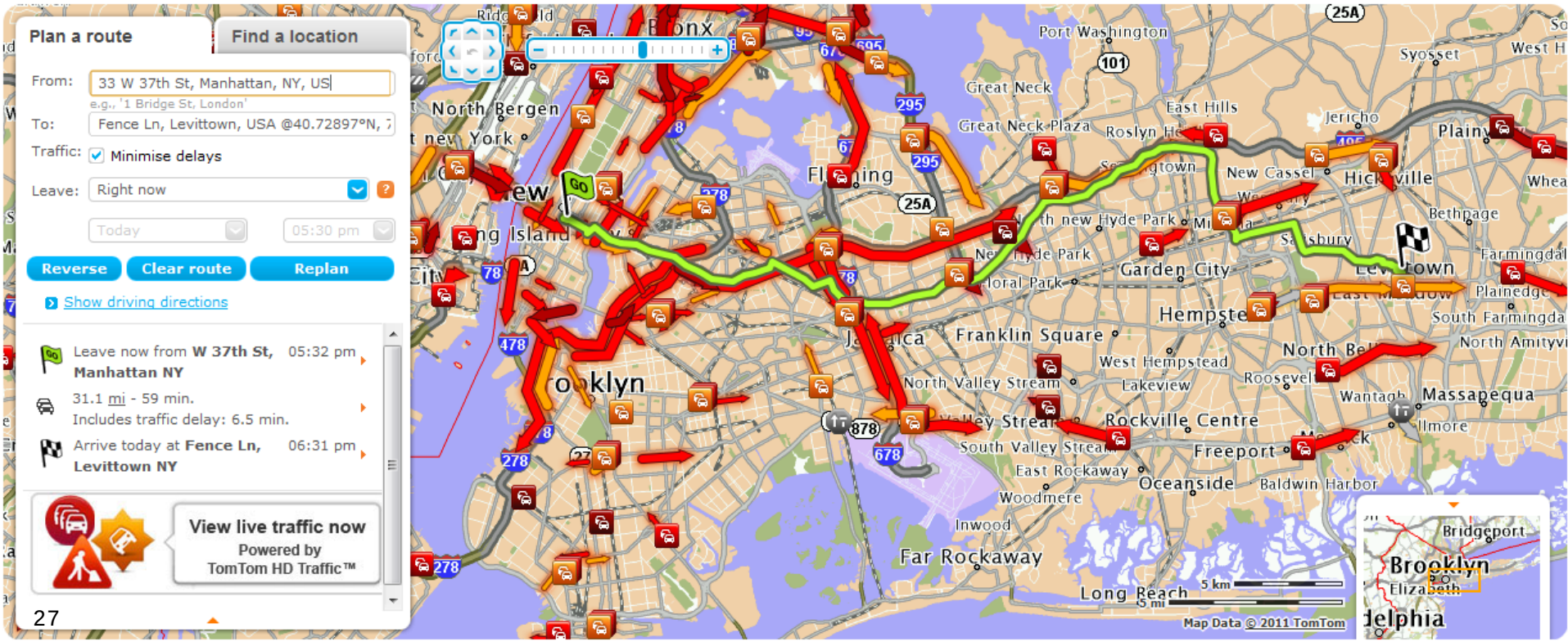
Monday



5 day historical– NYC

31 minutes

Monday



5 day historical– NYC

31 minutes

Monday

Tuesday

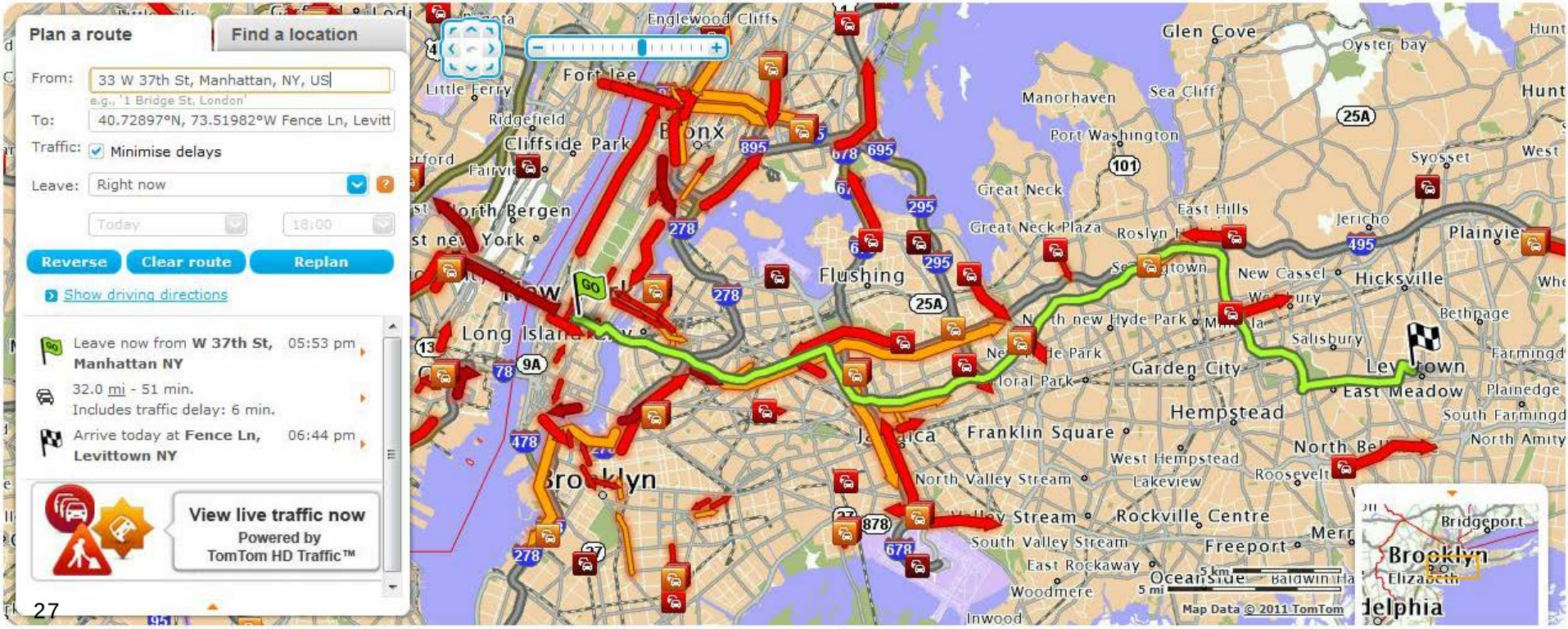
