

(Towards) Agent Computing for Intelligent Transport Systems

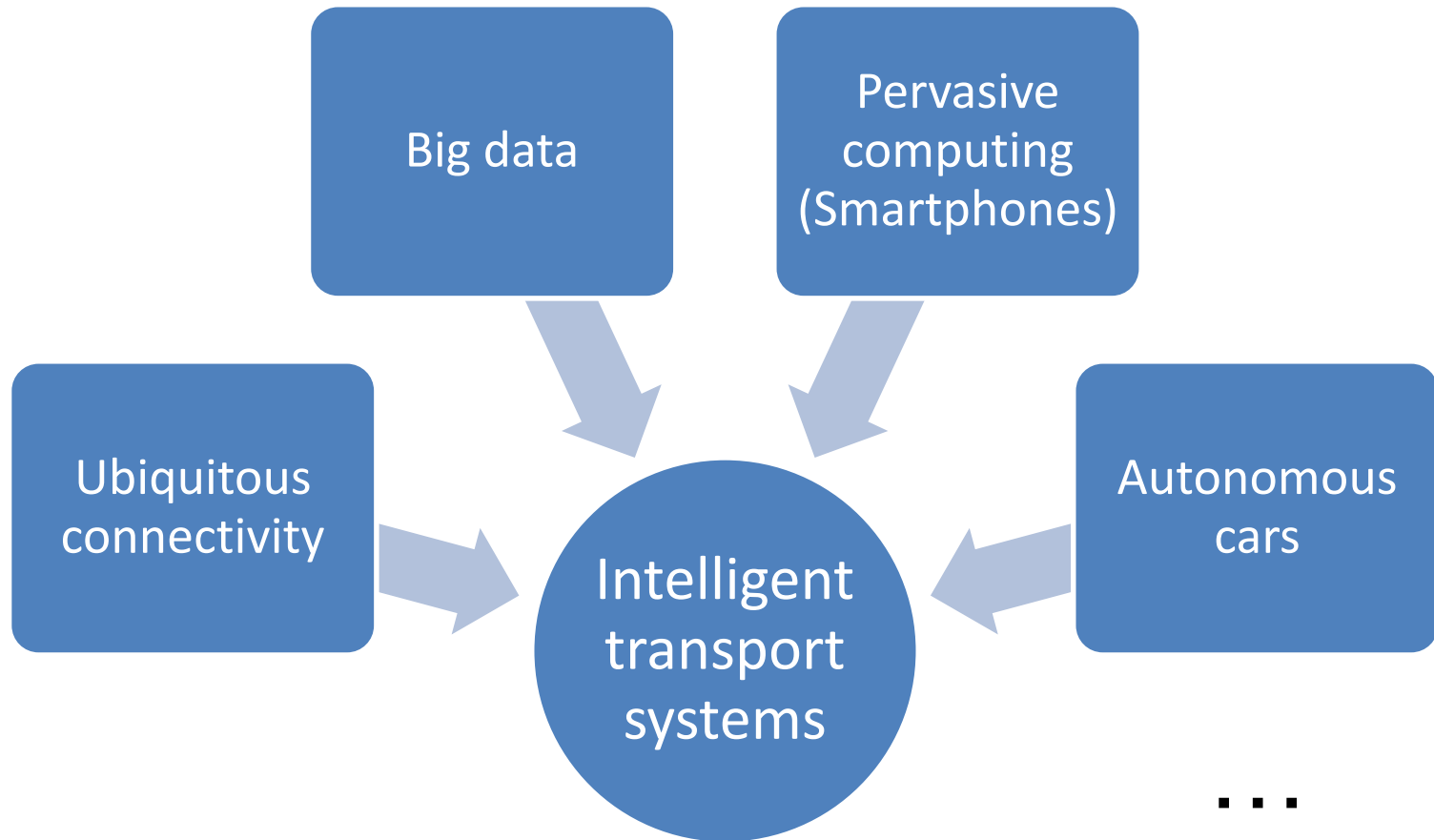
Michal Jakob, Jan Hrnčíř, Zbyněk Moler

Agent Technology Center, Czech Technical University in Prague

http://agents.fel.cvut.cz/topics/intelligent_transport_systems



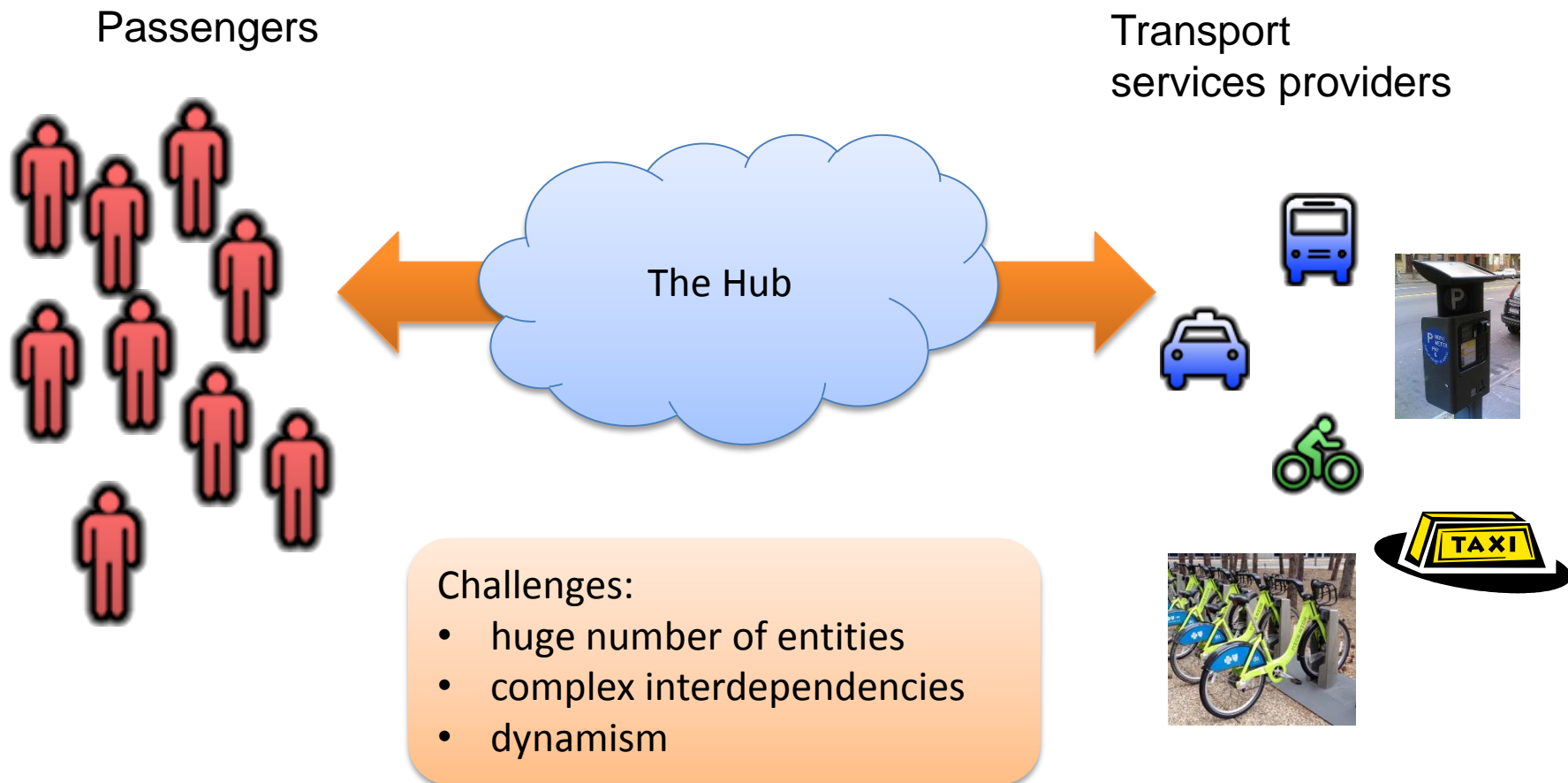
Trends/Vision



Flexible Transport Markets



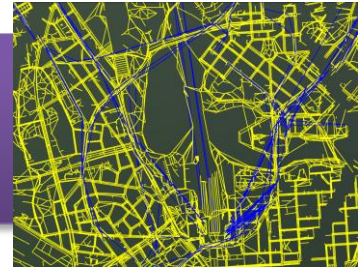
- Real-time matchmaking between demand and supply => **mobility as a service**



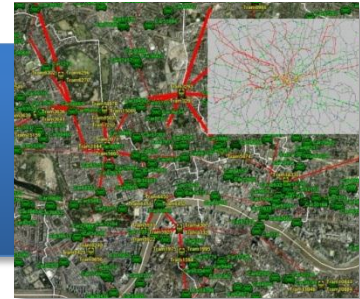
Layered Approach



Data Integration, Visualization and Analysis

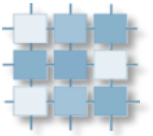


Agent-based Simulation (What-if)



