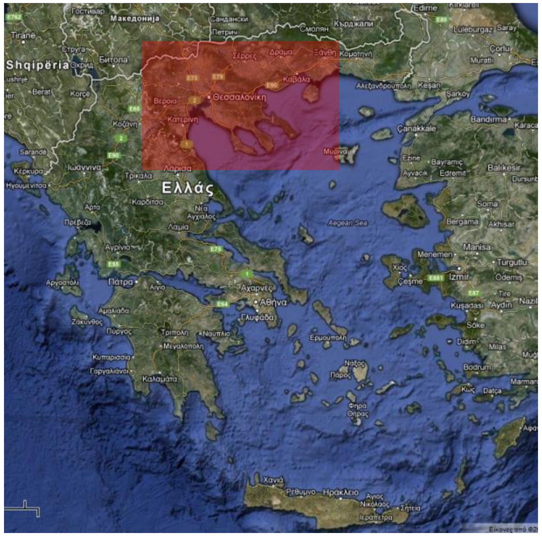
BIG DATA EUROPE

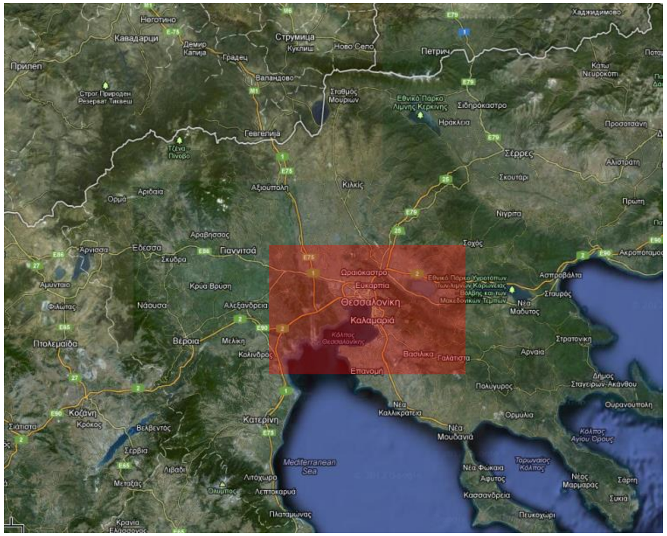
Empowering Communities with Data Technologies

# BIG DATA EUROPE TRANSPORT PILOT: INTRODUCING THESSALONIKI

Josep Maria Salanova Grau CERTH-HIT

# Thessaloniki on the map





~ 1.400.000 inhabitants & ~ 1.300.000 daily trips

~450.000 private cars & ~ 20.000 motorcycles

1 (+1) public transport operator for urban trips & 1.950 taxis

~35 public transport operators for extra-urban trips

6.433 kms of streets - 8,8 kms of dedicated bus lanes - 89,4 kms of ring road

197.696 parking places

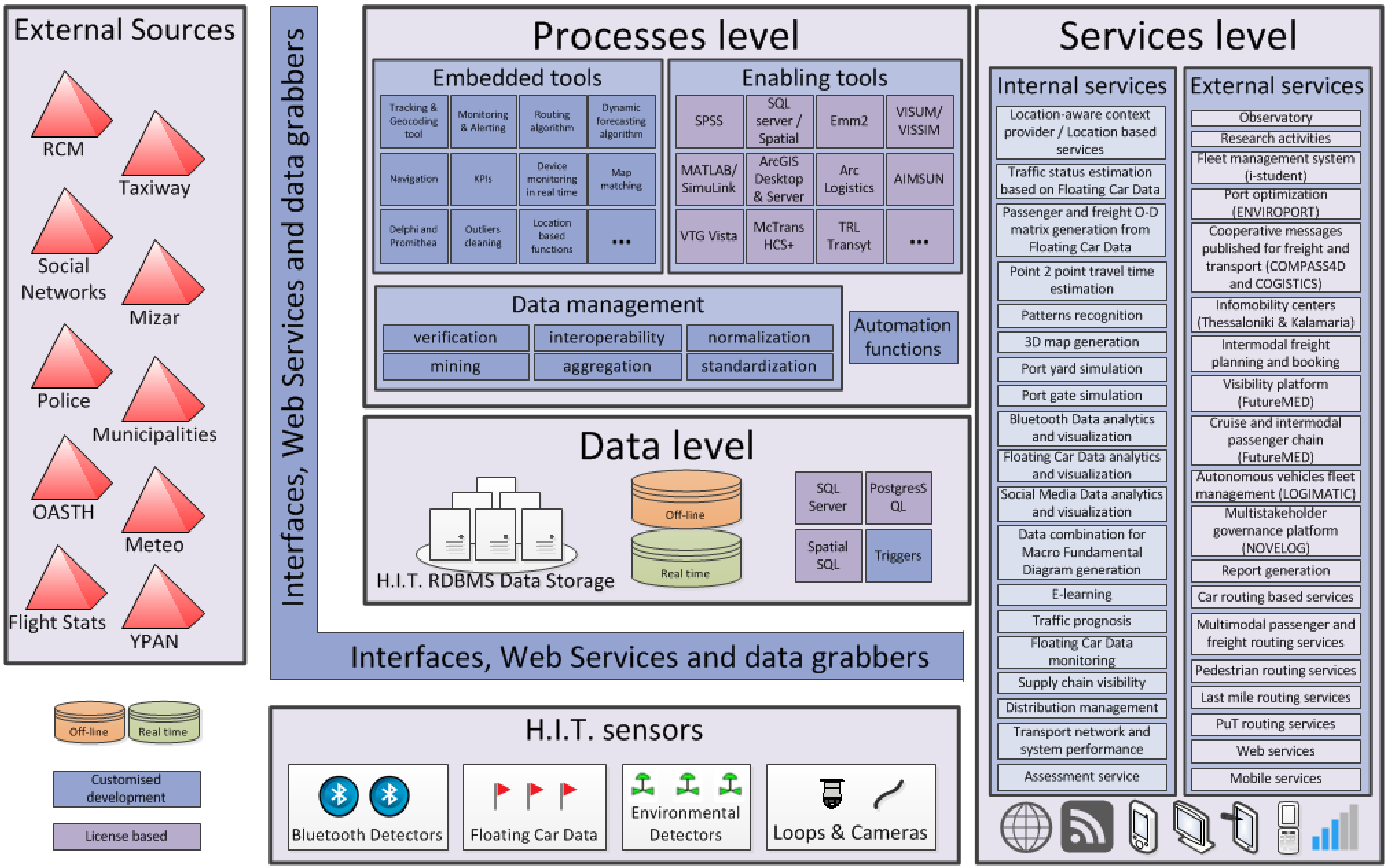
# Probe data in Thessaloniki

- Static sensors network: Point to point tracking of MAC ids along the network through Bluetooth detectors (43 devices).
- Dynamic sensors fleet: Floating Car Data provided in real time by a professional fleet (more than 1.200 vehicles).
- Cooperative technologies (COMPASS4D and COGISTICS): RSU is a static sensor and OBU is a dynamic sensors (CAM message).
- Social media (Twitter & Facebook)

# How do we use Probe Data?

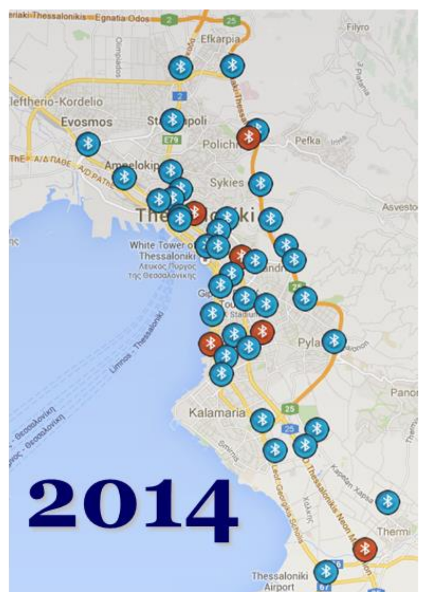
- Stationary sensors network: Point to point tracking of MAC ids along the network through 43 Bluetooth device detectors.
  - Travel time estimation
  - Route choice model calibration
  - Origin – Destination matrix estimation / **Mobility patterns estimation**
  - Traffic flow extrapolation
- Dynamic sensors fleet: Floating Car Data provided in real time by a professional fleets composed of 1.200 taxis and 600 buses
  - Traffic status estimation (average speed)
  - Origin – Destination matrix estimation / **Mobility patterns estimation**
  - Taxi/bus performance indicators
- Social media (geolocated tweets & Facebook check-in events)
  - Activity patterns estimation
  - Events / incidents detection
  - Attraction models estimation