5 day historical– NYC

31 minutes

16 minutes

Monday

Tuesday



5 day historical– NYC

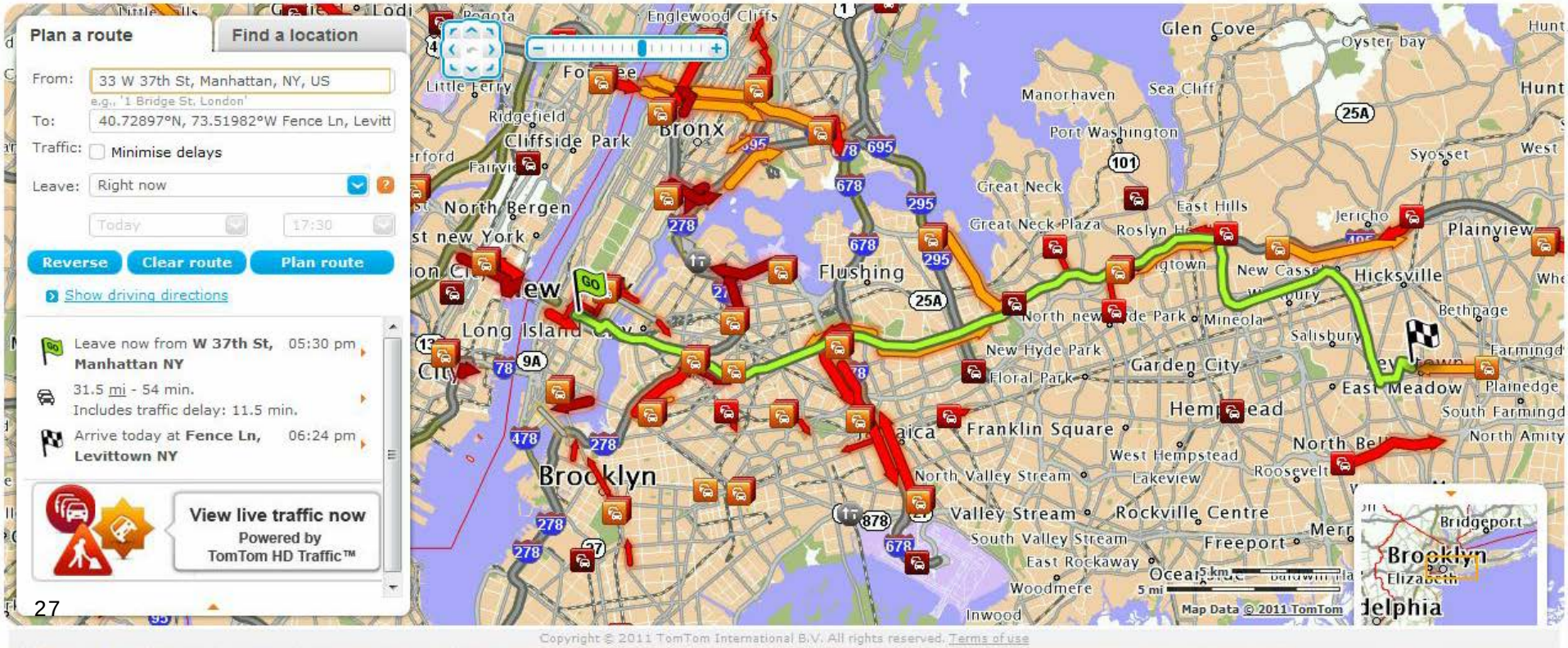
31 minutes

16 minutes

Monday

Tuesday

Wednesday