Planning, Coordination and Optimization



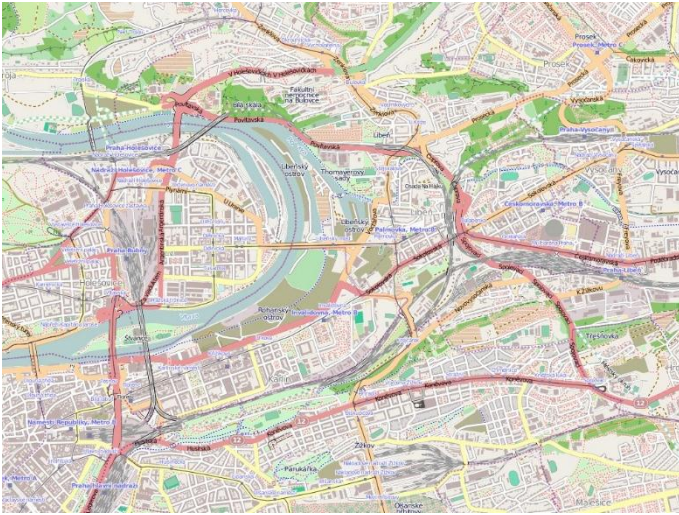


Data Integration and Analysis

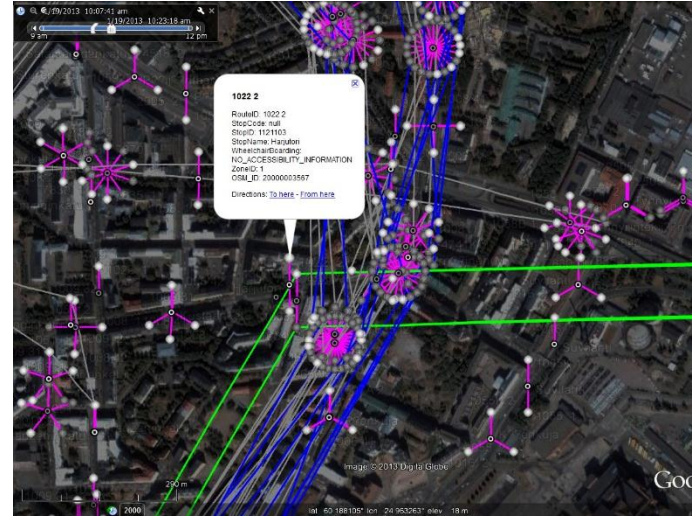
Main Data Sources



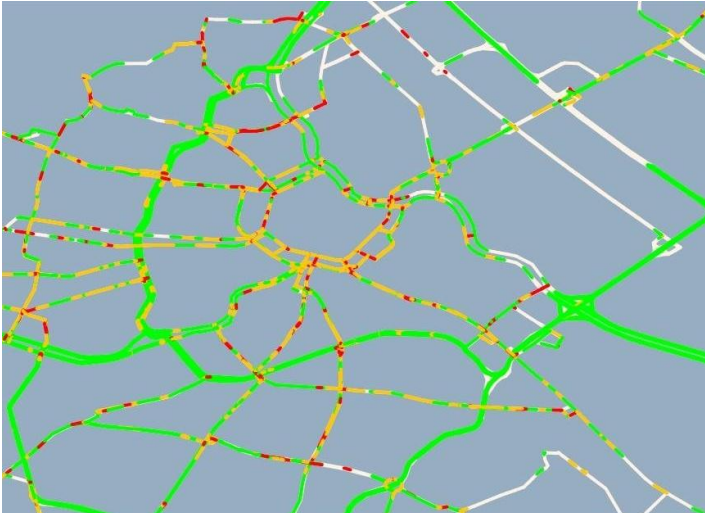
OSM road networks



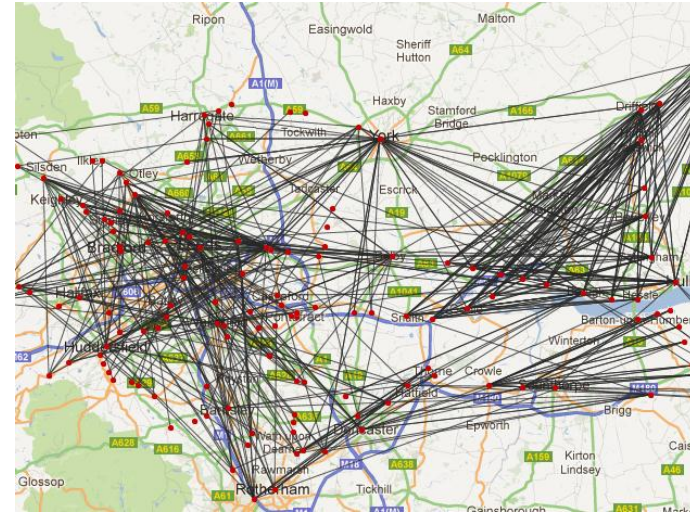
GTFS / JDF Timetables



Real-time Level of Service (FCD)



Real-time Origin-Destination Matrices



Transport Network Analysis

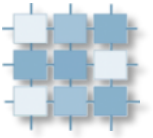
(BP Jan Nykl)



- Input: Timetables & stops of the PTN
- Output: Various PTN metrics
 - (duration of journey, number of interchanges, harness, PTN area and length etc.)
- Two modes of analysis
 - Many-to-many
 - One-to-others
- Time-expanded graph & Dijkstra used for finding a route in the PT



(Image from OpenTripPlanner Analyst)