# Thessaloniki Mobility lab



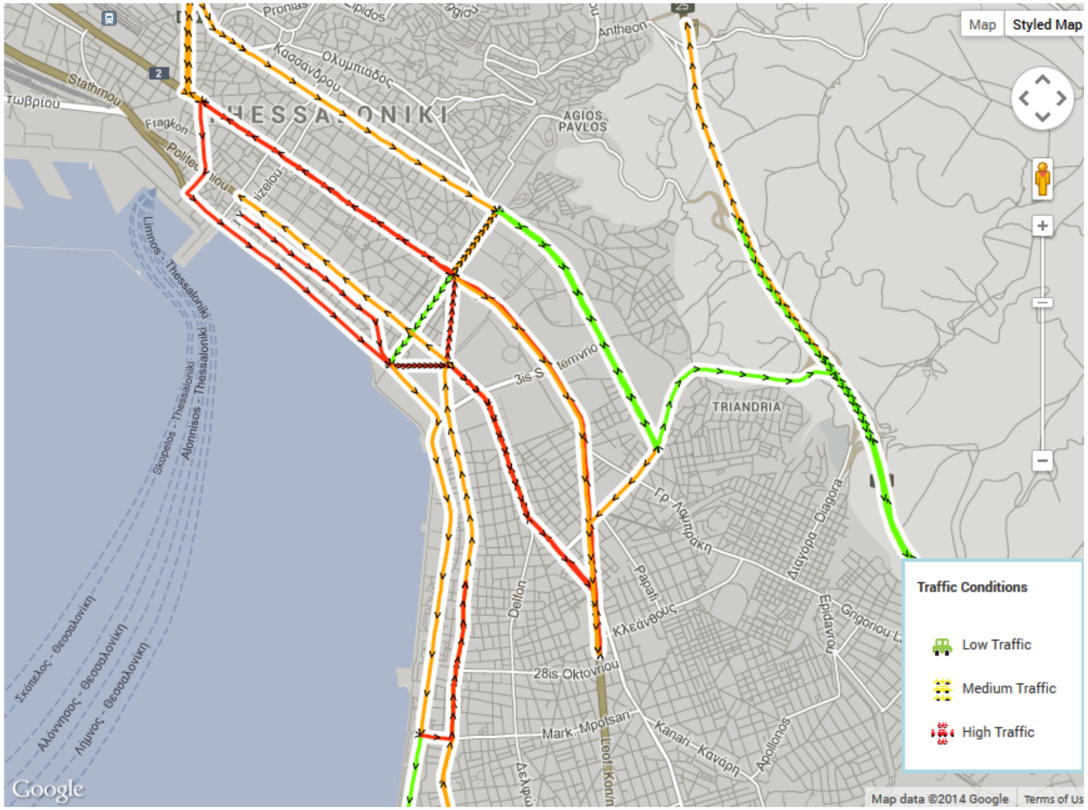
# Point to point BT network

- 43 detectors (EEA, SEE-ITS & EASYTRIP)
  - 4 million detections per week (peak period)
  - 25.000 unique devices detected  per day (one intersection)
  - 1 million “tracked” trips per week
  - 20.000 “tracked” trips per day (one path)
- More detectors installed in other cities and in Bulgaria (SEE-ITS & EASYTRIP)

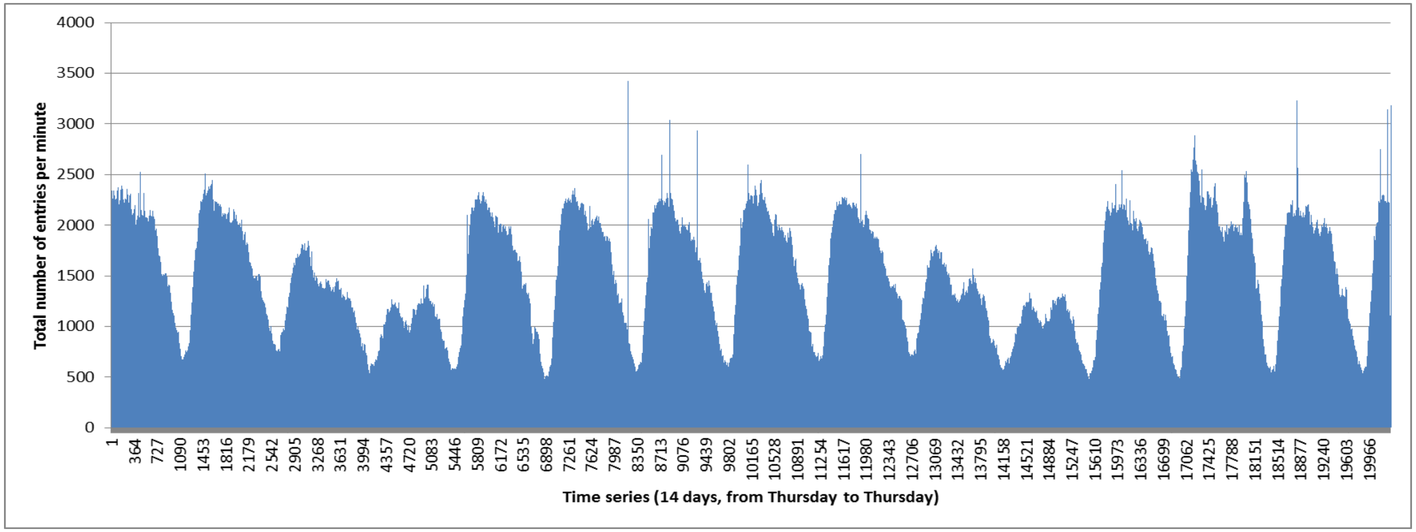

# Point to point BT network

- Real time travel time provision to drivers (VMS, internet, smart device)

# Floating Car Data

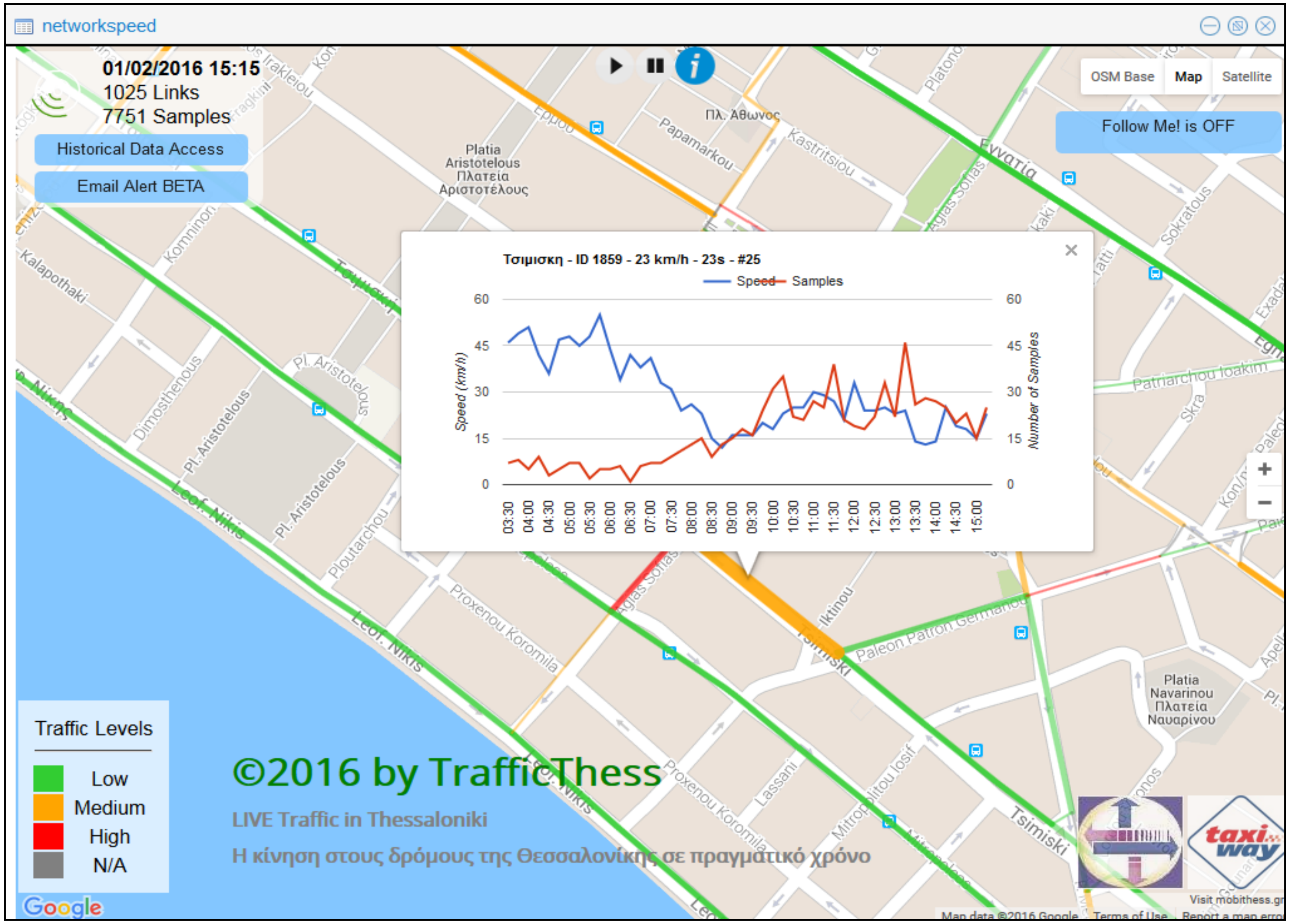
- More than 1.200 vehicles (one taxi fleet)
  - Circulating 16-24 hours per day
  - Pulse generated each 100 meters (10-12 seconds)
  - 500-2.500 pulses per minute




- 600 vehicles generating CAM each second

# Floating Car Data

- Real time traffic conditions information (speed)