5 day historical– NYC

31 minutes

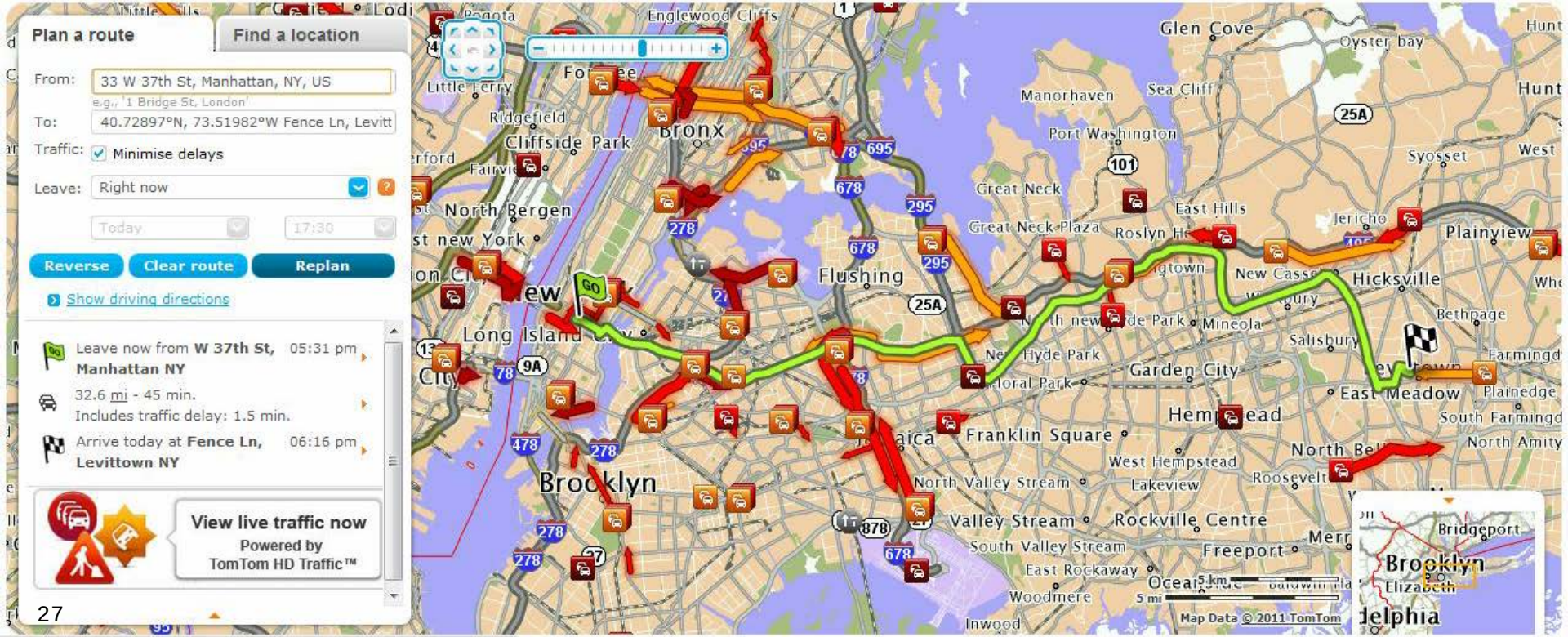
16 minutes

9 minutes

Monday

Tuesday

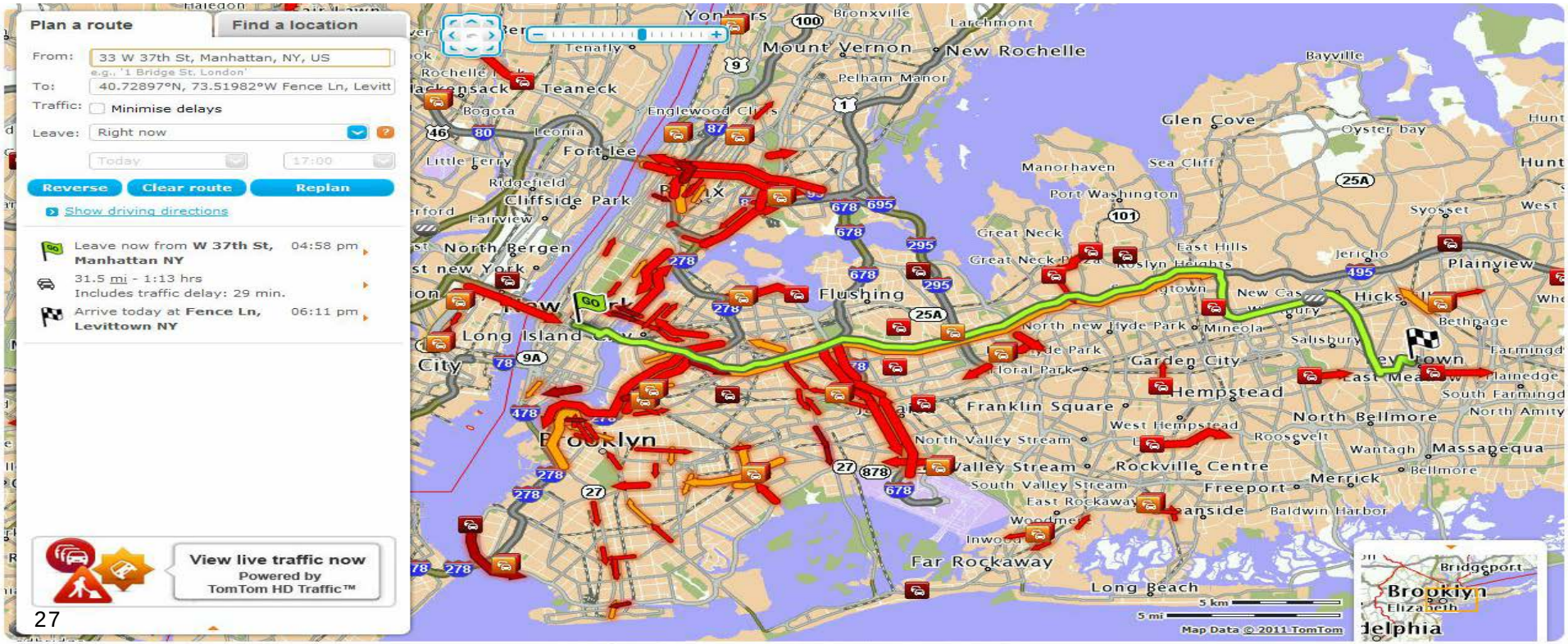
Wednesday



5 day historical– NYC