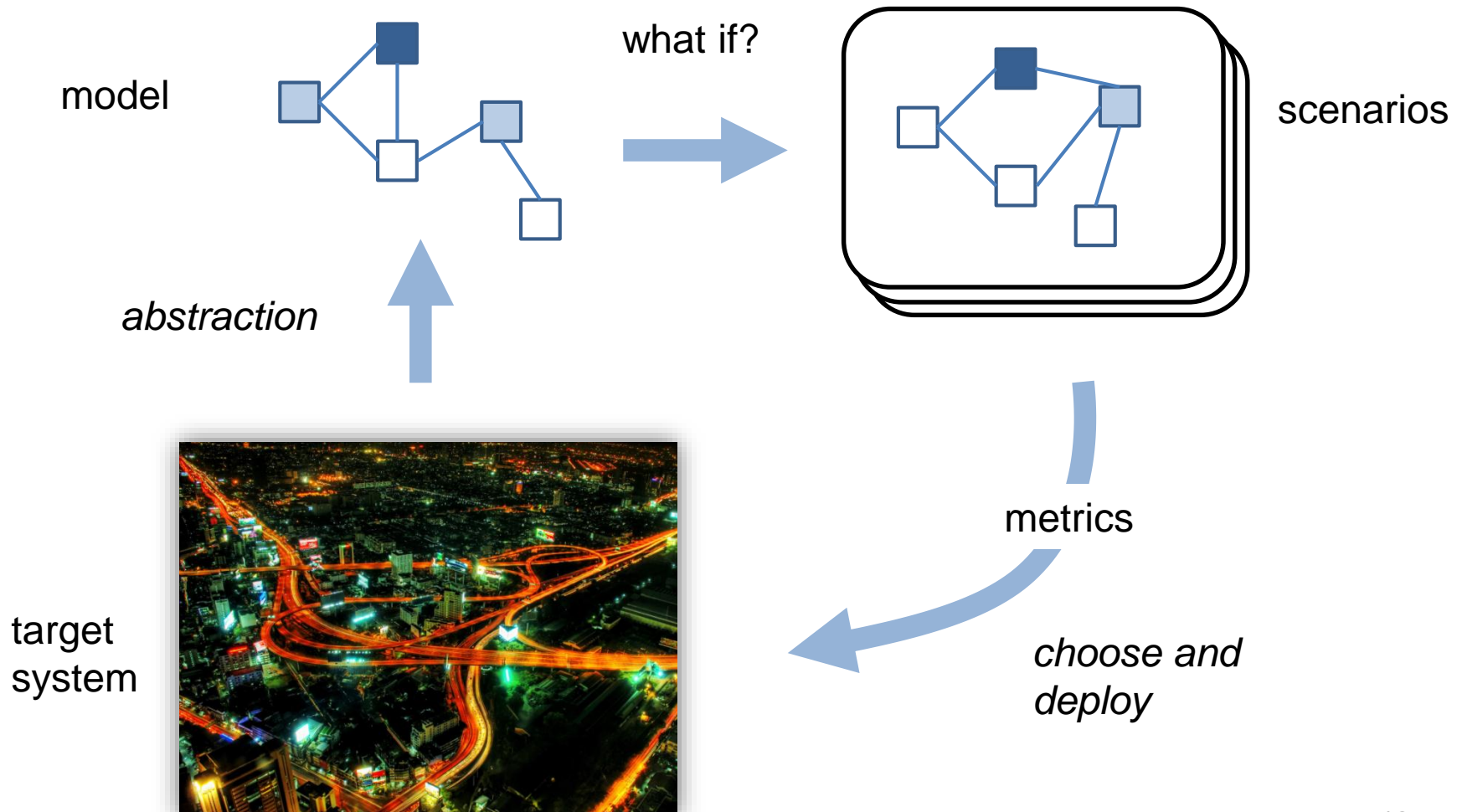


Simulation

What-If: Simulation Modeling



Estimate the behavior of the transport system under different circumstances



Simulation Inputs and Outputs



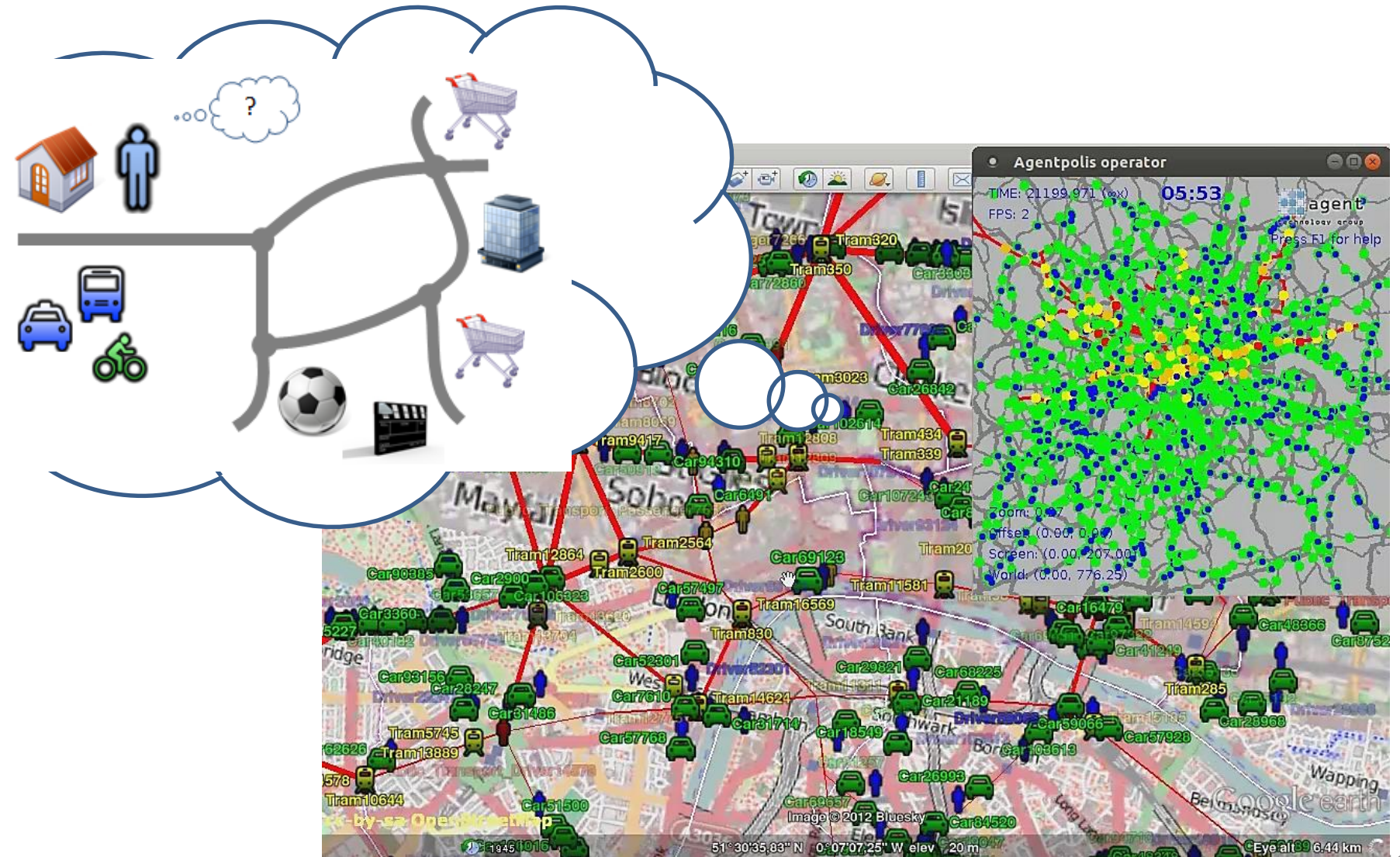
Scenarios

- Policies: congestion charge, parking regulation, ..
- Public transport: routes and schedules, ticket prices
- Planned events: big concerts, football matches
- Unexpected disruptions: accidents, bad weather
- Novel transport schemes: ridesharing, car sharing, bike sharing

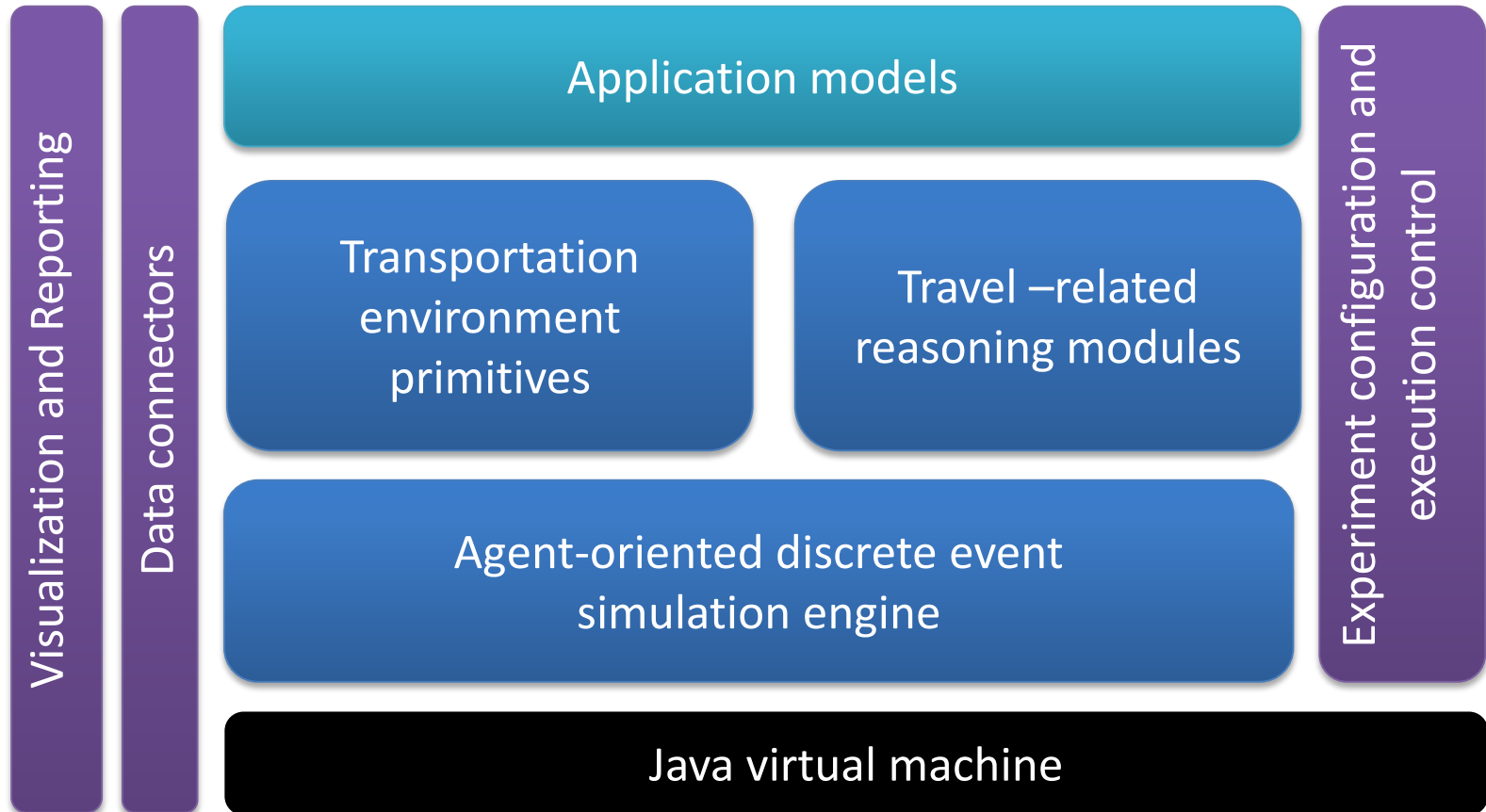
Metrics

- Travel: travel times, costs, modal split, ...
- Efficiency: utilization, energy consumption, congestion
- Environmental impact: emissions, noise,...