# Social media

*44.000 check-in events per week (750 locations)*

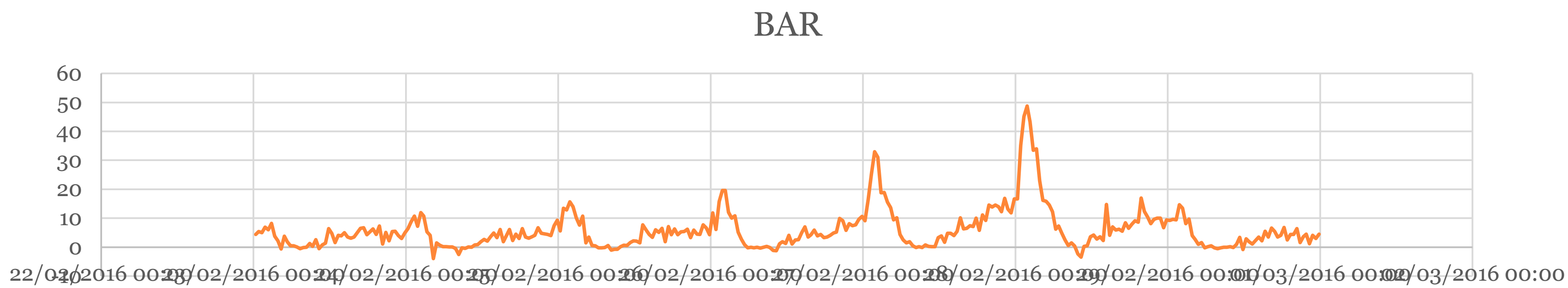
Up to

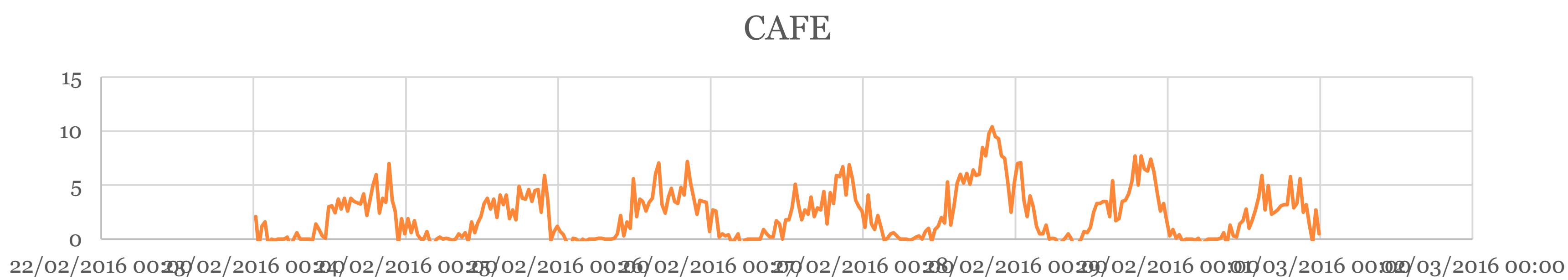
- 50 check-in events per minute (in the 136 locations tagged as bar)
- 17 check-in events per minute (in the 150 locations tagged as restaurant)
- 12 check-in events per minute (in the 32 locations tagged as outdoor)
- 10 check-in events per minute (in the 125 locations tagged as cafe)
- 10 check-in events per minute (in the 55 locations tagged as nightlife)

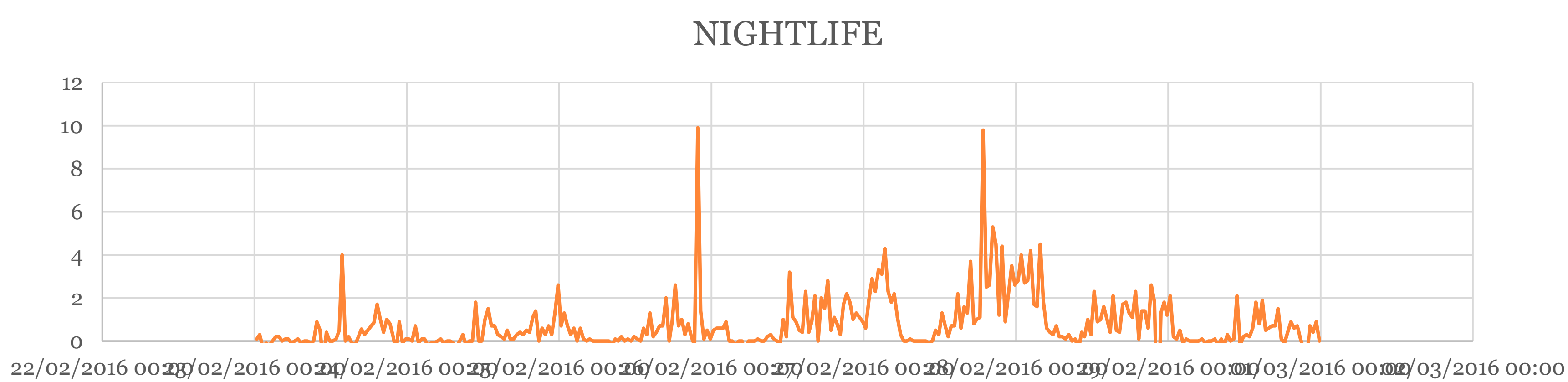
Up to

- 1265 check-in events during the “peak hour”
- 920 check-in events in bars (Sunday 01.00)
- 300 check-in events in restaurants (Saturday 22.00)

# Social media



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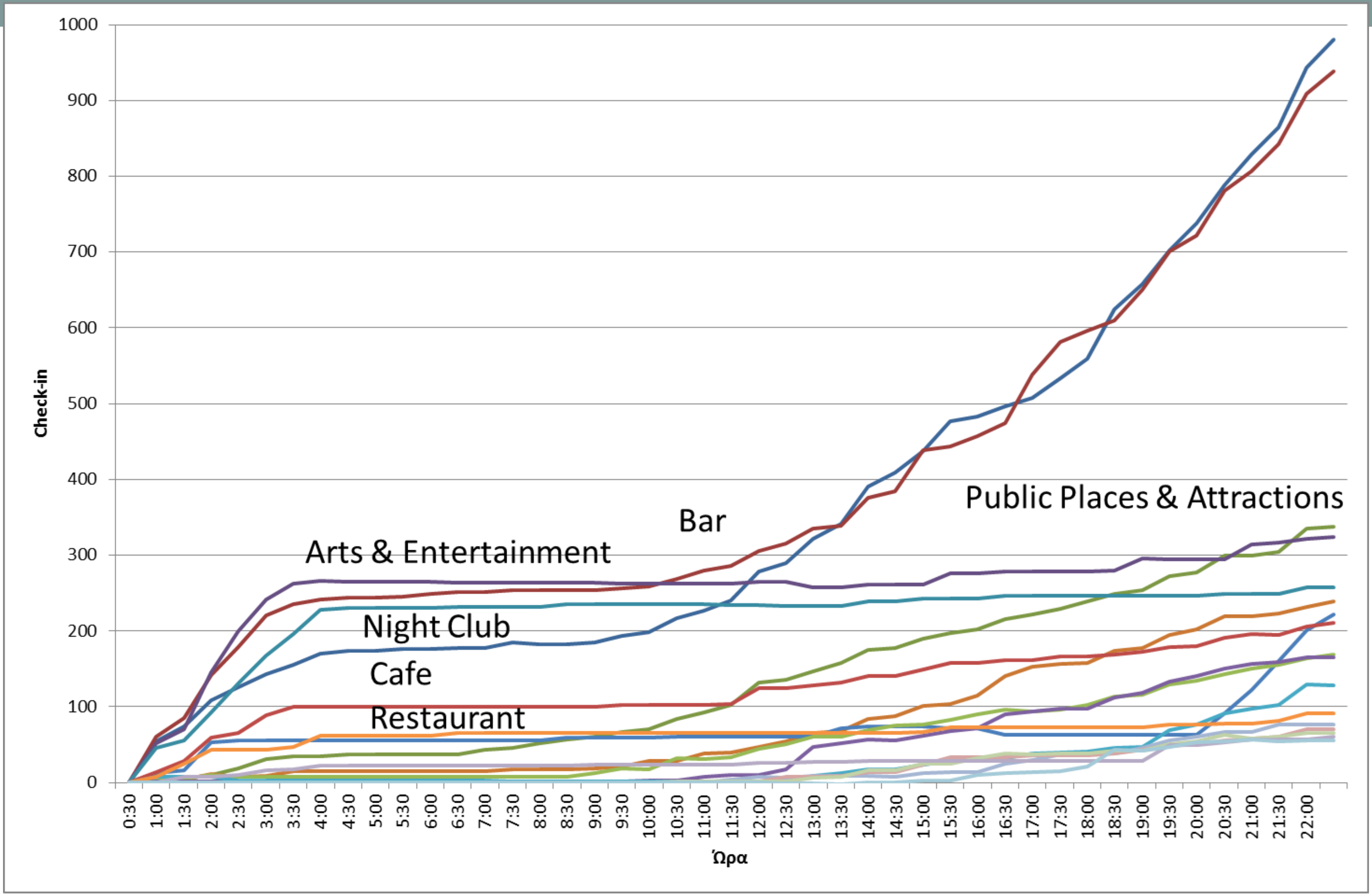

