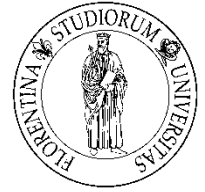


Università degli Studi di Firenze
Dipartimento di Meccanica e Tecnologie Industriali



Facility location model for the electric vehicles charging infrastructure

Filippo Romoli – University of Florence



International Encounters

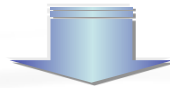
Mobilis 2012

Mulhouse - France
13th and 14th november

www.mobilisconference.com

Introduction to the problem

- Issues for electric vehicle diffusion
- Infrastructure needs



- Optimization model for the location of E.V. charging points
- Flow Refuelling Location Model (FRLM) Kuby, 2005
- n°3 modes of recharging solutions:

- ✓ *Slow charge (6-8 h)*
- ✓ *Fast charge (15 min)*
- ✓ *Battery switch (5 min)*



- Estimate n° of necessary charging infrastructure

Objective function

Objective function FRLM model

$$\max F = \alpha \sum_{q \in Q} f_q \cdot (y_{q_{rl}} + y_{q_{rv}} + y_{q_{sb}}) -$$

Maximize intercepted vehicles flows

$$(1 - \alpha) \cdot \left[\left(n_{rl \text{ tot id}} - \sum_{k \in K} n_{rl_k} \right)^2 + \left(n_{rv \text{ tot id}} - \sum_{k \in K} n_{rv_k} \right)^2 + \left(n_{sb \text{ tot id}} - \sum_{k \in K} n_{sb_k} \right)^2 \right]$$

Reduce «distance to target»

Weighting Coefficient

Independent variables

Constraint equations

About:

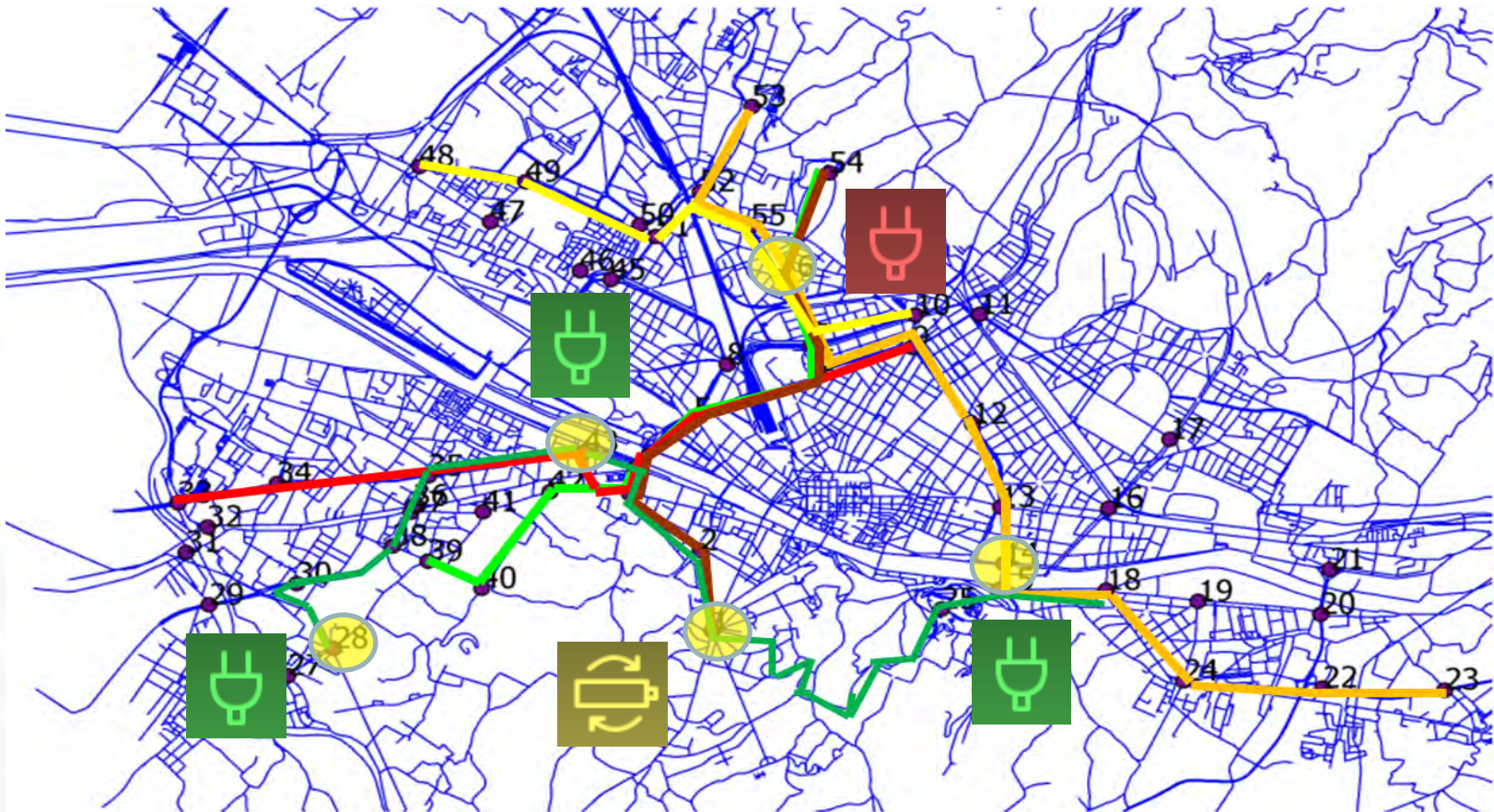
- *vehicle autonomy*
 - *the possible combinations of charging points must be able to recharge the vehicle moving on the path “q”*
- *total cost*
 - *total cost for the setting-up of the charging infrastructure*
- *n° of maximum charge spots in each node*
 - *for ex., in relation with the $n \downarrow p \downarrow k$ available parkings*
- *minimum number of charge spots / battery switch stations, at particular nodes*
 - *hospital,*
 - *shopping center*
 - *etc.*