Agent-based Approach



AgentPolis Framework: *Fully* Agent-Based Mobility Modelling

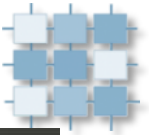


core



tools

AgentPolis Framework - Demo



The screenshot displays the Agentpolis operator interface. At the top left, the title bar reads "Agentpolis operator". Below it, the status bar shows "TIME: 652.345 (1x)", "FPS: 1", and a timer "00:10". A logo for "agent technology group" is visible with the text "Press F1 for help".

The main area is a map showing a network of roads with red lines and yellow dots representing agents. The map is zoomed in on a central area. The zoom level is 0.27, and the offset is (0.00, 0.00). The screen coordinates are (291.00, 173.00) and the world coordinates are (1091.25, 648.75).

On the left side, there is a file explorer showing the project structure:

- exp-5
 - config
 - config.groovy
 - scenario.groovy
 - data
 - src
 - target
 - test_scripts
 - tmp
 - pom.xml

On the right side, there is an "Event types" panel with a list of events and their status:

- PASSENGER_STARTED_TRAVEL
- PASSENGER_ENTRY_TO_VEHICLE
- PASSENGER_EXIT_VEHICLE_DONE_FULL_TRIP
- PASSENGER_EXIT_VEHICLE_DONE_PART_TRIP
- PASSENGER_MISS_VEHICLE
- PASSENGER_FINISHED_TRAVEL
- PASSENGER_TRANSFER
- PASSENGER_TRIP_FAILD
- PASSENGER_MOVE_ACROSS_NODE
- VEHICLE_CAPACITY
- DRIVER_ARRIVED
- DRIVER_DEPARTURE
- DRIVER_TIMETABLE_ARRIVE
- DRIVER_TIMETABLE_DEPARTUE

At the bottom right, there is a horizontal axis with numerical values: 420, 480, 540, 600, 660, 720.

Research Areas



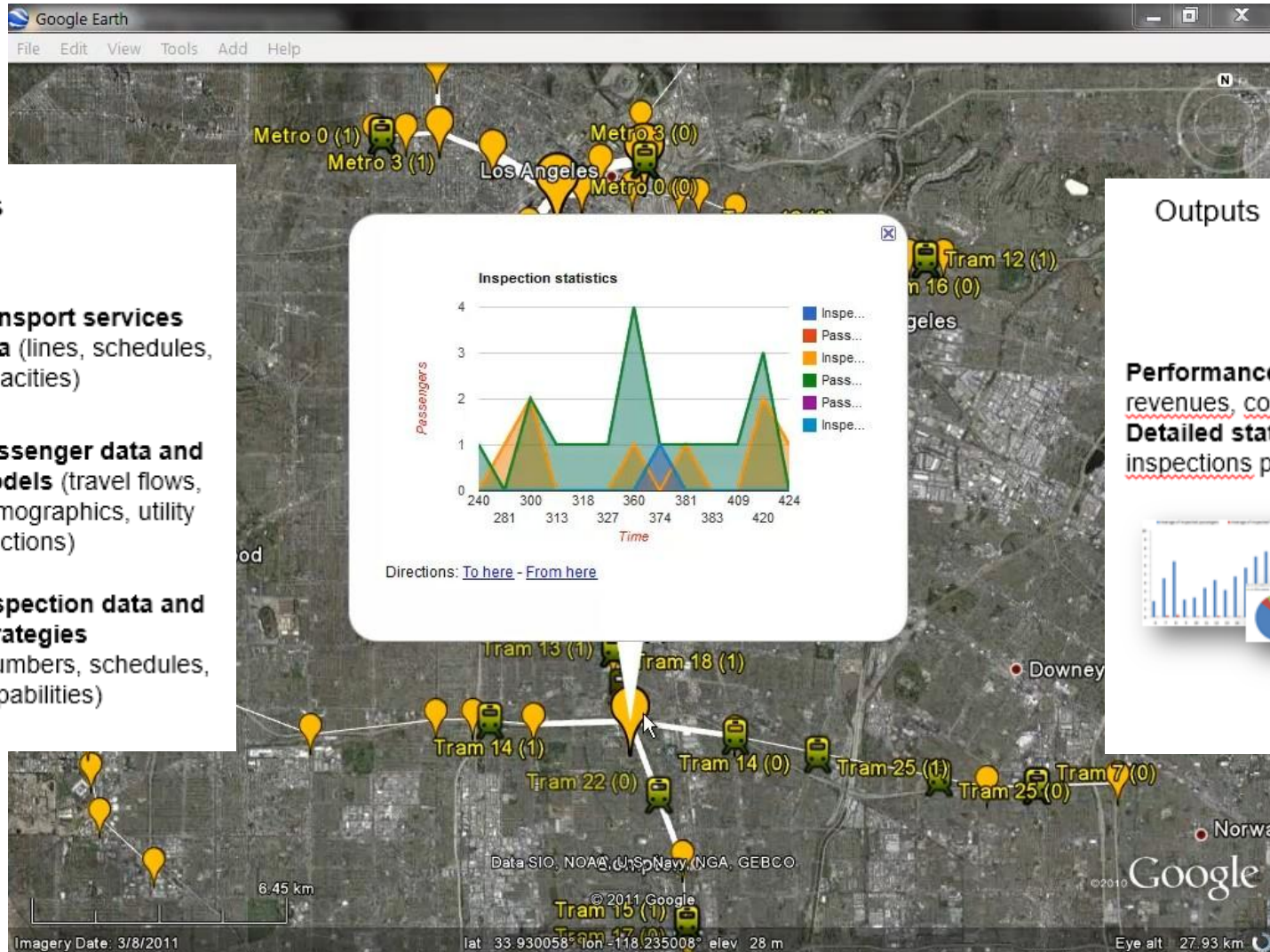
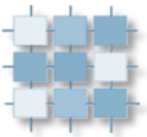
- Simulating transport environments (physics of transport)
 - abstractions for transport system models
 - efficient execution via discrete-event simulation
 - massively repeated journey planning (caching)
- Modeling human decision making (psychology of transport)
 - activity scheduling
 - plausible decision models
 - plausible memory models
 - cooperation with Centrum dopravního výzkumu (CDV)
- *Simulation-aided Design of ITS*

AgentPolis Models



- Multi-modal Urban Mobility
- Fare Inspection
- Real-time Ridesharing
- Auction-based Dynamic Taxi Pricing
- (Urban Parcel Delivery Logistics)

Fare Inspection Model



Inputs



Transport services data (lines, schedules, capacities)



Passenger data and models (travel flows, demographics, utility functions)

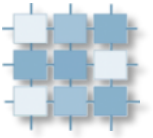


Inspection data and strategies (numbers, schedules, capabilities)

Outputs

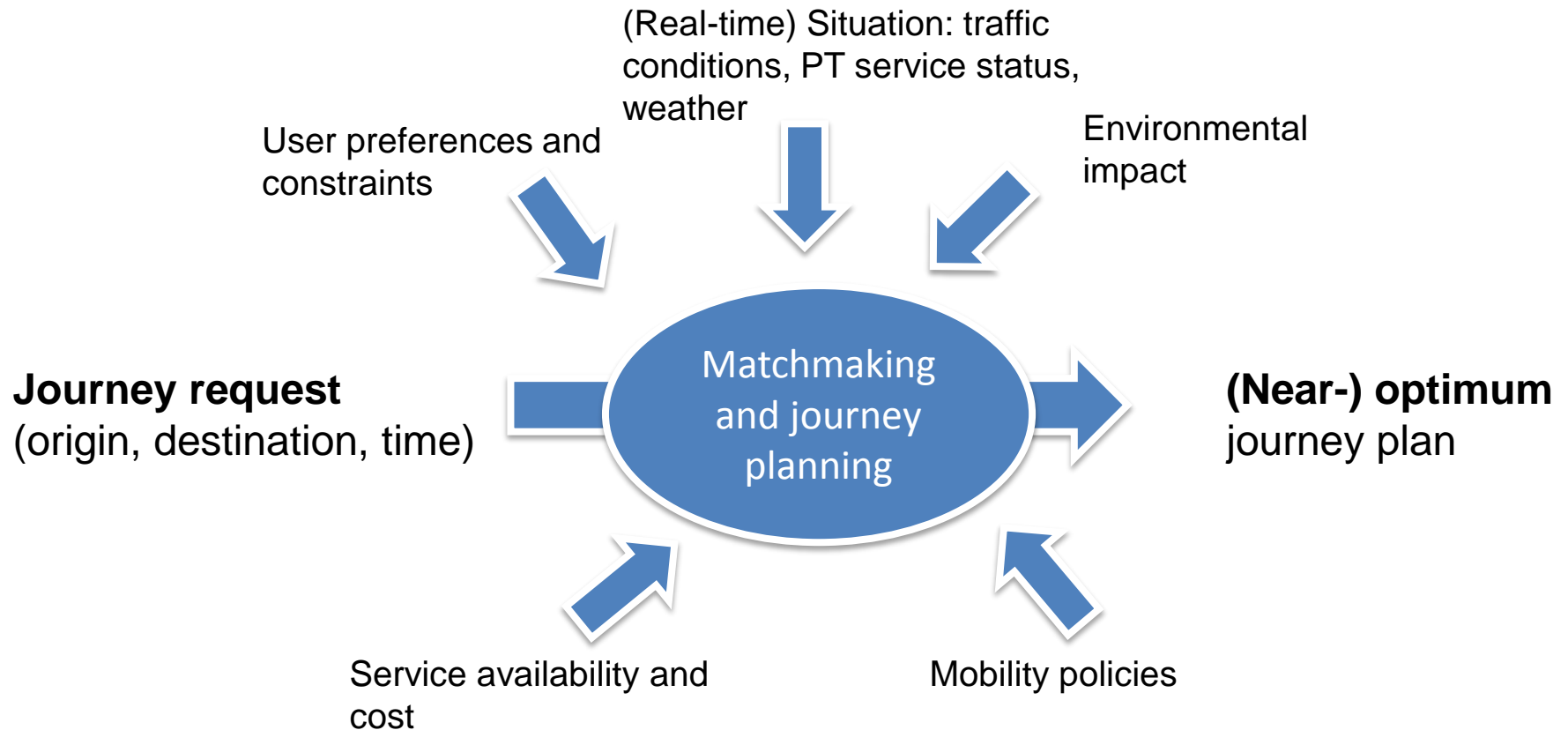
Performance indicators (e.g. revenues, costs)
Detailed statistics (e.g. inspections per station)