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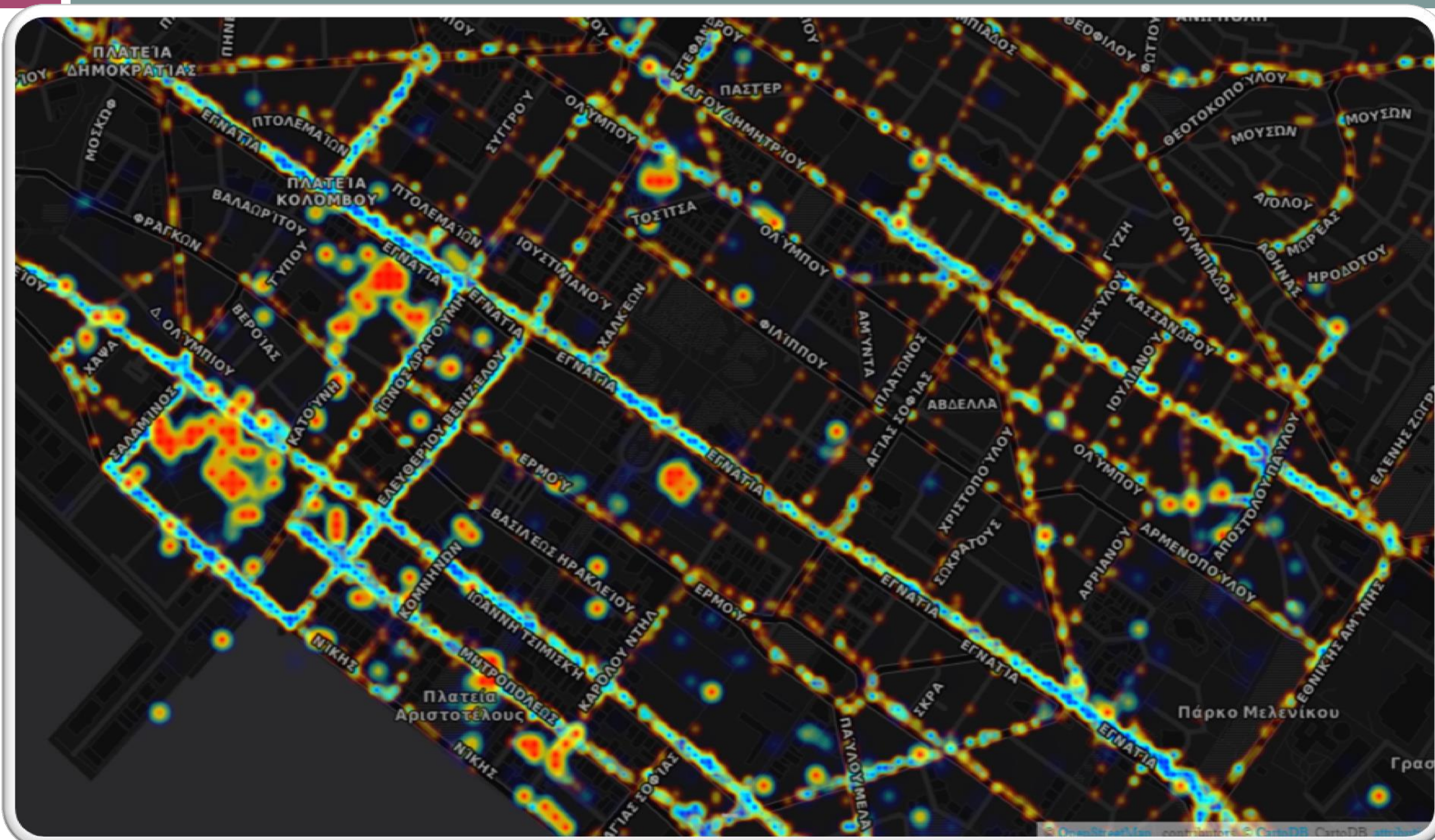
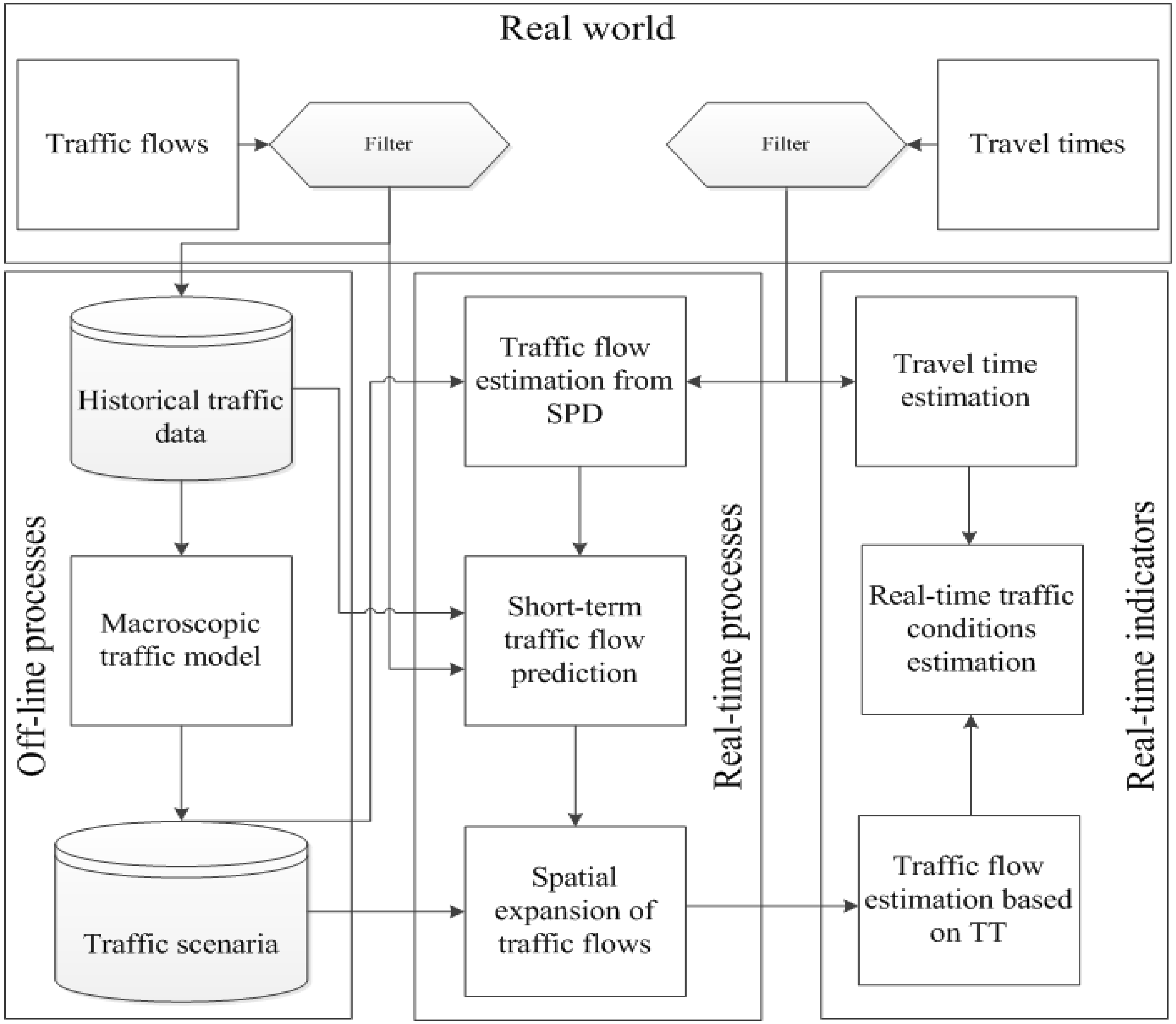


# Real-time traffic conditions estimation

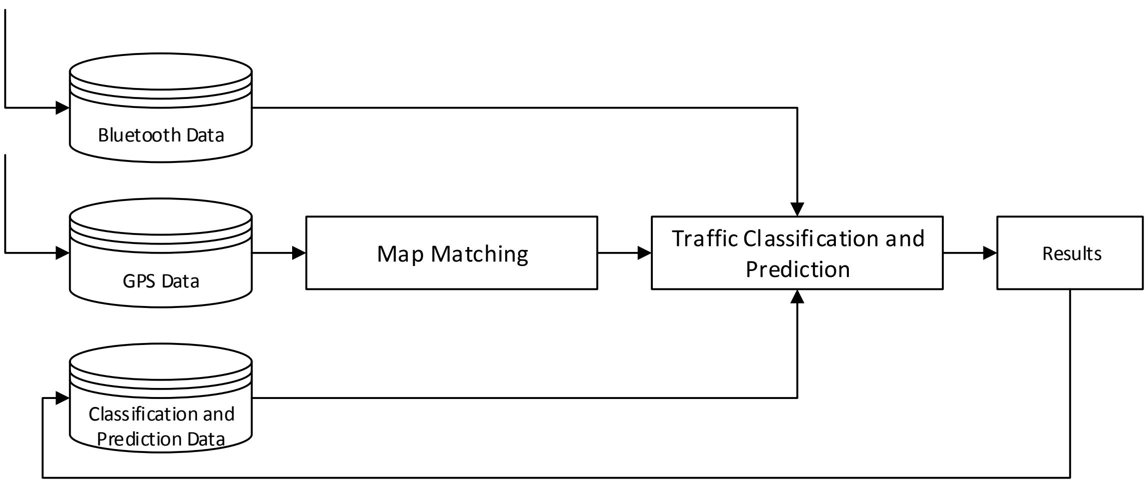


# Processing of big data in Thessaloniki

- Traffic flow estimation from stationary probe data
- Travel time estimation using stationary probe data
- Travel time estimation using floating probe data
- Traffic flow estimation based on travel time
- Short-term traffic flow prediction
- Spatial expansion of traffic flows
- Real-time traffic conditions estimation

# BDE pilot in Thessaloniki

- Probe data that is used
  - Floating Car Data (500-2.500 locations per minute)
  - Bluetooth detections (millions of daily detections in 43 locations)
- Services that are being implemented
  - Improved topology-based map matching
  - Mobility patterns recognition and forecasting