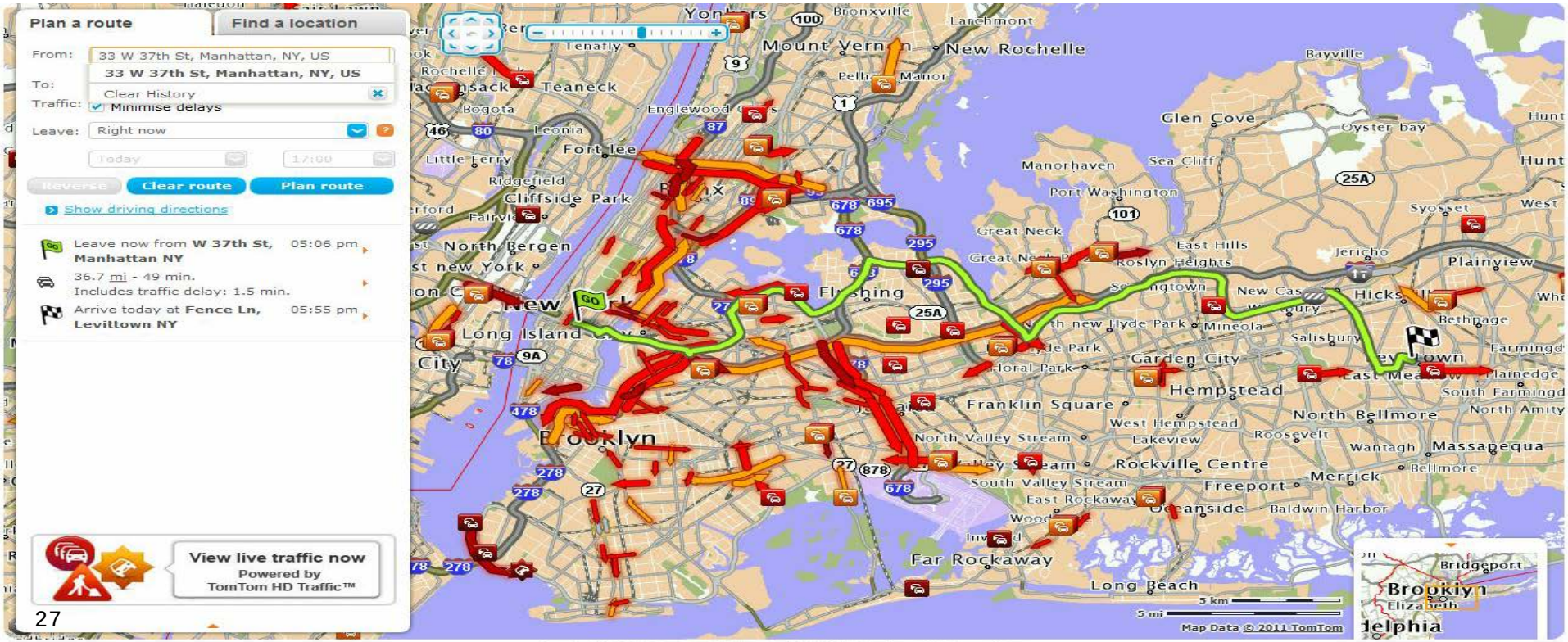
31 minutes	16 minutes	9 minutes

Monday	Tuesday	Wednesday	Thursday



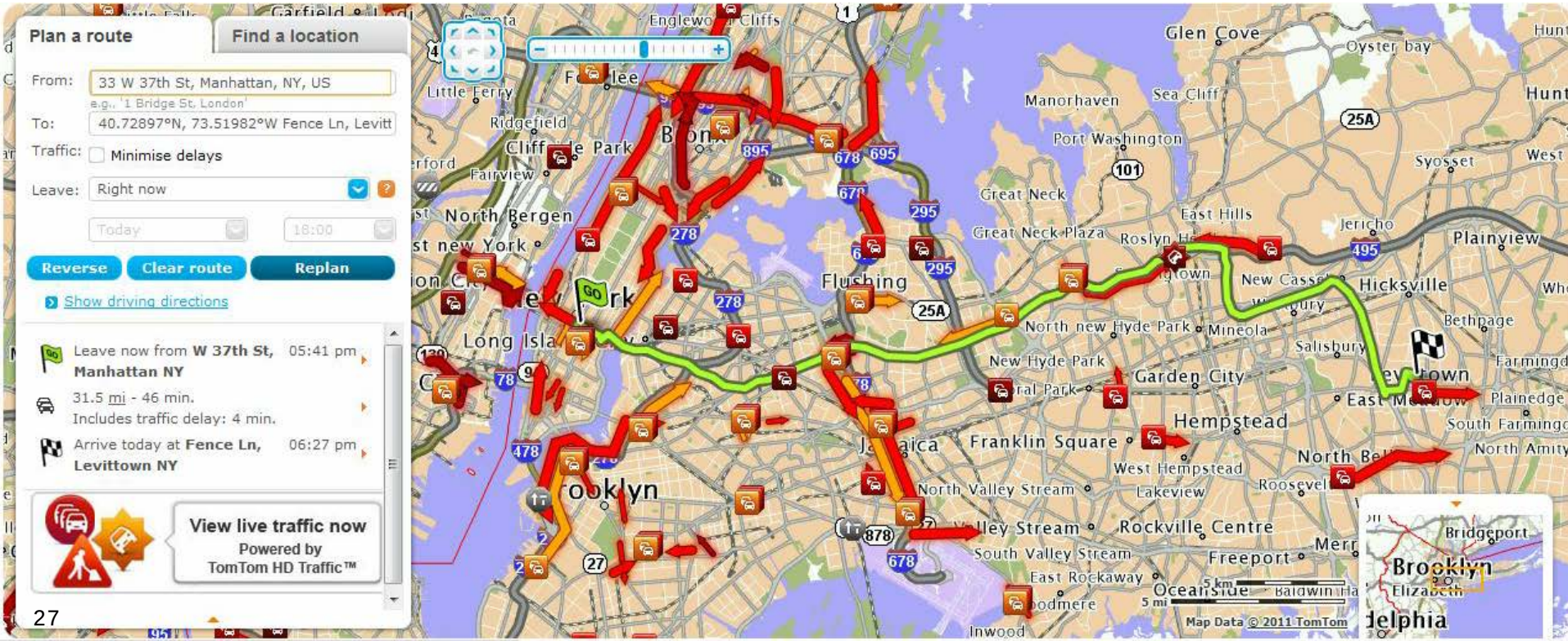
5 day historical– NYC

31 minutes	16 minutes	9 minutes	18 minutes
Monday	Tuesday	Wednesday	Thursday



5 day historical– NYC

Monday	Tuesday	Wednesday	Thursday	Friday
31 minutes	16 minutes	9 minutes	18 minutes	