Transport Planning, Coordination and Optimization

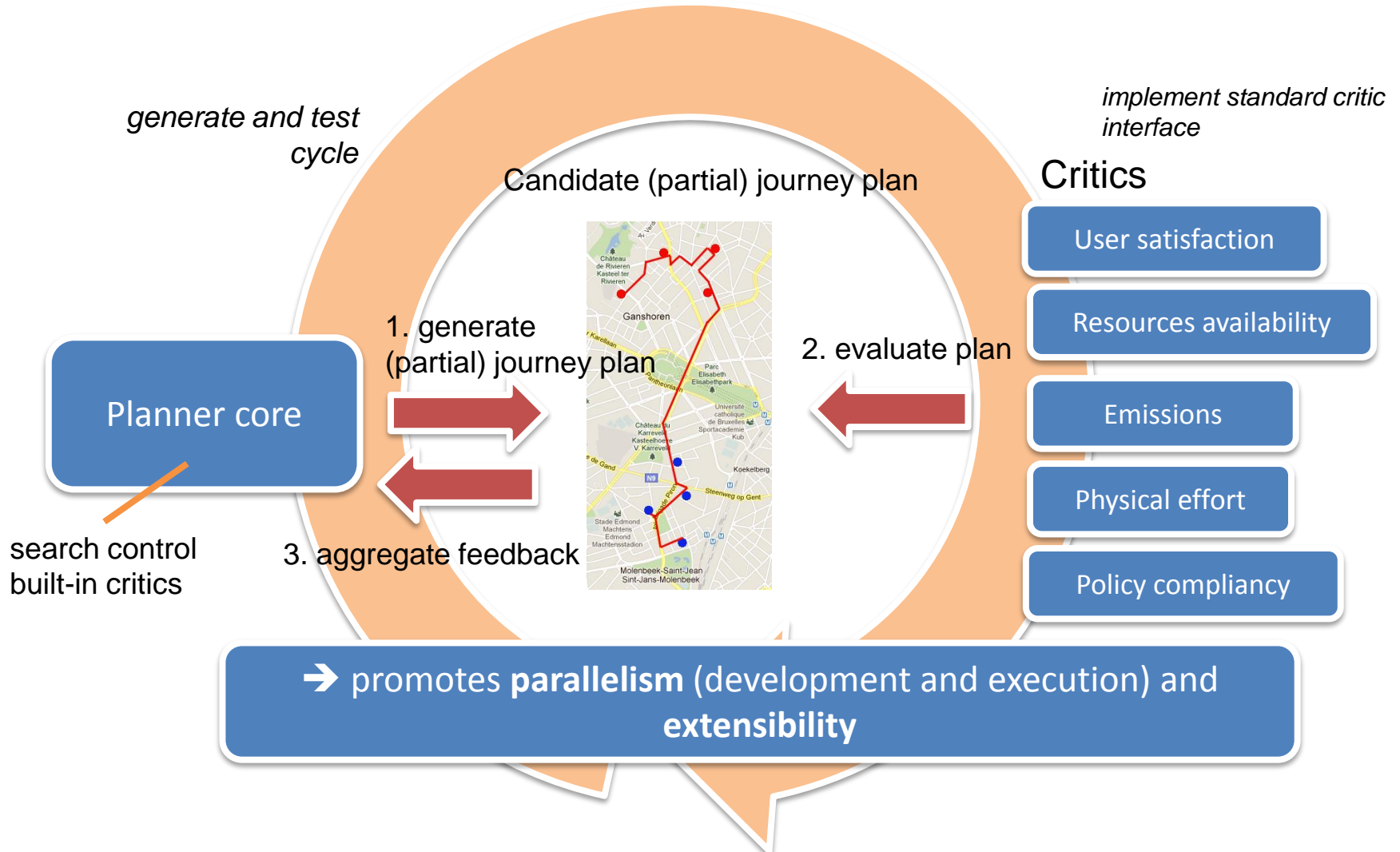
Multi-Criteria Multi-Modal Journey Planning