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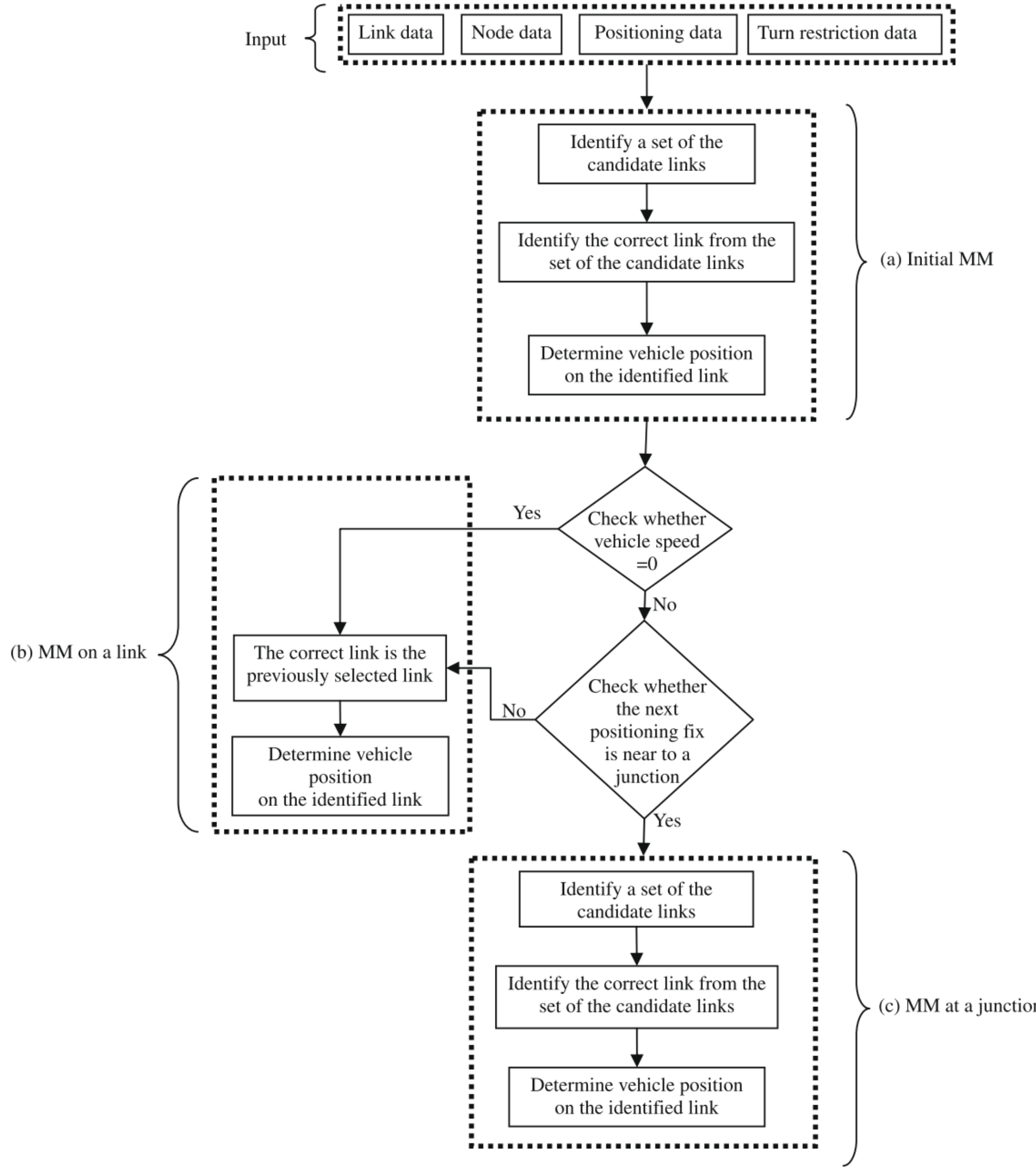

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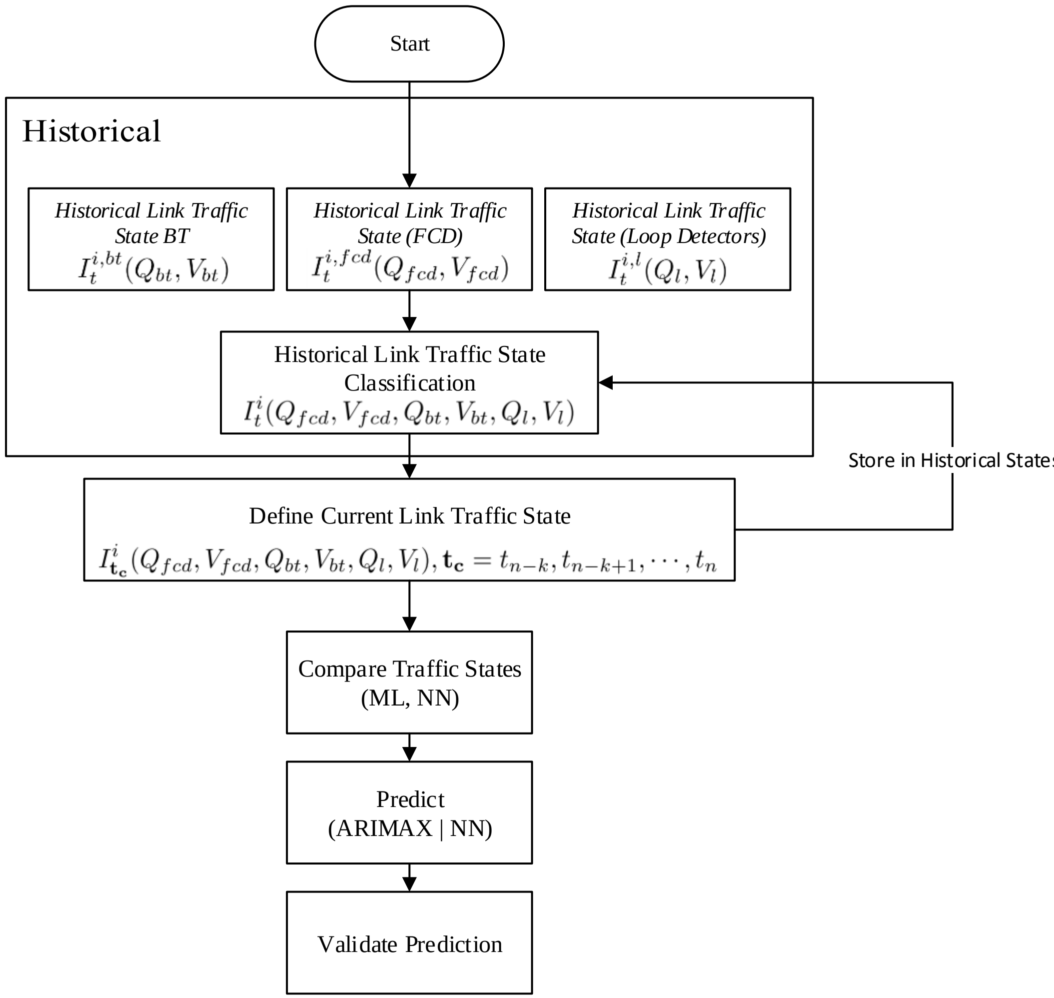

# BDE pilot in Thessaloniki

- Future plans (next 2 pilots)
  - Improve the 2 algorithms (historical data)
  - Replace the R components

  - Add the BT data source
  - Add other data sources (conventional and SM)
  - Include more datasets (PuT)
  - Use OSM data

  - Improve other processes (travel time estimation from BT)

# SESSION 2: TECHNICAL REQUIREMENTS AND ADDITIONAL TRANSPORT USE CASES

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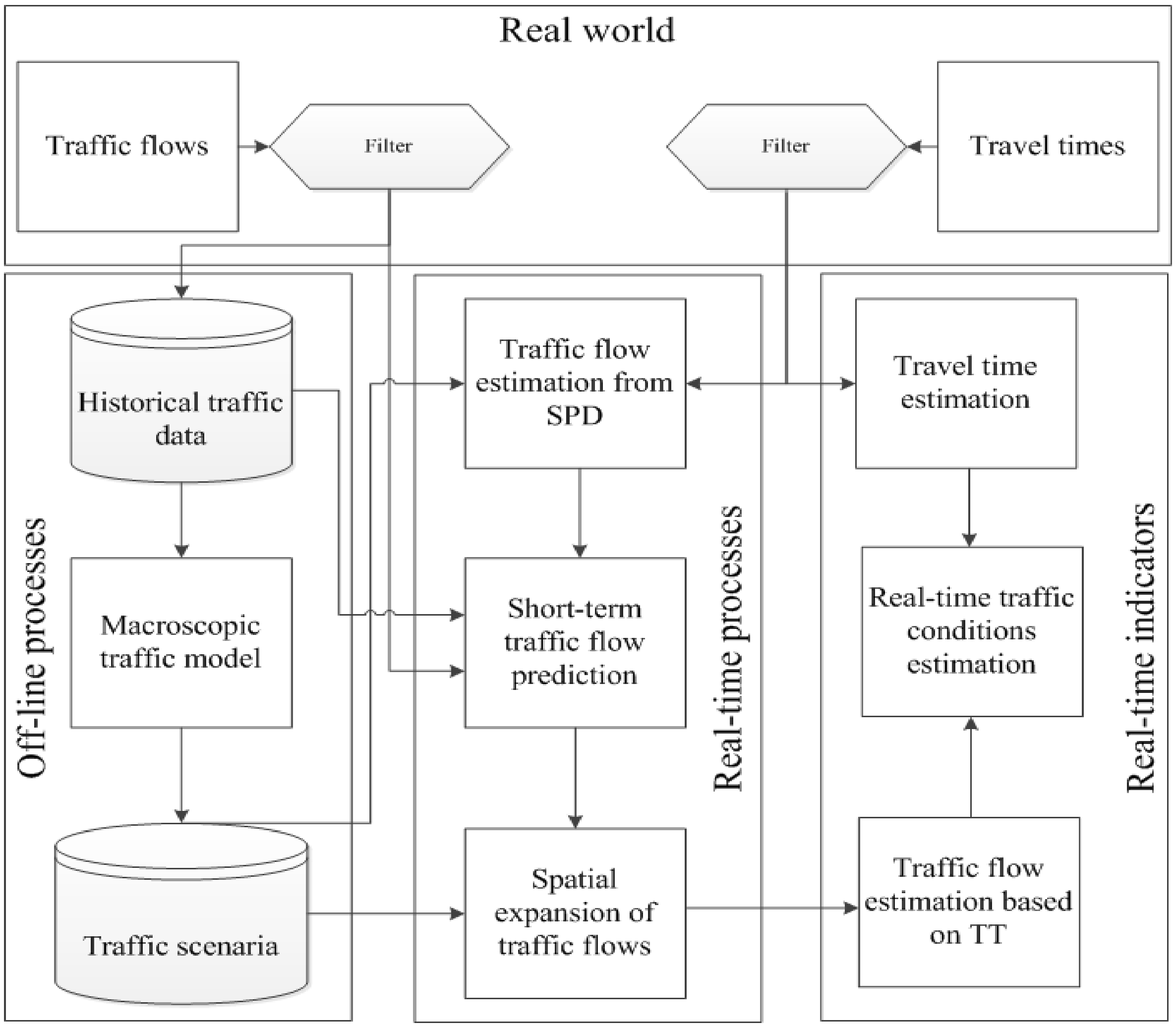
# Real-time traffic conditions estimation