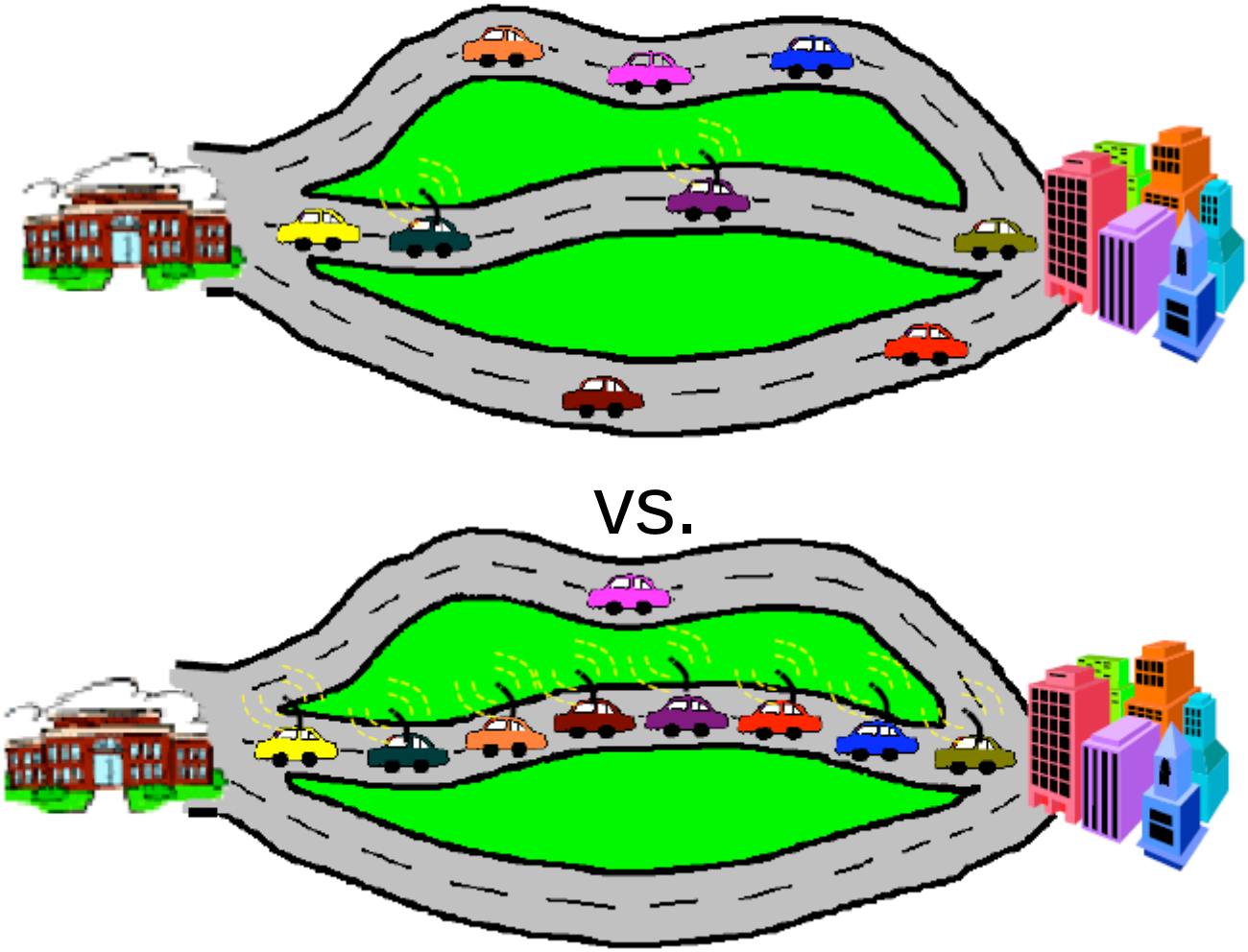
5 day historical– NYC

Monday	Tuesday	Wednesday	Thursday	Friday
31 minutes	16 minutes	9 minutes	18 minutes	4 minutes

Time Saved:
1 Hour, 18 Minutes

The (future) Traffic Management Challenge