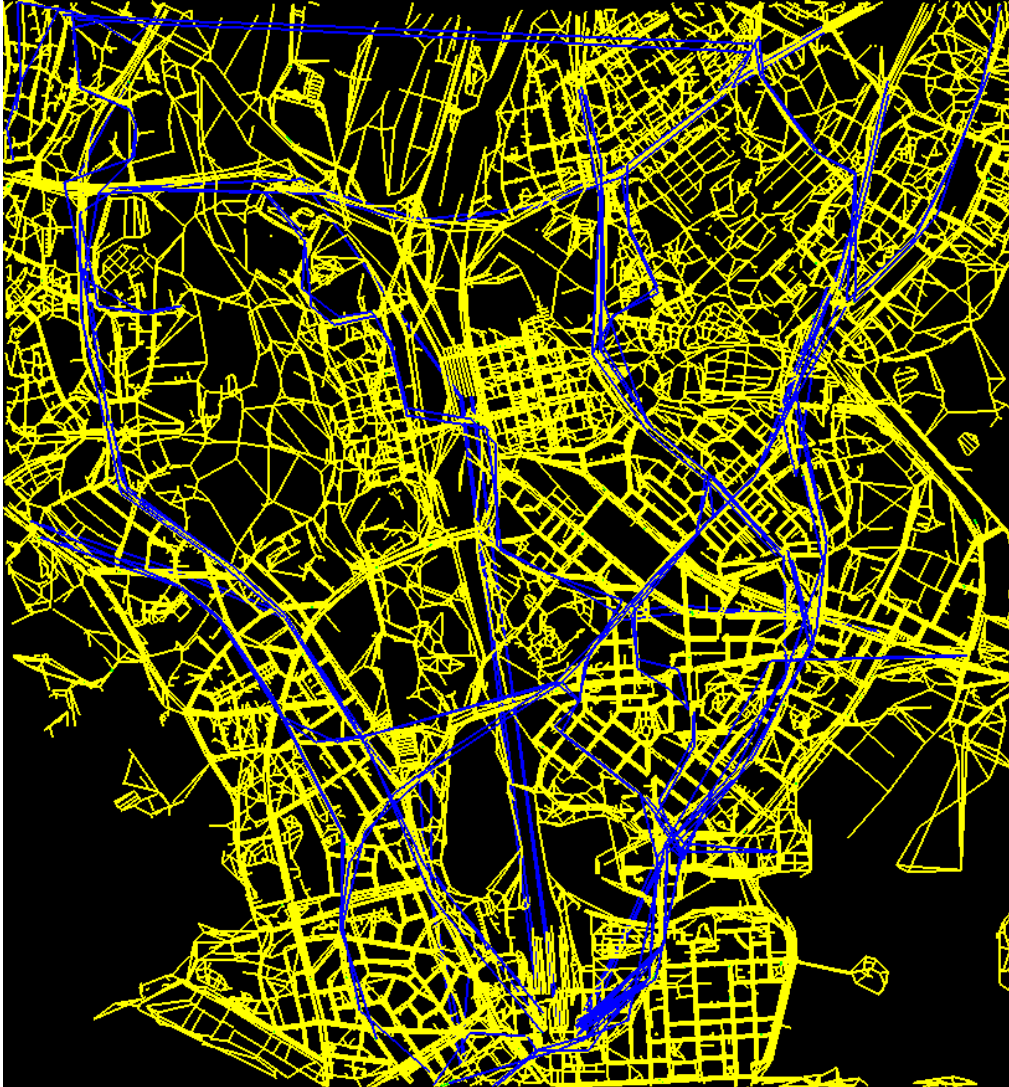
Multi-Critics Journey Planning



- Separates **plan search control** from **plan evaluation**



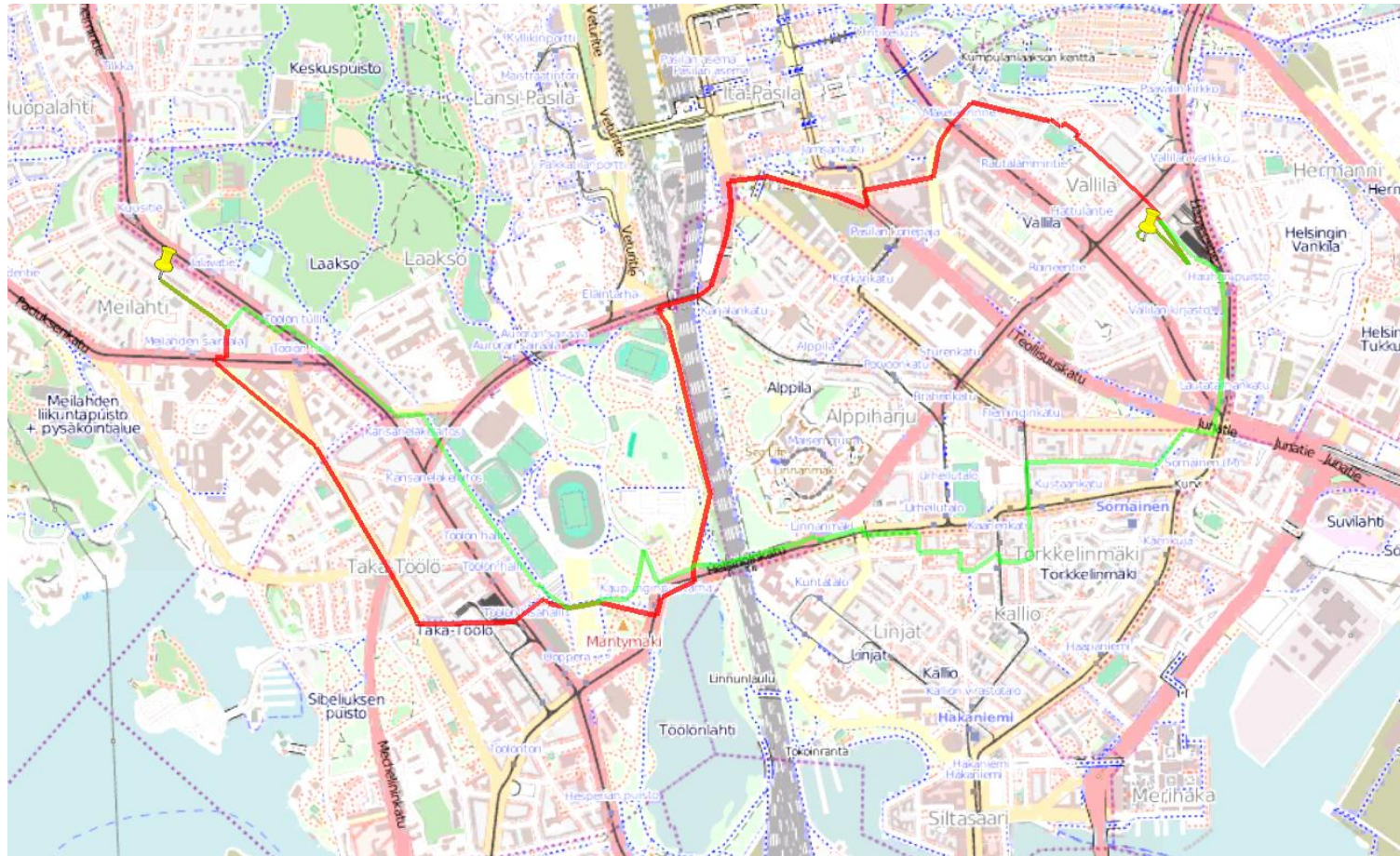
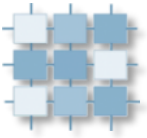
Example: Planning Graph



Helsinki statistics:

Graph	Nodes	Edges
PT	50320	764306
Road	87752	190822
Walk	160947	371637
Bike	156016	403750
R+B+w	404715	966209
Time dependent	256840	1401838

Example: Journey Response

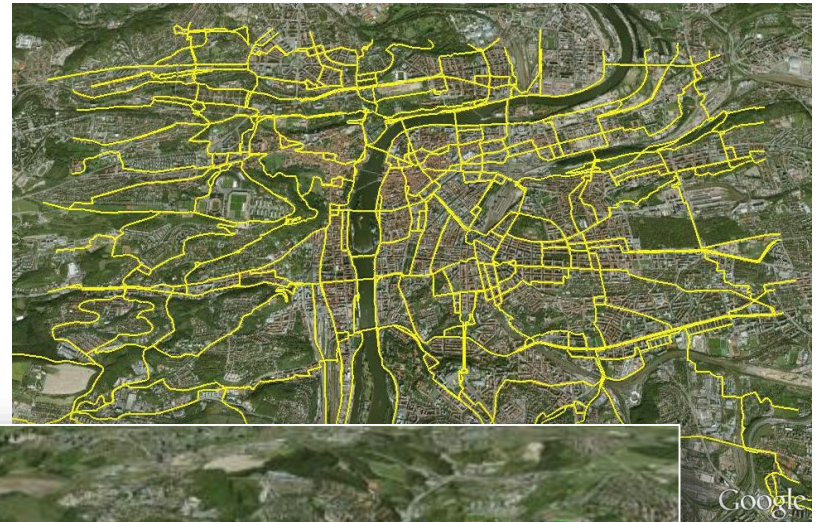


Open Bicycle Route Planner

(BP Marcel Nemet)



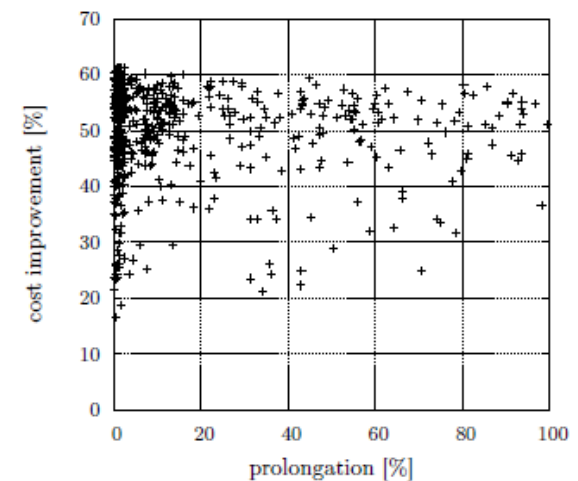
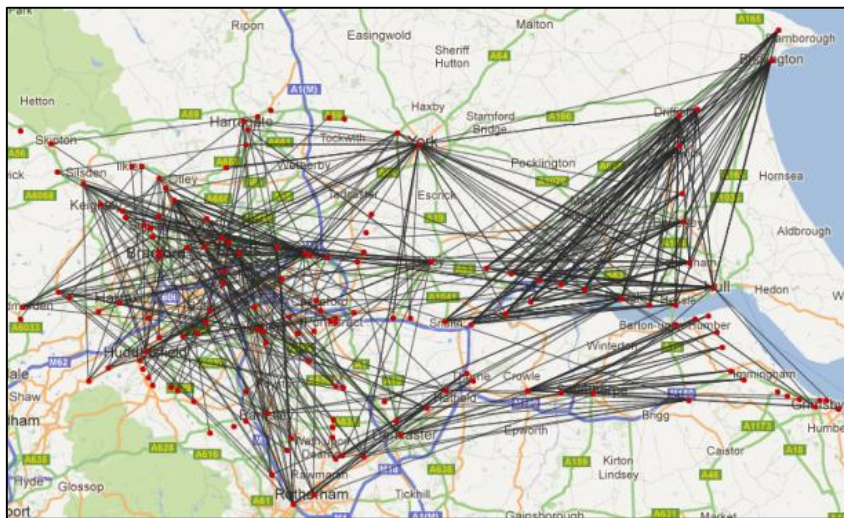
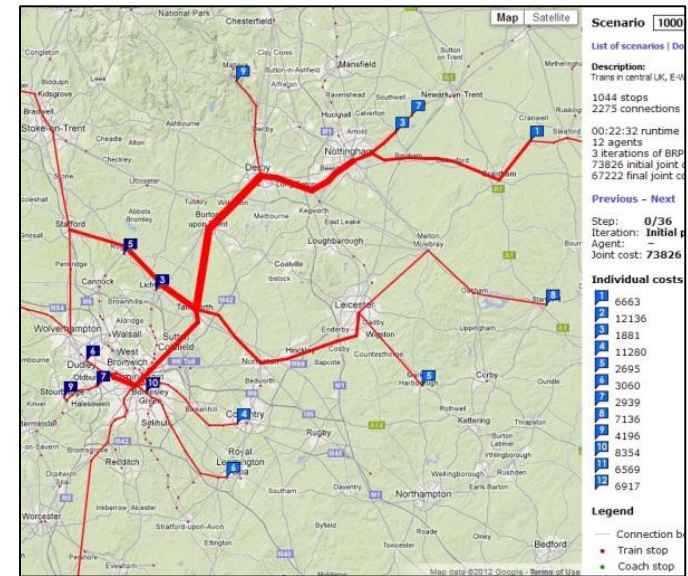
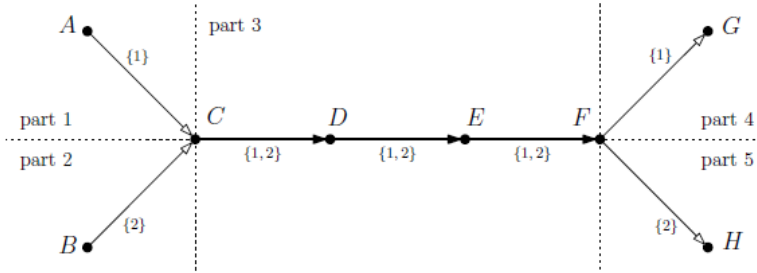
- Problem: Find a bicycle-friendly trip from origin to destination
 - Take into account trip duration & elevation
- Data
 - OSM maps
 - recommended routes for cyclists (by Auto*mat)
 - SRTM elevation data
- Solution approach: A*