Example: Florence map

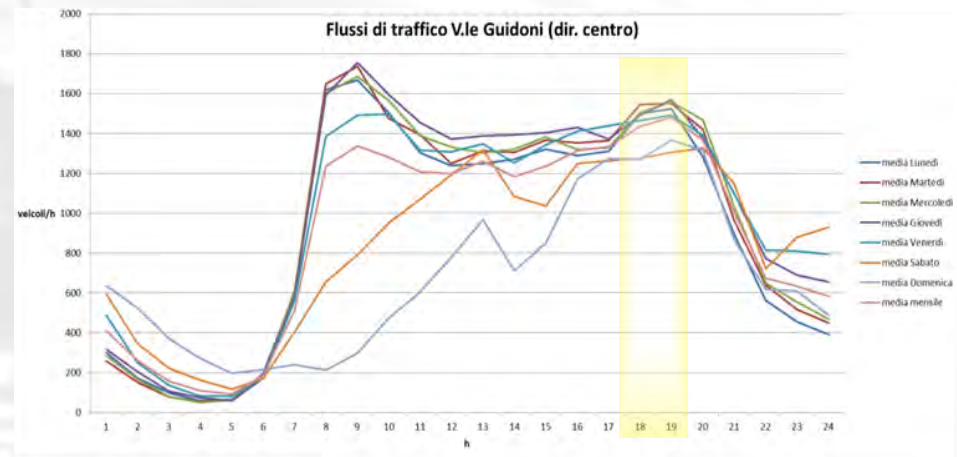
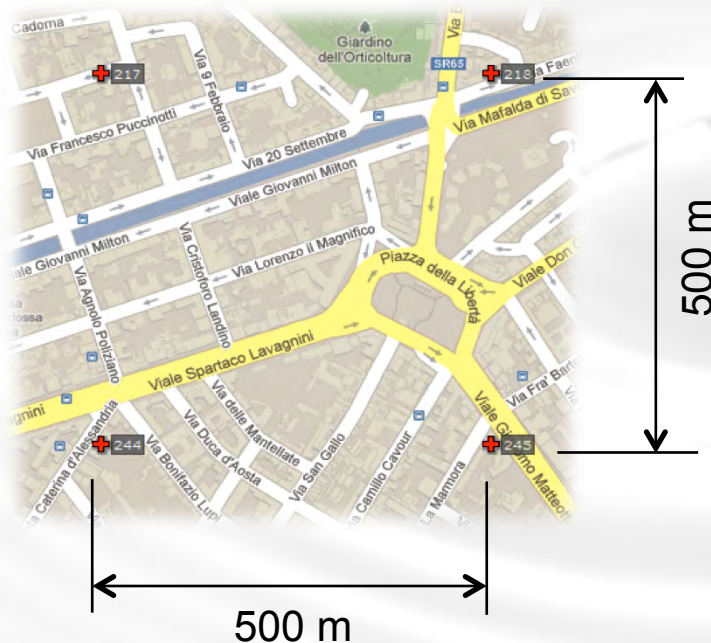
- n°6 minimum paths «q» from departure to arrival points