Load balanced vs unbalanced routing system using dynamic route guidance



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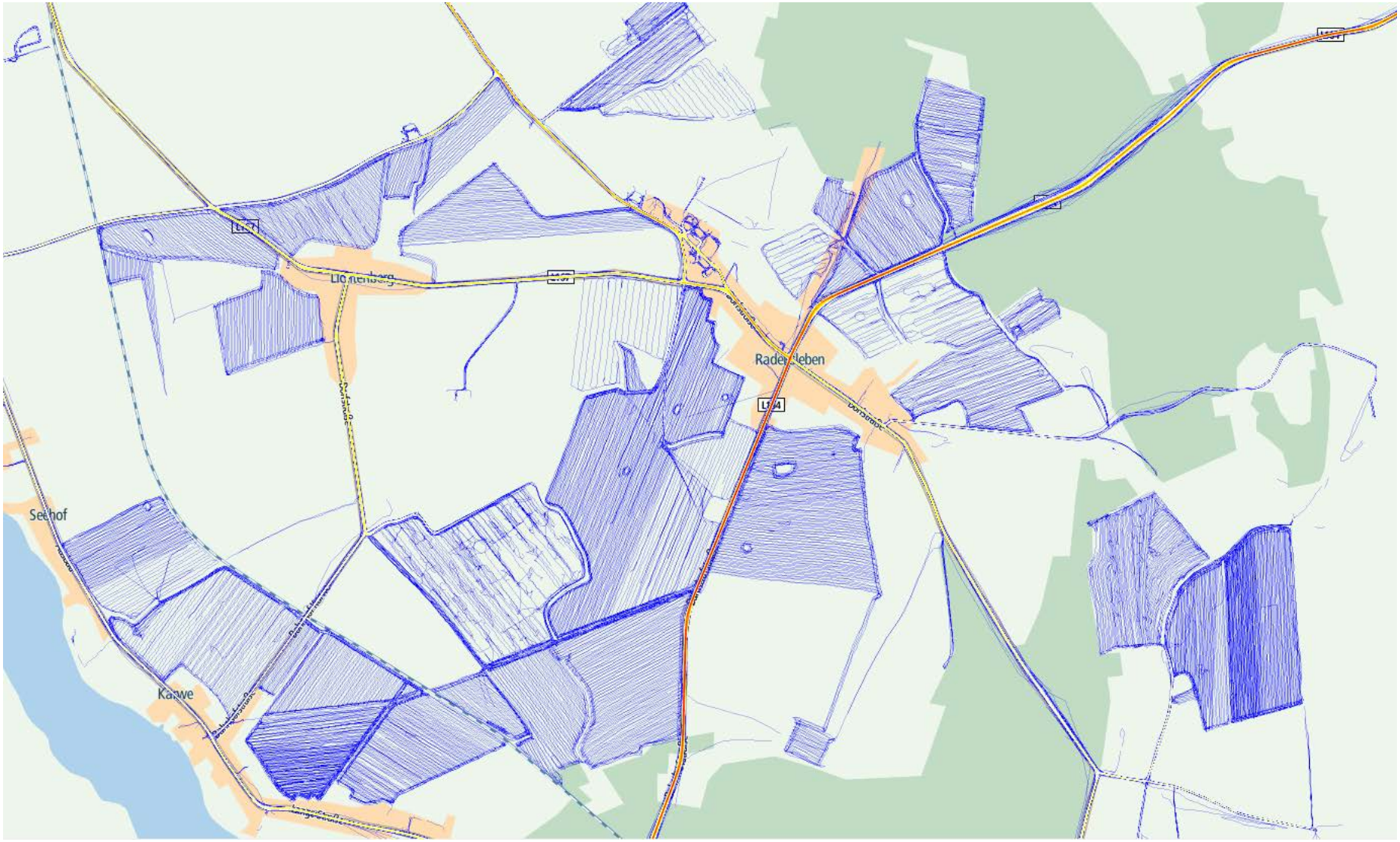
Educated Guess – Probe Data Source?