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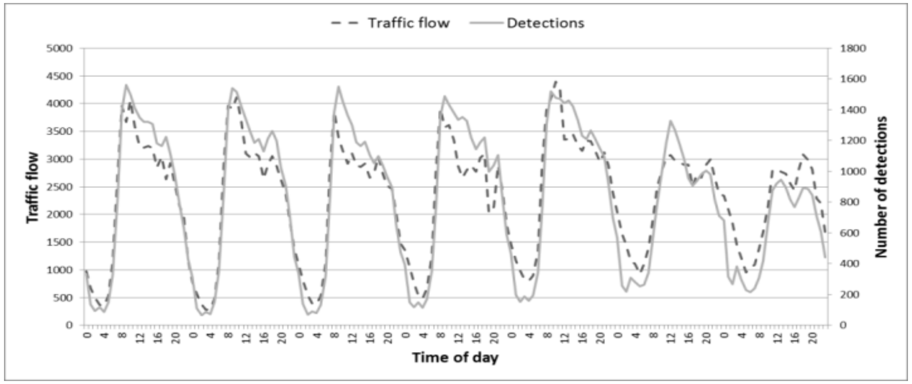
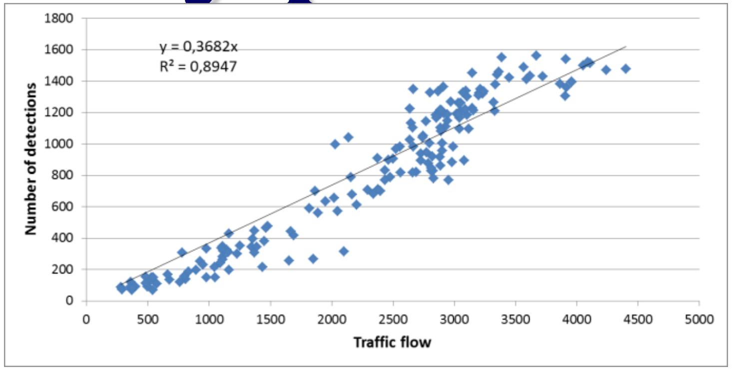
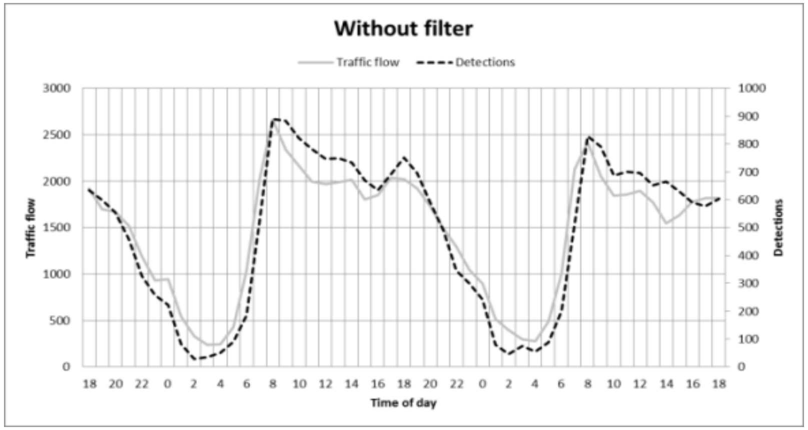
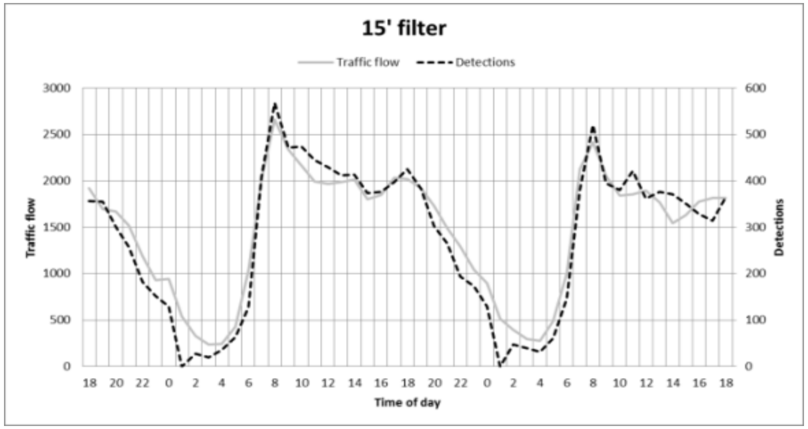
# Traffic flow estimation based on stationary probe