➡ Solution: nodes marked with yellow dots 



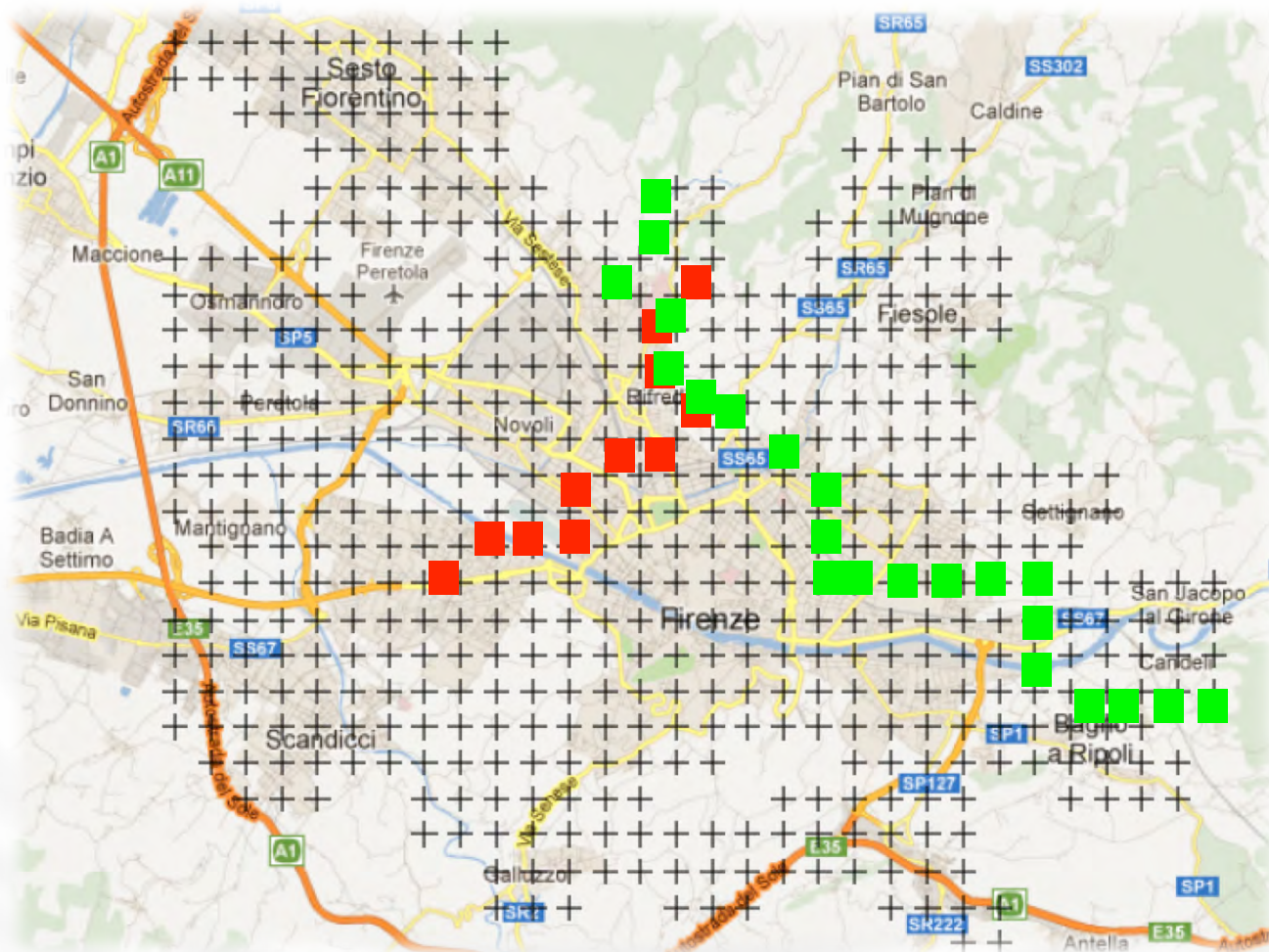
Conclusions and future development

- Use of real flow data coming from GPS data acquisition related to Florence area
- Definition of a grid on the map
- Squares of 500m side





- ✓ Discretized vehicle flow data
- ✓ Optimization on a discretized map





Thanks for the attention!



filippo.romoli@unifi.it