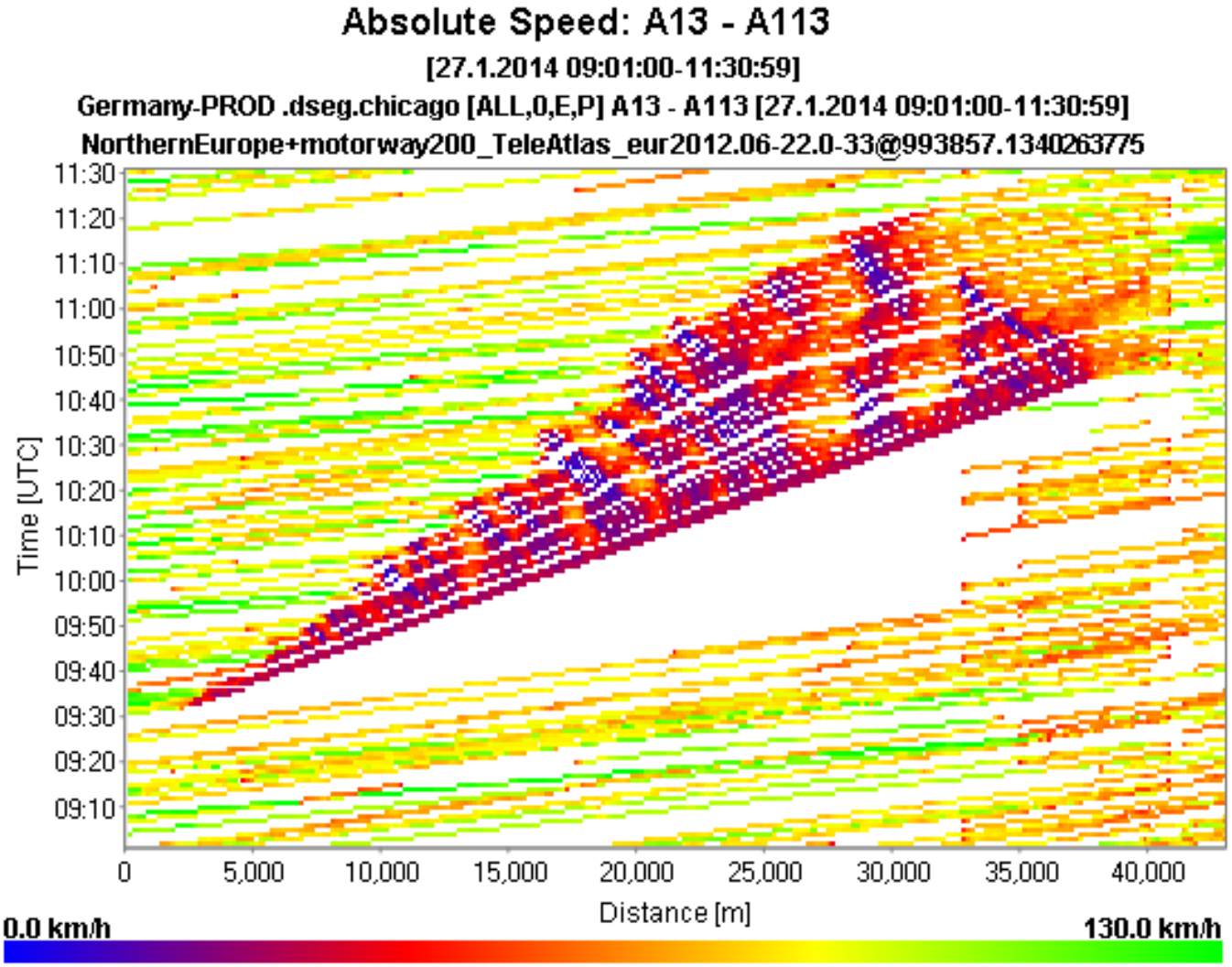


TOMTOM

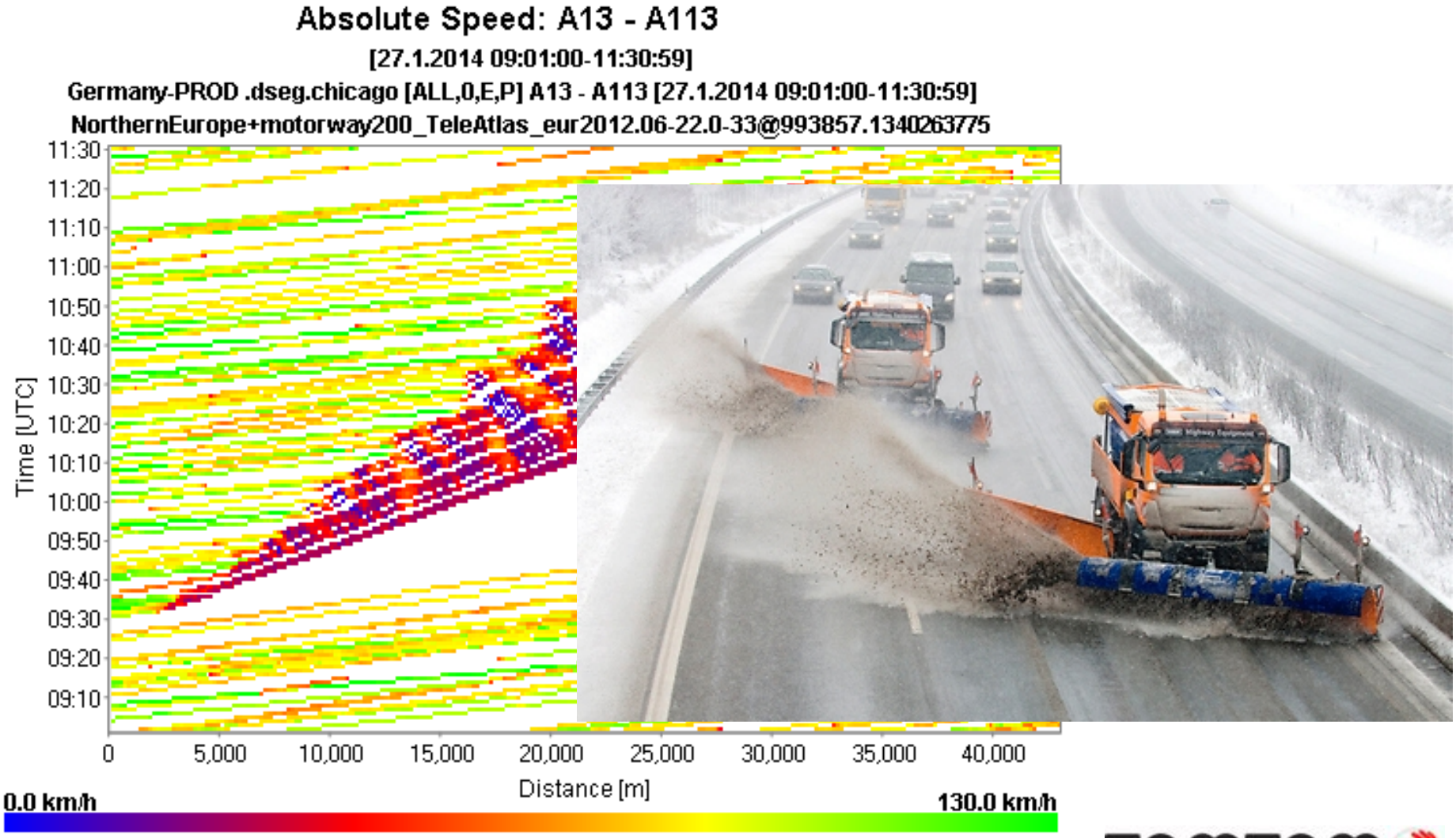
Educated Guess – Probe Data Source?

TOMTOM

Educated Guess 2nd – Probe Data Source?



Educated Guess 2nd – Probe Data Source?



Thank You

ralf-peter.schaefer@tomtom.com

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