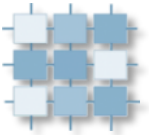
Multi-Agent Transport Coordination

Ride Sharing on Timetabled Services

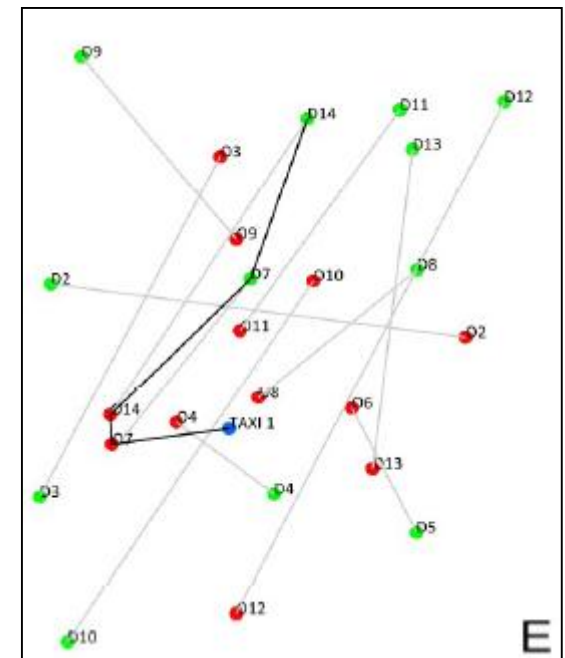
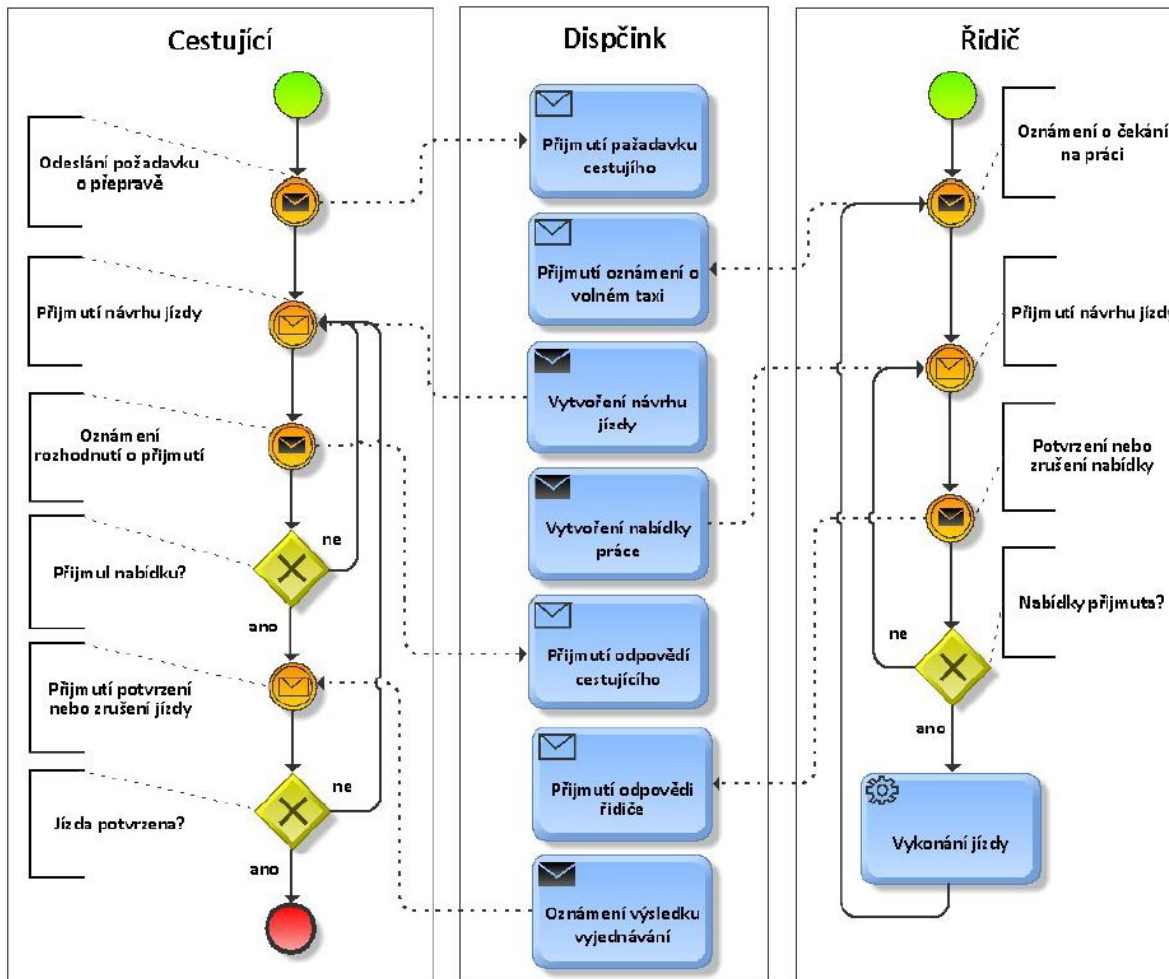


Taxi Ridesharing

(BP Petr Mezek)