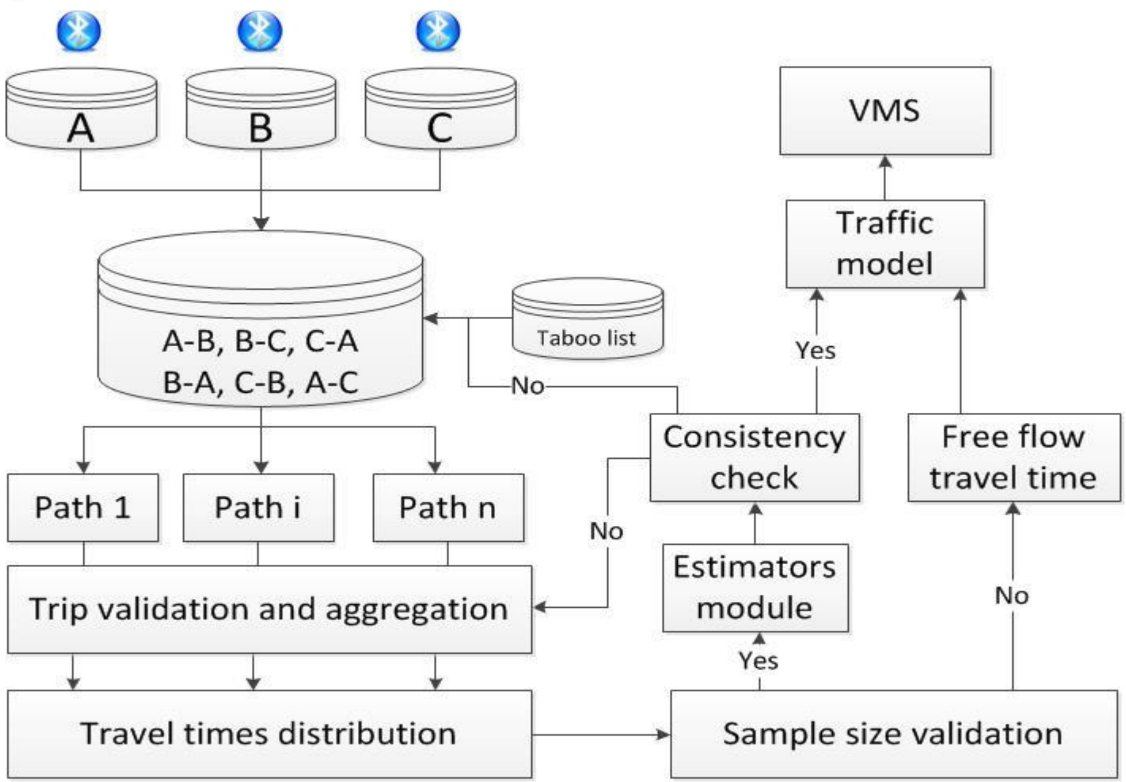



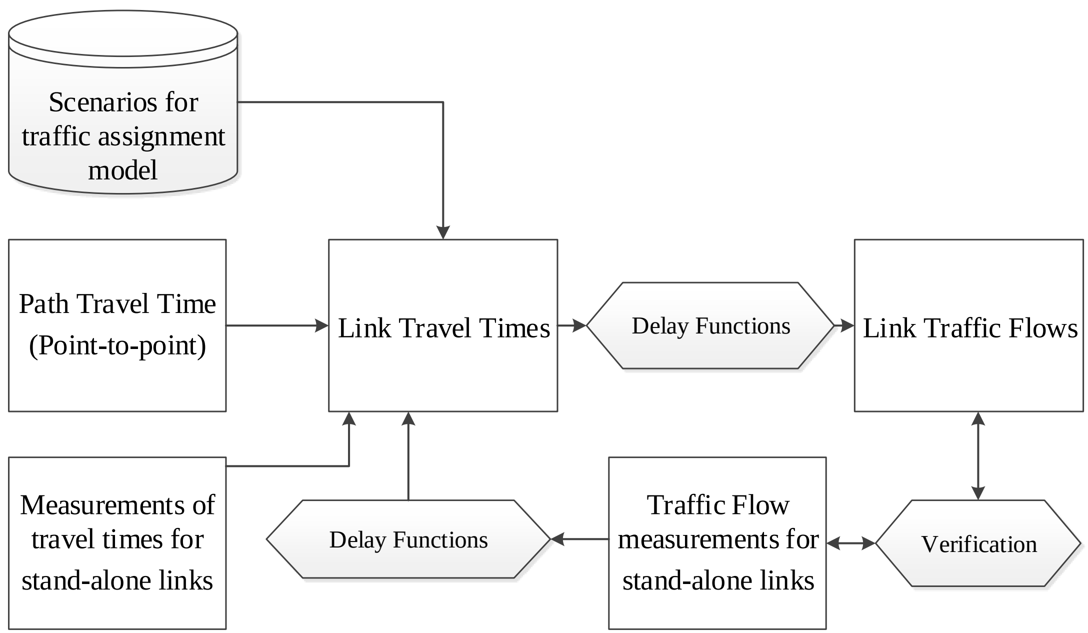




| Time interval used for data filtering | Without filtering | 5min filter | 15min filter | 60min filter |
|---|---|---|---|---|
| Correlation coefficient | 0.3412 | 0.2179 | 0.1972 | 0.0442 |
| $R^2$ | 0.9166 | 0.9193 | 0.9337 | 0.8594 |
| Largest differences<br>(absolute value and percentage ranges) | -401 / 623<br>-26% / 75% | -410 / 437<br>-23% / 61% | -336 / 389<br>-22% / 57% | -536 / 767<br>-35% / 79% |

# Travel time estimation based on stationary probe data



# Traffic flow estimation based on travel time




Conversion from route travel time to link travel time

$$\min \delta_1 * \sum(A * x - b) + \delta_2 * \sum((x - v0)/v0) \quad (1)$$

$$\text{s.t.} \quad x_i > t_{0i} \forall i \in I \quad (2)$$

$$x_j = t_j \forall j \in J \quad (3)$$

# Short-term traffic flow prediction

Linear autoregressive (AR) model

$$\varphi_k^{i+1} = \overline{\varphi} + \sum_{j=1}^{N} \beta_k^j * (\varphi_k^{i+1-j} - \overline{\varphi}) \qquad (4)$$

# Spatial expansion of traffic flow

Data Expansion Algorithm (DEA, [Lederman and Wynter 2009])

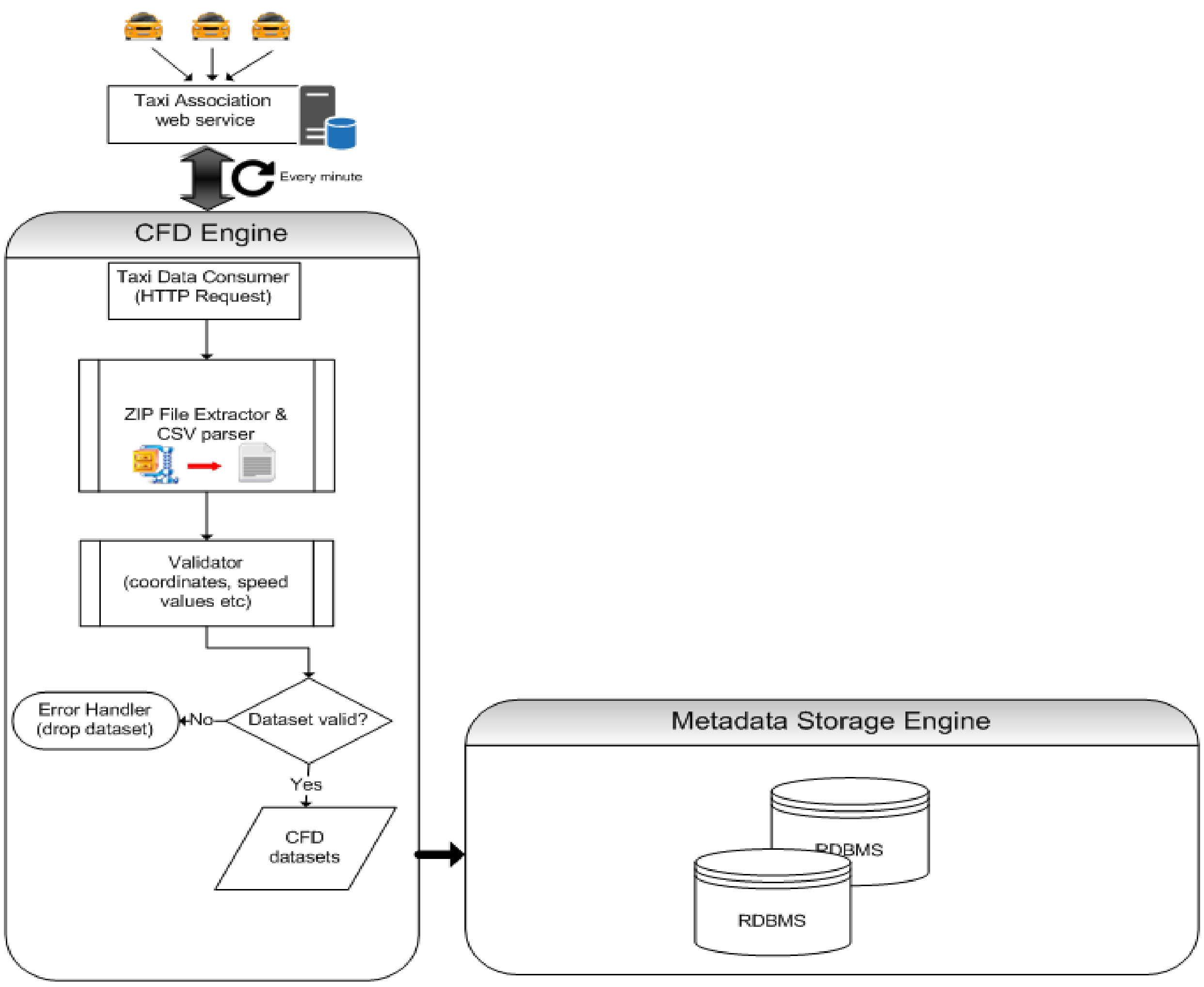
$$\text{Optimize } (D - p.* C_n) * x - (p.* C_c * c) \qquad (5)$$

$$\text{s.t.} \quad x_i > lb_i \forall i \in I \qquad (6)$$

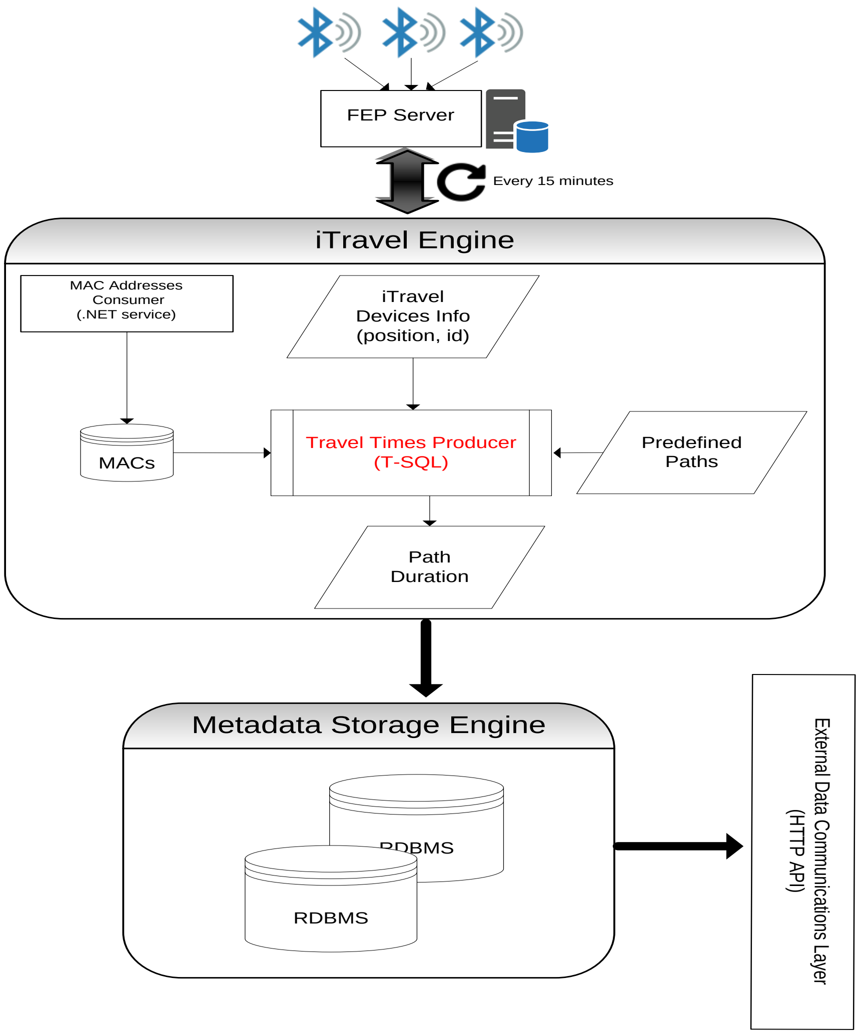
$$x_\iota < ub_i \forall i \in I \qquad (7)$$