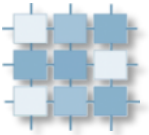


- Real-time coordination of shared taxi rides

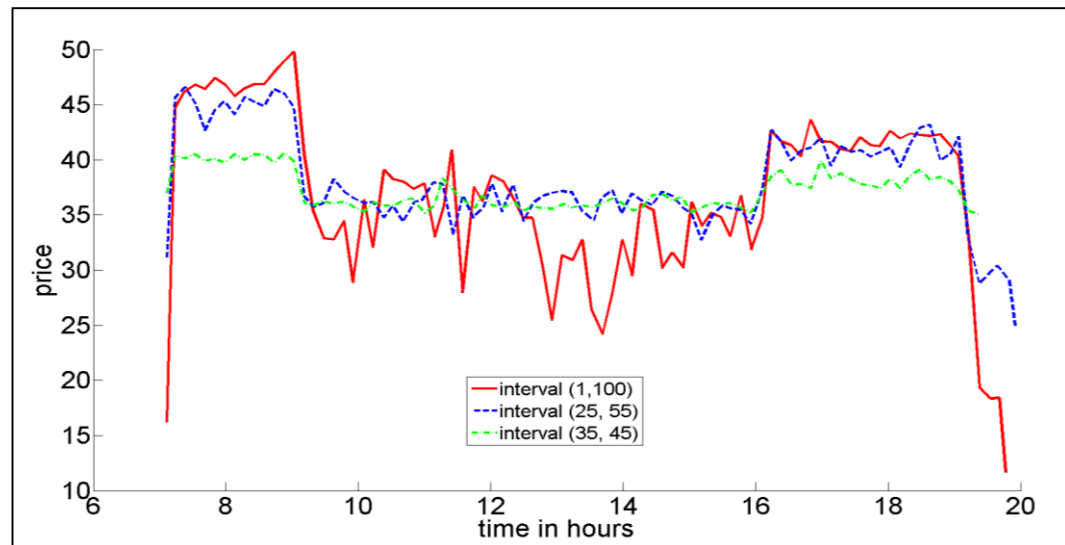
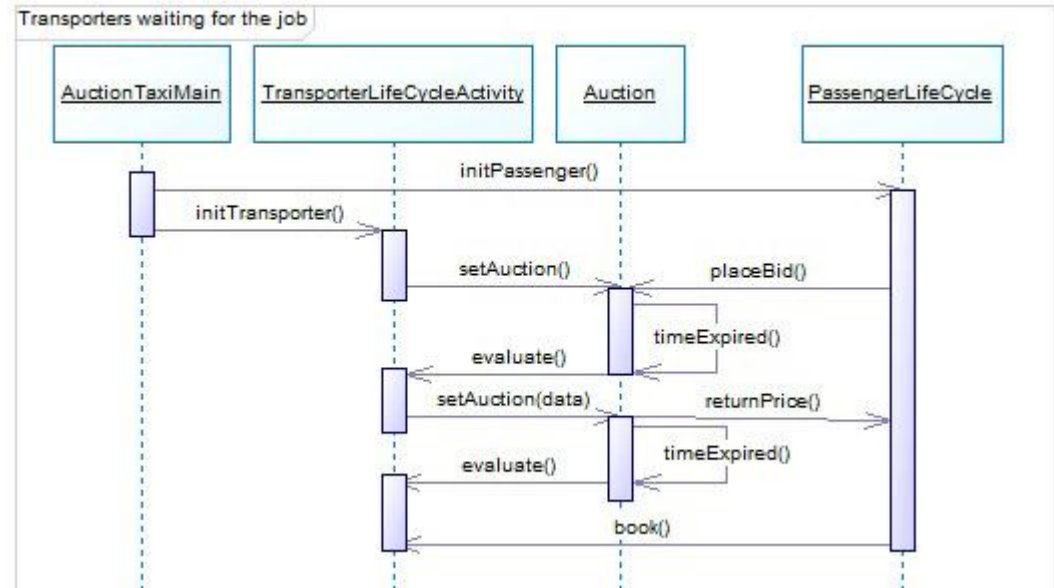


Auction-based Dynamic Pricing

(BP Jan Zikeš)



- Auction-based taxi allocation
- Passengers willing to pay more travel first in the peak time
- Passengers willing to wait travel cheaper

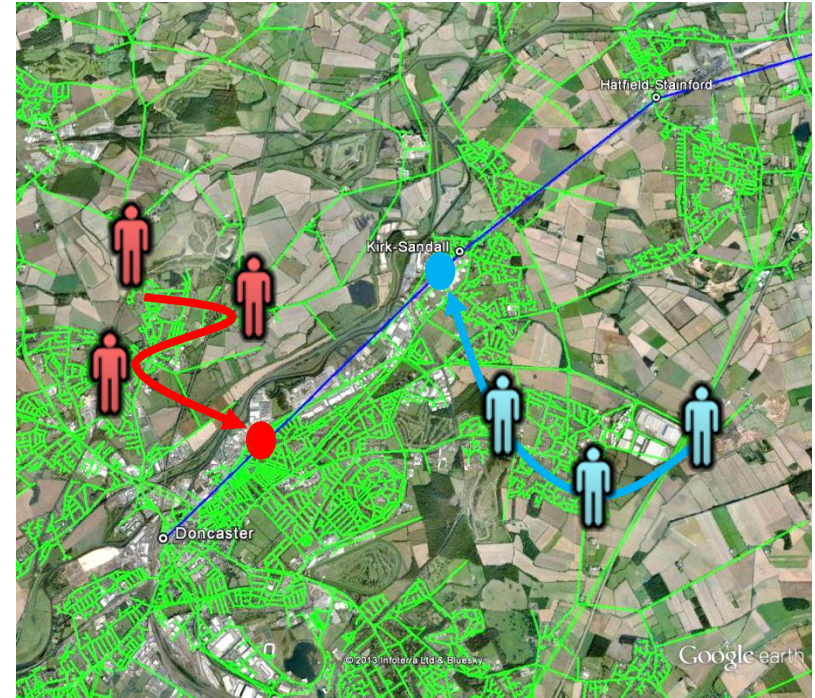


Flexible feeder services

(BP Tomáš Grubhoffer)



- Find feeder shared rides connecting to scheduled train service
- Solution approach
 - Find a single-agent plan for each agent
 - Cluster agents into groups for the first mile according to (First PT stop, Departure time, Location of origin)
- Find a joint plan for each group of agents



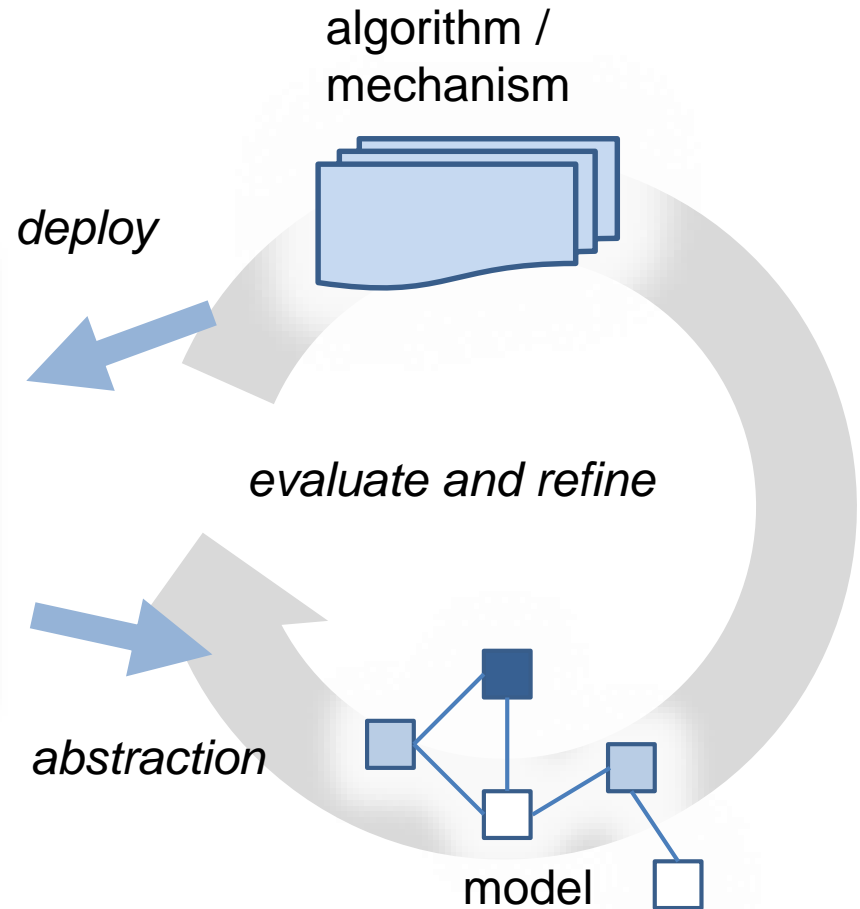


Conclusions

Simulation-aided Design of ITS

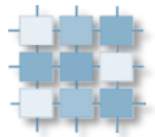


target system



SUPERHUB

Sustainable and PERSuasive Human Users moBility in future cities



We believe that in a great mobility project people should be protagonists.



- 2011-2014
- 20 partners
- FP7 Low-carbon multi-modal mobility and freight transport Future and Emerging Technologies (ICT-2011.6.6)
- Our role
 - Dynamic mobility matchmaking and Eco planner
 - Policy-aware mobility simulator



Kontakty | Pro média | Ke stažení | English

RODOS
ROZVOJ DOPRAVNÍCH SYSTÉMŮ

O centru | Partneři centra | Pro odbornou veřejnost | Pro státní správu | Pro uživatele

Vítejte v Centru pro rozvoj dopravních systémů.
Jsme platforma odborníků z akademické sféry, předních českých soukromých firem i státní správy a komplexně řešíme problematiku modelování, řízení a optimalizace dopravy budoucnosti.

Dáváme dopravě dynamiku



Přínosy centra


Kam míříme


Pracovní balíčky
Časová osa


Produkty a výstupy


- Projekt Centra competence TAČR 2012-2016
- Spolupráce: 3 univerzit, 1 výzkumného centra 6 firem
- ČVUT FEL vede pracovní balíček 6: Metody modelování a optimalizace multimodální mobility