$$x_j = f_j \forall j \in J \qquad (8)$$

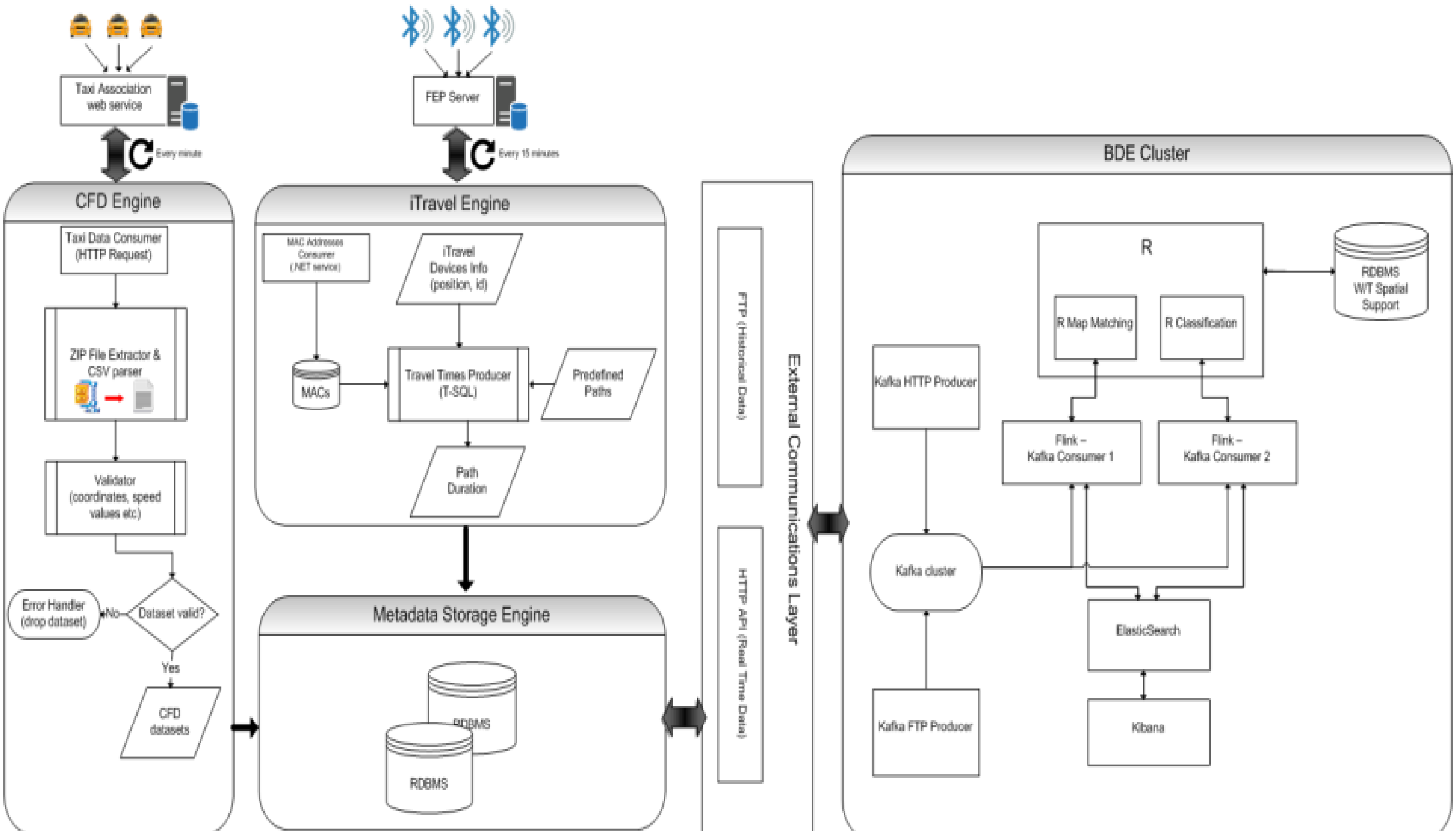
# FCD data and average speeds on the road network



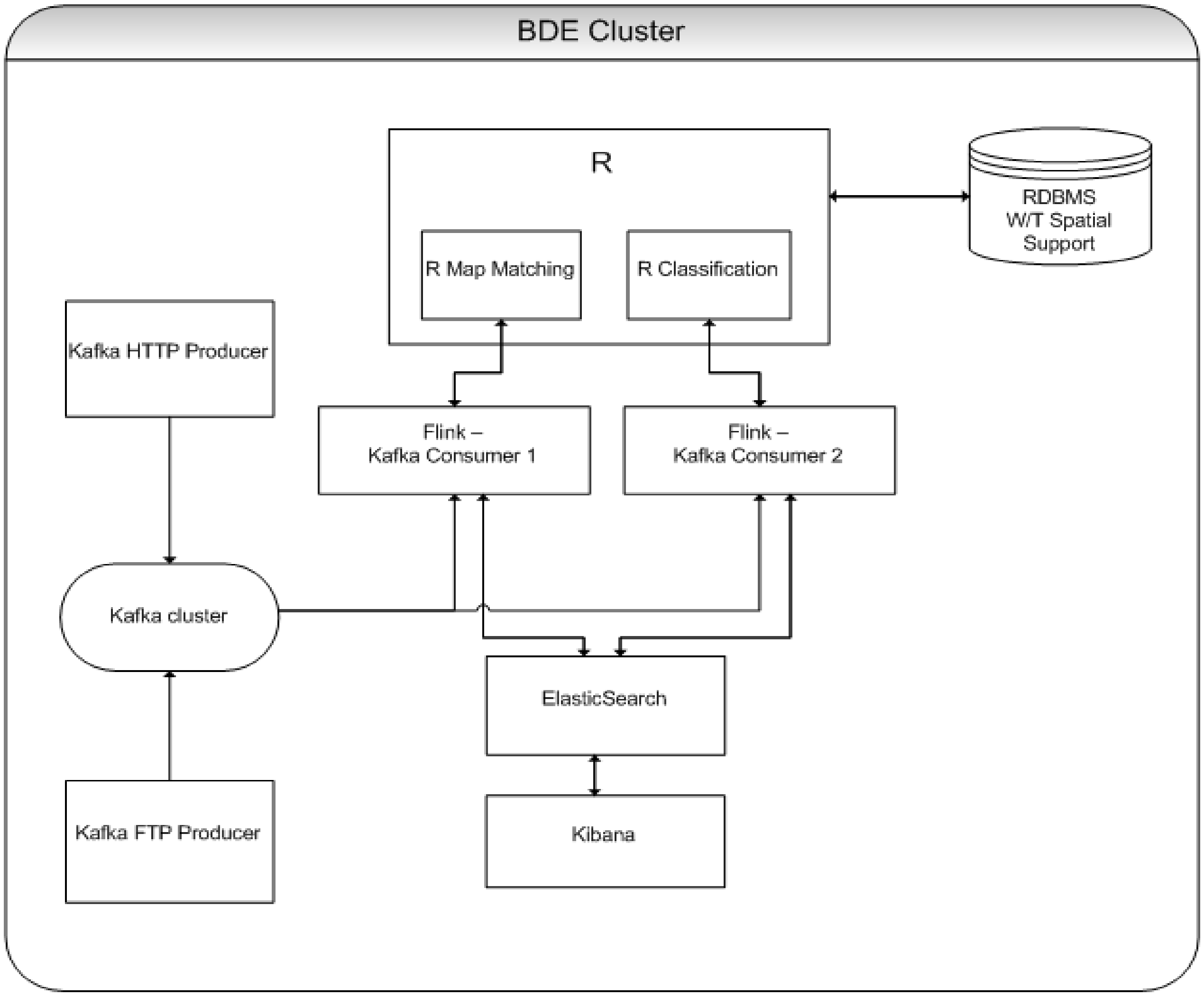
# Bluetooth Sensors data and estimated travel times on the road network



# BDE Components integration with the legacy system



# BDE Components



# QUESTIONS

- What are the pros and cons of the technical implementation of the platform offered by BigDataEurope?
- How easy is to implement it to transport use case?
- Lessons learnt from the first pilot implementation?
- How adaptable / usable is it?

# QUESTIONS

- Any non-technical barriers to be considered? (legal, open data)
- Does the open data flow initiative pose any threat/opportunity?
- In which transport use case can we reproduce the pilot?
- Which are the characteristics of the transport data that had to be considered in the design of the architecture ?

# QUESTIONS

- Any non-technical barriers to be considered? (legal, open data)
  - Privacy (the driver IDs are modified every 24 hours)
  - Data owner is a private entity (we rely on their willing to share the data)
  - Updated maps are needed (OSM can be a solution)
  - Telecommunication costs (in our case are covered by the private company since is crucial for their professional activity)

# QUESTIONS

- Does the open data flow initiative pose any threat/opportunity?
  - ++ data standardization
  - ++ data availability
  - ++ up-to-date datasets
  - -- data quality validation

# QUESTIONS

- In which transport use case can we reproduce the pilot?
  - In any city having similar data sets
  - In other transport modes (PuT)

BIG DATA EUROPE

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http://opendata.imet.gr/dataset

**itravel-traveltimes**

Current travel times for selected paths

JSON XML CSV

**fcd-compass4d**

Floating car data along 2 arterials (zones)

JSON XML CSV KML MAP


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